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The Theory Applications of Finance and Macroeconomics

Edited by
Helmi Hamdi

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Editor

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Article

The Growth of Private Sector and Financial Development in Saudi Arabia

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Abstract: In an attempt to diversify itself away from the dominance of oil on its economy, Saudi Arabia needs to emphasize on the growth of its private sector. Currently, the private sector's contribution to economic growth is meager as the oil sector dominates the economy. This study attempts to assess the role of financial development towards the growth of the private sector. Assessing this relationship is important, as it is quite probable that the dominant oil sector attracts the financial resources, affecting the private sector adversely. Johansen's method of cointegration is applied on the data for the period 1985–2018. The private sector's gross domestic product has a negative relation with the supply of money, positive relation with bank credit to private sector, and no significant relationship with share market capitalization, as shown by the results of the study. In addition, the private sector's growth has a positive and significant relationship with government expenditure, investment, and trade openness. Hence, the study recommends further strengthening of financial sector services. Besides the current trend on government expenditure, investment and trade openness should continue to enable the private sector to contribute significantly to the economic growth of the country. A previous study on the private sector's growth and financial variables is exclusively missing, and makes this study unique.

Keywords: broad money; share market; bank credit; private sector growth

JEL Classification: E44; G60; G19; 043

1. Introduction

Financial development is important for economic growth as it mobilizes savings and assists in capital accumulation. It is the process of strengthening the quantity and quality of the financial intermediation services. These intermediaries not only mobilize investment funds, but also regulate the efficient allocation of the resources. Besides financing, many things like selecting, screening, risk management, corporate governance, and monitoring business come in the realm of a financial system. In fact, the modern financial environment encompasses a wide range of activities like trading, risk pooling, hedging, and likewise. Basically, an efficient financial system leads to productive investment prospects, which leads to improvements in macroeconomic performance and facilitate economic growth.

The study on the relationship between financial development and economic growth can be traced back to the work of Schumpeter (1911), who established that the financial system acted as a catalyst to promote technological innovation, and ultimately economic growth. In a related study, Robinson (1952) documented a positive relationship between financial development and economic development. Subsequent studies by McKinnon (1973) and Shaw (1973) further strengthened the opinion and led to the development of financial liberalization hypothesis, which called for curtailing state restrictions to promote investment. Even the recent endogenous growth theory proposes that

financial development and growth are endogenous (Greenwood and Jovanovic 1990) and financial growth positively impacts steady-state growth (King and Levine 1993).

A related debate emerged as to whether financial development was 'demand following' or 'supply leading' (Patrick 1966). Both of them refer phenomenon when growth leads to financial development or economic growth. As argued by Robinson (1952), Lucas (1988), and Stern (1989), an economic growth leads to further demand for financial services, which result in the development of the financial sector. This demand following financial development gave a passive role to financial institutions in promoting economic growth as compared with the active role given by the supply leading phenomenon to the financial development of the financial institutions.

The link between the private sector and financial development has a theoretical underpinning in terms of the first theorem of welfare economics. It reveals that competitive markets are efficient in a Pareto sense as well as in terms of the efficient market hypothesis, which further declares that financial markets use information efficiently. The combination of these two factors leads to the efficient use of the factors of production, leading to economic growth. This financial development is more likely to happen in the private sector, which happens to be a free market for factors of production with minimal government interference and devoid of inefficient market distortions (Eatwell 1996; Jehle and Reny 2001, Aziakpono 2013).

Saudi Arabia is an oil-dominated economy and is currently trying to diversify itself away from excessive dependence on oil (Belloumi and Alshehry 2018). The current research explores the association between financial development and economic diversification in a developing country enriched with oil reserves. Nations with oil resources, dominating the gross domestic product (GDP), have distinct features compared with industrialized nations, and those resources are highly regulated by the state. That implies that, in such countries, the financial resources are diverted to its predominant oil sector. Saudi Arabian Monetary Agency (SAMA), the central bank of the country, provides estimations for GDP by institutional sector. It divides the data for GDP into 'oil sector', non-oil private sector', and 'non-oil government sector. Though the oil sector is controlled by the state, the database tries to differentiate between the oil sector and the non-oil government sector. Between 1985 and 2018, the contribution of the oil sector to GDP decreased from 46.02% to 43.84%, the contribution of the non-oil government sector decreased from 21.72% to 19.96%, while the contribution of the non-oil private sector increased from 32.25% to 39.54% (SAMA 2019).

Few important timelines are to be considered while studying the growth of the private sector in Saudi Arabia. In 2002, twenty new fields were set up in the private sector for the first time, which were previously under the government sector. In 2005, Saudi Arabia joined World Trade Organization, which led to the beginning of privatization in the kingdom. One of the strategic objectives of the National Transformation Plan was to restructure for the growth of the private sector, and it achieved this in 2016. The emphasis is on the private sector to contribute more in high potential less-developed regions like railway projects, health, water, housing, education, and so on. Further, the kingdom has brought in some major transformations to its economic policies in order to achieve its Vision 2030. In the process, it has extended a lion's share to the development of the private sector. The target as per Vision 2030 is to achieve a non-oil private sector contribution of 65% of GDP (Vision 2030). Therefore, in light of these discussions, the current research attempts to explore the influence of financial variables on the non-oil private sector growth of Saudi Arabia.

The private sector reduces the burden of the public sector and improves efficiency as it works on the principles of competitiveness. A private sector entity ceases to exist simply when it is no longer profitable. This is in contrast to the public sector, which must function even if is straightaway not leading to profits, like defense, subsidies, and social development. For the functioning of the private sector, apart from regular macroeconomic variables like investment, government expenditure, and trade openness, financial variables are also crucial. These financial variables indicate availability of funds to the private sector. Fund allocation in the private sector is purely based on merit. This merit is based on competitiveness and profitability. Money supply, bank credit to the private sector, and

share market capitalization are some of the important financial variables impacting the functioning of an economy. A flourishing private sector is essential for any vibrant economy.

The study aims to test the hypothesis that financial development leads to the growth of the private sector in Saudi Arabia. The study plans to study the long-run relationship between the variables towards which the study would first test the data for stationarity. The stationarity characteristics of the data would decide upon the method to be adopted by the study. If the data are stationary at level, the ordinary least squares (OLS) method would suffice the purpose. If the variables are stationary at first difference, which happens to be the most probable case for time series, the method of cointegration can be employed to study the relationship. If there is cointegration between the variables, the short-run relationship can be established through the vector error correction model (VECM). Moreover, in the case of absence of cointegration, the study would proceed with Granger causality in the vector autoregresssive (VAR) framework. The remaining part of the paper is as follows: the next section discusses the previous research studies, followed by data, methodology, empirical analysis, and discussion. The paper finally ends with insights upon which to throw light.

2. Review of the Literature

Financial development promotes economic growth as it stimulates domestic investment, augmenting savings in the economy, which reduces the cost of capital. It also promotes economic growth indirectly through development of institutions and improved governance, and instills macroeconomic prudence (Henry 2006; Kose et al. 2006). It is a customary saying in financial economics that a well-developed financial system proliferates economic performance. The erstwhile research suggests that financial growth effectively ventures to reward investment scenarios, enhance corporate control, mitigate different types of costs, increase expert knowledge, and so on (Darrat et al. 2005).

Empirically, there are many views associated with financial growth and economic development. Firstly, some researchers opine that financial growth influences economic development (De Gregorio and Kim 2000; Christopoulos and Tsionas 2004; Hamdi 2015). Secondly some opine that economic development leads to financial growth (Rajan and Zingales 1998; Al-Yousif 2002; Al-Malkawi et al. 2012; Grassa and Gazdar 2014). Thirdly, few researchers say that there is a two-way association between financial growth and economic development (Greenwood and Smith 1997; Abu-Bader and Abu-Qarn 2008). Finally, some researchers feel neither economic development nor financial growth influences each other (Stern 1989; Loayza and Ranciere 2006). Financial development has an added dimension for oil-rich economies like Saudi Arabia. It can counterbalance the problem of resource curse by directing oil revenues to productive avenues (Law and Moradbeigi 2017).

The demand for funds to finance production and facilitate capital accumulation specially in the private sector and the subsequent development of the financial sector is acknowledged by Lohmann (1992) and Greenwood and Smith (1997). Moreover, the development of the financial sector, particularly banks and stock markets, assists in corporate financing (Demirgüç-Kunt and Maksimovic 1996). The financial sector helps in mobilizing funds from the surplus sector to prospective companies (Allen and Gale 2004; Greenwood et al. 2013). It also aids the private sector in efficient resource allocation by shifting resources to productive units (Law and Singh 2014; Rioja and Valev 2004). The private sector gets the benefit of financial development as it helps not only in the mobilization of savings and arranging for transactions, but also to get funds for research, corporate control, and risk management (Levine 2005).

The study concentrates on the past literature of the current study in Saudi Arabia. Studies reported a positive effect of financial development on economic growth. Financial growth and economic development have a two-way causality between them (Al-Yousif 2002). Financial growth positively effects economic development through the establishment of a constructive financial system in an economy. The economic variables, such as private bank credit and industrial production, positively affect economic development, while the stock market does not have any impact on it (Ibrahim 2013). A study by Samargandi et al. (2014) reports that there is a positive impact of financial growth on

the development of non-oil sector, while the opposite is true with the oil sector. Similarly, studies of Marashdeh and Al-Malkawi (2014) and Hathroubi (2019) in the Saudi Arabian context reported a positive effect between financial inclusion and economic development in the long-run using different models, and both the studies found no short-run association between the two variables.

Apart from the above named studies, some other studies concentrated on the countries in the Gulf Cooperation Council (GCC) and Organization of Islamic countries (OIC). Darrat (1999), and Hassan et al. (2011) found a positive association between financial depth and economic development in the long-run using the error correction model (ECM) framework in Middle Eastern countries. Similarly, there were comparative effects of Islamic financial growth and traditional financial growth on the economic development of GCC nations, and Grassa and Gazdar (2014) predicted Islamic financial growth leading to economic development rather than traditional financial growth. While studying the OIC countries, Duasa (2014) reported a causal association between financial growth and economic development with regard to Saudi Arabia. Furthermore, Hamdi et al. (2014) found a significant positive relationship between financial growth and economic development in the GCC nations, and the positive impact of financial growth on economic development is related to foreign direct investment, fixed capital formation, and production of oil (Muhammad et al. 2016).

Other studies reported a negative effect of financial development on economic growth. For Saudi Arabia, Mahran (2012) found a negative impact of financial deepening on the growth rate. The study noted that the public sector influence in the country is large and it leaves very small space for the private sector. The study also reported low quality and carelessness in granting bank credit. Similarly, the study of Al-Tamimi et al. (2001) found a weak causal relationship between financial growth and economic development, and no bi-directional effect in some cases. Few other studies of multiple countries that examined the financial growth and economic development reported a negative association between the two owing to the influence of some factors, such as inflation, exports, and so on (Gillman and Harris 2004; Samargandi et al. 2014).

Few other studies reported no effect of financial development on economic growth. The influence of financial growth on economic development is in primeval stage and different economic sector reforms need to be undertaken (Masih et al. 2009). A similar study by Rehman (2018) on Saudi Arabia found no long-run relationship between financial growth and economic development and suggested to introduce efficient financial sector reforms in the kingdom. Further, different macro-economic variables have different impacts on financial growth in different regions of the world, and sometimes have an insignificant impact (Ayad and Belmokaddem 2017; Kouki 2013).

In summary, the study examines the research works of (Darrat 1999; Hassan et al. 2011; Ibrahim 2013; Grassa and Gazdar 2014; Hamdi et al. 2014; Marashdeh and Al-Malkawi 2014; Muhammad et al. 2016), which report a positive association between financial growth and economic development. In contrast, the studies of Rehman (2018) and Ayad and Belmokaddem (2017) reported no significant association between financial growth and economic development. Meanwhile, Al Tamimi (2001), Gillman and Harris (2004), Mahran (2012), Masih et al. (2009), Barajas et al. (2013), Samargandi et al. (2014), Kouki (2013), and Law and Moradbeigi (2017) reported negative and low-quality relationships between the two variables.

It is evident from the above-referred studies that there are empirical researchers studying the relationship between financial variables and economic growth. However, there is a literature gap in terms of studies that analyze the relationship between only private sector growth and financial variables. This is also more significant for a country that is planning to diversify itself and facilitate the growth of its private sector.

3. Model and Methodology

One of the frequently used indicators of financial development is broad money, measured by M2. It signifies the degree of financial intermediation and denotes the volume of the financial sector (King and Levine 1993). It increases with the growth of the financial sector. The other alternatives are M1

and M3. The variable M2 as a proportion of GDP has been used as a proxy for financial development by Darrat et al. (2006), Masih et al. (2009), Samargandi et al. (2014), Hamdi et al. (2014), Duasa (2014), Law and Moradbeigi (2017), and Rehman (2018). The variable bank credit as a proportion of GDP is considered an effective and dependable measure of financial depth (Beck 2011). A developed financial system allocates additional credit to the private sector. The variable bank credit as a proportion of GDP has been used as a proxy for financial development by Darrat et al. (2006), Masih et al. (2009), Hassan et al. (2011), Mahran (2012), Ibrahim (2013), Kouki (2013), Grassa and Gazdar (2014), Samargandi et al. (2014), Marashdeh and Al-Malkawi (2014), Hamdi et al. (2014), Duasa (2014), and Law and Moradbeigi (2017). The next variable stock market is also positively and strongly related with economic growth in the long run (Levine and Zervos 1998). The variable share market value of shares as proportion of GDP has been used as a proxy for financial development by Kouki (2013), Ibrahim (2013), Samargandi et al. (2014), and Rehman (2018). The raw data are summarized in Table 1 given below.

Table 1. Descriptive statistics of the raw data (million riyals).

Variables	PRGDP	M2	BC	S	I	T	G	GDP
Mean	498,419	590,267	477,375	788,615	279,792	938,927	297,403	1,235,838
Standard Error	66,440	93,342	83,120	126,462	40,252	128,085	36,287	157,885
Median	285,021	290,724	196,447	278,000	127,081	471,858	186,606	710,852
Standard Deviation	387,406	544,273	484,667	737,395	234,710	746,856	211,588	920,618
Kurtosis	−0.48363	−0.53987	−0.57122	−1.14874	−1.0649	−1.15742	−0.34489	−1.10359
Skewness	1.021382	1.000469	0.960771	0.58902	0.79311	0.679613	1.049594	0.73251
Range	1,140,369	1,541,099	1,389,115	2,374,600	669,876	2,114,565	636,916	2,628,526
Minimum	160,486	122,721	56,137	63,400	62,556	201,228	102,240	320,931
Maximum	1,300,856	1,663,820	1,445,252	2,438,000	732,432	2,315,793	739,156	2,949,457

Note: PRGDP is the private sector GDP; M2 is currency outside banks + demand deposits + time and saving deposits; BC is bank claims on the private sector; S is market value of shares; I is gross domestic capital formation; T stands for exports + imports; G stands for government final consumption expenditure; GDP stands for gross domestic product.

The study also controls the macroeconomic indicators, namely, government expenditure, investment, and trade openness in the country. The variable government expenditure as a proportion of GDP has been used in studies on financial development and economic growth by Hassan et al. (2011), Samargandi et al. (2014), Marashdeh and Al-Malkawi (2014), and Law and Moradbeigi (2017). The variable investment as a proportion of GDP has been used in studies on financial development and economic growth by Mahran (2012), Hamdi et al. (2014), and Duasa (2014). The variable trade openness (export plus import divided by GDP) has been used in studies on financial development and economic growth by Hassan et al. (2011), Mahran (2012), Grassa and Gazdar (2014), Samargandi et al. (2014), and Marashdeh and Al-Malkawi (2014). Lastly, to study the impact of these financial development variables and control variables on the private sector, the study used private sector GDP as a proportion of total GDP as the dependent variable.

The basic model used by this study is

$$\ln\text{PRGDP}_t = \alpha_0 + \beta_1 \ln\text{M2}_t + \beta_2 \ln\text{BC}_t + \beta_3 \ln\text{S}_t + \beta_4 \ln\text{G}_t + \beta_5 \ln\text{I}_t + \beta_6 \ln\text{TO}_t + \varepsilon_t \quad (1)$$

where rPRGDP = $\frac{\text{PRGDP}}{\text{GDP}}$ is the ratio of private sector gross domestic product to GDP; rM2 = $\frac{\text{M2}}{\text{GDP}}$ is the ratio of broad money to GDP; rBC = $\frac{\text{BC}}{\text{GDP}}$ is the ratio of bank credit to private sector to GDP; rS = $\frac{\text{S}}{\text{GDP}}$ is the ratio of market value of shares to GDP; rG = $\frac{\text{G}}{\text{GDP}}$ is the ratio of government expenditure to GDP; rI = $\frac{\text{I}}{\text{GDP}}$ is the ratio of gross domestic capital formation to GDP; and rTO = $\frac{\text{TO}}{\text{GDP}}$ is the ratio of exports and imports to GDP. The research aims to study the relationship of financial sector variables on the gross domestic product of the private sector. The financial sector variables taken here are broad money, bank credit to the private sector, and share market capitalization. The other three variables incorporated in the model, namely, government expenditure, investment, and trade, are control variables in the study. This study uses the data from Saudi Arabian Monetary Agency (SAMA), from 1985 to 2018, and

in million dollars at current prices. While testing for a relationship, the basic model takes the log of the variables. It is indicated by 'ln' prefixed to the variable name. EViews 10 is used to analyze the data.

First, the data are tested for stationarity as the data are time series in nature. To test for stationarity in the variables, this study proposes to use the augmented Dickey Fuller (ADF) test. The ADF test is basically in the autoregressive (AR) process. In the AR (1) process, the equation is estimated as follows

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \varepsilon_t \tag{2}$$

The null and alternate hypotheses are as follows:

$$\mathrm{H}_0 : \ \delta = 0 \text{ and } \mathrm{H}_\mathrm{a} : \ \delta < 0 \tag{3}$$

In AR (2) process, the equation is as follows:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \beta \Delta Y_{t-1} + \varepsilon_t \tag{4}$$

The null and alternate hypotheses are as follows:

$$\mathrm{H}_0 : \ \delta = 0 \text{ and } \mathrm{H}_\mathrm{a} : \ \delta < 0 \tag{5}$$

The study also uses the Phillips Perron (PP) test for stationarity. The equation given below estimates the PP test:

$$Y_t \ = \ \alpha + \ \rho Y_{t-1} \ + \ \varepsilon_t \tag{6}$$

where α is the constant, ρY_{t-1} is the non-parametric correction to the t-test for serial correlation, and ε_t is error term. The null and alternate hypotheses are as follows:

$$\mathrm{H}_0 : \ \rho = 1 \text{ and } \mathrm{H}_\mathrm{a} : \ \rho < 1 \tag{7}$$

To test for cointegration, this study proposes to use Johansen (1995) cointegration test. The null and alternate hypothesis are as follows:

$$\mathrm{H}_0 : \ \mathrm{r} = 0 \text{ and } \mathrm{H}_\mathrm{a} : \ \mathrm{r} \geq 1 \tag{8}$$

where r is the rank of cointegration. If the null hypothesis is accepted, it indicates no cointegrating relationships between the variables. Once the results reject the null hypothesis, another set of hypotheses is tested.

$$\mathrm{H}_0 : \ \mathrm{r} \leq 0 \text{ and } \mathrm{H}_\mathrm{a} : \ \mathrm{r} \geq 2 \tag{9}$$

Until the acceptance of the null hypothesis, the process repeats. Finally, the smallest value of r decides the number of cointegrating vectors. Trace statistics and Max-Eigen statistics lead to the decision.

After ascertaining the cointegrating relationship between the variables, the vector error correction model (VECM) estimates the equilibrating relationship between the variables. The equation given below is estimated.

$$\begin{aligned} \Delta \mathrm{lnrPRGDP}_t = \ \alpha_0 + \ \varphi_1 \mathrm{ECT}_{t-1} + \sum_{i=1}^{k} \beta_{1i} \Delta \mathrm{lnrM2}_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta \mathrm{lnrBC}_{t-i} + \sum_{i=1}^{k} \beta_{1i} \Delta \mathrm{lnrS}_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta \mathrm{lnrG}_{t-i} \\ + \sum_{i=1}^{k} \beta_{1i} \Delta \mathrm{lnrI}_{t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta \mathrm{lnrTO}_{t-i} + \ \varepsilon_{1t} \end{aligned} \tag{10}$$

Further, residual diagnostics is proposed. The Breusch–Godfrey serial correlation test is used to test for serial correlation; Breusch–Pagan–Godfrey is used to test for heteroscadisticity; and Jarque–Bera is used to check for normality. Finally, Wald's test is used to test for short-run relationships.

4. Results and Discussion

The results of stationary testing of the variables are presented in Table 2. Here, the null hypothesis is that the data series is stationary and the alternate hypothesis is that the data are stationary. The results indicate that all the variables have unit roots and become stationary at first difference, except for one variable. The variable bank credit (rBC) is stationary at level when the ADF test is calculated at constant with a linear trend. However, at constant and none criteria, rBC is not stationary at level. Hence, the study proposes to check for stationarity using an alternative Phillips Perron (PP) test.

Using the Phillips Perron test, the study finds that all the variables are non-stationary at level (Table 2). In addition, all the variables are stationary at first difference. Bank credit that was non-stationary at level in the ADF test is stationary at level according to the PP test. Hence, the ordinary least squares (OLS) method of regression is unable to estimate the relationship. Further testing shows that the data are stationary at first difference. The ADF and PP tests have been jointly used by studies that have reported that PP tests are sharper than ADF tests, as they adjust for possible serial correlation (Hasanov et al. 2016; Huang 2019).

As the data are stationary at first difference, the study applies Johansen's method of cointegration to test the relationship between the variables. Towards this, the study first estimates the lag order in the vector autoregressive (VAR) framework. The results suggest taking lag one based on SC criteria (Table 3). Upon performing Johansen's method of cointegration, the results indicate the presence of a cointegrating relationship between the variables. In fact, both trace statistics and Max-Eigen statistics indicate the presence of four cointegrating vectors (Table 4). This simply indicates the presence of four different linear combinations of the variables under study (Wickens 1996). Estimating more than one cointegrating equation has little statistical inference if not supported by theoretical foundation (Agoraki et al. 2019). In fact, the researcher needs to consider the economic theory and choose the equation with practical explanation (Dibooglu 1993).

The long-run equation is estimated as Equation (11) given below:

$$\text{lnrPRGDP}_t = 0.21 - 1.97\ \text{lnrM2}_t^{**} + 0.88\ \text{lnrBC}_t^{**} + 0.03\ \text{lnrS}_t + 1.43\ \text{lnrG}_t^{**} + 0.75\ \text{lnrI}_t^{**} + 0.22\ \text{lnrT}_t^{**} + \varepsilon_t \quad (11)$$

As the presence of cointegration is confirmed, the study moves to estimate the VECM (Table 5). The results show that the error correction term is −0.66591 and is significant (Table 6). This satisfies both conditions for the error correction term (ECT), which is to be negative and less than one. This indicates that any disequilibrium corrects itself by 66.59% in one time-period. The presence of cointegration between the financial variables has been reported by all of the previous studies except for Rehman (2018), which reported no cointegration between real GDP, M2/GGP, and the stock market. A probable reason could be non-inclusion for control variables in the said study.

Further, the study performs residual diagnostics (Table 7). The Breusch–Godfrey Serial Correlation Lagrange Multiplier (LM) test results support the null hypothesis that there is no serial correlation in the model. The Breusch–Pagan–Godfrey test supports the null hypothesis that the residuals are homoscedastic. In addition, the Jarque–Bera test supports the null hypothesis that the residuals are normally distributed. These robustness checks indicate that the studied model is fit. Finally, the study analyzes the short-run relationships. The study finds no relationship between the explanatory variables and private sector GDP in the short run at a 5% level of significance (Table 8). Only broad money and investment are significant at a 10% level of significance.

Table 2. Augmented Dickey Fuller (ADF) test results.

Variables	rPRGDP		rM2		rBC		rS		rG		rI		rTO	
	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	t-stat	t-stat	Prob	t-stat	Prob	t-stat	Prob
Constant	−2.00	0.28	−1.01	0.74	−2.23	0.2	−1.18	−2.23	−2.23	0.2	−1.18	0.67	−1.62	0.46
Const, Linear Trend	−1.98	0.59	−2.47	0.34	−2.08	0.54	−2.42	−2.08	−2.08	0.54	−2.42	0.36	−1.55	0.79
None	−0.05	0.66	1.25	0.94	−0.15	0.62	0.3	−0.15	−0.15	0.62	0.3	0.77	0.11	0.71
Variables	**rPRGDP(−1)**		**rM2(−1)**		**rBC(−1)**		**rS(−1)**		**rG(−1)**		**rI(−1)**		**rTO(−1)**	
Constant	−5.29	0	−4.80	0	−6.63	0	−5.43	−6.63	−6.63	0	−5.43	0	−4.87	0
Const, Linear Trend	−5.49	0	−5.74	0	−6.73	0	−5.32	−6.73	−6.73	0	−5.32	0	−4.90	0
None	−5.38	0	−5.64	0	−6.72	0	−5.50	−6.72	−6.72	0	−5.50	0	−4.94	0

Phillips Perron test results.

Variables	rPRGDP		rM2		rBC		rS		rG		rI		rTO	
	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	Prob
Constant	−2.00	0.28	−0.99	0.74	−0.85	0.79	2.05	0.27	−2.18	0.21	−1.19	0.67	−1.62	0.46
Const, Linear Trend	−1.92	0.62	−2.51	0.32	−2.57	0.29	−2.47	0.34	−2.08	0.53	−2.43	0.36	−1.55	0.79
None	−0.05	0.66	2.19	0.99	6.49	1	1.36	0.95	−0.18	0.61	0.33	0.78	0.11	0.71
Variables	**rPRGDP(−1)**		**rM2(−1)**		**rBC(−1)**		**rS(−1)**		**rG(−1)**		**rI(−1)**		**rTO(−1)**	
Constant	−5.27	0	−6.01	0	−7.99	0	−7.66	0	−6.80	0	−5.40	0	−4.84	0
Const, Linear Trend	−7.36	0	−8.31	0	−7.72	0	−7.72	0	−10.61	0	−5.29	0	−4.86	0
None	−5.37	0	−5.76	0	−4.43	0	−7.46	0	−6.87	0	−5.50	0	−4.92	0

Table 3. Lag structure.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	753.44	NA	1.29e−29	−46.65	−46.33	−46.55
1	905.99	228.81	2.16e−32	−53.12	−50.55 *	−52.27
2	978.87	77.43 *	7.84e−33 *	−54.61 *	−49.81	−53.02 *

* Denotes the selected lag length for the given criteria. LR: sequential modified LR test statistic; FPE: Final prediction error; AIC: Akaike information criterion; HQ: Hannan-Quinn information criterion; SC: Schwarz information criterion.

Table 4. Cointegrating relationships.

	Trace				Max-Eigen			
No. of CE(s)	**Eigen Value**	**Statistic**	**Critical Value**	**Prob. ****	**Eigen Value**	**Statistic**	**Critical Value**	**Prob. ****
None *	0.97	272.22	111.78	0.00	0.97	114.45	42.77	0.00
At most 1 *	0.88	157.76	83.93	0.00	0.88	66.56	36.63	0.00
At most 2 *	0.75	91.19	60.06	0.00	0.752	43.33	30.43	0.00
At most 3 *	0.48	47.86	40.17	0.00	0.48	20.52	24.15	0.14
At most 4 *	0.42	27.34	24.27	0.01	0.42	17.26	17.79	0.05
At most 5	0.22	10.07	12.32	0.11	0.22	7.78	11.22	0.18
At most 6	0.07	2.28	4.12	0.15	0.07	2.28	4.12	0.15

* Denotes rejection at 0.05 level. ** MacKinnon-Haug-Michellis *p*-values.

Table 5. Vector error correction model.

Cointegrating Eq:	**CointEq1**	**Variables**	**Variables**	**Variables**	**Variables**	**Variables**	**Variables**
lnrPRGDP(−1)	1.000000						
lnrM2(−1)	1.973332						
	(0.25029)						
	[7.88408]						
lnrBC(−1)	−0.8888						
	(0.14114)						
	[−6.29711]						
lnrS(−1)	−0.03002						
	(0.03079)						
	[−0.97509]						
lnrG(−1)	−1.43403						
	(0.11298)						
	[−12.6925]						
lnrI(−1)	−0.75161						
	(0.07841)						
	[−9.58608]						
lnrTO(−1)	0.229554						
	(0.06496)						
	[3.53394]						
C	−0.2117						
Error Correction:	D(lnrPRGDP)	D(lnrM2)	D(lnrBC)	D(lnrS)	D(lnrG)	D(Ilnr)	D(lnrTO)
CointEq1	−0.66591	−0.60445	−0.81684	1.963360	0.305705	−0.32957	0.418680
	(0.25394)	(0.24620)	(0.39175)	(0.83594)	(0.37387)	(0.29126)	(0.23059)
	[−2.62231]	[−2.45506]	[−2.08510]	[2.34867]	[0.81767]	[−1.13150]	[1.81569]
D(lnrPRGDP(−1))	−0.5273	−1.02349	−0.84463	−1.88538	0.154440	−0.79598	−0.71298
	(0.63298)	(0.61369)	(0.97649)	(2.08370)	(0.93193)	(0.72601)	(0.57477)
	[−0.83304]	[−1.66775]	[−0.86496]	[−0.90482]	[0.16572]	[−1.09638]	[−1.24046]
D(lnrPRGDP(−2))	−0.73404	−0.31539	−1.25131	−3.46561	0.867661	0.011951	0.512124
	(0.63751)	(0.61809)	(0.98349)	(2.09863)	(0.93860)	(0.73121)	(0.57889)
	[−1.15141]	[−0.51026]	[−1.27232]	[−1.65137]	[0.92442]	[0.01634]	[0.88466]
D(lnrM2(−1))	1.174578	1.179425	2.380032	2.465550	−1.06849	1.399585	−0.09349
	(0.81661)	(0.79173)	(1.25977)	(2.68819)	(1.20228)	(0.93663)	(0.74152)
	[1.43836]	[1.48968]	[1.88926]	[0.91718]	[−0.88872]	[1.49428]	[−0.12608]
D(lnrM2(−2))	1.401951	0.960564	1.790914	0.982619	−0.74252	0.135906	−1.30955
	(0.58267)	(0.56492)	(0.89888)	(1.91810)	(0.85786)	(0.66831)	(0.52909)
	[2.40607]	[1.70035]	[1.99238]	[0.51229]	[−0.86555]	[0.20336]	[−2.47508]
D(lnrBC(−1))	−0.4227	−0.25864	−0.81381	−1.03436	0.296840	−0.5644	0.328174
	(0.38797)	(0.37615)	(0.59852)	(1.27717)	(0.57121)	(0.44500)	(0.35230)
	[−1.08949]	[−0.68759]	[−1.35969]	[−0.80988]	[0.51967]	[−1.26833]	[0.93152]

Table 5. *Cont.*

Cointegrating Eq:	CointEq1	Variables	Variables	Variables	Variables	Variables	Variables
D(lnrBC(−2))	−0.31256	−0.16754	−0.65372	−0.15852	0.047264	0.068744	0.500384
	(0.21654)	(0.20994)	(0.33406)	(0.71283)	(0.31881)	(0.24837)	(0.19663)
	[−1.44342]	[−0.79802]	[−1.95691]	[−0.22238]	[0.14825]	[0.27678]	[2.54480]
D(lnrS(−1))	−0.03231	−0.07665	0.092024	−0.26051	−0.13687	0.048098	0.044973
	(0.06583)	(0.06382)	(0.10155)	(0.21670)	(0.09692)	(0.07550)	(0.05977)
	[−0.49076]	[−1.20102]	[0.90618]	[−1.20218]	[−1.41222]	[0.63703]	[0.75237]
D(lnrS(−2))	0.076143	0.038365	0.229143	0.694037	−0.11738	0.140853	−0.04974
	(0.08391)	(0.08136)	(0.12945)	(0.27623)	(0.12355)	(0.09625)	(0.07620)
	[0.90740]	[0.47156]	[1.77010]	[2.51249]	[−0.95008]	[1.46345]	[−0.65279]
D(lnrG(−1))	−0.19687	−0.08828	−0.84665	0.627936	0.428893	−0.03263	0.121606
	(0.31381)	(0.30425)	(0.48411)	(1.03302)	(0.46201)	(0.35993)	(0.28495)
	[−0.62735]	[−0.29015]	[−1.74888]	[0.60786]	[0.92831]	[−0.09065]	[0.42676]
D(lnrG(−2))	−0.29801	−0.11536	−0.34995	−0.50464	0.276492	−0.11987	0.241988
	(0.27446)	(0.26609)	(0.42340)	(0.90348)	(0.40408)	(0.31479)	(0.24922)
	[−1.08583]	[−0.43351]	[−0.82653]	[−0.55855]	[0.68425]	[−0.38079]	[0.97098]
D(lnrI(−1))	−0.68843	−0.47237	−0.72176	2.132162	−0.03004	−0.39438	0.425927
	(0.30533)	(0.29603)	(0.47103)	(1.00511)	(0.44953)	(0.35021)	(0.27725)
	[−2.25472]	[−1.59569]	[−1.53231]	[2.12132]	[−0.06682]	[−1.12613]	[1.53624]
D(lnrI(−2))	−0.44157	−0.57058	−0.53027	1.798643	0.223566	−0.29514	0.413684
	(0.34942)	(0.33878)	(0.53905)	(1.15027)	(0.51445)	(0.40078)	(0.31729)
	[−1.26371]	[−1.68421]	[−0.98371]	[1.56367]	[0.43457]	[−0.73641]	[1.30378]
D(lnrT(−1))	−0.63882	−0.63747	−0.74539	−0.80763	0.360226	−0.32086	0.327553
	(0.44299)	(0.42949)	(0.68339)	(1.45827)	(0.65220)	(0.50810)	(0.40225)
	[−1.44209]	[−1.48424]	[−1.09072]	[−0.55383]	[0.55232]	[−0.63150]	[0.81430]
D(lnrTO(−2))	0.179458	0.408026	−0.02088	−1.08556	0.559933	0.514639	−0.11688
	(0.27789)	(0.26943)	(0.42870)	(0.91480)	(0.40914)	(0.31874)	(0.25234)
	[0.64578]	[1.51442]	[−0.04871]	[−1.18667]	[1.36856]	[1.61462]	[−0.46319]
C	−0.00099	0.000168	0.000746	−0.00203	0.002040	−0.00025	−0.00068
	(0.00158)	(0.00153)	(0.00243)	(0.00519)	(0.00232)	(0.00181)	(0.00143)
	[−0.62862]	[0.10967]	[0.30654]	[−0.39053]	[0.87840]	[−0.13597]	[−0.47097]

Table 6. Estimating equation and results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	−0.66591	0.25394	−2.62231	0.0192
C(2)	−0.5273	0.632977	−0.83304	0.4179
C(3)	−0.73404	0.637513	−1.15141	0.2676
C(4)	1.174578	0.816607	1.438364	0.1709
C(5)	1.401951	0.582673	2.40607	0.0295
C(6)	−0.4227	0.387975	−1.08949	0.2931
C(7)	−0.31256	0.216542	−1.44342	0.1695
C(8)	−0.03231	0.065827	−0.49076	0.6307
C(9)	0.076143	0.083914	0.907396	0.3785
C(10)	−0.19687	0.313807	−0.62735	0.5399
C(11)	−0.29801	0.274456	−1.08583	0.2947
C(12)	−0.68843	0.305329	−2.25472	0.0395
C(13)	−0.44157	0.349425	−1.26371	0.2256
C(14)	−0.63882	0.442986	−1.44209	0.1698
C(15)	0.179458	0.277893	0.645781	0.5282
C(16)	−0.00099	0.001578	−0.62862	0.5391

D(lnrPRGDP) = C(1)*(lnrPRGDP(−1) + 1.97333239309*lnrM2(−1) − 0.888795066681*lnrBC(−1) − 0.0300235958207*lnrS(−1) − 1.4340302108*lnrG(−1) − 0.751605839079*lnrI(−1) + 0.22955429851*lnrTO(−1) − 0.2116978611) + C(2)*D(lnrPRGDP(−1)) + C(3)*D(lnrPRGDP(−2)) + C(4)*D(lnrM2(−1)) + C(5)*D(lnrM2(−2)) + C(6)*D(lnrBC(−1)) + C(7)*D(lnrBC(−2)) + C(8)*D(lnrS(−1)) + C(9)*D(lnrS(−2)) + C(10)*D(lnrG(−1)) + C(11)*D(lnrG(−2)) + C(12)*D(lnrI(−1)) + C(13)*D(lnrI(−2)) + C(14)*D(lnrTO(−1)) + C(15)*D(lnrTO(−2)) + C(16).

The results indicate that, in the long run, bank credit has a significantly positive impact on the growth of the private sector. A 1% increase in bank credit to the private sector increases private sector GDP by 0.88%. As the bank claims that the private sector has a positive and significant relationship, it is interpreted that banks will have an important role in the growth of the private sector of the country. This result goes along with all of the previous studies using bank claim to the private sector as a proxy

for financial development, except for Ibrahim (2013). Moreover, share market capitalization has no significant relationship with that of the private sector's gross domestic product. Previous studies of Ibrahim (2013) and Samargandi et al. (2014) also had similar results. The only unexpected result is that broad money negatively relates to private sector growth. Previous studies have also shown different results for the relationship between financial development and economic growth, depending on the choice of the indicator.

Table 7. Residual diagnostics.

Test	Test Statistic	*p*-Value
Breusch–Godfrey Serial Correlation LM Test:	0.330442	0.8477
Heteroskedasticity Test: Breusch–Pagan–Godfrey	20.74634	0.4745
Jarque–Bera	0.537758	0.764236

Table 8. Wald's test for short-run causality.

Hypothesis	Chi-Square Value	Probability
c(4)=c(5)=0	5.817595	0.0545
c(6)=c(7)=0	2.979553	0.2254
c(8)=c(9)=0	2.887682	0.236
c(10)=c(11)=0	1.196024	0.5499
c(12)=c(13)=0	5.107715	0.0778
c(14)=c(15)=0	2.744756	0.2535

The study reports a negative relationship between the ratio of M2/GDP and private sector growth. This contradicts the study of Marashdeh and Al-Malkawi (2014), which reported a positive relationship between the two for Saudi Arabia. However, the negative relationship between monetization ratio (M2/GDP) may be because of under-development of the financial sector below the threshold point, weak regulatory environment in the financial sector, business cycle obscuring long-run association, positive association between increased exchange of liquid into less-liquid investment and economic growth, lack of proper investment environment essential to nurture substantial private investment, lack of profitable investment opportunities, and high dependence on oil sector (Al-Yousif 2002; Gillman and Harris 2004; Mohamed 2008; Al-Malkawi et al. 2012; Mahran 2012; Grassa and Gazdar 2014; Barajas et al. 2013).

The control variables, namely, government expenditure, investment, and trade openness, also have a positive and significant impact on the private sector's gross domestic product, as expected. A 1% increase in government expenditure increases the private sector GDP by 1.43%. A 1% increase in gross domestic capital formation increases the private sector GDP by 0.75%. A 1% increase in trade openness increases the private sector GDP by 0.22%. These results are similar to the results of earlier studies. The results indicate that all three variables, namely, government expenditure, investment, and trade openness, facilitate the growth of the private sector. However, such a relationship is missing in the short run.

In a predominantly oil exporting economy like Saudi Arabia, the relationship between financial development and economic growth is not as important as in any other country (Grassa and Gazdar 2014). This predominance of oil provides the private sector with small a scope to contribute to economic growth. This in a sense leads to inefficient allocation of resources to less productive sectors (Mahran 2012). The non-competitiveness of non-oil sector results in lower revenues (Barajas et al. 2013). In a non-oil exporting country, the financial sector plays a greater role in resource allocation to firms, and subsequently revenue generation. Meanwhile, in an oil exporting country, the major economic activity is concentrated in generating revenue from processing oil, which happens to be a highly demanded commodity (Samargandi et al. 2014). Studies have cautioned against the usage of financial indicators to study economic growth, as expansionary monetary policy will not be effective in the absence of productivity (Gillman and Harris 2004).

High dependence of the oil sector and underdeveloped financial system can be the reason for a negative relationship between economic growth and financial development. Hence, this study recommends for greater financial deepening in banks as well as stock markets by improving access to financial institutions and increased competition in the financial sector. In addition, in line with Barajas et al. (2013), doing away with dominant fiscal policy and restrictive monetary policy might be a way to divert funds to the private sector. As a solution, this study recommends, in line with Samargandi et al. (2014), to increase the degree of diversification for the financial sector to contribute more to economic growth.

The share market of Saudi Arabia is considered not so efficient compared with its peers in mid-2015. The performance of Tadawul All Share Index (TASI) was poorer than the equity markets among global and regional peers (Jadwa Investment 2016). In 2017, the Saudi stock market started its journey of success with the launch of Nomu, which is a regulatory set-up for the equity market by the Capital Market Authority (CMA). It permitted space for investment by Saudi and Gulf companies, and also for qualified institutional investors (QFIs). Moreover, the Saudi stock market was upgraded to an emerging market from its standalone market position in the year 2018, and included in Morgan Stanley Index MSCI's Emerging Market Index in two phases in the year 2019. Therefore, the factors discussed above contributed to the rise of TASI by 15 percent since the start of 2019 (Jadwa Investment 2019).

Concurrent to the budget of 2018, the government disclosed that a total of SR133 billion would be spent by the Public Investment Fund (PIF) and the National Development Fund (NDF). Separately, prior to the budget, SR72 billion worth of activities was announced to encourage growth in the private sector. Furthermore, the foreign investors have pumped their investments to a large extent into the Saudi share market, and these investments shall help the kingdom in the development of the private sector. The government has a plan under Vision 2030 to increase its investment in the private sector by opening up new investment opportunities. Moreover, the government currently opened investment opportunities in the private sector, such as education and health, which were previously served by the public sector.

The current research suggests the government to increase the private sector's contribution in different sectors, such as energy, housing and finance, municipal services, and so on, by encouraging investments by nationals and foreign investors. The investments can be brought in through the capital market. Further, as Saudi Aramco has also gone for an Initial Purchase Offer (IPO) in 2019, the government can further plan for an IPO in its public sector companies. Aramco is the world's largest nationalized oil producer. Even it can encourage the large private sector companies to go for an IPO. Further, it can encourage the foreign direct investments in the proposed private sectors. The stock market should be more regulated and more private companies should be given provision to list in TASI, so that it can become a developed market. These improvements can lead to further growth in the private sector.

5. Conclusions

Though there have been many attempts to study the relationship between financial variables and economic growth, this study innovates by emphasizing the private sector. To the best knowledge of the researcher, there is no other study in the context of the private sector and financial sector. The closest study is of Samargandi et al. (2014), which studied non-oil sector and financial development and found a positive relationship between the two. The non-oil sector constitutes both the private sector and the government non-oil sector. Hence, the significance of this study stems from the fact that this study attempts to study the impact of financial factors on the private sector GDP of Saudi Arabia. Moreover, expanding this study by including other financial variables like M3 and the insurance sector can be the scope of further study.

Private sector not only boosts the volume of GDP, but also promotes economic diversification, generates employment, and enhances productivity and competitiveness in the economy. Besides government expenditure, investment, and trade openness, financial markets are important enablers

of the private sector. The private sector always has a need to expand its financing options and look for new options. The results indicate that bank credit to the private sector, government expenditure, investment, and trade openness significantly relate with private sector gross domestic product, in the long run.

The ongoing structural transformation program going on in the country to move away from oil provides both an opportunity and a challenge to the financial sector. The private sector has to come forward to attain diversification of the economy. Towards this, the financial sector has to play a bigger role to strengthen the private sector. The link between financial development and private sector economic growth established by the current study is of mixed nature. Out of the three financial variables studied, only bank credit to the private sector has a positive and significant relationship with the private sector growth. The ratio of broad money to GDP has a negative relationship and share market capitalization did not have a significant relationship with private sector growth. This indicates that the financial sector is still in the transition stage.

On the basis of the results, the study recommends further strengthening of financial sector services. The financial sector development can be instrumental in channeling oil receipts to productive ventures. In addition, the current trends in government expenditure, investment, and trade openness should continue to enable the private sector to contribute significantly to the economic growth of the country. This is important in view of the renewed emphasis on the private sector as the country is attempting to diversify itself and move away from the predominant oil sector. Increasing the resilience of the share market is a key recommendation of this study as an efficient capital market facilitates both investors and borrowers, leading to diversified and strong economic growth.

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Article

Determining the Financial Inclusion Output of Banking Sector of Pakistan—Supply-Side Analysis

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Abstract: Financial inclusion is the process of including the people who lack formal financial services. The concept of financial inclusion emerged globally in the times of millennium and is defined as the availability and usage of formal financial services. It essentially facilitates economic growth; the financially included individuals can invest in business, education, and entrepreneurship, which can pave way to poverty alleviation and economic development. In the context of Pakistan, a developing economy of South Asia, the financial landscape presents a grim picture of financial inclusion where only 16 percent of the population is financially included. Despite the current focus of policies and regulations devoted to enhancing access to finance in Pakistan from the supply side, the current state of financial inclusion is limited. Therefore, this study investigates the financial inclusion process for Pakistan from the supply side. We analyze the supply-side dimension of access by employing econometric technique of autoregressive distributive lag (ARDL) and using time series data of banking sector of Pakistan. Our empirical findings suggest that the greater the size, geographic outreach, and demographic outreach of the banks, the greater the contribution to the financial inclusion. Additionally, improvement in soft consumer loans and increase in small-sized advances reinforces the financial inclusion process.

Keywords: financial inclusion; banking sector of Pakistan; supply side; ARDL

JEL Classification: G21; G29; C22

1. Introduction

"Financial inclusion implies individual's ability to gain access to and effectively utilize appropriate conventional financial services and products" (Clark et al. 2005). Financial inclusion does not only mean the opposite of "financial exclusion"; it goes beyond that and is more profound in meaning. Allen et al. (2012) term financial inclusion as circumstances that exhibit broader access of financial services without price/nonprice impediments to their use. As per Chakravarty and Pal (2013), financial inclusion is deliverance of financial system of an economy to its participants and members and is considered to be synonymous with banking inclusion.

Although it is not rational to assume that all individuals have a preference for using mainstream banking services compared to use of cash, it still is essential to provide them equal opportunity and access to banking services. Thus, the role of banking services, credit, and debt in modern times cannot be disregarded, and all players in the market can benefit from the use of formal financial services properly. In particular, the supply side of financial inclusion offers prospects to individuals who can enhance financial stability by borrowing from banks and financial institutions.

The supply side of financial inclusion comprises of dimension of "access". Access to financial services presents the possibilities for individuals to use them. As per theoretical literature, access is one of the crucial dimensions for measuring supply-side financial inclusion. The literature suggests

that supply of financial services (formal) matters (Cámara and Tuesta 2014), banking services have a positive effect on financial inclusion (Mihasonirina and Kangni 2011), and there exists robust positive impact of financial inclusion on economic growth (Toxopeus and Lensink 2007).

Globally, the populace that is financially excluded is predominantly in developing countries, with only 41 percent adults having a formal account; only 37 percent of females holding formal account against 46 percent of men; the gender gap further widens because of varying income inequalities among developing countries. For high-income countries, account-based financial inclusion is much greater, with 89% of adults holding accounts with formal entities.

Pakistan's financial landscape presents a grim picture of limited financial inclusion. In a cross-country comparison, Pakistan was ranked the lowest in the context of financial inclusion not only in the region but also worldwide when juxtaposed with developing countries with similar demographic and socioeconomic profiles. The financial inclusion deprivation in Pakistan is evident from the Access to Finance Survey (A2F 2015) by the State Bank of Pakistan (SBP), which states that only 16% of the population is financially included. Thus, there is a dire need for financial sector to incorporate processes and channels to enhance financial inclusion to marginalized sections of Pakistani society.

Despite the current focus of policies devoted to enhancing access to finance in Pakistan, there are number of underlying factors causing financial exclusion. Therefore, the main goal and importance of the study is to identify those factors that determine the level of financial inclusion from the supply side in Pakistan. The research aim and objective are

- ❖ To establish the determinants of supply-side financial inclusion for Pakistan through the mainstream banking sector;
- ❖ To investigate the impact of supply-side dimension of "access" on the financial inclusion process for Pakistan;
- ❖ To determine if the banking sector of Pakistan is inclusive per se.

The significance of this study is twofold. First, this study gives the supply side of financial inclusion the due focus and explores the financial inclusion process for Pakistan from the supply side—the top–down approach; measures the supply-side dimension of "access", a first-time secondary data assessment by using the autoregressive distributive lag (ARDL) approach and data from 1973 to 2017 of all bank types in Pakistan. Moreover, unlike previous studies (Demirguc-Kunt et al. 2013; Efobi et al. 2014; Tuesta et al. 2015; Mohammed et al. 2017), this study uses both financial inclusion determinants of supply side and macroeconomic factors, financial development indicators, and micro determinants of the stylized banking sector of Pakistan.

Another significant contribution is that this study constructs new variables, especially the micro determinants of the banking sector for financial inclusion, based on and fully supported by theoretical literature—e.g., personal advances of financial inclusion, which only takes into account the advances that are financially inclusive in nature (credit cards, consumer durable and personal loans).

This study employs an extensive and authentic secondary data base of the State Bank of Pakistan (SBP) in the form of *Statistic on Scheduled Banks in Pakistan* and *The Hand Book of Statistics on Pak Economy*. We model important financial inclusion and micro determinants of the banking sector and find that the supply-side predictors of personal advances, advances by rate of interest, advances by size of account, and super inclusive advances impact the financial inclusion process. Our research shows that improvement in soft consumer loans and increase in small-sized, no-frill advances contribute to the financial inclusion process.

The structure of the study is as follows: Section 1 describes the financial inclusion output of the supply side of the banking sector and contains a brief introduction and literature review. Section 2 explains the methodology and data and variable construction. Section 3 presents the empirical findings and diagnostics, while Section 4 involves the discussion upon findings. Section 5 concerns the robustness of results. Section 6 shows the graphical analysis, while Section 7 gives conclusions and policy recommendations.

1.1. Literature Review

Considering the significant role of consumer spending in economic activity, it is presumed that a functioning market economy relies majorly on credit availability. Consumer credit may well promote economic growth by permitting the anticipation of purchases and shifting demand toward durable goods industries, which have great potential for expansion. By contrast, failure to provide access to reasonable credit can reduce consumer spending and hinder economic growth. When lending is hindered, progressive commerce comes to a halt.

However, there is not much evidence on the exact effect of credit availability for low-income–high-risk consumer groups on the macroeconomy. There is a possibility that the lower level of the personal credit market has fewer progressive influences on the economy, but there are several reasons that justify the provision of affordable credit to less affluent groups. Foremost is that credit allows people to avail that which they cannot afford with their current income; thus, credit can shift the time of cash flow. Credit demand in low-income–high-risk groups is more intense as compared to rich segments by virtue of mismatched income–expense because vulnerable segments have less spendable income and less saving. Availing manageable credit to a certain limit is therefore unescapable, although not desirable.

Second, affordable credit availability acts as a cushion for unforeseen events and a source of transitory income for consumption smoothing. In this context, credit is an external support for people who are unable to overcome difficulty by themselves. Therefore, nonaccess to affordable credit is regarded as an aspect of financial exclusion. However, despite the perpetual requirement for credit, it is difficult for some household and individuals to obtain credit from the banking sector. Ironically, those who require credit the most are often the "least credit worthy" among would-be borrowers.

The same applies to Pakistan, where there is a problem of financial exclusion in consumer credit. The exclusion is evident as A2F 2015 (SBP) shows that 84% of the population of Pakistan have absolutely no access to "high street credit" from the banking sector. In the context of this grim and infant landscape of financial inclusion in Pakistan, very few studies have investigated the financial inclusion scenario. Amin and Jalil (2017) studied remittances and the financial inclusion nexus for Pakistan, while Rizvi et al. (2017, 2018) investigated mobile banking and the Fin-tech revolution as a potential catalyst for financial inclusion and growth in Pakistan. Research upon the demand and supply dimension of financial inclusion has received little attention in the local literature and context.

1.1.1. The Supply Side of Financial Inclusion

The supply side of financial inclusion is a multidimensional phenomenon and cannot be captured by a single indicator but is determined by a much larger set of indicators. Literature shows the employment of various indicators of supply-side data at the country level for determining access to financial services. Honohan (2008) formulated the indicator of financial access to study the impact of country-specific characteristics such as population density, age dependency ratio, and gross national income on the financial inclusion process of 160 countries. Looking at the cross-country link between poverty and financial access, his results showed that financial access significantly reduces poverty. Kumar (2013) investigated the state of financial inclusion in India and concluded that branch network level significantly and positively impacts financial inclusion. He further added that ease of access and geographical region are also the determinants of financial inclusion level in certain segments of the population. Most studies used basic indicators such as automated teller machine (ATM)/100,000 adults, ATM/1000 km^2, commercial bank branches/100,000 adults, and commercial bank branches/1000 km^2. These indicators depict the "physical point of services" offered by financial service providers (commercial banks, rural and agri-banks, saving banks, saving and credit co-operations, microfinance institutions, and money market funds).

Certain studies used the variables of land mass, adult population, geographic outreach, and demographic outreach in terms of supply of financial services. The results of the studies suggested that population indicators contain more information in explaining the access dimension

of the supply side of financial inclusion to geographic (area) indicators. Park and Mercado (2015) studied financial inclusion determinants; investigated the relationships between inequality, poverty, and financial inclusion; and found that demographic determinants such as age dependency ratio, literacy rate, per capita income, and state of law impact the financial inclusion process in developing countries in Asia. Corrado and Corrado (2015) employed extensive data of the "life in transition survey" conducted in Europe during the 2008–2010 global crisis and showed that financial inclusion likelihood is dependent upon a household's economic, social, and demographic aspects.

Another variable of "having a loan" also depicts a consolidated stage of financial inclusion, as it belongs to that level in the hierarchy of availing financial services where such individuals have already utilized other forms of financial products such as bank accounts, pay roll accounts, etc. Having a loan may be an accurate indicator to identify more advance stages of financial inclusion (Cámara and Tuesta 2014). The literature also shows that the efficiency of the financial system is another variable that determines the supply-side level of financial inclusion. The efficiency of the financial system minimizes the barrier of the affordability of financial services (formal), as efficient financial systems provide services at a competitive price. Arora (2014) measured financial inclusion in the context of transactions, and the dimensions included "ease of transaction, cost of transaction, and outreach". Further, the supply side of financial inclusion is not only dependent on idiosyncratic financial market issues such as efficiency of financial institutions and financial stability but also on broader issues beyond the financial market, such as governance and macro factors like GDP, inflation, and the net interest margin. Financial inclusion is highly correlated with the net interest margin, as shown by Allen et al. (2012).

A number of studies have tried to establish the root causes, repercussions, and possible solutions concerning financial exclusion, but the majority of studies are either cross-country investigations or in a single country where the socioeconomic landscape considerably differs from that of Pakistan.

Sarma (2008) derived a financial inclusion index but was unable to define a common determinant for all countries due to the diversity in country-specific regulations. Characteristics and preferences giving way to financial inclusion greatly differ among countries (Kempson et al. 2004; Sinclair et al. 2009; Kendall et al. 2010; World Bank 2008). Despite these studies, the literature still lacks information on the determining factors of financial inclusion in Pakistan.

Most scholars adopted the *Global Findex Database* for understanding the financial inclusion process around the world (Allen et al. 2012; Efobi et al. 2014; Tuesta et al. 2015; Mohammed et al. 2017) and studied individual behavior in terms credit, payments, saving, and risk management based on Findex data of 148 countries. Other researchers used survey data; Swamy (2014) analyzed the relationships among financial inclusion, economic development, and gender using household survey data from India. However, little work has been done to identify financial inclusion by secondary data and country-specific characteristics. Explicitly, current literature mainly focuses on individual features to recognize the financially excluded ones. Banking determinants and the roles they play to provide the background for understanding microlevel factors of financial inclusion have gained little attention. Further, there have been few attempts to model and realize financial inclusion in a holistic way. This study differs from previous studies and attempts to model the financial inclusion supply side in a comprehensive manner.

1.1.2. The Banking Sector and Financial Inclusion Landscape in Pakistan

The banking industry, as a segment of financial market, is unique due to its stylized features, market power, interest rates, and accumulation of bank capital. It offers stylized products, loans, deposit contracts, and financial products from a composite basket that are differentiated at different prices. It is also exclusive due to its stylized credit risk (only the banking and insurance sectors have to deal with both the idiosyncratic and systematic risk, where the former is non-diversifiable) and balance sheet composition.

In Pakistan, the financial sector comprises the State Bank of Pakistan (2005, 2020), commercial banks, insurance companies, and nonbanking financial institutions (NBFIs). The commercial banking sector constitutes the nationalized commercial bank (NCB), state-owned provincial banks, privatized commercial banks, domestic private banks, foreign banks, and Islamic banks. Commercial banks offer short-/medium-term financing, retail banking, and trade finance. In terms of government securities and asset holdings, banks account for a major portion, but their share in the investment and total financial sector loan portfolio is considerably low.

In less developed countries, banks exhibit market power and operate in a concentrated market; the same applies to Pakistan, where a stylized banking sector operates under monopolistic competition where commercial banks prefer extending risk-free loans to the government for the purpose of improving the credit adequacy ratio (CAR). The government crowds out private investment by acquiring sizeable chunks of private-sector credit, bank corporate loan portfolios are skewed toward specific sectors/giants, and public sector banks finance loss-making public enterprises.

Concerning financial inclusion, the landscape is limited in Pakistan. A gap exists between the mainstream credit market and prospective borrowers, and low-income individuals in Pakistan are affected by this problem; nearly 50% of people save, yet only 8% entrust financial institutions with their money. One third of people borrow, but just 3% borrow from mainstream financial institutions. International remittances have risen by 29%, but only 2.3% of Pakistanis send or receive those remittances (A2F Survey 2015).

Additionally, the vast majority of women are excluded from the formal financial system. There is a significant gender difference in access to credit in Pakistan—women remain less likely to gain access to the overall financial sector compared to men. Notably, fewer females attain access to banking services (5.5% of women vs. 21.1% of men), money transfers (1.4% of women vs. 3.3% of men), and insurance (0.6% of women vs. 3.3% of men) as per the Access to Finance Survey.

There is a need for the formal financial sector to align with and incorporate informal channels and processes in order to increase financial outreach to the marginalized sections of the population.

2. Methodology

Although financial inclusion has remained a priority for years, the policy and approach regarding financial inclusion has remained questionable, essentially showing bias toward the measurement of financial inclusion. Our study, therefore, attempts to plug these analysis gaps from the supply side.

We presume that there are three dimensions that determine the magnitude of full financial inclusion—the usage and barriers dimensions from the demand side of financial inclusion, and the access dimension from the supply side of financial inclusion.

Concerning the supply side, the dimension of access is concurrently determined by various country-level supply-side characteristics. For establishing determinants and the measurement of financial inclusion from the supply side, we employed two aspects of the access dimension based on strong support from literature—availability and accessibility. The dimension of availability accounts for financial system outreach and the size and shape of banking outlets, as the distance covered to the financial services point can prove to be a crucial hindrance to financial inclusion (Allen et al. 2013). Availability is represented in the forms of banking industry branch network, penetration, assets, agents, or ATMs (Ahamed and Mallick 2019). For accessibility, the volume of bank loans, types of loan portfolios, and mobile accounts has been employed in studies to incorporate the level of financial accessibility. Based on a holistic approach, Sarma (2008) built a financial inclusion index stressing that precise measurements require the "availability and accessibility" of services and products from the supply side and the "usability" of services and products from the demand side.

Studies have also revealed the aggregate-level impacts of financial inclusion and shown that the bank-specific micro variables impact financial inclusion, translating into increased financial services and better solutions to user capital issues, improved consumption and convenience of use (Corrado and Corrado 2015). Concerning the macro-impact, the supply and availability of economic services

enhances the number of channels for users and enables equitable and more balanced distribution of resources (Chakravarty and Pal 2013).

Thus, for the supply side, we approached financial inclusion from a two-sided perspective. On one side, we considered the inclusiveness of the banking side by measuring the real use of financial services, namely, the inclusion output of financial system (LHS). On the other side, denoted as RHS, we took information from:

- the "Availability" aspect of the Access dimension of the supply side given by Equation (1), comprising the variables of banking industry size, network and outreach/penetration (macro-impact);
- the "Accessibility" aspect of the Access dimension of the supply side given by banking micro specific variables of the supply side in Equation (2) comprising banking portfolios of loans and advances, the size of loans and rate of interest (micro-impact).

2.1. Financial Inclusion—Supply-Side Model

The ARDL (autoregressive distributive lag) approach of co-integration developed by Pesaran et al. (2001) is employed to analyze the long-term relationship among variables. Co-integration is a powerful method of determining long-term relationships and steady state equilibria among variables. A number of co-integration techniques were devised to establish long-term relationships amongst the time series. For all these co-integration techniques, there is an important restriction that all series must be integrated in the same order. However, there is a co-integration approach developed in recent times which is called the autoregressive distributive lag (ARDL) approach, proposed by Pesaran et al. (2001), also known as bound testing In contrast to other co-integration approaches, e.g., Engle and Granger (1987) and Johansen and Juselius (1990), the ARDL is superior due to the fact that both the short- and long-term parameters of the specified model can be applied irrespective of the order of integration, whether the series under consideration are I (0), stationary at level or I (1), stationary at first difference. For convenience, the ARDL is extensively used, especially in multivariant models. Considering that we are dealing with time series data, and the main research objective of this study was to establish supply-side determinants of financial inclusion and their impact on the financial inclusion process, we employed the ARDL approach to analyze the long-term relationship among the variables in this study.

The empirical investigation method of ARDL comprises three steps. The first explores the stationarity of variables using unit roots tests. The second step tests the presence of long-term relationships among the variables. The third step is to study the short-term dynamics using the error correction mechanism (ECM).

Testing the Unit Root: As the first step of empirical analysis, we tested the order of integration of the series. This step is essential, as the ARDL technique requires the explanatory variables to be integrated in the order I (0) or I (1). If any series is I (2), then Wald (F-test) will generate biased results. Thus, we employed the standard version of ADF, augmented Dickey–Fuller test (Dickey and Fuller 1979) to check the non-stationarity assumptions. Apart from ADF unit root tests, we also performed PP (Phillips–Perron) and KPSS (Kwiatkowski–Phillips–Schmidt–Shin) tests. The results of the ADF, PP, and KPSS unit root tests, displayed in Table A1 of Appendix A, suggest that certain variables are nonstationary at level but attain stationarity after taking the first difference, which implies the possibility of long-term relationships among the variables.

Lag Length: The ARDL bound testing approach is highly sensitive to the selection of lag structure. Generally, the AIC (Akaike information criteria), SBC (Schwartz–Bayesian criteria), and LR (likelihood ratio) criteria are used. However, the most popular research approach is SBC due to its parsimonious nature. We selected the appropriate lag on the basis of lowest AIC/SBC values and fixed the lag length throughout the model for the purpose of making the study comparable to others.

ARDL Co-integration Test and Long-Term Relation: The existence of a long-term relationship is tested by restricting the coefficient of the lagged variables equals to zero. That is, the null hypothesis of the

presence of no long-term relationship is $\varphi 1 = \varphi 2 = \varphi 3 = 0$. This hypothesis testing was done by an F-test under bound testing.

Short-Term Dynamics: The short-term dynamics of the model were then explored by an error correction mechanism (ECM) which explains the adjustment process of the parameters to a long-term equilibrium.

2.2. Data Source

This study is based on data from all banks[1] operating in Pakistan, which are classified into three main groups, namely, public sector banks, domestic private banks, and foreign banks. Public sector banks are further divided into public sector commercial banks and specialized banks.

The time series data for Financial Inclusion determinants, micro determinants of the banking sector, comprising all categories of banks and macro- and financial determinants, are based on annual data of the "Statistics on Scheduled Banks in Pakistan" (SBP), "Hand Book of Statistics on Pakistan Economy" (SBP) and "Statistical Publications" (SBP). For financial inclusion determinants and macro determinants, time series data were used for the period ranging from December 1973 to December 2017. For micro determinants of the banking sector, data comprising four bank types were employed for a period ranging from December 1973 to December 2017. For certain variables, the Global Economy data set was used.

If we compare our study with the studies of developed countries, then data time series from 1973 to 2017[2] provide only 44 data points, seemingly a small sample; however, for a developing country like Pakistan, banking sector data are available only for this time frame. Because of this limitation, we performed the ARDL technique as it is consistent for small sample sizes.

Variable Construction The construction of *Financial Inclusion—Supply-Side variables* is as follows (Table 1):

Table 1. Variable construction of financial inclusion—supply side.

Dependent Variable		
Variables	**Construction**	**Source**
Financial Inclusion Output	FINC Output Gross Advances (Million Rs)	Banking Statistics of Pakistan, Annual, Statistical Publication, All Banks (1973–2017)
Dimension of Access—Supply Side		
Total Assets	TA (Million Rs)	3. Liabilities and Assets of Scheduled Banks Part I–III, Banking Statistics of Pakistan, Annual, Statistical Publication, All Banks, (1973–2017)
Demographic Outreach Bank Branches/100,000 Adults	Outreach by Population $DOUT_{POP}$ (#, number)	12. Distribution of Offices of Several Classes of Scheduled Banks by Population, Part I–XII, Banking Statistics of Pakistan, Annual, Statistical Publication, All Banks (1973–2017)
Geographic Outreach # of Banks (Total) # of Branches (Total)	Outreach by Area BNK_{TOT} (#, number) BBR_{TOT}	Appendix-I a) Scheduled Banks' Offices by Nationality, C. Appendices, Banking Statistics of Pakistan, Annual, Statistical Publication, All Banks (1973–2017)
Banking Variables—Supply Side		
Advances of Financial Inclusion Total (Amount)	As per the literature, these advances are disbursed to individuals and are financially inclusive in nature ADV PER_{AMOUNT} (Million Rs)	3.2 VI Advances Classified by Borrowers All Banks, # of Accounts and Amount (1973–2017) Statistics on Scheduled Banks in Pakistan (SBP)

[1] In terms of Section 13 of Companies Ordinance 1962, the scheduled banks maintain the minimum required capital and reserve balance, which is determined by SBP from time to time. Currently, as per BSD circular No. 7 of 2009, an aggregate value should be not less than Rs. 10 billion by 31 December 2013 and onwards.

