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Measuring Financial Contagion and Spillover Effects with a State-Dependent Sensitivity Value-at-Risk Model

Alin Marius Andries * and Elena Galasan

Faculty of Economics and Business Administration, Alexandru Ioan Cuza University of Iasi and Institute for Economic Forecasting, Romanian Academy, 22 Carol I Boulevard, 700505 Iasi, Romania; galasan.elena@gmail.com

* Correspondence: alin.andries@uaic.ro

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Abstract: In this paper, we measure the size and the direction of the spillover effects among European commercial banks, with respect to their size, geographical position, income sources, and systemic importance for the period from 2006 to 2016, using a state-dependent sensitivity value-at-risk model, conditioning on the state of the financial market. Low during normal times, the same shocks cause notable spillover effects during the volatile period. The results suggest a high level of interconnectedness across all the European regions, highlighting the importance of large and systemic important banks that create considerable systemic risk during the entire period. Regarding the non-interest income banks, the outcomes reveals an alert signal concerning the spillovers spread to interest income banks.

Keywords: financial contagion; risk spillovers; European commercial banks

JEL Classification: G01; G10; G21

1. Introduction

An important lesson from the 2007–2008 financial crisis is that banking regulation should be based on macroprudential level, rather than on individual financial institutions. Financial distress spread with a disastrous speed from the banking system to the real economy and affected the global financial stability. Acharya (2009) explain that the oversights in bank capital regulation caused the transfer of risk between financial and nonfinancial markets. Other proponents describe this phenomenon using the terms “contagion” and “negative spillovers”. The last financial crisis highlighted the impact of contagion risk on the economy, acting as a highly dangerous virus that contaminates all the cells in the body.

Despite the regulations imposed by Basel III, banks are not sufficiently focused on systemic risk. Gropp and Moerman (2004) argue that distress in one banking system conveys across borders to other banking systems. Furthermore, Billio et al. (2012) found that banks are the main transmitters of shocks within four categories of financial institutions (banks, insurance companies, hedge funds, and brokers).

The main reason that the subprime crisis was so deep and widespread is systemic risk and, thereafter, the global network that led to the spread of financial instability due to the contagion risk. Allen and Gale (2000) define “contagion” as a consequence of excess spillover effects, exemplifying that a banking crisis in one region may spill over to other regions. Thus, after the failure of a number of European banks and decline in indices, it became clear that the great financial crisis has shifted to Europe. For instance, the contagion risk measurement became one of the most important concerns on the daily agenda.

Given that commercial banks are responsible for the sustainable growth of the economy, receiving funds, and providing resources to households and companies, we consider them the most important transmitters of contagion to the real economy; hence, motivating us to research how the contagion spread between the banks, based on their characteristics. We built the main pillars of our paper starting with the identification of the major drivers of contagion such as size, systemic importance, geographical positioning, and income source. The size and systemic importance have been proven as contagion catalysts. Moreover, researchers provide evidence that non-interest income banks generate more systemic risk, therefore they can be contagiously dangerous for traditional banks. Previous literature studied the relation between Western European banks and Eastern European banks and found that Eastern banks suffered troubles caused by shocks in Western banks. Thereafter, the lack of a more detailed evidence of the behavior of spillovers inside of the mentioned sub-groups gives us the incentive to go further and to study them in a more detailed manner.

In this paper, we apply the state-dependent sensitivity Value at Risk model (SDSVaR) method developed by Adams et al. (2014), in order to measure the size and the direction of spillover effects across European commercial banks. We consider a sample of 228 European commercial banks and we measure the spillover effects with respect to four criteria: Geographical positioning (North, South, West, East), size (small, medium, large), income source (interest, non-interest), and systemic importance (global systemically important banks, other systemically important banks). Focusing on the categorization stated above, we built an index for each subgroup. Thus, the intra-group spillover effects mean the shocks spread by one subgroup to another.

The remainder of the paper is organized as follows. Section 2 presents an overview of the literature and the statement of hypotheses, Section 3 describes the data used and the appropriateness of the model, Section 4 provides the results, and finally, Section 5 concludes the research.

2. Literature Review and Statement of Hypotheses

During turmoil, spillover effects are spread in a different manner and with a distinct intensity. Sachs et al. (1996) express financial contagion as an excessive increase in cross-border correlations of volatilities and stock returns. Pritsker (2000) and Dornbusch et al. (2000) define contagion as the propagation of market anomalies, with negative effects, from one market to another. Scholars affirm that a significant increase in the correlation among the countries that trigger the shocks and all other countries that receive them is equivalent with the existence of contagion. Bekaert et al. (2005) explain contagion in equity markets as the co-movement of markets more closely during distress periods. Masson (1998) is more specific and describes contagion as only those disseminations of crises that cannot be recognized with identified changes in macroeconomic principles.

Literature makes a distinction between macroeconomic fundamentals and contagion. Forbes and Rigobon (2001) state that contagion is a significant growth in cross-market connections after a shock. Usually, this definition is mentioned as shift-contagion, but researchers specify that this definition of contagion excludes a permanent high degree of co-movement in a turmoil period. Thus, meaning that markets are just interdependent. Interdependence is a high degree of market co-movement in a period of stability without any shocks. Meanwhile, literature does not make a clear difference between contagion and spillover effects. As have many scholars, we adopt the definition proposed by Allen and Gale (2000) who interpret contagion as a consequence of excess spillovers, thus spillover effects are a compulsory condition for contagion, but not the only one. Therefore, it is mandatory to differentiate between normal and dangerous spillovers. Abnormal spillovers characterize an afflicted market and can cause financial instability, meaning a source of contagion and systemic risk. The pattern and magnitude of financial contagion depends on markets' sensitivity to macroeconomic and microeconomic risk factors. Bad bank management, in particular inappropriate governance (Kirkpatrick 2009), unreasonable risk (Demsetz et al. 1997), size priority rather than performance (Boyd and Runkle 1993), and liquidity inadequacy (Bird and Rajan 2001) are only few examples of spillover drivers.