[2] Due to the separation of East Pakistan (now Bangladesh) from West Pakistan (now Pakistan) in 1971, economic data for studies concerning Pakistan were used from 1973 onwards. In Pakistan, financial inclusion is a slow process. We were not able to find structural breaks or even outliers in the data.

Table 1. *Cont.*

Banking Variables—Supply Side		
Advances Microfinance Institutions (Amount)	Advances disbursed to Microfinance Institutions which in turn facilitate financial Inclusion **ADV MFI$_{AMOUNT}$** (Million Rs)	4.15 Classification of Scheduled Banks' Advances by Borrower 6-ii (Banks and Other Financial Institution proxy)1973–1981 2-II-F-v (NBFI proxy) 1982–2000 B-III-(ii) (Dev. Fin. Institution proxy) 2001–2005 B-III-(D) (Microfinance) 2006–2015 Dec value, Handbook of Statistics, All banks
Advances by Rate of Interest (Percent)	**ADVROI$_{AMOUNT}$** (Million Rs)	4.20 Weighted Average Rates of Return on Advances, 1973 onwards (Dec value)
Super-Inclusion Upmarket (Total Advances) Amount by All Banks	**SIAM$_{AMOUNT}$** (Million Rs) Measure of voluntary exclusion barrier of "lack of access to financial services" Large size Advances: 1 million to 10 million and above	6. Classification of Scheduled Banks' Advances by Size of Account Banking Statistics of Pakistan (SBP) 1973 onwards for all banks (Dec value)
Advances Financial Inclusion by Size of Account (Total) (Amount)	Small-sized advances identified against the full range of size of accounts from <5k–10 mill and above. The threshold selected for financially Inclusive advances is size of accounts from <5k–1Mill. **ADV SOA$_{AMOUNT}$**	6. Classification of Scheduled Banks' Advances by Size of Account Banking Statistics of Pakistan (SBP) 1973 0nwards for all banks (Dec value)

3. Empirical Findings

3.1. ARDL Co-integration Test—Access Dimension

The ARDL-Co-integration testing comprises a number of steps; the results are as follows:

3.1.1. Unit Root Test

The results of the augmented Dickey–Fuller (ADF), Phillips–Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root tests are given in Table A1—Summary of Unit Root Test—Supply Side of Appendix A. Certain variables display stationarity, while others do not depict any form of non-stationarity; thus, we cannot reject the null hypothesis of non-stationarity at their level form. On applying tests to first difference of these variables, we obtained stationarity for all. The variables in the supply dimension model are integrated both in the order 0 or 1 and are thus appropriate for ARDL.

3.1.2. Test of Lag Choice Criteria

As stated earlier, the optimal lag length turned out to be the same for all models.

3.1.3. ARDL Co-integration Test

We devised the following equation[3]:

$$\Delta \text{ FINC OUTPUT}_t = \beta_0 + \beta_1 \sum_{i=1}^{p} \Delta (\text{LTA})_{t-i} + \beta_2 \sum_{i=1}^{p} \Delta (\text{LBNK})_{t-i} + \beta_3 \sum_{i=1}^{p} \Delta (\text{LDOUT})_{t-i} + \alpha_1 (\text{LTA})_{t-1} + \alpha_2 (\text{LBNK})_{t-1} + \alpha_3 (\text{LDOUT})_{t-1} + \pi_t \quad (1)$$

Here, our dependent variable is "Inclusion output of the financial system-Supply[4] side" based on the theoretical stance that the use of formal financial services is considered an output of financial

[3] L in the equation refers to the log value.

[4] Since the focus of the research is supply side inclusion output of the banking sector of Pakistan, we used mainly banking industry data from Pakistan, comprising advance portfolios and financial inclusion determinants from the supply side. Certain data types such as data concerning the percentage of adults with a loan from a financial institution or a share of SMEs with a line of credit are present in the Global Findex dataset and global enterprise survey, upon which we are not focusing, as Global Findex data are demand side aggregates, missing in supply side aggregates, while enterprise survey data are incomplete for Pakistan.

inclusion rather than a measure of the inclusiveness of a financial system (Tuesta et al. 2015). This study used advances/loan portfolios as a dependent variable for measuring financial inclusion. Considering total deposits and total advances of the banking sector as proxies for financial inclusion is strongly supported by previous studies[5], such as Beck et al. (2007); Honohan (2008), Amidžić et al. (2014) and Uddin et al. (2017). The literature suggests that using the total advance portfolios of the banking sector to measure the financial inclusion of the supply side takes into account the broader perspective, where financial inclusion is not just limited to opening saving accounts, but availing other banking products that encompass loans and credits.

Uddin et al. (2017) in their study *"Determinants of Financial Inclusion in Bangladesh: Dynamic GMM and Quantile Regression Approach"* developed two separate models to depict both the depositor's side and borrowers' side of financial inclusion in Bangladesh. In the first model, *Total deposits* are considered a dependent variable, whereas in the second model, *Total loan and advances* are considered a dependent variable. The inclusion measured by the total deposits indicates that size, deposit interest rate, literacy rate, age dependency ratio, and gross national income have a significant impact on financial inclusion. The second model using loan and advances as an indicator of financial inclusion indicates size, the efficiency of the banks, interest charged on loans, and age dependency ratio; these are all important for financial inclusion.

Kumar (2013) modeled the credit ratio to determine financial inclusion from the supply side. Asuming et al. (2019) also modeled a number of bank loans and mobile accounts/1000 adult population to assess the depth of financial access. Chen et al. (2018) modeled the indicator of loan balance of financial inclusion/GDP, which demonstrated the financial inclusion promoted by the financial sector.

The prime aim of this research and the selected measure of financial inclusion was to establish how bank-specific factors influence the use of banking services by the population. It is worth noting that the microlevel impact of financial inclusion can be reflected at a bank-specific level, which promotes the participation of users and improves bank performance. In addition, the macrolevel impact of inclusive finance can be reflected in the banking industry level, which strengthens the intensity of capital networks.

Thus, we applied the ARDL co-integration technique[6] to test the long-term relationship between financial inclusion and the "Access" dimension of supply side. Table 2 presents the results of bounds test. The lower bound–upper bound critical values were obtained. The estimated Wald F-Statistic for the model is 13.47, which is larger than the lower bound critical value of 3.93 and upper bound critical value of 5.23 at 1 percent level of significance.

Table 2. Bound tests for the existence of a long-term relationship.

	Lags 1	Lag2	Lag3	1 Percent Critical Bounds	
				I(0)	I(1)
Model 1	13.4799	9.3698	7.2774	3.93	5.23
Model 2	9.6708	9.1425	6.5658	3.93	5.23

The critical values of last two columns are taken from Pesaran et al. (2001) for the null hypothesis of no co-integration.

Thus, co-integration exists between the variables in the Access model, and we reject the null hypothesis of no long-term relationship. Since the long-term relationship is evident through the bounds test approach, we proceeded to estimate the long-term equation and coefficient of the specified model.

[5] The literature suggests that to measure financial inclusion, primarily, three dimensions are used: availability, accessibility, and usage. For accessibility, certain studies used the number of bank loans to investigate the depth of financial inclusion (Ahamed and Mallick 2019). Essentially, the number and volume of advances relates to the pervasiveness of outreach of the financial sector. On similar lines, Beck et al. (2010) employed volume of deposits plus credits to measure the usage dimension of financial inclusion.

[6] The statistical software of E-Views was used for the ARDL technique.

3.1.4. ARDL Long-Term Estimates—Access Dimension of Supply Side

We estimated the long-term coefficient. The first model contains determinants of the Access dimension. The long-term result of the ARDL model is given in Table 3. All the variables are statistically significant. For the first generic specification, the coefficient of LTA (log of total asset) is highly significant, indicating that a 1 percent increase in assets of the banking sector leads to an increase of about 0.663 percent in the financial inclusion on the supply side. We employed log of total assets as a determinant of bank size based on the research of Beck et al. (2010) and Uddin et al. (2017).

Table 3. Long-term estimate of supply-side model—access dimension.

	Coefficient	Standard Errors	T-Stats
LTA	0.6630 *	0.3719	1.7829
LBNK	0.8628 **	0.4049	2.1307
LDOUT	0.8448 ***	0.1480	5.7097
Constant	0.5365	0.5773	0.9293
Diagnostic			
Normality	0.6205		
Serial Correlation	0.2223		
Heteroscedasticity	0.5042		
Functional Form	0.1684		

Note: *, **, and *** depict 10, 5, and 1 percent level of significance, respectively.

The long-term estimates show that the variable of number of banks LBNK (log of number of banks) is statistically significant and shows a positive relationship with financial inclusion measures and the geographic outreach of banks. The coefficient is reported to be 0.862. The coefficient of DOUT (demographic outreach) equals 0.844, confirming the relationship between the variables. This suggests that a 1 percent rise in DOUT will cause financial inclusion to increase by 0.84 percent.

3.1.5. ARDL Short-Run Estimates—Access Dimension Model

Table 4 summarizes the short-term parameters of the "Access Dimension Model". Again, the elasticity of the supply model is significant at 1 and 5 percent levels of significance. This implies that the series is not explosive, and equilibrium in the long-term is attainable. The coefficient reveals that a 9 percent disequilibrium in financial inclusion function for the current period will be corrected in the next year. The short-term model is estimated, as short-term dynamics are very important due to the coefficient of ECM. ECM_{t-1} signifies the speed of adjustment of a parameter, implying how quickly a series achieves long-term equilibrium. The coefficient must be significant and negative. According to Banerjee et al. (1993), a highly significant ECM coefficient confirms the presence of stable long-term relationships.

3.1.6. Diagnostics

The validity of the results hinges upon the goodness of fit and stability of the model; hence, Table 3 summarizes the results of a diagnostic check. The reported residual diagnostic of the "Access Model" shows normally-distributed residuals. The stats also reveal that no autocorrelation in the model appears as non-heteroscedastic due to passing a hetero test.

Table 4. Short-term estimate of supply-side model—access dimension.

	Coefficient	Standard Errors	T-Stats
ΔLTA	0.5867 ***	0.1372	4.2764
ΔLBNK	0.1961 ***	0.0495	3.9627
ΔLDOUT	0.2307 **	0.1080	2.1367
Constant	0.8279	0.5773	1.4340
ECM	−0.0974 ***	0.0214	−4.5449
Diagnostic			
R2	0.7466		
F-Stat	9.9048		
DW	1.7379		
CUMSUM	Stable		
CUSUMSQ	Stable		

Note: **, and *** depict 5, and 1 percent level of significance, respectively.

3.2. ARDL Co-Integration Test—Banking Determinants of Supply-Side Model

We estimate the fourth model of demand side using the following equation. The test of unit root indicates the integration of order (1) or order (0) in all series, with no exception of any series of order (2). This makes it possible to test the long-term relationship between financial inclusion and banking determinants of the supply side by employing bounds testing. Equation (1) is calculated using OLS, while the long-term relationship of Equation (2) is established by calculating joint F-Statistics.[7]

$$\Delta FINC\ OutPut_t = \varphi_0 + \varphi_1 \sum_{i=1}^{p} \Delta(LADVMFI)_{t-1} + \varphi_2 \sum_{i=1}^{p} \Delta(LADVPER)_{t-1} + \varphi_3 \sum_{i=1}^{p} \Delta (LADVROI)_{t-1} + \varphi_4 \sum_{i=1}^{p} \Delta(LADVSOA)_{t-1} + \varphi_5 \sum_{i=1}^{p} \Delta(LSIAM)_{t-1} + \theta_1(LADVMFI)_{t-1} + \theta_2(LADVPER)_{t-1} + \theta_3(LADVROI)_{t-1} + \theta_4(LADVSOA)_{t-1} + \theta_5(LSIAM)_{t-1} + \varepsilon_t \quad (2)$$

The calculated F-Statistics, along with the critical values proposed by Pesaran et al. (2001) at significant levels, are as per Table 2 of the Access dimension model. At the optimum lag length of order (1), the F statistic exceeds the critical value at 1 percent significance level. Thus, a strong long-term relation exists among the variables.

3.2.1. ARDL Long-Term Estimates—Banking Determinants of Supply Side

Next, we proceed to ARDL co-integration for long-term estimates of the banking determinants of the supply side[8]. The long-term estimates are given in Table 5.

The coefficient of LADV MFI (log of advances to MFIs) is 0.319, implying that a 1 percent increase in advances to microfinance leads to a 0.3 percent rise in the supply side of financial inclusion.

We also modeled other important predictors of LADV PER (log of advances—personal), ADV ROI (advances by rate of interest), and LADV SOA (log of advances by size of account) and LSIAM (log of super-inclusion advances for upmarket). The coefficient of LADV PER indicates that a 1 percent increase in personal advances, keeping everything else the same, will lead to a 0.53 percent increase in

[7] In Equation (2), the banking determinants of the supply side given in Figure 1 are used in log form.

[8] The right-hand-side variables are financial inclusion determinants of the supply side. They can lead to increases in financial inclusion of the supply side through the disbursement of financially inclusive personal loans (small soft loans with low interest), while super-inclusive loans (large-sized loans for upmarket clientele) impede the financial inclusion process, as shown by our results. Concerning the positive relationship of advances to MFI and financial inclusion, the relationship is also supported by the literature; e.g., Kipesha and Zhang (2013) found that in developing countries, financial inclusion was primarily spearheaded by Microfinance Institutes, and that loans given to MFIs by the banking sector actually facilitate financial inclusion. In order to see whether causality runs the other way, we performed a Granger causality test, and causality was not found from dependent to independent variables. However, the estimation results are not presented here in the interest of brevity.

the gross advances portfolio of banking, which also infers that improvement in soft consumer loans reinforces financial inclusion.

Table 5. Long-term estimate of supply-side model—banking determinants.

	Coefficient	Standard Errors	T-Stats
LADVMFI	0.3193 *	0.1677	1.9046
LADVPER	0.5322 ***	0.1665	3.1965
LADVROI	0.8362 ***	0.1956	4.2755
LADVSOA	0.4861 ***	0.1980	2.4557
LSIAM	−0.2879 **	0.1274	−2.2597
Constant	0.1037 ***	0.0177	5.8598
Diagnostic			
Normality	0.6583		
Serial Correlation	0.7321		
Heteroscedasticity	0.5817		
Functional Form	0.1178		

Note: *, **, and *** depict 10, 5, and 1 percent level of significance, respectively.

Similarly, the highly significant and positive coefficient of ADV SOA implies that a 1 percent increase in small, no-frill advances contributes to financial inclusion of almost 0.48 percent. No-frill advances are primarily designed for individuals with low incomes. Through a bank-specific view analysis, it is evident that the problem of NPL is largely affected by the size of loans and the bank management structure. We also modeled the super-inclusion of upmarket in the supply-side model of financial Inclusion. Super-inclusion exhibits a negative relationship with financial inclusion, and unit rise in large loans decreases the financial inclusion of the supply side by 0.28%.

3.2.2. ARDL Short-Term Estimates—Banking Determinants of the Supply Side

Here, we present the short-term result and the coefficient of ECM. The short-term estimates are similar in signs to the long-term estimates and are in line with prior expectations. The short-term dynamics are very important due to the coefficient of ECM. The ECMt-$_1$ lagged error correction coefficient is given in the last row of Table 6. Therefore, the co-integrating relationship among the variables has been confirmed. The ECMt-$_1$ coefficient depicts the pace of adjusting the long-term equilibrium after a short-term shock. ECMt-$_1$ coefficient 0.993 indicates that approximately 10 percent of last year's shock disequilibria adjust back to long-term equilibrium in the present year.

Table 6. Short-term estimate of supply-side model—banking determinants.

Variable	Coefficient	Standard Errors	T-Stats
ΔLADVMFI	0.2601 ***	0.1000	2.6022
ΔLADVPER	0.5099 ***	0.1485	3.4331
ΔLADVROI	0.1518 ***	0.0213	7.1313
ΔLADVSOA	0.3162 *	0.1820	1.7375
ΔLSIAM	−0.2333 ***	0.0832	−2.8048
Constant	0.8297 **	0.3535	2.3468
ECM	−0.09939 **	0.04815	−2.0642

Note: *, **, and *** depict 10, 5, and 1 percent level of significance, respectively.

3.2.3. Diagnostic Test

Our model qualifies the diagnostic test. The results are presented in the lower panel of Table 5. The *p*-values show the nonexistence of serial correlation. The *p*-value, 0.1178, of the functional form

for the model shows a well-specified model. Finally, the *p* value of normality, 0.6583, indicates the acceptance of the null hypothesis of the normality assumption of residuals.

4. Discussion

For the first generic specification of the *Access dimension model*, the coefficient of the log of total assets, *LTA*, is highly significant. The literature shows that the *Total Assets* of commercial banks are the prime factors affecting financial inclusion and economic development by controlling the capital flow. Zopounidis and Kosmidou (2008) showed that with greater assets and larger banks, there is more capability of reaching a greater part of the population and enhancing financial inclusion. Concerning statistically significant *LBNK*, which exhibits a positive relationship with financial inclusion measures, there is strong evidence in literature for using the number of bank/branches as a determinant of financial inclusion on the supply side. The literature cites physical distance between the individual and point of financial services as an important determinant of financial inclusion (Allen et al. 2013). The pervasiveness of outreach of the banking sector is measurable by bank branch network, Agents, and ATMs (Ahamed and Mallick 2019).

Since commercial banks take a leading role in the provision of access to finance, we used the penetration of the banking sector as a measure of access to finance in the form of *DOUT*, i.e., demographic outreach, which turned out to be highly significant, showing a positive relationship with financial inclusion. By contrast, the study of Kumar (2013) for India showed that branch density had a negative and significant impact on financial inclusion. The outcome suggested that though credit and deposit accounts improved over time, their penetration failed to match the population growth that was witnessed, thus generating a negative impact.

For the second model of banking determinants of the supply side, *LADV MFI*, the advances to microfinance institutions coefficient implies that a rise in advances to microfinance leads to an increase in the supply side of financial inclusion. The results are in line with literature such as Kipesha and Zhang (2013), who found that financial inclusion in developing countries was primarily spearheaded by microfinance institutes, and that these MFI presented considerable advances and deposit portfolios with banks and a sound repayment capacity when loans were channeled to them by government-owned banks.

There is still a debate in the literature concerning the relationship between interest rates and financial inclusion. Certain studies have shown a negative relationship between the two, whereas some favor a positive relationship between both. Our results are in line with the latter. We found a statistically significant positive sign with a magnitude of 0.836 for the rate of interest for loan portfolios.

The *LSIAM*, super-inclusion, exhibits a negative relationship with financial inclusion. The results are consistent with those of Espinoza and Prasad (2010), who showed that larger loans have a negative impact on NPLs, and that it is harder for bank managers to tackle the repercussions of timely credit risk. Scrutiny of banks' view indicates that increases in the NPL problem could be affected by the size of loans and bank management (Guan et al. 2017).

5. Robustness

The gross advances on the dependent side may be criticized, keeping the right-hand-side variables in view. Consequently, the question of spurious correlation may be raised. Therefore, we took an alternative measure to test the robustness of the estimates. We estimated two additional models by taking two different scaled variables on the dependent side. These are "Number of Borrowers" and "Number of Bank Accounts" as a measure of financial inclusion. Furthermore, in the model with "Number of Bank Accounts" as a dependent variable, we incorporated some important variables which can determine financial inclusion along with supply-side variables. These are the per capita GDP of Pakistan, level of education, and life expectancy.

Another important issue is estimation methodology. The dependent variable of regression, that is, the number of borrowers or number of bank accounts, is a count variable. The usual ordinary least square methodology or ARDL is not a valid estimation technique. The literature suggests that

this type of regression should be estimated using Poisson regression to avoid the biasness or the loss of efficiency and consistency. Therefore, we shall now estimate regression using Poisson regression. Notably, we shall use the autoregressive version of Poisson regression to handle time series issues in the model. Poisson regression is based on the maximum likelihood method. Therefore, the marginal effects of the estimates are interpreted in terms of probability.

Marginal Effects of Poisson Regression with Number of Borrowers			
Supply-Side Model—Access Dimension			
	dy/dx	**Standard Errors**	**Z-Stats**
LTA	0.1836 **	0.0801	2.2913
LBNK	0.2359 ***	0.0713	3.3096
LDOUT	0.5806 ***	0.1899	3.0573
Pseudo R^2		0.6357	

Note: **, and *** depict 5, and 1 percent level of significance, respectively.

We do not present a direct estimate of Poisson regression, but rather the marginal effects of the regression, to be consistent with the last model. The marginal effect of LTA is 0.1836, implying that there is an 18 percent chance of increasing the number of borrowers based on the increase of the total assets of the banking sector. Similarly, the marginal effects of loan portfolios, LADV MFI, LADV PER, and LADV SOA show that the probability of an increase in the number of borrowers (a measure of financial inclusion) increases by increasing these portfolios, whereas the chances of an increase in number of borrowers occurring declines with an increase in LSIAM.

Marginal Effects of Poisson Regression with Number of Borrowers: Banking Dimension			
	dy/dx	**Standard Errors**	**Z-Stats**
LADVMFI	0.2549 ***	0.0552	4.6196
LADVPER	0.2782 *	0.1497	1.8589
LADVROI	0.2869 **	0.1239	2.3148
LADVSOA	0.2485 ***	0.1048	2.3725
LSIAM	−0.0615	0.0574	−1.0724
Pseudo R^2		0.6911	

Note: *, **, and *** depict 10, 5, and 1 percent level of significance, respectively.

More on Robustness: The other important variable to measure financial inclusion is the number of bank accounts. This is also a count variable which may be estimated through an autoregressive version of Poisson regression. The results are in line with the previous model[9], that is, the sign and significance of the coefficient do not change. However, the size of the coefficient varies a bit. Similarly, the results do not change by including other macroeconomic variables such as per capita GDP, number of years of schooling, and life expectancy.

6. Graphical Analysis

It is convenient to establish from a graphical analysis whether the banking sector in Pakistan (supply side) is inclusive in nature.

Advances of the banking sector in Pakistan are given in Figure 1 for the period of study, where out of the total advances, a considerable portion comprises large advances and a small portion comprises

[9] Therefore, we are not presenting detailed tables of the results here in the interest of brevity. However, these are available on request.

small advances. It is evident that gross advances have increased over time, but the disbursed loans are essentially large and not meant for the disadvantaged segments of society.

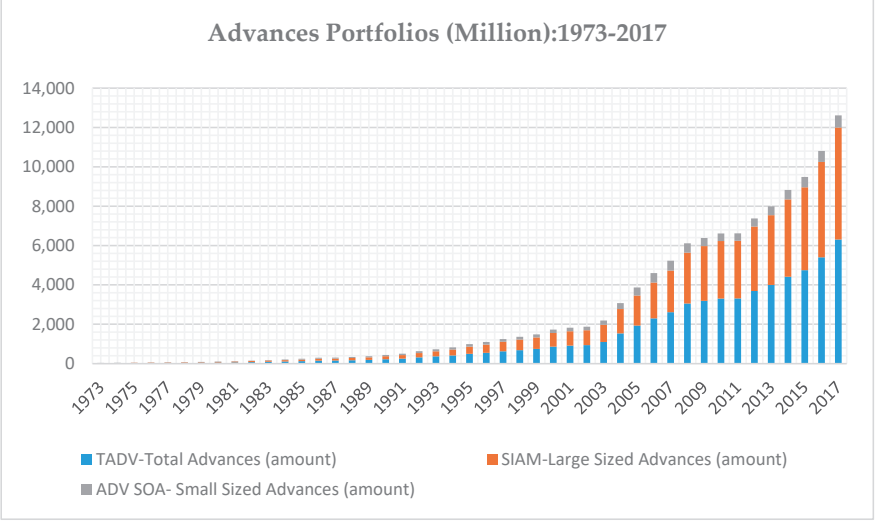

Figure 1. Total advances of the banking sector of Pakistan and their distribution into advance type.

Similarly, as per Figure 2, the proportion of collateralized advances is quite large. According to the evidence, collateralized loans discourage financial inclusion, as excluded individuals do not have the capacity to offer collateral. Figure 3 shows the small proportion of financially inclusive advances (soft, low-interest loans). Figures 4 and 5 highlight the notion that the size and outreach of the banking industry progressively increases over time. The graphs indicate that although the banking sector in Pakistan and the supply-side factors expanded over time, the advances were generally non financially inclusive in nature.

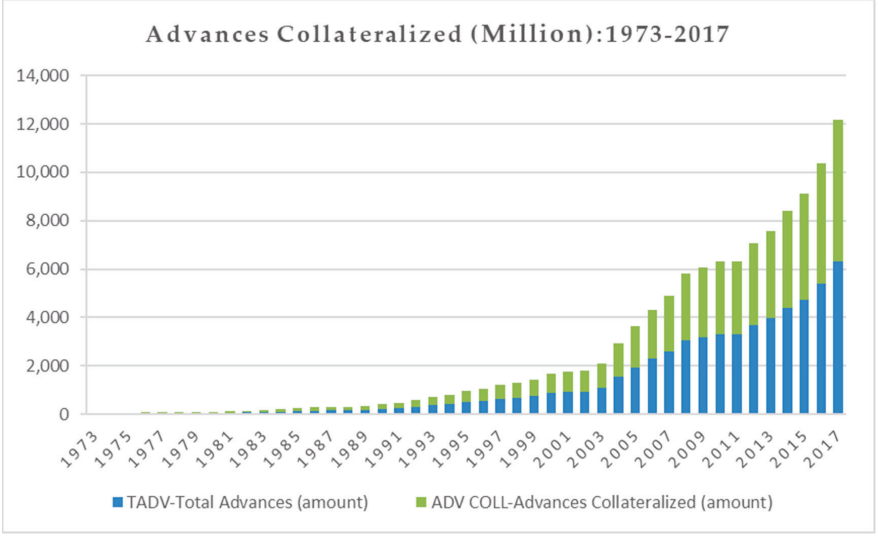

Figure 2. Collateralized advances out of total advances of the banking sector of Pakistan.

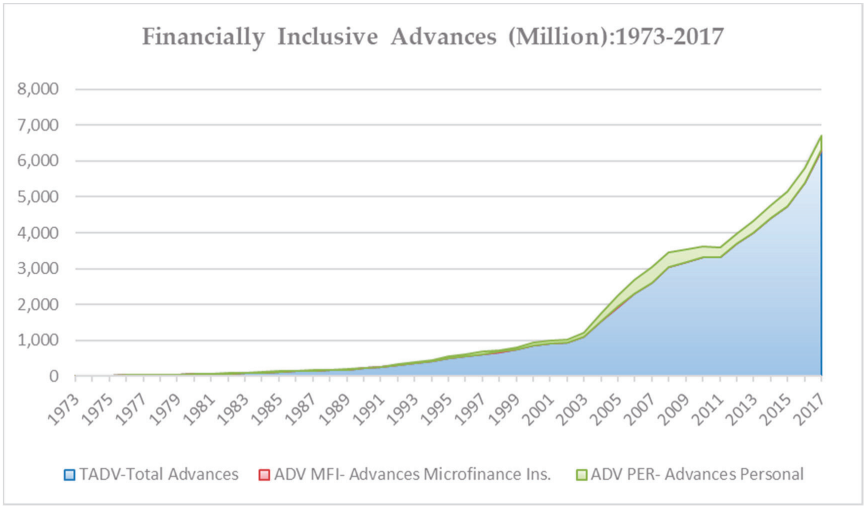

Figure 3. Financially inclusive advances out of total advances of the banking sector of Pakistan.

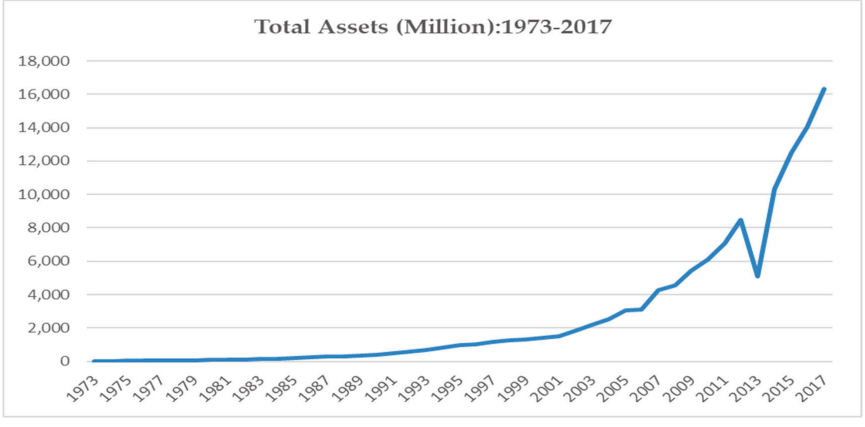

Figure 4. Total assets of the banking sector in Pakistan.

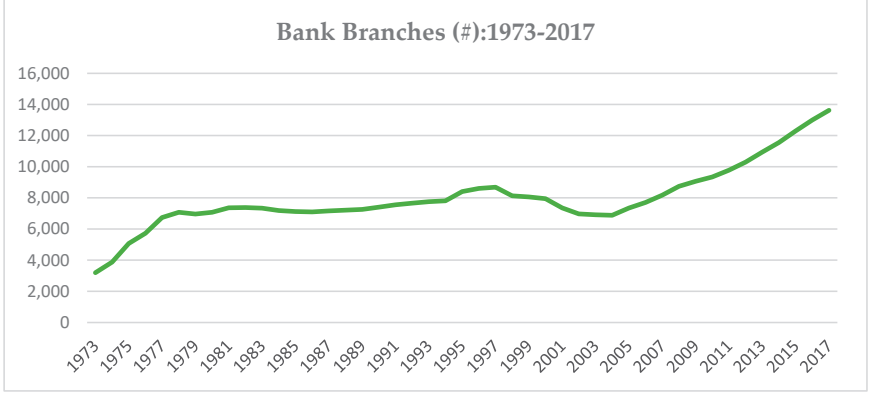

Figure 5. Total bank branches in Pakistan.

7. Conclusions

This study focused on the *Supply Side of Financial Inclusion* and investigated the financial inclusion process for Pakistan using the supply-side top–down approach by employing a number of indicators of the supply side. It also measured the supply-side dimension of *Access*, a secondary data measurement, using data from all bank types in the banking sector of Pakistan. In this context, the study dealt with the economic and financial determinants of financial inclusion in Pakistan. The empirical findings suggest that the greater the size, geographic outreach, and demographic outreach of the banks, the greater the contribution to financial inclusion. We also modeled other important predictors, i.e., advances—personal (LADV PER), advances by rate of interest (ADV ROI), advances by size of account (LADV SOA), and advances—super-inclusion of upmarket (LSIAM). The results signify that improvement in soft consumer loans and increases in small, no-frill advances contributes to financial inclusion.

We also investigated the super-inclusion of an upmarket supply-side model of financial inclusion. Super-inclusion exhibited a negative relationship with financial inclusion, and unit rise in large loans decreases the financial inclusion of the supply side.

Our findings lead us to make certain policy recommendations. First, according to the empirical results, the total assets of banks, the bank network, and the demographic outreach of banks significantly and positively enhance financial inclusion processes in the supply-side dimension. Additionally, advances to individuals and the size of loans also have an impact on financial inclusion, while collateralized loans are a product with a negative impact on the financial inclusion process. The banks must consider these aspects when devising products.

Second, to overcome the disconnect of *Access* and *Usage*, where access essentially does not translate into usage, and to ensure mass access to financial services, effective and evidence-based policy making can prove instrumental to overcoming the problem.

Finally, for Pakistan, which is at a low stage of financial inclusion progressiveness, the government should promote the opening up of domestic financial markets, which would have the ability to absorb the positive effects of the international financial inclusion development. Global financial market synergy and linkage can help to absorb these spatial spillover effects brought on by developed countries.

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Appendix A

Table A1. Augmented Dickey–Fuller (ADF), Phillips–Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) unit root test.

	ADF		PP		KPSS		ADF		PP		KPSS	
	Constant	Trend	Constant	Trend	Constant	Trend	Constant	Trend	Constant	Trend	Constant	Trend
	Level						First Difference					
LTADV	−1.640	−3.670	−1.630	−3.810	1.110	0.080	−10.480	−10.440	10.480	−10.440	0.030	0.030
LSIAM	−1.190	−3.070	−1.170	−3.200	1.090	0.090	−11.010	−10.960	−11.020	−10.970	0.040	0.040
LDOUT	−0.750	−2.900	−0.850	−3.110	1.130	0.090	−8.890	−8.860	−8.820	−8.800	0.060	0.050
LTA	−3.900	−4.090	−4.170	−8.170	0.990	0.110	–	–	–	–	–	–
LBNK	−3.590	−5.510	−4.510	−5.550	0.870	0.100	−15.280	−15.250	−15.820	−15.800	0.060	0.020
LBBR	−1.690	−3.570	−2.480	−5.670	1.060	0.080	−4.930	−4.840	−19.930	−19.870	0.040	0.040
LADVMFI	−1.560	−4.860	−1.670	−3.670	0.970	0.120	−9.590	−9.540	−9.520	−9.470	0.040	0.040
LADVPER	−1.250	−3.997	−1.047	−3.083	1.067	0.120	−4.243	−4.167	−8.790	−8.717	0.027	0.053
LADVROI	−3.765	−3.672	3.373	−4.143	1.117	0.130	–	–	–	–	–	–
LADVSOA	−1.780	−3.347	2.793	−3.203	1.167	0.140	5.447	1.543	−2.490	−9.387	0.007	0.073

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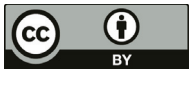

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Empirical Measurement of Competition in the Thai Banking Industry

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Abstract: The degree of competition in the banking industry can be observed and measured by two approaches, structural and nonstructural. Based on these two approaches, there are various indicators, which are different factors and methods. This paper aims to provide calculations, determine a good indicator, and assess the competitive environment of the Thai banking industry. Specifically, there are four indicators—concentration ratio, Herfindahl–Hirschman Index, Lerner Index, and Panzar–Rosse H statistic—which are widely used to examine the efficiency and effectiveness of policies in the banking industry. The findings indicate that the Lerner Index, calculated by stochastic frontier analysis, is the most reliable indicator of the banking competition environment in Thailand. It has a range of 0.36 to 0.60 and an average value of 0.40. Furthermore, during the period of study, the degree of Thai banking competition had a tendency to increase over time, which reflects an increase in allocative efficiency of resources in the banking industry. This is in accordance with the Financial Sector Master Plan of the country. However, this result probably leads to instability of the financial system. Therefore, policy-makers should carefully regulate competition policy by considering the systematic risk of the banking system at the same time.

Keywords: banking; competition; Lerner Index

1. Introduction

The banking sector is one of the most significant industries that has economic importance. Theoretically, banks act as intermediaries in the financial system, which allocate resources (funds) from savers to borrowers. The essential role of banks is to resolve asymmetric information in the financial market. Thailand is a developing country, which has a high degree of asymmetric information in financial market. Thus, all economic activities depends heavily on financial intermediaries, which are banks.

Competition in the Association of Southeast Asian Nations (ASEAN) banking sector (including Thailand) dramatically changed after the Asian financial crisis in 1997–1998. Mergers and acquisitions in the banking industry are critical in order to achieve financial stability in these regions. Moreover, the integration in the banking market is due to the Banking Integration Framework (BIF) in 2020 (Khan et al. 2016). Competition in the financial industry is often claimed as one factor involved in the global financial crisis in 2007–2009 (Coccorese 2014). After the global financial crisis, competition in the banking sector became a worthwhile subject of study for policy-makers and researchers (Chileshe 2017). Therefore, measurement of the degree of competition in the banking sector needs to be updated (Claessens 2009).

Furthermore, the existing literature indicates that role of competition in the banking sector has some special properties that differ from other industries. It is importance for the efficiency of production in banking industry, similar to other industries. At the same time, the stability of the banking system is also crucial for effective supervision (Claessens 2009). In aspect of efficient production in financial

service, level of bank competition has negatively associated with prices of bank's products (Anzoategui et al. 2010). A high competition leads to reduce bank's prices (interest rates). Consequently, this can induce a greater of businesses investment and household consumption, which in turn to foster economic development (Ghosh 2018). In addition to the prices, Ghosh (2018) points out that a high level of asymmetric information problem in developing countries would probably increase the costs of acquiring information of their borrowers. Therefore, the less competition can decrease efficiency in this sector by increasing costs of credit for borrower. Consequently, the less competitive in banking sector also leads to inefficiency allocation of banking products. In aspect of effective policy, competition in this sector can be correlated with government regulation. Since banks act as an intermediates, who use primary source of funds from saving of households and firms for investing in credit market. Especially in Thailand, overall economic activity depends heavily in bank credit. Hence, this sector is under the supervision of the central banks. Beck et al. (2004) point out that regulatory implementation can affect the behavior of bank's competition, which is not depending on the actual market structure. For instance, when the central banks strictly regulate the entry of new player in this sector, it will causes of obstacle to access financial products. Consequently, this may causes to increase monopoly power, reduces the contestability and competitiveness in banking industry. Some studies point out that competition can positively or negatively relates to stability of banking system (Beck 2008; Claessens 2009; Rao Subramaniam et al. 2019). Beside, numerous studies state that competition is one factors that significantly affects conduct of monetary policy transmission through banking sector (Olivero et al. 2011; Fungáčová et al. 2013; Khan et al. 2016). Up to this point, competition is the major focus for understanding banking sector in various aspects which cannot be abandoned.

Even though there are many indicators that are used as proxies to measure competition, most studies use one indicator over another. However, there seems to be no consensus on which indicators are the best measurement. Moreover, different indicators are derived from different factors, which may contribute to dissimilar inferences about the interpretation of competition. Choosing competition indicators is highly significant for the understanding of practical outcomes. Therefore, the advantages and disadvantages of each indicator should be carefully considered.

For the above reasons, the analysis of competition in the banking sector should be improved by studying more indicators as proxies for competition. This study approaches four main indicators: concentration ratio (CR), Herfindahl–Hirschman Index (HHI), Lerner Index (LI), and Panzar–Rosse H statistic (PRH), as the popular methods in economics, finance, banking, and monetary policy. Even though there are many studies in this area, there has been no study proving which indicators are strongly represented to the greatest extent in the Thai banking industry, contributing to an analysis of competition in the banking sector.

To fill this gap, structural and nonstructural approaches as empirical methods are used to determine the degree of competition. As studied in previous research (Bikker and Haaf 2002; Anzoategui et al. 2010, 2012; Fungáčová et al. 2013) using the structural approach on the traditional industrial organization, banking competition should be considered based on market structure, measured by the concentration ratio (CR) or the Herfindahl–Hirschman Index (HHI). For a nonstructural approach, as found in studies on the new empirical industrial organization (NEIO), banking competition should be investigated based on the bank's conduct, which includes the bank's market power (LI) or elasticity of its revenue with respect to variation of its input factors (PRH) (Bikker and Haaf 2002; Anzoategui et al. 2010, 2012; Fungáčová et al. 2013).

The rest of this study is organized as follows: Section 2 presents the structure of the Thai banking sector, Section 3 describes the literature review of banking competition, Section 4 explains the methodological approach and describes the data used to obtain the measurement of competition, Section 5 reports the results of the analysis of banking competition in Thailand, and Section 6 presents conclusions.

2. Competition of Banking Industry in Thailand

The banking industry plays an extremely significant role in the Thai economy. The Thai banking industry has largely been dominant because domestic credit to the private sector, which is provided by the banking sector, increased from 93% in 2001 to 112.53% in 2018 (% of gross domestic product (GDP)) (World Bank 2019). Credit from banks is a crucial factor in real sector behaviors. Overall economic activity in the country requires support by the banking industry. Banking business can be classified into four types: domestic commercial banks, retail banks, foreign financial institution representative offices, and specialized financial institutions (SFIs) (Bank of Thailand 2019). Domestic commercial banks act as depository institutions, which do business by accepting deposits subject to withdrawal on demand or the end of maturity date from savers and lending funds to potential bank borrowers. In Thailand, there is only one retail bank, and its business operation focuses specifically on microfinance lending. However, most commercial banks certainly do microfinance lending business as well. A core business of foreign financial institution representative offices is to facilitate their clients who do business in Thailand. SFIs are incorporated for special purposes in order to support fiscal policy implementation. Because of different core business operations, they are not direct competitors. Therefore, domestic commercial banks are emphasized and explained in terms of the competition of the banking sector.

After the Asian crisis in 1998, Thai domestic commercial banks experienced significant reforms. The number of mergers and acquisitions of small banks increased over a period of time. In January 2004, the Financial Sector Master Plan (FSMP) was established in order to assess and strengthen the financial system. Particularly, as indicated by Kubo (2006), one of the most important objectives for setting the FSMP was likely a signal for an increase in environmental competition in the banking industry (Kubo 2006).

During FSMP Phase I (2004–2008), the Bank of Thailand (BOT) issued new bank licenses. Three new banks were established: TISCO bank (TISCO) in 2005,[1] Land and House bank (LH) in 2006,[2] and Thai Credit for Retail bank (TCR) in 2007.[3] The emergence of new banks reflects the ease of access to bank services and fostering of competition. The main aim of FSMP Phase II (2010–2014) and Phase III (2016–2020) was to enhance financial efficiency by promoting competition and enhancing financial access. This resulted in increased competition in the banking industry. Because of the availability of new technology, banking activities were rapidly transformed from bank branches and ATMs to Internet platforms. Obviously, customer services such as mobile banking platforms, prompt pay system, and other digital payments increased. At the beginning, because of the expensive costs and low reliability of the system, especially in security, the use of banking technology in Thailand was unpopular. However, as driven by regulators, transaction fees for using the new technology were removed, and the amount of usage increased. Moreover, the financial technology was indirectly accelerated by Thai governmental policy, which can be called Thailand 4.0. The policy was implemented in 2016 and was aimed at creating innovation, new technology, and high-quality services of many industries. Overall, the change in circumstances induced a competitive environment in this sector. Competition in Thai banking has absolutely changed by relaxing the barriers for new banks and reducing restrictions to accessing financial products.

3. Literature Review

The analysis of industrial competition in microeconomics is based on market structure theory. There are two theoretical concepts of industrial competition, static and dynamic views. The static view believes that the long-run equilibrium of industrial competition would exist if the industry is

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1 TISCO upgraded its status from finance company to commercial bank according to the Financial Sector Master Plan of the Bank of Thailand in 2005.
2 LH bank was incorporated as a retail bank in 2006 and became a commercial bank in 2011.
3 Thai Credit for Retail (TCR) bank was incorporated as a retail bank in 2007.

characterized as a perfect competition market[4] subject to a given of constant technology. Imperfect competition derives from an advantage of production processes, such as economies of scale and lower average costs, which contribute to higher market power of one over its rivals in both price competition and non-price competition. In contrast to the static view, the dynamic view argues that the market is always imperfect. Imperfect competition stems from the latest innovations or product differentiations and the technological progress of production. Moreover, the monopoly status is impermanent due to creative destruction (Lipczynski et al. 2017). However, empirical studies in the banking industry often measure the degree of competition from the static view. This is because the related factors in dynamic view, which are technological progress and innovations of banking firms, are difficult to observe.

At this point in this study, the literature review mainly focuses on empirical approaches from the static view, which have frequently been used to measure competition in the banking industry. Empirical studies are divided into two approaches, structural and nonstructural. An explanation of each approach comprises underlying theory, advantages, limitations of each indicator, and empirical results.

3.1. Structural Approach

In the empirical studies, the structural approach is based on the structure–conduct–performance (SCP) paradigm, which can be linked to a relationship between the market structure and the firm's conduct in the market's performance. In this case, the degree of competition can be assessed by the firm's conduct. Structure commonly refers to the market structure, which is measured by many factors: the number and size of buyers and sellers, the entry–exit conditions, or product differentiation. Conduct refers to the behaviors of each firm in the market, such as pricing policies, collusion, mergers, or business objectives. Performance refers to industrial outcomes, such as product quality, profitability, productive efficiency, and allocative efficiency (Lipczynski et al. 2017; Leon 2014; Anzoategui et al. 2010; Claessens 2009). This approach measures the level of competition from the characteristics of industry. The n-firm concentration ratio (CR) and the Herfindahl–Hirschman Index (HHI) are usually used as competitive indicators. In empirical studies of traditional industry economics, these two indicators are the most widely used to assess competition. Calculating these specific indicators can reflect the importance of large firms at both inter- and intra-industry strata (Lipczynski et al. 2017).

The above two indicators have both strengths and weaknesses. Understanding the advantages and disadvantages can assist researchers in measuring and interpreting industrial competition in the right way. Measuring concentration is clear and simple because it is uncomplicated in the use of data (Leon 2014). However, in order to select suitable indicators, there are some important criteria that must be taken into account. Computing the CR may differ by the choice of the number of top n firms. This is because there are no rules on the choice. However, the choice of top n firms is not a critical point. The key issue for using the CR as indicator for measuring competition is the serious limitations on explaining the number and size distribution. It takes into account only the total value in the data of the top n firms (sales, assets, and employment), while the value outside those firms and the distribution within them are apparently ignored (Lipczynski et al. 2017). Regarding the Hannah and Kay's criteria, when there is a merger between incumbent firms, the concentration ratio should be increased; consequently, the competition level should be decreased. However, the outcome of the CR fails to satisfy this criterion if those incumbent firms are other small firms. Additionally, distributions within the top n firms are the vital factor. When there is a high skew distribution within the top n firms, the competition level should be lower than when there is a low skew or a symmetric distribution. Due to the limitations of the CR, the HHI is one of the most valuable indicators often used to measure market concentration. Compared with the CR, the HHI considers not only the number of all firms but also their size distribution (Lipczynski et al. 2017).

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[4] See Lipczynski et al. (2017, pp. 1–6).

To sum up, the CR can be used as a competition indicator if there is no change in the number of sellers and the size distribution does not vary. Otherwise, if there are structural changes in firms within the industry, such as mergers, acquisitions, new firms, and a highly skewed distribution of all firms in the industry, the HHI indicator can strongly represent market concentration.

3.2. Nonstructural Approach

The nonstructural approach is based on the new empirical industrial organization (NEIO)[5] and is more complicated than the structural approach in terms of both data requirements and measurement methodologies. Studies on the nonstructural approach do not infer that the market structure can identify the level of competition by indirectly observing a firm's conduct. It is possible to determine industrial competition from the firm's conduct instead (Lipczynski et al. 2017).

At this point, the area of empirical research in the NEIO has mainly focused on estimating behavioral equations. Empirical studies in the banking industry frequently employ balance sheets and income statements as proxies for output and input factors. Regarding the intermediate approach[6] to modeling in banking firms, total bank assets specified on the balance sheet statement are usually used as output. This is because they can explain not only loans producing but also other earning assets, such as securities or cash excess bank reserves. Three types of expenses are often used as proxies of input factors to produce bank assets; these are personal expenses, other nonfinancial expenses, and financial expenses, which represent labor, physical capital, and deposits, respectively (Leon 2014).

Even if there are many indicators under the nonstructural approach,[7] empirical studies on banking usually use the two main indicators, the Lerner Index (LI) and Panzar–Rosse H statistic (PRH) to measure competition (Kubo 2006; Anzoategui et al. 2010; Olivero et al. 2011; Fungáčová et al. 2013; Coccorese 2014; Rao Subramaniam et al. 2019). In practical terms, between these two indicators, choosing the proper one is important to interpret competition. Hence, the advantages and shortcomings should be clarified. The Lerner Index, one of the most useful and popular indicators, is used to measure a firm's market power from markup prices over marginal cost. One of the most distinctive features is the possibility to analyze the gradual evolution of individual bank pricing behavior over time. Moreover, the LI is flexible to observe the firm's market power in different market structures, since it does not require defining the market structure. However, under neoclassical theory, market power alone may not sufficiently explain the competition level. There are many factors that should be considered, such as product differentiation and entry–exit barriers. Moreover, computing LI by the conventional approach naturally assumes perfect technical and allocative efficiency, and it is difficult to demonstrate the circumstances of bank operation under perfect efficiency (Lipczynski et al. 2017; Leon 2014). In addition to the LI, the PRH has been widely applied to gauge rivals in the banking industrial. The PRH is one of the indicators under the static view of competition. The PRH always assumes the long-run equilibrium by applying the equilibrium of a monopolist, which is based on oligopoly theory. At the equilibrium, where marginal cost is equal to marginal revenue, when the bank's input price factors are raised, the bank's marginal cost will increase accordingly. The monopolist reacts to an increase of input price factors by a decrease in their quantity. Then, the bank's total revenues increase under the hypothesis that price elasticity of demand is greater than one. Panzar and Rosse (1987) showed that market competition can be measured by the sum of the elasticity of the firm's total revenues with respect to its factor input prices. The transmission from input factors to total revenues can reflect the degree of competition. The use of the PRH has an advantage in measuring competition across countries and less mature banking systems, which are often found in developing countries.

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[5] The NEIO comprises two generations: the first is based on oligopoly theory under the neoclassical concept, and the second is based on the Australian school concept (see Leon 2014).

[6] Two approaches are used in modeling banking firms, production and intermediate (see Leon 2014).

[7] The other indicators are rarely used in the banking industry. Some indicators, such as persistence of profit, are inappropriate for a developing country like Thailand (see Leon 2014).

Moreover, similar to the LI, the PRH does not require detailed specification of market definitions in order to estimate the revenue equations (Claessens and Laeven 2003; Sherrill 2004; Leon 2014).

Among these competition indicators, there is an unresolved conflict between theoretical and empirical evidence in previous studies on the impact of competition on financial stability and the effectiveness of monetary policy (Chileshe 2017). Some studies found that increased competition in the banking sector leads to strengthened stability in the financial system. This is because the low interest rates are likely to reduce payment defaults and systemic risk. As a result, the stability of the financial system is stronger (Boyd and Nicolo 2005; Tabak et al. 2012). At the same time, other views state that less competition in the banking sector leads to solid financial system stability. Due to the fact that less competition produces higher bank profitability, the bank's motivation to invest in high-risk assets is reduced, and subsequently, any crisis is more likely to be cushioned (Chileshe 2017; Tabak et al. 2012; Agoraki et al. 2011; Hellmann et al. 2000).

Several indicators are widely used to measure rivals in the competitive market of the banking sector. The main objective of the current study is to measure banking competition in Thailand by four indicators: concentration ratio (CR), Herfindahl–Hirschman Index (HHI), Lerner Index (LI), and Panzar–Rosse H-statistic (PRH). These indicators have different methods and factors. Previous studies argued that the indicators in the new empirical industry organization (NEIO) are the most useful, rather than the traditional industry indicators. Hence, this study focuses on calculating and measuring the individual indicators, and analyzing individual differences between them. Since approaches and indicators are options, understanding all dimensions is beneficial for further analysis of the impact of the degree of competition on banking market efficiency and policy effectiveness. Moreover, there are rarely studies on competition in the domestic banking industry. Therefore, this study provides an update on the level of competition of the banking industry in Thailand, and also clarifies the degree of competition in all aspects.

4. Data and Methodology

For the above reasons, the methodologies and calculations of banking competition indices in this study can be categorized into two groups: the structural approach, which includes the CR_5 and the HHI, and the nonstructural approach, which includes the LI and PRH.

4.1. Structural Approach

4.1.1. Concentration Ratio

The CR_5 is calculated by the sum of asset shares of the five largest banks. The computation of the concentration ratio can be written as follows:

$$CR_n = \sum_{i=1}^{n} \frac{S_i}{S}; n = 1, \ldots, 5 \quad (1)$$

where n is the number of banks; S_i denotes the total assets of bank i; and S denotes the total assets of all banks in the banking industry.

4.1.2. Herfindahl–Hirschman Index

The HHI is calculated by the summing the square of asset shares of all banks in the banking system. The computation of HHI can be written as follows:

$$H = \sum_{i=1}^{N} \left[\frac{S_i}{S} \right]^2 \quad (2)$$

where S_i denotes the total assets of bank i, N denotes the number of banks, and S denotes the total assets of all banks in the banking industry.

4.1.3. Interpretation of Competition by CR_5 and HHI

The CR_5 takes into account size distribution of the top five banks. Its values can vary between 0 and 1. Greater values reflect a more highly concentrated market, which is likely to increase a bank's market power and contribute to low competition in the banking industry. In comparison to the CR_5, the HHI takes into account the size distribution of both the top five banks and banks outside the top five. According to the US Department of Justice and the Federal Trade Commission, the value of HHI can determine the degree of concentration on three strata: values lower than 1000 (or 0.1) determine low market concentration, values from 1000 to 1800 (or 0.1–0.8) determine moderate market concentration, and values higher than 1800 (or 0.18) determine high market concentration. The link between degrees of concentration and competition of HHI values is very similar to the CR_5, which implies that the higher the concentration, the less competitive behavior among firms.

4.2. Nonstructural Approach

4.2.1. Lerner Index

Calculation of the LI considered in this study can be separated into two approaches, traditional and stochastic.

The computation of LI based on the traditional approach can be written as follows:

$$Lerner_{i,t} = \frac{P_{i,t} - MC_{i,t}}{P_{i,t}}; i = 1, \ldots, N \text{ and } t = 1, \ldots, T \quad (3)$$

where $P_{i,t}$ stands for the output prices set by bank i at time t, and $MC_{i,t}$ stands for the marginal cost of bank i at time t. Since the bank's marginal cost cannot be directly observed, it is necessary to identify the total cost function in order to obtain the bank's marginal cost.

Under the traditional approach, the calculation of LI is done with three steps: first, specify the total cost function of bank loan production; second, estimate the cost function and take the first derivative to obtain the bank's marginal cost; and third, use the marginal cost to calculate the LI according to Equation (3).

Based on the financial intermediaries approach, the bank's multiple output generally refers to total assets. The bank's total costs usually depend on only one output and three input prices. The three input prices widely used in the banking literature are the prices of labor, physical capital, and borrowed funds (Carbó et al. 2009; Beck et al. 2013; Fungáčová et al. 2013). Following these studies, the translog total cost function[8] can be specified as

$$\ln TC = \alpha_0 + \alpha_1 lnQ + \frac{1}{2}\alpha_2 (lnQ)^2 + \sum_{j=1}^{3} \beta_j lnw_j + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{jk} lnw_j lnw_k + \sum_{j=1}^{3} \gamma_j lnQ lnw_j + \varepsilon \quad (4)$$

where the bank's output (Q) is total assets. The first bank's input price is the ratio of personal expenses to total assets (W_1), which represents the price of labor. The second is the ratio of non-interest expenses to fixed assets (W_2), which represents the price of physical capital. The third is interest expenses and short-term funding (W_3), which represents the price of borrowed funds. The cost function can be

[8] This cost function is assumed to have symmetric and linear homogeneity restrictions in the three input prices.

estimated by the fixed effects method.[9] Then, the estimated coefficients from the cost function can be used to obtain the bank's marginal cost:

$$MC = \frac{TC}{Q}\left[\alpha_1 + \alpha_2 lnQ + \sum_{j=1}^{3} \gamma_j \ln w_j\right]. \tag{5}$$

The traditional Lerner Index in Equation (3) can be calculated once the marginal costs are made explicit.

The computation of the LI based on the stochastic approach can be written as follows:

$$L_{i,t} = \frac{\theta_{i,t}}{1 + \theta_{i,t}} \tag{6}$$

where θ is the estimated value of distance between technical efficiency and technical inefficiency in the production of banking firms, i stands for an individual bank, and t stands for time. Since the distances cannot directly observed, it is necessary to know the derivation of loan production in order to obtain the distance.

Based on the financial intermediaries approach, bank loans can be a single output of the bank's production, since credit activity is the most important part of banking business. Bank input prices can be classified into three factors, borrowed, physical capital, and labor. Following Coccorese (2014), the translog total cost function can be specified as

$$\begin{aligned} lnTC = {} & \alpha_0 + \alpha_1 lnQ + \sum_{h=1}^{3} \alpha_h lnW_h + \tfrac{1}{2}\alpha_{QQ}(lnQ)^2 + \tfrac{1}{2}\sum_{h=1}^{3}\sum_{k=1}^{3} \alpha_{hk} lnW_h lnW_k \\ & + \sum_{h=1}^{3} \alpha_{Qh} lnQ lnW_h + \alpha_E lnE + \tfrac{1}{2}\alpha_{EE}(lnE)^2 + \sum_{h=1}^{3} \alpha_{Eh} lnE lnW_h \\ & + \alpha_{EQ} lnE lnQ + \alpha_T T + \tfrac{1}{2}\alpha_{TT} T^2 \sum_{h=1}^{3} \alpha_{Th} T lnW_h + \alpha_{TQ} T lnQ \end{aligned} \tag{7}$$

where the bank's single output (Q) is the quantity of loans. The three bank input prices (W_h) are the ratios of interest expenses to total deposits ($W_{h=1}$), personal expenses to total assets ($W_{h=2}$), and other operating expenses to total fixed assets ($W_{h=3}$). The time trend (T) is included in order to explain technological change over the period. The bank's total equity is included in order to present the use of bank capital as a source of funds to invest in loan assets.

According to Coccorese (2014), banks produce loans by assuming profit maximization. Therefore, the possibility to produce loans depends on the condition that all banks will mark up their output prices not less than their marginal costs:

$$P_{it} \geq MC_{it}. \tag{8}$$

For the above equation, the maximum level of productive efficiency for the banking market can occur when output prices equal marginal cost. Otherwise, the production is inefficient. Hence, the greater the distance, the lower the productive efficiency.

From the empirical aspect, Equation (8) can be transformed[10] to revenue share to total costs (RC) and cost elasticity with respect to output ($E_{TC,Q}$), which can be written as follows:

$$RC_{i,t} \geq \frac{\partial \ln TC_{i,t}}{\partial \ln Q_{i,t}}. \tag{9}$$

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[9] See Appendix A.

[10] The transformation is to multiply both terms of Equation (8) by output and total cost ratio $\left(\frac{Q}{TC}\right)$, to get $\frac{TR}{TC} \geq \frac{\partial \ln TC_{i,t}}{\partial \ln Q_{i,t}}$, where $\frac{TR}{TC} = RC$.

By taking the derivative of the total cost function in Equation (7), the cost elasticity with respect to output can be revealed:

$$\frac{\partial \ln TC_{i,t}}{\partial \ln Q_{i,t}} = \alpha_Q + \alpha_{QQ} lnQ_{i,t} + \sum_{h=1}^{2} \alpha_{Qh} \ln\left(\frac{W_{h,i,t}}{W_{3,i,t}}\right) + \alpha_{TQ} T + \alpha_{EQ} lnE_{i,t} + \varepsilon_{i,t}. \tag{10}$$

Since Equation (9) is under the condition of profit maximization, similar to Equation (8), it can be inferred that the distance between $RC_{i,t}$ (revenue to total cost ratio) and $E_{TC,Q}$ (cost elasticity with respect to output) demonstrates the bank's market power or productive efficiency for the banking market.

At this point, in doing empirical work, the stochastic cost frontier model[11] can be applied to estimate the technical inefficiency (TE) of bank production (Coccorese 2014). According to the stochastic cost frontier model, cost minimization is the maximum possibility of output that the bank can produce with given input factors. The stochastic cost frontier model of the bank's production can be written as

$$RC_{i,t} = \frac{\partial \ln TC_{i,t}}{\partial \ln Q_{i,t}} + v_{i,t} + u_{i,t} \tag{11}$$

where i stands for an individual bank, t stands for time, RC or revenue–cost ratio is a dependent variable that stands for total production of a bank's output, $\frac{\partial \ln TC_{i,t}}{\partial \ln Q_{i,t}}$ are independent variables that stand for the deterministic part of the frontier, $v_{i,t}$ stands for the stochastic part of the frontier (a combination of these two is determined as the stochastic frontier), and u stands for technical inefficiency (TE), which is a non-negative one-sided term.

For the above approach, following Coccorese (2014), an explicit model for estimating production and cost function can be rewritten as follows:

$$RC_{i,t} = \alpha_Q + \alpha_{QQ} lnQ_{i,t} + \sum_{h=1}^{2} \alpha_{Qh} \ln\left(\frac{W_{h,i,t}}{W_{3,i,t}}\right) + \alpha_{TQ} T + \alpha_{EQ} lnE_{i,t} + u_{i,t} + v_{i,t} \tag{12}$$

where the bank's output prices (Q) are defined as loans and other earning assets. The price of deposits (W_1) is defined as the ratio between interest expenses and total deposits. The price of labor (W_2) is defined as the ratio of personnel expenses to total assets. The price of capital (W_3) is defined as the ratio of other operating expenses to total fixed assets. The error term (v) is assumed to be independently normally distributed with zero mean and constant variance properties. Technical inefficiency u is assumed to have half-normal distribution and non-negative value.

According to Coccorese's approach, Equation (12) can be estimated by maximum likelihood in order to obtain the distance between price and marginal cost (θ). Then, the calculation of the Lerner Index can be written as follows:

$$L_{i,t} = \frac{\theta_{i,t}}{1 + \theta_{i,t}}. \tag{13}$$

To be more specific, there are four steps to calculate the LI by applying the stochastic cost frontier model: (1) estimate the production and cost function with Equation (13), (2) predict the technical inefficiency $(u_{i,t})$ with Equation (12), (3) predict the revenue–cost ratio ($RC_{i,t}$) with Equation (12), and (4) calculate the LI according to Equation (13).

4.2.2. PRH

Calculating PRH in an empirical work can be separated into two steps. The first step is to estimate the dynamic revenue equation for bank-level data. This study follows the methodology of Goddard and John and Wilson (2009) and Olivero et al. (2011), and the estimating model can be written as

[11] See Appendix A.

$$\ln(R_{i,t}) = \beta_1 \ln(R_{i,t-1}) + \beta_2 \ln(W_{1\ i,t}) + \beta_3 \ln(W_{2\ i,t}) + \beta_4 \ln(W_{3\ t,t}) + x'_{i,t}\gamma + e_{i,t} \quad (14)$$

where i stands for an individual bank; t stands for time; R stands for the bank's total revenues; (W_1) stands for input factor prices of the bank's deposits, which is the ratio of interest expenses to total assets; (W_2) stands for the input factor prices of the bank's capital, which is the ratio of non-interest expenses to total assets; (W_3) stands for the input factor price of labor, which is the ratio of personnel expenses to total assets; x stands for the vector of control variables, which are the ratios of equity to total assets, loans to total assets, and other revenues to total assets; and e is a random disturbance term. It has been criticized in previous studies that an analysis of PRH in a static equation would be biased toward zero. This is because the bank market is always assumed in long-run equilibrium each time. Therefore, Arellano and Bond's (1991) generalized method of moments (GMM)[12] is employed to estimate Equation (13) (John and Wilson 2009; Olivero et al. 2011).

After estimating Equation (14), the second step is to calculate the sum of long-run elasticity of the bank's total revenue with respect to each of its factor input prices. The sum of elasticity is the H statistic, which was introduced by Panzar and Rosse (1987). The formula can be written as follows:

$$\frac{\beta_1 + \beta_2 + \beta_3}{1 - \beta_0}. \quad (15)$$

4.2.3. Interpretation of Competition by LI and PRH

The LI identifies the market power of banks by investigating the ratio of difference between price and marginal cost. This can reflect the competition behavior among banks. The bank's market power is assumed to have a negative relationship with competitive behavior. More market power leads to less competitive behavior in the banking industry. The LI has a range between 0 and 1. A value close to zero reflects a highly competitive market. A number of recent studies have pointed out that the Lerner Index is a beneficial index that thoroughly measures individual bank-level behavior.

PRH has different values, which leads to different interpretations of bank conduct. The interpretation is specified in Tables 1 and 2.

Table 1. Classifying market power of industries with the Lerner Index (LI).

Market Power	Value
Monopoly	$L = 1$
Perfect Competition	$L = 0$

Source: (Lipczynski et al. 2017, p. 74).

Table 2. Classifying industries with Panzar–Rosse H statistic (PRH).

Market Structure	Value of PRH
Monopoly	$H \leq 0$
Monopolistic Competition	$0 < H < 1$
Perfect Competition	$H = 1$

Source: (Lipczynski et al. 2017, p. 374).

4.3. Data Descriptions

This study uses quarterly panel data on bank balance sheets and income statements from Q1 2001 to Q1 2019, which is the period after the end of the International Monetary Fund (IMF) bailout program. The data are available online from the Securities and Exchange Commission (SEC) of Thailand. Other financial institutions, such as financial companies, securities companies, foreign bank branches, and

[12] See Appendix A.

state enterprise banks, are excluded from the study because they are dissimilar in business scope, capital structure, and regulatory environment. The sample is an unbalanced panel totaling 795 observations. The descriptive statistics of the variables used in the empirical specification are reported in Table 3.

Table 3. Descriptive statistics of variables used to calculate the indices.

Variable	Description	Mean	SD	Min	Max
Total revenue (1)	Sum of interest income and non-interest income	13,452.35	12,271.11	27.58752	47,932.95
Total cost (1)	Sum of interest expenses, personal expenses, and other operating expenses	8756.12	7257.953	23.24	27,853.04
Revenue share to total cost (2)	Total revenue to total cost ratio	1.47	0.31	0.4	2.88
Bank output (1)	Sum of loans and other earning assets	885,558.60	813,554.80	8360.36	3,106,581
Price of deposits (2)	Interest expenses to total deposits ratio	7.63	4.73	2.06	47.64
Price of labor (2)	Personal expenses to total assets ratio	0.002	0.001	0.000	0.035
Price of capital (2)	Other operating expenses to total fixed assets ratio	0.1	0.08	−0.11	0.95
Total equity (1)	Sum of bank's equity	87,645.94	92,685.39	109.44	413,378.9
Total assets (1)	Sum of bank's total assets	900,147.70	819,463.20	308.48	3,071,110
Equity to total assets (2)	Equity to total assets ratio	0.01	0.04	0.01	0.35
Loans to total assets (2)	Loans to total assets ratio	0.71	0.11	0.19	1.01
Other operating income to total assets (2)	Other operating income to total assets ratio	0.00	0.00	−0.01	0.04

(1) Constant million THB; (2) ratio, 796 observations.

5. Empirical Results

As outlined in the introduction, it has been not entirely clear which competition indicators are suitable for the Thai banking industry. This section begins to analyze outcomes of the structural and nonstructural approach. The explanations of both approaches are based on an analysis of trends and the value of each indicator in order to interpret competitive behaviors and identify the best measurement, and the implications of proceeding with policies for banks.