Studying historical financial crises, Allen et al. (2009) found that the failure of important and interconnected financial organizations such as Lehman Brothers, makes investors more careful when assessing risk. Because of this reason, other institutions may be hit, regardless of whether they are interconnected. Therefore, the participants are fearful of entering into the cascade. Billio et al. (2012) found that banks are the main transmitters of shocks, while researching the connectedness between hedge funds, insurance companies, brokers, and banks using principal component analysis and Granger causality networks. However, this network has a static character and does not allow the comparison of shocks in time. Diebold and Yilmaz (2009, 2012) develop a General Vector Autoregression (GVAR) approach in order to quantify total and directional volatility spillovers from and to four assets classes: Stocks, bonds, foreign exchange, and commodities. Their results show that after the collapse of Lehman Brothers, the volatility spillovers from stock market to all other markets increased significantly. Ballester et al. (2016) apply their methodology for the bank CDS market and discover supporting evidence of contagion in banking markets. De Bruyckere et al. (2013) use excess correlations to measure bank/sovereign risk spillovers in the European debt crisis and they found significant empirical evidence of contagion between bank and sovereign credit risk. Giudici and Parisi (2018) propose a novel credit risk measurement model for corporate default swap (CDS) spreads that combines vector autoregressive regression with correlation networks.

Recently, a new strand of literature has emerged, making use of network graphs in order to describe the interdependence between markets/institutions. Diebold and Yilmaz (2014) propose connectedness measures based on variance decomposition and apply them to US financial institutions' stock return volatilities. Singh (2017) capture conditional variance of Indian banking sector's stock market returns employing different GARCH-based symmetric and asymmetric models. Giudici and Abu-Hashish (2019) use a new model based on a correlation network VAR process that models the interconnections between different crypto and classic asset prices. Peltonen et al. (2019) employ macro-networks to measure the interconnectedness of the banking sector and document that a more central position of the banking sector in the network significantly increases the probability of a banking crisis.

On the same subject line, Gorton and Metrick (2012) and Caballero and Simsek (2013) promote the idea that contagion is not only an issue of direct connection, but also the affiliation to a complex network.

The heterogeneous and non-linear character of European banking system has been one of the major causes of the high degree of cross-regional contagion during the last financial crisis. The main vulnerability is that ECB cannot solve the problem by taking a unique decision for all the countries. Moreover, Gropp and Kadareja (2012) argues that the introduction of euro coins and banknotes in 2002 increased the probability of contagion risk among Euro area. In this context, the collapse of the housing market in US affected Western Europe due to the concentration of foreign capital in banks. Therefore, the Eastern region had to suffer the most given the 60% of foreign direct investments came from the volatile Western European banks.

Cocozza and Piselli (2011) argue that the interconnectedness between Western and Eastern European banks strengthened with the increase in foreign banks presence in Eastern Europe, with 60% of foreign direct investments in Eastern Europe being from West. In their paper, they use the distance to default method on a sample of 33 listed European banks to analyze the contagion risk in Western and Eastern European banking sector. The results show that before the crisis, contagion was limited to the most important Western banks while the contagion between the regions was less likely. However, during the crisis, the pattern changed, and researchers found evidence of contagion from East to West but with a much lower intensity. They also assume two transmission mechanisms, direct linkages in the interbank markets and informational spillovers as an outcome of market perspective and expectation about banks.

As we believe that the high degree of interconnectedness in the European banking system led to a much complex transmission track of contagion, we want to go further and we state our first hypothesis.

Hypothesis 1. *Due to the interconnectedness of the interbank market, shocks from Western European Banks spill over all the European regions with a higher magnitude in distress periods.*

Laeven et al. (2016) and Varotto and Zhao (2018) agree that another important determinant of contagion risk is the bank size. Varotto and Zhao (2018) observed that typical systemic risk indicators are primarily powered by firm size, drawing a major attention to "too-big-to-fail" institutions. However, the Northern Rock example showed that smaller banks might still threaten the financial system. After 1990s, the size of large banks increased significantly as a result of their involvement in trading activities. Large banks became more complex, while keeping lower capital and practicing more market activities. This suggests that large banks may have a weaker business model. Laeven et al. (2016) say that large banks create more systemic risk than individual risk when they are involved in non-traditional activities. Moreover, a default of a large bank is more destructive to the banking system. However, their opinion with respect to the optimal bank size is inconclusive, because of the differences in regulatory treatment and difficulties in implementation.

In our paper, we use total assets and market value as measures for bank size. We expect different results between the two approaches. In the first case, the health of the bank is expressed through the amount of assets on balance sheet, while in the second case, the size of the bank is reflected in the stock price, which is a subjective perception of the market about the value of the bank, it might be undervalued or overvalued. At this point, the second and the third hypotheses are:

Hypothesis 2. *Large European banks are highly connected in terms of contagion and spillover effects with small banks during the entire period, while small banks create significant spillovers only in volatile periods.*

Hypothesis 3. *European banks with high market values transmit stronger spillovers to banks with medium and low market values in normal and tranquil times comparing to crises times.*

The next point of interest is whether the type of bank activities (traditional or non-traditional) contribute to contagion risk. The core bank activities, namely, deposit taking and lending, are essential for the capital supply in the economy. However, before the crisis, banks tended to earn an important share of their revenues from non-interest income. Non-interest income consists of income from investment banking and advisory fees, venture capital, gains on non-hedging derivatives, fiduciary income, trading and securitization, and brokerage commissions. These operations are distinct from the main business of taking deposits and lending. Therefore, it is obvious that in pursuit of new sources of income, banks started to compete with other financial institutions such as insurance companies, mutual funds, hedge funds, and investment banks. From 1989 to 2007, the average non-interest income to interest income ratio increased around three times, from 0.18 to 0.59.

Brunnermeier et al. (2019) analyze the contribution of non-interest income to systemic bank risk applying the ΔCoVaR measure and the systemic expected shortfall (SES) measure. The results show that banks with a higher non-interest-income-to-interest-income ratio are subject to higher systemic risk. A one-standard-deviation shock to a bank's non-interest-income-to-interest-income ratio increases its systemic risk contribution by 11.6% in ΔCoVaR and 5.4% in SES. These findings lead us to the fourth hypothesis.