5.1. Structural Approach

Figure 1 presents trends of the indicators CR_5 and HHI during Q1 2001 to Q1 2019. The CR_5 has an upward trend, which means that the Thai banking industry tends to be more concentrated and less competitive over time. In contrast to the CR_5, the HHI shows a downward trend, which means that the Thai banking industry tends to be less concentrated and more competitive over time.

Average values of the CR_5 and HHI are presented in Table 4. The CR_5 has an average value of 0.91 and a range of 0.83 to 0.95. The HHI has an average value of 0.15 and a range of 0.14 to 0.18. In comparison, the CR_5 shows that the Thai banking industry is nearly noncompetitive, whereas the HHI reveals moderate competition. Interestingly, it is obvious that even though both the CR_5 and the HHI are under the same approach, the results present the tendency of Thai banking competition in different ways.

Table 4. Outcomes of concentration ratio (CR_5) and Herfindahl–Hirschman Index (HHI).

Indicator	Mean	SD	Min	Max
CR_5	0.91	0.04	0.83	0.95
HHI	0.15	0.01	0.14	0.18

Author's calculation.

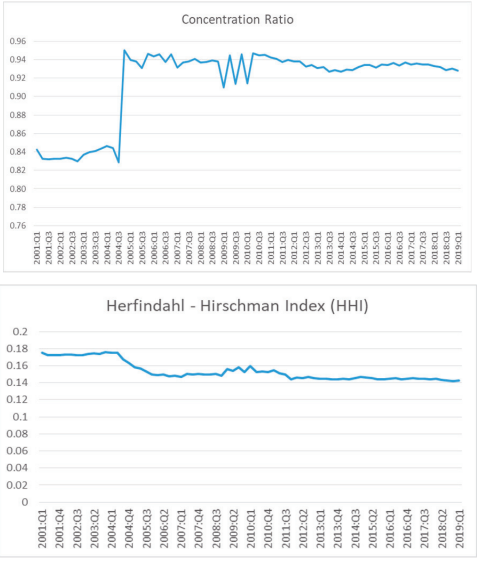

Figure 1. Trends of bank competition under the structural approach. Source: Authors' calculation.

At this point, with regard to the different results of the CR_5 and HHI, it is significant to discuss why they assess competition in different ways and which indicator can accurately measure a fit state of competition in the Thai banking sector. Based on the structural approach, the explanation of different outcomes can be divided into two reasons. The first is derived from the formulation for calculating of these indicators. The calculation of the CR_5 considers the asset shares of the five largest banks only. Other banks seem to lack consideration. Thus, if there has a change in bank assets outside the largest five banks, the CR_5 would fail to explain the characters of banking market structure accurately. Meanwhile, the HHI considers the asset shares and size distribution of all banks in the banking system. Hence, it can capture all structural changes within the industry. The second is the facts that Thai banking industry experienced changes in size distribution many times during the period of this study. Besides, the changes originated from outside the top five banks. The Thai banking industry crucially changed from the significant circumstances of mergers and acquisitions activities, such as Bank of Asia and UOB Ratanasin bank merging with United Overseas Bank, and CIMB acquiring Bank Thai. Additionally, medium-size banks, including Bank of Ayudhya (BAY), Thai Military Bank (TMB), and Thanachart bank (TBANK), accepted a share acquisition in order to target the strengths and capture market synergies. Moreover, three new banks entered the industry during 2005–2007, TISCO, LH, and TCR respectively. This reflects a change in the size distribution of the banking sector, which is a key consideration for using the concentration measure. Obviously, these changes occurred sporadically outside the five largest banks. According to the above reasons, we may not conclude that HHI is the best measurement of the Thai banking competition under the structural approach. This is because the theory underlying of this approach, which is the SPC paradigm has been heavily criticized. It has been attacked by the contestable theory, which states that even if market structure is characterized as highly concentrated, it can behave competitively if obstacles to entry and exit are low. The SPC paradigm states that market structure can determine firm's behavior then the behavior can determine profitability. If banking market characterized as a high concentration, the level of collusion will increase, contributing to high profitability, which implies lower competition. In case of Thailand, the outcome of CR_5 and HHI presents a very high level of concentration in banking market. Furthermore, the results is remarkably similar to actual data of market shares, which proxy by total assets in Thai banking

sector. As can be seen in Figure 2, the market shares of top five banks are BBL18%, SCB 17%, KBANK and KTB 16%, and BAY 12%.

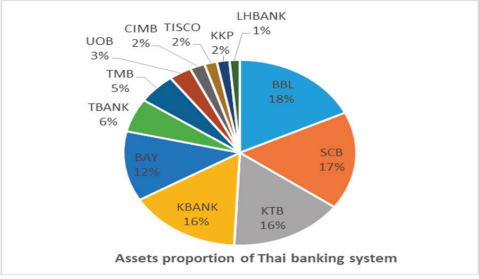

Figure 2. Market share of Thai banking sector during 2001–2009. Source: the security and exchange commission, Thailand (SEC). (www.sec.or.th 2020).

It can be conclude that market structure of the banking sector in Thailand is considerably concentrated therefore it possibly contribute high bank's profitability according to the SPC paradigm. However, when we consider the Net Interest Margin: NIM (see Figure 3), which is a proxy for reflecting bank's profitability. It is obvious that the bank profitability tends to stable which not represents high profitability and also contradicts to the SPC theory. Moreover, this disaggregate data of the NIM indicates that each bank is less likely to set its interest rates different from other banks. The more concentrated in Thai banking sector might not determine bank's market power. Therefore, competition level in Thai banking sector cannot identify based on the structural approach. For these reasons, in view of the structural approach, this study concludes that the indicators, which measure from the structural approach are not suitable for interpretation of competitive environment in the Thai banking sector.

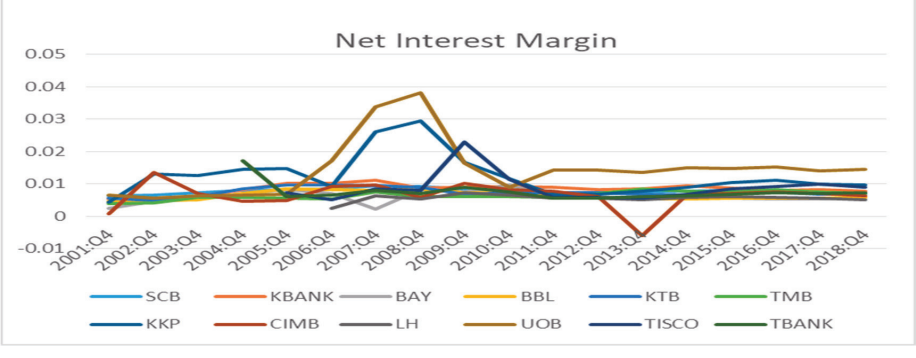

Figure 3. Net interest margin disaggregated by individual banks over the period 2001–2018. Source: Authors' calculation.

5.2. Nonstructural Approach

Under the nonstructural approach, the indicators LI and PRH are used as empirical measures of competition in the Thai banking industry. Assessing competition by the PRH has limitations for trend analysis, because it can observe only one outcome of competition on the long-run equilibrium. However, it is tremendously useful for cross-country studies, as widely applied in much of the literature. With regard to average value analysis, the PRH (see Table 5) has an average value of 0.17 over the period of study (Q1 2001 to Q1 2019). It can be inferred that the Thai banking industry has moderate competitive behavior among banks.

Table 5. Outcomes of PRH and LI. SFA, stochastic frontier analysis.

Approach	Indicator	Mean	SD	Min	Max
Nonstructural	Panzar–Rosse H statistic	0.17	0.03	-	-
	Lerner Index (SFA method)	0.40	0.03	0.36	0.60
	Lerner Index (traditional method)	0.37	0.17	−1.25	0.69

Author's calculation.

In addition to the PRH, calculation by the LI in this study is divided into two methods, traditional and stochastic frontier. A trend analysis is illustrated in Figure 4. Regarding the SFA method, the average LI presents a downward trend, which means a decline of market power and a tendency toward more competition over time. On the other hand, the traditional LI shows an upward trend, though somewhat fluctuating, which indicates a rise in bank market power and a decrease in bank competition. The average value of the LI (see Table 5) obtained from the SFA method is 0.40, and it varies from 0.36 to 0.60. The average value using the traditional method is relatively close to that of the SFA method at 0.37, while the range is quite wide, −1.25 to 0.69. The average values of the LI calculated by the two methods are quite similar, while the ranges are very different. The range values of LI (SFA) is more reliable than LI (FE), since the theoretical concept states the range value between zero to one. Zero value defined as perfect competition and value of one defined as pure monopoly. Outside the range of zero to one cannot be defined about competition level. In addition, the range of values, which below to zero or exceed unity can be indicated the market power as well. However this study only specifies the best measurement for evaluating the level of competition in Thai banking sector. Moreover, the average values of LI (SFA) equal to 0.4 is adjacent to zero which implies as competitive in the sector. As a result, we believe that LI(SFA) is greater explained the study of competition in Thai banking sector.

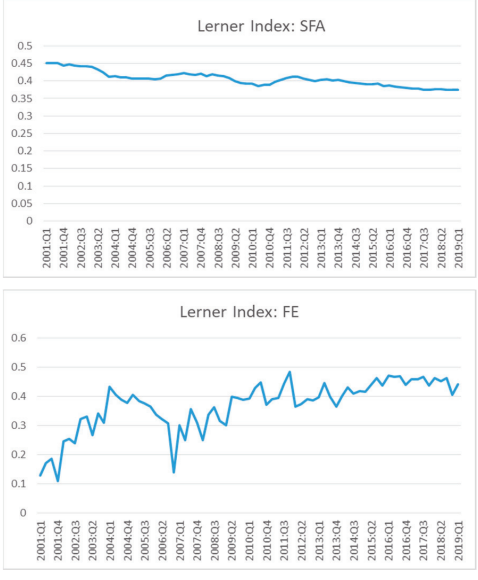

Figure 4. Trends of bank competition under the nonstructural approach. Source: Authors' calculation.

Calculating the three indicators produces different outcomes, which causes a problem in interpreting the competitive environment. Therefore, this study attempts to identify the best indicator that can accurately measure competition in the Thai banking industry. For the result of the PRH, since this indicator is valid in the long–run equilibrium condition, which is hard to achieve. It has

been argued that using the H statistic can result in bias (Claessens and Laeven 2003; Shaffer 1983). Bikker et al. (2006) claim that there is misspecification of the calculation of the H statistic. They found that the use the ratio of total income to total asset as the endogenous variable when calculating the H statistic will lead to an overestimation of the competition degree. In addition, Claessens and Laeven (2003) point out that this statistics tends to be biased when the bank sample size is very small (below 20 banks). At this point, because of the small sample size of the Thai banking sector (12 banks), the LI is appropriate as a reliable indicator to represent competition.

Regarding the outcomes obtained from empirical measurement of the LI, the calculation by the SFA method is considered to be a suitable technique for the Thai banking industry. The reasons can be divided into two aspects, the first aspects is all the non-negative value of the LI (SFA). In an explanation of competition, the negative values can explain the bank's market power but cannot interpret competition level. Some studies point out that the negative value of LI can occur when markup price is lower than marginal cost in the short run. However, no conclusions can be drawn about competitive environment under the negative value of LI (FE). The second aspect is correlation between the LI, calculating from SFA method, and banking industry-specification of Thailand. Banking industry-specification can be divide into five variables (see Ghosh 2018). Bank profitability is represented by return of assets (ROA), which is defined as bank's net income after-tax to average total assets. It is expected a positive relationship between LI (SFA) and bank's profitability. The higher competition stems from the lower profitability ratio. This matters to lower value of LI (SFA). Diversification is defined by share of non-interest income to total income. It is expected a negative relationship between LI (SFA) and bank's diversification. The higher competition is caused by the higher non-interest incomes to total incomes ratio. Due to the facts that banks can expand their variety of financial services which is fostering competitive environment. This matters to the lower value of LI (SFA). Cost efficiency is represented by bank cost to income ratio, which is defined as the share of bank's operating expenses to banks total revenues. It is expected a negative relationship between LI (SFA) and the cost efficiency. The higher competition is a consequence of the less effective costs (a high value of cost-to-income ratio), leading to higher marginal cost and lower profits. This matter refers to the lower value of LI (SFA). Capitalization is represented by total equity capital to assets ratio. It is expected a positive relationship between LI and the capitalization. The higher competitive environment is due to lower capitalization, which contributes to lower the bank's market power. This matter refers to the lower value of LI (SFA). As can be seen in Appendix B Table A1, Correlation between LI (SFA) and bank's profitability, capitalization, diversification variables are statistically significant at 1%. In addition, correlation between LI (SFA) and bank's cost efficiency is statistically significant at 5%. All these variables have relationship as expected, except for capitalization. This reflects to the fact that the high bank capital structure may not leads to the high market power in the Thai banking industry. Additionally, as the Thai economy depends heavily from banking sector, the higher competition should be caused the economic growth. Thus a negative relationship is hypothesized between GDP and the LI (SFA). The result reports that correlation between the LI (SFA) and GDP is positive and significant at level 1%. Up to this point, this study concludes that using competition measurement by the structural approach, which are CR_5 and HHI indicator may ineffective in the context of Thai banking sectors. The non-structural approach, which is LI calculated by the SFA method is a good indicator of interpretation of Thai banking industry.

6. Conclusions

Thailand is one of developing countries, which the banking industry plays a significant role in the economy because banks hold a large amount of financial assets and their business activities are related to economic agents, which are household savings and business sector investments. At this point, this sector is regulated by policy-makers, therefore a change in its competitive environment could significantly affect not only the economy but also policy effectiveness.

For the above reason, this paper was aimed at computing the competition indices in the Thai banking sector during the period from Q1 2001 to Q1 2019 by using bank-level data. We focused on the

four indicators of competition that are usually found in the banking literature: the concentration ratio of the five largest banks (CR_5), the Herfindahl–Hirschman Index (HHI), the Lerner Index (LI), and Panzar–Rosse H statistic (PRH). Several methods were employed to gauge the degree of competition through these specific indicators. Since the indicators have different factors and methods, their outcomes may be inconsistent. Furthermore, numerous studies have used one indicator over another, although there is no consensus on which one is better for the Thai banking sector. The findings of this study indicate that measuring competition based on the structural approach is inappropriate in the context of Thai economy. One of the key reason is the result from empirical measurement incompatible with the SPC paradigm. Thai banking sectors characterize as a high concentrated banking system while the net interest margin of banks are not difference and the number of banks are limited. The high concentration may not lead to high profitability behavior of banks. Therefore, to measure bank competition by using this approach may causes to misleading.

With regard to the nonstructural approach, we found that the Lerner Index calculated by the stochastic frontier method represents a useful indicator. This is because all values of Lerner Index from this method reveal a non-negative value, which can explain bank competition by implying from the market power values. Besides, the inference of the competitive environment in the banking industry is consistent with the true circumstances and character of Thai banking system.

The role of competition in the banking sector has some special properties that differ from other industries. Competition among banks is important for the efficiency of the industry, similar to other industries. At the same time, the stability of the banking system is also crucial for effective supervision. The trend in the Thai banking industry today is moving toward digital banking. This digital transformation is leading to a change in the competitive environment. Policy-makers should consider the effect of the change when controlling and regulating monetary policy. If they do not carefully control the competitive environment in the country, it will probably raise inefficiency or instability in the economy. This paper provides a better understanding of competition indicators for the Thai banking sector. It will useful for further study in order to test the efficiency of this industry or the effectiveness of monetary policy through this sector in Thailand by using the reliable indicators shown in this study. However, there are some limitations in this paper: in addition to market power and industrial concentration, the level of competition can be measured in different dimensions, such as product differentiation, barriers to entry and exit, numbers of buyers and sellers, level of technological progress, level of access to banking services, and level of information. Thus, further research could extend the investigation in this area by focusing on other approaches.

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Appendix A

Appendix A.1. Stochastic Frontier Model

Stochastic frontier analysis (SFA) is usefully employed to calculate the Lerner Index in Section 4. The stochastic frontier model can capture distance, which represents technical inefficiency in the production function in the banking industry.

The model specification can be written as

$$lny_{it} = \alpha + x_{it}'\beta + v_{it} + u_{it} i = 1, 2, \ldots, N, \text{ and } t = 1, 2, \ldots, T \quad \text{(A1)}$$

where i represents a bank and t represents time, y_{it} is a dependent variable, α is an intercept term, x_{it} stands for the $(k \times 1)$ vector of independent variables, β stands for the $(k \times 1)$ vector of coefficients, v_{it} is a disturbance term, and u_{it} stands for technical inefficiency (TE).

Technical inefficiency, u_{it}, should have a non-negative value in this analysis because the key consideration in this study is cost minimization. In general, firms should be setting their output prices over their costs. In a perfect competitive market, the setup prices of firms should be equal to the marginal cost of production, which reflects the lowest possible value of the firm. The cost minimization frontier problem represents the lowest boundary of a firm in any produced output. There is no possibility to set prices lower than the marginal cost in a competitive market because it will cause firms to leave the market. In other words, the frontier illustrates the technical efficiency of setting up prices in the market. However, in general situations, prices can be marked up higher than marginal costs due to higher market power of firms, differentiated products, and asymmetric information of buyers and sellers. This circumstance will reflect the technical inefficiency of the market, which is represented by output prices higher than efficiency cost at any output level. Hence, the distance between markup prices and the lowest boundary of the frontier will show the non-negative value of technical inefficiency.

However, Equation (A1) cannot be directly estimated by ordinary least squares (OLS) because there are two error components. Estimating by OLS will lead to inconsistent estimators and unpredictable technical efficiency. The maximum likelihood (ML) method is more widely used in this modelling. Some additional assumptions are required for the two error components, as follows:

1. The probability density function (PDF) of the disturbance term has symmetric distribution.
2. The two component errors, v_{it} and u_{it}, are statistically independent of each other.
3. The two component errors, v_{it} and u_{it}, are independent and distributed across observations.

Therefore, based on the above assumptions, it is necessary to form a joint density function of v_{it} and u_{it}, which can be written as

$$f_{v,u}(v_{it}, u_{it}) = f_v(v_{it}) f_u(u_{it}) \tag{A2}$$

where $f_v(v_{it})$ is the PDF of the error term and $f_u(u_{it})$ is the PDF of the technical inefficiency. Then, Equation (A2) can be formulated as

$$f_{\varepsilon,u}(\varepsilon_{it}, u_{it}) = f_v(\varepsilon_{it} - u_{it}) f_u(u_{it}) \tag{A3}$$

where $\varepsilon_{it} = v_{it} + u_{it}$. Note that the Jacobian transformation from (v_{it}, u_{it}) to $(\varepsilon_{it}, u_{it})$ is equal to 1. To find the probability density function of ε_{it}, the values of u_{it} need to be integrated out of Equation (A3). Then we get the marginal PDF of ε_{it} as

$$f_\varepsilon(\varepsilon_{it}) = \int_0^\infty f_u(u_{it}) f_v(\varepsilon_{it} - u_{it}) du_{it}. \tag{A4}$$

From Equation (A4), the log likelihood function is as follows:

$$lnL\left(\alpha, \beta, \sigma_u^2, \sigma_v^2 \middle| ln y_{it}, x_{it}\right) = ln f_\varepsilon\left(y_{it} - \alpha - x_{it}'\beta \middle| \sigma_u^2, \sigma_v^2\right). \tag{A5}$$

From Equation (A5), estimation by ML can obtain consistent estimators and predict the technical inefficiency. In this study, half-normal distribution is assumed for the technical inefficiency.

Appendix A.2. Fixed Effects Model

According to the measure of banking competition through the traditional Lerner Index in Section 4, the fixed effects model can be used to estimate the total cost function (Fungáčová et al. 2013). The model specification can be written as

$$y_{it} = x_{it}'\beta + c_i + u_{it} i = 1, 2, \ldots, N \text{ and } t = 1, 2, \ldots, T \tag{A6}$$

where i represents a bank and t represents time, y_{it} is a dependent variable, x_{it} stands for the $(k \times 1)$ vector of independent variables, β stands for the $(k \times 1)$ vector of coefficients, c_i stands for the time-invariant unobserved effect, and u_{it} is a disturbance term, which is assumed to be identically and independently distributed (i.i.d.).

Under the fixed effect approach, c_i is assumed to be correlated with the independent variable (x_{it}), which causes an endogeneity problem. In general, an instrumental variable is a useful tool in order to solve the problem. However, instrumental variables cannot apply in this case. This is because c_i is unobservable.

Since c_i cannot be estimated, the model should be transformed to eliminate the unobserved effect variables by taking mean difference[13] with Equation (A6), which can be written as

$$y_{it} - y_i = (x_{it} - x_i)'\beta + (u_{it} - u_i),\ i = 1, 2, \ldots, N \text{ and } t = 1, 2, \ldots, T \tag{A7}$$

where y_i is $\frac{1}{T}\sum_{t=1}^{T} y_{it}$, x_i is $\frac{1}{T}\sum_{t=1}^{T} x_{it}$, and u_i is $\frac{1}{T}\sum_{t=1}^{T} u_{it}$. Then, Equation (A7) can be estimated by OLS; the estimated parameters are unbiased and consistent properties (Wooldridge 2010).

Appendix A.3. Dynamic Panel Model

According to the measure of bank competition by the PRH in Section 4, the dynamic panel model is employed to estimate the elasticity of total revenue with respect to input factors. Following Olivero et al. (2011), the model specification can be written as

$$y_{it} = \rho y_{it-1} + x_{it}'\beta + c_i + u_{it},\ i = 1, 2, \ldots, N \text{ and } t = 1, 2, \ldots, T \tag{A8}$$

where i represents a bank and t represents time, y_{it} is a dependent variable, y_{it-1} is a lagged dependent variable, ρ stands for coefficients corresponding to a lagged dependent variable, x_{it} stands for the $(k \times 1)$ vector of independent variables, β stands for the $(k \times 1)$ vector of coefficients, c_i stands for the time-invariant unobserved effect, and u_{it} is a disturbance term, which is assumed to be iid. The assumption of the unobserved effect variable c_i is similar to Equation (A6). Therefore, by taking the first difference of Equation (A8), the model can be written as follows:

$$y_{it} = \rho y_{it-1} + x_{it}'\beta + u_{it},\ i = 1, 2, \ldots, N \text{ and } t = 1, 2, \ldots, T \tag{A9}$$

where y_{it} stands for $(y_{it} - y_{it-1})$, y_{it-1} stands for $(y_{it-1} - y_{it-2})$, x_{it} stands for $(x_{it} - x_{it-1})$, and u_{it} stands for $(u_{it} - u_{it-1})$. However, there is a correlation between the explanatory variable (y_{it-1}) and the error term (u_{it}), which produces an inconsistent estimated coefficient. Although sequential exogeneity is assumed, the problem still occurs: $E(y_{it-1}, u_{it}) \neq 0$.

In general, Anderson and Hsiao (1981) suggested that in order to obtain efficient estimators, the valid instrument variable should be y_{it-2}, which not only is uncorrelated with $(u_{it} - u_{it-1})$ but also has high correlation with y_{it-1} Besides, to gain more efficient estimators, Arellano and Bond (1991) indicated that adding instrumental variables in the first differenced equation is the best way to

[13] Note that there are alternative ways to transform the model by taking the first difference as well.

improve model efficiency. The available instrumental variable, as suggested by Arellano and Bond (1991), should be $Z = (y_{it-2}, y_{it-3}, \ldots, y_{i1})$. However, using many instrumental variables will cause an overidentification problem. Equation (A9) can be estimated by generalized method of moments (GMM). The estimated parameters will be consistent (Cameron and Trivedi 2005).

Appendix B

Table A1. Correlation between LI (SFA) and banking industry-specification.

Variables	Correlation	*p*-Value
GDP	−0.5415	0.0000
Profitability	0.1914	0.0000
Capitalization	0.6591	0.0000
Diversification	−0.3921	0.0000
Cost efficiency	−0.0852	0.0166

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The Impacts of China–Africa Economic Relation on Factor Productivity of African Countries

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Abstract: This study attempts to empirically examine the impacts of the China–Africa economic relationship on factor productivity. The two-step system Generalized method of moments (GMM) estimator is applied to analyze the impacts of the Africa–China economic relationship on factor productivity of 44 African countries controlling Africa–China trade, Chinese foreign direct investment (FDI), and aid allocation to African countries for the periods 2003–2017. The estimation strategy controls endogeneity concerns. Another novelty of this study is calculating total factor productivity (TFP) using the regression approach and driving capital stock data. Additionally, the institutional quality index of countries is derived using principal component analysis. The findings of this study refer that the impact of the China–Africa economic relationship on the TFP of African countries is conditional to the domestic institutional quality of African countries. The results imply that the productivity embodied by the Africa–China economic relationship should be backed by the domestic adaptive capacity to use the benefit of China–Africa economic relations to excel factor productivity. Hence, the capability of African countries to benefit from the China–Africa economic relationship to enhance factor productivity should improve the institutional quality.

Keywords: economic relationship; TFP; system GMM; China–Africa

JEL Classification: F35; F41

1. Introduction

For developing nations, like African countries, the adoption of technology from the international market is vital, since it might be the only way for them to improve their productivity growth and technical progress. The nexus of openness and factor productivity in terms of attracting foreign direct investment (FDI), aid allocation and trade openness to enhance the factor productivity of the domestic economy is essential to study. The impacts of foreign trade and FDI on economic growth and development flow to the FDI and trade partner countries indirectly speeds up productivity growth through fostering technological transfer from a technologically innovative developed economy to less technologically innovative developing countries (Blomstrom 1986; Busse and Königer 2012). Particularly, trade and investment in capital goods, technological inputs and equipment related to foreign research and development can improve the productivity of importing countries by being integrated into production processes (Lucas 1988; Le 2008; Alcala and Ciccone 2004). Besides, technology transfer through international trade and the FDI takes on even more importance for productivity growth in developing countries, including African countries, as they undertake minimal domestic research and development (Henry et al. 2009).

The impact of China–Africa economic relation on the total factor productivity (TFP) of African countries is debatable. For example, some scholars argue that the trade relationship between Africa and China has an insignificant or negative effect on factor productivity and economic growth for

African countries and is more dominated by China's economic interests to access critical resources (Adisu et al. 2010; Busse et al. 2016). As well as this, some researchers argue that Africa's trade with China is centered on Chinese interest in Africa and is deteriorating the African economy. Conversely, others consider that Africa's trade with China is benefiting Africa by triggering its economic growth. Additionally, Elu and Price (2010) found that increasing trade with China had no direct effect on the country's total productivity. It might even negatively affect total productivity, making it harder for Africans to work toward industrialization. Furthermore, they found that for Sub-Saharan manufacturing firms, increasing their trade with China does not help them transfer technology and managerial know-how and skills that enhance firm-level productivity.

The extent of productivity spillover and skill transfer by Chinese companies to host countries is a crucial topic of debate. Foster et al. (2008) argue that Chinese FDI in Africa has little skills transfer to Africans. Shen (2013) also finds that private Chinese FDI has a negative impact on technological transfer. Likewise, Wang et al. (2014) argue that Chinese FDI is currently domestic-oriented to enhance domestic productivity and strengthen domestic production in China. Thus, technology transfers to host countries from Chinese FDI are limited.

China–Africa economic relations can also be revealed in terms of Chinese financial aid to African countries. A number of studies have been conducted regarding the motives of the financial aid (Dreher and Fuchs 2015), its effect on the African economy (Sun 2014; Busse et al. 2016) and the link among Chinese aid, FDI and trade activities (Sanfilippo 2010). However, empirical studies on the nexus of Chinese financial aid and total factor productivity of African countries are limited.

Therefore, the major objective of this study is to analyze the impacts of the China–Africa economic relationship on the TFP of African countries. More specifically, it is mainly concerned with the impacts of China–Africa trade, Chinese FDI, and financial aid to Africa on the TFP of African countries. Besides, the absorptive capacity of African countries in terms of institutional quality is included in the study, using the interaction terms of institutional quality indicators with the China–Africa economic relationship. Likewise, interaction among China–Africa trade, Chinese aid and FDI are examined, as Chinese financial aid and trade have interacted with FDI, and one instrument conditioned the other one.

This study is crucial for a few reasons. First, it examines the impacts of the China–Africa economic relationship on the TFP for 44 African countries, emphasizing the China–Africa economic interaction instruments, which is an under-researched topic. Second, we employ the two-step system GMM estimator that helps control the endogeneity concern. Third, it examined the mediating role of African countries' institutional quality in the nexus of the China–Africa economic relationship and TFP of African countries. Fourth, it also examined the complementary of China–Africa trade, Chinese FDI, and aid to African countries, as they are mixed and affect each other. Finally, given the significance of the China–Africa economic relationship, this study provides a policy framework and foundation for further intensifying the Africa–China economic linkage. Besides this, the study will provide a sound basis for further research on the China–Africa economic relationship. To preview our main results, we found that the impacts of China–Africa trade, Chinese FDI, and aid allocation to African countries on TFP of African countries are conditional to African countries' domestic absorptive capacity.

The rest of this paper is organized as follows. Part two presents the stylized facts of China–Africa economic relationship. Part three discusses the literature review. Part four explains the data and methodology of the study. Part five presents the results and findings of the study, and part six gives discussions and policy implications.

2. Stylized Facts of China–Africa Economic Relationship

2.1. Overview of China–Africa Trade

China has a long trade relationship with African countries. However, the fastest growing of trade between African countries and China has been registered in the last two decades. Trade between China

and Africa has been increased at the fastest rate since 2000. Total trade between Africa and China has registered a compound growth rate of 24.7% in the last two decades. In general, Africa is much more dependent on China for trade. The pattern of China–Africa trade is depicted in Figure 1 below.

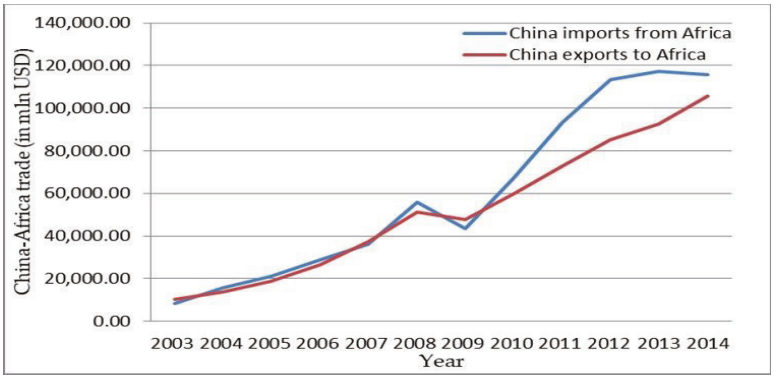

Figure 1. Africa–China trade. Note: Computed by authors based on data from Global Trade Atlas.

Trade between African countries and China can be split in to imports from China and exports to China from African countries. The major commodities African countries imported from China for the last two decades have been electronic equipment, machinery, clothing and textile goods, transport materials, footwear and plastic commodities (see Figure 2). Among these commodities, electronic equipment and machinery import were first in share. Clothing and textile, transport equipment and materials, footwear and plastic products imported from China to African countries have also increased significantly (Tralac 2014), for example, the imports of some countries such as Algeria, Central Africa Republic, Chad, Ethiopia, Mali, Rwanda, Zambia and Zimbabwe Trucks, tractors and motor vehicles for the transport, television receivers and electric app for line telephony. Additionally, countries like Benin, Gambia, Madagascar, Mauritania, Tanzania and Togo imported textile and clothing products.

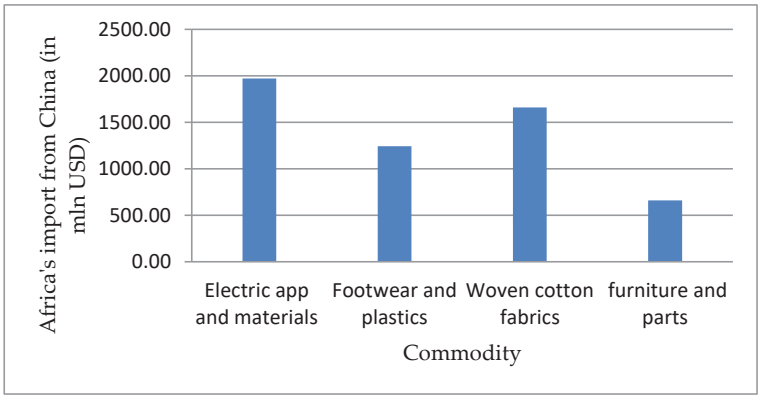

Figure 2. Composition of import of Africa from China. Note: Authors' own calculation based on data compiled by Trade and Law Centre, Africa–China.

Regarding the export of African countries to China, it was concentrated on mineral products, base metals, precious stones, other unclassified primary commodities, with only a few shares of textiles and clothes. The composition of African countries' exports to China has been reported in Figure 3 below.

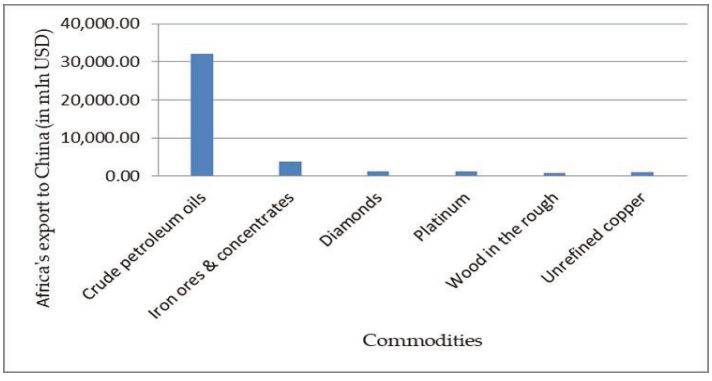

Figure 3. Composition of Africa's export to China. Note: Authors' own calculation based on data compiled by Trade and Law Centre, Africa–China.

Figure 3 above shows that more than 58% of total Africa's export to China is primarily mineral products such as crude oil, natural gas and copper. The major exporting African countries to China are South Africa, Sudan, Angola, Democratic Republic of Congo and Equatorial Guinea, which are relatively abundant in natural resources and minerals.

Furthermore, the China–Africa trade has grown significantly compared to Africa's traditional trade partners. The average share of Africa's foreign trade with its three major trading partners—the US, EU and China—was 49%, having a percent share of 9, 30 and 10, respectively, for the last two decades. The share is almost half of Africa's total trade with its all trade partners (see Figure 4).

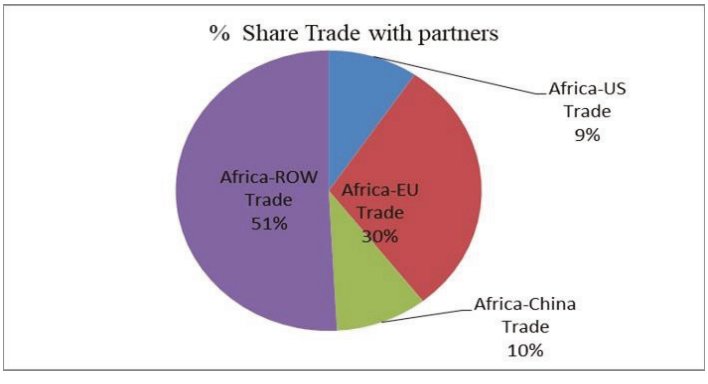

Figure 4. The percentage share of trade with partners. Note: computed by authors.

The average growth rate of total trade between Africa and China was the highest compared to Africa's trade with the United States and European Union countries. China–Africa trade was grown at the fastest rate since 2000, achieving over 209 billion USD in 2013, more than double the Africa–US bilateral trade (Tralac 2014). As we can see from the trend of growth, the gap between the Africa–China and Africa–US bilateral trade is also growing. The growth rate of total trade between Africa and China is growing faster than the growth rate of trade between Africa and the European Union. In terms of volume, however, Africa's trade with the European Union member countries is at the top (see Figure 5).

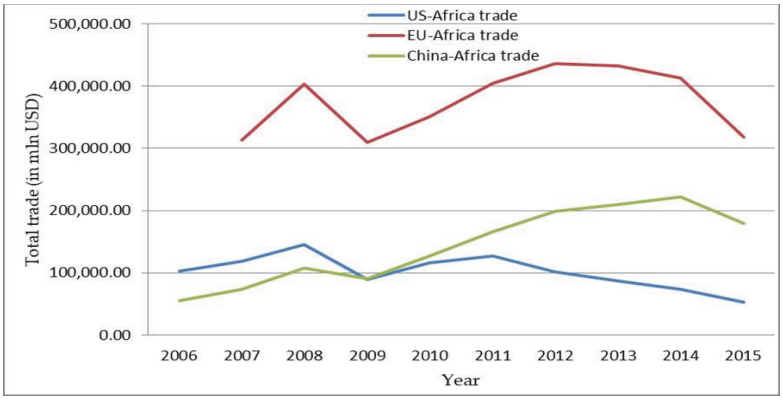

Figure 5. The pattern of Africa's trade with major trade partners. Note: calculated by authors based on data for Africa–US trade from the Census Bureau and Africa–China from Global Trade Atlas.

2.2. Chinese FDI Flow to African Countries

Chinese FDI reaches almost all African countries, including those that do not have a formal diplomatic relationship with China (São Tomé and Príncipe). This indicates that Chinese outward foreign direct investment plays a prominent role in China's economic interaction with many African countries. Furthermore, this strong interrelationship between Chinese foreign direct investment and economic cooperation indicates China's significant role in African countries' economic arena. However, the bulk of Chinese investment is focused on a few resource-rich countries and slow expansion to resource-poor countries (Pigato and Tang 2015). A host country's natural resources have a significant contribution to China's decision on the actual amount to invest in the country; it does not affect its decision as to whether to invest in the country or not (Sanfilippo 2010; Rian and Blomkvist 2013; Kolstad and Wiig 2011; Ming 2010). As one can observe from Figure 6 below, South Africa is the top destination, followed by Nigeria, Zambia, Angola, Sudan and the Democratic Republic of Congo. Meanwhile, state-owned enterprises are prominent in China's natural resource and energy industries and have dominated this form of Chinese investment within Sub-Saharan African countries.

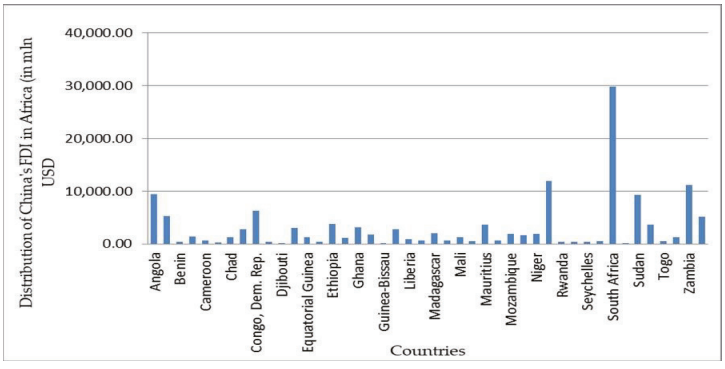

Figure 6. Distribution of Chinese FDI in Africa. Note: Authors' computation from China–Africa Research Initiative AidData.

For example, in 2014, 50% of China's FDI stock in Africa was allocated to only six African countries, with South Africa having the largest share at 18%. Interestingly, the other five countries, such as Algeria, Nigeria, Zambia, the Democratic Republic of the Congo, and Sudan, are all resource-rich

countries. The report attributes this trend to the Chinese central government state-owned enterprises' focus on the petroleum and non-ferrous metals sectors.

Chinese companies have increasingly been locating in Nigeria. As of 2013, according to the local investment agency, there were 208 registered Chinese companies in Nigeria focusing on oil and gas, construction and telecommunication (Umejei 2015).

However, the flows of FDI to the top five countries have been declining since 2011, an indication that Chinese FDI in Africa has started to diversify away from resource-rich countries into other economies in Africa. Moreover, while the top countries possess significant natural resources, these are not necessarily the main reasons for the Chinese investment presence. For example, the surge of Chinese FDI flows to South Africa was driven by the one-time purchase of shares in Standard Bank, as described above. In contrast, Chinese investment in Nigeria is not limited to oil, given that the majority of Nigeria's oil investment is from Dutch, Italian and American companies and the diversity of Chinese investment activities as described by Chen et al. (2018).

2.3. Chinese Aid Allocation to African Countries

Chinese aid covered about 20 percent of the total financial aid of the committee of Organization for Economic Cooperation and Development's Development Assistance for the periods between 2001 and 2011. In contrast to Western countries' foreign aid, which comes primarily in the form of direct money and material transfers, Chinese foreign aid comprises primarily of quick, flexible, and predominantly unconditional export credits and infrastructure investment loans (Wang et al. 2014).

Africa is one of China's most emphasized regions to receive Chinese foreign financial assistance. Since the launch of the Forum on China–Africa Cooperation (FOCAC) in 2000, Chinese official development assistance to African countries has increased significantly. In 2009, China allocated 47% of its total foreign development assistance to African countries. This was almost half of total Chinese foreign financial assistance, indicating that Africa is the top destination for Chinese aid allocation. The top five Chinese aid receipt African countries from 2000–2013 were Mozambique, Zimbabwe, Gambia, Ivory Coast and Egypt (see Figure 7).

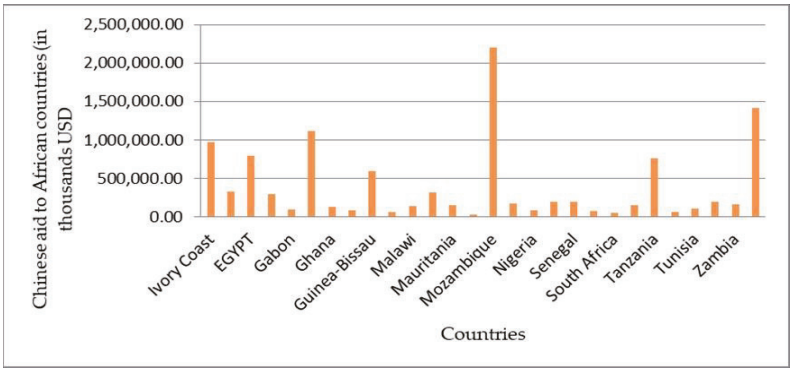

Figure 7. Chinese financial aid to Africa. Note: Computed by the author from China–Africa Research Initiative AidData.

In comparison, Chinese governments, banks, and contractors extended loans totaling 86.9 billion US dollars to African governments and state-owned enterprises between 2000 and 2014. Of this, 24.2 billion US dollars were for transportation, 17.6 billion US dollars for energy, and 9.0 billion US dollars for mining (Jyhjong et al. 2016). Fifty-four percent of Chinese loans in this period were made to five countries: Angola, Ethiopia, Sudan, Kenya and the Democratic Republic of Congo.

Lending to Angola is heavily tied to the country's oil, with about half of loans being made to the state-owned oil company and the other half being oil-backed infrastructure loans. In contrast, the loan

portfolio in Ethiopia is spread out across transportation, communications and energy (hydropower), among other sectors (Jyhjong et al. 2016). About 56% of China's loans to Africa from 2003 to 2011 were backed by commodities (Brautigam and Gallagher 2014). This has exposed their portfolio to serious risk in the face of falling oil prices and may prompt them to diversify their loan portfolio away from commodity—especially oil-backed lending (Gallagher et al. 2016).

According to a 2011 white paper on China's foreign aid, published by the State Council of China, Chinese foreign aid can fall into three categories: grants, interest-free loans and concessional loans (China Africa Research Initiative 2017). Grants are primarily used to assist recipient nations to construct hospitals, schools and low-cost homes, and assist well-digging or water-supply projects, as well as other small and medium social welfare projects. In addition, grants are used in projects in the areas of development cooperation, human resources, technical collaboration, and urgent humanitarian and in-kind assistance (China's Information Office of the State Council 2011).

Interest-free loans are primarily used to help loan recipient nations build public infrastructure and launch initiatives to enhance their livelihood. Usually, the tenure of such loans is 20 years, including ten years of repayment, five years of use, and five years of grace time. Interest-free loans are currently granted primarily to developing nations with comparatively excellent financial circumstances (China's Information Office of the State Council 2011).

Concessional loans are used fundamentally to assist loan recipient nations to undertake productive projects that generate social and economic opportunities as well as medium- and large-sized infrastructure projects or to provide mechanical and electrical products, complete plants, technical services and other equipment. Concessional loans are raised on the market by China's Export-Import Bank, and as the loan interest is smaller than the People's Bank of China's benchmark interest, the distinction is made up by the State as financial subsidies. Currently, China's concessional loans have an annual interest rate of between 2% and 3%, and the repayment period is generally 15 to 20 years (including 5 to 20 years) (China's Information Office of the State Council 2011).

Chinese aid comprises mainly quick, flexible and mainly unconditional export credits and infrastructure loans (often with little or no interest) (Wang et al. 2014). However, it is allocated in a number of sectors, and emergency and economic development. It is mainly allocated to different sectors such as health, communication, education, infrastructure, energy, agriculture, trade and tourism, banking and financial services (Guillon and Mathonnat 2017).

3. Literature Review and Hypothesis Development

3.1. China–Africa Trade and Total Factor Productivity

The impact of international trade on economic growth has been well studied following the endogenous growth model (Rivera-Batiz and Romer 1991). This theory argues that trade among countries is inclined to promote economic growth by positively affecting domestic productivity and taking advantage of economies of scale, which encourages specialization and productivity. This theory further gives the reason that trade openness stimulates competition, which forces local firms to innovate for higher production efficiency and improvement in production.

Douglas C. North formulated the export base theory based on the justification that foreign trade is an engine of growth. It stems from the notion within the export base theory that the growth of exports provides externality and productivity benefits to trading economies. This theory suggests that regional growth in output and employment is a function of exogenous demand for a region's exports, assuming a perfect elasticity of input supply and export demand (Leichenko 2009). Based on these reasons, international trade contributes to the development of economic sectors and industries by influencing the global allocation of economic resources among countries, including technology transfer. As a result, international trade can play an important role in determining global knowledge, skill, managerial know-how, and technology transfer.

According to the report by UNCTAD (2014), the impact of international trade on productivity improvement is based on two assumptions. The first assumption is that as goods and services are traded among countries, the technology embodied in them is transferred to trading countries. An essential part of the knowledge embodied in capital goods or necessary for their productive use is tacit knowledge, which is not easily transferable or not transferrable at all. The second assumption is that a significant determinant in technology and knowledge transfer is the cost of access. In this regard, the case for trade liberalization argues that reducing legal, regulatory and political barriers to trade, and in particular for goods that have a high technology component, would reduce the cost of technology and knowledge transfer. From this angle, restrictive trade practices limit the flow of goods and services and make it inherently costlier for local firms to adopt technologies embodied in the imported goods, while open trade encourages the flow of goods and services and may positively affect economic growth by lowering the barriers to technology and know-how adoption (UNCTAD 2014).

Based on this traditional perspective, a number of empirical studies have been conducted on the impact of trade on total factor productivity. For instance, the study by Mayer (2001) justifies that international trade, more especially, machinery and equipment relating to foreign research and development, is one of the ways to transfer technologies and productivity to trading countries. This analysis is supported by the study of Söderbom and Teal (2003) that analyzed openness as sources of productivity growth and found a significant effect of trade openness on factor productivity growth. Besides, Alcala and Ciccone (2004) study examined the impacts of international trade on factor productivity and found that international trade has an economically significant and statistically robust positive effect on total factor productivity.

Furthermore, the recent study by Sun and Heshmati (2012) investigates the impacts of international trade on economic growth and development in China through analyzing the effect of foreign trade on the improvement of productivity. The findings of their study show that trade volume and trade structure towards high-tech exports result in positive effects on productivity improvement in different regions in China.

More specifically, a few studies have been conducted on the nexus of China–Africa trade and total factor productivity of African countries. For example, Yin and Vaschetto (2011) and Busse et al. (2016) provide evidence that Chinese trade with African countries has a displacement effect on African firms and affects productivity negatively.

The limitations of the literature mentioned above would stem from the failure to consider the absorptive capacity of developing countries, including African economies. If the countries have better institutional quality, they can maximize the benefit from foreign trade. This can be argued because better institutional quality reduces uncertainties related to international trade activities. It can reduce the issues of imperfect contract enforcement and protection of intellectual property rights, so the competition brought by foreign firms becomes fierce (Yu 2010). This improves its effect on the productivity of the local economy of the trading countries. Therefore, better institutional quality could accelerate the growth effect of China–Africa trade openness by better facilitating the efficiency improvement process and strengthening the advantages of economies of scale.

Hypothesis 1 (H1). *The impact of China–Africa trade on TFP is conditional to domestic absorptive capacity.*

3.2. China FDI and Total Factor Productivity

The relationship between FDI and total factor productivity has been given due consideration in the recent literature. The role of FDI on productivity stems from its root from neoclassical exogenous models and endogenous growth models. The neoclassical growth model assumes technological progress to be exogenous and growth is a function of capital accumulation. However, in the new growth models, technological change has a vital role in economic growth. In the endogenous growth models of Romer (1990) and Lucas (1988), economic growth is driven by the stock of human capital and technological changes. Endogenous growth theory postulates that the FDI spillover

effect can be transformed into productivity improvement and, consequently, economic growth (Grossman and Helpman 1991). In these endogenous growth models, FDI can affect economic growth in FDI-receiving countries through technology transfer, diffusion, and spillover effects. Hence, the theoretical bases for empirical studies on the impacts of FDI on economic growth can be from the neo-classical models of growth or from endogenous growth models.

Based on the basic theories of FDI and total factor productivity, Jude and Levieuge (2016) reveal that a weak domestic institutional environment is significantly associated with high transaction costs, and increased risk for long-term commitment. In turn, this loosens the linkages between foreign affiliates and domestic firms, limiting the spillover effect of FDI. On the other hand, reliable institutional quality enhances the positive effect of FDI on factor productivity. The findings of Jude and Levieuge (2016) are supported by the results of Baltabaev (2013) that showed that an increase in FDI would lead to an improvement in productivity growth in FDI-hosting countries subject to the local conditions (absorptive capacities) of domestic economies can determine the benefit from possible externalities of FDI to host countries.

Elu and Price (2010) reveal no relationship between productivity-enhancing foreign direct investments with China. Likewise, Wang et al. (2014) showed that technology spillover from Chinese investment in African countries is limited partly due to skill mismatch. Additionally, Shen (2013) also finds that private Chinese FDI has a negative effect on technological transfer and has a mixed impacts in terms of local industrialization. The major limitations of these studies might be not considering the local absorptive capacity of African countries in the analysis, which will be solved by this study.

In line with the arguments of Baltabaev (2013) and Jude and Levieuge (2016), we suggest that the positive effect of FDI on economic growth will be stronger in countries with relatively high institutional quality. Thus, good institutions like the rule of law, lack of corruption, efficient government and good regulations can create synchronization between the domestic and foreign firms by providing them with competitive playfields and encourage them in healthy competition.

Hypothesis 2 (H2). *The impact of Chinese FDI on the total factor productivity of African countries is a positive subject to domestic institutional quality.*

3.3. Chinese Financial Aid and Total Factor Productivity

Currently, the development economics concentrates not only on direct sources of growth (and development) but also on its indirect causes such as productivity (Kliber and Świerczyńska 2019). Financial aid that directly or indirectly expedites technology transfer and learning in developing countries can be mutually beneficial.

Decomposing financial aid by type of flow for 24 African countries, Kliber and Świerczyńska (2019) investigate the effect of the official development aid on the total factor productivity of Sub-Saharan African countries over the period 1995–2014. The study results show that the total value of financial aid does not enhance total factor productivity. This implies that the implementation of technical cooperation enables the absorption of technology and contributes to the increase in technology development in recipient Sub-Saharan African countries. According to Nachega and Fontaine (2006), aid can contribute to total factor productivity growth, especially if it involves investments in infrastructure (roads, power points, irrigation). Additionally, Alvi and Senbeta (2012) findings claim that aid negatively affects total factor productivity; it reduces the efficacy of financial institutions and causes efficiency losses. The institutional quality can positively affect the aid–growth relationship. In conclusion, it is enough to control the impact of corruption, political instability and lack of transparency, which are common in countries with weak institutions, on the use of aid, in order to examine the role institutional quality in the relationship between economic growth and financial aid (Addison and Baliamoune-Lutz 2006). However, few studies have been conducted in the nexus of Chinese financial aid and total factor productivity of African countries. Therefore, based on the general literature, we develop the following hypothesis.

Hypothesis 3 (H3). *the impact of Chinese aid on the total factor productivity of African counties is positive subject to the institutional environment of African countries.*

4. Methodology and Data

4.1. Estimation of the TFP

This section attempts to highlight the strategy used in this study to calculate the TFP of sample African countries. The static panel data approach is employed to estimate parameters that are used to calculate TFP, because if there is no model specification problem and no data, it can avoid measurement problems related to labor shares in the model (Park 2010).

In the approach, a specific form of the production function is assumed, and then the coefficient of the parameters are found using the input and output data. The output elasticity is calculated from the function, and, in turn, TFP is derived. This study is based on the Solow (1956) growth model that he conducted to show the relationship between production (Y_{it}) and factors of production, such as physical capital (CAP_{it}), the labor force (LAB_{it}), energy and natural resources extraction (R_{it}) and technology (A_{it}). It can be shown as per the following Cobb–Douglas specifications of the production function. TFP, in this case, is the residual of the growth model. The panel model specification can be written as

$$Y_{it} = f[LAB_{it}, CAP_{it}, R_{it}, A_{it}] \tag{1}$$

Based on this specification, there are two basic approaches to calculate TFP. These approaches are growth accounting and regression-based approaches.

The growth accounting approach utilizes available data on output, labor input and capital, and uses output elasticities to calculate TFP and to separate the contribution of TFP on growth. Among the fundamental issues in this approach, one basic problem is that the output elasticities are not observed. One commonly used approach to deal with this problem is to impose assumptions of constant returns to scale and competitive labor markets. This assumption indicates that the output elasticities are equal to the shares of each input. This is very appropriate since only the labor shares are needed for the derivation and the actual labor shares can be collected from each country's national accounts data. Nonetheless, the problem is that the labor share data depends on the data for compensation for employees, which suffer from various measurement errors and are unavailable for most of the economies (Park 2010).

The regression-based approach considers a specific form of production function and estimates the parameters of production function utilizing the input and output data. In principle, the regression-based approach does not assume a competitive market assumption. Hence it does not use labor share data in the estimation. Different functional forms are supposed in the estimation for the production function of Cobb–Douglas. Constant elasticity of substitution, transcendental logarithmic form, depending on the nature of technology and the restrictions on output elasticities, are among the areas for the assumptions. Output elasticities can be derived from the factors of the estimated coefficients and, in turn, the TFP can be calculated. Compared to the first one, this method has the advantage of avoiding measurement problems related to labor shares and strong assumptions regarding labor markets (Park 2010). The specification of the production function will be specified as

$$Y_{it}[LAB_{it}, CAP_{it}, R_{it}, A_{it}] = A_{it} LAB_{it}^{\alpha} CAP_{it}^{\beta} {R_{it}}^{\delta} \tag{2}$$

The logarithm transformation of the Cobb–Douglas specifications of production function can be written as

$$\ln Y_{it}[LAB_{it}, CAP_{it}, R_{it}, A_{it}] = \ln A_{it} + \alpha \ln LAB_{it} + \ln \beta CAP_{it} + \ln \delta R_{it} \tag{3}$$

The difference between output represented by Y_{it} and inputs (capital, labor and natural resources) represents TFP, which is specified in the following equation

$$TPF_{it} = \ln A_{it} = \ln Y_{it}[LAB_{it}, CAP_{it}, R_{it}, A_{it}] - \alpha \ln LAB_{it} - \ln \beta CAP_{it} - \ln \delta R_{it} \quad (4)$$

where α is the elasticity of output to the capital stock, β measures elasticity of output to labor, i is for different countries and t is the time in a year. We assumed less than unitary elasticity, as this is consistent with approximate constant capital shares in the long-term. Therefore, TFP for the sample countries for the given period (2003–2017) is calculated using Equation (4). The inclusion of human capital as one of the inputs in the production function is relevant (Romer 1990; Lucas 1988). However, it is ignored in this specification because of the data availability. Therefore, we emphasized physical capital stock, energy, and natural resources and labor force.

Another issue to be addressed here is capital stock data. Since data for the capital stock were not found, they were calculated from the gross fixed capital formation. Among these issues, the major concern was raised in the measurement of factor inputs, especially capital stock. In constructing capital stock series from investment series, many critical assumptions are bound to be made to compromise the choice of measurement methods. These include the valuation method of capital inputs, choice of deflators, depreciation methods, assumptions on capacity utilization rate, use of weights in the aggregation of sub inputs, a choice between gross or net capital stock, and choice between using depreciation or obsolescence concept (Park 2010).

The method used by Alvi and Ahmed (2014) used to calculate capital stock is adapted to calculate the TFP of African countries in this study

$$K_I = \frac{GrFiK_I}{\delta + \theta} \quad (5)$$

where K_I is initial capital stock, $GrFiK_I$ represents gross fixed capital formation, δ is depreciation rate for capital per year and θ represents the average growth rate of gross fixed capital formation. A five percent depreciation rate is used following the preposition of Alvi and Ahmed (2014) and World Bank (2011) as they used a 5% depreciation rate to estimate capital stocks of several countries. Annual series data for the capital stock for each year can be calculated using

$$K_t = K_{t-1} - \delta K_{t-1} + GrFiK_t \quad (6)$$

where K_t a capital stock is at the current year, K_{t-1} is capital stock in the previous year; G_rFiK_t is the real gross fixed capital formation.

4.2. The TWO-step System GMM for the TFP Specification

This section aims to provide a wide discussion on the method used to examine the impacts of the China–Africa economic relationship (China–Africa trade, Chinese FDI and aid allocation) on the TFP of African countries. The two-step system GMM estimator is applied to analyze the impacts of the China–Africa economic relationship on the TFP of African countries. Since our model for estimation of the effect of China–Africa economic relationship is based on a panel dataset of cross-country and time-series observations, a two-step GMM system estimator is used. Using TFP estimated from Equation (4) as a dependent variable, the model that relates the dependent variable with its determinants is specified in the following formula

$$\begin{aligned} \ln TPF_{it} = {} & \theta_0 + \theta_1 \ln lagTFP_{it} + \theta_2 \ln \mathrm{infr}_{it} + \theta_3 \ln cre_{it} + \theta_4 heal_{it} + \theta_5 \ln fdichina_{it} + \\ & \theta_6 \ln tradechina_{it} + \theta_7 \ln aidchina_{it} + \theta_8 \ln ins_{it} + \theta_9 \ln efree_{it} + \chi_m \ln INTRa_{it} + \eta_{it} \end{aligned} \quad (7)$$

where $lagTFP_{it}$ is lagged value of dependent variable (TFP), $infr_{it}$ the level of infrastructure proxied by ICT infrastructure, $\mathrm{cre_{it}}$ credit to private sector, $heal_{it}$ is the expenditure to health sector, $fdichina_{it}$ is

Chinese FDI to African countries, $tradechina_{it}$ is China–Africa trade, $aidchina_{it}$ is Chinese aid to African countries, ins_{it} is institutional quality indicator, $efree_{it}$ is economic freedom and $INTRa_{it}$ is to represent interaction terms. η_{it} is the stochastic term.

In Equation (7), the ins_{it} variable represents the index of the institutional quality of countries. In addition, the interaction terms represented by $INTRA_{it}$ can be specified as per the following variables, including (ins.aid, ins.fdi, openaid, openindex, openfdi)

$$\begin{aligned} ins.fdi &= fdichina \times institutions \\ ins.trade &= tradechina \times institutions \\ isn.aid &= aidchina \times institutions \\ open.fdi &= tradechina \times fdichina \\ aid.fdi &= aidchina \times fdichina \\ openindex &= tradechina \times fdichina \times aidchina \end{aligned} \tag{8}$$

where *ins.aid* represents the interaction term of financial aid from China and domestic institutional quality of African countries. *ins.fdi* is a variable indicating the conditional effect of Chinese FDI to the domestic institutional quality of African countries. openaid shows the interaction between Africa–China trade openness and Chinese financial aid flow to African countries. openindex is the interaction term representing the interaction among China–Africa trade, Chinese FDI to Africa and Chinese financial aid flow to African countries and openfdi indicates the conditional effect of FDI to Africa–China trade openness.

4.3. The Data and Instrument of Measurement

This study used data for the periods 2003–2017 based on the data availability for 44 African countries. The sample of countries included in the study is reported in Appendix B. The data used for this research are drawn from various sources. China–Africa trade, Chinese FDI and aid allocation (loans to African countries) was maintained from Johns Hopkins China–Africa Research Institute website. The Johns Hopkins China Africa Institute compiled Chinese FDI to Africa from United Nations Com Trade (UNCTAD) bilateral FDI Statistics and China Statistical Yearbook. The definitions and sources of data are presented in Table 1.

Table 1. Definition of variables and source of data.

Variable	Definition of Variables	Source of Data
$loggdpc_{it}$	Logarithm form of real GDP per capita (in Million US Dollar at constant 2005 US dollar)	WDI
$loglab_{it}$	Logarithm form of the labor force (in Million labor unit)	WDI
$logk_{it}$	Logarithm form of capital derived from gross fixed capital formation (in Million US Dollar)	WDI
$logins_{it}$	Logarithm form of institutional quality index of countries	WGI
$logcre_{it}$	Logarithm form of credit to private sector from banks (% of GDP)	WDI
$logheal_{it}$	Logarithm form of health expenditure (% GDP) to proxy human capital	WDI
$lognatural_{it}$	Logarithm form of natural resources extraction rate (% of GNI)	WDI
$logchinatrade_{it}$	Logarithm form of the trade between China to African countries	China Africa Research Initiative
$logaidchina_{it}$	Logarithm form of official development assistance (aid) from China to Africa particularly loan	China Africa Research Initiative

Table 1. *Cont.*

Variable	Definition of Variables	Source of Data
$loginfr_{it}$	Logarithm form of mobile subscription of African countries	WDI
$logcre_{it}$	Logarithm form of the domestic credit to private sector per GDP	WDI
$logfdichina_{it}$	Logarithm form of Chinese FDI flow to African countries	China Africa Research Initiative

4.4. Diagnostic Tests

Wald test is conducted for the overall performance of the two-step GMM estimator. The Arellano and Bond test is used to test for autocorrelation. Arellano and Bond (1991) introduced a test for autocorrelation in dynamic panel data estimation for the fixed T, large N context similar to our model as we have 44 countries and a 15-year time period.

An overidentification test was conducted using Hansen statistics. If the estimation is exactly identified, the detection of invalid instruments is impossible. However, if the system is overidentified, a test statistic for the joint validity of the moment conditions (identifying restrictions) falls naturally out of the GMM framework.

5. Results and Findings

In this sub-section, we spell out the derivation of TPF and the effects of China–Africa economic relationship on the TFP of African countries. The China–Africa trade, FDI and aid allocation, by offering more generous incentive packages and justifying their actions with the expected knowledge of externalities generated by foreign affiliates, can affect the level of domestic productivity of African countries. Hence, the emphasis of this section is on the impacts of Chinese FDI, aid allocation and China–Africa trade on the TFP of African countries. The first section mainly focuses on the derivation of TFP using the Cobb–Douglas production function. The second section contains the nexus of China–Africa economic relations and the TFP of African countries controlling the mediating role of institutional quality of African countries, as well as controlling the complementarity of China–Africa economic relationship instruments.

5.1. Derivation of TFP

The Solow (1956) suggests that TFP is the key economic growth factor. If the economy is based solely on capital accumulation without technological progress, the declining returns on capital accumulation will eventually slow economic growth to zero. In the development process, the rate of technological progress is the dominant factor in the long run. An economy with a higher growth rate of productivity than others can always overrun her contestants in the long run. In chapter four, it was stated that there are two different approaches to calculate TFP. These are the growth accounting approach that utilizes the available data on output, labor input and capital, and uses output elasticities to calculate TFP, and the regression-based approach that considers a specific form of production function and estimates the parameters of production function utilizing the input and output data. This study uses the regression-based approach for its superiority over the growth accounting approach and its simplicity. After driving TFP growth patterns for the sample countries using the regression approach, we proceed to analyze the effects different factors influencing TFP, giving due emphasis to Africa–China trade, Chinese FDI flow and aid allocation to African countries.

TFP is estimated based on comprehensive country-level panel data for 44 African countries. The Fixed Effect model is employed to estimate TFP using the Solow (1956) growth model considering technology as a residual. The necessary data for the calculation of the TFP growth are real GDP per capita (output), capital stock, natural resources extraction and labor participation. The specification

shows the relationship between production (Y_{it}) and factors of production, such as physical capital, labor force and technology. Hence TFP, in this case, is calculated by subtracting the contribution of capital, labor and natural resources extraction rate from the total output. The capital stock data were derived from the gross fixed capital formation.

As we have Random effect and Fixed effect static panel data models, one should select the most convenient method to drive TFP. The most commonly used technique to evaluate the models is the Hausman test. Therefore, the Hausman test was conducted to choose between the Fixed Effect Model (FEM) and Random Effect Model (REM). According to the results of the test, we failed to reject FEM. Thus, the FEM was applied to drive TFP. Since we assumed increasing economies of scale, the sum of the coefficients of labor and capital is greater than one. The results reported in Table 2 below show the elasticity of capital and labor force. Using this elasticity, we then derived the residual of the model, deducting the sum of the products of the coefficients of labor and coefficient of capital with their values from the total output or production.

The results reported in Table 2 below show the elasticity of capital, energy and natural resources and labor force. To test the sensitivity of the estimates, we repeated the exercise using fixed capital formation. The results of the alternative estimation are reported in Table A6 in Appendix A. Using this elasticity, the residual of the model is derived deducting the sum of the products of the coefficients of labor, capital and energy with their values from the total output or production. Nonetheless, this exercise does not attempt to explain the forces that drive the growth rates of each of the inputs or factor shares.

Table 2. Derivation of parameters to calculate total factor productivity (TFP).

Variables	I (REM)	II(FEM)
lnlabor_{it}	0.527 ***	0.630 ***
	(0.030)	(0.027)
lncapital_{it}	0.044 ***	0.032 ***
	(0.008)	(0.007)
lnenergy_{it}	−0.006 *	−0.009 ***
	(0.003)	(0.003)
Constant	−1.944 ***	−3.248 ***
	(0.414)	(0.373)
Obs.	498	498
Group	37	37
Wald chi2(2) *p*-value	0.000	0
sigma_u	0.510	1.252
sigma_e	0.064	0.064
rho	0.985	0.997
Hausman fixed random: chi2(2) = (b−B)'[(V_b−V_B)^(−1)](b−B)	0.000	

Notes: *** significant at 1%, * significant at 10%, standard error in parenthesis and Obs: observations. Dependent variable: logarithm form of GDP per capita. Source: Authors' calculations.