Hypothesis 4. *European Banks with a higher non-interest income to interest income ratio spread notably higher spillovers than banks with a lower ratio, especially in volatile times.*

The default of Lehman Brothers emphasized the crucial impact on financial stability of the crash of an important financial institution. The Financial Stability Board (Financial Stability Board 2011) defines systemically important financial institutions as "financial institutions whose distress or disorderly failure, because of their size, complexity and systemic interconnectedness, would cause significant disruption to the wider financial system and economic activity". In 2011, FSB acted by emitting a set of policy in order to approach systemic and moral hazard risks related to global systemically important banks (G-SIBs). G-SIBs were determined by a methodology proposed by Basel Committee. Given the fact that 13 out of 30 G-SIBs are located in Europe (PNB Paribas, Unicredit, Societe Generale, Deutsche Bank, and others), their role during the crisis has been more than significant. Mink and Haan (2014) address this issue in order to analyze the extent in which banks' market values were influenced by changes in default risks of G-SIBs. Their results suggest that G-SIBs market values respond vaguely to the increases in the default risk of individual banks, while it is highly explained by changes in G-SIBs default risk. Therefore, we analyze the extent in which a shock in other systemically important institutions (O-SIBs) leads to further shocks in volatilities of G-SIBs and vice-versa and state the fifth hypothesis.

Hypothesis 5. *A shock in O-SIBs leads to lower but still important further shocks in G-SIBs than vice-versa, with a notable magnitude in volatile times.*

3. Data and Methodology

3.1. Data

The last financial crisis hit the large European banks in the early stage; afterward, the phenomenon of financial contagion spread to medium- and small-sized banks from all four regions (West, East, North, and South). In order to study the financial contagion track across European banks in depth, we selected a sample that consisted of daily stock prices for 228 European commercial banks for the period 31 December 2004–30 December 2016. The data are collected from Datastream, Thomson Reuters, and Orbis Bankscope.

Consequently, we investigated how the spillovers propagated in compliance with the bank size, geographical position, income source, and systemic importance. With this purpose, we grouped the bank performance into indices based on this criterion: Position (West, East, North, South), size (large, medium, and small and poorly capitalized, well capitalized, and highly capitalized), income source (interest or non-interest), and systemic importance (global systemically important banks or other systemically important banks). The list of the banks included in indices is presented in Appendix A. We compared daily return distributions and time series of the own indices with Stoxx Europe 600, in order to check if they were truly representative. As a result, indices followed the pattern of the Stoxx Europe 600, with some differences in the *Eastern European Index.* This fact could bias the results, but the error is likely to be small.

We split the banks into indices in order to test the five hypotheses. The number of banks considered when addressing each of them is different. Data that we used as filter in order to divide the banks into indices (total assets, market capitalization, non-income to income ratio) were not available for all the banks; for this reason, the sample size for each criterion varied.

Western European Banks Index contains 58 banks, Eastern European Banks Index—52, Northern European Banks Index—63, and Southern European Banks Index—55.

According to the size, the banks are grouped based on value of total assets, which is the most prominent size indicator by central bankers and financial supervisors. In our case, banks with the value of total assets lower than 10 million are considered as small, in the interval from 10 million to 1 billion are medium, and those that exceed this threshold are considered large banks. In consequence, *Small European Banks Index* includes 96 institutions, *Medium European Banks Index*—116 institutions, and *Large European Banks Index*—11 institutions.

We used market capitalization as another way to group the banks with respect to their size. The banks with a market value below the median were considered poorly capitalized, those with the market value between the median and the quantile 0.75 were considered to be well capitalized, and the banks that were positioned above were highly capitalized. Taking into account that through this method, different banks are included, the results are distinct. Therefore, in the category of *poorly capitalized* *banks* are included *80 institutions*, *well capitalized banks—82 institutions*, and *highly capitalized banks—66 institutions.*

In order to classify the European commercial banks according to their income source, we computed non-interest-income-to-interest-income ratio. Banks with the percentage of non-interest income higher than 30% were considered as non-traditional. Empirical evidence shows that non-traditional banks generate more systemic risk than traditional ones. Consequently, we will point out the magnitude of spillover effects spread by non-interest focused banks comparing to interest focused banks. The class of *traditional banks* contains *86 institutions* and the class of *non-traditional banks—31 institutions*.

When we refer to banks' systemic importance, there are two categories: Global systemically important banks (G-SIBs) and other systemically important banks (O-SIBs). At the level of European Union, domestic systemically important banks (D-SIBs) are considered as O-SIBs. In our sample, there were present *12 G-SIBs and 33 O-SIBs* wherewith we determine the mutual impact during tranquil, normal, and volatile states of financial markets

The indices were market-capitalization weighted. The computation method was according to the Laspeyres formula, which assess price changes against a constant base quantity weight. Each index has a unique index divisor, which is adjusted to maintain the continuity of the index's values across changes due to corporate actions.

$$Index_t = \frac{\sum_{t=1}^{n}(p_t * s_{it} * ff_{it} * cf_{it} * x_{it})}{\boldsymbol{D_t}} = \frac{M_t}{\boldsymbol{D_t}}$$

where:

t = time the index is computed;
n = number of companies in the index;
p_{it} = price of company (i) at time (t);
s_{it} = number of shares of company (i) at time (t);
ff_{it} = free float factor of company (i) at time (t);
cf_{it} = weighting cap factor of company (i) at time (t);
x_{it} = exchange rate from local currency into index currency for company (i) at time (t);
M_t = free float market capitalization of the index at time (t);
$\boldsymbol{D_t}$ = Divisor of the index at time (t), where the index devisors are calculated as follows:

$$\boldsymbol{D_{t+1}} = \boldsymbol{D_t} * \frac{\sum_{i=1}^{n}(p_{it} * s_{it} * cf_{it} * x_{it}) \pm \Delta MC_{t+1}}{\sum_{i=1}^{n}(p_{it} * s_{it} * cf_{it} * x_{it})}$$

where:

$\boldsymbol{D_{t+1}}$ = Divisor at time (t+1);
$\boldsymbol{D_t}$ = Divisor at time (t);
$\boldsymbol{n}$ = number of companies in the index;
p_{it} = price of company (i) at time (t);
s_{it} = number of shares of company (i) at time (t);
ff_{it} = free float factor of company (i) at time (t);
cf_{it} = weighting cap factor of company (i) at time (t);
x_{it} = exchange rate from local currency into index currency for company (i) at time (t);
$\Delta \boldsymbol{MC_{t+1}}$ = The difference between the closing market capitalization of the index and the adjusted closing market capitalization of the index.