The coefficients of capital stock and labor force are robustly positive, indicating that they have a significant effect on output (real GDP per capita). However, the impact of natural resource extraction has a negative effect on output.

Natural resource extraction is negatively associated with GDP per capita, which might be because of appreciation of the exchange rate and the negative consequences related to institutional quality, such as deterioration in governance, corruption, rent-seeking and conflict (Van der Ploeg 2011).

The coefficient of labor is consistent with the standard cross-country analysis that supposes that a two-thirds share of output is commonly assigned to labor (Gollin 2002). However, as human capital is not considered in the analysis, the magnitude of the labor's coefficient will decrease when decomposed to skilled and non-skilled labor.

On the other hand, the coefficient of physical capital did not reach a one-third share of output. Unlike in the simple model with two factors (labor and physical capital), the magnitude of the coefficient is lower, partly because the residual share (TFP) will have a large growth accounting share and human capital may also contribute relatively larger amounts. Additionally, the share is inconsistent as we have a controlled additional variable (natural resources extraction) unlike the traditional two factors model in the growth accounting. Furthermore, it is argued that traditional estimators can be biased upwards because of measurement error (Caselli 2005). This further implies that creating the incentives for productive factor accumulation is more important for output than factor accumulation itself (Easterly and Levine 2001). Likewise, Ekanayake and Moslares (2020) in the nexus of remittances and economic growth (GDP per capita growth) controlling capital, labor, human capital and remittance found the consistent magnitude (0.0644) of physical capital on GDP per capita growth. Based on the results in Table 2, TFP is derived using the coefficients of capital, labor and natural resources extraction rate. The TFP here is the residual estimated using the coefficients of labor and capital.

The estimates of TFP derived from Table 2 are almost consistent with the growth rate of TFP of Sub-Saharan African countries estimated by Kim and Loayza (2019) for the period 2004–2014. The estimates of TFP derived show the same pattern of TFP growth. For example, some countries, such as Mozambique and Zimbabwe, have quite low average TFP growth rates (negative). Similarly, the values of TFP for these countries are negative in our estimates. Furthermore, their estimates indicate that for Sub-Saharan Africa, TFP growth rates increase from around −1 in 1994 to +1 in the time spanning 1994–2014. Our result shows nearly the same result (average of 1.962), even though the time span is different (2003–2017).

5.2. The Impact of China–Africa Economic Relation on TFP

In the section mentioned above, TFP is calculated, and its values are derived. Therefore, using TFP calculated in the above section, reported in Table 2 as the dependent variable, we examine the effects of trade openness between China and Africa and Chinese FDI flow and aid allocation to African countries on the TFP of African countries conditional to institutional quality. The results of the two-step system GMM model are reported in Table 3. We have regressed controlling the mediating role of an institutional quality index derived using governance indicators such as the absence of violence and instability, government effectiveness, regulatory quality, the rule of law, control of corruption and voice and accountability. The indices of institutional quality, educational level, doing business and border and transport efficiency are derived using principal component analysis. The results of the index of the institutional quality, business environment and transport efficiency are reported in Tables A1–A4, respectively, in Appendix A.

We fail to reject the Hansen test's insignificant statistics for all system GMM (see Table 3). Therefore, this confirms that the instruments satisfy the orthogonality condition, or all instruments are valid in the model. Similarly, the Wald test for the joint significance of the variables does not reject our model specification. The serial correlation test does not reject the null that there is no second-order serial correlation. Therefore, these diagnostic tests validate the use of the two-step system GMM model to analyze the impact of variables on TFP.

We repeated the exercise controlling additional covariates such as education, doing business environment and transport efficiency indices. However, because of the significant decrease in sample size, the results are reported separately in Table A5 in Appendix A. Thus, these covariates are excluded from further analysis.

The coefficient of the lag of TFP is positive and statistically significant. Besides, the level of infrastructure of African countries has a robust positive effect on the TFP of African countries. Likewise, the effect of health expenditure on TFP is significantly positive, implying that African countries' health expenditures improve the TFP of African countries. Furthermore, economic freedom has a positive effect on the TFP of African countries.

Table 3. The effects of China–Africa economic relationship on the TFP of African countries.

Variables	I	II	III	IV
$\ln lagtfp_{it}$	0.859 ***	0.792 ***	0.882 ***	0.893 ***
	(0.012)	(0.014)	(0.013)	(0.017)
$\ln inf r_{it}$	0.001 ***	0.001 *	0.002 ***	0.002 ***
	(0.000)	(0.000)	(0.000)	(0.000)
$\ln cre_{it}$	0.002 ***	−0.001 **	0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.000)
$\ln heal_{it}$	0.006 ***	0.006 ***	0.007 ***	0.008 ***
	(0.001)	(0.001)	(0.001)	(0.001)
$\ln fdichina_{it}$	0.001	0.001	−0.004 ***	−0.005 ***
	(0.004)	(0.001)	(0.001)	(0.001)
$\ln tradechina_{it}$	0.013 ***	−0.008 **	−0.062 ***	0.008 ***
	(0.002)	(0.004)	(0.009)	(0.003)
$\ln loanchina_{it}$	0.003	−0.003	0.007 ***	−0.017 *
	(0.002)	(0.002)	(0.002)	(0.010)
$\ln ins_{it}$	−0.005 **	−0.002	−0.008 ***	−0.006 ***
	(0.002)	(0.002)	(0.001)	(0.002)
$\ln efree_{it}$	0.004 *	−0.006 *	0.005 ***	0.006 ***
	(0.002)	(0.004)	(0.002)	(0.002)
$ins.fdi_{it}$		0.002 ***		
		(0.000)		
$ins.trade_{it}$			0.044 ***	
			(0.005)	
$ins.aid_{it}$				0.004 **
				(0.002)
_cons	0.259 ***	0.405 ***	0.220 ***	0.193 ***
	(0.022)	(0.031)	(0.027)	(0.032)
Obs.	397	397	397	397
Groups	35	35	35	35
Wald (*p*-value)	0.000	0.000	0.000	0.000
AB2 (Ch2-sta) *p*-value	0.511	0.152	0.732	0.623
Hansen (Ch2sta) *p*-value	0.983	0.992	0.949	0.965

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%, standard error in parenthesis, AB2test is Arellano and Bond tests for autocorrelation, Hansen test is test for over-identification, Wald: overall fitness of the model test, Obs.: observations, Group: Group of countries.

Turning to our explanatory variables of primary interest, the sign of the coefficient of trade between Africa and China is positive and statistically significant in Column (I) in Table 3. However, the coefficients of Chinese aid allocation and FDI to African countries are insignificant in Column (I), implying that the individual effect of these variables does not have an impact on TFP.

Unlike the previous literature, we further investigate the impacts of the China–Africa economic relationship incorporating the productivity-enhancing domestic absorptive capacity of African countries. We claim that the results presented in Table 3 Column (I) are logical because the Africa–China economic relationship can be constrained by the domestic absorptive capacity of African countries. It should be supported by the domestic absorptive capacity of countries incorporating institutional quality indicators of African countries. For example, it is argued that the absence of good institutions in the developing world has been a significant cause of slow economic growth, and that good institutions or governance are essential for long-term development in the development process through helping countries utilize technology transferred through international trade. Hence, based on the above explanation, we incorporated the interaction term of Africa–China trade, Chinese FDI and aid allocation variables and institutional quality indicator of African countries (Table 3 in Column (II) to Column (IV)). The impact of China–Africa trade on the TFP of African countries is strongly positive. Furthermore, the coefficient of the interaction of the China–Africa trade and institutional quality is

positive and significant, revealing that the effect of China–Africa trade is increasing to institutional quality improvement. Therefore, the result is consistent with the hypothesis stated in the study.

In contrast to the coefficients of Chinese FDI and aid alone, the interaction of Chinese FDI with domestic institutional quality of African countries has a robust positive impact on factor productivity for African countries. Therefore, Chinese FDI promotes productivity improvement as the countries' institutional quality improves considerably (Table 3). Therefore, the result is in line with the hypothesis (H2). Likewise, the coefficient of the interaction term of Chinese financial aid and domestic institutional quality has changed to be positive and statistically significant. Thus, the result supported the acceptance of the hypothesis of the study (Table 4).

Therefore, the government's ability to formulate and implement sound policies and regulations that are conducive to the private sector and government capacity to keep political stability and avoid ethnic tensions and internal and external conflict is worthwhile for African countries to realize trade benefits. Likewise, effectiveness in evaluating the bureaucratic quality and governments' commitment to policies is essential to utilize productivity-enhanced technology transfer from China efficiently.

Increase in trade between Africa and China and Chinese FDI and financial aid flow, hence, should be backed by good domestic institutions to change the impact of Africa–China trade, Chinese FDI and financial aid to positive. Therefore, overall improvement in institutional quality is a critical tool to benefit African countries in terms of their TFP from the Africa–China economic relationship.

Table 4. Hypothesis test.

Parameter	Estimate	Std. Err.	z-Value	*p*-Value	Decision
H1 ($ins.trade_{it}$)	0.044	0.005	8.25	0.000	supported
H2 ($ins.fdi_{it}$)	0.002	0.000	9.72	0.000	supported
H3 ($ins.aid_{it}$)	0.004	0.002	2.38	0.017	supported

Notes: $ins.trade_{it}$, $ins.fdi_{it}$ and $ins.aid_{it}$ are the interaction terms of China–Africa trade and institutional quality, Chinese FDI and institutional quality and Chinese aid and institutional quality, respectively.

We also examined the complementarity of China–Africa economic relationship instruments as Africa–China trade, Chinese FDI and aid allocation have been carefully combined (McCormick 2008). Additionally, an increase in trade between countries and an open economy has been known to attract FDI flow and receive more financial aid from trade partner countries (Asamoah et al. 2019). As a result, the interaction terms are included in the model specification. Thus, the results using interaction terms of China–Africa trade and Chinese FDI, Chinese FDI and aid allocation and three of them have been reported in Table 5 below.

Table 5. The effects of China–Africa economic relationship on the TFP of African countries.

Variables	I	II	III	IV
$lnlagtfp_{it}$	0.859 ***	0.783 ***	0.884 ***	0.894 ***
	(0.012)	(0.016)	(0.015)	(0.016)
$lninfr_{it}$	0.001 ***	−0.001	0.002 ***	0.002 ***
	(0.000)	(0.001)	(0.000)	(0.000)
$lncre_{it}$	0.002 ***	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
$lnheal_{it}$	0.006 ***	0.003 ***	0.007 ***	0.008 ***
	(0.001)	(0.001)	(0.001)	(0.001)
$lnfdichina_{it}$	0.001	0.002 **	−0.005 ***	−0.004 ***
	(0.004)	(0.001)	(0.001)	(0.001)
$lntradechina_{it}$	0.013 ***	−0.012 ***	0.001	0.003
	(0.002)	(0.003)	(0.002)	(0.003)
$lnloanchina_{it}$	0.003	0.001	−0.053 ***	−0.001
	(0.002)	(0.002)	(0.009)	(0.002)

Table 5. *Cont.*

Variables	I	II	III	IV
lnins_{it}	−0.005 **	0.004	−0.005 ***	−0.007 ***
	(0.002)	(0.002)	(0.001)	(0.001)
ln$efree_{it}$	0.004 *	−0.003	0.003 ***	0.004 **
	(0.002)	(0.003)	(0.001)	(0.002)
trade.fdi$_{it}$		0.002 ***		
		(0.000)		
fdi.aid$_{it}$			0.008 ***	
			(0.001)	
trade.fdi.aid$_{it}$				0.291 ***
				(0.051)
_cons	0.259 ***	0.419 ***	0.212 ***	0.195 ***
	(0.022)	(0.034)	(0.030)	(0.032)
Obs.	397	397	397	397
Groups	35	35	35	35
Wald (*p*-value)	0.000	0.000	0.000	0.000
AB2 (Ch2-sta) *p*-value	0.511	0.105	0.449	0.624
Hansen (Ch2sta) *p*-value	0.983	0.938	0.938	0.915

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%, standard error in parenthesis, AB2test is Arellano and Bond tests for autocorrelation, Hansen test is test for over-identification, Wald: overall fitness of the model test, Obs.: observations, Group: Group of countries.

The interaction of China–Africa trade and Chinese FDI has a positive and significant effect on the TFP of African countries. Thus, trade relations between countries can also draw attention to resources and markets that can provide investment opportunities. Besides, the interaction term of Chinese aid allocation and FDI is robustly positive. Therefore, from a theoretical standpoint, the financial aid could be complementary to foreign investment. This justification is in line with the arguments that appropriately targeted foreign aid can have an infrastructure effect, which in turn will invite foreign investment and expanding trade through reducing costs of trade and facilitating doing business environment. Finally, the interaction of China–Africa trade, Chinese aid allocation and FDI has a strongly positive effect on TFP of African countries.

5.3. Robustness Test

To check the sensitivity of the result reported in Table 3, we re-examined the model excluding some Chinese major economic partner African countries (South Africa, Zambia and Sudan).

The results are reported in Table 6 below.

Table 6. The effects of China–Africa economic relationship on the TFP of African countries.

Variables	I	II	III	IV
lnlagtfp$_{it}$	0.839 ***	0.682 ***	0.827 ***	0.851 ***
	(0.018)	(0.023)	(0.015)	(0.017)
lninfr$_{it}$	0.002 ***	0.001	0.001 ***	0.002 ***
	(0.000)	(0.000)	(0.00)	(0.000)
lncre_{it}	0.000	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
ln$heal_{it}$	0.008 ***	0.002	0.006 ***	0.009 ***
	(0.001)	(0.002)	(0.002)	(0.002)
lnfdichina$_{it}$	0.002	0.015 ***	0.005	0.003
	(0.002)	(0.003)	(0.004)	(0.003)
lntradechina$_{it}$	0.003	−0.001	−0.116 ***	0.005 *
	(0.002)	(0.003)	(0.040)	(0.003)
lnloanchina$_{it}$	0.005 *	0.002	0.005	−0.024 **
	(0.003)	(0.002)	(0.003)	(0.010)

Table 6. *Cont.*

Variables	I	II	III	IV
lnins_{it}	−0.006 ***	0.007 **	−0.010 ***	−0.005 **
	(0.002)	(0.003)	(0.003)	(0.002)
ln$efree_{it}$	0.002 *	−0.015 ***	0.005 ***	0.002
	(0.001)	(0.004)	(0.001)	(0.001)
ins.fdi$_{it}$		0.002 ***		
		(0.000)		
ins.trade$_{it}$			0.078 ***	
			(0.025)	
ins.aid$_{it}$				0.005 ***
				(0.002)
_cons	0.305 ***	0.626 ***	0.332 ***	0.276 ***
	(0.036)	(0.051)	(0.032)	(0.035)
Obs.	382	382	382	382
Groups	33.000	33	33	33
Wald (*p*-value)	0.000	0.000	0.000	0.000
AB2 (Ch2-sta) *p*-value	0.728	0.062	0.841	0.713
Hansen (Ch2sta) *p*-value	0.903	0.992	0.993	0.962

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%, standard error in parenthesis, AB2test is Arellano and Bond tests for autocorrelation, Hansen test is test for over-identification, Wald: overall fitness of the model test, Obs.: observations, Group: Group of countries.

The signs of coefficients of our interest variables (China–Africa economic relationship instruments and the interaction terms) and their significance are similar to our results in Table 3. The conditional impacts of China–Africa trade and Chinese FDI and aid allocation on TFP subject to the institutional quality of African countries are statistically robust and reinforce the results in Table 3 (see Table 6).

Similarly, the impacts of the interaction terms of all China–Africa economic relationship instruments on the TFP of African countries are robustly positive and support results in Table 5. That is, the interaction of China–Africa trade openness and FDI to positive and statistically significant, revealing that trade openness between China and African countries fuels the TFP of Chinese FDI and aid allocation to African countries (see Table 7).

Table 7. The effects of China–Africa economic relationship on the TFP of African countries.

Variables	I	II	III	IV
lnlagtfp$_{it}$	0.839 ***	0.650 ***	0.847 ***	0.851 ***
	(0.018)	(0.013)	(0.016)	(0.019)
ln$infr_{it}$	0.002 ***	−0.002 ***	0.002 ***	0.002 ***
	(0.000)	(0.000)	(0.000)	(0.000)
lncre_{it}	0.000	0.003 ***	0.000	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ln$heal_{it}$	0.008 ***	−0.001	0.006 ***	0.008 ***
	(0.001)	(0.002)	(0.002)	(0.002)
lnfdichina$_{it}$	0.002	0.015 ***	0.004	0.004
	(0.002)	(0.003)	(0.003)	(0.003)
lntradechina$_{it}$	0.003	−0.009 **	0.002	0.002
	(0.002)	(0.004)	(0.003)	(0.002)
lnloanchina$_{it}$	0.005 *	0.001	−0.034 **	0.000
	(0.003)	(0.002)	(0.013)	(0.002)
lnins_{it}	−0.006 ***	0.005 **	−0.002	−0.007 ***
	(0.002)	(0.002)	(0.002)	(0.001)
ln$efree_{it}$	0.002*	−0.010 ***	0.000	0.002
	(0.001)	(0.004)	(0.001)	(0.002)
trade.fdi$_{it}$		0.003 ***		
		(0.000)		

Table 7. *Cont.*

Variables	I	II	III	IV
$fdi.aid_{it}$			0.006 *** (0.002)	
$trade.fdi.aid_{it}$				0.172 * (0.094)
_cons	0.305 *** (0.036)	0.696 *** (0.031)	0.286 *** (0.034)	0.281 *** (0.040)
Obs.	382	382	369	382
Groups	33.000	33	33	33
Wald (*p*-value)	0.000	0	0	0
AB2 (Ch2-sta) *p*-value	0.728	0.144	0.428	0.78
Hansen (Ch2sta) *p*-value	0.903	0.992	0.991	0.925

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%, standard error in parenthesis, AB2test is Arellano and Bond tests for autocorrelation, Hansen test is test for over-identification, Wald: overall fitness of the model test, Obs.: observations, Group: Group of countries.

6. Discussion and Policy Implications

6.1. Discussion

The theoretical models predict that economic relationships among countries and exposure to external activities of the countries significantly influence countries' economic performance and result in the differences in economic development. For instance, in their theoretical models, Grossman and Helpman (1991) show that trade among countries can enhance the transfer of new technologies and facilitate countries' productivity improvement. That is, in addition to its direct effect on capital accumulation, trade among countries can positively impact the economic performance of trading countries through channels such as technology transfers, scale economies and comparative advantage. Therefore, it can generate economic growth by facilitating the diffusion of knowledge and technology from the direct import of high-tech goods.

However, unlike the theoretical notion of the trade-total factor productivity nexus, our findings indicate that the China–Africa trade has a significant negative effect on the total factor of productivity when included in our regression individually. However, it enhances the total factor productivity of African countries subject to the domestic institutional environment as its coefficient turns positively and robustly significant when interacting with African countries' institutional quality. This finding is inconsistent with the findings of Mayer (2001), Söderbom and Teal (2003), Alcala and Ciccone (2004) and Sun and Heshmati (2012), who found that international trade has an economically significant and statistically robust positive effect on factor productivity.

This finding is further loosely explained because the impact of trade on total factor productivity partly depends on the components of international trade. Among the components of international trade, capital goods imports, intermediate goods imports and exports of manufactured commodities can play a significant role in the TFP of trading countries. In this regard, the China–Africa trade plays a considerable role in enhancing the TFP of African countries. For example, the major commodities African countries imported from China for the last two decades were some goods such as machinery, clothing and textile goods, transport materials, footwear, and plastic commodities. Among these commodities, machinery import was first in share. It has grown by 24% on average. Hence, this plausibly justifies that the China–Africa trade should play a positive role on the total factor productivity of African countries. However, the average institutional quality indicators of African countries are mostly less than the rest of the world. It is worth emphasizing that the China–Africa trade productivity gain depends on the quality of institutions (Dollar and Kraay 2004; Matthew and Folasade 2014). Thus, the weakness of institutional quality negatively affects total factor productivity enhancement of China–Africa trade. On the other hand, countries that have a higher quality of institutions experience larger productivity growth responses of China–Africa trade.

In sum, the relationship between China–Africa trade and factor productivity hinges on African countries' institutional environment. Hence, our results reveal that the China–Africa trade fosters the total factor productivity of African countries when institutional quality improves. In other words, an environment with high-quality governance seems to be more favorable to the emergence of new knowledge and it allows using productivity or skill transfer embodied in the trade integration, allowing the economy to grow faster.

Additionally, this study investigates the effect of Chinese FDI on the total factor productivity of African countries. The relationship between total factor productivity and FDI emanates from endogenous growth theory that assumes that the FDI spillover effect can be transformed into productivity improvement (Grossman and Helpman 1991). The theory argues that FDI can affect economic growth in FDI-receiving countries through affecting factor productivity.

From the previous literature, it is justifiable to conclude that the impact of FDI on factor productivity is also controversial. Some claim that it has a positive effect on total factor productivity (Herzer 2011; Khordagui and Saleh 2013) and others argue that it has a negative effect on the total factor productivity of FDI-hosting countries (Elu and Price 2010; Shen 2013; Wang et al. 2014).

The findings of our study imply that the effect of Chinese FDI on total factor productivity of African countries is negative and changed to positive when its effect on TFP is mediated by African countries' institutional environment (see Table 3). This result indicates that the effect of Chinese FDI on the total factor productivity of African countries depends on the level of institutional quality of FDI hosting countries. This finding is logical as a good level of institutional development can favor synergies between FDI and local firms, and hence promote productivity spillovers. On the contrary, the weak institutional framework can negatively affect productive activities and may result in less exploitation of knowledge spillovers by domestic firms. Furthermore, it can be argued that institutions can influence not only the quantity but also the quality of FDI, as foreign firms are non-homogeneous and of varying quality concerning knowledge-spillovers (Ali et al. 2010). Therefore, good institutions effectively channel information to market participants and allow proper exploitation of market opportunities, which in turn favors technology transfer.

In conclusion, this study has extended the relationship between Chinese FDI and total factor productivity based on the endogenous growth theory controlling the mediating role of institutional quality of African countries. It comes with the evidence that the productivity improvement effect of Chinese FDI is conditional to the absorptive capacity of African countries.

Finally, the relationship between Chinese financial aid and total factor productivity of African countries is addressed in detail. According to some studies, the effect of financial aid concentrates not only on direct sources of growth but also on its indirect causes, such as productivity (Kliber and Świerczyńska 2019). It can contribute to total factor productivity growth, especially if it involves investments in infrastructure (Nachega and Fontaine 2006).

However, based on the gaps of the big push theory, another paradigm has emerged, which argues that financial aid works in countries where institutional and macroeconomic frameworks are robust (Burnside and Dollar 2000). That is, financial aid fails to achieve its expected results because of the poor policy environment in the aid-receiving countries (Easterly 2006). Based on this theory, it is claimed that foreign aid has a positive effect on economic growth through supplementing technological skill and productivity (Fayissa and El-Kaissy 2012). Hence, financial aid is more effective when the country has strong institutions. To come up with the conclusion, it is enough to control the impact of corruption, political instability and lack of transparency which are common in countries with weak institutions on the use of aid in order to examine the role institutional quality in the relationship between economic growth and financial aid (Addison and Baliamoune-Lutz 2006).

Based on this theoretical framework, the findings of this study support the evidence that aid has a dampening effect on TFP growth when considered individually (see Table 3). Thus, Chinese financial aid flow to African countries requires a conducive institutional environment that positively impacts total factor productivity. These results are in line with the findings of Alvi and Senbeta (2012) reveal

aid has a dampening effect on TFP growth. Chinese FDI positively affects the total factor productivity of African countries provided that absorptive capacity is high. Hence, the result concludes that the domestic institutional quality of African countries is vital for improvement in FDI effect on total factor productivity. Therefore, this finding implies that, to enhance the total factor productivity improvement effect of Chinese financial aid, the institutional framework is needed in African countries. This implies that Chinese financial aid allocation should be based on the basis of country performance, combining governance and general policy environment related to institutional quality.

6.2. Practical Implications

Improving institutional quality is an essential aspect of developing economies. Promoting economic openness to the rest of the world in the presence of poor institutional quality, as characterized by corruption, the weak rule of law, ineffective government and regulatory quality, and poor contract enforcement policies may have an adverse effect on the economic performance of the countries. In other words, institutional environment weakness diverts resources from productive sectors to the less productive and rent-seeking sectors (Kandiero and Wadhawan 2003). As countries provide their interaction in the economic relationships among countries in terms of FDI, trade and financial aid, complementary policies such as institutional quality should also be taken into significant consideration.

This study provides new evidence that Chinese FDI to African countries has a positive role on factor productivity when the institutional environment of African countries has a robust and moderate productivity and FDI relationship. From theoretical assumptions, the difference in institutional quality is strongly associated with differences in economic performance across countries. That is, countries with poorer institutional performance perform badly, while countries with better institutional quality tend to perform better in enhancing FDI to boost the productivity of host countries. It is, therefore, imperative to suppose that improvement in countries' institutional environment has a role in altering the FDI-TFP nexus. In other words, stronger institutions like good and efficient governance, the rule of law and lack of corruption can speed up the process of technology spillover to domestic firms and contributes to the productivity enhancement of FDI inflow, whereas week institutions like the presence of corruption, lack rule of law and property rights could prevent domestic firms from reaping the benefits of the knowledge spillover and productivity improvement effect from the FDI firms. Therefore, the same level of FDI could be expected to induce a different level of productivity improvement in different economies with different levels of institutional quality (Baltabaev 2013; Jude and Levieuge 2016).

To sum up, the benign impacts of Chinese FDI flow to African countries remain contingent upon timely and appropriate policy action by the relevant national authorities to improve the institutional quality environment. In order to benefit from FDI-led productivity, the improvement in the institutional framework should precede FDI attraction, as better institutional quality contributes to the FDI-induced productivity.

The decision to offer financial aid to low-income countries can be made on purely economic grounds. However, in practice, it has been heavily influenced by the commercial and political calculations of donor countries that can be solved by a strong institutional quality in aid-receiving countries. In the minds of many politicians and scholars, this is seen less as effective in speeding up economic growth and more as a humanitarian gesture to less fortunate people. However, if aid-receiving countries have a strong institutional quality, it can positively contribute to the economic growth and factor productivity of aid-receiving countries. Therefore, to maximize the growth benefits of financial aid, there should be a strong institutional quality with commitments to greater transparency and more effective monitoring and accountability in aid handling. Financial aid is more effective in countries where there is good governance and institutional quality.

As a result of this study implies, the impacts of Chinese financial aid on the factor productivity of African countries is conditional to the institutional level of African countries. It gives a good foundation for policymakers to develop policy measures that can improve African countries' institutional quality. Improvement in institutional quality, in turn, helps countries efficiently use Chinese financial aid for the targeted purposes mitigating both local and donor purposes that divert the aid from its purpose.

Additionally, from the policy point of view, especially promoting China–Africa trade, this study gives a detailed analysis looking at its effect on productivity spillover incorporating the institutional environment of African countries. Among major China's trading partners among African countries, one can find Angola, South Africa and the Republic of Congo at the forefront. The average institutional-quality performance of Angola and the Republic of Congo is among the weakest. The weak institutional environment, in turn, negatively influences the effects of China–Africa trade on the factor productivity of the countries. Thus, to benefit from China trade, African countries should build sound institutional quality so that they can benefit from the productivity spillover and the accumulation effect of a trade relationship with China.

Furthermore, from both theoretical and practical aspects, it is supposed that trade can benefit countries if they export their comparative advantage or commodity-intensive to abundant resources in the production and import comparatively disadvantaged or commodity-intensive to scarce resources. The nature of the China–Africa trade relationship indicates that African countries mostly export natural resources and raw materials (mineral products, base metals, precious stones, other unclassified primary commodities with only a few shares of textile and clothes) to China. They import processed commodities (machinery, clothing and textile goods, transport materials, footwear and plastic commodities). Therefore, the pattern of trade flow between China and Africa fits the theoretical predictions of international trade as African countries have a comparative advantage in terms of raw materials as a result of their abundance, and they are importing relatively disadvantaged commodities from China. However, from the perspective of practical implications, improvement in the institutional quality of African countries can enhance the factor productivity of China–Africa trade through improving regulatory quality and effectiveness of government, reducing corruption and maintaining the rule of law, and stability. Thus, policymakers should take into account measures that can improve African countries' institutional environment in the effort to expand their trade capacities to stimulate total factor productivity.

Another practical implication of this study is that it is difficult to separately determine the impacts of the China–Africa economic relationship instruments (China–Africa trade, Chinese FDI and financial aid flow). From general consensus, an increase in trade between countries, and, to that effect, an open economy, has been known to attract FDI flow and receive more financial aid from trade partner countries (Asamoah et al. 2019). These mean that there is an intersection among trade, FDI and aid allocation and examining the impacts of these instruments separately may not give the full conclusion of the impact of China–Africa economic relationship. That is, the effect of financial aid flow from China to African countries on factor productivity is significant and conditional to trade linkage between China and African countries and Chinese FDI flow. From trade-related initiatives, Chinese aid allocation has a meaningful role in facilitating the trade relationship. In this regard, the composition of Chinese financial aid is significantly different from traditional aid providers because the significant amount of China's financial aid allocation to African countries is toward infrastructure sectors. Thus, Chinese aid allocation should further emphasize financing infrastructural investment.

Furthermore, from the theoretical standpoint, development financial aid could be complementary to foreign investment. This justification is in line with the arguments that appropriately targeted foreign aid can have an infrastructure effect, which in turn will invite foreign investment and expand trade through reducing the costs of trade and facilitating a business environment. When a donor gives aid for trade that is dedicated to infrastructure, enhancing the production capacity for trade facilitation in general, these measures should reduce trade costs, and hence boost exports and attract FDI. Chinese aid can ease critical bottlenecks in African countries by financing public infrastructure that would not have been undertaken by private actors to facilitate trade and FDI flow. Therefore, improving the synergies between Chinese FDI flows and financial aid through providing carefully targeted financial assistance leverages FDI flows and enhance its productivity effect. Besides, trade relations between countries can also draw attention to resources and markets that can provide investment opportunities. Hence, unsurprisingly, greater trade correlates with greater investment flows and stimulates FDI to enhance the factor productivity of host countries. Thus, this study suggests that African countries should promote trade relations with China.

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Appendix A

Additional Tables

The results reported in Tables A1–A3 are calculated using principal component analysis. Multivariate analysis often starts with data involving a substantial number of correlated variables. Principal component analysis (PCA) is a dimension-reduction tool that can be used to reduce a large set of variables to a small set that still contains most of the information in the large set. It is a mathematical operation that converts (potentially) a number of correlated variables into a (lower) amount of uncorrelated variables called the main components. The first main component accounts for as much information variation as necessary, and as much of the remaining variation as possible is accounted for by each successor component. We select this method because it allows us to apply a purely mathematical transformation without considering any priors about the underlying data structure.

We have derived institutional quality indicators from six single variables using principal component analysis that aim to reduce the dimensionality in data. This changes the data into new aggregate variables. The first aggregate indicator is the business environment. Each principal component is essentially the weighted average of the variables included. The variances of the principal components are eigenvalues of the components. The first principal component usually has the maximum variance for any of the combinations. The rule of law and regulatory quality mostly explain institutional quality as their values are relatively larger compared to the values of control of corruption, government effectiveness, voice and accountability and stability and absence of violence. The first component has an eigenvalue greater than 1 (4.565) and shows 76% of the weight.

Likewise, the education index is derived using primary, secondary and tertiary enrollment to proxy human capital (Table A2). The doing business and transport efficiency indices are derived to proxy business environment. Doing business is calculated using procedure to register property, minimum capital required to start job and cost to register property (Table A3). Documents to export and import as well as time to export and import are used to calculate border and transport efficiency (Table A4). The first components of both doing business and transport efficiency are used.

Table A1. Principal component analysis for institutional quality African countries.

Component	PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
Eigenvalue	4.565	0.613	0.460	0.178	0.104	0.079
Proportion	0.761	0.102	0.077	0.030	0.017	0.013
Cumulative	0.761	0.863	0.940	0.969	0.987	1.000
Eigenvector						
Variable	**Vector 1**	**Vector 2**	**Vector 3**	**Vector 4**	**Vector 5**	**Vector 6**
Control corruption	0.428	−0.240	−0.120	0.778	−0.338	0.162
Rule of law	0.448	−0.178	−0.051	−0.072	0.134	−0.861
Regulatory quality	0.435	0.071	−0.282	−0.565	−0.613	0.180
Government effectiveness	0.433	−0.152	−0.370	−0.125	0.692	0.397
Absence of instability	0.368	−0.209	0.868	−0.158	0.043	0.203
Voice and accountability	0.322	0.916	0.117	0.177	0.110	−0.027

Source: computed by authors.

Table A2. Index of educational achievement.

Component	PC1	PC2	PC3
Eigenvalue	1.941	0.898	0.161
Proportion	0.647	0.299	0.054
Cumulative	0.647	0.946	1.000
Eigenvector			
Variable	**Eigenvector 1**	**Eigenvector 2**	**Eigenvector 3**
Primary	0.331	0.935	0.127
Secondary	0.680	−0.143	−0.719
Tertiary	0.654	−0.324	0.684

Table A3. Index of doing business.

Component	PC1	PC2	PC3
Eigenvalue	1.456	0.901	0.643
Proportion	0.485	0.300	0.214
Cumulative	0.485	0.786	1.000
Eigenvector			
Variable	**Eigenvector 1**	**Eigenvector 2**	**Eigenvector 3**
Procedure to register property	−0.4257	0.9012	0.0817
Minimum capital required to start job	0.6309	0.3604	−0.6871
Cost to register property	0.6487	0.241	0.7219

Source: computed by authors.

Table A4. Index of transport and border efficiency.

Component	PC1	PC2	PC3	PC4
Eigenvalue	2.618	1.036	0.282	0.064
Proportion	0.654	0.259	0.071	0.016
Cumulative	0.654	0.913	0.984	1.000
Eigenvectors				
Variable	**Eigenvector 1**	**Eigenvector 2**	**Eigenvector 3**	**Eigenvector 4**
Document (import)	0.4771	0.5144	−0.6684	0.247
Document (export)	0.4665	0.5377	0.6748	−0.195
Time (import)	0.5358	−0.4454	−0.2134	−0.6848
Time (export)	0.5174	−0.4979	0.229	0.6573

Table A5. The effects of China–Africa economic relationship on TFP controlling additional covariates (education index, doing business and transport efficiency.

Variables	Estimates
loglagtfp	0.638 ***
	(0.105)
logmob	−0.002 ***
	(0.001)
logcre	−0.001
	(0.001)
logfdinorm	0.016
	(0.015)
logtradenorm	0.041 ***
	(0.011)
logloannorm	−0.012
	(0.021)
logins	0.007
	(0.006)
logefree	0.036 **
	(0.018)
doingbusiness	−0.002
	(0.001)
education	0.008 ***
	(0.002)
btransport	−0.001
	(0.000)
_cons	0.643 ***
	(0.192)
Obs.	145
Groups	29
Wald (*p*-value)	0.000
AB2 (Ch2-sta) *p*-value	0.209
Hansen (Ch2sta) *p*-value	0.999

Notes: *** significant at 1%, ** significant at 5%, standard error in parenthesis, AB2test is Arellano and Bond tests for autocorrelation, Hansen test is test for over-identification, Wald: overall fitness of the model test, Obs.: observations, Group: Group of countries.

Table A6. Alternative regression for TFP derivation.

$loglabor_{it}$	0.127 *
	(0.067)
$lognatural_{it}$	−0.010 ***
	(0.003)
$logcapital_{it}$	0.095 ***
	(0.010)
Cons.	3.067 ***
	(1.001)
Time fixed effect	yes
Obs.	514
Group	39
Wald chi2(2) *p*-value	0.000
sigma_u	0.860
sigma_e	0.058
rho	0.995

Notes: *** significant at 1%, * significant at 10%, standard error in parenthesis and Obs: observations. Dependent variable: logarithm form of GDP per capita. Source: Authors' calculations.

Appendix B African Countries Included in the Sample

Angola, Benin, Burkina Faso, Botswana, Ivory Coast, Cameroon, Congo Republic, Comoros, Cabo Verde, Djibouti, Algeria, Egypt, Ethiopia, Gabon, Ghana, Guinea, Gambia, Guinea-Bissau, Kenya, Liberia, Libya, Morocco, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, Sudan, Senegal, Sierra Leone, Seychelles, Chad, Togo, Tunisia, Tanzania, Uganda, South Africa, Zambia and Zimbabwe

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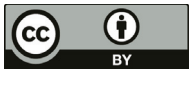

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Model Selection Procedures in Bounds Test of Cointegration: Theoretical Comparison and Empirical Evidence

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Abstract: Only unstructured single-path model selection techniques, i.e., Information Criteria, are used by Bounds test of cointegration for model selection. The aim of this paper was twofold; one was to evaluate the performance of these five routinely used information criteria {Akaike Information Criterion (AIC), Akaike Information Criterion Corrected (AICC), Schwarz/Bayesian Information Criterion (SIC/BIC), Schwarz/Bayesian Information Criterion Corrected (SICC/BICC), and Hannan and Quinn Information Criterion (HQC)} and three structured approaches (Forward Selection, Backward Elimination, and Stepwise) by assessing their size and power properties at different sample sizes based on Monte Carlo simulations, and second was the assessment of the same based on real economic data. The second aim was achieved by the evaluation of the long-run relationship between three pairs of macroeconomic variables, i.e., Energy Consumption and GDP, Oil Price and GDP, and Broad Money and GDP for BRICS (Brazil, Russia, India, China and South Africa) countries using Bounds cointegration test. It was found that information criteria and structured procedures have the same powers for a sample size of 50 or greater. However, BICC and Stepwise are better at small sample sizes. In the light of simulation and real data results, a modified Bounds test with Stepwise model selection procedure may be used as it is strongly theoretically supported and avoids noise in the model selection process.

Keywords: bounds cointegration test; information criterion; model selection techniques; plausible model

JEL Classification: C22; E00; F00; R00

1. Introduction

The concept of avoiding the spurious regression in case the time series under consideration are I(1) was firstly explored by (Engle and Granger 1987) in their seminal paper. They argued that spurious cointegration could be avoided if the I(1) time series are cointegrated, i.e., having a long-run relationship. Following their paper, numerous tests were developed, and empirical studies were carried out to find the long-run relationship between time series. Since the development of the first cointegration test, various cointegration tests have been developed, and one of them is the Bounds cointegration test developed by (Pesaran et al. 2001). Since the development of the Bounds test of cointegration by (Pesaran et al. 2001), it has been widely and frequently used by researchers to examine the level relationship between different macroeconomic and financial variables (Adeleye et al. 2018; Tsoulfidis and Tsaliki 2014; Tang 2014).

The information criteria/unstructured model selection procedures are used by the Bounds test of cointegration for plausible model selection. The five unstructured procedures, commonly known as

information criteria, are Akaike Information Criterion (AIC) developed by (Akaike 1973b), Akaike Information Criterion Corrected (AICC) formulated by (Hurvich and Tsai 1989), Bayesian or Schwarz Information Criterion (BIC or SIC) developed by (Schwarz 1978), Bayesian or Schwarz Information Criterion Corrected (BICC or SICC) developed by (McQuarrie and Tsai 1998) and an information criterion proposed by (Hannan and Quinn 1979) generally abbreviated as HQC. These criteria were developed for the lag selection in different testing approaches. In addition to these information criteria, there are other model selection procedures such as Forward Selection (FS), Backward Elimination (BW) and Stepwise (SW) Regression, which can be used for plausible model selection. These three model selection procedures are known as single-path structured procedures which were developed by (Efroymson 1960) and are routinely used in SPSS and STATA for plausible model selection.

Bounds cointegration test has some additional features as compared to its single-equation rivals as it is based on an Error Correction form of the equation, and it does not require pretesting for unit root. Furthermore, if cointegration is found, then the same error correction form serves as the famous error correction model, and if it is not found, then it is a simple autoregressive model in difference of the variables. Therefore, for the Bounds cointegration test, it is not a simple problem of lag selection, it is a very vital and crucial problem of model selection as the same model will be used for policy implications.

The performance of these model selection techniques has been assessed in numerous studies; however, one should note that the performance of these model selection techniques has yet not been evaluated for Bounds test. Moreover, single-path procedures' performance has also not been assessed for the Bounds test so far. However, scholars have frequently and widely applied the Bounds test to explore the level relationship between several financial and macroeconomic series.

Therefore, it is worth exploring the efficiency and assessing the performance of the different techniques and procedures which can be used by Bounds test for selecting a plausible model. This paper, therefore, fills the existing vacuum in the literature by finding an appropriate model selection technique from these eight model selection procedures by investigating their size and power properties on the basis of Monte Carlo simulations. Furthermore, this study also assesses the behavior of these model selection procedures by evaluating the existence of cointegration between different macroeconomic variables for BRICS (Brazil, Russia, India, China, and South Africa) member countries. Moreover, as the Bounds test has not been used for cross-country comparison of level relationship in the literature for BRICS, a cross-country comparison was also carried out, based on the existence of long-run relationships between different macroeconomic variables for BRICS economies.

These cross-country or cross-regions comparisons have been carried out in literature in several studies like (Sari 2015; Mayor and Patuelli 2015; Delbecq et al. 2013) and many more. We consider three different pairs of variables, i.e., Energy Consumption (EC) and Gross Domestic Product (GDP), Oil Price (OP) and GDP, and Broad Money (BM) and GDP, to ensure the robustness of our findings.

The rest of the paper is structured as follows. The next section presents the literature review, tracked by methodology; Section 4 presents the empirical results, and Section 5 concludes the article.

2. Literature Review

Some of the studies assessing the long-run relationship between time series after the development of cointegration include the following: long-run performance of Slovenia apple markets illustrates an almost perfect price transmission along the marketing chain with an elasticity close to unity. Economic theory generally explains this as an indicator of market productivity (Hassouneh et al. 2015). The price-level variations mainly favor retailers by increasing their marketing margins. Increases in international wheat stocks reduce producer prices, while higher interest rates boost their instability (Hassouneh et al. 2017).

A spatial price transmission is analyzed from several perspectives, using a variety of econometric techniques to shed light upon the degree of integration, adjustment asymmetries, and the role of market share upon price transmission. A linear and nonlinear Vector Error Correction (VEC) model were found to be capable of adequately depicting the long-run wheat producer price relationship between

Hungary and Slovenia (Bakucs et al. 2015). The cointegration relation implies a common stochastic trend of variables, which are modelled in the empirical analysis. Inflation rate and hospitality industry prices are found to be integrated of order one with a nonzero mean, suggesting that the present level of costs can be composed as a sum of all the previous shocks to inflation and hospitality industry prices. The general price level influences hospitality industry prices in the short run, but less in the long-term equilibrium price relation in the dynamic specifications (Gričar and Bojnec 2013).

The eight model selection approaches along with other approaches were compared using Monte Carlo simulations and real data in numerous studies such as (Hoover and Perez 1999; Hendry and Krolzig 1999; Kudo and Sklansky 2000; Castle et al. 2011) and many more having mixed conclusions. For a detailed survey of the comparison of model selection techniques, please read (Rashid 2014). (Rashid 2014) concluded that stepwise regression performs better than the rest of the single-path and unstructured model selection techniques. Moreover, (Rashid 2014) also showed that for small sample sizes, AIC is the second better performer, and BIC is the second better performer at large sample sizes.

The existence of a long-run relationship between EC and GDP has been explored in numerous studies like (Shahbaz et al. 2018; Belke et al. 2011; Mehrara 2007) and many more. Similarly, the relationship between OP and GDP has been explored in a number of studies like (Foudeh 2017; Ghalayini 2011; Du et al. 2010) and many more. A lot of studies have explored the dynamics between BM and GDP, such as (Denbel et al. 2016; Ogunmuyiwa and Ekone 2010; Liu and Jin 2005), but they are not restricted to these. The panel cointegration analysis and cointegration regression used Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) for 31 OECD (Organization for Economic Co-operation and Development) countries covering the time span 1990–2016. It shows that there is strong bidirectional causality between variables. The energy consumption elasticities of high-technology exports are comparatively high compared to medium- and low-tech exports (Şanlı 2019).

The causality tests disclosed the following: (1) unidirectional causality running from energy consumption to real GDP in Egypt, Iran, Lebanon, and Tunisia; (2) unidirectional causality running from real GDP to energy consumption in Algeria, Morocco, and Saudi Arabia; (3) bidirectional causality in Oman and the United Arab Emirates; and (4) no causality between energy consumption and real GDP in Bahrain and Malta. These conclusions suggest that energy conservation policies can be implemented in Algeria, Bahrain, Malta, Morocco, and Saudi Arabia (Ozturk 2017). The magnitude of the coefficient estimates of Natural Gas Consumption (NGC) becomes substantially smaller in the long run, and the sign of short-run estimates of NGC shifts to negative after accounting for capital and labor as well. The direction of causality between growth rate (GR) and NGC using the vector error correction model Granger causality approach revealed the evidence of feedback hypothesis for Turkey (Dogan 2015).

The higher oil prices transform income from oil-importing countries to oil-exporting countries. So, increases in oil prices have a negative impact on the economy of oil importers. Moreover, it has a significant impact on economic growth. Trade openness also has a positive and significant impact on economic output. Long-run results indicate that the coefficient of government investment has a positive and significant impact on growth. Long-run and short-run dynamics between variables, respectively, used annual data from 1972 to 2011 in the context of Pakistan. Through examining the results, the long-run and dynamic relationships have detected for all the variables except industrial oil consumption, and oil price variables for the model have no short-run impact on GDP. Oil prices impact real GDP negatively in the long run but positively in the short run (Nazir and Qayyum 2014).

The oil prices have no vital impact on the most variables during the short term, with the exception that they have a positive effect on inflation and negative effect on the real effective exchange rate. The result of Variance Decomposition (VD) analysis is consistent with the Impulse Response Function (IRF) in that there is a positive impact in the long term of oil prices on the real GDP (RGDP) and inflation (INF). On the other hand, there is a negative impact on the real effective

exchange rate (REER) and unemployment rate (UNE), with no effect at all on Money supply (M2) (Bouchaour and Al-Zeaud 2012).

3. Methodology

The details of the Bounds Cointegration test and model selection procedures are laid out. The data generating process (DGP) and the details of data sources with their description are also given.

3.1. Bounds Test of Cointegration

The Bounds test of cointegration uses the following form of the Error Correction Model (ECM hereafter):

$$\Delta y_t = c_0 + c_1 t + \phi(\pi_0 + \pi_1 t + \alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{q} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (1)$$

where y_t is a $T \times 1$ vector of endogenous/dependent variable, X_t is a $T \times k$ vector of k regressors, i.e., $(x_{1t}, x_{2t}, - - - - - - - x_{kt})$, ε_t is a $T \times 1$ vector of random errors and p, and q is the maximum number of lags of Y and X, respectively. The parameters of interest are c_0, the unrestricted intercept, c_1 the unrestricted linear time trend, π_0 the restricted intercept, and π_1 the restricted linear time trend. (Pesaran et al. 2001) considered the following five different models, i.e.,

Model-1: No intercepts, No trends: In ECM (1) $c_0 = c_1 = \pi_0 = \pi_1 = 0$ and it becomes

$$\Delta y_t = \phi(\alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (2)$$

Model-2: Restricted intercept, No trends: In ECM (1) $c_0 = c_1 = \pi_1 = 0$ and it becomes

$$\Delta y_t = \phi(\pi_0 + \alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (3)$$

Model-3: Unrestricted intercept, No trends: In ECM (1) $c_1 = \pi_0 = \pi_1 = 0$ and it becomes

$$\Delta y_t = c_0 + \phi(\alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (4)$$

Model-4: Unrestricted intercept, Restricted trends: In ECM (1) $c_1 = \pi_0 = 0$ and it becomes

$$\Delta y_t = c_0 + \phi(\pi_1 t + \alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (5)$$

Model-5: Unrestricted intercept, Unrestricted trend: In ECM (1) $\pi_0 = \pi_1 = 0$ and it becomes

$$\Delta y_t = c_0 + c_1 t + \phi(\alpha y_{t-1} + \beta X_{t-1}) + \sum_{i=1}^{p} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{p} \delta_i \Delta X_{t-i} + \varepsilon_t \quad (6)$$

For the testing of the existence of a long-run relationship, the null hypothesis of no cointegration, i.e.,

$$H_0 : \varphi = 0 \ (No\ Long - run\ relationship) \quad (7)$$

is tested against the alternative hypothesis of cointegration, i.e.,

$$H_A : \varphi \neq 0 \ (Long - run\ relationship\ exists) \quad (8)$$

(Pesaran et al. 2001) used the standard $F-test$ for linear restrictions to test H_0, i.e.,

$$F = \frac{\frac{(RSSR-RSSU)}{q}}{\frac{RSSU}{(T-k)}} \tag{9}$$

where $RSSR$ is the Residual Sum of Squares for Restricted Regression, $RSSU$ is the Residual Sum of Squares for Unrestricted Regression, q is the number of restrictions, and k is the total number of parameters estimated. Two critical values of $F-stat$ were obtained; one was named as lower bound, denoted as F_{LB} and it was the $100(1-\alpha)th$ percentile of F when X_t are generated as $I(0)$, i.e., integrated of order zero. The other was named as upper bound denoted as F_{UB} and it was the $100(1-\alpha)th$ percentile of F when X_t are generated as $I(1)$, i.e., integrated of order one. The α is the assumed significance level. The null hypothesis of no cointegration is rejected when $F \geq F_{UB}$ and it is concluded that there is a long-run relationship between y_t and X_t. If $F \leq F_{LB}$, then it is concluded that there is no long-run relationship between y_t and X_t. However, if $F_{LB} < F < F_{UB}$, then it is concluded that the test is inconclusive.

For the selection of a plausible model, the following eight model selection procedures are used belonging to two types of structured and unstructured model selection procedures.

3.2. Structured Model Selection Procedures

These procedures and algorithms use Several Linear Regression models and their conclusions for the selection of a plausible and parsimonious model from a set of candidate variables. These algorithms were first developed by (Efroymson 1960) and are routinely used by social scientists. The details of these three algorithms are below.

3.2.1. Forward Selection (FS) Procedure

It is a unidirectional algorithm that first estimates the model with no candidate variable, and then it estimates the linear regression model for all candidate variables separately one by one. Let Y be the dependent variable, $X_i \; for \; i = 1, \; 2, \; 3, \; \ldots \; \ldots \; \ldots \; \ldots, \; k$ be k independent variables, be k respective regression coefficients, and ε be the random error, then FS algorithm estimates k linear regressions, i.e.,

$$Y = X_i\beta_i + \varepsilon \quad \forall \; k = 1, \; 2, \; 3, \; \ldots \; \ldots \; \ldots \; \ldots, \; k \tag{10}$$

The independent variable having the minimum significant p-value or maximum significant t-stat is chosen. Then this variable is maintained in the model throughout the further selection technique. In the next step, again $k-1$ linear regressions are estimated, and another most significant variable is chosen from remaining $k-1$ candidate variables. This process is continued until either there is no significant variable to be included or all variables have been included.

3.2.2. Backward Elimination (BW) Procedure

It is also a unidirectional algorithm that first estimates that the most general multiple linear regression model was having all the candidate variables. Say that Y is the $(T \times 1)$ vector of the dependent variable, X is $(T \times k)$ matrix of independent variables, β is $(k \times 1)$ vector of respective regression coefficients, and ε is the $(T \times 1)$ vector of random errors, then BW algorithm estimates the multiple linear regression model:

$$Y = X\beta + \varepsilon \tag{11}$$

In this estimated model, the independent variable, either having the maximum insignificant p-value or minimum insignificant t-stat, is dropped, and the model is reduced to $k-1$ regressors. Again, the same procedure is adopted for the remaining regressors, and another variable is dropped, and the

model is reduced to $k-2$ regressors. This procedure continues until either there is no insignificant variable to be dropped or all of the variables have been dropped.

3.2.3. Stepwise (SW) Regression Procedure

There are two algorithms, i.e., Stepwise with Forward Selection and Stepwise with Backward Elimination, whose details are below:

Stepwise with Forward Selection

It is a bidirectional selection algorithm, which uses both forward selection and backward elimination for plausible and parsimonious model selection. Take the same model as it is in forward selection, i.e., let Y be the dependent variable, $X_i \; for \; i = 1, \; 2, \; 3, \; \ldots \; \ldots \; \ldots \; \ldots, \; k$ be k independent variables, $\beta_i \; for \; i = 1, \; 2, \; 3, \; \ldots \; \ldots \; \ldots \; \ldots, \; k$ be k respective regression coefficients, and ε be the random error. Then for the first two steps, the forward selection is used to select two variables, i.e., FS algorithm estimates k linear regressions separately:

$$Y = X_i\beta_i + \varepsilon \quad \forall \; k = 1, \; 2, \; 3, \; \ldots \; \ldots \; \ldots \; \ldots, \; k \tag{12}$$

The independent variable having the minimum significant p-value or maximum significant t-stat is chosen as the valid first regressor. Then, this variable is retained in the model for the second-step selection procedure. In the second step, again $k-1$ separate linear regressions are estimated, and another most significant variable is chosen from remaining $k-1$ candidate variables as the second valid regressor. Then, backward elimination is run on these two selected valid regressors by FS to drop the variable, which is insignificant in the model if there is any. In the third step again, forward selection is used to select another valid variable if it is significant, and then again, backward elimination is used to drop the insignificant regressors. This process continues until all the candidate regressors are accounted for.

Stepwise with Backward Elimination

In this algorithm for the first two steps, backward elimination is used to drop the two most insignificant variables, and then in the forward selection is used to check whether the two dropped variables may or may not be included again. In the third step again, backward elimination is used to drop another most insignificant variable (if any), and then again forward selection is used. This process continues until a parsimonious model is obtained.

3.2.4. Unstructured Model Selection Procedures

These methods are generally known as Information Criteria in Statistics and Econometrics. These are no-parametric methods, which calculate the information lost by imposing penalties. The models having the minimum value of these information criteria are selected as the most plausible and parsimonious model. The general procedure of all these methods is the same; however, they differ in penalty. The general form is as follows:

$$IC = c{\cdot}ln\left(\sigma^2\right) + Penalty \tag{13}$$

where c is a constant, σ^2 is the estimated error variance, and $Penalty$ is a function which differs with type.

In order to implement the information criteria for model selection, first, all possible models are estimated, and for each model, information criteria are calculated. Then, the model having the minimum information criteria is selected as the most plausible model. If there are k candidate variables, then there will be $(2^k - 1)$ possible models, and all these models are to be estimated. So, if there are a large number of candidate variables, say $k = 15$, then there will be $(2^{15} - 1 = 32{,}767)$ possible models to be estimated, which is a massive task. For all information criteria, let there be k candidate variables; l is

the value of the log-likelihood function of the estimated model, T is the total number of observations, and σ^2 is the estimated variance of the model. The five information criteria's performance is assessed in this paper and their details are:

3.2.5. Akaike Information Criterion (AIC)

It was developed by (Akaike 1973a), and it is a measure of goodness of fit of the model. It is given as

$$AIC = ln\left(\sigma^2\right) + 2(k+1)/T \tag{14}$$

Its likelihood form is

$$AIC = -2l + 2k \tag{15}$$

3.2.6. Akaike Information Criterion Corrected (AICC)

This criterion is a modification of AIC, modified by (Hurvich and Tsai 1989). It is given as

$$AICC = ln\left(\sigma^2\right) + (T+k+1)/(T-k-3) \tag{16}$$

Its likelihood form is

$$AIC = -2(l/T) + 2(k/T) \tag{17}$$

3.2.7. Bayesian Information Criterion (BIC)

BIC was developed by (Schwarz 1978), also known as Schwarz Information Criterion (SIC) in literature. Analytically, it is given as

$$BIC = ln\left(\sigma^2\right) + (k+1)\cdot ln(T)/T \tag{18}$$

Its likelihood form is

$$BIC = -2l + k\cdot ln(T) \tag{19}$$

3.2.8. Bayesian Information Criterion Corrected (BICC)

BICC is a modification of BIC and modified by (McQuarrie and Tsai 1998). BICC is also known as Schwarz Information Criterion Corrected (SICC). It is given as

$$BICC = ln\left(\sigma^2\right) + (k+1)\cdot ln(T)/(T-k-3) \tag{20}$$

Its likelihood form is

$$BIC = -2(l/T) + k\cdot ln(T)/T \tag{21}$$

3.2.9. Hannan-Quinn Information Criterion (HQC)

HQC was developed by (Hannan and Quinn 1979). It is given as

$$HQC = ln\left(\sigma^2\right) + 2k\cdot ln(ln(T)) \tag{22}$$

Its likelihood form is

$$HQC = -2(l/T) + 2k\cdot ln(ln(T))/T \tag{23}$$

3.3. Data Generating Process (DGP)

The ECM specified in Equation (1) has been used as DGP. However, X is a single regressor in our DGP and being generated as a random walk without drift and trend. The performance of model selection procedures is free of nuisance parameters (a different set of values of nuisance parameters were taken, and it was observed that they do not affect the size or power), so their values are set to 1, i.e.,

$$c_0 = c_1 = \pi_0 = \pi_1 = \alpha = \beta = 1 \tag{24}$$

Under the null hypothesis of no cointegration, $\varphi = 0$ and under the alternative hypothesis of cointegration $\varphi = \{0.005,\ 0.008,\ 0.011\}$ have been considered.

3.4. Basis of Monte Carlo Comparison

Eight model selection procedures have been compared on the basis of size and power using Monte Carlo simulations. The size and power are defined as

$$\begin{aligned} Size &= Probability\left(Rejection\ of\ H_0 / \ H_0\ is\ True\right) \\ Power &= Probability\left(Rejection\ of\ H_0 / \ H_0\ is\ False\right) \end{aligned} \tag{25}$$

50,000 simulation has been carried out for estimation of size and power.

3.5. Data Description and Source

In our empirical analysis, we used the data for BRICS (Brazil, Russia, India, China, and South Africa) member countries. We considered these countries because BRICS is one of the essential alliances of five nations, and these are five rapidly emerging economies representing four different continents (Lissovolik and Vinokurov 2019; Huang and Osborne 2017). Three pairs of variables have been considered to assess the cointegration among them, and these are {Energy Consumption (EC hereafter) and Gross Domestic Product (GDP hereafter)}, {Oil Price (OP hereafter) and GDP} and {Broad Money (BM hereafter) and GDP}. The annual data for three considered pairs of macroeconomic variables of BRICS member countries have been taken from WDI (World Bank's online data source). The data covers the period from 1990 to 2017. Data of "GDP per Capita in current US$" for each of the BRICS members is taken as GDP for the first two pairs, and "GDP in Current Local Currency Unit (LCU)" has been taken as GDP for the third pair as BM is also in LCU. The data of "Energy use (kg of oil equivalent per capita)" has been taken as Energy Consumption (EC), and "Cushing, OK WTI Spot Price FOB (US$ per Barrel)" are taken as Oil Prices (OP).

4. Results and Discussion

To evaluate the relative performance of all eight model selection procedures, the findings of Monte Carlo experiments are discussed first and then the findings of real data are discussed.

4.1. Theoretical Comparison

The size of the Auto-Regressive Distributed Lags (ARDL) Bounds test is assessed considering all five models at four different time dimensions of 25, 50, 100, and 200 using asymptotic critical values at a 5% level of significance as given in (Pesaran et al. 2001). These sizes are displayed in Table A1 in the Appendix A. At the smallest time dimension/sample size of $T = 25$, all model selection procedures have high size distortions as the empirical sizes are way higher than the assumed nominal size of 5%. However, when gradually the time dimension T is increased, the empirical size of each model selection procedure also improves, with varying convergence rates. FS, SW, BIC, and BICC have a better convergence rate than others.

To find the size-adjusted power, simulated critical values are obtained and are displayed in Table A2 in the Appendix A. All eight model selection procedures are evaluated based on their powers using these simulated critical values. To summarize, first, the information criteria are compared on the basis of powers, and it is found that AICC and BICC outperform the rest in a small sample size of $T = 25$. However, as T increases, all five information criteria tend to have the same powers. The power comparison of these five information criteria for $T = 25$ are displayed in Figure A1 in Appendix A. For the rest of the time dimensions considered in this paper, i.e., $T = 50,\ 100,$ and 200, all five information criteria have the same powers (see Table A3). Similarly, the three structured model

selection procedures, i.e., BW, FS, and SW, were compared on the basis of their powers, and it was found that FS and SW are better as compared to the BW at the smallest time dimension of $T = 25$. However, with the increase of T, the three structured procedures have the same powers. The power comparison for three structured procedures at $T = 25$ are displayed in Figure A2 in the Appendix A. At other larger time dimensions, the three structured procedures have the same powers (see Appendix A Table A4).

The two better-performing information criteria, i.e., AICC and BICC, are compared with two better-performing structured model selection procedures, i.e., FS and SW at T = 25, 50, 100, and 200. The comparison at T = 25 is displayed in Figure 1. However, for T >= 50, all these four procedures have approximately the same power. From Figure 1, it is clearly evident that for Models I and II, SW and FS have slightly higher powers than BICC and AICC. However, for Models III, IV, and V, BICC has higher powers than the rest of the three, and the rest of the three have the same powers. Even for these three models (III, IV, and V), the maximum gap is around 10% between the BICC's power and the powers of the other three (AICC, SW, and FS).

Figure 1. Power Curves of Better Performing Model Selection Procedures at T = 25. Note: Null and different alternative hypotheses are along the X-axis, and Size and Power in % are along the Y-axis.

4.2. Real Economic Applications

Coming to the real economic data application, we estimated the five error correction models, i.e., Model-1, Model-2, Model-3, Model-4, and Model-5, using the annual data of GDP[1] and Energy Consumption (EC)[2] of BRICS countries from 1990 to 2014. The eight model selection techniques have been used to select a plausible model with maximum lag length $p = 2$. The results are presented in Table 1. It is apparent from the table that, for all five BRICS countries, if only first ECM (Model-1) is considered, then there is no significant evidence for the existence of cointegration using any of the model selection techniques except for India, where cointegration exists at the 1% level of significance only using the three single-path procedures, i.e., FS, BW, and SW. For the second ECM (Model-2), cointegration does not exist for Brazil using any of the model selection approaches. Similarly, for India, cointegration does not exist using any of the information criteria (AIC, AICC, BIC, BICC, and HQC). In the same manner, cointegration does not exist for South Africa using FS and SW. However, cointegration exists at the 1% level of significance for Russia and China using any model selection techniques. Similarly, cointegration exists at the 1% level of significance for South Africa using any of the model selection approaches except two, i.e., FS and SW. In the same manner, cointegration exists at the 1% level of significance for India, using only three structured model selection approaches, i.e., FS, BW, and SW.

For Model-3, there is no significant evidence about the existence of cointegration for Brazil and India using any of the model selection approaches. However, cointegration exists at the 1% level of significance for Russia and China using any of the model selection approaches. Similarly, for South Africa, cointegration exists at the 1% level of significance using any of the model selection techniques except two, i.e., FS and SW. When the fourth ECM (Model-4) is considered, then there is no evidence about the existence of cointegration for Brazil and India using any of the model selection procedures. Similarly, cointegration does not exist for South Africa using any of the model selection techniques except AICC. Cointegration exists for Russia and China using any of the model selection procedures. If the fifth ECM (Model-5) is assumed, then cointegration does not exist for Brazil and India using any of the model selection approaches. Similarly, cointegration does not exist for South Africa using any of the model selection procedures except AICC. However, cointegration exists for Russia and China using any of the model selection techniques. From the overall 25 cases (5 ECMs and 5 BRICS countries), cointegration is detected only 10 times when AIC is used. Similarly, cointegration is detected 11, 10, 10, 11, 10, 12, and 10 times when AICC, BIC, BICC, HQC, FS, BW, and SW are used, respectively.

Table 1. Bounds Test Results for Energy Consumption and GDP.

Type of ECM	Model Selection Procedure							
	AIC	**AICC**	**BIC**	**BICC**	**HQC**	**FS**	**BW**	**SW**
				BRAZIL				
Model-1	2.619 (0.172)	2.619 (0.173)	2.619 (0.166)	2.619 (0.166)	2.619 (0.172)	1.349 (0.463)	2.619 (0.174)	1.349 (0.463)
Model-2	2.261 (0.352)	2.046 (0.417)	2.046 (0.409)	2.046 (0.409)	2.046 (0.414)	0.947 (0.851)	2.046 (0.414)	0.947 (0.851)
Model-3	2.927 (0.337)	2.408 (0.454)	2.408 (0.447)	2.408 (0.447)	2.408 (0.451)	0.246 (0.964)	2.408 (0.452)	0.246 (0.964)
Model-4	2.848 (0.417)	4.236 (0.138)	2.848 (0.408)	4.234 (0.129)	2.848 (0.411)	4.234 (0.132)	4.233 (0.133)	4.234 (0.132)
Model-5	4.246 (0.327)	6.225 (0.110)	4.246 (0.322)	6.225 (0.105)	4.246 (0.324)	6.225 (0.107)	6.225 (0.107)	6.224 (0.107)

[1] The data of "GDP per Capita in Current US$" has been taken as GDP.
[2] The data of "Energy Use (Kg of oil equivalent per Capita)" has been taken as Energy Consumption (EC).

Table 1. *Cont.*

Type of ECM	Model Selection Procedure							
	AIC	**AICC**	**BIC**	**BICC**	**HQC**	**FS**	**BW**	**SW**
				RUSSIA				
Model-1	1.735	1.735	1.735	0.478	1.735	0.478	0.478	0.478
	(0.351)	(0.350)	(0.346)	(0.796)	(0.345)	(0.7961)	(0.796)	(0.796)
Model-2	7.037 ***	6.116 ***	7.037 ***	6.116 ***	7.037 ***	6.1164 ***	7.037 ***	6.116 ***
	(0.002)	(0.006)	(0.001)	(0.007)	(0.002)	(0.007)	(0.002)	(0.007)
Model-3	10.546 ***	7.335 **	10.546 ***	7.335 **	10.546 ***	7.335 ***	10.546 ***	7.335 **
	(0.001)	(0.017)	(0.001)	(0.016)	(0.001)	(0.017)	(0.001)	(0.017)
Model-4	6.980 **	4.644	6.980 ***	4.644 *	6.980 ***	4.644 *	6.980 ***	4.644 *
	(0.011)	(0.102)	(0.009)	(0.096)	(0.009)	(0.099)	(0.009)	(0.099)
Model-5	10.454 ***	6.763 *	10.454 ***	6.763 *	10.454 ***	6.763 *	10.454 ***	6.763 *
	(0.010)	(0.082)	(0.007)	(0.077)	(0.008)	(0.077)	(0.01)	(0.077)
				INDIA				
Model-1	0.789	1.285	1.285	1.285	0.789	10.114 ***	10.114 ***	10.114 ***
	(0.668)	(0.484)	(0.477)	(0.477)	(0.664)	(0.000)	(0.000)	(0.000)
Model-2	1.182	0.817	0.817	0.817	1.182	6.51 4***	6.514 ***	6.514 ***
	(0.759)	(0.896)	(0.894)	(0.894)	(0.760)	(0.003)	(0.003)	(0.003)
Model-3	0.681	0.110	0.110	0.110	0.681	0.125	0.125	0.125
	(0.883)	(0.988)	(0.986)	(0.986)	(0.881)	(0.985)	(0.985)	(0.985)
Model-4	4.339	3.528	3.528	2.535	4.339	1.427	1.427	1.427
	(0.126)	(0.247)	(0.234)	(0.497)	(0.121)	(0.876)	(0.874)	(0.876)
Model-5	6.422	5.205	5.205	3.780	6.422 *	1.927	1.927	1.927
	(0.095)	(0.198)	(0.189)	(0.409)	(0.094)	(0.808)	(0.809)	(0.808)
				CHINA				
Model-1	1.236	1.372	1.236	1.372	1.236	1.372	1.372	1.372
	(0.503)	(0.461)	(0.493)	(0.451)	(0.497)	(0.457)	(0.458)	(0.457)
Model-2	6.999 ***	35.701 ***	19.89 ***	35.701 ***	8.546 ***	35.701 ***	35.678 ***	35.702 ***
	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	8.726 ***	23.109 ***	18.453 ***	23.109 ***	10.97 ***	23.109 ***	17.830 ***	23.109 ***
	(0.005)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Model-4	19.618 ***	16.871 ***	19.618 ***	15.653 ***	19.618 ***	16.871 ***	16.871 ***	16.871 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-5	29.313 ***	25.264 ***	29.313 ***	23.099 ***	29.313 ***	25.264 ***	25.264 ***	25.264 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
				SOUTH AFRICA				
Model-1	0.597	1.01	0.597	1.01	0.596	0.863	0.863	0.863
	(0.748)	(0.583)	(0.748)	(0.574)	(0.750)	(0.634)	(0.636)	(0.634)
Model-2	7.153 ***	7.153 ***	7.153 ***	7.153 ***	7.153 ***	1.415	7.153 ***	1.415
	(0.002)	(0.002)	(0.000)	(0.000)	(0.0018)	(0.662)	(0.002)	(0.662)
Model-3	9.131 ***	9.131 ***	9.131 ***	9.131 ***	9.131 ***	1.784	9.131 ***	1.784
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.601)	(0.004)	(0.601)
Model-4	3.855	5.815 **	3.855	2.012	3.855	3.215	3.855	3.215
	(0.188)	(0.032)	(0.178)	(0.686)	(0.182)	(0.301)	(0.182)	(0.301)
Model-5	5.551	7.932 **	5.551	3.017	5.551	4.734	5.551	4.734
	(0.163)	(0.043)	(0.155)	(0.575)	(0.156)	(0.247)	(0.158)	(0.247)

Note: ***, ** and * indicate the existence of cointegration at 1%, 5%, and 10% level of significance, respectively, *p*-values are given in parenthesis.

As far as the cross-country comparison is concerned, for Brazil, there is no evidence of a long-run relationship between EC and GDP, irrespective of the model selection technique. However, the long-run relationship between the said macroeconomic variables exists for Russia, considering all models except Model-1. In the same manner, there is evidence of a long-run relationship between EC and GDP for India when Model-1 or Model-2 are considered, and structured model selection techniques are used. Coming to China, it is evident that there is a long-run relationship between EC and GDP for all models except Model-1. Finally, the long-run relationship between EC and GDP exists for South Africa when Model-2 and Model-3 are considered majorly.

For the detection of cointegration between Oil Prices (OP) and GDP, the five ECMs, i.e., Model 1, Model 2, Model 3, Model 4, and Model 5 have been estimated using the annual data of GDP[3] and Oil Prices[4] from 1990 to 2016 for all BRICS member countries by considering Oil Prices as an exogenous and GDP as an endogenous variable. The results are given in Table 2. For the first ECM (Model 1), cointegration does not exist between Oil Prices and GDP for Brazil, Russia, China, and South Africa using any of the model selection procedures. However, cointegration exists between Oil Prices and GDP for India using any of the model selection approaches. When the second ECM, i.e., Model 2, is considered, then only for Brazil cointegration does not exist using any of the model selection techniques. From the rest of the four countries, cointegration exists for India and China using any of the model selection procedures. For Russia, cointegration exists using any of the model selection approaches except AIC. Similarly, for South Africa, cointegration exists using any of the model selection approaches except BIC, FS, and SW.

If the third ECM, i.e., Model 3, is assumed, then cointegration does not exist for Brazil and India using any of the model selection techniques. However, cointegration exists for China using any of the model selection techniques. For Russia, cointegration exists using any of the model selection approaches except AIC. Similarly, for South Africa, cointegration exists using any of the model selection procedures except BICC, FS, and SW. In the same manner, when the fourth ECM, i.e., Model 4, is considered, then cointegration does not exist for Brazil and India using any of the model selection techniques. Cointegration exists at the 1% level of significance for China using any of the model selection procedures except two, i.e., FS and SW. Similarly, for Russia, cointegration is detected at the 10% level of significance using six model selection techniques (AICC, BIC, BICC, FS, BW, and SW) and using the rest of two (AIC and HQC), cointegration is not detected. Similarly, for South Africa, there is evidence about the existence of cointegration using any of the model selection techniques except three, i.e., BICC, FS, and SW.

When the fifth ECM, i.e., Model 5, is assumed, then for only Brazil, cointegration does not exist using any of the model selection procedures. Similarly, cointegration does not exist for India using five model selection techniques (AICC, BICC, FS, BW, and SW) and using the rest of three (AIC, BIC, and HQC) cointegration exists. However, cointegration between oil prices and GDP exists at the 1% level of significance for China using any of the model selection approaches except two, i.e., FS and SW. In the same manner, cointegration exists at the 10% level of significance for Russia using any of the model selection procedures except two, i.e., AIC and HQC. Similarly, cointegration between oil prices and GDP exists for South Africa using any of the model selection approaches except three, i.e., BICC, FS, and SW. From the overall 25 cases (5 ECMs and 5 BRICS countries), cointegration between oil price and GDP is detected 11 times using AIC as a model selection technique. Similarly, cointegration is detected 14, 15, 10, 13, 8, 14, and 8 times using AICC, BIC, BICC, HQC, FS, BW, and SW as the model selection techniques, respectively.

Coming to cross-country comparison, there is no evidence of the long-run relationship between OP and GDP for Brazil, positive evidence for Russia when mainly Model-2 and Model-3 are considered, positive evidence for India when majorly Model-1 and Model-2 are considered, strong evidence for China when all models are considered except Model-1 and strong evidence for South Africa considering all models except Model-1.

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[3] Data of "GDP per Capita in current US$" is taken as GDP.
[4] Data of "Cushing, OK WTI Spot Price FOB (US$ per Barrel)" is taken as Oil Prices (OP).

Table 2. Bounds Test Results for Oil Prices and GDP.

Type of ECM	Model Selection Procedure							
	AIC	**AICC**	**BIC**	**BICC**	**HQC**	**FS**	**BW**	**SW**
				BRAZIL				
Model-1	1.725	1.725	1.725	1.725	1.725	1.725	1.725	1.725
	(0.353)	(0.353)	(0.348)	(0.348)	(0.348)	(0.345)	(0.345)	(0.345)
Model-2	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
	(0.798)	(0.799)	(0.796)	(0.796)	(0.800)	(0.800)	(0.800)	(0.800)
Model-3	1.634	1.634	1.634	1.634	1.634	1.634	1.634	1.634
	(0.642)	(0.643)	(0.633)	(0.633)	(0.635)	(0.636)	(0.636)	(0.636)
Model-4	1.545	1.545	1.545	1.545	1.545	1.545	1.545	1.545
	(0.849)	(0.848)	(0.845)	(0.845)	(0.846)	(0.846)	(0.845)	(0.846)
Model-5	1.605	1.605	1.605	1.605	1.605	1.605	1.605	1.605
	(0.868)	(0.868)	(0.864)	(0.864)	(0.864)	(0.864)	(0.865)	(0.864)
				RUSSIA				
Model-1	1.916	0.737	0.737	0.737	1.916	0.737	0.737	0.737
	(0.309)	(0.691)	(0.688)	(0.687)	(0.310)	(0.689)	(0.691)	(0.689)
Model-2	2.028	5.840 ***	5.840 ***	5.840 ***	5.840 ***	5.840 ***	5.840 ***	5.840 ***
	(0.423)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Model-3	3.026	8.253 ***	8.253 ***	8.253 ***	8.253 ***	8.253 ***	8.253 ***	8.253 ***
	(0.321)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)
Model-4	2.110	5.247 *	5.247 *	5.247 *	2.110	5.247 *	5.247 *	5.247 *
	(0.661)	(0.06)	(0.052)	(0.052)	(0.652)	(0.056)	(0.056)	(0.056)
Model-5	2.209	6.754 *	6.754 *	6.754 *	2.209	6.754 *	6.754 *	6.754 *
	(0.754)	(0.083)	(0.077)	(0.077)	(0.753)	(0.078)	(0.079)	(0.078)
				INDIA				
Model-1	13.106 ***	13.106 ***	13.106 ***	13.106 ***	13.106 ***	16.131 ***	16.131 ***	16.131 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-2	12.867 ***	13.045 ***	13.98 ***	13.045 ***	13.98 ***	10.985 ***	10.985 ***	10.985 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	3.063	1.885	2.833	1.885	2.833	0.418	0.418	0.418
	(0.316)	(0.577)	(0.353)	(0.574)	(0.3537)	(0.936)	(0.937)	(0.936)
Model-4	4.553	3.302	4.469	2.327	4.552	1.190	1.190	1.190
	(0.1077)	(0.292)	(0.109)	(0.565)	(0.105)	(0.935)	(0.936)	(0.935)
Model-5	6.820 *	4.874	6.621 *	3.490	6.820 *	1.782	1.782	1.782
	(0.080)	(0.233)	(0.083)	(0.469)	(0.075)	(0.834)	(0.835)	(0.8340)
				CHINA				
Model-1	0.916	1.417	0.916	1.417	0.916	1.417	1.417	1.417
	(0.62)	(0.446)	(0.614)	(0.437)	(0.615)	(0.443)	(0.443)	(0.443)
Model-2	48.58 ***	48.024 ***	48.04 ***	108.765 ***	48.024 ***	48.024 ***	48.024 ***	48.024 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	41.635 ***	40.717 ***	40.717 ***	23.929 ***	40.717 ***	40.717 ***	40.718 ***	40.718 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-4	28.219 ***	20.553 ***	28.219 ***	16.195 ***	28.219 ***	2.189	25.504 ***	2.189
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.626)	(0.000)	(0.626)
Model-5	41.975 ***	30.798 ***	41.975 ***	24.279 ***	41.975 ***	3.21	38.204 ***	3.21
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.54)	(0.000)	(0.54)
				SOUTH AFRICA				
Model-1	0.884	1.405	0.884	0.411	0.884	0.769	1.405	0.77
	(0.632)	(0.449)	(0.625)	(0.829)	(0.629)	(0.673)	(0.447)	(0.673)
Model-2	11.656 ***	10.417 ***	11.656 ***	1.521	11.656 ***	1.521	10.909 ***	1.521
	(0.000)	(0.000)	(0.000)	(0.617)	(0.000)	(0.615)	(0.000)	(0.615)
Model-3	17.117 ***	14.937 ***	17.118 ***	1.821	17.117 ***	1.821	16.283 ***	1.821
	(0.000)	(0.000)	(0.000)	(0.589)	(0.000)	(0.590)	(0.000)	(0.590)
Model-4	10.384 ***	5.174 *	10.745 ***	1.661	10.384 ***	1.661	10.745 ***	1.661
	(0.0003)	(0.064)	(0.000)	(0.810)	(0.000)	(0.811)	(0.000)	(0.811)
Model-5	15.383 ***	7.503 *	15.301 ***	2.378	15.383 ***	2.378	15.301 ***	2.378
	(0.000)	(0.053)	(0.000)	(0.716)	(0.000)	(0.716)	(0.000)	(0.716)

Note: *** and * indicate the existence of cointegration at 1%, 5%, and 10% level of significance, respectively. *p*-values are given in parenthesis.

For the detection of cointegration between Broad Money (BM) and GDP by Bounds test for all five BRICS member countries, the five Error Correction Models (ECMs), i.e., Model 1, Model 2, Model 3, Model 4, and Model 5 have been estimated considering Broad Money as exogenous and GDP as an endogenous variable. The annual data of Broad Money[5] and GDP[6] from 1993 to 2015 have been used for this purpose. The results are given in Table 3. When the first ECM, i.e., Model 1, is assumed and estimated, then cointegration does not exist using any of the model selection procedures for China. However, cointegration is detected at the 1% level of significance using any of the model selection procedures for South Africa. Similarly, cointegration exists using any of the model selection approaches except two, i.e., FS, and SW for Russia. In the same manner, there is evidence of cointegration at the 1% level of significance for India using any of the model selection methods except two, i.e., AIC and BW. Continuingly, there is evidence about the existence of cointegration at the 1% level of significance for Brazil using only five model selection methods, and these five are AICC, BICC, FS, BW, and SW.

If the second ECM (Model 2) is considered and estimated for the detection of cointegration, then there is evidence about existence of cointegration at the 1% level of significance for Brazil, Russia, China, and South Africa using any of the model selection procedures. However, cointegration is detected at the 5% level of significance for India using only three model selection methods, and these are AIC, BIC, and HQC. When the third ECM, i.e., Model 3, is estimated for the detection of cointegration, then there is evidence about the existence of cointegration at the 1% level of significance for Brazil, Russia, and China using any of the model selection methods. However, for India, cointegration at the 5% level of significance is detected using only three model selection approaches, and these three are AIC, BIC, and HQC. Similarly, for South Africa, detection of cointegration is possible when six model selection methods are used and these six are AIC, AICC, BIC, BICC, HQC, and BW. If the fourth ECM (Model 4) is considered for the detection of cointegration between them, there is evidence about the existence of cointegration for Brazil, Russia, and China. Similarly, cointegration exists for India using only four model selection methods, and these four are AIC, BIC, HQC, and BW. In the same manner, when these same four model selection methods are used for the detection of cointegration in the case of South Africa, then there is evidence about the existence of cointegration.

If the fifth ECM (Model 5) is estimated for detection of cointegration, then cointegration exists for Brazil, Russia, and China using any of the model selection methods. Continuingly, for India only, the use of four model selection methods results in the existence of cointegration and these four are AIC, BIC, HQC, and BW. Similar is the case of South Africa, where use of the same four model selection techniques (AIC, BIC, HQC, and BW) results in the existence of cointegration. From the overall 25 (5 ECMS and 5 BRICS member countries) cases, 22 times cointegration has been detected when AIC is used as the model selection method. Similarly, cointegration has been detected 18, 23, 18, 23, 16, 21, and 16 times using AICC, BIC, BICC, HQC, FS, BW, and SW as the model selection methods, respectively.

The long-run relationship between BM and GDP has significant evidence of its existence for Brazil, Russia, and South Africa irrespective of any of the five models considered, for India when Model-1 is considered only and for China when all models are considered except Model-1.

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[5] The data of "Broad Money in Current Local Currency Unit (LCU)" has been taken as Broad Money (BM).
[6] The data of "GDP in Current Local Currency Unit (LCU)" has been taken as GDP.

Table 3. Bounds Test Results for Broad Money and GDP.

Type of ECM	Model Selection Procedures							
	AIC	**AICC**	**BIC**	**BICC**	**HQC**	**FS**	**BW**	**SW**
				BRAZIL				
Model-1	1.221 ***	104.171 ***	0.63	104.171 ***	1.221	92.133 ***	104.171 ***	92.133 ***
	(0.508)	(0.000)	(0.734)	(0.000)	(0.503)	(0.000)	(0.000)	(0.000)
Model-2	9.156 ***	20.129 ***	20.129 ***	20.129 ***	9.156 ***	20.129 ***	20.129 ***	20.129 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	10.117 ***	13.052 ***	13.052 ***	13.052 ***	10.117 ***	13.052 ***	13.052 ***	13.052 ***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Model-4	5.930 **	9.151 ***	6.084 **	9.151 ***	6.084 ***	9.151	5.895 **	9.151
	(0.03)	(0.001)	(0.021)	(0.001)	(0.022)	(0.001)	(0.028)	(0.001)
Model-5	8.889 **	13.719 **	9.113 **	13.719 ***	9.113 **	13.719 ***	8.450 **	13.719 ***
	(0.023)	(0.001)	(0.018)	(0.001)	(0.019)	(0.001)	(0.028)	(0.001)
				RUSSIA				
Model-1	9.457 ***	9.457 ***	9.457 ***	9.457 ***	9.457 ***	1.450	9.457 ***	1.450
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.433)	(0.001)	(0.433)
Model-2	16.706 ***	22.609 ***	16.706 ***	50.177 ***	16.706 ***	50.177 ***	22.884 ***	50.177 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	25.06 ***	32.784 ***	25.06 ***	56.533 ***	25.06 ***	56.533 ***	32.650 ***	56.533 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-4	21.124 ***	45.165 ***	52.81 ***	47.882 ***	55.647 ***	45.165 ***	52.809 ***	45.165 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-5	7.328 *	13.834 ***	17.221 ***	14.844 ***	18.021 ***	13.834 ***	17.221 ***	13.834 ***
	(0.061)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
				INDIA				
Model-1	1.457	5.965 ***	5.965 ***	5.965 ***	5.965 ***	5.965 ***	1.682	5.965 ***
	(0.434)	(0.009)	(0.007)	(0.007)	(0.008)	(0.008)	(0.364)	(0.008)
Model-2	4.619 **	3.427	5.468 **	3.427	4.619 **	3.427	3.427	3.427
	(0.032)	(0.126)	(0.014)	(0.115)	(0.033)	(0.119)	(0.12)	(0.119)
Model-3	6.907 **	3.057	7.163 **	3.057	6.907 **	3.057	3.057	3.057
	(0.020)	(0.316)	(0.017)	(0.307)	(0.02)	(0.311)	(0.313)	(0.311)
Model-4	6.316 **	1.915	6.316 **	1.915	6.316 **	1.915	5.000 *	1.915
	(0.020)	(0.733)	(0.016)	(0.728)	(0.017)	(0.732)	(0.076)	(0.732)
Model-5	8.793 **	2.872	8.793 **	2.872	8.793 **	2.872	6.412 *	2.872
	(0.025)	(0.614)	(0.022)	(0.605)	(0.023)	(0.610)	(0.097)	(0.610)
				CHINA				
Model-1	0.126	1.443	0.125	1.443	0.126	1.443	0.175	1.443
	(0.949)	(0.438)	(0.950)	(0.430)	(0.949)	(0.434)	(0.926)	(0.434)
Model-2	5.332 **	23.521 ***	23.521 ***	23.521 ***	23.521 ***	23.521 ***	23.521 ***	23.521 ***
	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	5.629 *	32.121 ***	32.12 ***	32.121 ***	32.121 ***	32.121 ***	32.121 ***	32.121 ***
	(0.049)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-4	9.676 ***	20.572 ***	9.676 ***	20.572 ***	9.676 ***	20.572 ***	9.676 ***	20.572 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-5	14.498 ***	30.725 ***	14.498	30.725 ***	14.498 ***	30.725 ***	14.498 ***	30.725 ***
	(0.000)	(0.000)	(0.0003) ***	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
				SOUTH AFRICA				
Model-1	16.257 ***	16.257 ***	16.257 ***	16.257 ***	16.257 ***	16.257 ***	16.257 ***	16.257 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-2	17.830 ***	17.651 ***	17.651 ***	17.651 ***	17.830 ***	13.836 ***	17.651 ***	13.836 ***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model-3	11.63 ***	11.657 ***	11.657 ***	11.657 ***	11.63 ***	1.555	11.657 ***	1.555
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.658)	(0.001)	(0.658)
Model-4	7.053 **	2.284	7.222 ***	2.284	7.222 ***	2.284	7.222 ***	2.284
	(0.011)	(0.591)	(0.006)	(0.579)	(0.007)	(0.583)	(0.007)	(0.583)
Model-5	9.555 **	2.807	9.608 **	2.807	9.608 **	2.807	9.608 **	2.807
	(0.017)	(0.628)	(0.013)	(0.617)	(0.014)	(0.620)	(0.015)	(0.620)

Note: ***, ** and * indicate the existence of cointegration at 1%, 5%, and 10% level of significance, respectively. *p*-values are given in parenthesis.

5. Conclusions and Recommendations

This paper aimed to find a better model selection technique and to assess the performance of eight different model selection techniques for Bounds test of cointegration by comparing the performance of

these eight model selection techniques. Furthermore, it is also aimed to compare the structured model selection procedures with unstructured, i.e., information criteria. Moreover, it was also investigated how these information criteria are behaving for real data, i.e., whether they behave similar to the unstructured ones or differently.

The Monte Carlo experiment suggests and concludes that, for a small sample size of 25, these are performing slightly different. However, for moderate and large sample sizes, they behave the same. These results and conclusions are partially in line with (Castle et al. 2011; Rashid 2014). The difference in the result is due to the model as, in the current study, error correction model is considered which has not been explored and considered earlier for assessing model selection procedures. From the results of real data analysis using three pairs of macroeconomic variables for BRICS member countries, the first pair is of Energy Consumption and GDP, and for this pair nearly all model selection procedures have the same behavior when they are used in the Bounds test to detect the cointegration between Energy Consumption and GDP. However, three model selection approaches, two are the information criteria, i.e., Akaike Information Criterion Corrected (AICC) and Bayesian Information Criterion (BIC) and one is the structured single-path model selection approach, i.e., Backward Elimination (BW), have the most common behavior than the rest. Similarly, for the detection of cointegration between Oil Price and GDP, three model selection procedures have the same behavior when these are used in the Bounds test for model selection. From these three similarly behaving model selection techniques, two are information criteria, i.e., Akaike Information Criterion Corrected (AICC) and Bayesian Information Criterion (BIC), and one is the structured single-path model selection approach, i.e., Backward Elimination (BW). Continuingly, for the testing of existence of cointegration between Broad Money and GDP, the behavior of three model selection information criteria, i.e., Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Hannan and Quinn Information Criterion (HQC), is the same. However, for the same pair, the Backward Elimination (BW) procedure of model selection also behaves similar to the three.

Carrying out the cross-country comparison, it is concluded that strong and compelling evidence of a long-run relationship between EC and GDP exists only for the two large economies from BRICS, i.e., Russia and China. For India and South Africa, there is evidence in favor of and against a long-run relationship between EC and GDP. Strong and compelling evidence is found that there is no long-run relationship between EC and GDP for Brazil. The same is the case for the pair of OP and GDP, with one exception that now strong evidence is also found for South Africa. However, for the last pair of BM and GDP, except India, all five economies of BRICS have strong evidence of level relationship.

In the light of the above conclusions, it is concluded that, in general, information criteria and structured model selection procedures have the same behavior and they select the same model for the Bounds cointegration test. However, as structured model selection procedures are strongly supported by econometric theory, so they may be preferred over the unstructured ones, i.e., information criteria. This is due to the fact that, in testing of cointegration using Bounds test, the problem is model selection, not lag selection, because the same test equation will act as an error correction model if cointegration is found and will be used for policy implications. Furthermore, the structured model selection procedures may be preferred greatly in dealing with a large number of candidate variables due to their quick and easy calculation.

The current study has certain limitations in terms of data availability as it has time series of length less than 30. Furthermore, it also does not account for model validation using residual diagnostics and stability testing, because the model selection procedures compared here in the study do not consider model validation. Therefore, it will be a worthy investigation in the future as to how the model procedures with model validation (like Autometrics) are performing and also how the performance of these procedures change when there is enough length of time series.

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Appendix A

Table A1. Size of Model Selection Procedures when Asymptotic Critical Values are used.

T	AIC	AICC	BIC	BICC	HQC	BW	FS	SW
Model I								
25	30.25	21.29	25.92	17.2	29.43	21	13.84	13.84
50	12.76	11.71	10.39	9.81	11.62	9.85	8.96	8.96
100	8.56	8.45	7.67	7.61	8.04	6.88	6.74	6.74
200	6.41	6.33	5.93	5.91	6.14	5.86	5.85	5.85
Model II								
25	47.01	30.1	41.29	24.63	46.39	34.01	19.72	19.72
50	19.4	16.66	14.42	12.68	17.05	13.84	11.65	11.65
100	10.54	10.21	8.42	8.22	9.3	8.5	8.12	8.12
200	7.67	7.57	6.55	6.51	7.01	6.47	6.4	6.4
Model III								
25	39.84	25.31	35.1	20.82	39.33	29.05	16.45	16.45
50	17.27	15.21	12.97	11.52	15.45	12.29	10.42	10.43
100	10.31	9.92	8.4	8.2	9.2	8.22	7.81	7.81
200	7.42	7.29	6.6	6.59	6.85	6.14	6.12	6.12
Model IV								
25	58.09	33.83	53.66	27.58	58.09	47.08	23.22	23.22
50	24.89	20.52	17.47	14.77	21.89	16.67	13.05	13.06
100	13.74	12.96	10.29	10.05	11.71	10.16	9.55	9.56
200	9.24	9.14	7.82	7.77	8.48	7.42	7.28	7.28
Model V								
25	50.17	30.06	46.79	24.25	50.24	41.58	20.18	20.21
50	19.99	16.61	14.38	11.87	17.56	13.53	10.61	10.61
100	14.07	13.82	13.18	13.14	13.57	8.97	8.74	8.74
200	8.53	8.47	8.29	8.28	8.36	7.39	7.38	7.38

Note: Size is in % when the Nominal Size is 5%.

Table A2. Simulated Critical Values.

T	Type of CV	AIC	AICC	BIC	BICC	HQC	BW	FS	SW
				Model I					
25	**UB:X_t~I(1)**	10.40	8.63	10.04	7.52	10.46	8.91	6.69	6.69
	LB:X_t~I(0)	8.54	7.02	8.32	6.12	8.61	7.39	5.34	5.34
50	**UB:X_t~I(1)**	5.98	5.76	5.38	5.20	5.78	5.24	4.99	4.99
	LB:X_t~I(0)	5.13	4.86	4.50	4.30	4.87	4.51	4.08	4.08
100	**UB:X_t~I(1)**	4.92	4.84	4.67	4.66	4.76	4.47	4.43	4.43
	LB:X_t~I(0)	4.29	4.21	3.80	3.78	4.01	3.94	3.72	3.72
200	**UB:X_t~I(1)**	4.41	4.41	4.30	4.29	4.32	4.29	4.28	4.28
	LB:X_t~I(0)	4.00	3.98	3.71	3.70	3.82	3.75	3.56	3.56
				Model II					
25	**UB:X_t~I(1)**	11.47	9.52	11.47	8.03	11.46	10.77	7.34	7.34
	LB:X_t~I(0)	9.50	7.68	9.54	6.55	9.56	8.53	6.01	6.01
50	**UB:X_t~I(1)**	6.42	6.14	5.80	5.51	6.17	5.81	5.39	5.40
	LB:X_t~I(0)	5.41	5.26	4.97	4.71	5.29	4.97	4.58	4.58
100	**UB:X_t~I(1)**	5.04	5.01	4.75	4.72	4.88	4.74	4.71	4.71
	LB:X_t~I(0)	4.61	4.55	4.24	4.22	4.44	4.21	4.05	4.05
200	**UB:X_t~I(1)**	4.63	4.61	4.46	4.45	4.51	4.42	4.40	4.40
	LB:X_t~I(0)	4.21	4.18	4.00	3.99	4.07	4.04	3.93	3.93
				Model III					
25	**UB:X_t~I(1)**	15.21	12.67	15.43	10.74	15.40	14.71	9.60	9.60
	LB:X_t~I(0)	12.36	9.81	12.42	8.63	12.48	11.49	7.66	7.66
50	**UB:X_t~I(1)**	8.75	8.34	7.85	7.44	8.40	7.68	7.19	7.19
	LB:X_t~I(0)	7.37	7.02	6.56	6.22	7.13	6.71	6.02	6.02
100	**UB:X_t~I(1)**	7.05	7.00	6.61	6.58	6.84	6.48	6.37	6.37
	LB:X_t~I(0)	6.21	6.17	5.80	5.77	6.01	5.77	5.48	5.48
200	**UB:X_t~I(1)**	6.40	6.39	6.19	6.18	6.27	6.12	6.12	6.12
	LB:X_t~I(0)	5.77	5.72	5.38	5.37	5.56	5.49	5.35	5.35
				Model IV					
25	**UB:X_t~I(1)**	15.13	12.38	15.64	10.35	15.32	15.07	9.56	9.56
	LB:X_t~I(0)	12.79	10.24	13.11	8.79	12.83	12.61	7.99	7.99
50	**UB:X_t~I(1)**	8.26	7.83	7.39	6.87	7.99	7.47	6.75	6.75
	LB:X_t~I(0)	6.97	6.66	6.37	5.99	6.75	6.57	5.94	5.94
100	**UB:X_t~I(1)**	6.54	6.46	6.04	5.99	6.29	6.03	5.92	5.92
	LB:X_t~I(0)	5.93	5.82	5.42	5.38	5.65	5.59	5.32	5.33
200	**UB:X_t~I(1)**	5.91	5.90	5.65	5.64	5.78	5.57	5.56	5.56
	LB:X_t~I(0)	5.45	5.44	5.20	5.18	5.33	5.21	5.09	5.09
				Model V					
25	**UB:X_t~I(1)**	20.41	16.87	21.13	14.02	20.65	20.64	12.85	12.86
	LB:X_t~I(0)	17.16	13.87	17.92	11.86	17.38	17.12	10.95	10.98
50	**UB:X_t~I(1)**	11.21	10.59	10.07	9.35	10.79	10.04	9.19	9.18
	LB:X_t~I(0)	9.69	9.16	8.71	8.18	9.32	8.83	7.93	7.93
100	**UB:X_t~I(1)**	7.03	6.90	6.48	6.43	6.74	6.35	6.22	6.22
	LB:X_t~I(0)	6.25	6.18	5.88	5.82	6.07	5.84	5.57	5.57
200	**UB:X_t~I(1)**	4.00	3.98	3.83	3.82	3.90	3.85	3.83	3.83
	LB:X_t~I(0)	4.34	4.31	3.88	3.87	4.01	4.02	3.77	3.77

Table A3. Powers in % of Information Criteria for T = 50, 100, and 200.

	T = 50					T = 100					T = 200				
Model I															
Phi	**AIC**	**AICC**	**BIC**	**BICC**	**HQC**	**AIC**	**AICC**	**BIC**	**BICC**	**HQC**	**AIC**	**AICC**	**BIC**	**BICC**	**HQC**
0	5.55	5.43	5.44	5.35	5.35	4.63	4.82	4.45	4.46	4.61	4.63	4.82	4.45	4.46	4.61
0.005	27.14	28.01	28.83	29.35	27.92	48.83	49.4	49.99	49.98	49.8	48.83	49.4	49.99	49.98	49.8
0.008	68.77	69.93	71	71.48	69.93	84.55	84.75	84.87	84.87	84.81	84.55	84.75	84.87	84.87	84.81
0.011	89.19	89.98	90.69	91	89.99	95.34	95.38	95.55	95.54	95.44	95.34	95.38	95.55	95.54	95.44
Model II															
0	5.03	4.96	4.98	5.08	5.02	5.13	4.96	4.86	4.86	4.97	5.13	4.96	4.86	4.86	4.97
0.005	20.87	22.08	22.82	23.05	22.04	43.64	43.77	44.58	44.77	44.28	43.64	43.77	44.58	44.77	44.28
0.008	62.04	63.91	65.3	66.06	63.82	81.53	81.76	82.13	82.27	82.05	81.53	81.76	82.13	82.27	82.05
0.011	85.54	87.19	87.94	88.49	87.12	94.86	94.93	95.14	95.15	95.09	94.86	94.93	95.14	95.15	95.09
Model III															
0	4.89	4.71	5.03	5.09	4.79	5.15	4.99	5.05	4.95	5.01	5.15	4.99	5.05	4.95	5.01
0.005	20.25	22.17	23.14	23.98	22.19	42.56	42.89	43.42	45.39	42.48	42.56	42.89	43.42	45.39	42.48
0.008	61.26	62.08	64.13	65.03	62.16	80.14	80.32	81.07	83.14	80.72	80.14	80.32	81.07	83.14	80.72
0.011	84.57	86.61	86.93	87.43	86.56	93.92	94.03	94.62	96.59	93.13	93.92	94.03	94.62	96.59	93.13
Model IV															
0	4.85	5.05	5.23	5.23	5.03	5.31	5.18	5.35	5.5	5.27	5.31	5.18	5.35	5.5	5.27
0.005	22.07	22.95	23.76	24.93	22.61	42.24	42.86	43.36	44.94	42.91	42.24	42.86	43.36	44.94	42.91
0.008	61.46	62.99	63.28	65.14	61.48	80.81	81.87	81.99	83.65	80.94	80.81	81.87	81.99	83.65	80.94
0.011	84.17	85.02	85.71	88.26	84.55	99.78	99.82	100	100	99.8	99.78	99.82	100	100	99.8
Model V															
0	4.86	4.64	4.79	4.99	4.87	4.74	4.74	4.9	4.94	4.65	4.74	4.74	4.9	4.94	4.65
0.005	20.86	22.83	23.79	24.7	20.95	33.32	34.22	34.83	37.78	32.14	33.32	34.22	34.83	37.78	32.14
0.008	61.73	62.65	63.56	66.43	61.74	76.57	77.41	79.42	79.79	78.31	76.57	77.41	79.42	79.79	78.31
0.011	84.68	85.38	85.97	88.97	85.11	99.98	99.98	100	100	99.98	99.98	99.98	100	100	99.98

Table A4. Powers in % of Structured Procedures for T = 50, 100, and 200.

	T = 50			T = 100			T = 100		
Model I									
Phi	**BW**	**FS**	**SW**	**BW**	**FS**	**SW**	**BW**	**FS**	**SW**
0	4.76	4.81	4.81	4.92	5	5	4.89	4.9	4.9
0.005	29.26	29.86	29.87	51.09	51.3	51.3	72.31	72.31	72.31
0.008	72.52	73.27	73.27	85.14	85.23	85.23	93.88	93.85	93.85
0.011	90.67	91.1	91.1	95.83	95.88	95.88	98.57	98.57	98.57
Model II									
0	4.75	4.75	4.75	4.95	4.9	4.9	4.55	4.66	4.66
0.005	21.77	23.14	23.12	44.8	44.77	44.77	68.14	68.26	68.26
0.008	66.76	67.79	67.79	82.75	82.74	82.74	92.63	92.67	92.67
0.011	88.9	89.47	89.47	95.04	95.05	95.05	98.43	98.43	98.43
Model III									
0	5.59	5.61	5.61	5.33	5.34	5.34	4.57	4.47	4.47
0.005	22.89	23.28	23.28	43.51	43.54	43.54	65.36	65.46	65.46
0.008	65.03	66.91	66.92	81.06	81.22	81.22	81.79	81.86	81.86
0.011	85.35	87.57	87.57	94.13	94.43	94.43	96.54	96.54	96.54
Model IV									
0	5.27	5.37	5.38	5.29	5.28	5.29	4.98	4.86	4.86
0.005	22.59	23.97	24	42.95	42.96	42.96	64.85	64.96	64.97
0.008	67.75	68.29	68.29	80.95	80.99	80.99	80.99	81.56	81.56
0.011	84.03	85.45	85.45	93.99	94.09	94.1	95.97	95.97	95.97
Model V									
0	5.13	4.78	4.82	4.83	4.87	4.88	4.53	4.49	4.49
0.005	22.87	23.86	23.87	41.92	42.79	42.79	64.82	64.9	64.9
0.008	66.07	66.67	66.68	82.3	82.89	82.89	80.95	81.09	81.09
0.011	83.63	84.22	84.26	93.91	94.1	94.11	95.91	95.91	95.91

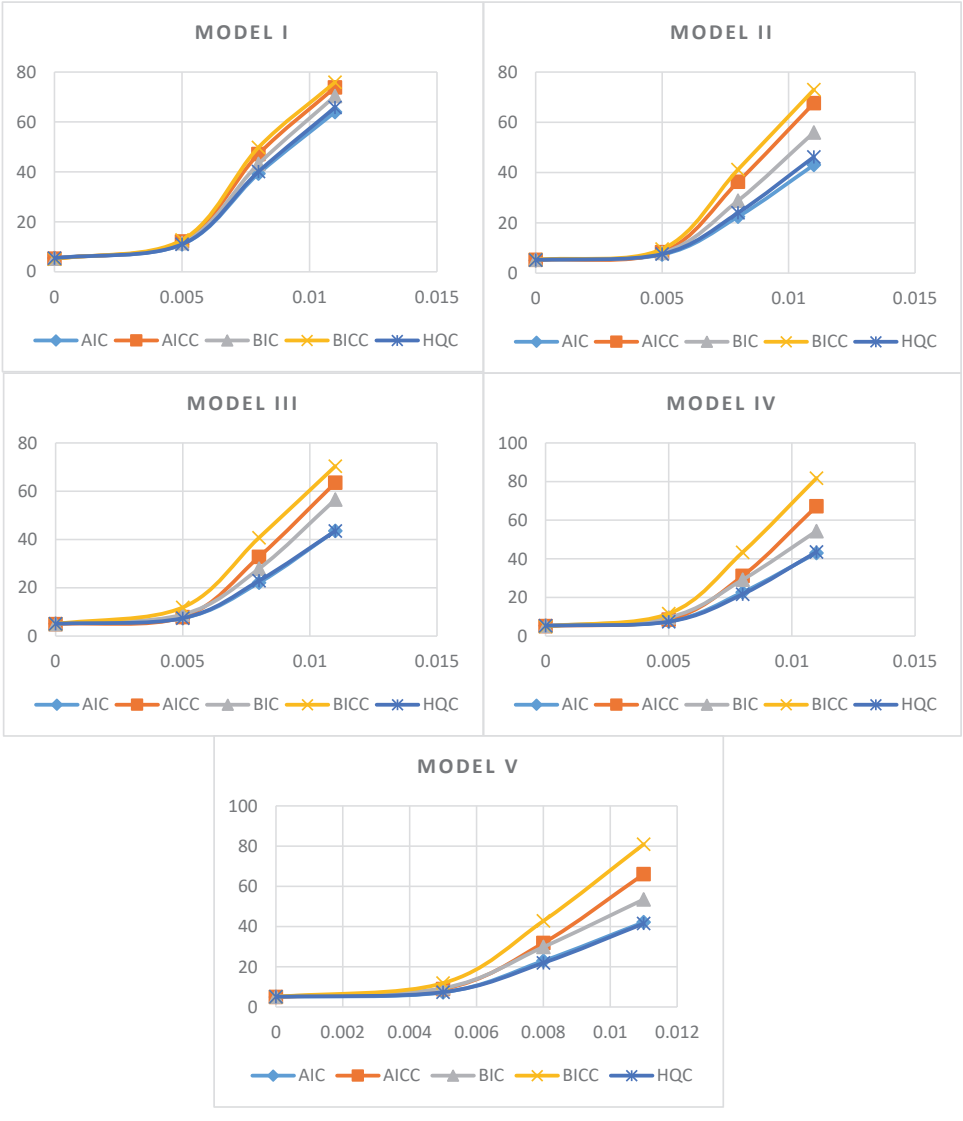

Figure A1. Power Curves of Information Criteria at $T = 25$. Note: Null and different alternative hypotheses are along the X-axis and Size and Power in % are along the Y-axis.

Figure A2. Power Curves of Structured Model Selection Procedures at $T = 25$. Note: Null and different alternative hypotheses are along the X-axis, and Size and Power in % are along the Y-axis.

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Research on Property Income Inequality Effect of Fiscal Finance

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Abstract: "Creating conditions for more people to have property income" has become a national policy after the 17th National Congress of the Communist Party of China. Based on the micro survey data from Chinese Family Panel Studies (CFPS) in 2010, 2012, 2014, 2016 and the macro panel data at the provincial level, a logarithmic linear equation was built to estimate the impact of micro and macro factors on property income. Furthermore, the contribution of fiscal expenditure and financial development on property income equality can be recognized using the regression-based inequality decomposition method. This research revealed that fiscal expenditure improves residents' property income and slightly reduces the inequality of property income distribution. With respect to financial development, it improves residents' property income but aggravates the inequality of property income distribution. However, there is a significant difference between the different regions. In eastern and central regions, inequality of property income distribution greatly benefits from fiscal expenditure, while in northwest regions, fiscal expenditure makes property income inequality even worse. Therefore, the focus of financial sustainable development is to reduce property income inequality through the establishment of an effective government and the improvement of the rule of laws.

Keywords: fiscal redistribution; financial development; fiscal expenditure; property income

JEL Classification: G10; H30; E6

1. Introduction

The concept of "creating conditions for more people to have property income" was first introduced at the 17th National Congress of the Communist Party of China in October 2007. The propositions related to enriching residents' property income were proposed at the 18th and 19th National Congresses of the Communist Party of China, respectively. Although residents' property income grew rapidly in the past decade in China, it has not become an important source of national income as expected, according to previous research.

The purpose of this article was to analyze the impact of fiscal expenditure and financial development on property income and to measure their contributions to property income inequality. Therefore, both fiscal and financial factors are included in the framework of income distribution in this paper. With the regression-based inequality decomposition method, this paper quantitatively measured the degree of property income inequality and identifies the factors that affect residents' property income using a large number of micro investigation data and macro data. Eventually, this article provides policy recommendations for optimization and reform of fiscal, financial and taxation systems based on the results of empirical analysis.

The results show that financial development can improve the level of residents' property income though it can be harmful to the equality of property income distribution. Fiscal expenditure is

beneficial to residents' property income, but the regional differences are significant. Overall, fiscal expenditure slightly reduces the inequality of property income. As a result, the focus of financial sustainable development is to reduce property income inequality and build an effective government and law system.

This paper provides a new perspective and research direction on the adjustment of the financial market system in the field of primary distribution and the reform of fiscal and tax systems in the field of redistribution. More importantly, this article takes the lead in analyzing macroeconomic policies in the dimension of microeconomics. With the combination of macro data and micro household survey data, the effect of fiscal expenditure and financial development on residents' property income inequality can be measured. Besides, this paper quantitatively measures the contribution of macro and micro factors to property income inequality based on microsimulation analysis. Eventually, suggestions on the reform of the tax system and the optimization of the property income distribution are provided according to the quantitative results.

The rest of the paper is organized as follows. Section 2 introduces the relevant literature on residents' property income. Section 3 provides a brief description of the data derived from the Chinese Family Panel Studies (CFPS) and explains the design of the regression-based inequality decomposition method. Section 4 shows the results of the property income determining equation. Section 5 concludes the whole study and Section 6 provides policy recommendations according to the research findings.

2. Literature Review

According to the experience of developed countries, property income will become an important source of residents' income when the per capita GDP exceeds 2000 US dollars and China has reached this level as early as 2006 (Tang and Lai 2013). Based on the data released by the International Monetary Fund, the level of per capita GDP in China has reached $8643 in 2018, which is four times higher than the threshold level. According to the National Bureau of Statistics (NBS), the proportion of property income in national income increased from 2.68% at the end of 2006 to 8.11% at the end of 2017. However, a large number of empirical researches based on household surveys show that the proportion is only about 3% and property income has not become an important source of national income as expected. Although property income cannot be regarded as the primary source of national income, the growth rate of property income is 5% higher than the growth rate of disposal income in both urban and rural areas according to NBS. As the studies conducted by NBS mainly rely on samples from rural residents, data from urban areas, and the whole country needed to be supplemented. Consequently, this paper employs microdata such as the China Household Income Project (CHIP) and Chinese Family Panel Studies (CFPS) to expand the original research. Table 1 divides the property income of urban and rural residents in 2002 and 2012 into five categories. It can be noticed that 20% of low-income groups take only 0.3% of the property shares, while 20% of high-income groups occupy 77.37% of the property shares. In other words, a great amount of social wealth is concentrated in a small group of people, and the property income of residents is extremely likely to become an important factor in income inequality.

In recent years, the main relevant researches focus on the following aspects:

The first one is analyzing the impact of unequal property income distribution on social stability. Inequality of property income was first introduced by Lampman as a source of social problems in 1962 (Lampman 1962). Nobel Prize winner Stiglitz pointed out the inefficiency of governments in income redistribution. He stated that the existing system is continuously transferring wealth from the bottom of the society to the top and it will lead to slow growth of GDP and social instability (Stiglitz 2013).

Table 1. Property shares of urban and rural residents in five categories.

Unit: RMB								
Property Classification	**Property Mean Value (Yuan)**		**National Share of Property**		**Town Property Share**		**Rural Property Share**	
	2002	**2012**	**2002**	**2012**	**2002**	**2012**	**2002**	**2012**
Low-income households	7525	3422	2.37%	0.30%	3.32%	1.59%	3.35%	0.66%
Middle to the bottom	21,523	25,498	6.77%	2.25%	9.60%	5.32%	9.53%	3.68%
Middle-income household	38,251	69,395	12.03%	6.13%	15.22%	9.02%	15.17%	7.08%
Medium by upper	69,083	157,771	21.73%	13.94%	23.13%	16.30%	22.82%	13.86%
High income households	181,660	875,707	57.11%	77.37%	48.72%	67.78%	49.13%	74.73%

Data source: Calculated from the data listed in "the widening trend of residents' property gap in the 13th five-year period" by the research group of China institute of income distribution, Beijing normal university.

The second one is studying the impact of property income on social welfare. In 1953, Harsanyi proposed that there is a two-way effect between the level of personal welfare and social income distribution. That is, the level of personal welfare depends on the social income distribution system, and the level of personal welfare also affects the social income distribution system (Harsanyi 1953). Milanovic believes that unequal property income distribution will result in higher redistribution, which distorts the tax burden and weakens economic growth (Milanovic 2000). Similarly, Bourguignon suggests that the suitability of economic policies will lead to different levels of residents' property income (Bourguignon 2003).

The third one is studying the impact of property income on economic growth. There is no consistent conclusion on whether property income has a positive or negative effect on economic growth. For example, scholars such as Galor and Zeira (1993), Persson and Tabellini (1994), Xu et al. (2003) concluded that income inequality will reduce economic growth based on empirical research. However, Fields (2003) obtained an opposite conclusion with different measurement methods, that is, the impact of income inequality on economic growth is positive.

Finance is the foundation of governance. Modern finance theories suggest that finance can adjust the primary distribution of residents' property income through the indirect adjustment to realize fair distribution and ensure social stability. The government's influence on income distribution is mainly realized by adjusting the scale and structure of fiscal expenditure. In developed countries, the proportion of fiscal expenditure on GDP normally over 30%, while the percentage in China is less than 25%. With respect to the structure of fiscal expenditure, Yang and Fang found that the transfer expenditure and security spending are the main part of fiscal expenditure in the United States while fiscal expenditure in China mainly focuses on investment and government consumption (Yang and Fang 2010). In the market economy, fiscal expenditure realizes primarily through the financial system, especially for investment spending. Therefore, the development of a financial mechanism is included in the reform of the financial system in China. Liu and Fu divided the information process of China into four stages (Liu and Fu 2018). The first stage is the exploration of investment and financial system (1979–1991), when a loan is introduced in financing infrastructural projects. The second stage is the establishment of government investment and the reform of the financial system during the period of the socialist market economy (1992–2002), when the Policy Banks and financial asset management companies are founded and issuing bonds becomes the main channel of infrastructure financing. The third stage is the reform of government investment and financial system during the period of the improved socialist market economy (2003–2012), when infrastructure construction is financed by local financing platforms. The fourth stage is the period of comprehensively deep reform (from 2013 to now), during which the local government mainly uses debt replacement and standardized PPP (Public-Private Partnership) pattern to allocate bank credit resources. Figure 1 shows the relationship intuitively. At the early stage of Reform and Opening-up, the reform of using loans instead of allocation changed the previous accounting concept of fiscal expenditure for state-owned

enterprises. With the development of Reform and Opening-up, national wealth increases year by year. However, if replaced the total amount of deposits and loans with the increment amount of each year, the development is similar to the path of fiscal reform and fluctuates with the change of fiscal policy. It can be seen that finance in China, especially for banking, is set up for fiscal purposes and developed with fiscal reform.

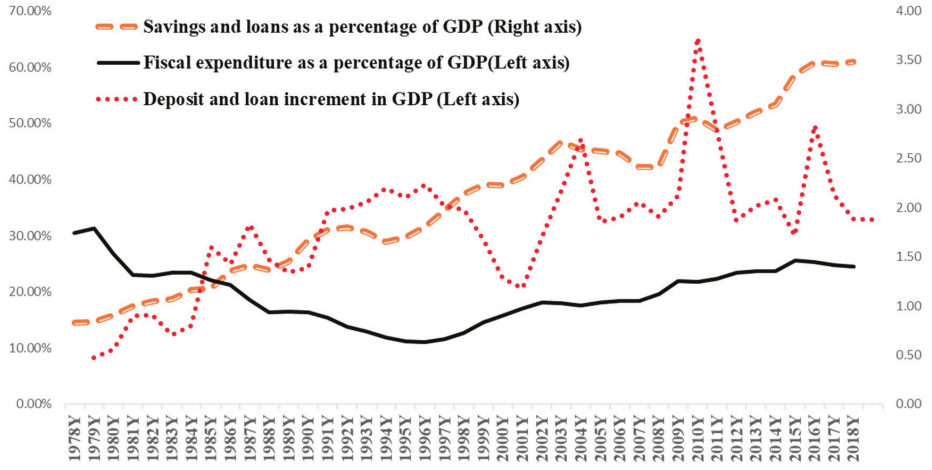

Figure 1. Relationship between financial development and fiscal expenditure. Source of data: Calculated according to the statistical yearbook of previous years.

Although the history of financial development theory is limited, existing studies show that financial development is related to economic growth and income distribution, and it may widen or narrow the gap of income distribution. The original research of the relationship between finance and economy started in 1912, Schumpeter believes that finance can distinguish the innovative entrepreneurs and provide credit support for their innovation, and therefore promote economic growth (Schumpeter 1912). McKinnon and Edward (1973) study the relationship between financial development and economic growth from different perspectives and propose the theory of "financial repression" and "financial deepening", which are the foundation of financial development theories in developing countries. They suggest that excessive government intervention will negatively affect financial efficiency and economic development, and therefore financial liberalization should be advocated. The marketization of the interest rate can increase savings and investment and help to achieve the goal of financial and economic growth. However, Stiglitz and Weiss hold different opinions on their proposition (Stiglitz and Weiss 1981). They suggested that information asymmetry of credit cooperation is the biggest problem in the financial market. Stiglitz put forward the financial constraint theory in 1993 and pointed out that governments should support financial institutions to guide enterprises and residents through a series of financial restraint policies such as deposit regulation and market access restrictions. The financial restraint theory believes that governments can solve the problem of financial market failure and promote economic growth, and therefore financial supervision should be adopted and strengthened. On the other hand, the financial repression theory suggests that the government's control in the financial market distorts the allocation of resources and damages economic growth, and thus financial liberalization should be advocated. In reality, after the second world war, the phenomenon of financial repression did not appear in Thailand, Indonesia, Malaysia and China and the exercise of financial constraint theory also failed in the United States and Europe. As early as 1969, Goldsmith systematically elaborated on the concept of financial structure (Goldsmith 1969). He suggested that financial development is about the change of financial structure and the evolution process of financial structure is the process of financial development. He also proposed the eight indicators

to measure financial structure, including the Financial Interrelations Ratio (FIR). This indicator is very complicated in the original design and it is used as a measure of financial structure and financial development scale. To measure the financial level of a country or a region, McKinnon proposed a quantitative index of financial level, which is M2/GDP, based on Goldsmith's theory (McKinnon and Edward 1973). This index reflects the function of payment intermediation and saving in monetary and financial systems. Although the measures of Goldsmith and McKinnon reflect the scale of financial development in a country, they ignore the ability of finance in diverting savings into investment. In 1992, Asian Development Bank optimized McKinnon's index by replacing M2 with the credit volume of the private sector and this indicator can be used to represent the allocation efficiency of credit resources.

3. Data, Variables and Research Methods

A log–linear equation was constructed to estimate the impact of macro and micro factors on property income. On this basis, the regression-based inequality decomposition method was adopted to identify the contribution of financial instruments and financial development to property income inequality (Fields 2003).

First, we construct the income determining equation:

$$lnY_i = \beta_0 + \beta_1 x_i^1 + \beta_2 x_i^2 + \ldots\ldots + \beta_K x_i^K + \varepsilon_i \tag{1}$$

where Y is individual property income, $\left(x^1, x^2, \ldots, x^K\right)$ is K factors affecting property income. In the empirical regression, the selected factors mainly include individual factors, village or neighborhood committee factors and regional macro factors. β_0 is a constant term, β_1-β_K is other parameters needed to be estimated, and ε is the random disturbance term.

Write Equation (1) in the form of matrix:

$$lnY = a'Z \tag{2}$$

where $a = [\beta_0, \beta_1, \ldots, \beta_K, 1]$, $Z = \left[1, x^1, x^2, \ldots, x^K, \varepsilon_i\right]$ and 1 as x^0, ε as x^{k+1}, then there are $K+2$ variables in Z. If the variance of both sides of Equation (1) is calculated, the left side of Equation (1) is a simple inequality measure index, namely the logarithmic variance. According to the covariance theorem of random variables (Mood et al. 1974), the following equation holds:

$$Cov\left[\sum_{k=0}^{K+1} \beta_k Z_k, lnY\right] = \sum_{k=0}^{J+1} Cov[\beta_k Z_k, lnY] \tag{3}$$

The left side of Equation (3) is the covariance of $[lnY]$ with itself, which is actually the variance of $[lnY]$, so we get:

$$\sigma^2[lnY], = \sum_{k=0}^{J+1} Cov[\beta_k Z_k, lnY] \tag{4}$$

Divide both sides of Equation (4) by $\sigma^2[lnY]$:

$$\frac{\sum_{k=0}^{J+1} Cov[\beta_k Z_k, lnY]}{\sigma^2[lnY]} = \sum_{k=0}^{J+1} s_k[lnY] = 100\% \tag{5}$$

Among them,

$$s_k[lnY] = \frac{Cov[\beta_k Z_k, lnY]}{\sigma^2[lnY]} = \frac{\beta_k \sigma(Z_k) cor[Z_k, lnY]}{\sigma[lnY]} \tag{6}$$

s_k is the relative contribution weight on income inequality of the k factor. If we ignore the influence of random disturbance on inequality, we can get:

$$\frac{\sum_{k=0}^{J} Cov[\beta_k Z_k, lnY]}{\sigma^2[lnY]} = R^2[lnY] \tag{7}$$

$R^2[lnY]$ is the decision coefficient of the logarithmic linear regression model in Equation (1). At this point, the relative contribution weight on income inequality of the k factor can be expressed as:

$$p_k[lnY] = \frac{s_k[lnY]}{R^2[lnY]} \tag{8}$$

The data used in this paper comes from CFPS. CFPS is an interdisciplinary survey covering more than 16,000 families in 25 provinces, municipalities and autonomous regions in the mainland of China. The samples include all kinds of data from sample families such as the changes and dynamic relationships in families, economic activities, education and health condition. Household income of CFPS in 2010, 2012, 2014 and 2016 are used in this paper, and household property income is chosen as the explanatory variable. In order to make the measurement as accurate as possible, the first step is to clean the database.

Firstly, as the property income in CFPS dataset belongs to the whole family, the size of property income may be different depends on the number of family members. Therefore, it is necessary to control the size of the family in the model.

Secondly, it is common to use the relevant characteristic of residents as explanatory variables when constructing income determining equations based on existing studies (Li and Zhao 1999; Luo and Wang 2012; Li and Liu 2013; Luo 2018). During the period of original data collection of the CFPS database, investigations are conducted on all members in families without a clear specification of the head of the household. In order to remedy this limitation, members with the highest income in families will be considered as the head of the household, and their characteristic variables will be introduced to the model as explanatory variables. These variables include age, gender, residence ("1" stands for urban areas and "0" stands for rural areas), education level, occupation and health condition ("1" stands for "relatively healthy", "healthy" and "very healthy" while "0" stands for other conditions).

In addition, variables from two villages are added to the model to investigate the impact of the economic development of the community on residents' property income. It includes the economic condition of the community ("1" represents the poorest condition and "7" represents the richest condition) and the per capita income level of community. As a community survey was not conducted in 2012 and 2016, the results in 2012 and 2016 were cautiously simulated by the data in 2010 and 2014, respectively, and it will not lead to obvious bias due to the stability of the community's economic situation in recent years.

Finally, this study focuses on the impact of fiscal expenditure and financial development on household property income. Therefore, the proportion of fiscal expenditure in GDP, the index of financial development scale and the index of financial development efficiency were placed in the model. Furthermore, provincial macro data are matched to each family according to the code of each province. For each family, investments related to real estate, property transactions and financial assets generally will not occur across provinces. Thus, the degree of financial development at the provincial level can reflect the market conditions of family property transactions better, and affect the level and distribution of residents' property income.

As some values are missing in several variables, only those families with complete information remained. Therefore, the sample sizes in 2010, 2012, 2014 and 2016 are 4988, 4610, 4216 and 6104 respectively. The total number of samples for four years is 19,918 and the descriptive statistics for all variables are shown in Table 2.

Table 2. Descriptive statistics of variables.

Variable	Mean	Standard Deviation	Minimum	Maximum
Property income	613.4283	15,555.498	−700,000	2,000,300
Householder age	44.45778	14.58847	16	110
Householder gender	0.678833	0.466936	0	1
Residence of head of household	0.218847	0.413475	0	1
Education level of householder	5.02617	4.518692	0	18
The head of the household professional	0.478763	0.499561	0	1
The head of the household health	0.745456	0.435615	0	1
Family size	4.106323	1.764394	1	26
Economic conditions of the village	4.150969	1.431242	1	7
Per capita income of the village	4830.161	4517.651	53	45,000
The proportion of regional fiscal expenditure	0.222123	0.087673	0.105822	0.437482
Regional financial development scale index	2.856067	0.843307	1.689742	7.875152
Regional financial development efficiency index	0.71111	0.085913	0.460515	0.956331

4. Decomposition Results and Analysis

Table 3 reports the estimated results of the property income determining equation. Firstly, samples from CFPS in 2010, 2012, 2014 and 2016 were used to estimate the income determining equation in different years, respectively. Then, the samples for four years were collected and used as a sample to estimate the income determining equation. When the regression conducted year by year, dummy variables of provinces were introduced in each model to control the heterogeneity of data. When the regression used the samples for four years as a whole, dummy variables of both provinces and periods were necessary to be controlled. The estimated results show that:

(1) Factors related to the head of household and family. Householder's age is positively related to family property income. Though the result is not significant in 2012, the results of other samples are significant at the statistical level of 10%. It can be explained that property income depends on property value. After a long period of accumulation, the property value of the elderly will be higher than the young people's, and therefore the elderly will get higher property income. The gender of the householder has no significant effect on household property income except in 2016. The influence of householder's residence is only significant in 2012, but it is significant when considering all samples as a whole at the statistical level of 10%. It indicates that the property income of households living in urban areas is slightly higher than those living in rural areas. The estimated coefficient of householder's education level is positive in all samples, but it is statistically significant only in 2010 and for the whole sample. It means that this variable can be an important factor in household property income. Although the estimation coefficient of the householder's occupation is positive in all samples, it is not statistically significant except in 2014 and for the whole sample. It suggests that the influence of householder's occupation on household property income is uncertain. The health condition of householder and family size has no significant effect on household property income. In general, wages and operating income are relevant to health conditions and family size. However, property income is different from wage and operating income and it mainly depends on long-term accumulation of property value. Therefore, it is reasonable that the health condition of householder and family size are not relevant to property income.

(2) Community factors. The economic condition of the community has no significant effect on household property income. However, per capita income level of the community has a positive relationship with household property income. It shows that residents in a well-developed community tend to own properties with higher value, and therefore the sales and rents of those properties will be higher. Moreover, the degree of economic development should be determined not only by the appearance of the community but also by the level of residents' income.

(3) Provincial macro factors. The influence of the proportion of regional fiscal expenditure in GDP on household property income is relatively complex. In the sample of 2010, this variable is negatively related to the property income at a significant level of 1%. In the samples of 2012 and 2014, the variables are positively related to the property income at a significant level of both 1% and 5%. In the sample of 2016, the coefficient of variables is positive but not statistically significant. Due to the inter-annual heterogeneity, the effect of financial expenditure on household property income in the whole sample is not statistically significant. Overall, the government's allocation uses more economic resources, which may affect residents' savings, wealth level and household property income. The index of financial development scale can positively promote the growth of residents' property income in all samples at a significant level of 1%. And the index of financial development efficiency has a negative impact on residents' property income at a significant level of 1% except for 2014. In general, property transactions and financial investments develop better in regions with a higher degree of financial development, and residents from those areas tend to gain higher property income. Besides, the ability of the regional financial sector in converting savings into investment would be higher if the region's financial market is regulated and the greater efficiency of capital flows represents the higher efficiency of financial development. On the contrary, speculation will appear in the financial market of regions that lack effective supervision, and it will damage the profitability of financial assets for residents.

Table 4 reports the breakdown results of property income inequality in the sample years. On the whole, characteristics of the head of household including age, gender, residence, education level, occupation, health condition and family size, and community economic conditions including indicators such as economic conditions and per capita income of residents, contribute little to property income inequality.

This paper primarily focuses on the proportion of fiscal expenditure, the index of financial development scale and the index of financial development efficiency. In the three core variables, the contribution of the proportion of regional fiscal expenditure on property income inequality in 2010 is 9.34%, and the ratio changes into −17.31%, −19.23% and −7.38% in 2012, 2014 and 2016, respectively. As the variable's contribution to property income inequality is negative, the proportion of fiscal expenditure can help to reduce the inequality of property income distribution. In terms of the whole sample, a high percentage of fiscal expenditure can also reduce the inequality of property income distribution, but the ratio is only −4.94% in this sample. Combined with the estimated results from the determining equation, it can be concluded that governments can participate in resource allocation and intervene in the market and private sector through fiscal expenditure. Nevertheless, it is helpless for residents to gain higher property income, but it can reduce the inequality of property income distribution by improving the restraint of the rich. But the effect of redistribution is relatively low, and it remains to be improved in the future.

Table 3. Estimation results of property income determining equation.

Explanatory Variables	2010 Samples	2012 Samples	2014 Samples	2016 Samples	All the Samples
Householder age	0.001 (1.91) *	0.001 (1.51)	0.014 (3.72) ***	0.010 (3.21) ***	0.009 (5.10) ***
Householder gender	0.025 (0.28)	0.128 (1.34)	−0.050 (−0.50)	−0.222 (−2.87) ***	−0.038 (−0.83)
Residence of head of household	−0.029 (−0.26)	0.566 (4.69) ***	−0.135 (−1.19)	0.088 (0.96)	0.105 (1.91) *
Education level of householder	0.021 (2.1) **	0.003 (0.27)	0.017 (1.52)	0.001 (0.09)	0.015 (2.71) ***
The head of the household professional	0.136 (1.47)	0.158 (1.57)	0.207 (1.91) *	0.117 (1.26)	0.123 (2.50) **
The head of the household health	0.006 (0.05)	−0.111 (−1.15)	0.025 (0.24)	−0.025 (−0.29)	−0.051 (−0.98)
Family size	0.019 (0.81)	0.099 (3.77) ***	0.032 (1.21)	0.018 (0.75)	−0.015 (−1.15)
Economic conditions of the village	−0.0001 (0)	−0.064 (−1.81) *	0.029 (0.91)	−0.038 (−1.33)	−0.024 (−1.46)
Per capita income of the village	−0.00001 (−0.76)	−0.00002 (−1.03)	0.00001 (0.88)	0.0001 (5.75) ***	0.0001 (9.33) ***
The proportion of regional fiscal expenditure	−4.049 (−5.24) ***	4.734 (2.46) **	7.341 (4.10) ***	1.791 (1.36)	1.123 (1.20)
Regional financial development scale index	3.741 (3.8) ***	9.218 (10.32) ***	6.095 (6.68) ***	7.350 (7.41) ***	4.834 (11.87) ***
Regional financial development efficiency index	−0.59 (−6.71) ***	−0.332 (−3.83) ***	1.044 (11.35) ***	−0.565 (−6.26) ***	−0.809 (−19.46) ***
Constant term	1.127 (1.44)	−4.111 (−4.94) ***	−7.815 (−9.23) ***	8.556 (11.30) ***	0.563 (1.59)
Whether to control the province dummy variable	Y	Y	Y	Y	Y
Whether to control the period dummy variable	—	—	—	—	Y
Adj_R2	0.1305	0.1519	0.143	0.172	0.139

Note: "*", "**" and "***" mean significant at the statistical level of 10%, 5% and 1% respectively.

Table 4. Decomposition results of property income inequality (%).