3.2. Methodology

The next step was to include the obtained indices in the main model: A state-dependent sensitivity VaR model (SDSVaR). This approach was developed by Adams et al. (2014) and has been used to measure the spillover coefficients among financial institutions. This paper brought important contributions to the literature. Their two-stage quantile regression enables to identify spillover effects, opposed to common shocks that affect the entire financial system; permits to follow the direction of the spillover and its magnitude from tranquil to turmoil state of the economy; emphasizes the role of hedge funds as amplifier of systemic risk; and allows to quantify intra-month spillover effects between different sets of financial institutions.

The methodology involves estimating value-at-risk measures for indices that, in turn, are employed as inputs in a quantile regression.

First, we estimated the VaR measures for each index.

$$\widehat{VaR}_m = \hat{\mu}_{m,t} + z\hat{\sigma}_{m,t}$$

where $\hat{\mu}_{m,t}$ represents the mean estimated in a rolling window of 500 days of index m at time t, Z is the z-score value for the 99% confidence interval, and $\hat{\sigma}_{m,t}$ is the conditional standard deviation extracted from GARCH model. This practice fits better the sensitivity of VaR to changes in the returns. Given the rolling window that we used in estimating the mean, we lose 499 observations, thus $\hat{\sigma}_{m,t}$ is computed for the period May 2006–December 2016.

Thereafter, the individual value-at-risk measures serve as inputs in the quantile regressions. Thus, $\widehat{VaR}_m$ becomes the dependent variable $\widehat{VaR}_{Y,\ t,\theta}$ and it is modeled by the VaR values of the other indices, by its own lag and by the VaR values of the control variables. The parameters are estimated using two-stage quantile regression, where θ represents the states of financial markets: Tranquil, normal, and volatile. Thus, we run the same regression three times, once for each state of the economy in order to capture the change in spillovers as the state of the economy changes.

Based on the selected criteria, we run the following regressions:

1. Geographical position

   i. $\widehat{VaR}_{North,\ t,\theta} = \alpha_{1,\theta} + \beta_{1,\theta}\widehat{VaR}_{South,t} + \beta_{2,\theta}\widehat{VaR}_{East,t} + \beta_{3,\theta}\widehat{VaR}_{West,t} + \gamma_{1,\theta}\widehat{VaR}_{North,t-1} + u_{North,t}$

   ii. $\widehat{VaR}_{South,\ t,\theta} = \alpha_{2,\theta} + \beta_{4,\theta}\widehat{VaR}_{North,t} + \beta_{5,\theta}\widehat{VaR}_{East,t} + \beta_{6,\theta}\widehat{VaR}_{West,t} + \gamma_{2,\theta}\widehat{VaR}_{South,t-1} + u_{South,t}$

   iii. $\widehat{VaR}_{West,\ t,\theta} = \alpha_{3,\theta} + \beta_{7,\theta}\widehat{VaR}_{South,t} + \beta_{8,\theta}\widehat{VaR}_{East,t} + \beta_{9,\theta}North + \gamma_{3,\theta}\widehat{VaR}_{West,t-1} + u_{West,t}$

   iv. $\widehat{VaR}_{East,\ t,\theta} = \alpha_{4,\theta} + \beta_{10,\theta}\widehat{VaR}_{South,t} + \beta_{11,\theta}\widehat{VaR}_{North,t} + \beta_{12,\theta}\widehat{VaR}_{West,t} + \gamma_{4,\theta}\widehat{VaR}_{East,t-1} + u_{East,t}$

2. Size (defined by total assets volume)

   v. $\widehat{VaR}_{Large,\ t,\theta} = \alpha_{5,\theta} + \beta_{13,\theta}\widehat{VaR}_{Small,t} + \beta_{14,\theta}\widehat{VaR}_{Medium,t} + \gamma_{5,\theta}\widehat{VaR}_{Large,t-1} + u_{Large,t}$

   vi. $\widehat{VaR}_{Medium,\ t,\theta} = \alpha_{6,\theta} + \beta_{15,\theta}\widehat{VaR}_{Small,t} + \beta_{16,\theta}\widehat{VaR}_{Large,t} + \gamma_{6,\theta}\widehat{VaR}_{Medium,t-1} + u_{Medium,t}$

   vii. $\widehat{VaR}_{Small,\ t,\theta} = \alpha_{7,\theta} + \beta_{17,\theta}\widehat{VaR}_{Large,t} + \beta_{18,\theta}\widehat{VaR}_{Medium,t} + \gamma_{7,\theta}\widehat{VaR}_{Small,t-1} + u_{Small,t}$

3. Size (defined by market capitalization)

   viii. $\widehat{VaR}_{HighCap,\ t,\theta} = \alpha_{8,\theta} + \beta_{19,\theta}\widehat{VaR}_{WellCap,t} + \beta_{20,\theta}\widehat{VaR}_{PoorCap,t} + \gamma_{8,\theta}\widehat{VaR}_{HighCap,t-1} + u_{HighCap,t}$

   ix. $\widehat{VaR}_{WellCap,\ t,\theta} = \alpha_{9,\theta} + \beta_{21,\theta}\widehat{VaR}_{HighCap,t} + \beta_{22,\theta}\widehat{VaR}_{PoorCap,t} + \gamma_{9,\theta}\widehat{VaR}_{WellCap,t-1} + u_{WellCap,t}$

   x. $\widehat{VaR}_{PoorCap,\ t,\theta} = \alpha_{10,\theta} + \beta_{23,\theta}\widehat{VaR}_{WellCap,t} + \beta_{24,\theta}\widehat{VaR}_{HighCap,t} + \gamma_{10,\theta}\widehat{VaR}_{PoorCap,t-1} + u_{PoorCap,t}$