Explanatory Variables	2010 Samples	2012 Samples	2014 Samples	2016 Samples	All the Samples
Householder age	0.2069	0.5709	3.2228	1.6276	1.346
Householder gender	0.0209	0.2474	0.0093	0.6758	−0.001
Residence of head of household	−0.0336	3.6984	−0.504	0.5294	0.5352
Education level of householder	0.4612	0.0795	0.2784	0.0153	0.5088
The head of the household professional	0.3856	0.4614	0.3381	0.4654	0.4587
The head of the household health	0.0009	0.0543	−0.0297	0.037	0.0201
Family size	−0.062	0.1473	−0.8322	−0.4453	0.2153
Economic conditions of the village	0	−0.8518	0.6564	−0.6113	−0.2485
Per capita income of the village	−0.0215	−1.2101	1.9604	8.1616	5.901
The proportion of regional fiscal expenditure	9.3441	−17.311	−19.2328	−7.3842	−4.937
Regional financial development scale index	11.9309	5.991	6.9719	13.7861	20.8108
Regional financial development efficiency index	7.9053	15.561	11.6876	3.8047	7.62
Province dummy variable	69.8613	92.562	95.4736	79.3378	65.2859
Province dummy variable	—	—	—	—	2.4847

From the perspective of financial development, two indicators that measure the level of regional financial development have positive contributions to the inequality of property income. The contributions of two variables different with years, however, when considered as a whole sample,

a bigger scale of regional financial development will lead to more inequality in the property income distribution of residents. The contribution rate of the financial development scale is up to 20.81% while the contribution rate of each year is 11.93%, 5.99%, 6.97% and 13.79% respectively. The efficiency of financial development also damages the equality of property income distribution, and the rate of contribution is 7.62%. Specifically, the contributions of financial development efficiency on property income inequality in 2010, 2012, 2014 and 2016 are 7.9%, 15.56%, 11.69% and 3.8% respectively. It can be concluded that financial development provides a normative market for resident's property transaction and leasing, and ensures the property traded at a more reasonable price. However, families with higher property value gain benefit from property transactions and earn more property income, while low-income families with less property cannot benefit from the improvement and development of financial markets. As a consequence, financial development will widen the gap of property income between the rich and the poor.

Table 5 reports the estimated results of the property income determining equation according to different regions. In the eastern region, the proportion of fiscal expenditure significantly positively related to property income at a significant level of 1%, and the estimated coefficient value is as high as 32.326. Government intervention has a positive effect in economically developed areas. It will effectively promote trade and leasing of property, and becomes an important factor in increasing residents' property income. In central and western regions, fiscal expenditure also significantly contributes to residents' property income, but the estimated coefficients are only 5.798 and 9.672, which are much weaker than the effect in the eastern region.

Table 5. Estimation results of the determining equation of property income in the eastern, central and western regions.

Explanatory Variables	Eastern Full Sample	Middle Full Sample	Western Full Sample
Householder age	0.008 (2.77) ***	0.004 (1.23)	0.007 (2.71) ***
Householder gender	−0.047 (−0.66)	0.192 (2.03) **	−0.087 (−1.23)
Residence of head of household	0.008 (0.10)	−0.146 (−1.35)	−0.062 (−0.62)
Education level of householder	0.007 (0.88)	0.039 (3.57) ***	0.006 (0.71)
The head of the household professional	−0.069 (−0.89)	0.0005 (0.01)	0.096 (1.22)
The head of the household health	0.004 (0.04)	−0.219 (−2.11) **	0.138 (1.78) *
Family size	−0.010 (−0.49)	0.075 (3.05) ***	0.021 (1.08)
Economic conditions of the village	0.060 (2.18) **	−0.236 (−7.29) ***	0.006 (0.26)
Per capita income of the village	−0.000003 (−0.37)	−0.00005 (−2.86) ***	0.000005 (0.28)
The proportion of regional fiscal expenditure	32.236 (5.29) ***	5.798 (2.35) **	9.672 (9.14) ***
Regional financial development scale index	2.621 (1.75) *	3.146 (3.32) ***	−2.477 (−3.38) ***
Regional financial development efficiency index	−0.210 (−1.36)	−1.151 (−8.01) ***	−0.287 (−1.94) *
Constant term	−6.367 (−3.07) ***	2.594 (3.65) ***	0.617 (1.17)
Whether to control the province dummy variable	Y	Y	Y
Whether to control the period dummy variable	Y	Y	Y
Adj_R2	0.270	0.121	0.020

Note: "*", "**" and "***" mean significant at the statistical level of 10%, 5% and 1% respectively.

Similarly, the scale of financial development contributes to the improvement of residents' property income in the eastern region, but the estimated coefficient has reduced to 2.621. However, the influence of financial development efficiency is not significant and presents a weakly negative relationship. This shows that in developed regions, the financial market is relatively standardized and stable, and market competition is relatively strong. Property transactions, leasing and financial investment behaviors are normal businesses for residents, and they will not largely increase the residents' income. On the contrary, in the central region, the scale of financial development is statistically significant at 1% level and the estimated coefficient is 3.146. The efficiency of financial development is also statistically significant at a 1% level and the value of the estimated coefficient is −1.151. The results show that, in the central area, a high value of the financial development scale index can improve residents' property income while the situation is opposite for the financial development efficiency index. In the western area, two indicators that measure the level of financial development are significantly negatively correlated with property income. One of the reasonable explanations is that financial development cannot benefit the resident's property income in the irregular financial market.

Finally, Table 6 reports the breakdown results of property income inequality in the eastern, central and western regions. It can be seen that in the eastern region, the contribution of regional fiscal expenditure on the inequality of property income is −26.87%. Governments can significantly reduce the inequality of property income distribution through fiscal intervention. In the central region, fiscal expenditure still plays a role in reducing the inequality of property income distribution though its effect is only −4.66%. In the western region, fiscal expenditure deteriorates the level of property income inequality, resulting in a substantial increase in property income inequality of 18.49%. In terms of financial development index, financial development in the three regions worse the distribution of property income, but in the eastern region, the index of financial development scale only increases 1.77% of property income inequality and the index of financial development efficiency leads to less than 8% increase in property income inequality. In the central region, the index of the financial development scale significantly damages the equality of property income and its contribution is up to 28.24%. Compared with scale, the index of financial development efficiency slightly increases the inequality of property income with the contribution of 3.88%. In the western region, the contributions of financial development scale and financial development efficiency on property income inequality are relatively high, which leads to further deterioration of property income distribution.

Table 6. Decomposition results of property income inequality in the eastern, central and western regions (%).

Explanatory Variables	Eastern Full Sample	Middle Full Sample	Western Full Sample
Householder age	0.8149	0.0510	4.3681
Householder gender	0.039	0.5480	0.2749
Residence of head of household	0.026	0.0300	0.266
Education level of householder	−0.0537	1.8627	−0.1011
The head of the household professional	−0.0798	−0.0014	−0.3104
The head of the household health	−0.0033	0.6232	1.5146
Family size	0.1728	2.3464	0.8999
Economic conditions of the village	0.8961	13.0441	−0.2811
Per capita income of the village	−0.1856	3.2857	−0.2737
The proportion of regional fiscal expenditure	−26.8675	−4.6575	18.4925
Regional financial development scale index	1.7659	28.2435	11.4649
Regional financial development efficiency index	7.9471	3.8816	10.5014
Province dummy variable	76.5969	36.4697	52.2776
Province dummy variable	38.9312	14.2731	0.8748

5. Conclusions

With the construction of the logarithmic linear income determining equation, this paper uses the data from CFPS in 2010, 2012, 2014 and 2016 to estimate the correlation coefficient of property income determining equation, and measures the contribution of influencing factors based on the regression of inequality decomposition method. Empirical analysis shows that:

(1) The scale of fiscal expenditure is a "double-edged sword" for residents' property income. Effective fiscal expenditure can promote the growth of residents' property income, but the redistribution effect of fiscal expenditure on property income is relatively low. Overall, the crowding-out effect appears in government allocation as it occupies economic resources from residents, and thus affect the wealth of residents and their property income. The regional difference is obvious. In terms of the eastern, government intervention has a notable positive incentive effect in the market. It effectively promotes the trade and leasing of property, becoming an important factor in increasing residents' property income. The scale of financial expenditure significantly promotes property income at the statistical level of 1% and the estimated coefficient is as high as 32.236. In central and western regions, the effect of government fiscal expenditure has been significantly weakened, with the estimated coefficient of 7.7 (5.798 in the central area and 9.672 in the western area, both significant at the statistical level of 5%). In the redistribution effect, the research shows that an appropriate size of fiscal expenditure can reduce the inequality of residents' property income. The government's participation in resource allocation and market intervention through fiscal expenditure will not help residents gain higher property income, but it can reduce savings and accumulations of rich groups and then improve the equality of property income distribution. As for the relative scale of fiscal expenditure, its contribution to property income inequality in the eastern is up to −26.87%, but this rate drops into −4.66% in the central. In the western area, fiscal expenditure even worsens property income inequality, resulting in inequality increased by 18.49%. Combining the governance performance of the eastern, central and western regions, the importance of government's financial management is obvious and the government still has a large space in increasing residents' property income.

(2) The development of finance and economy is complementary. Financial development improves residents' property income, but at the same time aggravates the inequality of residents' property income. On one hand, except in the western region, the analysis of the financial development scale index suggests that financial development promotes the residents' property income growth at a statistically significant level of 1%. The development of finance helps to provide a standard market for residents' property transactions and leasing, encouraging more and more residents to engage in financial transactions. Meanwhile, financial development constantly enriches financial products and promotes greater property income for more and more households. On the other hand, except in 2014, the financial development efficiency index also has a negative effect on property income at a statistically significant level of 1%. In general, a great financial development scale leads to inequality of property income distribution and the contribution is as high as 20.81%. This number indicates that residents with none or a small amount of property cannot benefit from financial development and the gap between families with property and without property will expand accordingly. High efficiency of financial development results in deterioration of property income distribution and its contribution ratio of unequal distribution is 7.62%.

(3) Financial development is also related to the efficiency of local government. In financial markets with strong supervision, financial development can improve residents' property income and restrain the inequality of property income, and vice versa. In an economically developed area, financial development contributes to the growth of residents' property income, and the financial development scale index increases property income inequality by 1.76% and the financial development efficiency index leads to a nearly 8% increase in property income inequality. In economically developed areas, the financial market is well-organized with various kinds of

financial products and strong market competition, and therefore the growth of residents' property income is relatively stable. In the central part of China where the economic development is relatively backward, although financial development can increase residents' property income, it leads to the deterioration of unequal property income and the contribution is up to 28.24%. In the western region, financial development negatively affects residents' property income and its contribution to unequal property income distribution is about 10%.

6. Policy Recommendations

Despite the current percentage of property income in total income is small, residents' property income has grown rapidly in recent years. Financial development contributes to the rapid growth of property income but damages the equality of property income distribution. In addition, the redistribution effect of fiscal expenditure on residents' property income is limited, and therefore fiscal and financial policy fails to achieve the original purpose of "create conditions to let more people own property income". According to the findings above, recommendations of policy are listed as follows.

(1) It is advisable to allocate government expenditure rationally and spare no effort to build an effective government.

The results of this paper show that an appropriate scale of fiscal expenditure has an inhibitory effect on the inequality of property income in economically developed regions while the situation is contrary to less developed regions. Under the condition of the socialist market economy with Chinese characteristics, the budget and final account system in China are different from western countries. With the maturity of the market economy, expanding fiscal expenditure is inevitable. In order to keep the balance of the budget system, both "increasing income" and "reducing spending" is necessary. In terms of "increasing income", the government primarily needs to eliminate the factors that hinder the development of productive forces through streamline administration and institute decentralization. Besides, innovation is recommended to improve the enterprises' efficiency and then promote the growth of GDP. Moreover, the government needs to accelerate the reform process of the financial and taxation system. In the context of "Supply-side Structural Reforms", the situation of tax revenue growth rate exceeding GDP growth rate is unlikely to continue. Thus, the financial and tax reform should focus on the revolution of the tax system, especially in the tax structure. Specifically, the government should promote the implementation of inheritance tax and real estate tax, and reduce the proportion of indirect tax to increase the proportion of direct tax. "Reducing spending" is about the best use of every penny. That is to say, the government is suggested to strengthen the constraints of public fiscal expenditure, and further improve the "Budget Law" and its supporting implementation rules to achieve the requirements of "establish a comprehensive, standardized and binding budget system and fully implement performance management".

(2) It is suggested to improve the rule of law, adjust financial support policies and promote market equity.

To realize the redistribution of national income, the government uses different fiscal policies to ensure fund flow in financial institutions without changing the ownership of capital. Proactive fiscal policies can promote national economic development and contribute to the rapid growth of finance. However, this study shows that the current financial policy not only promoting residents' property income but also worsening inequality, and the deterioration is more obvious in developed regions compared with less developed regions. Therefore, it is necessary to promote the legislation, standardization and routinization of market regulation to build a fair market.

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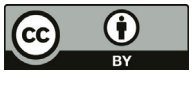

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Trade Balance Effects on Economic Growth: Evidence from European Union Countries

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Abstract: A growing number of recent research analyse the trade balance impact on economic growth. However, ambiguous results of studies imply the need for the research as the deteriorating trade balance hinders economic growth. This research aims to investigate the impact of the trade balance on economic growth as well as to evaluate it during the periods of trade deficit. Our estimations are based on the European Union (EU) 28 countries panel data over the period of 1998–2018, using the OLS method of multivariate regression analysis with fixed effects and focusing on two strategies: (i) including all trade balance periods, and (ii) adding deficit dummy variable seeking to evaluate whether during deficit periods we can find different and significant effect on economic growth. Evaluating all trade balance periods, the obtained results indicate the negative and lagging impact of the trade balance on economic growth, and no significant differences of the impact were identified during the deficit periods. The deterioration of trade balance reduces average economic growth and from linear relationship evaluation, we can state that it does not matter whether it starts from trade deficit or surplus result. The results obtained may also obscure the possibility of a non-linear effect, which would suggest a stronger negative impact on economic growth when the trade balance deteriorates in the presence of a large trade deficit. When discussing directions for further research it would make sense to consider other factors, such as the size of the deficit and its permanence.

Keywords: economic growth; trade balance; panel estimates

JEL Classification: C23; F40; F43

1. Introduction

The integration of countries into the world economy is often seen as an important factor of the increasing income and growth. International trade boosts the global economy and at the same time can become an important driver of the country's economic growth. International trade promotes efficient resource allocation, enables a country to realize economies of scale, facilitates knowledge diffusion, promotes technological progress, and fosters competition in domestic and international markets, leading to production processes optimization and new product development.

Substantial attention has been paid to the examination of trade balance effects on economic growth as it becomes an important indicator of a country's competitiveness and is important in assessing the country's economy and its relations with the rest of the world (Topalli and Dogan 2016; Kang and Shambaugh 2016; Akbas and Lebe 2015). Previous studies mostly show positive results of trade impact on economic growth (Michelis and Zestos 2004; Awokuse 2007, 2008; Andersen and Babula 2009; Cetintas and Barisik 2008; Sun and Heshmati 2010; Busse and Königer 2012; Bakari 2017; Bakari et al. 2019a, 2019b), while others indicate a negative result of trade deficit (Abbas and Raza 2013; Bakari and Tiba 2019) or no effect (Bakari and Tiba 2019).

Despite the strong interest, the impact of the trade balance on economic growth in the context of the European Union countries has not been extensively studied (Michelis and Zestos 2004; Awokuse 2007; Bakari 2017). To fill this gap, our paper aims to supplement the existing literature on estimated impact of trade in a few ways: (i) since most of the previous studies have been carried out in developing countries or at a single country level, our paper examines 28 European Union countries; (ii) our research includes 21-year data (1998–2018) to assess the impact of the trade balance on economic growth in the long-term; (iii) the majority of studies (Awokuse 2007, 2008; Cetintas and Barisik 2008; Bakari and Mabrouki 2017; Bakari 2017) investigate the effects on the economic growth of both export and import separately; also the authors (Sun and Heshmati 2010) studied the effects using only the export indicator, and there were also authors (Abbas and Raza 2013) who only examined the effect of trade deficit on economic growth or the combined effects of trade balance (surplus and deficit) (Busse and Königer 2012). Therefore, this study analyses the trade balance effects on economic growth in terms of the periods according to the trade balance result (deficit or surplus). The research analyses whether the effect of trade balance on economic growth differs evaluating its result of trade balance (deficit or surplus).

The rest of the paper is organized as follows: Section 2 presents a literature review. Section 3 discusses the research model. Section 4 presents the estimation results and discussion. The last section concludes the paper.

2. Theoretical Background of the Trade Balance Impact on Economic Growth

The assessment of the trade balance impact is widely discussed in the scientific literature. Economic theory identifies well-known channels through which trade can influence economic growth: trade promotes efficient resource allocation, enables the country to realize economies of scale, facilitates knowledge diffusion, promotes technological advancement as well as fosters competition in domestic and international markets and new product development. Andersen and Babula (2009) identified the channels through which international trade may affect the economic growth: (i) it provides access to foreign intermediates and technologies; (ii) it facilitates the dissemination of knowledge internationally; (iii) it expands the market size for new product varieties. The Thirlwall Law defines the traditional explanation of why the trade balance should be linked to economic growth (Thirlwall 1979). The balance of payment (BOP) constrained growth model states that actual growth can be projected on the basis of the ratio of export growth to import demand income elasticity, and that BOP must be in equilibrium. The basic idea of Thirlwall model is that export performance and import behavior determine the long-term economic growth. Increasing foreign exchange revenue from export is the only sustainable way financing increasing imports caused by the expanding domestic activity. There were various attempts to test empirically the assumptions of Thirlwall model. Soukiazis et al. (2012, 2014a, 2014b, 2018) developed a model based on the assumption of Thirlwall Law testing in different countries (Portugal, Italy, Slovakia, Greece) and additionally taking into account internal imbalances (twin deficit), also that relative prices are not neutral for economic growth. Garcimartin et al. (2016) testing the sources of business cycle in the framework of BOP constrained growth. Alleyne and Francis (2008) extended the model including interest payments and net transfers as these variables are very important to development of developing countries. Kvedaras et al. (2020) contributed the analysis of BOP constrained growth model decomposing economic growth rates and a cyclical growth term caused by net capital inflows.

Empirical studies have strong evidence that international trade has a positive impact on economic growth by facilitating capital accumulation, modernization of industrial structure, technological and institutional progress. More specifically, increased imports of capital and intermediate products not available on the domestic market may increase the productivity of production (Sun and Heshmati 2010). Wagner (2007) stated that the promotion of increased export fosters more intense competition and improved productivity. In the export industry, learning-by-doing activities can be accelerated by the spread of knowledge and technology. In addition, the benefits of the trade are largely generated by the

external environment, the proper trade policy, and the structure of trade. Extensive empirical studies have been conducted on the impact of the trade on economic growth. Prior to the 1960s, trade impact studies were conducted only in a few specific countries. The development of econometrics, based on a mathematical model, has been introduced to analyse the interactive effects of trade and economic growth. The focus is on the investigation of the causal link between trade and economic growth: whether economic growth is driven by trade or vice versa. We have revised a number of studies that assessed the impact of the trade balance on economic growth (see Appendix A), concluding that there is likely positive relationship between trade and economic growth.

Empirical studies have been conducted on cross-country and panel or individual country case. Among studies that analyse the causal relationship between trade and economic growth on individual country level mostly developing countries were analysed. Sun and Heshmati (2010) stated that international trade exerts a positive impact on China's economic growth, however, facing with low domestic absorptive capacity, deterioration trade conditions, the negative impact on the environment, trade friction with partners and uneven regional development. The research by Altaee et al. (2016) provided ARDL and ECM to investigate the long-run and the short-run effects of trade on economic growth. The results of their study show that export has positive impact on economic growth, however, import affects real GDP growth negatively in the Kingdom of Saudi Arabia. Bakari (2017) found that exports and imports are seen as the source of economic growth in Germany. Bakari and Mabrouki (2017) pointed out that exports and imports have no effect on Panamanian economic growth. Keho (2017) confirmed that foreign trade has positive effects on economic growth in Ivory Coast. Bakari et al. (2019a, 2019b) analysed the long-term and short-term relationship between exports, imports and economic growth in Brasilia and China. The positive effects of exports, however negative effects of imports, were found in both countries, pointing out the importance of exports to provide positive economic performance. Kumar (2020) has highlighted the positive spillover effects of India's trade on the economic growth of Bangladesh, Sri Lanka, Nepal, and Bhutan.

The second group of studies examines the relationship between trade and economic growth by applying cross-country or panel data. Michelis and Zestos (2004) determined Granger causality from export and import growth to GDP growth, pointing out that policies orientated only to export promotion can be inefficient. Awokuse (2007) stated that trade stimulates economic growth emphasising the role of export and import. Moreover, the study by Awokuse (2008) analysing three countries in Europe confirmed trade impact on economic growth as well. Cetintas and Barisik (2008) analysing 13 transition economies concluded that economic growth is likely affected by import demand growth. The study by Awokuse and Christopoulos (2019) examined the non-linear relationship between export and economic growth in five industrialized economies (Canada, Italy, Japan, the UK, and the US) noting that impact of export on economic growth is diminishing what allows to identify the threshold level when export is still beneficial for economic growth. Busse and Königer (2012), by developing a panel model for 108 countries (of which 87 are developing countries), stated that trade had a positive and significant effect on economic growth. The estimation results by Fetahi-Vehapi et al. (2015) in 10 South East European countries indicated positive effects of trade on economic growth conditioned by the initial income per capita and other explanatory variables, such as human capital and gross fix capital formation. Were (2015) investigated trade effects on economic growth for 85 developed, developing and least developed countries, showing that trade positively impacts economic growth in developed and developing countries, but insignificantly impacts it in the least developed countries. On the contrary, the study by Bakari and Tiba (2019) concluded that exports negatively affect economic growth and imports have no effect due to positive externalities related to technology transfer bias, financial capacities, human expertise, large market size, and spillover effect. Butkus and Seputiene (2018) included trade balance indicator analyzing debt threshold level (turning point) and its impact on economic growth. Their research shows that trade balance is a crucial factor affecting the threshold level.

Empirical evidence can be sensitive to the study periods and data sources chosen, as well as trade measurement. The majority of authors (see Appendix A) analysed the change in GDP as a dependent

variable in their research. However, there is no consensus on the choice of independent variables. The empirical studies analysed distinguished three independent factors: trade balance, imports and exports. The authors used different variables to analyse the trade balance factor: trade volume as a share of GDP (Busse and Königer 2012; Fetahi-Vehapi et al. 2015; Were 2015; Keho 2017), trade deficit (Abbas and Raza 2013). The import factor was used by the authors (Michelis and Zestos 2004; Awokuse 2007, 2008; Cetintas and Barisik 2008; Velnampy and Achchuthan 2013; Altaee et al. 2016; Bakari and Mabrouki 2017; Bakari 2017; Bakari and Tiba 2019; Bakari et al. 2019a, 2019b; Kumar 2020). Other authors (Michelis and Zestos 2004; Awokuse 2007, 2008; Cetintas and Barisik 2008; Awokuse and Christopoulos 2019; Sun and Heshmati 2010; Velnampy and Achchuthan 2013; Altaee et al. 2016; Bakari and Mabrouki 2017; Bakari 2017; Bakari and Tiba 2019; Bakari et al. 2019a, 2019b) used the export variable. It can be concluded that there is no clear consensus on the inclusion of independent variables in the model of trade balance effects on economic growth, as it depends on the subjective purpose of the study and the theoretical approach chosen. As can be seen, there is a lack of studies analysing trade balance impact on economic growth in European countries, as well as it is important to include not only export or import separately but also to reveal trade balance. It is not uncommon for a country with high export volumes for a number of years to be confronted with even greater import flows, which, as a result of the overall trade deficit, lead to a steady outflow of cash flows each year. When assessing the economic significance and validity of international trade for a country or shaping its future trade policy, it is important to assess the impact of the trade balance on economic growth.

Summarizing all empirical studies analysed, we can conclude that the trade balance has significant impact on economic growth. The results of previous research may depend on analysis period, country policy, level of development, the source of data, the different units of measurement, and the statistical methods used. Thus, the question remains in what direction the changes in the trade balance affect the country's economic growth.

3. Methodology

The concept of this paper is related to the assumption that the international integration of country economic growth depends on the country's trade balance and its result—deficit or surplus which is in line with Velnampy and Achchuthan (2013), Fetahi-Vehapi et al. (2015), and Were (2015). The study aims to reveal the situation of a group of countries without focusing on the individual country's assessment, so 28 European Union countries have been selected for the study. According to Apostolakis et al. (2019), there is a strong financial interdependence among the Eurozone countries, but there is evidence of stronger interdependence among the countries of the same cluster. This research assesses the sensitivity of the economic growth to trade balance changes in this group, which is particularly important in the context of the increasing interrelation between countries. The research covers 28 EU countries between 1998 and 2018, ensuring the statistical reliability of the study and to consider the fact that including lagging variables entails the loss of many observations in the study. The data used in this work were obtained from the Eurostat database.

The study was carried out based on 1998–2018 period panel data because, according to Hsiao (2003), due to the greater number of degrees of freedom, greater variability, and lower collinearity, aggregate data models are more reliable than time series or cross-sections. Their use makes it possible to include a larger number of independent variables in a relatively short time series. Aggregate data allows controlling the heterogeneity of variables as well as to check the lagged effects. One of the most commonly used methods for estimating the dependence between variables using panel data employed in this research is the ordinary least squares (OLS) method, following Busse and Königer (2012), and Abbas and Raza (2013). The multivariate regression method was used to assess the impact of the trade balance, all estimates were calculated using stabilized residual error regression.

While assessing the impact of the trade balance on economic growth, additionally it was chosen to group the observations according to the trade balance result (deficit or surplus). Based on this, two models were created. The first model (Equation (2)) will analyse the impact of the trade balance

on economic growth, considering all observations, whether the trade balance is in surplus or in deficit. The following model (Equation (3)) will group periods in which there was a trade deficit, i.e., with an *import/export ratio higher than 1*. Seeking to distinguish deficit periods from surplus periods, the balance deficit periods are coded 1, surplus periods are coded 0.

As the aim of the study is to assess the impact of the trade balance, rather than export or import, on economic growth, the *trade balance* was chosen as the main independent variable. The trade balance variable was expressed as an import-export ratio indicator (*Ld_ImEx*) in order to avoid the impact of absolute figures on the results of the research. The trade balance indicator will be logarithmic to obtain the elasticity coefficients. The deficit of trade balance can be identified as a problem for every country facing it, especially when it lasts for several or more years. Many authors (Cooper 2007; Papadimitriou et al. 2008; Gabberty and Vambery 2014; Awan and Mukhtar 2019) regard the long-term trade deficit as one of the main factors slowing down economic growth. The study will use a dummy variable to proxy the trade balance result. The encoded variable is the trade deficit (*Def*), which will examine the periods of trade deficit, i.e., with $Import/Export > 1$. The purpose of grouping is to assess whether the deficit periods are significant in assessing the impact of the trade balance on economic growth. It is hoped that differences in exposure between the general and deficit periods would be obtained, which would explain the significance of the trade result—the deficit. The trade deficit is expected to have a stronger and more negative impact on economic growth in periods of deficit. We focused to evaluate how the economic growth is affected by trade balance, as a final result of all possible international effects and interactions, such as international interconnectedness (Marfatia et al. 2020), spillover effects of international development on economic growth through trade (Marfatia 2016, monetary policy and capital flows channel Marfatia 2020).

The dependent variable, i.e., *economic growth* is expressed as an indicator of real GDP change. Because in most macroeconomic factors the effects of the phenomenon only appear after some time, it is appropriate to include lagging variables in the multivariate regression analysis. Lagging is an unavoidable feature of the interaction of all socio-economic processes, and here too, the resulting models include lagging independent variables. As economic growth was assumed to be affected by the trade balance of previous years, the average economic growth rates for 3, ... and 10 years were calculated, using real GDP per capita. The average economic growth for a given year will be calculated using Equation (1):

$$\Delta RGDP_{((t+a)\ year\ average)} = \frac{\ln((t+a)\ years\ RGDP\ per\ capita\ Eur) - \ln(t\ years\ RGDP\ per\ capita\ Eur)}{(t+a)-1} \quad (1)$$

where: $\Delta RGDP_{((t+a)\ year\ average.)}$—average economic growth $(t + a)$ years; t – year.

This average economic growth over the relevant periods is calculated to more accurately measure average economic growth. The trade balance of the current year is not expected to lead to the same period of economic growth – the effect is lagged. It should be observed that the trade balance for year t, with control variables, determines the future $(t + 3; \ldots ; t + 10)$ economic growth. The aim was to find out in which year the effect is the strongest. All independent variables are included in a given year (t).

Real GDP per capita (*ln_RGDP*) is a logarithmic independent control variable, in chain linked volume gross domestic product per capita, in millions of Euros in country i. It approximates average economic growth in year t. This control variable will check if current economic growth is affecting the average economic growth for the year $(t + n)$.

The econometric model of the trade balance effect on economic growth included two benchmark indicators that proxy the main factors of economic growth: human capital (*ld_Lab*) and net capital (*ld_Cap*). According to Goldin (2016), human capital is defined as qualification and accumulated knowledge. Human capital is a direct contributor to labour productivity and a prerequisite for technological advancement, making human capital development a key source of economic growth.

The size of the knowledge and the development of skills increase the share of output per employee, and it is difficult to quantify these benefits. Following Awokuse (2007, 2008), Malik et al. (2015), and Sun and Heshmati (2010), we use *indicator of human capital*, i.e., persons with higher education (ISCED) and/or working in science and technology, as a share from the total population. Capital is the basis of economic growth, and the growth of the modern economy is determined not by the quantity of capital but by its quality. *Capital Indicator* (*ld_Cap*) is Net capital as a percentage of GDP, which was also used by Awokuse (2007, 2008) and Sun and Heshmati (2010).

In the analysis of the impact of the trade balance on economic growth, two models were developed to test the statements summarized in this article. With the model I (see Equation (2)) we will evaluate if the impact of the trade balance on economic growth is lagging and is felt in later years. The current year's trade balance is expected to affect only later economic growth—the effect is lagged.

$$\begin{aligned}\Delta RGDP_{(i,t+n)} = \alpha + \theta_t + \beta_1 \ln\left(RGDP_{(i,t)}\right) + \beta_2 \mathrm{ld}\left(ImEx_{(i,t)}\right) + \beta_3 \mathrm{ld}\left(Lab_{(i,t)}\right) \\ + \beta_4 \mathrm{ld}\left(Cap_{(i,t)}\right) + \Delta u_{i,t}\end{aligned} \tag{2}$$

where $RGDP_{i,(t+n)}$—is the gross domestic product per capita in chain linked volume, in millions of Euros in i country in $(t + n)$ year. $\Delta RGDP_{i,(t+n)}$—represents the average economic growth in year $(t + n)$; $\Delta RGDP_{i,(t+n)}$—the dependent variable is the average economic growth in country i in year $(t + n)$; θ_t—time dummy variables of 1999, … , 2018 year, allowing the intercept (α) to change over time is important in our analysis. Secular trends in the EU will cause economic growth rates in all Member States to change significantly over a year. It is important to allow the temporal part ($\propto$) to change during the analysis; $\beta_1 \ln RGDP_{(i,t)}$—logarithmic independent control variable, gross domestic product per capita in chain linked volume, in millions of Euros in country i in year t. $\Delta RGDP_{i,t}$—approximate average economic growth in year t. This control variable will test whether current economic growth will affect the average economic growth for the year $(t + n)$; $ImEx_{(i,t)}$—the ratio of imports to exports in country i in year t. If $ImEx > 1$, this indicates a deficit, if $ImEx < 1$, it indicates a surplus; $\beta_2 \mathrm{ld}\left(ImEx_{(i,t)}\right)$–logarithmic differentiation of independent variable, import-export ratio; $\beta_3 \mathrm{ld}\left(Lab_{(i,t)}\right)$—logarithmic differentiation of independent control variable, skilled labour as a share of total population; $\beta_4 \mathrm{ld}\left(Cap_{(i,t)}\right)$—logarithmic differentiation of independent control variable, net capital as a share of GDP; β_1, β_2, β_3, β_4—are explained as elasticity coefficients, reflecting the impact of lagged economic growth, trade balance, labour and capital on average $(t + 3; \ldots ; t + 10)$ economic growth; n—delayed period; i—denotes the number of observed countries (28 EU countries); t—denotes the number of periods (21 years, between 1998 and 2018). In a panel approach we accounted for a cyclical pattern of growth by introducing time dummies and estimated models, using fixed effects to account for country individual effects. As the same cross-sectional units (EU Member States) appear in each time period, there is no need to control the factors that have constant distribution across time. Therefore, they will be eliminated using first difference transformation.

The second model (see Equation (3)) enables to evaluate if the trade deficit periods in countries are significant while assessing the effect of the trade balance on economic growth.

$$\begin{aligned}\Delta RGDP_{(i,t+n)} = \alpha + \theta_t + \beta_1 \ln\left(RGDP_{(i,t)}\right) + \beta_2 \mathrm{ld}\left(ImEx_{(i,t)}\right) + \beta_3 \mathrm{ld}\left(Lab_{(i,t)}\right) + \\ \beta_4 \mathrm{ld}\left(Cap_{(i,t)}\right) + \beta_5 (Def) + \Delta u_{i,t}\end{aligned} \tag{3}$$

where $\beta_5(Def)$—is a dummy variable denoted by 1 if country i has a trade deficit for year t $(ImEx > 1)$; β_5—is interpreted as an elasticity coefficient reflecting the effect of trade deficit periods on average $(t + 3; \ldots ; t + 10)$ economic growth.

4. Results and Discussion

Analysing the European Union countries from 1998 to 2018, it was found that 8 countries had trade surplus for the whole analysed period: Belgium, Denmark, Germany, Ireland, Luxembourg, The Netherlands, Austria, and Sweden. Only 4 countries had a trade deficit for the whole period under review: Greece, Latvia, Romania and the United Kingdom. We could argue that trade surplus is a result that is seen as less risky and therefore more desirable result in countries. Total EU trade surplus 1998–2008 increased by as much as 3.5 times over the period—about 423 billion Euros. Meanwhile, the overall trade deficit of EU countries in that period was increasing, rising from 53 billion Euros to 251 billion Euros, about 4.7 times. However, from 2009 to 2018, the trade deficit tended to shrink to 66 billion Euros, i.e., about 3.8 times.

Before discussing the results of trade balance impact or changing trends, two concepts must be distinguished: *trade balance deterioration*—a situation in which the deficit is increasing or the surplus is decreasing; *improvement of the trade balance*—a situation when the deficit is decreasing or the surplus is increasing. Because the trade balance in this research is indicated as import-export ratio, we should define the possible results by discussing the cases. If we confirm the negative impact of trade balance on economic growth, the trade balance deterioration will lead to a slowdown in economic growth, otherwise in a case of positive impact, the trade balance deterioration leads to the acceleration of economic growth.

A comparison between the change of average trade balance and economic growth rate for 21 year-period is presented in Figure 1[1].

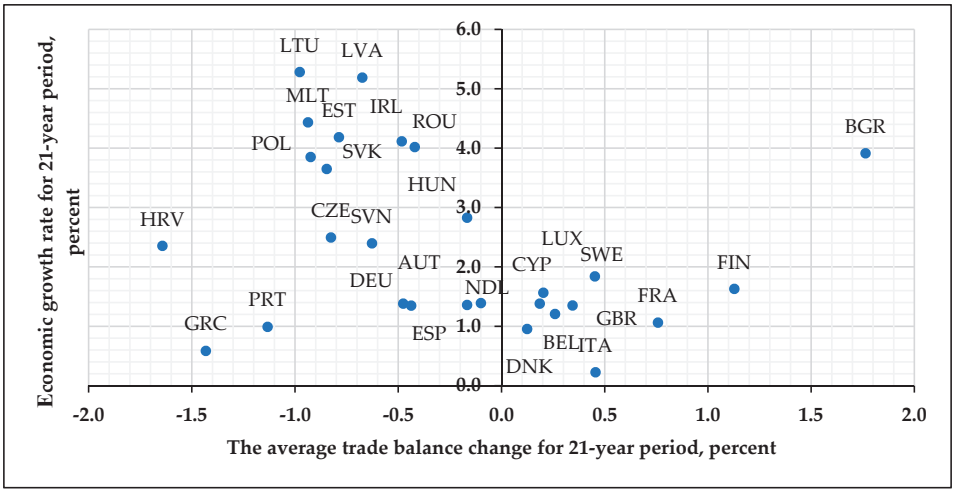

Figure 1. A comparison between the average trade balance change and economic growth rate for 21-year period.

Figure 1 indicates that in most countries (18 EU countries: LTU, LVA, MLT, EST, IRL, ROU, POL, SVK, HUN, CZE, SVN, HRV, DEU, AUT, NDL, ESP, PRT, GRC) the trade balance ratio is decreasing, and trade balance is improving, therefore, faster economic growth is noticeable. In a small number of

[1] Country codes: BEL—Belgium, BGR—Bulgaria, CZE—the Czech Republic, DNK—Denmark, DEU—Germany, EST—Estonia, IRL—Ireland, GRC—Greece, ESP—Spain, FRA –France, HRV –Croatia, ITA –Italy, CYP—Cyprus, LVA—Latvia, LTU—Lithuania, LUX –Luxembourg, HUN–Hungary, MLT–Malta, NLD—The Netherlands, AUT—Austria, POL—Poland, PRT—Portugal, ROU—Romania, SVN—Slovenia, SVK—Slovakia, FIN—Finland, SWE—Sweden, GBR—the United Kingdom.

countries (10 EU countries: BGR, LUX, CYP, SWE, DNK, BEL, ITA, GBR, FRA, FIN) the trade balance ratio is increasing, i.e., trade balance is deteriorating and the countries face slower economic growth.

Figure 2 compares the change in 10-year annual average trade balance with the economic growth rate in the EU-28 countries.

Even when analysing a shorter period (10 years), the situation does not change significantly, i.e., the countries were divided into four groups. The average 10-year data in Figure 2 shows that in the first group of countries (19 EU countries: IRL, BGR, ROU, LVA, LTU, POL, MLT, EST, SVC, HUN, CZE, PRT, ESP, HRV, SVN, GBR, DNK, FRA, NLD) trade balance ratio is decreasing, i.e., trade balance is improving and economic growth is noticeable. In the second group of countries (4 EU countries: DEU, BEL, AUT, SWE) the trade balance ratio is increasing, i.e., the trade balance is deteriorating and economic growth is slowing down. In the third group of countries (3 EU countries: GRC, CYP, ITA) the trade balance ratio is decreasing, i.e., trade balance is improving and economic growth is slowing down. In the fourth group of countries (2 EU countries: LUX, FIN) the trade balance ratio is increasing, i.e., the balance is deteriorating and economic growth is slowing down.

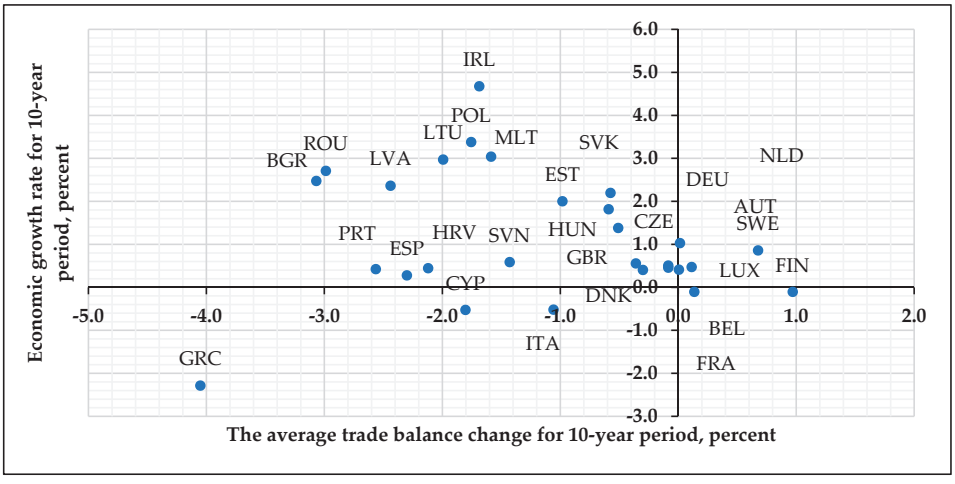

Figure 2. A comparison between the average trade balance change and economic growth rate for 10-year period.

The results of the multivariate regression analysis of the first model, assessing the effect of the trade balance on economic growth, are presented in Table 1. This model (based on Equation (2)) tests whether the effect of the trade balance on economic growth is lagging and is obvious in later years. The first model contains 588 observations.

Table 1. Results of a multivariate regression analysis of trade balance effects on economic growth in EU countries (model I).

	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
const	0.2180 ***	0.2475 ***	0.2651 ***	0.2732 ***	0.2786 ***	0.2822 ***	0.2737 ***	0.2530 ***
l_RGDP	−0.0245 ***	−0.0263 ***	−0.0271 ***	−0.0274 ***	−0.0275 ***	−0.0273 ***	−0.0266 ***	−0.0253 ***
ld_ImEx	−0.0452 ***	−0.0463 ***	−0.0447 ***	−0.0431 ***	−0.0426 ***	−0.0416 ***	−0.0397 ***	−0.0374 ***
ld_Lab	0.0115 ***	0.0137 ***	0.0149 ***	0.0154 ***	0.0149 ***	0.0144 ***	0.0138 ***	0.0124 ***
ld_Cap	0.0046	−0.0026	−0.0070	−0.0096 **	−0.0113 ***	−0.0131 ***	−0.0119 ***	−0.0081 **

, * indicate statistically significant at the 5% and 1% levels, respectively. Model I—588 observations. 3Y; . . . ; 10Y—models reflecting the effect of trade deficit on periods on average (t + 3; . . . ; t + 10) economic growth. All estimations include time tummies. All models are estimated, using fixed effects to account for country individual effects.

As shown in Table 1, the average economic growth is affected by the trade balance, labour, economic growth, and net capital (from the 6Y model). The results of multivariate regression analysis show that the trade balance has a statistically significant effect on economic growth. The trade balance ratio has a negative impact on economic growth, i.e., 1 percent increase in trade balance ratio (trade deficit grows or trade surplus decreases) reduces economic growth by about 0.04 percent on average. However, from the analysis, we can see that the effect of trade balance β decreases with each following model, indicating that the trade balance has a stronger effect on 3-year average economic growth (0.0452 percent) than the impact on 10-year average growth (0.0374 percent).

Analysing the control variables (economic growth, labour and capital), it was observed that economic growth and labour were statistically significant in all 8 models (99 percent of significance level in all models). Based on the results of a multivariate regression analysis, it is possible to state that 1 percent increase in the *labour* variable increases the average economic growth by about 0.02 percent. As the economic growth variable increases by 1 percent, the average economic growth is reduced by about 0.03 percent. Capital was statistically insignificant in the first three models, but ranging from model 6Y to model 10Y, it was already statistically significant. Based on the results, it can be stated that if the capital variable increases by 1 percent, economic growth is reduced by about 0.01 percent. Analysing the model I (based on Equation (2)), we can state that the impact of the trade balance on economic growth is lagged and can be seen in later years, but the effect is deteriorated when analysed over the long term.

The results of the model II (based on Equation (3)) are discussed below. This model incorporates a dummy variable ($\beta\_5\ (Def)$), which is coded 1 if country t has a trade deficit in year t ($ImEx > 1$). It represents the effect of trade deficit periods on the average economic growth of 3, . . . , 10 years, respectively. This model provides 518 observations (269 of them are deficit observation). The results of the multivariate regression analysis of the model II, additionally assessing the effect of trade deficit on economic growth, are presented in Table 2. This model sought to determine if the impact of trade balance on economic growth differs while compering the impact on deficit periods considering with all periods (deficit and surplus). Also we test whether the trade deficit periods in countries are significant while assessing the effect of the trade balance on economic growth.

Table 2. Results of a multivariate regression analysis of trade balance effects on economic growth in EU countries (model II).

	3Y	4Y	5Y	6Y	7Y	8Y	9Y	10Y
const	0.2902 ***	0.3110 ***	0.3083 ***	0.3095 ***	0.3133 ***	0.3212 ***	0.3188 ***	0.3098 ***
l_RGDP	−0.0301 ***	−0.0314 ***	−0.0317 ***	−0.0318 ***	−0.0319 ***	−0.0319 ***	−0.0318 ***	−0.0302 ***
ld_ImEx	−0.0313 ***	−0.0352 ***	−0.0355 ***	−0.0341 ***	−0.0328 ***	−0.0325 ***	−0.0299 ***	−0.0272 ***
ld_Lab	0.0150 **	0.0176 ***	0.0186 ***	0.0186 ***	0.0179 ***	0.0170 ***	0.0159 ***	0.0144 ***
ld_Cap	−0.0049	−0.0102	−0.0121 **	−0.0130 ***	−0.0137 ***	−0.0150 ***	−0.0158 ***	−0.0146 ***
Def	0.0012	0.0022	0.0018	0.0013	0.0002	0.0002	−0.0004	−0.008

, * indicate statistically significant at the 5% and 1% levels, respectively. Model II—518 observations. 3Y; . . . ; 10Y—models reflecting the effect of trade deficit on periods on average ($t + 3$; . . . ; $t + 10$) economic growth. All estimations include time tummies. All models are estimated, using fixed effects to account for country individual effects.

As shown in Table 2, the average economic growth is affected only by four variables (excluding dummy variable *Def*). The inclusion of the dummy *Def* variable makes it possible to assess whether there is the difference of the effect of trade balance on economic growth in deficit periods compared to all periods. The dummy *Def* variable is insignificant in all model specifications. We did not find a significant effect of trade deficit periods while assessing the impact of the trade balance on economic growth.

As shown in Table 2, the trade balance has a negative impact on average economic growth. Based on the results of the multivariate regression analysis, it can be stated that the trade balance ratio increased by 1 percent (i.e., trade deficit increases), and the economic growth declines by about

0.03 percent on average. However, from the analysis, we can see that the effect of trade balance on economic growth β decreases with each model, showing that the trade balance has a stronger effect on 3-year average economic growth (0.0313 percent) than the impact on 10-year average growth (0.0272 percent).

The results of both models highlight the need for modelling the inherent nonlinearities, that would suggest a stronger negative impact on economic growth when the trade balance deteriorates in the presence of a large trade deficit. Reviewing the statistical sense of models, we can state, that all models satisfy all assumptions of regression model. The models were estimated, using fixed effects, also with robust standard errors (HAC).

Based on the results of the multivariate regression analysis, it can be stated that the increase of the labour variable by 1 percent leads to an increase in economic growth of about 0.02 percent on average. As the economic growth variable increases by 1%, the average economic growth is reduced by about 0.03 percent. Capital was statistically insignificant in the first two models, but from the 3rd model to the 8th model it was already statistically significant. An increase of 1% in the capital variable decreases the economic growth by 0.01 percent. Analysing the results of model II, we can state that the trade deficit periods are significant while assessing the impact of trade balance on economic growth.

Both I and II models (with all sub models) satisfy the assumptions of the validation, i.e., model errors are not correlated, independent variables are strongly correlated with the dependent variable. A multivariate regression analysis revealed a lag of the impact of the trade balance on economic growth, therefore, using the trade balance change and other obtained parameters, we will forecast the average expected economic growth for the period 2019–2021 in EU-28 countries (see Figure 3).

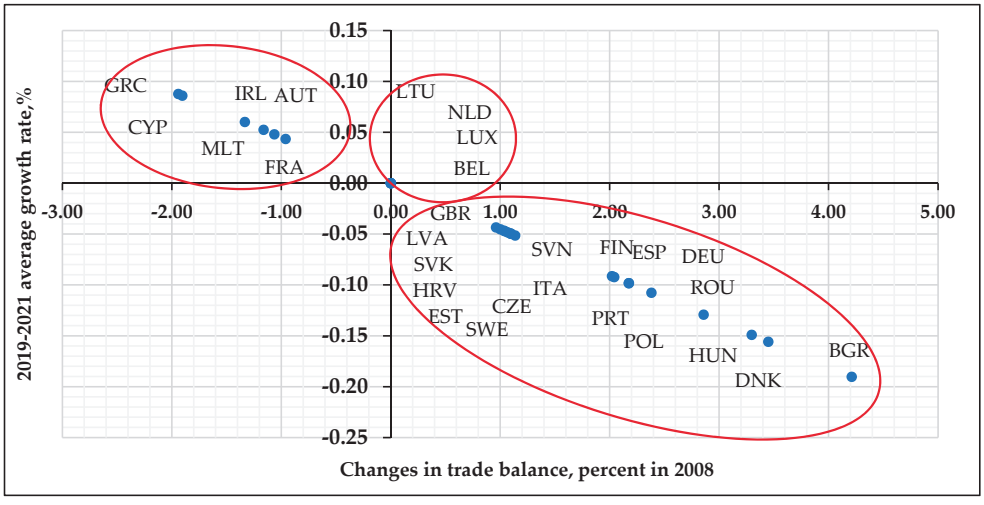

Figure 3. Changes in the trade balance in 2018 and economic growth rates, percent.

Figure 3 shows that the countries were divided into three groups. A positive average economic growth over the period 2019–2021 is forecast in six countries (GRC, CYP, IRL, AUT, MLT, FRA), when the trade balance is improving, i.e., either the surplus is increasing or the deficit is decreasing. In four countries (LTU, NDL, LUX, BEL), the situation of trade balance remained quite similar, so it should not lead to changes in average economic growth. In the remaining 18 EU countries (GBR, LVA, SVK, HRV, EST, SWE, CZE, ITA, SVN, FIN, ESP, DEU, ROU, PRT, POL, HUN, DNK, BRG) because of deteriorating trade balance in 2018 (i.e., declining surplus or increasing deficit) in 2019–2021 there is a forecast decline in average economic growth.

5. Conclusions

The previous studies provide evidence on the impact of the trade balance on economic growth, however, the results are ambiguous. This raises the need to determine the importance of trade balance on economic growth as it is stated that trade is one of the key factors promoting economic growth by facilitating capital accumulation, modernization of industrial structure, technological progress, and institutional progress. The majority of studies investigate the effects on the economic growth of both export and import separately but this does not allow evaluating the overall trade balance effect.

Aiming to assess the trade balance impact on economic growth, we focused on all trade balance periods and included only trade balance deficit periods. Evaluating all 28 EU countries shows positive changes in their overall trade balance: gross surplus is increasing and gross deficit is decreasing. Therefore, we can state that the trade balance of EU countries is improving. However, comparing the rates of average trade balance growth and economic growth in both 10 and 20-year cases shows that the situation in 28 EU countries differs, and it could be a cause for the deeper trade balance, or its deficit evaluation.

Our findings are in line with Busse and Königer (2012), Abbas and Raza (2013), Cetintas and Barisik (2008) who suggest that deterioration of trade balance has a negative impact on economic growth or vice versa. The results of multivariate regression analysis (model I) confirm statistically significant negative trade balance impact on economic growth. Analysing the control variables, it was observed that labour variable has a statistically significant positive impact. Also, capital and initial economic growth has a negative impact on economic growth. Commenting on the results of model II and evaluating only trade deficit periods, we confirm a statistically significant negative trade balance impact on economic growth.

Comparing the results of both models, we can state that generally trade balance deterioration reduces average economic growth and from linear relationship evaluation we can state that it does not matter whether it starts from trade deficit or surplus result. When discussing directions for further research, it would make sense to consider other factors as the size of the deficit as well as its permanence. Also, while evaluating the effect on economic growth, we can evaluate the interaction between the trade deficit and its determinants. The results obtained, following Cecen and Xiao (2014), Chen (2011), Wu et al. (2013), may also obscure the possibility of a non-linear effect, which would suggest a stronger negative impact on economic growth when the trade balance deteriorates in the presence of a large trade deficit. The results of both models highlight the need for modelling the inherent nonlinearities in the relationship between export and output growth as well as the impact of deficit size and the factors effecting its impact heterogeneity. Trade policymakers should be concerned about the deteriorating trade balance in countries, not only in deficit but also in surplus.

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Appendix A

Table A1. Summary of empirical research on the impact of the trade balance on economic growth.

Researcher(s)	Period	Sample	Method *	Trade Variable	Outcome Variable	Main Results
Michelis and Zestos (2004)	1950–1990	Belgium, France, Germany, Greece, Italy, and The Netherlands	VECM and Granger-Causality	First logarithmic differences of export and import	First logarithmic differences of GDP	Bi-directional significant causality from GDP to exports and imports
Awokuse (2007)	1994–2004	Bulgaria, the Czech Republic, Poland	ECM	Real exports, real imports	Real GDP growth	Significant long-run causal relationship from export and import to GDP
Awokuse (2008)	1994–2004	Argentina, Colombia, Peru	Granger-Causality	Real exports, real imports	Real GDP growth	Significant causal effects from imports to economic growth
Cetintas and Barisik (2008)	1995–2006	13 transition economies	Panel unit root, panel cointegration, panel causality	Export and import growth	GDP growth	Positive significant impact of import on economic growth
Awokuse and Christopoulos (2019)	1960–2005	Canada, Italy, Japan, the UK, and the US	STAR	Real exports growth	Real GDP growth	Significant non-linear relationship between exports and economic growth
Sun and Heshmati (2010)	2002–2007	China	SFA, Divisia index	Net export ratio and high-tech exports ratio	Logarithm of GDP	Significant positive effect on economic growth
Busse and Königer (2012)	1971–2005	108 countries	OLS, FE, GMM	Volume of exports and imports as a share of lagged total GDP	Growth rates of difference in the logarithm of GDP per capita	Positive and significant on economic growth
Abbas and Raza (2013)	1988–2011	Pakistan	OLS	Trade deficit	GDP	Significant negative effect on economic growth
Velnampy and Achchuthan (2013)	1970–2010	Sri Lanka	Time series: simple regression analysis	Export income, import expenses	GDP growth rate	Export income and import expenses have a significant positive effect on GDP
Fetahi-Vehapi et al. (2015)	1996–2012	10 SEE countries	GMM	Exports plus imports to GDP	Logarithm of real GDP per capita	Positive significant effects on economic growth
Were (2015)	1991–2011	85 countries	Standard growth regression	Exports plus imports, exports and imports as a share of GDP	GDP per capita growth	Positive significant effects of export on economic growth in developed countries
Altaee et al. (2016)	1980–2014	Kingdom of Saudi Arabia	ARDL, ECM	Real export, real import	Real GDP	Export has a positive impact on economic growth. Import affects real GDP growth negatively
Bakari (2017)	1985–2015	Germany	VAR, Granger-Causality	Logarithm of export and import	Logarithm of GDP	Exports and imports are the source of economic growth
Bakari and Mabrouki (2017)	1980–2015	Panama	VAR, Granger-Causality	Exports and imports (current US$)	Logarithm of GDP	No effect
Keho (2017)	1965–2014	Ivory Coast	ADLB test, VAR, Granger-Causality	Real export per capita plus real import per capita	Real GDP per capita	Trade openness is positively significantly related to economic output
Butkus and Seputiene (2018)	1996–2016	152 countries	SYS-GMM, OLS, LSDV	Exports plus imports in percent of GDP	The real per capita GDP of a country five years ahead	Significant impact on debt threshold level

Table A1. *Cont.*

Researcher(s)	Period	Sample	Method *	Trade Variable	Outcome Variable	Main Results
Bakari and Tiba (2019)	2002–2017	24 Asian economies	FE, RE	Logarithm of export and import (2010 constant US$)	Logarithm of GDP	Negative significant or no effect
Bakari et al. (2019b)	1970–2017	Brasilia	VECM	Logarithm of export and import	Logarithm of GDP	Exports have a positive significant effect on economic growth. Imports—significant negative effect
Bakari et al. (2019a)	1960–2015	China	VECM, Granger Causality	Logarithm of export and import	Logarithm of GDP	Exports have a positive significant effect on economic growth. Imports—significant negative effect
Kumar (2020)	1990–2016	South Asian Association for Regional Cooperation Countries	ARDL	Import and export share of India with dependent country	GDP growth rate	Trade has significant spillovers on the economic growth

* OLS—Ordinary Least Squares; FE—fixed-effects estimation; GMM—generalized method of moments estimator; VAR—Vector Auto Regression Model; ECM—multivariate error correction model with Gaussian errors, RE—random -effects estimation; SFA—stochastic frontier analysis; VECM—Vector Error Correction Model; ARDL—Autoregressive distributed lag model, ECM—Error correction method, ADLB test—Autoregressive Distributed Lag bounds test; ADF test—Augmented Dickey Fuller test; STAR—smooth transition autoregressive model; SYS-GMM—system generalized method of moments estimator.

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Poverty Alleviation and Microfinance for the Economy of Pakistan: A Case Study of Khushhali Bank in Sargodha

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Abstract: Poverty is a universal reality, and no one can deny the omnipresence of it all over the world. It is considered as the most harmful economic and social problem of human beings since their creation. It affects individuals as well as society as a whole in a very destructive way, and it is considered that poverty is the mother of all human rights violations. Perhaps no one would argue against the notion that microfinance can be a very useful apparatus in human, social, economic, political and national development. Microfinance has been established to fill the gap of a missing credit market for the poor. Among all other anti-poverty strategies, it has become one of the most important and successful tools for poverty elimination throughout the world. In this study, we investigate the impact of microfinance on poverty alleviation for the economy of Pakistan. The literacy is very poor for the area of Pakistan, so our research will help policy makers in making the right decisions in order to help the people that are living below the poverty line. Primary data of 300 households from Khushhali Microfinance Bank Limited were collected. The findings reveal that microfinance imparts a vital role in poverty eradication where the poverty level has decreased from 42.67% in comparison household (CHH) to 29.33% in the program household (PHH). Finally, it unveils the fact that there is a negative association between the provision of microfinance and poverty level of the household. The availability of micro financing facilities to the poor has declined the poverty rate from 42.67 percent to 29.33 percent. The Logistic Regression model implies that poverty has a negative association with the duration of microfinance, education and existence of a market in the locality, whereas it is positively related to family size and gender of the respondent.

Keywords: macroeconomics; poverty; microfinance; Pakistan

JEL Classification: F41; E60; I38

1. Introduction

Poverty is a universal reality, and no one can deny the omnipresence of it all over the world. It has various types and facets in different parts of the world. In the present scenario, poverty works as a breeding ground for clashes among the people. Poverty is taken as the most harmful economic and social problem of human beings since their creation. It affects individuals as well as society as a whole in a very destructive way and it is considered that poverty is the mother of all human rights violations. In the modern age, poverty has become a gigantic problem of the world. It is not only an obstacle in the economic development of the country but it also hinders human development. Generally, it is defined as deprivation of well-being.

According to the World Bank, poverty is a multi-facet phenomenon that is about insufficiency or lack of political, economic, cultural and social entitlements. Similarly (Alkire and Foster 2011) define that it is an insufficient income or lack of means with which to satiate basic needs. Furthermore, there are numerous indicators of poverty like hunger, low income and unavailability of shelter, sickness and lack of knowledge, poor health, unemployment and powerlessness, no freedom to speech and vote and lack of clean drinking water. In addition, there are also some other factors that trap the people into poverty such as political instability, gender disparities, big family size, natural disaster, corruption, socio-economic and regional disparities. So, poverty eradication is not only a developmental goal, but it is also a main threat to human life in the 21st century. It is imperative to think about a tool that can uplift the income level of the poor, reduce their vulnerability and boost their self-confidence while devising an anti-poverty policy. In this context, microfinance is often recommended as a solution to multiple social problems and ultimately will lead to the economic development of a country (Balamurugan and Selvaraj 2014).

Microfinance has brought a positive impact to the life of clients, boosted the ability of poor individuals to improve their conditions and others have indicated that poor people have taken advantage of increased earnings to improve their consumption level, health and build assets Ebimobowei et al. (2012). Today, microfinance is increasingly becoming an important investment opportunity, mainly in developing regions such as Latin America and Africa, and all major international institutions, like the European Union, the United Nations, the World Bank, the Asian Bank, and the American Development Bank dedicate funding and research to microfinance. The relationship between microfinance and poverty is still in question and this paper provides some new empirical evidence on the poverty-reducing effects of microfinance.

In some countries, microfinance in general can be seen as a political tool, where the politicians often intervene in favor of individuals who are struggling to repay their loans during times of economic stress. Microfinance can be an appropriate solution against financial and social exclusion by ensuring the availability of suitable loans, savings and other financial products or services. In this perspective, we should keep in mind that while "there is no internationally accepted definition of microfinance", the term is generally used to indicate a range of financial services/products (of small amounts) offered to low-income/non-bankable customers and microenterprises. Microfinance targets those individuals who are denied credit by formal financial and banking institutions because of financial illiteracy or lack of knowledge of the formal rules that they should follow to access credit provided by these institutions (Leone and Porretta 2014).

Lack of or limited access to credit is a main hurdle behind the sea of poverty. Generally, in developing countries both formal and informal financial sectors have failed to provide financial services to the destitute people. Collateral requirements, preference for rich people, large amount of loans and tedious bureaucratic processes exclude the low income people from the banking sector. Similarly, the informal financial sector has also denied providing credit to the poor due to a very high rate of interest and exploitation (Chaudhry 2009). Hence, microfinance has been established to fill the gap of the missing credit market for the poor. It has tackled the collapse of the conventional banking sector by extending micro loans to poor needy people for earning a livelihood. Microfinance assists the poor by raising income, providing access to education and self-empowerment. Among all other anti-poverty strategies, microfinance has become one of the most important and successful tools for poverty elimination throughout the world (Chughtai et al. 2015).

Since the creation of Pakistan in 1947, poverty has been the most challenging issue. The poverty trend in Pakistan has been fluctuating heavily over time. According to Pakistan's Economic Survey (Government of Pakistan 2016), 29.50 percent of the population is living below the poverty line. In Pakistan, most of the people are residing in villages and their livelihood is based on the agricultural sector of the economy. Specifically, rural people are living in a very pathetic condition due to a shortage of basic facilities like drinking water, basic education, health facility, roads, energy, communication and unemployment.

In Pakistan, poverty can be said as double edge razor because, on the one hand, poor people have low income while, on the other hand, they cannot access basic requirements of life like clean drinking water, basic education, health facilities and sanitation. The objective of our research is to investigate the role of micro financing initiated by Khushhali Microfinance Bank Limited (KMBL) for poverty mitigation in the district of Sargodha. The literacy is very poor for the area of Pakistan so our research will help policy makers in making the right decisions in order to help the people that are living below the poverty line. Summarizing all the above, the current study is trying to investigate the role of microfinance in poverty elimination. Moreover, we are trying to determine the contribution of microfinance in the lessening of poverty according to the poverty status of households. We also try to investigate the relation between poverty, family size, existence of schools in the locality and duration of microfinance. There is a growing debate as to the best strategy for alleviating global poverty. Our study attempts to shed light on microfinance focusing on the districts of Pakistan. The poverty trend in Pakistan has been fluctuating heavily over time and is one of the major problems not only for Pakistan but also for the entire world. The governments should be informed about all of the available strategies for alleviating property, and microfinance is considered as one of the best tools in the hands of policy makers. The next section provides a review of the relevant literature on microfinance, especially its effect on poverty reduction at the macro level. Methodology specifications and data are discussed in Section 3. Section 4 shows the analyses and empirical results. The final section offers concluding observations.

2. Literature Review

In the literature, there is a broad convergence, both academic and that produced by the international institutions involved in economics, finance and development, in that microfinance today is essentially facing two challenges. On the one hand, it must be more and more sustainable, economically and financially. On the other hand, it must increase the outreach to have a more significant effect on the development processes in poorer areas of the world (Cull et al. 2011; Bogan 2012; Leone and Porretta 2014).

Over the past decade, the microfinance universe has undergone several changes (Leone and Porretta 2014). Generally, microfinance is associated with developing countries, where large segments of the population need to access these types of financial services; however, microfinance includes a number of activities that extend to developed countries too, where—especially after the international economic and financial crisis—an increasing number of people deal with poverty issues due to factors such as immigration, unemployment, inactivity and marginalization.

According to La Torre (2006) the lack of access to finance, especially for self-development or social advancement purposes, may lead to impoverishment and worsen a 'vicious circle of poverty'. When people in poor countries have low income levels, thus low savings and low capital accumulation, their productivity and growth are limited. Meanwhile, the ultimate benefit of microfinance is to endeavor to reverse this trend into low income, injection of credit, investment, more income, more savings, more investment, more income.

Provision of credit to the low income people without any collateral was a daunting task for the financial sector. However, in 1983, Dr. Mohammad Yunus came up with a revolutionary idea of nipping this issue in the bud with the establishment of Grameen Bank (GB) in Bangladesh. He believed that "credit is a fundamental human right". Thus, Dr. Mohammad Yunus is known as the pioneer of the notion of microfinance in the present era. According to him, five percent of credit users get rid of poverty in Bangladesh per year (Yunus 2001). Now microfinance is being taken as an effective device for getting rid of poverty from the world.

The utilization of microfinance reduces poverty and vulnerability as well. Zaman (2000) deployed a study to check the degree to which micro credit eliminated poverty and vulnerability by a case study of Bangladesh Rural Advancement Committee (BRAC). The empirical findings of the study were that micro credit had played its role in eradicating income poverty and vulnerability. Adeola (2000)

also explained that microfinance is one of the most effective tools that successfully eliminates poverty. Microfinance has a significant impact on income of the borrower households. Park and Ren (2001) found that there is a positive link between credit and income of the household in China. Along with provision of microfinance, a good anti-poverty policy and strategy is very imperative. Robinson (2001) explained this fact that microfinance could be a tool of anti-poverty strategy by reviewing the policies. Provision of microfinance could lead to a reduction in poverty while a lack of access to credit triggers poverty. The study observed a positive relationship between micro credit and the income of the destitute people.

Bhatt and Tang (2001) explained that the need of micro credit was increasing in poor nations due to the rise in the poverty level. Thus, microfinance institutions should spread out their facilities to the area where the problem of poverty emerges. The microfinance sector should introduce different financial products to satiate the need of a poor man to earn more fame and to compete with the conventional banking industry. Mayoux (2001) explored that microfinance had played a positive and defining role for women empowerment, health facilities, and child education and for other socio-economic factors of the poor community. In a similar research, Simanowitz (2003) concluded that with the help of a microfinance program there was an improvement in economic conditions of the borrower families and almost half of these clients were able to raise their income above minimum income level. Weiss et al. (2003) argued that the revolution of microfinance had changed the mindset of people for helping the poor all over the world. The poor people could get access to the credit market with the inception of the microfinance program.

Mohammad and Mohammed (2007) investigated the effect of microfinance on the borrowers in Bangladesh. The aim of this study was to analyze the working of microfinance in the context of poverty alleviation and 109 clients were interviewed. The collected data were analyzed by different statistical techniques like percentage, correlation, ANOVA, and regression analysis. The outcomes demonstrated that micro credit has raised the living standard of the clients. It helped the poor to get rid of poverty by economically empowering them.

Swain and Floro (2012) observed the role of microfinance on poverty eradication and vulnerability of the destitute people in India. The prime purpose of the study was to investigate whether microfinance can lead to reduced vulnerability as well as poverty of the lower income people. The results showed that the members of SHG were no more vulnerable as compared to non-members and the incidence of poverty is also found high in non-member people. So, microfinance had played a positive role in the reduction of poverty and vulnerability as well. The effective utilization of microfinance is also attached with the provision of basic infrastructure. Ebimobowei et al. (2012) observed the relationship between microfinance and the eradication of poverty in the Bayelsa State of Nigeria. The findings showed that there was a positive association between microfinance and poverty eradication. The study also revealed the fact that only the availability of microfinance could not eliminate poverty without the provision of basic infrastructures. Therefore, it is recommended by the study that the governments of developing countries like Nigeria should also focus on the provision of basic infrastructure along with micro financing. Kireti and Sakwa (2014) analyzed the socio-economic effect of the microfinance program on women in Nakuru County, Kenya. The data of 370 women clients were taken by using a structured questionnaire. The study showed that the availability of a micro credit facility raised income and expenditure on education and health facilities. Miled and Rejeb (2015) made an effort to explore the relationship between micro credit and poverty alleviation by collecting the data from 596 microfinance institutions (MFIs). The findings showed that a country with high level of microfinance provision had less poverty and a higher level of per capita income.

In Pakistan, microfinance has also earned great popularity among the public as well as policy makers fighting against poverty. Therefore, different studies have been designed to investigate the impact of microfinance on poverty eradication over time. Adil and Hammad (2003) observed a relationship between micro credit and agri production in the area of district Dera Ghazi Khan. The findings showed that micro credit had a positive impact on agri production. Ahmad et al. (2004)

examined the effectiveness of the microfinance program initiated by Khushali Microfinance Bank Limited (KMBL) for poverty eradication in Tehsil Rahim Yar Khan, Pakistan. The findings of the study showed a positive link between credit and income, credit and saving, credit and yield per acre, credit and assets formation and credit and farm expenses. It was concluded that (KMBL) Rahim Yar Khan was efficiently working to serve the poor and assisting them to come out of poverty.

Lodhi et al. (2006) devised the study to evaluate the micro credit program carried out by NRSP. The findings showed that NRSP was playing a vital role in empowering females. It also boosted the living standard of women in the community. Chaudhry (2009) argues that the microfinance program is a very effective tool to fight against poverty in Southern Punjab, Pakistan. However, he concludes that these activities can be made more useful by ensuring macroeconomic stability in the country. Saboor et al. (2009) observed the nexus between microfinance and poverty reduction in Pakistan. They gave empirical evidences that microfinance helped to raise the income of the clients. Ayuub (2013) made an effort to analyze the role of microfinance in the fight against poverty in the Bahawalpur District. The study focused on the impact of the microfinance scheme started by the National Rural Support Program (NRSP) in this area. It was observed that microfinance had a significant impact on poverty reduction in that area. The empirical findings also revealed that microfinance policy uplifted the living standard of poor people and helped them to develop their business. The study suggested to increase the loan size and the SBP should support and regulate MFIs to provide credit facilities to the poor people on reasonable terms and conditions.

Alam et al. (2014) tried to establish a relationship of microfinance initiated by PRSP with social and economic position of rural poor farmers in Gujranwala. He concluded that micro credit was playing a vital role for these poor farmers. Imtiaz et al. (2014) examined the part of microfinance in poverty elimination in the Faisalabad district. The data had been collected by using a household survey method from the borrowers of Khushhali Microfinance Bank Limited (KMBL), district Faisalabad. The findings showed that microfinance had reduced poverty. Saad et al. (2014) examined the social and economic effects of microfinance on the agricultural sector in district Multan. The prime objective was to explore the economic and social effects of micro financing on the life of formers and to point out the factors that compel farmers in debt. The sample of the study was comprised of the clients of ZTBL. Systematic random sampling was deployed to retrieve the data of 120 borrowers. The result revealed that the provision of microfinance led to improvement in the productivity of farmers and increased their livelihoods.

After examining the literacy on microfinance and poverty, the conclusion is that microfinance is one of the most important and effective tools being used for poverty alleviation all over the world nowadays. The results of some studies may differ from one another due to different methodologies deployed in different studies. Also, all the above selected studies are analyzed because they are studying countries or areas that have common characteristics for poverty and microfinance programs like Pakistan. All these studies and their results will help us to compare our research. Some studies take a different line in that the fruit of microfinance are spoiled by high rates of interest, low levels of infrastructure and small scale businesses. While most of the studies depict the same picture that microfinance helps the poor to come out of poverty, increase their income and consumption, enable them to have better education and health facilities and raise their standard of living. This research is designed to analyze the contribution made by the microfinance program initiated by KMBL in poverty reduction in the area of district Sargodha.

Among all other microfinance initiatives, Khushhali Microfinance Bank Limited (KMBL) has been performing its functions since 2000 in different parts of Pakistan. The prime purpose of KMBL is to provide financial assistance to micro-enterprises in Pakistan. The microfinance program initiated by KMBL has a considerable effect on poverty eradication all over Pakistan. There are different studies like (Ahmad et al. 2004; Akram and Hussain 2011; Imtiaz et al. 2014; Iqbal et al. 2015; Mahmood et al. 2016) that have been conducted along with KMBL and reveal that microfinance provided by KMBL has a positive impact on the poverty level of the poor client. Micro financing has helped them to get rid of

this curse and overall poverty has come down. In the district of Sargodha there is a large network of micro financing. According to the Pakistan Microfinance Network (2017), the Sargodha district stands among the top three districts with an 11.11 percent increase in micro credit outreach all over Punjab by the end of 2016. In Sargodha, KMBL has three branches (Bhalwal, Sargodha, and Sahiwal) to provide micro financing facilities.

3. Data and Methodology

In this section, we analyze the techniques and methods we used in order to show the role of microfinance in poverty elimination in the area of district Sargodha. The proposed research is based upon the primary data of the borrowers of Khushhali Microfinance Bank Limited, collected from the district of Sargodha. Per capita income has been used as a proxy for poverty by different studies such as (Asghar 2012; Waheed 2009). Keeping in view the above research, the current study also used per capita income as a proxy for poverty. Similarly, in this research, the duration of microfinance is marked as a proxy for microfinance as used by Chowdhury and Alam (2008). The designed study categorized the household into two types.

a. Program household; those households that have received more than one loan from KMBL.
b. Comparison household; those households that have applied for microfinance and yet have to receive their first loan.

3.1. Data Sources

In researches related to poverty, a household survey is the main tool for data collection and it is used at a national as well as international level. According to Deaton (1997), household data have been used in almost all the poverty-oriented studies. This research is using the household survey method as used by Jegede et al. (2011) in Nigeria to analyze the effect of microfinance on poverty alleviation.

3.2. Questionnaire

The current study has formulated two different well-organized close ended types of questionnaires for data collection. The first questionnaire is for the comparison of households and it includes questions about households and locality level characteristics of CHH (comparison household). Whereas the second questionnaire has been designed for program households and it comprises household, locality level and microfinance characteristics of PHH (program household). The researchers have conducted face to face interviews for filling out the questionnaires.

3.3. Sampling Technique

In this study, a Probability Proportional to Size Sampling technique (PPS) was used for sample selection. PPS is a method of sampling in which units are sampled on the basis of probability proportional to their size. Also, it is used in a targeted population when different units vary in size. In this situation an ideal solution is to assign probability proportional to their size so that larger units may have greater contribution to total sample size. In this way, the selected sample would have more efficient estimates. In the district of Sargodha, Khushhali Microfinance Bank Limited have three branches: Bhalwal, Sahiwal, and Sargodha and the total active borrowers were 13,031 in 2017. The share of each branch to total active clients is given by Table 1.

Thus, by using the probability to size sampling technique, we have 60 percent weight to Sargodha, 30 percent to Bhalwal and 10 percent to the Sahiwal branch. The primary data of 300 households were collected from all the three branches of KMBL operating in district Sargodha during March–April 2018, out of which 150 households belong to comparison household (CHH) and 150 to Program Household (PHH).

Table 1. Distribution of borrowers.

Branch (KMBL)	Date of Establishment	Active Borrowers (2017)
Sargodha	2003	7818
Bhalwal	2008	3909
Sahiwal	2015	1303

Source: Khushhali Microfinance Bank Limited.

3.4. Poverty Line

The poverty line is a cut-off point in which below that point a person is considered to be poor. Basically, poverty line is the measure of lowest acceptable level of income or consumption that splits the poor from non-poor (Anyanwu 2004). In the case of developing nations, the absolute poverty line is more useful and relevant than relative poverty line because most people there are living below the poverty line (World Bank 2011).

Historically, Pakistan has been using a food energy intake (FEI) method to check poverty estimations. By deploying this approach and the poverty line of 2259.44 (PKR) per adult per month, poverty in Pakistan declined from 29.33 percent in 1998–1999 to 9.33 percent in 2013–2014. The poverty estimation of 9.33 percent looks very skeptical in a country like Pakistan. Hence, to tackle this issue, Pakistan Planning Commission adopted a new methodology that is based on the cost of basic needs (CBN) approach. CBN has the following advantages.

1. It is very transparent.
2. It is often used in developing countries.
3. This covers non-food expenditure as well.

Hence, in 2016, the poverty line was revised to 3030.32 (PKR) per person per month and the proposed research has used this national poverty line for poverty estimation as given by the Pakistan Economic Survey (Government of Pakistan 2016).

3.5. Methodology of Binary Logistic Regression

Logistic regression is a suitable regression technique to carry out when the outcome variable is categorical in nature. Binary logistic regression technique (BLR) is deployed to investigate the relationship between a binary response variable and a set of explanatory variables. When our dependent variable is dichotomous or categorical, the assumption of linearity in a normal regression analysis is violated. To tackle this issue, binary logistic regression deploys logarithmic transformation on an outcome variable. In this way, logistic regression describes the multiple linear regression equation in a logarithmic term, which is known as logit.

A logit model is a logarithmic transformation of probability or natural log of the ratio of probability. A logit model defines the conditional probability of a dependent variable. The literature reveals that for poverty estimation, the logit and Probit model has been extensively used by different studies such as (Apata et al. 2010; Awan et al. 2011; Chowdhury and Alam 2008). According to Gujarati and Porter (2009), the logit model is more reliable, normal and efficient. The logit model is widely recognized because it gives more rigorous outcomes.

Assumption of Binary Logistic Regression

There are the following three assumptions.

1. The outcome variable must be dichotomous;
2. The relationship between the dependent and explanatory variables must be non-linear;
3. The error term should not be normally distributed.

In our study, the outcome variable (poverty) is a binary or dichotomous variable, with (0) if the household is non-poor and with (1) if the household is poor. So, all the above conditions are satisfied in the present study and that is why binary logistic regression analysis is deployed in this research as used by Chowdhury and Alam (2008).

3.6. Construction of Variables

We are treating poverty as the outcome variable. While household, locality wise and microfinance characteristics of the borrowers are used as explanatory variables.

The proposed research has conducted two different types of analysis. The first approach is based upon descriptive and graphical analysis, whereas the second approach is about econometric analysis (BLR). All variables, which are used in both types of analysis in order to investigate the effectiveness of microfinance in poverty eradication in the area of the district of Sargodha, are given by Tables 2 and 3.

Table 2. Variables of descriptive and graphical analysis.

Variable	Explanation
Poverty Status of PHH and CHH	Poor or Non-Poor
Gender of Respondent	Male or Female
Educational Status of Respondent	Literate or Illiterate
Family Size of Respondent	Minimum, Maximum, Mean
Economic Characteristics of Household (AMFI, AMFEEX, AMFHEX, AMFSAV, AMFEX)	Measured in Pak-Rupees
Locality Level Characteristics (ESHL, SGC, EMKT, MTROD)	Yes or No
Duration of Microfinance (Percentage)	Loan Period (1, 2, 3, … 5 or above)
Reasonable Interest Rate (RIR)	Yes or No
Loan Helped in Changing Economic Condition (LHCEC)	Yes or No
Wish for another Loan (WFAL)	Yes or No
Loan invested in the Sector (Trading, Manufacturing, Services, Live Stock, Others)	Yes or No
Loan Amount (PKR)	Minimum, Maximum, average

Table 3. Variables of the logistic regression analysis.

Variable	Explanation
POVT	=1 if household is poor =0 if household is non-poor
GEN	Gender of the respondent
EDU	=1 if respondent is literate =0 if respondent is illiterate
FSZ	Family size of the respondent
ESHL	=1 if a school exist in the locality =0 if a school do not exist
EMKT	=1 if market exist in the locality =0 if market does not exist
TRAD	=1 if loan is invested in trading sector =0 if loan is not invested in trading sector
MANU	=1 if loan is invested in manufacturing =0 if loan is not invested in manufacturing
SERV	=1 if loan is invested in services sector =0 if loan is not invested in services sector
OTHER	=1 if loan is invested in other sector =0 if loan is not invested in other sector
DOMF	Duration of Microfinance

Table 2 incorporates all the variables included in descriptive analysis. Our research explores the characteristics of beneficiaries of a microfinance program and makes a comparison between the program

household (PHH) and comparison household (CHH) to analyze the effectiveness of microfinance in poverty eradication with the help of descriptive analysis.

Table 3 presents the variables that are included in the econometric analysis to examine the impact of microfinance on poverty eradication and to identify the occupational sectors that have more positive contribution towards poverty alleviation in the area of the district of Sargodha.

3.7. Construction of Econometric Model

The study has formulated two different econometric models for empirical analysis.

3.7.1. Model One

This model is used to investigate the impact of microfinance on poverty eradication in the area of district Sargodha.

$$Y = \alpha + \beta_1 FSZ + \beta_2 ESHL + \beta_3 DOMF + \mu \quad (1)$$

$Y =$ outcome for the household
$FSZ =$ family size of the household
$ESHL =$ existence of school in the locality
$DOMF =$ duration of microfinance of the borrowers
$\mu =$ error term of the model
$(\alpha, \beta_1, \beta_2, \beta_3) =$ the parameters to be estimated

Now this model is converted into a logistic regression model by applying the following mathematical procedure.

The general function is given as below:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (2)$$

where *Xs* represent independent variables as

$X_1 =$ Family Size (FSZ)
$X_2 =$ Existence of School in the Locality $(ESHL)$
$X_3 =$ Duration of Microfinance $(DOMF)$
$Y =$ Poverty $(POVT)$

A household is considered poor with a value of (1), if its per capita income is less than 3030.32 (PKR) and non-poor with a value of (0), if per capita income is greater than 3030.32 (PKR).

$\alpha =$ intercept of the equation
$\beta_i =$ coefficient of the explanatory variables

As we know, logit is the logarithmic transformation of probability or natural log of the ratio of probabilities. It can be expressed as follows

$$Logit(Y) = \ln\left[\frac{Probability\ of\ happening\ of\ an\ event}{Probability\ of\ not\ happening\ of\ an\ event}\right] \quad (3)$$

$$Logit(Y) = \ln\left[\frac{p}{1-p}\right] \quad (4)$$

$p = probability\ of\ happening\ of\ an\ event$
$1 - p = Probability\ of\ not\ happening\ of\ an\ event$

To get logistic regression model, Equation (2) is put into the right hand side of Equation (4).

$$\ln\left[\frac{p}{1-p}\right] = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (5)$$

3.7.2. Tests Performed

According to Menard (1995), the overall robustness of the model is tested through likelihood ratio statistics, which is based on chi square. The author shows that the model is fitted well and predictors have a statistically significant impact on the outcome variable. The Cox and Snell R Square works as a pseudo R^2, which shows how much variability can be explained by the model. Furthermore, R^2 does not represent the same sense in BLR as in linear regression. Gujarati and Porter (2009) explain that goodness of fit of the model is not very important in BLR, whereas the signs of estimated coefficient and their practical and statistical significance matter a lot.

4. Results and Discussion

Table 4 explains the classification of poverty status of comparison households as well as program household by duration of microfinance. The table shows that program households of Khushhali Microfinance Bank Limited divest from poverty as duration of microfinance increases. As per depiction, without participating in the microfinance program, 42.67% comparison households are poor. However, after participating in micro financing activities, the poverty status of the program household is declining along with increasing duration of microfinance, while on the other hand, the non-poor percentage of borrower households is also increasing. In membership duration of 12–24 months, the poverty status of the program household has declined to 37.33 percent and non-poor percentage has increased to 62.72 percent. Similarly, the poverty status of the program household is declining with an expanding period of membership in the microfinance program. Finally, in a membership period of above 60 months, just 15 percent of program households are poor, which indicates that almost 28 percent less poor are in program households as compared to the comparison household.

Table 4. Poverty status of the household.

Variable	Percentage of Poor	Percentage of Non-Poor
Comparison Household	42.67	57.35
Program Household		
12–24 (months)	37.33	62.72
25–36 (months)	33.91	66.17
37–48 (months)	28.84	71.21
49–60 (months)	26.97	73.19
Above 60 months	15	85

Source: Author's own calculations.

Overall, poverty rate has declined from 42.67 percent in CHH to 29.33 percent in PHH. This difference between poverty status of the comparison household and program household reveals that microfinance significantly eradicates poverty of borrower households. So, this reduction in poverty status shows the effectiveness, viability, as well as significance of a microfinance program initiated by KMBL in the area of district Sargodha.

Figure 1 supports the result we have established in the above table. The graph shows that as the duration of micro financing is increasing, the number of poor households is decreasing, while the number of non-poor households is increasing. The graph reveals the fact that provision of microfinance leads to a reduction in poverty. Thus, microfinance has an effective contribution in poverty alleviation in the district of Sargodha.

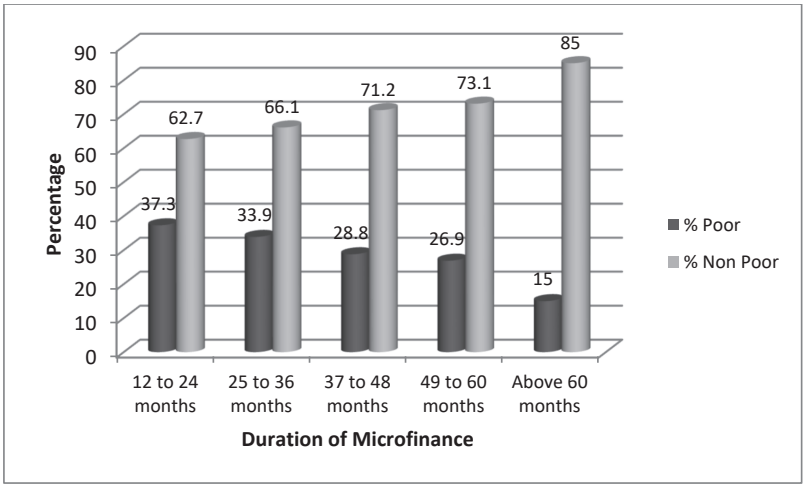

Figure 1. Poverty status of the household. Source: Author's own calculations.

Table 5 shows the distribution of the respondents by their gender. As per the table, 70.74 percent were males and just 29.326 percent were females. Whereas, in program households, the share of females in beneficiaries of micro financing has increased to 34.63 percent and male's share has squeezed to 65.37 percent.

Table 5. Gender of the respondent (Percentage).

Gender	Comparison Household	Program Household
Male	70.74	65.37
Female	29.26	34.63

Source: Author's own calculations.

Table 6 reveals the distribution of borrowers' household by duration of microfinance. The depiction reveals mostly borrowers, i.e., 36 percent of the total borrowers are in between the period 12–24 months. Twenty percent of borrowers are in 25–36 months. Just eight percent of the total borrowers took a five year loan. The last category depicts that 19.30 percent of borrowers got a loan above six years.

Table 6. Duration of microfinance of the borrower (percentage).

Period (Month)	Percentage
12–24	36
25–36	20
37–48	16.70
49–60	8
Above 60	19.30

Source: Author's own calculations.

Figure 2 classifies the borrowers by their duration of microfinance. According to the figure, 36 percent of borrowers are availing their two years loan. Twenty percent and 16.70 percent borrowers are in 25–36 months and 37–48 months, respectively. Just eight percent are taking a five year loan and 19.30 percent of total borrowers are above 60 months.

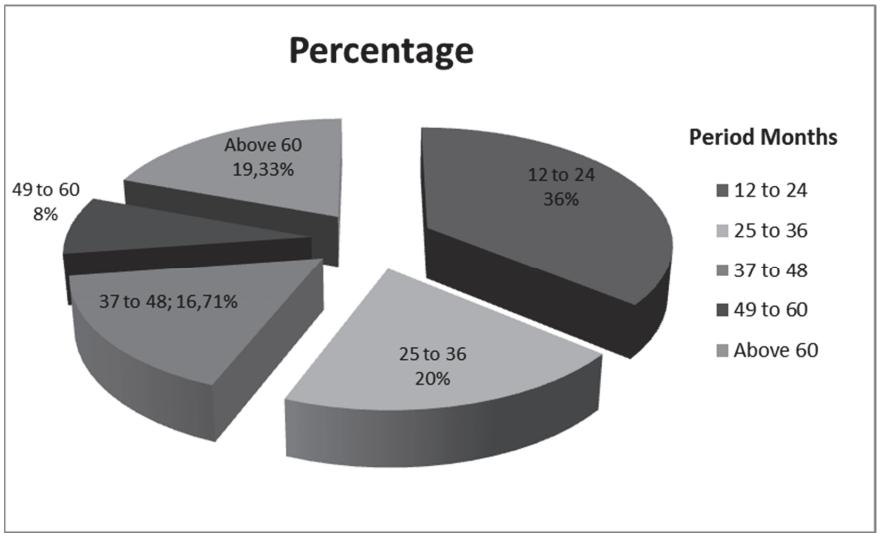

Figure 2. Duration of microfinance of the borrower (percentage). Source: Author's own calculations.

Table 7 depicts the response of the borrowers to three different variables (reasonable interest rate (RIRI), loan helped in changing their economic condition (LHCEC) and wish for another loan (WFAL)). The findings reveal that a big percentage of the respondents, i.e., 71.30%, are not satisfied with the rate of interest charged by KMBL. Higher cost of borrowing impedes the borrower from using the fund in the most effective way. The high rates of interest, surge cost of borrowing, complicate the repayment schedule and their inefficiency to manage or inability to utilize the amount of loan are major reasons of default. The fruit of microfinance are highly sensitive to the interest rate. It has a vital role in determining the effectiveness of microfinance in poverty reduction. The poor are taking micro loans and investing them in small enterprises. Their small businesses are already operating at an inefficient level and when a high rate of interest is charged, it becomes very difficult for the borrowers to ripen the fruit of microfinance in an appropriate way. Ninety-five percent of the borrowers replied that microfinance has played a key role in uplifting their economic status. According to results, 90 percent of the borrowers want to take another loan.

Table 7. Response of the client (RIR, LHCEC, WFAL).

Variable	Percentage
RIR	
Yes	28.7
No	71.3
LHCEC	
Yes	95
No	5
WFAL	
Yes	90
No	10

Source: Author's own calculations.

Table 8 shows the distribution of different sectors according to their share in total loan invested. The results reveal that almost half of the loans (48.70%) are being invested in the livestock sector. Fourteen percent (14%), 9.30 percent, 18 percent and 10 percent are being invested in trading, manufacturing, services and other sectors, respectively. Thus, a major share of the total loans is going to the live stock sector, which reveals that most borrowers are attached with the agricultural sector.

Table 8. Loan invested in the sector.

Variable	Percentage
Trading	14
Manufacturing	9.30
Services	18
Live Stock	48.70
Others	10

Source: Author's own calculations.

Figure 3 explains the fact that most of the loans are being allocated for livestock purposes. Just 9.3 percent is invested in the manufacturing sector. So, most of the borrowers want to invest in the livestock sector instead of other sectors like trading, manufacturing and services.

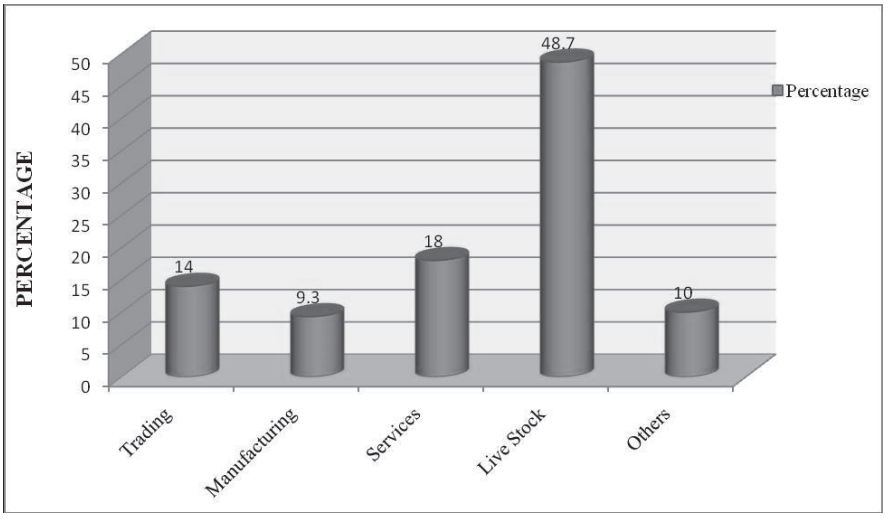

Figure 3. Loan invested in the sector. Source: Author's own calculations.

Table 9 explains the characteristics of loan amounts taken by the borrowers of Khushhali Bank Limited. The minimum amount of loan is 20,000 PKR whereas 147,000 PKR is the maximum amount taken by the borrowers. The mean of the loan extended by KMBL to its clients is 37,083.40 PKR.

Table 9. Loan Amount (amounts in PKR).

Variable	Minimum	Maximum	Mean
Loan Amount	20,000	147,000	37,083.40

Source: Author's own calculations.

4.1. Econometric Analysis

The impact of microfinance on poverty eradication is investigated using binary logistic regression on model one. In this model, poverty is the dependent variable whereas family size, existence of school in the locality and duration of microfinance are independent variables.

The below table (Table 10) presents the estimated parameters (log odds) of the binary logistic regression. The interpretation of the estimated coefficient in logistic regression is very similar to the linear regression. It shows the change in the logit (log odds) of the outcome variable due to one unit change in the predictor. The logit of the outcome variable is obtained by simply taking the natural log of the odds of (Y) occurring. The standard errors of these estimated coefficients have been given in

the column labeled (S.E). *p*-value of the corresponding parameters is given in the column labeled as *p*-value in the table.

Table 10. Estimates of binary logistic regression.

Variable	Coefficient	S.E	*p*-Value	Odds Ratio
FSZ	0.31	0.10	0.002 *	1.37
ESHL	−1.67	0.48	0.000 *	0.19
DOMF	−0.41	0.15	0.008 *	0.66
CONSTANT	−0.61	0.80	0.450	0.54

Note. −2 LL = 150.454, Cox and Snell R Square = 0.18, Chi-Square = 31.079, Probability = 0.000. * (1% level).

One of the most important advantages of binary logistic regression is that its coefficients (log odds) can be interpreted in terms of odds ratios. It is very difficult to interpret the coefficient (log odds) of BLR. Therefore, they are exponentiated to convert into odds ratios, as depicted in the column odds ratio, and can be interpreted as change in probability or odds of outcome variable due to one unit change in predictor. If the value of odds ratio exceeds 1, then the probability of an outcome occurring increases along with an increase in the predictor, and if the value of odds ratio is less than 1, then the probability of an outcome occurring decreases along with an increase in the predictor. In the regression, a 95% confidence interval is taken and it is calculated for the odd ratios for the significant risk factors.

The empirical outcomes of the study reveal that the sign of family size is positive and its *p*-value is (0.003), which means it is highly significant at 1% level. The odds ratio is higher than 1, implying that if family size increases by one unit, the odds of being poor will also rise by 1.37 times. This finding is the same as (Asghar 2012; Waheed 2009).

The existence of a school in the locality has a negative and significant impact on poverty. The value of the odds ratio is less than 1, meaning that if a locality has a school, the probability of being poor among the residents of that area would be less as compared to the locality that does not have a school. This finding indicates that when people have access to education, their likelihood of being poor decreases because with the help of education they can unleash their potential and earn their livelihood easily. So, the results are consistent with (Omoniyi 2013; Pervez 2014).

The table shows that there is a negative association between provision of microfinance and poverty. The Duration of Microfinance (DOMF) has a negative sign and its *p*-value is (0.008), which indicates that it is statistically significant at the 1% level. The results show that as the duration of microfinance increases, the poverty level of the borrower households decreases. The value of odds ratio is also less than 1, implying that as the membership period of microfinance increases, the odds of being poor decreases.

In the research literature, it is concluded that microfinance assists the poor in coming out of poverty by providing them a wide series of financial products. The poor people can unleash their potential with the help of micro financing and can get rid of poverty. The outcomes of the current study are also consistent with the other studies like (Ahmad et al. 2004; Ayuub 2013; Jegede et al. 2011; Chaudhry 2009; Fareed et al. 2004; Ghalib et al. 2015).

According to Menard (1995), overall robustness of the model is tested through likelihood ratio statistics, which is based on chi square. In the present study, the value of chi square is 31.079 and its *p*-value is (0.000). It shows that the model is a good fit and predictors have a statistically significant impact on the outcome variable. The Cox and Snell R Square works as a pseudo R^2, which shows how much variability, can be explained by the model. Furthermore, R^2 does not represent the same sense in BLR as in linear regression. Gujarati and Porter (2009) explain that goodness of fit of the model is not very important in BLR, whereas the signs of the estimated coefficient and their practical and statistical significance matter a lot.

4.2. Limitations of the Research

This empirical study has two limitations. Firstly, the scope of the investigation was only Pakistan. Therefore, in terms of external validity in generalizing the behavior for all countries is still questionable. Secondly, the findings of this study depend largely on the respondent's honesty and integrity. However, if the respondent's answers were biased towards more socially desirable answers, the findings will also indicate bias.

5. Conclusions and Policy Recommendations

The current study investigates the role of micro financing in poverty elimination. Perhaps no one would argue against the notion that microfinance can be a very useful apparatus in human, social, economic, political and national development. Primary data of the clients of KMBL operating in district Sargodha have been analyzed by deploying both descriptive as well as econometric techniques (BLR). On the basis of empirical evaluation, it is very easy to determine that microfinance has a vital and noteworthy contribution to the lessening of poverty.

According to the descriptive statistics, it is more than obvious that program households of Khushhali Microfinance Bank Limited divest from poverty as duration of microfinance increases. Without participating in the microfinance program, 42.67% comparison households are poor. However, after participating in micro financing activities, the poverty status of program households declines along with an increase in the duration of microfinance, while on the other hand, the non-poor percentage of borrower households also increases. So, this reduction in poverty status shows the effectiveness, viability, as well as significance of the microfinance program initiated by KMBL in the area of district Sargodha. As the duration of micro financing increases, the number of poor households decreases, while the number of non-poor households increases. Thus, microfinance has an effective contribution to poverty alleviation in district Sargodha.

One other important finding is that a large number of respondents, i.e., 71.30%, are not satisfied with the rate of interest charged by KMBL. Higher cost of borrowing impedes borrowers from using the fund in the most effective way. The high rates of interest, surge cost of borrowing, complicate the repayment schedule and their inefficiency to manage or inability to utilize the amount of loan are major reasons of default. The fruits of microfinance are highly sensitive to the interest rates. We can say that it has a vital role in determining the effectiveness of microfinance in poverty reduction. The poor are taking micro loans and investing them in small enterprises. Their small businesses are already operating at an inefficient level and when a high rate of interest is charged, it becomes very difficult for the borrowers to ripen the fruit of microfinance in an appropriate way.

The study unveils the fact that there is a negative association between provision of microfinance and poverty level of the household. With the availability of micro financing facilities to the poor, the poverty rate has come down from 42.67 percent to 29.33 percent. Hence, almost 14 percent of the borrower households have got rid of poverty by availing micro financing.

Also, our outcomes reveal that the sign of family size is positive, the odds ratio is higher than 1, implying that if family size increases by one unit, the odds of being poor will also rise by 1.37 times. This finding is the same as Asghar (2012) and Waheed (2009). Moreover, the existence of schools in the locality has a negative and significant impact on poverty. The value of odds ratio is less than 1, meaning that if a locality has a school, the probability of being poor among the residents of that area would be less as compared to a locality that does not have a school. This finding indicates that when people have access to education, their likelihood of being poor decreases because with the help of education they can unleash their potential and earn their livelihood easily. Our results are consistent with Omoniyi (2013) and Pervez (2014). Also, we have similar results with the studies conducted by Simanowitz (2003), Weiss et al. (2003) and Chaudhry (2009). In the research literature, it is concluded that microfinance assists the poor in coming out of poverty by providing them a wide series of financial products. The poor people can unleash their potential with the help of micro financing and can get rid of poverty. The outcomes of the current study are also consistent with the other studies like

Ahmad et al. (2004), Ayuub (2013), Jegede et al. (2011), Chaudhry (2009), Fareed et al. (2004) and Ghalib et al. (2015).

Although the microfinance program has played a key role to combat poverty in the district of Sargodha, this scheme is not a silver bullet that can be a panacea for the impoverished people, because poverty is a multidimensional and very complex phenomenon. The relationship between microfinance and poverty is not so simple, which is why microfinance should be used very consciously. Microfinance is not a miracle solution. It is not for everyone and is not solely responsible for poverty alleviation. Microfinance must also be coupled with other social programs that are flexible to meet the diverse needs of destitute families. The effectiveness of microfinance can be enhanced by simultaneously taking some other steps. Therefore, along with the provision of microfinance services to the poor people, subsequent policy measures are suggested for policy makers and Khushhali Microfinance Bank Limited to use microfinance as a valuable tool in poverty reduction. There is a need to minimize the interest rate and the cost of borrowing must be reduced to a minimum. Special attention should be given to educating the borrowers to utilize loans in a better way.

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Financial Inclusion and Firms Growth in Manufacturing Sector: A Threshold Regression Analysis in Selected Asean Countries

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Abstract: This paper examines the effect of financial inclusion on the firm growth of the manufacturing sector (513 firms) in selected ASEAN countries (Malaysia, Philippines, and Vietnam) using a cross-section threshold estimation technique. The levels of financial inclusion across firms were measured based on the distribution of financial services (access to credit). The main findings revealed that there is a non-monotonic effect of financial inclusion on the firm's growth. These findings show that the impact of financial inclusion on firm growth in the manufacturing sector is significantly positive below a threshold point, and turns to significantly negative after a certain threshold point has been reached. These new findings suggest that manufacturing firm owners and banking institutions should deepen their financial inclusion efforts, and limit the distribution of credit access within the optimum value or threshold level in promoting the growth of the firm.

Keywords: financial inclusion; firm growth; threshold estimation

JEL Classification: O4; O47; C31; C18; C50

1. Introduction

Financial inclusion is an essential issue in development finance and is one of the dimensions of the quality of financial development. Financial inclusion entails the effective use of formal financial services by economic agents, including individuals and firms. In the case of this study, our focus is on firms, in which the financial inclusion measures by firms have a line of credit from a financial institution. Credit distribution across firms at the sector level has an essential influence on industrial structure, competition or unfairness in the sector, particularly in low-income countries (Beck et al. 2005). Access to credit reduces liquidity constraints, increases investment, and exerts a further impact on the industry structure and size of firms. For instance, credit obtained through financial institution loans is used to improve the flow of capital invested for the development and maintenance of fixed assets of a firm, such as property, building, factory, equipment and technology.

The study relating to the impact of financial inclusion on firm growth in Malaysia, Philippines and Vietnam is motivated by the report by the World Bank Enterprise Survey (WBES) in 2017. The report shows that these three countries hold the highest access to credit compared to firms in other countries globally, particularly those in the East Asian and Pacific regions. Access to credit, however, has been identified as one of the main obstacles to the development of the private sector in developing countries (Chauvet and Jacolin 2017). The growth of the East Asian economies and countries is traced to the benevolence of the financial institutions in this region granting credit to the private sector (Beck et al. 2012; Tchamyou and Asongu 2016). However, high access to credit does not necessarily

guarantee the high sales growth of the firms. Therefore, this study will look into the threshold level of financial inclusion (access to credit) concerning firm manufacturing growth. To what extent the level of financial inclusion impacts a manufacturing firm's growth is one of the empirical questions we need to investigate further.

Manufacturing firms are of interest in this study because the WBES survey generally collects the data for this category of firms. Besides, manufacturing firms are involved in the real sector, and their performance will likely have a sporadic impact on the industrialization process of countries (Efobi et al. 2016). Therefore, micro-enterprises, informal enterprises, and those in the service sector like hotel services, transport services and Information and Communication Technology (ICT) provision are omitted from the analysis, as suggested by Clarke (2012).

Furthermore, there are no econometric studies that have analyzed the non-monotonic impact of financial inclusion on firm performance, with particular attention to the manufacturing firms in these countries. The empirical approach has used a cross-sectional data analysis rather than the traditional panel data approach due to the data availability of WBES (cross-section survey data). Thus, it is not possible to proceed with a panel data technique due to there being no yearly time frequency for the survey, and the firms differed across the survey period.

This paper contributes to the literature on the financial inclusion–growth nexus, and also to policymaking, in the following ways. First, the study extends the existing research by providing the non-monotonic relationship between financial inclusion and firm manufacturing growth. By providing new evidence on the impact of financial inclusion (FI) on a manufacturing firm's growth, this study will elucidate whether there exist threshold levels of financial inclusion in the firm's growth nexus. Thus, the threshold analysis has been used in obtaining the optimal level of financial inclusion that fosters a favorable effect on the firm's growth. Past literature, such as that by Chauvet and Jacolin (2017), has shown the linear relationship of financial inclusion and firm growth, whereas this study will extend the current literature by further investigating the issue of the nonlinearity relationship between financial inclusion and firm growth.

Second, this study contributes to the policy-making of manufacturing firms and financial institutions. The relationship between financial inclusion and the firm's growth may be contingent, whereby financial inclusion has a different effect on a firm's growth following its access to credit if it exceeds a certain threshold level. By knowing the contingent effect and appropriate financial inclusion threshold level, the firm owner and financial institutions will be able to limit the credit surplus to within the optimum level provided. Therefore, if there is clear evidence that a negative effect exists after a certain point of threshold level has been attained, then it provides new important policy implications, where the firm owner and financial institutions should devise an effective strategy and limit the distribution of credit access in fostering the firm's growth.

This paper is structured as follows. Section 2 provides a discussion on the literature review concerning financial inclusion as related to the firm's growth. Section 3 describes the data, the empirical model, and the econometric method. Section 4 discusses the empirical findings of the study. Finally, Section 5 provides a summary and conclusions.

2. Literature Review

Financial inclusion plays a positive role in improving the growth of a firm. Previous empirical studies have used financial development or financial deepening as a proxy in demonstrating its relationship with the growth. Studies on the impact of financial institution development on firms have concluded that there is a positive relationship. These studies are largely concentrated on understanding how financial institution development enhances a firm's ability to mobilize investment funds and reduce labor costs (Fafchamps and Schündeln 2013), innovation through the improvement of firms' productivity (Dabla-Norris et al. 2010), firms' sales and asset growth, as well as firms' sizes (Beck et al. 2004; Giannetti and Ongena 2009; Bas and Berthou 2012).

Empirically, financial inclusions, which indicate the quality of financial development, are more significant in contributing to the firm's growth. Financial inclusion is universal access to financial products and services. A firm's access to some financial services may be of importance to its capital structure (Efobi et al. 2016). Credits channeled by financial institutions will increase the firm's capital, which will subsequently affect its growth. This condition will attract investors to increase the distribution of their credit funds, and will directly attract firms to access financial products such as loans, to boost the firm's growth. However, credit-funded investments do not generate significant net profit, but create assets through permanent investments from customers (Nwankwo and Ogonna 2014). According to Garg and Agarwal (2014), easy access to an efficient financial system by creating equal opportunities enables economists to contribute to the development and to protect themselves from the impact of economic shock.

International organizations (IMF Financial Access Survey and Findex Database) regularly survey access to credit as a measure of financial inclusion. During a global financial crisis, total deposits fall in an economy where financial inclusiveness is higher in terms of bank deposits, particularly for middle-income countries (Han and Melecky 2013). Such an outcome is advantageous to the government and private sector efforts in terms of boosting business in the financial sector through increasing access and the effective use of financial services to increase efficiency. In addition, a structural framework by Dabla-Norris et al. (2015) also showed that financial inclusion drives Gross Domestic Product (GDP) growth through access to credit, credit depth, as well as credit mediation efficiency among firms, in six countries studied (Malaysia, Kenya, Uganda, Philippines, Mozambique and Egypt).

A recent study by Chauvet and Jacolin (2017) on 55,596 firms in 79 developing and emerging countries showed that the distribution of financial services among firms had a positive impact on their growth. However, the study also took into account banking concentration, including suboptimal banking market conditions, in elucidating the effect of financial inclusion on a firm's growth. In their research, banks are more inclined to invest in information acquisition in a more concentrated market; however, in a highly comprehensive financial system, bank concentration harms the firm's performance. The findings show that bank concentration has a positive effect on firm growth for levels of financial inclusion lower than 85% of firms with a bank loan. Only 1093 firms out of the 55,596 belong to a sector with such a high level of financial inclusion. This positive effect of bank concentration (for levels of financial inclusion lower than 85%) may appear counter-intuitive at first sight, since bank competition has various efficiency effects on credit markets where there is lower prices, better financial infrastructure and more financial inclusion.

In the past literature, credit distribution across firms at the sector level has also been shown to have an essential influence on industrial structure, competition and unemployment (Beck et al. 2005). However, credit access among firms needs to be controlled, as the impact of this excess credit may not significantly affect firm growth to some extent. The previous study by Huong Giang et al. (2019) and Fowowe (2017) argued that financial access has a positive effect (monotonic relationship) on firm growth. There is a possibility of financing unprofitable investment activities if access to finance is not controlled, whereby high economic freedom could affect firm growth. A high level of economic independence will cause business activities to be exposed to high risk and inefficiencies in business operations, and thus could affect firm growth.

Another study by Ina Ibor et al. (2017) in Nigeria concluded that there was a significant relationship between financial inclusion and the growth of large-scale SME firms, in which inclusive financial policies exerted a significant and positive impact on the operations of micro, small and medium enterprises. Some researchers have identified financial inclusion (for example, Beck et al. (2009)) as one of the solutions to the development of firms. In Koomson and Ibrahim (2017) showed that a non-farm firm's growth was boosted by 43% due to an increase in financial inclusion among entrepreneurs. Meanwhile, in India, Bas and Berthou (2012) noted that improved financial inclusion in terms of making credit accessible to firms would enhance firms' growth.

Despite these important benefits and linear relationships of the financial access to firms' growth and productivity, some evidence suggests that the development of the financial sector may not necessarily lead to a positive growth outcome for firms (Asongu 2015). For instance, Arellano et al. (2008) observed that in less financially developed economies, small firms grow faster than large firms. Castelli et al. (2009) show evidence that Italian firms' performances decrease as the number of bank relationships increases, while Yazdanfar and Öhman (2015) concluded that firms relying on bank credit and debt are less profitable than their counterparts that do not rely on these credit facilities.

Furthermore, Thanh and Ha (2013) also found that Vietnamese firms which rely on a short-term credit financing relationship with banks are worse off, although the opposite direction has been seen for firms that depend on long term credit. Most of these contrary relationships have generally been theorized as caused by financial market imperfections, inadequate information, heightened transactions and contract enforcement costs, which are particularly prevalent in developing countries (Bigsten et al. 2000; Beck et al. 2004; Francis 2016; Tchamyou and Asongu 2016; Asongu et al. 2016). In these countries, businesses that lack collaterals, credit histories and interpersonal relationships with the bank could face the challenges of the impeded flow of capital, and even when they have access to this finance, the cost may outweigh any future benefit from it. To shed light on this emphasis, a growing financial inclusion (access to credit) may not necessarily reflect positive growth externalities for firms.

Therefore, this study was motivated to evaluate the extent to which the level of a firm's access to credit (financial inclusion) affects its growth. In the case of a manufacturing firm, the studies that relate to financial inclusion–growth are still limited in the literature. Most of the previous empirical studies (Zulfiqar et al. 2016; Dixit and Ghosh 2013) have entirely focused on individual or household access to financial services and the linearity effect of financial inclusion, which is an essential area of study. However, this study takes a different direction by considering manufacturing firms' access to financial services, determining the non-monotonic effect between the firm's access to credit and firm growth.

Given this backdrop, this study fills the gaps in the existing literature in three ways. First, it aims to examine the non-monotonic effect of financial inclusions on the growth of the manufacturing firms in Malaysia, the Philippines and Vietnam. Second, the study focuses on the current period wherein the data is based on the latest completed survey by WBES in 2015. Lastly, the study provides new evidence on the non-monotonic relationship of financial inclusion and the firm's growth. The past literature has identified monotonic relationships between financial inclusion and firm growth, whereas this paper extends the study to the non-monotonic effect of the financial inclusion–firm growth nexus.

3. Methodology and Data

3.1. Data Description

This study utilized cross-section firm-level data from Malaysia, Philippines and Vietnam (as listed in Table A1) in the Appendix A. The selection of firms was primarily dictated by the availability and reliability of the most current data (2015) obtained from the World Bank Enterprise Survey (2017). The dependent variables used in this study were the real annual average growth rate of sales over three years for each available survey, $GROWTH_{i,k,j,t-3}$, as a proxy variable for the firm's growth. Meanwhile, the independent variable (threshold variable) included financial inclusion as measured by the value of the most recent loans from a financial institution, $LOAN_{i,k,j}$, as a firm's access to credit. The values of credit are initially recorded in the local currency unit (Ringgit (MYR), Peso (PHP) and Dong (VND)), but were converted to USD (USD) using the prevailing exchange rate as at the period of the survey (2015). We deemed this step as reasonable in order to enhance the comparability of the findings from our study.

Table 1 summarized the variables in modeling the determinants of manufacturing firm-growth. For explanatory variables, firm's characteristics have been considered in modeling the determinants of firm growth, as suggested by Chauvet and Jacolin (2017). These variables are as follows: (i) Credit

access, the logarithm of recent loans from financial institutions (converted into USD), (ii) Initial sale, the logarithm of lagged sales ($SALES_{i,k,j,t-3}$) with the sales in the three previous years, deflated and converted into USD for catching-up effects; (iii) kind of ownership, including either owned by the state $\left(STATE_{i,k,j}\right)$ or being a foreign entity ($FOREIGN_{i,k,j}$); (iv) Dummy variable of $EXPORT_{i,k,j}$, which would be equal to one (1) if the firm exported part of its production either directly or indirectly; (v) Size of the firm ($SIZE_{i,k,j}$), which was categorized into three values; one (1) for small firms with less than 20 employees, two (2) when employees were between 20 and 100, and three (3) for firms with more than 100 employees.

Table 1. Measurements of Variables.

Variables	Acronyms/Proxies for Model Estimation	Definition and Explanation
Firm Growth	*GROWTH*	Sales growth of the firm is between the completed fiscal year and the previous three years. All sales were (deflated) to 2009 using the GDP deflator of each country.
Credit Access	*LOAN*	Credit access is the logarithm of recent loans from financial institutions (converted into USD).
Initial Sales	*SALES*	Initial sales are the logarithm of lagged sales; three years' prior sales (deflated and converted into USD).
State Ownership	*STATE*	State ownership is defined as when part or all of the firm was owned by the state (%).
Foreign Ownership	*FOREIGN*	Foreign ownership is defined as when part or all of the firm was owned by a foreign entity (%).
Direct/Indirect Export	*EXPORT*	Dummy variable, which was equal to one (1) when the firm exports part of its production either directly or indirectly (as a supplier of an exporting firm), while it was equal to zero (0) when there was no direct or indirect export transaction.
Size of firm	*SIZE*	Size refers to the category of variables that comprised three values: one (1) when the firm was small (less than 20 employees), two (2) when it employed between 20 and 100 employees, and three (3) when employees exceeded 100.

3.2. Model Specification and Empirical Strategy

The empirical models based on Rajan and Zingales (1998), Chauvet and Jacolin (2017), and Nizam et al. (2020) were employed to explore the role of financial inclusion in the firm's growth. The econometric model took on the following form:

$$GROWTH_{i,k,j(t,t-3)} = \beta_0 + \beta_1 FI_{i,k,j} + \beta_2 X_{i,k,j} + \varepsilon_i \quad (1)$$

$GROWTH_{i,k,j(t,t-3)}$ = sales growth for firm i in industry k, country j. The average growth rates have been computed over three years, between t and $t-3$.

$FI_{i,k,j}$ = Financial inclusion as measured by the firm's access to credit.

$X_{i,k,j}$ = vector of control variables that affect the sales growth for the firm, set of time-varying firm-level characteristics including the initial values of sales, ownership of the firm, the firm's export, and the size of the firm.

ε_i = error term.

There are two threshold effect hypotheses of nonlinearity in this study, namely:

$$H_0\colon\ \beta_1 = \beta_2$$

$$H_1\colon\ \beta_1 \neq \beta_2$$

where β_s are vectors of the parameter. The null hypothesis is linear regression, and the alternative hypothesis is nonlinear regression. If the null hypothesis is rejected, then we have a two-regime, nonlinear threshold regression. The following Equation (2) is particularly well suited to testing the hypothesis outlined, and to capturing the presence of contingency effects between financial inclusion and firm growth. The model based on threshold regression takes the following form:

$$Growth_i = \left\{ \begin{array}{l} \beta_0^1 + \beta_1^1 FI_i + \beta_2^1 X_i + e_i\,, \ FI_i \leq \gamma \\ \beta_0^2 + \beta_1^2 IFI_i + \beta_2^2 X_i + e_i\,, \ FI_i > \gamma \end{array} \right\} \tag{2}$$

where FI_i (firm's access to credit) is the threshold variable used to split the sample into regimes or groups, and γ is the unknown threshold parameter. This type of modeling strategy allows the role of financial inclusion to differ depending on whether the firms are below or above some unknown level of γ. In this equation, the firm's access to credit acts as a sample-splitting or threshold variable. The impact of financial inclusion on the firm's growth is designated β_1^1 and β_1^2 for firms with a low or high regime, respectively. On the other hand, under the hypothesis $\beta_1 = \beta_2$, the model becomes linear and reduces to (1). Equation (2) can be re-written in a general form as:

$$y_i = \beta_1' x_i I(q_i < \gamma) + \beta_2' x_i I(q_i \geq \gamma) + e_i = \beta_1' x_i(\gamma) + e_i \tag{3}$$

where $I(.)$ is an indicator function,

$$\beta = \left(\beta_1', \beta_2'\right) \text{ and } x_i(\gamma) = \left[\begin{array}{c} x_i I(q_i < \gamma) \\ x_i I(q_i \geq \gamma) \end{array} \right] \tag{4}$$

3.3. Cross-Section Threshold Regression

The first step in the estimation was to test the null hypothesis of linearity, $H_0: \beta_1 = \beta_2$, against the threshold model in Equation (2). If the null hypothesis is rejected, then statistically, there is evidence of a threshold level of regression with two regimes, and the model is nonlinear. When there exists a threshold value, the sample is estimated to be $FI_i \leq \gamma$ in reference to the first regime and $FI_i > \gamma$ in reference to the second regime. The first regime is when the threshold level variable exceeds the threshold value. Statistically, both regimes give different decisions in terms of estimation.

This study adopted Hansen (1996, 2000) suggestion of using a heteroscedasticity-consistent Lagrange Multiplier (LM) bootstrap procedure to test the null hypothesis of a linear formulation against a threshold regression alternative. Since the threshold parameter γ was not identified under the null hypothesis of the no-threshold effect, the p values have been computed by a fixed bootstrap method. Hansen (2000) showed that this procedure yields asymptotically correct p values. If the hypothesis of $\beta_1 = \beta_2$ is rejected and a threshold level identified, then we test the threshold regression model against a linear specification after dividing the original sample according to the threshold level that is identified. This procedure was carried out repeatedly until the null of $\beta_1 = \beta_2$ could no longer be rejected.

4. Results and Discussion

The impact of financial inclusion on the manufacturing firm's growth in Malaysia, Philippines and Vietnam is estimated using Equation (2). As mentioned previously, we employed a splitting sample threshold method from Hansen (1996, 2000) to investigate the threshold effect of financial inclusion as measured by the firm's access to credit.

The descriptive statistics of the main variables of interest have been presented in Table 2, which contains the mean and standard deviations as well as a brief description. From the table, the average growth of the sampled firms is about 4.55%. Concerning the measures of financial inclusion, the statistics show that 11.99% have access to a line of credit or loan.

Table 2. Statistic of firms in ASEAN-5 before Outliers.

Variables	Measurement	Mean	SD	Min.	Max
$GROWTH_{i,k,j(t,t-3)}$	% sales growth	4.550	18.137	−60.925	66.585
$LOAN_{i,k,j}$	Logarithm (USD)	11.994	2.506	2.659	29.191
$SALES_{i,k,j,t-3}$	Logarithm (USD)	8.977	1.986	1.836	15.140
$STATE_{i,k,j}$	% Ownership	1.865	9.478	0	80
$FOREIGN_{i,k,j}$	% Ownership	6.540	22.659	0	100
$EXPORT_{i,k,j}$	Dummy	0.407	0.492	0	1
$SIZE_{i,k,j}$	Category	2.057	0.744	1	3

Note: Number of observation (N): 513 firms in the sample.

Based on the test of the null hypothesis of no threshold against the alternative hypothesis of a threshold allowing heteroskedastic errors (White corrected), Table 3 showed that the *p*-value of the hypothesis of no threshold effects, as computed by the bootstrap method with 5000 replications and 15% trimming, was rejected at a highly significant level. These findings clearly indicate that the relationship between the firm's growth and financial inclusion is non-monotonic, and therefore the imposition of an a priori monotonic restriction on the relationship could also be ambiguous. The finding provides a better explanation for a dynamic relationship between financial inclusion and firm growth, where the former could effectively contribute to the growth of the firm at a certain level of threshold or at any of its interaction terms. We also tested further whether the group with high access to credit could be split further into sub-regimes. The bootstrap *p*-values were significant for the second sample split, which suggests that a double threshold is adequate for this model. However, we presented the empirical results for the first sample split in Table 4, while the results estimated for the second split are available upon request. The findings revealed several interesting observations.

Table 3. Threshold estimates of financial inclusion (Access to credit, $LOAN_{i,k,j}$).

	First Sample Split	Second Sample Split
LM test for no threshold	30.916	16.206
Bootstrap *p*-value	0.000 ***	0.036 ***
Threshold estimate	13.541	17.577
95% confidence interval	[12.785, 17.859]	[17.577, 17.859]

Notes: *** significant at 1%.

The result of the first sample split in Table 4 clearly showed the presence of the threshold level, which indicates that the sample can be split into two regimes depending on the level of access to credit in the firm.

The threshold model specifications in Table 4 show that above the threshold level ($LOAN_{i,k,j} > 13.541$), the coefficient of access to credit is significant and negatively affects firm growth. Therefore, above the threshold, a 13.541% (USD 760,000), with a confidence interval in between 12.785% (USD 357,000) and 17.859% (USD 57 million), access to credit will decrease the firm's growth. Access to credit thus has a significant negative effect on the firm's growth after a certain threshold level has been attained. In our sample, 112 firms display access to credit above the threshold. The estimated coefficient of access to credit significantly harms the firm's growth. Thus, a 1% increase in access to credit will decrease the firm growth by 2.540%. Only the estimated coefficients of initial sales were significant determinants of a firm's growth at the 1% level.

Table 4. First sample split: regression results using financial inclusion (FI-Loan) as a threshold variable. Dependent variable: firm growth (sales growth).

Variable	Linear Model OLS without Threshold	Regime 1 $LOAN_{i,k,j} \leq 13.541$	Regime 2 $LOAN_{i,k,j} > 13.541$
Constant/Intercept	19.198 ***	15.373 ***	65.846 ***
	(4.951)	(6.295)	(16.362)
$LOAN_{i,k,j}$	1.213 **	2.786 ***	−2.540 ***
	(0.619)	(0.645)	(0.699)
$SALES_{i,k,j,t-3}$	−4.625 ***	−6.461 ***	−2.385 ***
	(0.640)	(0.659)	(0.859)
$STATE_{i,k,j}$	0.072	−0.149 *	0.125
	(0.077)	(0.078)	(0.084)
$FOREIGN_{i,k,j}$	−0.026	−0.015	−0.046
	(0.028)	(0.035)	(0.035)
$EXPORT_{i,k,j}$	−3.121 *	−4.669 ***	3.503
	(1.609)	(1.803)	(2.711)
$SIZE_{i,k,j}$	6.626 ***	7.459 ***	1.262
	(1.276)	(1.410)	(2.559)
R-square	0.134	0.231	0.236
Heteroscedasticity test (*p*-value)	0.396	-	-
No. of Observation	513	401	112
Sum of squared residuals	145,910.210	108,572.661	20,739.677

Notes: Number in parentheses are standard errors. ***, ** and * denote significance at 1%, 5% and 10% levels, respectively.

On the other hand, below the threshold level ($LOAN_{i,k,j} \leq 13.541$), with confidence interval [12.785, 17.859], the coefficient is significant and positive in influencing the firm's growth. As such, the growth has been shown to be positively correlated with its access to credit, $LOAN_{i,k,j,}$, where a 1% increase in access to credit will increase firm growth by 2.786%. All the estimated coefficients were significant determinants of a firm's growth, except in the case of foreign ownership, where it is an insignificant determinant irrespective of the level of inclusion threshold. Similarly, the size of the firm was positively associated with the firm's growth regardless of the threshold level. Larger firms with high credit access thus experience better performance, while the value of initial sales in the previous three years, $t-3$, showed a negative effect on the firm's growth irrespective of the threshold level. Firms that showed a low level of sales in $t-3$ displayed better growth or performance. This thus shows that initial sales are significant in influencing growth in both the regimes of the models.

Figure 1 displays a graph of the normalized likelihood ratio sequence, $LR_n^*(\gamma)$, as a function of the threshold output. The LS estimate of γ in Figure 1 is the value that minimizes the graph, which at its minimum occurs at $\hat{\gamma} = 13.541$. The 95% critical value (dotted line) shows the asymptotic 95% confidence interval from the graphs, where $LR_n^*(\gamma)$ crosses the dotted line. The results indicate reasonable evidence for a two-regime specification. Among the 513 firms with initial output above 13.541, a sample split based on the firm's access to credit is shown to be significant at the 1% level, with a *p*-value of 0.00. The findings suggest a possible threshold effect in the access to credit that further split these two subsamples. The results of the bootstrap test statistics were shown to be significant at the 1% level.

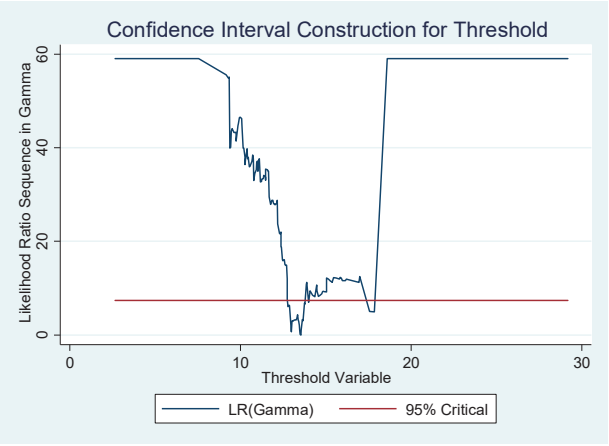

Figure 1. First sample split: confidence interval construction for threshold. Threshold variable: access to credit, $LOAN_{i,k,j}$.

5. Summary and Conclusions

This study provides new evidence of the nonlinearities associated with the impact of financial inclusion (access to credit) on the firm's growth (513 manufacturing firms sampled) in Malaysia, Philippines and Vietnam. The cross-section model based on the concept of the threshold effect proposed by Hansen (2000) was used to capture the relationship between financial inclusion and the firm's growth. The empirical results indicate that there is a significant financial inclusion threshold in the financial inclusion–firm's growth nexus. The threshold point tests the different effects of financial inclusion on firm growth with comparisons made between a low level of credit access and a high level of credit access.

The main empirical results of the cross-section threshold regression can be summarized in two conclusions: First, there is a threshold effect in the relationship between financial inclusion and the firm's growth, which was within expectations. Below this threshold level, financial inclusion should foster a significantly positive effect on a firm's growth. However, above the threshold level, the impact of financial inclusion was significantly negative. As such, an a priori monotonic restriction on the analysis of the financial inclusion–firm's growth nexus, as reported in the past literature, such as Chauvet and Jacolin (2017), could lead to a premature conclusion. However, this study presents a new finding on the non-monotonic relationship in the nexus. Second, we introduced new evidence whereby financial inclusion (access to credit) contributes to the negative effect of the firm's growth after a certain threshold level has been reached. Thus, the firm's owners and the financial institutions in these countries need to control the value of the credit access of the firms, since higher access to credit, above the threshold level of the confidence interval, will exert a negative effect on the firm's growth, particularly for those in the manufacturing sector.

These findings, therefore, underline the importance for firm owners and financial institutions to focus on the optimal value of the credit access of the firms, so as to ensure their higher performance. Financial inclusiveness exhibits a non-monotonic relationship with the firm's growth. The further expansion of access to credit above the threshold level would significantly decrease the firm's growth. The findings thus underline the importance of policymakers or banking institutions determining the level of access to credit among firms so as to ensure credit surplus above the threshold level will not confer adverse effects on their growth. Based on this study, the threshold value of credit access for the firms in the manufacturing sector is USD 760,000, with a confidence interval of USD 357,000 for firms with lower access to credit and USD 57 million for firms with high access to credit. A firm's owners and financial institutions in the developing economies must control the value of credit access, since

an access level higher than the threshold of the confidence interval will exert a negative effect on the firm's growth.

This study identified several possibilities for future research. Beyond access to credit, other relevant variables can be considered as proxies and measurements of financial inclusion in its analysis, like working capital with bank credit and overdraft facility. Different financial inclusion indicators may respond differently and react rigorously. Due to the limitation of available data in these countries, future research should consider using the index as a proxy of financial inclusion across firms, and a large panel dataset to capture the broader perspectives on the relationship between financial inclusion and firm growth. Other measures of firm growth as an explained variable could also include some accounting ratios (return on assets of the firm, or even investment ratios) to measure the performance of the firm.

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Appendix A

Table A1. List of countries and number of observations: manufacturing firms in Malaysia, Philippines and Vietnam.

Countries	Number of Firms (513 firms)
Malaysia	88
Philippines	139
Vietnam	286

Estimation Procedures:

The setup of the LM test results for no threshold, reported in Table 3: Stata command 'thresholdtest' computes a test for a threshold in linear regression, allowing for heteroscedasticity. In Stata, to run the model, the standard syntax is 'thresholdtest y x, q(z) trim_per (p) rep(R)'.

The inputs are:

y = dependent variable
x = independent variable
z = threshold variable
p = percentage of sample to trim from ends, e.g., $p = 0.15$ (default value if option omitted) trimming proportion to estimate each threshold
R = number of bootstrap, e.g., R = 5000 (default value if option omitted)

Therefore, the command for testing the presence of the threshold is:

thresholdtest growth lloanus ln3us b2cstate b2bforeign exportdummy sizecategory, q(lloanus) trim_per(0.15) rep(5000)

This study did not test for the presence of possible multiple thresholds, since the cross-section threshold regression tests the null hypothesis of linearity H_0: $\beta_1 = \beta_2$ against the threshold model of $Growth_i = \left\{ \begin{array}{l} \beta_0^1 + \beta_1^1 FI_i + \beta_2^1 X_i + e_i, \ FI_i \le \gamma \\ \beta_0^2 + \beta_1^2 IFI_i + \beta_2^2 X_i + e_i, \ FI_i > \gamma \end{array} \right\}$.

The p-value is computed by a fixed bootstrap method. Hansen (2000) shows that this procedure yields asymptotically correct p-values.

For Figure 1, the Stata command 'thresholdreg' computes estimates and confidence intervals for the threshold models. The standard syntax in Stata is 'threhsoldreg y x, q(z) h(ind)'. The inputs are:

y = dependent variable
x = independent variables
z = threshold variable
ind = heteroscedasticity indicator

Therefore, in this study, the thresholdreg syntax is:

thresholdreg growth lloanus ln3us b2cstate b2bforeign exportdummy sizecategory, q(lloanus) h(1)

The program estimates a threshold regression, and prints the results to the screen. The program also plots a graph of the likelihood ratio process in the threshold, useful for threshold confidence interval construction.

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Debt-Growth Nexus in the MENA Region: Evidence from a Panel Threshold Analysis

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Abstract: This study examines whether a debt-to-GDP threshold exists in the public debt and economic growth relationship for 20 Middle East and North Africa (MENA) countries from 1990 to 2016 using the threshold estimation technique. The empirical results reveal that there is a threshold effect in the public debt and economic growth relationship. The MENA region's debt-to-GDP threshold value as a developing region is lower than the debt threshold computed by earlier studies for developing countries. We found that the effect of public debt on economic growth is significant and positive only below the threshold value of debt-to-GDP. More precisely, debt has a promoting influence on economic growth when the debt is less than 58% of the GDP. This finding indicates that the relationship between public debt and economic growth is contingent on the debt-to-GDP ratio. Importantly, policymakers need to be more prudent when establishing a policy regarding debt issues.

Keywords: public debt; economic growth; threshold effects; MENA region

JEL Classification: E62; H63; N17; C24

1. Introduction

The substantially growing threat to the economic growth of debt accumulation has been one of the most controversial and discussed issues among economists and policymakers in both developed and developing countries. Recently, economic challenges, such as chronic fiscal balance deficits, which may affect the public debt ratio, have gained significance. In the aftermath of the financial crisis in 2007–2008, many studies have been conducted to examine the relationship between public debt and economic growth (Egbetunde 2012; Al-Zeaud 2014; Zouhaier and Fatma 2014; Akram 2015; Spilioti and Vamvoukas 2015; Fincke and Greiner 2015; Muye et al. 2017). By and large, the previous studies have confirmed that there is a closer link between public debt accumulation and economic growth, whether this linkage is positive or negative for any country.

In the 1980s, many countries in the Middle East and North Africa (MENA) region undertook reforms in the financial sector. These reforms were a part of the structural adjustment programs (SAPs) often adopted with the support of the IMF and the WB, particularly in low-income countries[1]. The main goal of SAPs is to promote the long-term economic growth of a developing economy by decreasing borrowing in the country's fiscal imbalances in both the short and medium terms. These reforms led to considerable economic growth by the late 1990s. Nonetheless, the economic growth rate in the MENA region has underperformed and fluctuated compared to that in other developing regions, such as

[1] For example, Jordan, Morocco and Tunisia.