4. Income source

   xi. $\widehat{VaR}_{IntInc,\ t,\theta} = \alpha_{11,\theta} + \beta_{25,\theta}\widehat{VaR}_{NIntInc,t} + \gamma_{11,\theta}\widehat{VaR}_{IntInc,t-1} + u_{IntInc,t}$

xii. $\widehat{VaR}_{NIntInc,\ t,\theta} = \alpha_{12,\theta} + \beta_{26,\theta}\widehat{VaR}_{IntInc,t} + \gamma_{12,\theta}\widehat{VaR}_{NIntInc,t-1} + u_{NIntInc,t}$

5. Systemic importance

xiii. $\widehat{VaR}_{G-SIB,\ t,\theta} = \alpha_{13,\theta} + \beta_{27,\theta}\widehat{VaR}_{O-SIB,t} + \gamma_{13,\theta}\widehat{VaR}_{G-SIB,t-1} + u_{G-SIB,t}$

xiv. $\widehat{VaR}_{O-SIB,\ t,\theta} = \alpha_{14,\theta} + \beta_{28,\theta}\widehat{VaR}_{G-SIB,t} + \gamma_{14,\theta}\widehat{VaR}_{O-SIB,t-1} + u_{O\_SIB,t}$

In fact, we obtain as many equations as variables, meaning that the computed VaR for each index will become a dependent variable and the others will be independent.

The goal of the research is to estimate the spillover coefficients: $\beta'_{North,\theta} = (\hat{\beta}_{1,\theta}, \hat{\beta}_{2,\theta}, \hat{\beta}_{3,\theta})$; $\beta'_{South,\theta} = (\hat{\beta}_{4,\theta}, \hat{\beta}_{5,\theta}, \hat{\beta}_{6,\theta})$; $\beta'_{West,\theta} = (\hat{\beta}_{7,\theta}, \hat{\beta}_{8,\theta}, \hat{\beta}_{9,\theta})$; $\beta'_{East,\theta} = (\hat{\beta}_{10,\theta}, \hat{\beta}_{11,\theta}, \hat{\beta}_{12,\theta})$; $\beta'_{j,\theta} = (\hat{\beta}_{4,\theta}, \hat{\beta}_{5,\theta})$; $\beta'_{k,\theta} = (\hat{\beta}_{7,\theta}, \hat{\beta}_{8,\theta})$ and so forth, obtaining 14 sets of spillovers, and to analyze the extent in which shocks in one subgroup of banks affect the health of another one depending on the listed criteria. Thereafter, we perform the Granger causality test in order to examine the trajectory of spillovers.

4. Results

In this section, we present the results for the estimated equations stated above. The point of interest is represented by the spillover coefficients. The database consists of daily data from 31 December 2004 to 30 December 2016 in order to cover tranquil, normal, and volatile market periods. First, the market conditions are described as 75% quantile for tranquil state, 50% quantile for normal state, and 12.5% quantile for volatile state. Adams et al. (2014) explain that during tranquil market times risk spillovers are approximately zero so that the choice of a specific upper quantile has no significant impact on the outcomes. Likewise, 50% quantile is appropriate for normal market times. Given that their empirical results were more sensitive to lower quantiles because of outliers, they decided on the 12.5% quantile, which measures in the best way the tails of the VaR distribution where the largest spillovers occur. In the regressions, we included three lags of the dependent variable (bank index that is receiving spillovers) to verify for contemporaneous effect; we found the first two lags to be significant for 1% confidence interval and the third to be significant only for a few of them.

In the intention to identify the direction of spillovers, we performed a Granger causality test for the entire period sample. The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. We use the Granger Test for causality technique, in order to follow the direction of causality between the spillovers spread from one category of banks to another.

4.1. Geographical Positioning

First, we discuss the results based on the geographical position criterion. It is interesting to follow the spread of spillover effects across the European regions, taking into account that previous literature studied the relation between Western and Eastern regions only. Our results are more comprehensive and show a detailed picture. The outcomes highlight that the Western part has the most important impact on the financial health of the market. During the turmoil period, it receives and transmits significant and the most severe shocks to all the regions, while during normal and tranquil times, it gets shocks only from the South and spread to South and East, but with a lower magnitude. Southern Europe is the most active contagion broadcaster, and it spreads significant spillovers to all the regions in all the states of the economy (except East in distress period). Results highlight a high interdependence between South and West during crises; for the 12.5% quantile, South receives the harshest spillovers—0.47 ppt for an increase of 1 ppt in Western Banks' volatility—while a 1 ppt increase in Southern banks' volatility leads to an increase of 0.31 ppt in the Western banks' volatility. Moreover, results show that the spillover coefficients are decreasing as the financial health of the market is increasing. A 1 ppt increase in the Southern European Index volatility leads to 0.31 ppt increase in Western European Banks Index during turmoil period, to 0.17 ppt in normal times, and to 0.13 ppt in tranquil times. Eastern Europe receives severe shocks from North and West during volatile times and responds with weak spillovers to West. According to the outcomes, North seems to be the most stable region from Europe in terms of contagion. It spreads significant but very low shocks during normal and tranquil times (0.08 ppt to East and 0.02 ppt to South), with a higher impact on East during distress (0.18 ppt); and receives moderate spillovers from South (0.12 ppt) and West (0.13 ppt) during the volatile period.

Using tertiles instead of quantiles as a way to define the states of the financial markets enforces the relationship between the Western and Southern banks and highlight the role of the Southern banks in generating shocks during the volatile periods, while the Western banks have a more profound effect during tranquil times, with all the coefficients being significant for 1% confidence level. The evidence is consistent with Hypothesis 1, which says that spillovers from Western European Banks affect all other regions with a higher magnitude in distress periods. The results are summarized in Table 1.