ASEAN-5 and Sub-Saharan Africa. Over the last decade, the average economic growth rates were 3.4% in MENA, 5% in ASEAN-5, and 4.7% in Sub-Saharan Africa[2]. The MENA region is still facing various economic challenges, such as the fiscal deficit, current account deficit, and high debt accumulation (see Saeed and Somaye 2012; Asghari et al. 2014; Samadi 2006). Some countries of the MENA region, particularly non-oil countries, were affected by the global financial crisis in 2007–2008 because of their high interdependence on the US's financial assistance, which put pressure on them when this assistance was lost[3]. The MENA region witnessed significant development in its infrastructure accompanied by expansions in government expenditures, government size, and debt accumulation. As a developing region, MENA's debt-to-GDP ratio is high and troubling compared to that in other developing regions, such as ASEAN-5 and Sub-Saharan Africa. Over the last few decades, the debt-to-GDP ratio has held an average of approximately 43.7%, which is 2.1% higher than the average for ASEAN-5 and 9.9% higher than that for Sub-Saharan Africa[4]. Researchers studying the MENA region consider that the economic challenges are related to the broad interventions and the low quality of fiscal policies adopted by MENA governments, such as the larger government size than that in other developing regions.

These stylized facts about public debt and economic growth raise serious concerns regarding the debt-to-GDP ratio's threshold value at which economic growth can be sustained in the MENA region. This study aimed to address this issue. Reinhart and Rogoff (2010) showed that both developed and developing countries are highly concerned with their debt level. The authors suggested that a suitable debt-to-GDP threshold rate is 60% for developing countries and that exceeding this threshold will lead to negative consequences for developing countries' economies by increasing the burden on their economies through debt service and repayment.

This study examines whether there is a debt-to-GDP threshold in the public debt and economic growth relationship for 20 MENA countries. The MENA region is selected because many MENA countries undertook reforms in the institutional and financial sector by decreasing borrowing to reduce their fiscal imbalances in both the short and medium terms and attained economic growth through the gradual removal of trade barriers, which led to strengthened trade relationships. Data from only 20 MENA countries during the period from 1990 to 2016 are included because the data are bounded. This study contributes to the existing literature in three aspects. First, in terms of the policy, this study can directly help fiscal policymakers in the MENA region. Overall, in the MENA region, there is no fixed threshold for the debt-to-GDP ratio; it is dependent on a country's condition. The region must address many crucial issues to avoid potential bankruptcy. Therefore, determining the optimum debt-to-GDP level can prevent the adverse effects of overborrowing in the MENA region by providing signals for policymakers in managing debt accumulation. Second, while previous studies have identified the debt-to-GDP threshold values for some countries and regions, for example, the debt-to-GDP threshold of 90% for OECD countries estimated by Reinhart and Rogoff (2010), the MENA region may have a different debt-to-GDP ratio threshold value because of its different economic structure. The secure level of debt-to-GDP for the MENA region has not previously been investigated to the best of our knowledge. Finally, this study also sheds light on other explanatory variables and explores their influence on the MENA region's economic growth.

This study is organized as follows. Section 2 reviews the literature on the relationship between public debt and economic growth. Section 3 discusses the methodology and describes the data. Section 4 is devoted to discussing the empirical results. Finally, the last section presents a summary and conclusion of the findings.

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2 Source: world Bank.
3 In 1961, congress passed the Foreign Assistance Act, reorganizing U.S. foreign assistance programs and separating military and non-military aid. Egypt, Jordan, Iraq, Israel and Lebanon are the recipient countries in MENA.
4 Source: world Bank.

2. Literature Review

From a theoretical perspective, two streams of thought have been proposed to distinguish the relationship between public debt and economic growth. First, in the classical theory, Ricardian equivalence states that if a government borrows today, then it has to repay this borrowing in the future by raising taxes above the normal level; thus, the impact of debt accumulation on growth will be neutralized (Ricardo 1817). The Great Recession of the 1930s was the key catalyst for the development of the modern theory of public debt. According to Keynes, foreign assistance or foreign investment is required to fill the savings-investment gap. Furthermore, Keynes argued that fiscal policy is the best policy for growth in any economy because it meets the general public's needs. Second, the neo-classical theory argues that public debt directly influences economic growth contingent on the amount borrowed. If a government exploits and takes advantage of debt in inefficient ways, the amount of investment is anticipated to increase in the long run through spending on hospitals, schools, sanitation, and infrastructure as a strategy to counteract the negative effects of debt. As long as countries use the borrowed funds for productive investment and do not suffer from macroeconomic turbulence, policies that distort the economic motivation should be implemented to stimulate appropriate debt services and repayment.

In the neo-classical view, Diamond (1965) formally proposed public debt as a variable demonstrating economic growth. Diamond postulated that internal debt decreases the attainable capital stock due to the replacement of public debt for physical capital. In addition, Diamond contended that the decrease in capital stock arises from the internal borrowing of the government to finance the deficit. Fiscal and monetary policies play an essential role in promoting economic growth in the endogenous growth model. Consequently, through public debt as a fiscal policy tool, technical progress can be reached and result in a boost in economic growth. Nevertheless, Saint-Paul (1992) noted that using endogenous growth models noted that economic growth slowdowns arise from debt accumulation.

Furthermore, Krugman (1988) proposed the concept of "Debt Overhang" where the government's ability to repay external debt decreases below the actual debt value. Modern growth theories have recently demonstrated that the government debt-growth nexus is related to governance (see Zak and Knack 2001; Acemoglu and Robinson 2006). Against this backdrop, the main channel where public debt can affect economic growth is the long-term interest rate. The government's overborrowing to finance the fiscal balance deficit will result in a higher long-term interest rate. Consequently, the higher long-term interest rate tends to decelerate economic growth via the crowd-out of private investments.

Empirically, several macroeconomic studies have provided inconsistent or even contradictory results about the relationship between public debt and economic growth in developed and developing countries. By and large, empirical studies have demonstrated either a positive or negative association between the two variables. The preponderance of evidence has indicated that there is a significant influence of public debt on economic growth. Recently, research has shifted towards estimating the threshold value of debt-to-GDP that can maintain economic growth, rather than investigating the effect of public debt on economic growth itself. Nevertheless, many growth theories have admitted that government expansion is necessary for low-income countries to stimulate economic growth (see Levine 2005; Carlin and Mayer 2003). At the other extreme, most of the recent economic studies on the relationship between the public debt and growth relationship have contended that there is a non-linear (inverted U-shape) relationship between the accumulation of public debt and economic growth, where the effect of public debt on economic growth may change based on the level of economic development (See Pattillo et al. 2003; Kumar and Woo 2010; Cordella et al. 2010). As a consequence, there should be a level of secured debt that can boost economic growth. If a country borrows more without limitations, then economic growth will decrease even further.

After the financial crisis of 2008–2009, which was followed by the European debt crisis in countries including the PIIGS (Portugal, Italy, Ireland, Greece, and Spain), the relationship between public debt and economic growth for both developing and developed countries gained increased attention

among scholars. As government size increases over time, overborrowing to finance many unproductive projects may dampen long-term economic growth. El-Mahdy and Torayeh (2009); Bal and Rath (2014); Puente-Ajovín and Sanso-Navarro (2015); Zouhaier and Fatma (2014); Eberhardt and Presbitero (2015); and Mitze and Matz (2015) also contended that there is a negative relationship between public debt and economic growth. Conversely, several studies have employed recent econometric techniques to evaluate the debt-growth nexus. For example, Al-Zeaud (2014); Spilioti and Vamvoukas (2015); Fincke and Greiner (2015); Owusu-Nantwi and Erickson (2016); and Muye et al. (2017) maintained that public debt affects economic growth in a positive and significant manner.

In a major break with the existing macroeconomic literature, for 20 developed countries, Lof and Malinen (2014) commented that public debt has no real effect on economic growth even at higher public debt rates. In the second set of estimations, which considers more than two countries, as in our case, the results are different depending on the sample, and methodological tools are shown in Table 1.

Table 1. The main studies which estimate the debt-growth threshold level with more than two countries.

Author/s	Period	Countries	Methods	Outputs
Nasa (2009)	1970–2000	56 countries of heavily indebted countries	Panel Threshold Regression	Estimated debt-to-GDP threshold ratio at 45%.
Kumar and Woo (2010)	1970–2007	38 advanced and emerging economies.	Dynamic Panel GMM	A 10% increase in the debt-to-GDP ratio was offset by a 0.2% deceleration in real per capita GDP growth.
Reinhart and Rogoff (2010)	2 centuries	44 countries	Panel Analysis	Identify a 90% for both advanced and emerging market economies, while a debt-to-GDP of 60% for developing countries.
Cordella et al. (2010)	1970–2002	79 developing countries	SGMM	Debt-to-GDP ratio of 70–80% can sustain economic growth.
Baglan and Yoldas (2013)	1954–2008	20 advanced economies	Panel Threshold Regression	Identify a threshold effect of 20%.
Wright and Grenade (2014)	1980–2012	13 Caribbean countries	Panel OLS and Threshold Dynamics	Identify a 61% for the sample countries, with a debt/GDP ratio exceeding that threshold having an adverse impact on investment and growth.
Boukhatem and Kaabi (2015)	1990–2011	19 MENA countries	GMM Approach	Debt below 15% tends to boost economic growth.
Égert (2015)	1946–2009	20 Advanced countries 21 Emerging countries	Panel Threshold Regression	Identify a debt threshold between 20% and 60%.
Omrane et al. (2017)	1970–2010	4 MENA countries (Tunisia, Turkey, Morocco, Egypt)	Panel Threshold Regression	The debt-to-GDP estimated at 39.5%, beyond this threshold, debt was negatively associated with economic growth.
Khanfir (2019)	2003–2012	4 MENA countries (Tunisia, Algeria, Morocco, Egypt)	Panel Threshold Regression	A 187 debt-to-GDP threshold ratio of 42% correlated positively with economic growth

Given this backdrop, this present study fills the gaps in the following ways. First, while Khanfir (2019) and Omrane et al. (2017) focused on a few MENA countries using the panel smooth transition model (PSTR), this study differs in terms of the countries considered and methodology used. More precisely, this study conducts an empirical estimation of the entire sample of MENA countries using a different method (two regimes model) developed by Hansen (1996) during the most recent years (1990–2016) to determine the debt-growth nexus in the MENA region. Second, this study provides paramount evidence highlighting the role of the debt-to-GDP threshold in sustaining economic growth. In particular, we estimate whether there exists an optimum debt-to-GDP threshold value for the public debt-growth nexus. The outcomes of the study may have significant implications for economic policy. Therefore, if there is clear evidence that debt accumulation significantly restrains economic growth, then policymakers need to establish an effective policy that sustains and boosts economic growth. In summary, while most studies conducted in the MENA region have focused on a small group of countries, the present study adopts a different sample and methodology.

3. Methodology

3.1. Model Specification

The log-linearized Cobb-Douglas production function has empirically estimated the debt role in economic growth by controlling other explanatory variables. The model can be written as follows:

$$Y_{i,t} = \alpha_t + \beta_1 K_{i,t} + \beta_2 Pop_{i,t} + \beta_3 Debt_{i,t} + \beta_4 X_{i,t} + \mu_{i,t} \quad (1)$$

where $Y_{i,t}$ denotes real GDP per capita growth. α_t denotes time-fixed effect, $K_{i,t}$ denotes physical capital and $Pop_{i,t}$ denotes the population growth. $Debt_{i,t}$ denotes general government debt. $X_{i,t}$ is a vector of explanatory variables government expenditure ($GE_{i,t}$), which captures government policy, trade openness ($Open_{i,t}$) to measure the effect of trade policies; inflation rate ($inf_{i,t}$); and money supply ($M2_{i,t}$) as a percentage of GDP, and the initial income ($Initial_{i,t}$). Initial income is the lagged-dependent variable of the real GDP per capita growth to consider the convergence effect of the model.

3.2. Data and Variable Description

This study employs data for 20 MENA countries in estimating the growth model in Equation (1). The data adopt an annual frequency from 1990 to 2016. All the datasets are collected World Bank (WB) databases, except the data for Syria for the period 2010–2016, which has been obtained from the central bank and Central Bureau of Statistics of Syria. The real GDP per capita growth (Y) is a measure of economic growth, and (K) is the total investment as a percentage of GDP to proxy for gross capital formation. The population growth rate (Pop) has been used as a proxy for the labor force. Data for the public debt ($Debt$), the general government debt as a percentage of GDP, were collected from the IMF. Government expenditure (GE) is the total government expenditure as a percentage of GDP and captures government policy. The trade openness ($Open$) is the sum of exports plus imports as a percentage of GDP and is used as a proxy to capture trade openness. Money supply ($M2$) as a percentage of GDP used as a proxy for financial depth, as in Baharumshah et al. (2017). Inflation rate (Inf) is the annual percentage of average consumer prices. Finally, the initial income is the GDP per capita at constant prices (2010).

3.3. Methodology Selection

Previous studies have provided inconclusive results regarding the impact of debt accumulation on economic growth. The earlier studies show that debt accumulation effects may have nonlinear characteristics because of the potential presence of threshold in debt-growth nexus (see Pattillo et al. 2003; Kumar and Woo 2010; Cordella et al. 2010). Given the inconsistent results reported by earlier literature, this study estimates threshold effects in the debt-growth nexus for the case of MENA regions. The classical static panel data methods, such as fixed or random effect, have some

limitations, showing only the heterogeneity in intercepts and linear relationship among the variables. In contrast, the panel threshold method's main advantages are the shifting character or structural break in the association between dependent and explanatory variables (Lee and Wang 2015), explaining the possible nonlinear relationship between the threshold and dependent variables. The threshold model is considered an essential model for estimating many economic issues and has recently been utilized in many macroeconomic studies (Lee and Wang 2015). Consequently, to assess the nonlinear behavior of the debt-to-GDP ratio in the relationship with economic growth, this study employs the threshold regression approach suggested by Hansen (1996). The model in Equation (1) can be written based on the fixed effect panel threshold regression as follows:

$$rgdpcg_{i,t} = \mu_i + \beta_1 X_{i,t} I(Debt_{i,t} \leq \lambda) + \beta_2 X_{i,t} I(Debt_{i,t} \geq \lambda) + e_{i,t} \quad (2)$$

where $rgdpcg_{i,t}$ is the real GDP per capita growth, $Debt_{i,t}$ is the public debt, which is a threshold variable that divides the sample into upper and lower regimes; λ is the unknown threshold parameter; $I(.)$ is the indicator function, which takes the value 1 if the argument in the indicator function is valid, and 0 otherwise; μ_i is the individual effect; and e_{it} is the disturbance. X_i is a vector of the control variables (investment, population growth rate, government expenditure, trade openness, inflation, money supply, and initial income). Equation (2) can be rewritten as two equations, Equation (3) represents the lower regime threshold and Equation (5) represents the upper regime threshold:

$$rgdpcg_{i,t} = \mu_{i,t} + \beta_1 X_{i,t} I(Debt_{i,t} \leq \lambda) \quad (3)$$

$$rgdpcg_{i,t} = \mu_{i,t} + \beta_2 X_{i,t} I(Debt_{i,t} > \lambda) \quad (4)$$

$$rgdpcg_{i,t} = \mu_{i,t} + \beta_1 X_{i,t} I(Debt_{i,t} \geq \lambda) \quad (5)$$

$$rgdpcg_{i,t} = \mu_{i,t} + \beta_1 X_{i,t} I(Debt_{i,t} < \lambda) \quad (6)$$

Therefore, this methodology allows for the examination of differentiating effects of public debt on economic growth in the lower and upper regimes depending on whether the threshold variable is smaller or higher than the threshold value γ. Coefficient β_1 and β_2 indicate the considered effects in the lower and higher regimes, respectively.

To carry out the panel threshold regression, we have to test the null hypothesis of linearity against the threshold model in Equation (2), where the null hypothesis is H_0: $\beta_1 = \beta_2$. According to Hansen (1996), there is a problem executing the LM and Wald test statistics under the null hypothesis because the λ parameter is not specified; therefore, inferences are implemented by calculating an LM or Wald statistic for each potential value of λ and depend on the least upper bound of the Wald or LM for all potential λs (Law et al. 2013). Consequently, the inferences are conducted via bootstrapping in a model whose validity and properties were developed by Hansen (1996) because tabulations are not possible. Once the value of λ is obtained, the slope parameters $\hat{\beta}(\hat{\lambda})$ and $\hat{\gamma}(\hat{\lambda})$ can also be obtained.

4. Empirical Results

Table 2 shows the descriptive statistics for each variable employed in the model. The dataset is free from any extreme values, which may affect the estimated results' significance by affecting the mean, standard deviation, minimum, and maximum of each variable of the entire sample. Table 3 shows the correlation matrix of the variables employed in the analysis. Table 4 reports the panel threshold estimation results and presents the number of thresholds in terms of the debt-to-GDP ratio. According to the bootstrap *p*-values, the corresponding statistics F_1, F_2 and F_3 suggest the number of thresholds. The test for the single threshold F_1 is highly significant, with a bootstrap *p*-value of 0.05, while F_2 and F_3 are nonsignificant, with bootstrap *p*-values of 0.16 and 0.68, respectively. In addition, the F statistic is highly significant. Therefore, we reject the linear model. The statistical significance of the threshold estimate is evaluated by the *p*-value calculated utilizing the bootstrap method with 1000 replications and a 0.1% trimming percentage. Consequently, the sample is split into two regimes. The point

estimate of the debt-to-GDP threshold value is 58.51%, with a corresponding 95% confidence interval of (52.3465, 58.9060) for the full sample model. The MENA region's debt-to-GDP threshold value as a developing region is close to 60%, as computed by Reinhart and Rogoff (2010), and 64% as computed by Grennes et al. (2010) for developing countries. This finding is also close to the debt-to-GDP threshold calculated by Sanusi et al. (2019), which is 57% for Southern African countries, and higher than the debt-to-GDP threshold value computed by Khanfir (2019); Omrane et al. (2017) and Boukhatem and Kaabi (2015). The estimated debt-to-GDP threshold is different from that found in previous studies conducted on the MENA countries because of the different sample and methodology employed.

Table 2. Descriptive and Summary Statistics for 20 Middle East and North Africa (MENA) Countries, 1990–2016.

Variables	Unit of Measurement	Mean	Std. Dev.	Minimum	Maximum
Rgdpcg	%	0.0140	0.0793	−0.6132	0.9276
Initial income	US$ 2010 constant prices	8.2476	1.3796	4.7178	11.3513
Investment	% of GDP	3.1072	0.4072	0.4213	3.9282
Expenditure	% of GDP	3.4146	0.3044	2.4158	5.3189
Public debt	% of GDP	3.5971	0.9941	−0.5978	5.3924
Trade openness	% of GDP	4.2787	0.4322	2.1800	5.3478
Money growth	% of GDP	3.9866	0.6310	2.1492	5.5561
Population growth	%	2.8027	2.4244	−4.5365	17.5109
Inflation	%	8.6301	14.7768	−9.7976	105.215

Table 3. Correlations between Variables for 20 MENA Countries, 1990–2016.

	Rgdpcg	Initial	INV	Popgr	Exp	Debt	Open	Inflation	M2
Rgdpcg	1.0000								
Initial	−0.0545	1.0000							
INV	0.0735	0.1909	1.0000						
Popgr	−0.1138	0.3793	0.0944	1.0000					
Exp	−0.0288	0.1744	0.0851	−0.1953	1.0000				
Debt	0.0432	−0.5118	−0.1927	−0.1516	0.0868	1.000			
Open	−0.0209	0.4671	0.0939	0.2460	0.2463	−0.1796	1.0000		
Inflation	0.0299	−0.1877	0.0114	−0.0752	−0.1112	0.2114	−0.2975	1.0000	
M2	0.0182	0.1327	0.1818	−0.0045	0.3167	−0.0885	0.3042	−0.1529	1.0000

Notes: Rgdpcg = real GDP per capita; INV = total investment (% of GDP); Popgr = population growth; Exp = government expenditure (% of GDP); Debt = public debt (% of GDP); Trade openness = openness in trade policy (% of GDP); Inflation = inflation rate; M2 = money supply (% of GDP) and Initial = GDP per capita in constant prices (2010).

Table 4. Tests for Threshold Effects for 20 MENA Countries, 1990–2016.

Test for Single Threshold		
p-value (1%, 5%, 10% critical values)	F_1	13.26 *** (0.05) (11.2595, 12.9904, 18.2513)
Test for Double Threshold		
p-value (1%, 5%, 10% critical values)	F_2	8.33 (0.16) (10.2692, 13.0625, 16.3608)
Test for Triple Threshold		
p-value (1%, 5%, 10% critical values)	F_3	5.99 (0.68) (24.4019, 34.6089, 56.4302)

Note: A total of 1000 bootstrap replications were used for each of the three bootstrap tests. *** denotes significant at 1% level.

To estimate how the debt-to-GDP threshold affects the economy under the upper and lower threshold values of the debt-to-GDP ratio, Table 5 shows the panel threshold model's empirical results for the debt-growth relationship from Equation (2). The coefficient estimates of the explanatory variables are significant for promoting growth. First, public debt turns out to be a significant positive determinant of economic growth in the lower regimes. Still, in the upper regime, public debt has a nonsignificant positive effect promoting growth. In other words, debt at a level below 58% of GDP positively influences economic growth. The result is ambiguous when debt exceeds 58% of GDP because the coefficient is insignificant. This implies that if the debt-to-GDP threshold level is beyond 58%, it tends to have positive or negative effects on the MENA region's economic growth. Arguably, this finding is consistent with the Laffer curve and the theory that debt accumulation tends to dampen economic growth through the burden of higher debt servicing in the long term.

Table 5. Regression Results using Public Debt (Debt) as a Threshold Variable. Dependent Variable: Real GDP per Capita.

	Coefficient	**Standard Error**
Regime-independent regressors		
Initial income	−0.0016 **	(0.0074)
Investment	0.0015 ***	(0.0005)
Population growth	−0.0047 **	(0.0019)
Government expenditure	−0.0018 **	(0.0003)
Trade openness	0.0004 **	(0.0002)
Inflation rate	−0.0020 ***	(0.0002)
Money supply	−0.0048 ***	(0.0018)
Threshold variable		
Debt-to-GDP ≤ 58.51	0.0092 ***	(0.002)
Debt-to-GDP > 58.51	0.0013	(0.001)
Constant	0.130 **	(0.637)
R-square	0.801	
No. Observations	540	

Note: ***, and ** denotes significant at 1% and 5% level respectively. The results correspond to a trimming percentage of 0.1%. F test that all ui = 0: F(19, 511) = 1.99. Prob > F = 0.0008.

Turning to physical capital, it positively affects economic growth, which is consistent with theory. Moreover, the labor force has a significant negative effect on economic growth, which reflects the labor market policies in the MENA region. Furthermore, government expenditure behavior is conflicting for the anticipations, since government expenditure is negatively and significantly associated with economic growth. This result shows the significance of fiscal policy for the MENA region. At 58% of debt-to-GDP ratio, government expenditure hinders economic growth. A plausible explanation is that ineffective governments in MENA countries depress private investment, so public investment may substitute private investment. Consequently, the MENA reign needs to allocate government expenditures prudently to curb adverse influences and take full advantage of beneficial economic growth. However, trade openness is in line with expectations. It has a significant positive influence on economic growth, possibly because of trade barriers removal.

The coefficient estimates of inflation are significant and negatively associated with economic growth. Besides which, the model shows that the money supply plays a significant negative role in promoting economic growth in the studied period. Although monetary policy has a vital role in enhancing the economic growth of any country, there has been a long debate in economics about the role of money in the economy. At 58% of the debt-to-GDP ratio, the money supply increases over time, coupled with a decrease in the interest rate. As a consequence, consumption, lending and borrowing will be increased. Hence, expansionary money policy leads to crowd-out investment, often resulting in stagnation, which finally hinders economic growth. Finally, the initial income coefficients are significant

and have a positive effect on economic growth. These findings are consistent with the theory. Overall, the ambiguity regarding the MENA region's estimations may be because of the development of the financial sector and indicate that the MENA region has not yet reached a sustainable level of debt.

To smooth short-run fluctuations, we split the MENA region's full sample into three periods over nine years for all variables. This leaves us with three intervals: 1990–1998, 1999–2007 and 2008–2016. Table 6 shows the threshold estimates for the periods.

Table 6. Threshold Estimates.

	Threshold Estimated	95% Confidence Interval
$\hat{\gamma}^1$	26.59	(26.27, 27.60)
$\hat{\gamma}^2$	47.69	(46.27, 48.76)

With the two estimated thresholds categorizing the countries into three levels based on their debt-to-GDP ratio, the significant estimate of each level proves the existence of nonlinear effects on the debt-to-GDP ratio. Table 7 shows the countries in each level of debt-to-GDP in the observed periods. In 1990, two countries, namely Bahrain and the UAE, had low levels of debt-to-GDP. On the other hand, 13 countries had a high debt-to-GDP threshold. By 1999, the number of countries with a medium level of debt-to-GDP had increased from five to seven, and the number of countries with a high level had decreased to nine. By 2008, Comoros, Djibouti, Ethiopia, and Tunisia had notably decreased their debt accumulation level and joined the countries with a medium level of debt-to-GDP, while Morocco and Jordan still had high levels of debt-to-GDP.

Table 7. 20 MENA Countries with Different Debt-to-GDP Threshold Levels, 1990–2016.

Threshold Variable	Period	Debt-to-GDP ≤ 26.59	26.59 < Debt-to-GDP ≤ 47.69	Debt-to-GDP > 47.69
Debt-to-GDP	(1990–1998)	Bahrain and UAE	Lebanon, Turkey, Oman, Iran, Qatar	Jordan, Ethiopia, Comoros, Syria, Egypt, Tunisia, Djibouti, Morocco, Algeria, Kuwait, Libya, Saudi Arabia, Yemen
	(1999–2007)	Bahrain, Iran, Oman, UAE	Yemen, Turkey, Algeria, Saudi Arabia, Kuwait, Libya, Qatar	Jordan, Lebanon, Syria, Djibouti, Tunisia Morocco, Ethiopia Comoros, Egypt
	(2008–2016)	Algeria, Iran, Kuwait, Libya, Oman, Qatar, Saudi Arabia, UAE Yemen, Syria	Tunisia, Djibouti, Turkey, Ethiopia, Comoros, Bahrain	Jordan, Lebanon, Morocco, Egypt

5. Summary and Conclusions

This study examined whether there is a debt-to-GDP threshold value in the public debt-economic growth nexus for 20 MENA countries over 1990–2016. This study's novel contribution is the adoption of the regression model proposed by Hansen (1996) to provide a reliable optimum debt-to-GDP threshold, which has not previously been addressed. The results reveal that debt promotes economic growth only below the debt-to-GDP threshold. The empirical findings also demonstrate that the estimated threshold percentage value for the developing MENA region is lower than the debt threshold computed by Reinhart and Reinhart and Rogoff (2010) and Grennes et al. (2010) for developing countries. This study concludes that debt has a positive effect on growth below the threshold value. In contrast, the impact of debt above the threshold value is ambiguous because the coefficient is nonsignificant.

This study's policy implications are that accumulating debt to boost economic growth is not a wise policy choice for countries in the MENA region. Instead, reducing the debt-to-GDP ratio seems to enhance these countries' economic performance; the average debt-to-GDP ratio of approximately 52% over the full sample period seems to support this view. Arguably, the relationship between public debt and economic growth depends on the debt-to-GDP ratio. This study finds that government debt can promote economic growth if used for productive projects and limited to optimal. Therefore, policymakers may eventually enhance growth by reducing the debt-to-GDP ratio, efficiently allocating financial sources, reducing sterile government-funded programs, and using timely austerity measures to curb shocks' effects financial crisis.

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Applying Quantum Mechanics for Extreme Value Prediction of VaR and ES in the ASEAN Stock Exchange †

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Abstract: The advantage of quantum mechanics to shift up the ability to econometrically understand extreme tail losses in financial data has become more desirable, especially in cases of Value at Risk (VaR) and Expected Shortfall (ES) predictions. Behind the non-novel quantum mechanism, it does interestingly connect with the distributional signals of humans' brainstorms. The highlighted purpose of this article is to devise a quantum-wave distribution methodically to analyze better risks and returns for stock markets in The Association of Southeast Asian Nations (ASEAN) countries, including Thailand (SET), Singapore (STI), Malaysia (FTSE), Philippines (PSEI), and Indonesia (PCI). Data samples were observed as quarterly trends between 1994 and 2019. Bayesian statistics and simulations were applied to present estimations' outputs. Empirically, quantum distributions are remarkable for providing "real distributions", which computationally conform to Bayesian inferences and crucially contribute to the higher level of extreme data analyses in financial economics.

Keywords: quantum mechanics; wave function; extreme value analysis; Bayesian inference; stock market; Value at Risk (VaR); Expected Shortfall (ES); prediction

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1. Introduction

Physicists' interest in the social sciences is not novel. The word "econophysics" is the perspective applied to economic computational models and concepts associated with the "physics" of systematical complexity—e.g., statistical mechanics (quantum mechanics), self-organized criticality, microsimulation, etc. (Hooker 2011). Fundamentally, most econophysicists have in mind that the approach—computational physics for econometrics—seeks to structure physically realistic models and theories of economic phenomena from the actually observed features of economic systems. Practically, econophysicists and economists are connected by analyzing financial markets, but the problem is that they are trained in "different schools" (Ausloos et al. 2016). The exploration of the tangible of computational physics and financial econometrics is the nexus of this paper.

Not surprisingly, physics students have been trained and have known that the frontier of modern physics uses plain language—quantum physics and relativity (Bowles and Carlin 2020). The power of quantum physics substantially existed in the chaotic period of World War II—reasonably called the "beginning" of modern physics—by Werner Heisenberg, who was a founder of quantum mechanics and a significant contributor to the physics of fluids and elementary particles (Saperstein 2010). With this great exploration, modern quantum physics has brought people to distinctly shift the standard of living through numerous inventions such as microwaves, fiber optic telecommunications, super computers, etc.

In economics, "Marshall plus Keynes" neoclassical synthesis is still teachable for the non-specialist future citizen since the "visible hands" stated by Adam Smith has been elusive, and the story has therefore never been all that easy to see—as a perusal of his original text demonstrations (Persky 1989). However, human decision-making processes are significantly from their "power" explained by integrating psychological aspects and

individual social-economic ideas (Sijabat 2018). From this perspective, quantum physics can potentially affect a merger with computational economic models through the concept of the power behind a decision. More expressly, Figure 1 displays the diverse iceberg for economic movements. Along with fluctuations in the trend, traditionally computational economics restrictedly captures only the observable zone (the top of the iceberg). However, numerous amounts of information exist underneath the water, which potentially motivate human perspectives to conclude a final decision, are intentionally neglected by the assumption called "normality". With this strongly theoretical supposition, traditional econometrics has been trustworthy for more than a hundred years.

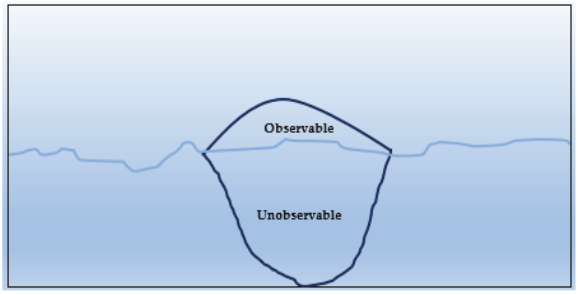

Figure 1. Diverse economies iceberg.

Unfortunately, there have been many economic collapses after the industrial revolution in the mid-18th century. Economists and econometricians are blemished with their predictive foresight's computational failures, especially forecasting in financial investments. The deep root of the problem is about their fundamental thoughts. Thinking as a traditional econometrician is to model observed information by a random walks model, the easiest way to imitate rational human aspects. Box 1 represented in Figure 2 displays the concept that the random walk model is the logic to reach B from A. This principle's systematic idea is to sample only a static spot when the arrow is tangible B. However, the critical query is that this fundamental cannot seemingly support the existence of human thinking.

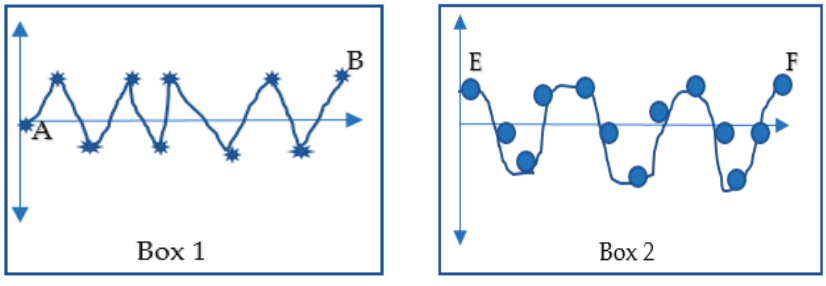

Figure 2. Two different concepts between Random walks and wave function (Quantum walks).

Human decisions are sourced from electromagnetic waves and particles since cell-to-cell communications occur through a process known as "synaptic transmission", where chemical signals are passed between cells generating electrical spikes in the receiving cell. To think like modern econophysicists (Quantum Mechanics: Wave-particle duality), it is reasonable to state the arrow from E to F displayed in box 2 is not a random walk model (Quantum walk process). The observation at the point F exists when it passes the process of dynamic wave movements. In other words, the reason to decide to select F is the origin of numerous latencies, which are attitudes, perspectives, morals, etc. Interestingly, this fundamental can potentially raise a novel horizon for observing information using modern econometric (Quantum econometrics) estimations and predictions.

Financial markets have several of the properties that characterize complex systems and interact nonlinearly in the presence of estimations (Mantegna and Stanley 2000). One of the interesting areas in finance is the pricing of derivative instruments. The graphical trend displayed in Figure 3 shows the example of dynamic stock exchanges in Thailand between 2000 and 2020—investors have a variety of reasons and decide the process of brainstorms. The graph implies that it is identical to a wave transmission. Hence, it is time to seek an alternative tool to compute this kind of complex data econometrically.

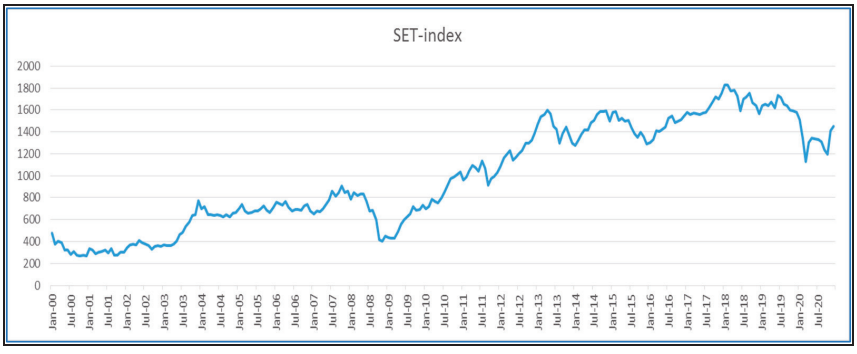

Figure 3. The dynamic movement of the Thailand stock exchange between 2000 and 2020. Source: Stock Exchange of Thailand (SET)

This research tries to fill the research gaps between the traditional econometrics method and modern econophysicists (Quantum Econometrics), which apply in financial markets, especially the extreme value prediction in the ASEAN stock exchange. However, this research is organized, as follows, by explaining the conceptual framework between traditional econometrics and Quantum Econometrics (Modern Econophysicist). The second part is how to apply this conceptual framework in extreme value prediction, especially the extreme value of Value at Risk (VaR) and Expected Shortfall (ES) of five stock markets in ASEAN countries. The last part of this research is an exclusive summary for comparison between two methods to forecast the extreme value of Value at Risk (VaR) and Expected Shortfall (ES) in five stock markets of ASEAN countries based on Risk management analysis.

2. Literature and Critical Thinking

It is not simple to exactly explain and picture humans' decisive believes or faiths. In terms of a mathematical expression, deductive logic was the ideal invention trying to reach a conclusion. However, thoughts are not logically controllable as similar to a robotic mechanism. In econometrics, this is defined as "extreme distribution". To make sense of it, the root of distributional generating is interesting to reconsider.

2.1. The Origin of Quantum Distributions

Inside of the area of traditional econometrics, the original process of a random walk based on the scaling limit, which generalizes the so-called iterated Brownian motion, is useable and acceptable academically. This theoretical concept of the random walk graphically displayed in Figure 4 was considerably generalized and extended by the Polish physicist Marjan Smoluchowsk (Kac 1947). It is continuously modified to be functional in modern quantitative research. Jung and Markowsky (Jung and Markowsky 2013) showed the random walk's advantage at random times to be considered the "alternating random", which rewards the schematic scale to indicate fractional stable motions. Although the theory of random-walk processes is continuously acceptable, the theory has started to be criticized. The weakness of random walk algorithms is stated by (Saghiri et al. 2019). The non-intelligent random walk models may not be a problem-solving method in real-world

problems since some complex systems such as biological networks or social networks work as a "learning mechanism". It seems the performance of random-walk processes is low when used to explain mechanical information about the practical problems' nature.

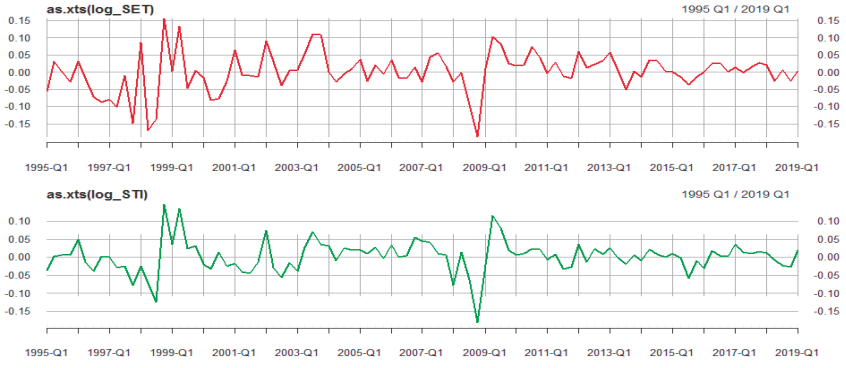

Figure 4. The example of random walk patterns based on Brownian motion. The data visualize two log-return sets of quarterly stock indexes in Thailand (SET) and Singapore (STI) between 1995Q1 and 2019Q1. The fluctuation of index trends is the difference in pitch between positive and negative values, but it inclines stationary (close to 0 and unchangeable) in the long-term consideration.

Modernly, there are many attempts to make a reconsideration in the impetus of humans' decision calls. As Adam Smith said, invisible hands are behind the scenes. This undetectable power is deliberately linked to quantum behaviors. Quantum mechanics based on Newton's motion laws are good enough to predict how behavioral complexities are inspired. Newton's laws are seen to be consequences of the fundamental way the quantum world works (Ogborn and Taylor 2005). However, in accounting for small occurrences, Newtonian physics' failure is evident at the atomic level. This implies that the lack of precise calculations cannot be simply captured by Newtonian quantum computing. It turns out that the "Hamiltonian formulation" is the formalism that most readily generalizes to quantum mechanics via the Schrodinger equation (Piziak and Mitchell 2001), which is the crucial fundament for exploring quantum key distributions

One of the highlighted obstacles in quantum key distributions is capturing and pointing signals of quantum mechanism exactly. As stated in the contribution by (Bruß and Lütkenhaus 2000), the problem of cross-polarized cryptography between the two polarization modes and a random (classical) rotation of the polarization along the propagation direction is informationally detected by using Ekert's privacy amplification (Ekert et al. 1994). Interestingly, the quantum distribution is being a truly evolutional data analysis for post-modern econometrics.

2.2. Quantum Computing in Financial Econometrics

The Hamiltonian formulation for the time-independent Schrödinger equation composes a quantum evolutional enlargement of the classical harmonic oscillator approaches to economics' business cycle dynamics. As the literature on Piotrowski and Sładkowski (2001); Choustova (2007); Gonçalves and Gonçalves (2008); Choustova (2009); Gonçalves (2013); and Gonçalves (2015); Chaiboonsri and Wannapan (2021), a quantum application to extreme financial optimizations, therefore, contributes to the novel discussion within forecasting financial economics and raises a criticism to the empirical validity of the geometric Brownian motion and geometric random walk models of price dynamics, which is commonly employed in financial economics as mathematical tools for solving pricing problems, especially risks and returns analyses.

3. The Objective and Scope of Research

The risk and return of financial markets are the main investigations of the paper. Quarterly data from 1995 to 2019 were observed. Five major stock exchanges in five ASEAN countries such as Thailand (SET), Singapore (STI), Malaysia (FTSE), Philippines (PSEI), and Indonesia (PCI) were processed in three sections of the research framework, including data visualization, risks management (Value at Risk: VaR), and returns forecasting (Expected Shortfall: ES). Technically, parametric estimations' main statistical tool is the subjective method called "Bayesian inference", and observations are deliberately focused on the extreme tail loss of distributional portraits, theoretically known as "extreme value".

The scope of the research processes is displayed in Figure 5. Expressly, the observations are processed to the section of data visualization (screening data). Descriptive explanation, stationary testing, and normality checking are the main consideration, and then the raw data is modified by two critical concepts—a random walk (Gaussian) distributional set and quantum-wave distribution. The next step is to insert two distinguished data into the function of the Generalized Pareto Distribution (GPD) extreme value analysis. Heavy loss tails are clarified and analyzed by setting the prior density for parameters at the Bayesian estimation threshold. The most precise prediction between two distributions is validated by computing the Deviation Information Criteria (DIC).

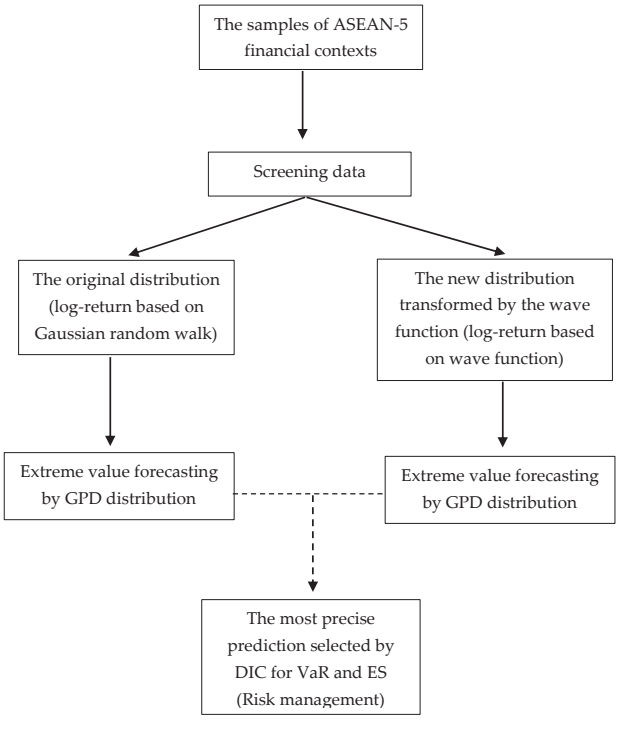

Figure 5. The scope of research.

4. Methodology

4.1. Quantum Mechanics and Wave Function for Time Series Movement

Since 1926, Erwin Schrödinger developed the wave function implemented to predict the quantum system's behavior or quantum mechanics, especially for the prediction of the momentum of energetic electrons (Schrödinger 1926). This quantum mechanics based on the idea of Louis de Broglie's wave–particle duality in 1924 was played an important role that has significantly influenced the development of Schrödinger's wave

function (Recherches sur la théorie des quanta Researches on the quantum theory). Basically, energy can be expressed by a simple equation, as shown below:

$$E = KE + PE \tag{1}$$

where E = Energy, KE = Kinetic Energy, PE = Potential Energy, $KE = \frac{1}{2}MV^2$, M = Mass (kg), V = Velocity (m/s). Consequently, we obtain

$$E = \frac{1}{2}MV^2 + U, PE = U \tag{2}$$

The momentum of $P = MV$, the object is empowered to move by $P^2 = M^2V^2$ then $V^2 = \frac{P^2}{M^2}$. However, Equation (2) can be rewritten by substitution of V^2 and this is presented in Equations (3) and (4) as follows:

$$E = \frac{1}{2}M\frac{P^2}{M^2} + U, \tag{3}$$

$$E = \frac{P^2}{2M} + U. \tag{4}$$

Once again, the wave function from Schrödinger's equation's original idea used ψ to represent the energy of the particle-wave duality movement. This can be demonstrated as follows:

$$\psi = e^{i(kx-\omega t)} \tag{5}$$

$$\frac{d\psi}{dx} = ike^{i(kx-\omega t)} = ik\psi \tag{6}$$

$$\frac{d^2\psi}{dx^2} = (ik)^2e^{i(kx-\omega t)} \tag{7}$$

$$\frac{d^2\psi}{dx^2} = i^2k^2e^{i(kx-\omega t)} \tag{8}$$

$$\frac{d^2\psi}{dx^2} = i^2k^2e^{-i(\omega t-kx)} \tag{9}$$

$$\frac{d^2\psi}{dx^2} = -k^2e^{-i(\omega t-kx)} \tag{10}$$

and Equation (10) is defined that: $k = \frac{P}{\hbar}$, (de Broglie relation) then

$$\frac{d^2\psi}{dx^2} = -(\frac{P^2}{\hbar^2})\psi, \psi = e^{-i(\omega t-kx)}. \tag{11}$$

Equation (11) is multiplied by $\hbar^2$ on both sides, we obtain

$$-\hbar^2\frac{d^2\psi}{dx^2} = P^2\psi \tag{12}$$

From Equation (4), it can be modified, and it can be rewritten by the equation as displayed below:

$$E = \frac{P^2}{2M} + U, \tag{13}$$

$$E\psi = \frac{P^2\psi}{2M} + U\psi, \tag{14}$$

$$E\psi = \frac{-\hbar^2}{2M}\frac{d^2\psi}{dx^2} + U\psi, -\hbar^2\frac{d^2\psi}{dx^2} = P^2\psi, \tag{15}$$

Equation (15) was mentioned by Schrödinger to implement the quantum mechanics prediction for electrons moved by energy relied on the case of time-independence. For making a sensible computation, the time-dependent case can be done by starting from the Planck–Einstein relation (Griffiths 1995) as presented that $E = \hbar\omega = hf, E = hv = hf$, $h =$ Planck constant (6.626×10^{-34}). The Planck–Einstein relation suggests that whenever energy is empowered, frequencies (v) are parallel increments, the Planck constant h is stable. The proof of the following equations can express electrons' energic movements:

$$\frac{d\psi}{dt} = -i\omega e^{i(kx-\omega t)} \tag{16}$$

$$\frac{d\psi}{dt} = -i\omega\psi, \psi = e^{i(kx-\omega t)} \tag{17}$$

From the Planck–Einstein relation, we obtain

$$E = \hbar\omega, \tag{18}$$

$$E\psi = \hbar\omega\psi \tag{19}$$

Multiplied $\frac{-i}{\hbar}$ into Equation (19) on both sides,

$$\frac{-i}{\hbar}E\psi = -i\omega\psi, (\frac{d\psi}{dt} = -i\omega\psi), \tag{20}$$

$$\frac{-i}{\hbar}E\psi = \frac{d\psi}{dt} \tag{21}$$

$$E\psi = \frac{\hbar}{-i}\frac{d\psi}{dt}. \tag{22}$$

The time-independence should be transformed into the Schrödinger equation for the time-dependent by replacing Equation (22) into (15). The finalized result of these steps is Equation (23):

$$\frac{\hbar}{-i}\frac{d\psi}{dt} = \frac{-\hbar^2}{2M}\frac{d^2\psi}{dx^2} + U\psi \tag{23}$$

and

$$i\hbar\frac{d\psi}{dt} = \frac{-\hbar^2}{2M}\frac{d^2\psi}{dx^2} + U\psi \tag{24}$$

The finalized equation is the fundamental of the Schrödinger equation for predicting the momentum of wave-particle dualities in different cases. However, the right-hand and left-hand sides of those equations can be substituted by $\hat{H}$ (Hamiltonian OPERATOR, $i\hbar\frac{d}{dt}\left|\psi(t)\right\rangle = \hat{H}\left|\psi(t)\right\rangle$ (Time-dependent), $\hat{H}\left|\psi\right\rangle = E\left|\psi\right\rangle$ (Time-independent)) for forecasting the total systematic energy. In particular, the behavior for the quantum mechanism. In terms of the Schrödinger wave function's interpretation, this is the highlight for this article to apply the periodic function for measuring the momentum of returns of stock markets in ASEAN countries. Mathematically, we start with

$$\psi = A\sin(\frac{2\pi}{\lambda}x), \tag{25}$$

where ψ represents the prediction value of total energy for the momentum of return movements during observable periods. A is the amplitude of Equation (25) and λ is the wavelength included in the equation simultaneously.

Figure 6 implies the concept of quantum mechanics applying for stock return predictions. In other words, this cognition is applied from the concept of sound amplification mathematically explained in Equation (25). The upper regime (high energy zone) is a quadrant of positive positions, which explains that returns are still moved. In this case, the high energy zone stands for the explanation of Bull market momentums (Ahn et al.

2018; Ataullah et al. 2008). Conversely, the fall of returns (Bear market momentum) is the negative quadrant—compared with the case of low energy with no evidence or information to push up. Interestingly, this is a huge challenge from quantum mechanics' performance to figure out the better frontier for understanding stock return fluctuations, especially when extremes data are intensively mentioned, but distribution is elusive to find.

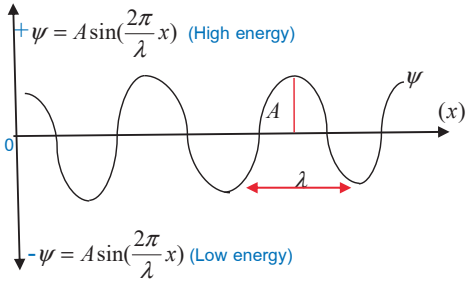

Figure 6. The wave function is based on the Schrödinger equation.

4.2. Extreme Value Analysis

Many distributions have been mentioned to model share returns as a whole observation (normal tail distributions). However, the weakness of the whole distribution is the missing of extreme tail losses. The Generalized Pareto Distribution (GDP) introduced by Pickands (1975) intentionally focuses on the threshold of the extreme losses by taking the negative of the log-returns and then choosing a positive threshold. The model assumes observations under the threshold, μ, is from a certain distribution with parameters η. $H(\cdot|\eta)$ is from a GPD. Thus, the distribution function f of any sample x can be expressed following Behrens et al. (2004) as

$$f(x|\eta,\xi,\sigma,\mu) = \begin{cases} H(x|\eta), & x < \mu \\ H(x|\eta) + (1 - H(\mu|\eta))G(x|\xi,\sigma,\mu), & x \geq \mu. \end{cases} \tag{26}$$

For an observation of size η, $x = (x_1, ..., x_n)$ from f, parameter vector $\theta = (\eta, \sigma, \xi, \mu)$, $N = [i : x_i < \mu]$, and $P = [i : x_i \geq \mu]$, the likelihood equation is

$$L(\theta; x) = \prod_N H(x|\eta) \prod_P (1 - H(x|\eta)) \left[\frac{1}{\sigma} \left(1 + \frac{\xi(x_i - \mu)}{\sigma} \right)_+^{-(1+\xi)/\xi} \right], \tag{27}$$

for $\xi \neq 0$, and for $\xi = 0$,

$L(\theta; x) = \prod_N H(x|\eta) \prod_P (1 - H(x|\eta))[(1/\sigma) \exp\{(x_i - \mu)/\sigma\}]$.

The threshold μ is the point where the density has a disruption. Depending on the parameters, the density jump can fluctuate positively or negatively, and in each case, the choice of which observations will be defined as exceedances that can be more obvious or obscure.

4.3. Bayesian Inference and Simulations for Value at Risk (VaR) and Expected Shortfall (ES)

Recall that the parameters in the extreme value model are $\theta = (\eta, \sigma, \xi, \mu)$. The prior and posterior distributions are respectively described as follows

4.3.1. The Origin of the Prior Information

Since expressing prior beliefs directly in terms of GPD parameters is a difficult task. The idea to deal with this problem is information within a parameterization on which

experts are familiar. Equation (1) can be re-written as an inversion; thus, we obtain the 1-p quantile of the distribution as follows

$$q = \mu + \frac{\sigma}{\xi}\left(P^{-\xi} - 1\right), \tag{28}$$

where q is defined as the level of returns associated with a return period of $1/p$ time units. The elicitation of the prior information is expressed in terms of (q_1, q_2, q_3), referring to as the location-scale parameterization of GPD, for specific values of $p_1 > p_2 > p_3$. Consequently, parameters are ordered and $q_1 < q_2 < q_3$. Therefore, the prior information is suggested by setting the median and 90% quantile estimations for specific values of p, for example.

Next, the elicited parameters are transformed to gain the equivalent gamma parameters, $d_i \sim Ga(\rho_i, \gamma_i)$ where $i = 1, 2, 3$ and the physical lower bound of the factor is $e_1 = q_0$. $e_1 = 0$ is preferable. The following gamma distributions with hyper parameters: $d_1 = q_1 \sim Ga(\rho_1, \gamma_1)$ and $d_2 = q_2 - q_1 \sim Ga(\rho_2, \gamma_2)$, knowing as the marginal prior distribution for σ and ξ, which is expressed as follows

$$\begin{aligned}\pi(\sigma,\xi)\alpha &\left[\mu + \tfrac{\sigma}{\xi}\left(p_1^{-\xi} - 1\right)\right]^{p_1-1} \exp\left[-\gamma_1\left\{\mu + \tfrac{\sigma}{\xi}\left(p_1^{-\xi} - 1\right)\right\}\right] \\ &\times \left[\tfrac{\sigma}{\xi}\left(p_2^{-\xi} - p_1^{-\xi}\right)\right]^{p_2-1} \exp\left[-\gamma_2\left\{\tfrac{\sigma}{\xi}\right\}\left(p_2^{-\xi} - p_1^{-\xi}\right)\right] \\ \times &\left[-\tfrac{\sigma}{\xi^2}\left\{(P_1P_2)^{-\xi}(\log P_2 - \log P_2) - P_2^{-\xi}\log P_2 + P_1^{-\xi}\log P_1\right\}\right],\end{aligned} \tag{29}$$

where ρ_1, ρ_2, γ_1, and γ_2 are hyper parameters obtained from the prior information. In the form of the median and some percentiles, the correspondences are the return periods of $\frac{1}{p_1}$ and $\frac{1}{p_2}$. The prior for q_1 is in the principle depended on μ. This dependence is substituted by the dependence on the prior mean of μ. Interestingly, in some cases, the situation where $\xi = 0$ is considered. For example, a positive probability is set, and the prior distribution evaluates a probability q if $\xi = 0$ and $1 - q$ if $\xi \neq 0$.

4.3.2. The Prior Density for Parameters at the Threshold

Apart from the information above the threshold, u is assigned to follow a truncated normal distribution with parameters $\left(u_\mu, \sigma_\mu^2\right)$, curtailed from below at e_1 with density as Equation (30)

$$\pi\left(\mu \middle| u_\mu, \sigma_\mu^2, e_1\right) = \frac{1}{\sqrt{2\pi\sigma_\mu^2}} \times \left\{\frac{\exp\left[-0.5(\mu - u_\mu)^2/\sigma_\mu^2\right]}{\Omega\left[-(e_1 - u_\mu)/\sigma_\mu\right]}\right\}, \tag{30}$$

with u_μ is included in some high percentile and σ_μ^2 is sufficient to present a reasonably noninformative prior. In other words, de Zea Bermudez et al. (2001) suggested that the higher level to set the prior distribution for μ, and this requires setting a prior distribution for the hyper thresholds.

4.3.3. Posterior Density Estimations

From the expression of the likelihood in Equation (27) and the priors, the posterior distribution is given from using Bayes theorem, which is combined with simulations (the MCMC methods via Metropolis–Hastings algorithms, (Metropolis et al. 1953)). To get hold

of a gamma distribution for data below the threshold, the functional form on the logarithm scale is derived as follows

$$\begin{aligned}\log p(\theta|x) = K &+ \sum_{i=1}^{n} I(x_i < \mu)[\alpha \log \beta - \log \tau(\alpha) + (\alpha-1)\log x_i - \beta x_i] \\ &+ \sum_{i=1}^{n} I(x_i \geq \mu) \log\left(1 - \int_0^{\mu} \tfrac{\beta^{\alpha}}{\tau(\alpha)} t^{\alpha-1} e^{-\beta t} dt\right) - \sum_{i=1}^{n} I(x_i \geq \mu) \log \sigma \\ &- \tfrac{1+\xi}{\xi} \sum_{i=1}^{n} I(x_i \geq \mu) \log\left[1 + \tfrac{\xi(x_i-\mu)}{\sigma}\right] \\ &+ (a-1)\log\alpha - b\alpha + (c-1)\log\tfrac{\alpha}{\beta} - d\left(\tfrac{\alpha}{\beta}\right) + \log\left(\tfrac{\alpha}{\beta^2}\right) \\ &- \tfrac{1}{2}\left(\tfrac{\mu-u_{\mu}}{\sigma_{\mu}}\right) - b_1\left[\mu + \tfrac{\sigma}{\xi}\left(p_1^{-\xi} - 1\right)\right] \\ &+ (a_2-1)\log\left[\mu + \tfrac{\sigma}{\xi}\left(p_2^{-\xi} - p_1^{-\xi}\right)\right] - b_2\left[u + \tfrac{\sigma}{\xi}\left(p_2^{-\xi} - p_1^{-\xi}\right)\right] \\ &+ \log\left\{-\tfrac{\sigma}{\xi}\left[(p_1 p_2)^{-\xi}(\log p_2 - \log p_1) - p_2^{-\xi}\log p_2 + p_1^{-\xi}\log p_1\right]\right\},\end{aligned} \tag{31}$$

where k is the normalizing constant. For the computation, making analytical posterior distributions depends on the convergence rate in each MCMC simulations case.

4.3.4. Risk Measurement

As the goal of the article is the risk analysis for a financial context. The famous Value at Risk (VaR) can summarize the worst loss over a target horizon with a given level of confidence and outline the overall market risk faced by an institution (Assaf 2009).

For extreme data analyses, the GPD continues to boundlessness. This kind of extreme distribution is not known with certainty in practice, but the Bayesian framework allows us to quantify this uncertainty. Expressly, the posterior predictive distribution follows

$$p\left(x^f \middle| x\right) = \int_{\theta} p\left(x^f \middle| \theta\right) p(\theta|x) d\theta. \tag{32}$$

If uncertainty regarding an unknown parameter is captured in a posterior distribution, a predictive distribution for any quantity μ that depends on the unknown parameter, through a sampling distribution, can be achieved by the Equation (33). In this case, $p\left(x^f \middle| x\right)$ mentions to an updated GDP observation obtained a set of parameters. The following transformation gives the updated information:

$$U \sim Uniform(0,1) \geq \log p(\theta|x) = \left[\left(U^{-e} - 1\right) + \frac{\sigma}{e} + \mu\right] \sim GPD(\mu, \sigma, e) \tag{33}$$

By the MCMC methods, a large number of large updating samples can be stimulated. In terms of the GDP, the Value at Risk (VaR) and Expected Shortfall (ES) can be the expression as follows:

$$VaR(1-\alpha) = \left(\alpha^{-e} - 1\right)\frac{\sigma}{e} + \mu, \tag{34a}$$

$$ES(1-\alpha) = VaR(1-\alpha) + \frac{\sigma\alpha^{-e}}{1-e}. \tag{34b}$$

These measures are ordered to obtain quantiles to create intervals. Note that since negative log share returns are included, which are the GPD above a suitable threshold, it is crucial to rescale α by multiplying by the divide between the number of observations and number of exceedances.

5. Computational and Comparative Results

5.1. Data Visualization

In this section, the historical data tries to explain the type of non-normal distributions. Table 1 details the log-return transformation, which assures the set of observed data

are stationary in long-term periods, and the Phillips-Perron (PP) unit-root test confirms this. Additionally, the expression to define the data set is not normally distributed is represented by the significant level of the Jarque–Bera test. All financial indexes reject the null hypothesis, which refers to the normal distribution.

Table 1. Descriptive statistics (original data).

	LOG_STI (Singapore)	LOG_SET (Thailand)	LOG_PSEI (Philippines)	LOG_PCI (Indonesia)	LOG_FTSE (Malaysia)
Mean	0.001480	0.000502	0.004399	0.010991	0.003793
Median	0.005334	0.001854	0.011447	0.016087	0.007192
Maximum	0.147158	0.154828	0.147340	0.161394	0.063923
Minimum	−0.181316	−0.188425	−0.166256	−0.213672	−0.087201
Std. Dev.	0.044216	0.056605	0.048931	0.051288	0.025348
Skewness	−0.228034	−0.514831	−0.455003	−0.714628	−1.066256
Kurtosis	6.995341	4.894663	4.245375	6.527976	5.221788
Jarque-Bera	67.37811	19.37479	9.912792	60.37246	39.51644
Probability	0.000000	0.000062	0.007038	0.000000	0.000000
PP-test statistics	−7.761860	−8.330687	−8.993564	−7.475574	−7.891177
Probability	0.000000	0.000000	0.000000	0.000000	0.000000

Source: authors.

5.2. The Distribution Outlook Comparison

In this crucial section, adapting from the contribution conducted by Gençay and Selçuk (2004), the threshold is set as 6%, which refers to the approximately understandable return of the stock exchanges. This is the prior information at the threshold line level that explicitly separates exceedance samples and risk-free samples. Shape and scale parameters are estimated from two comparative sources—an original observed distribution (Gaussian random walk) and quantum-wave distribution from each selected financial index. To compute the VaR model at 99% confidence and the corresponding expected shortfall, Table 2 represents the comparative outcome that indicates the modified distribution by applied quantum computing for Bayesian extreme value forecasting can capture missing information more efficiently than the traditional econometrics (Gaussian random walk process) because every DIC values indicate that the quantum distribution of five stock markets in five ASEAN countries is appropriate with the model of Bayesian extreme value prediction compared with data distribution based on the Gaussian random walk process.

Table 2. The model validation by Deviance Information Criterion (DIC).

		Data Distribution Based on Gaussian Random Walk	Data Distribution Based on the Wave Function
		DIC	DIC
Thailand	**(SET)**	−909.6436	−934.5987 *
Singapore	**(STI)**	−910.8061	−1089.0160 *
Malaysia	**(FTSE)**	−1288.4080	−1339.4820 *
Philippines	**(PSEI)**	−925.4325	−1032.0220 *
Indonesia	**(PCI)**	−960.8347	−1025.6590 *

Noted: * stands for the minimum value of DIC calculations. Source: authors.

5.3. Risk Measures by the Quantum Distribution

In Table 3, it seems to be clear that the risk projections estimated from data sourced by quantum-wave distributions; risk measurements calculated by the VaR model and corresponding expected shortfalls are reported by this table. First, the strong advantage of Bayesian posterior densities is the ability to provide random parametric intervals, which are more suitable for quantile settings in the GPD and random distributions in financial sectors. The 2.5% interval can be applied to stand for the case of risk aversions, the mean

(50%) indicates the risk-neutral case is mentioned, and the 97.5% interval pinpoints the risk lovers. In terms of the investors who need to maximize profits from the markets and protect the minimum risk as much as possible. For the predominant case, investing in Malaysia seems safer than the other four countries, the chance of failures is 16.78% in the case of risk taking, and the opportunity to loss equals 11.37% in risk-avoiding. This is supported by (Pero and Apandi 2018) to introduce Malaysia's leadership role in ASEAN. Malaysia can be deemed as a leader within ASEAN, championing several important policies in the international arena. On the other hand, Thailand's stock exchange is indicated to have the highest rate of losses in both the risk lover case and risk-avoiding case in ASEAN financial markets. The forecasting results are between 16.56% and 30%. Since the financial market partially depends on the situation of business confidence and the political atmosphere. The Thai stock exchange seems to absorb risks more than other ASEAN countries. For Singapore, the Philippines, and Indonesia, risk and return predictions are ranked in the third, fourth, and fifth, respectively. In the scenario of maximizing profit, 24.72% to 26.22% are approximately the taking losses when focusing on the investment in these three markets. Conversely, 14.32% to 15.20% are the chance of losses for the case of risk aversion.

Table 3. The extreme value prediction of Value at Risk (VaR) and Expected Shortfall (ES) is based on quantum mechanics.

		2.5%	Mean	97.5%
Thailand	VaR at 99% confidence (0.01)	0.1523	0.1940	0.2508
	Expected shortfall	**(−0.1656)**	**(−0.2201)**	**(−0.3000)**
Singapore	VaR at 99% confidence (0.01)	0.1287	0.1569	0.1982
	Expected shortfall	**(−0.1432)**	**(−0.1831)**	**(−0.2472)**
Malaysia	VaR at 99% confidence (0.01)	0.1080	0.1256	0.1496
	Expected shortfall	**(−0.1137)**	**(−0.1361)**	**(−0.1678)**
Philippines	VaR at 99% confidence (0.01)	0.1399	0.1691	0.2094
	Expected shortfall	**(−0.1544)**	**(−0.1941)**	**(−0.2529)**
Indonesia	VaR at 99% confidence (0.01)	0.1377	0.1702	0.2148
	Expected shortfall	**(−0.1520)**	**(−0.1960)**	**(−0.2622)**

Source: authors.

6. Conclusions

Most economic collapses have appeared in many computational predictions relied on raw observed distributions, which are still common sense for traditional econometrics research. The concept of the Gaussian random walk process continues to be suspicious, especially econometrics for stock predictions. In other words, the assumption of distributional normality is sensibly understandable, but it is sensitive to face suspicious predicted outcomes. At the center of the research gap to determine the origin of real data distributions, this article contributes to quantum mechanics applied for matching the wave function, which is relevant to the fundamental processes of thoughts. For this article, risk management in financial analyses is one of the top issues people have struggled to eliminate unquestionably.

Every level of complexities in data science potentially empowers the ability to capture missing information of the quantum-wave distribution. Expressly, the distribution generated by the quantum mechanics done in the wave equation is compatible with Bayesian inference for measuring risks and expected shortfall predictions, especially when exploring for preciseness in ASEAN financial markets. The comparison of DIC strongly secures this statement. With the quantum distribution, it is sensible to state that a realistic parameter is found, a harmonic inference regarding humans' decision making can be computed, and a meticulous estimation for dealing with extreme tails information in raw data can be demonstrated numerically. In conclusion, the quantum distribution can potentially fix the

gap of missing information in data analyses, especially modern econometrics in financial research.

For upcoming research, applying quantum computations in social science is more challenging. The clue that the quantum distribution can give more real observations is the research changer in the age of big-data analyses. The future plan for installing the novel distribution into behavioral economic research and financial econometrics is the major issue that critically confronts traditional aspects.

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