Table 1. Spillover coefficients of the state-dependent sensitivity VaR model (SDSVaR) model, based on geographical position.

From . . . to . . .	**East**	**North**	**South**	**West**
Volatile period (0.125)				
East		0.1894 ***	0.0969	0.1691 ***
North	0.0150		0.1240 ***	0.1387 ***
South	0.0247	0.0486		0.4748 ***
West	0.0178 ***	0.0797 ***	0.3114 ***	
Normal period (0.5)				
East		0.0877 **	0.1202 ***	0.0529 **
North	0.0068		0.0367 **	0.0269
South	0.0128 **	0.0222 *		0.1699 ***
West	0.0009	0.0074	0.1670 ***	
Tranquil period (0.75)				
East		0.0868 **	0.1772 ***	0.0104
North	0.0077 **		0.0335 **	0.0027
South	0.0076 **	0.0172 *		0.1213 ***
West	0.0008	0.0029	0.1328 ***	

*** Significance for 1%; ** Significance for 5%; * Significance for 10%.

Granger causality test shows that banking systems from all the regions Granger cause each other except the Northern side that is not caused by Southern and Eastern side for a 95% confidence level. The results are summarized in Table 2.

Table 2. Granger causality test for the geographical position criterion.

Hypothesis	**Coefficient**	**Probability**
Spillovers from WEST does not Granger Cause Spillovers from EAST	5.45868	0.0000 ***
Spillovers from EAST does not Granger Cause Spillovers from WEST	3.05564	0.0056 ***
Spillovers from NORTH does not Granger Cause Spillovers from EAST	7.67281	0.0000 ***
Spillovers from EAST does not Granger Cause Spillovers from NORTH	1.96942	0.0666 *
Spillovers from SOUTH does not Granger Cause Spillovers from EAST	5.00073	0.0000 ***
Spillovers from EAST does not Granger Cause Spillovers from SOUTH	4.04704	0.0005 ***
Spillovers from NORTH does not Granger Cause Spillovers from WEST	4.83235	0.0000 ***
Spillovers from WEST does not Granger Cause Spillovers from NORTH	8.76000	0.0000 ***
Spillovers from SOUTH does not Granger Cause Spillovers from WEST	2.18982	0.0412 **
Spillovers from WEST does not Granger Cause Spillovers from SOUTH	6.49295	0.0000 ***
Spillovers from SOUTH does not Granger Cause Spillovers from NORTH	1.08900	0.3664
Spillovers from NORTH does not Granger Cause Spillovers from SOUTH	5.96121	0.0000 ***

*** Significance for 1%; ** Significance for 5%; * Significance for 10%.

4.2. Size (Total Asstes)

The empirical evidence shows that large banks generate more risk than smaller banks, but the individual risk created is lower than the systemic risk. We want to be more specific and to quantify the bi-directional effect and state our second hypothesis that says that large European banks are highly connected in terms of contagion and spillover effects with small banks during the entire period, while small banks create significant spillovers only in volatile periods. In order to test this hypothesis, we repeat the procedure for the new indices based on the size of the banks. The results presented in Table 3 enforce this hypothesis, by showing highly significant spillover coefficients transmitted during all the scenarios, especially during turmoil periods. While small banks are affected uniformly over the three states, medium-sized banks receive a huge shock during the volatile times. An increase with 1 ppt in the large banks' volatility increases the volatility of medium-sized banks with 0.48 ppt. During the crisis period, large banks are hit by the distress in small banks. An increase of 1 ppt in small banks' volatility augments the large banks' volatility with 0.37 ppt. The significant number of small banks, which connect with large banks, may explain this fact. As Allen and Gale (2000) mention in their work, large banks are better diversified and are assumed immune, but a failure in such an institution may provoke a domino effect in the banking system also called systemic effect.

Table 3. Spillover coefficients of the SDSVaR model, based on the total assets measure of the size.

From . . . to . . .	**Small**	**Medium**	**Large**
Volatile period (0.125)			
Small		0.0465	0.1168 **
Medium	0.0012 ***		0.4794 ***
Large	0.3669 ***	0.0014	
Normal period (0.5)			
Small		0.0495 **	0.1257 ***
Medium	0.0058 ***		0.1440 ***
Large	0.0006	0.0915 ***	
Tranquil period (0.75)			
Small		0.0689 ***	0.1296 ***
Medium	0.0074 ***		0.1001 ***
Large	0.0011	0.0437 ***	

*** Significance for 1%; ** Significance for 5%

Granger causality shows that the shocks received in large banks Granger cause shocks in medium banks and shocks in medium banks Granger cause shocks in small banks. The results are summarized in Table 4.

Table 4. Granger causality test for the size criterion, measured by total assets.

Hypothesis	**Coefficient**	**Probability**
Spillovers from MEDIUM banks does not Granger Cause Spillovers from LARGE banks	0.5644	0.6384
Spillovers from LARGE banks does not Granger Cause Spillovers from MEDIUM banks	7.7688	0.0000 ***
Spillovers from SMALL banks does not Granger Cause Spillovers from LARGE banks	0.0911	0.9649
Spillovers from LARGE banks does not Granger Cause Spillovers from SMALL banks	0.3535	0.7866
Spillovers from SMALL banks does not Granger Cause Spillovers from MEDIUM banks	0.0910	0.9650
Spillovers from MEDIUM banks does not Granger Cause Spillovers from SMALL banks	2.3889	0.0670 *

*** Significance for 1%; * Significance for 10%.

4.3. Size (Market Capitalization)

We use market capitalization as an alternative measure for the size and we reach different results. An explanation might be that this indicator reflects market's opinion about the company, which fluctuates a lot during the entire period, while total assets consider the bank's intrinsic value and is quite stable over the period. Given the long run effect of Banks with high market values, we expect our third hypothesis, which states that European banks with high market values transmit stronger spillovers to banks with medium and low market values in normal and tranquil times compared to crises times, to be validated.

The results presented in Table 5 show an opposite impact, compared to banks with a large amount of assets, regarding the shocks spread by highly capitalized banks; they are much higher in normal and tranquil periods than in crisis periods. An increase in value-at-risk of highly capitalized banks with 1 ppt increases the value-at-risk of well capitalized banks with 0.17 ppt in volatile times, with 0.39 ppt in normal times and with 0.46 ppt in tranquil times; while medium banks transmit lower shocks in normal times, thus confirming the theory. Banks with a lower market value have an inconsiderable impact in transmitting shocks, but they receive impressive spillover effects from big banks. An increase in VaR of large banks with 1 ppt spread a shock of 0.36 ppt in normal period and 0.94 ppt in tranquil period. Granger causality outcomes highlight that increasing volatilities in poorly capitalized banks Granger cause volatilities in well-capitalized banks. The results are summarized in Table 6.

Table 5. Spillover coefficients of the SDSVaR model, based on the market value measure for the size.

From ... to ...	**Poorly Capitalized**	**Well Capitalized**	**Highly Capitalized**
Volatile period (0.125)			
Poorly capitalized		0.2386	0.3484
Well capitalized	0.0283 ***		0.1757 ***
Highly capitalized	0.0004	0.0187	
Normal period (0.5)			
Poorly capitalized		0.0774	0.3694 **
Well capitalized	0.0057		0.3935 ***
Highly capitalized	0.0001	0.0015 ***	
Tranquil period (0.75)			
Poorly capitalized		0.0017 ***	0.9406 ***
Well capitalized	0.0037		0.4678 ***
Highly capitalized	0.0002 **	0.0003 ***	

*** Significance for 1%; ** Significance for 5%.

Table 6. Granger causality test for the size criterion, measured by market capitalization.

Hypothesis	**Coefficient**	**Probability**
Spillovers from WELL capitalized banks does not Granger Cause Spillovers from HIGH capitalized banks	0.10002	0.9964
Spillovers from HIGH capitalized banks does not Granger Cause Spillovers from WELL capitalized banks	0.25854	0.9560
Spillovers from POORLY capitalized banks does not Granger Cause Spillovers from HIGH capitalized banks	0.16369	0.9863
Spillovers from HIGH capitalized banks does not Granger Cause Spillovers from POORLY capitalized banks	0.25346	0.9581
Spillovers from POORLY capitalized banks does not Granger Cause Spillovers from WELL capitalized banks	5.82110	0.0000 ***
Spillovers from WELL capitalized banks does not Granger Cause Spillovers from POORLY capitalized banks	0.62720	0.7087

*** Significance for 1%.

4.4. Income Source

Given the source of income, interest or non-interest, banks can be categorized as traditional if their main activity is accepting deposits and advancing loans or non-traditional if they pursue investing and trading activities. Taking into account that banks, which compete in the same field as insurance companies, hedge funds, and investment banks are riskier than common activities of lending and taking deposits, non-traditional banks generate more systemic risk. This fact is confirmed by our results structured in Table 7, which indicates that a shock of 1 ppt in non-traditional banks spread an effect of 0.54 ppt in traditional banks during turmoil periods and 0.18 ppt and 0.14 ppt during normal and tranquil times, respectively. The intensity of these shocks is significantly higher comparing to those transmitted in the opposite direction. Our results confirm Hypothesis 4 and are in line with Brunnermeier et al. (2019) who reached the same conclusions. Regarding the direction of spillovers, the Granger test indicates that shocks in non-traditional banks provoke shocks in traditional banks. The outcomes are presented in Table 8.

Table 7. Spillover coefficients of the SDSVaR model, based on the banks' income source.

From . . . **to . . .**	**Interest**	**Non-Interest**
Volatile period (0.125)		
Interest		0.5450 ***
Non-interest	0.2989 ***	
Normal period (0.5)		
Interest		0.1883 ***
Non-interest	0.1211 ***	
Tranquil period (0.75)		
Interest		0.1425 ***
Non-interest	0.0905 ***	

*** Significance for 1%.

Table 8. Granger causality test for the income source criterion.

Hypothesis	**Coefficient**	**Probability**
Spillovers from NON-TRADITIONAL banks does not Granger Cause Spillovers from TRADITIONAL banks	11.5894	0.0000 ***
Spillovers from TRADITIONAL banks does not Granger Cause Spillovers from NON-TRADITIONAL banks	1.85091	0.0997 *

*** Significance for 1%; * Significance for 10%.

4.5. Systemic Importance

Due to the "too big to fail" phenomenon during the crisis, in November 2011, the notion of systemically important financial institutions has been introduced. In order to protect the financial system of the potential impact of those banks, it is important to identify and to control for the eventual shocks transmission. The largest, the most complex, and the global interconnected banks were called global systemically important banks. Those with a regional impact are included in other systemically important banks category. The results summarized in Table 9 show the connection between them. The Granger causality test presented in Table 10 outlines that there is a mutual Granger causality between G-SIBs and O-SIBs, but volatilities in G-SIBs cause volatilities in O-SIBs with a higher confidence level.

Table 9. Spillover coefficients of the SDSVaR model, based on systemic importance of the banks.

From … to …	G-SIB	O-SIB
Volatile period (0.125)		
G-SIB		0.2187 ***
O-SIB	0.4597 ***	
Normal period (0.5)		
G-SIB		0.0439 ***
O-SIB	0.1293 ***	
Tranquil period (0.75)		
G-SIB		0.0168 ***
O-SIB	0.1117 ***	

*** Significance for 1%.

Table 10. Granger causality test for the systemic importance criterion.

Hypothesis	Coefficient	Probability
Spillovers from G-SIB does not Granger Cause Spillovers from O-SIB	8.0127	0.0000 ***
Spillovers from O-SIB does not Granger Cause Spillovers from G-SIB	2.7839	0.0106 ***

*** Significance for 1%.

They prove the prominent impact of G-SIBs, which is significantly high during distress periods and still persistent during normal and tranquil times. A shock of 1 ppt in VaR of G-SIBs provokes an increase of 0.45 ppt in VaR of O-SIBs during crises and 0.13 ppt and 0.11 ppt during normal and tranquil times, respectively. O-SIBs have a major effect during turmoil period, as an increase with 1 ppt in its volatility increases the volatility of G-SIBs with 0.21 ppt. Thus, our last hypothesis, which says that a shock in O-SIBs leads to lower but still important further shocks in G-SIBs than vice-versa, with a notably magnitude in volatile times, can be validated.

5. Conclusions

In this paper, we have analyzed the financial contagion among European commercial banks, using a state-dependent sensitivity value-at-risk model, which measures spillover coefficients as a function of the state of the economy. Estimating a system of quantile regressions for group of banks based on their size, geographical position, income source, and systemic importance, we emphasized the size and the direction of the spillover coefficients. Moreover, we executed the Granger causality test to determine which categories of banks are leaders in emitting spillovers and which are followers. As an overall image, the shocks are small during normal times and increase significantly in distress periods.

Regarding the geographical position, the outcomes highlight the important impact of Western European banks on the entire European financial market. The Eastern Europe get spillovers from all the regions, but do not affect them in response. The North is quite stable, it receives shocks from West and South, but they are not excessive. The results suggest that the Southern European banking system is sensitive to shocks that come from the Western region and transmit them back with a lower intensity. Southern Europe is the most active contagion broadcaster, as it spreads significant spillovers to all the regions in all the states of the economy. The Granger causality test shows a high interconnectedness between all the regions, except the North, which is immune to troubles in Southern and Eastern European banking systems.

According to previous literature, large banks are important transmitters of shocks, while small and medium banks receive them. The results suggest that large banks create systemic risk during the entire period, but the spillover transmitted during the crisis to medium banks are much higher. Small banks produce an important effect during turmoil periods with respect to large banks, by increasing their volatility with 0.37 ppt at an increase with 1 ppt in their own volatility. The Granger causality test denotes a logical chain of causality, with shocks in large banks triggering shocks in medium banks and shocks in medium banks causing shocks in small banks, in turn. If the measure of size is considered market capitalization instead of total assets, the results show an increasing impact during normal and tranquil times compared to distress periods of highly capitalized banks on medium and poor capitalized banks. Given that market capitalization varies during the period, it is expected that for upper quantiles, the spillovers would be higher. Thus, the results suggest that banks with high market values transmit spillovers during all the states of the economy, particularly in tranquil times. Nevertheless, the Granger causality test identifies as origin of shocks banks with low market values, which cause volatilities in bank with medium market values. According to outcomes of the regressions, poorly capitalized banks generate significant spillovers during distress times and transmit them to medium banks.

Concerning the income source and the systemic importance of European commercial banks, the results are in line with the empirical evidence confirming that non-traditional and global systemically important banks generate and transmit impressive and persistent spillovers during all the periods, in particular during crises. We found that non-interest income banks are getting riskier in our times by spreading a shock of 0.99 ppt at an increase in own volatility with 1 ppt. This is a sign of awareness transmitted to the economy that has to be taken into account. The Granger causality test shows that volatilities in interest income banks are highly responsive to volatilities in non-interest income banks.

Regarding the systemic importance criterion, the causality is bidirectional, but the lower probability highlights the greater implication of global systemically important banks in originating spillovers.

As a further improvement for our paper, we consider it appropriate to analyze the impact of the EU debt crisis comparing to subprime crisis in terms of spillovers severity and direction. Moreover, it would be valuable to analyze the feedback effects, in order to catch the leader and the followers in transmitting distress shocks.

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Appendix A

Table A1. The list of the banks included in the sample, particularly in each index.

		Indices				
No	**Bank**	**Geographical Positioning**	**Size (Market Capitalization)**	**Size (TA)**	**Income Source**	**Systemic Importance**
1	BANCO ESPR.SANTO (OTC)	South	Poorly capitalized	Medium		
2	ALLIED IRISH BANKS	North	Highly capitalized	Medium	Traditional	O-SIB
3	BANQUE NALE.DE BELGIQUE	West	Well capitalized	Medium		
4	DEXIA	West	Poorly capitalized	Medium		
5	KBC GROUP	West	Highly capitalized	Medium		O-SIB
6	BARCLAYS	North	Highly capitalized	Large		G-SIB
7	BGEO GROUP HDG.	North	Well capitalized	Small		
8	BANK OF IRELAND	North	Highly capitalized	Medium	Traditional	
9	CB BGN.AMER.CR.BK.	East	Poorly capitalized	Small	Traditional	
10	CB CENTRAL COOP.BANK	East	Poorly capitalized	Small		

Table A1. *Cont.*

No	Bank	Indices				
		Geographical Positioning	Size (Market Capitalization)	Size (TA)	Income Source	Systemic Importance
11	CB FIRST INVESTMENT BANK	East	Well capitalized	Small	Traditional	
12	IK BANKA ZENICA	South	Poorly capitalized	Small	Traditional	
13	INTESA SANPAOLO BANKA	South	Poorly capitalized	Small	Traditional	
14	CARIBBEAN INVESTMENT HOLDINGS	North	Poorly capitalized	Small		
15	HRVATSKA POSTANSKA BANKA	South	Well capitalized	Small		
16	ISTARSKA KREDITNA BANKA	South	Poorly capitalized	Small	Traditional	
17	KARLOVACKA BANKA	South	Poorly capitalized	Small	Traditional	
18	KREDITNA BANKA ZAGREB	South	Poorly capitalized	Small	Traditional	
19	NAVA BANKA DD	South	Poorly capitalized			
20	PODRAVASKA BANKA	South	Poorly capitalized	Small	Traditional	
21	PRIVREDNA BANKA	South	Highly capitalized	Medium	Traditional	O-SIB
22	SLATINSKA BANKA	South	Poorly capitalized	Small	Traditional	
23	VABA	South	Poorly capitalized	Small	Traditional	
24	ZAGREBACKA BANKA SER A	South	Highly capitalized	Medium	Traditional	O-SIB
25	KOMERCNI BANKA	East	Highly capitalized	Medium	Traditional	O-SIB
26	MONETA MONEY BANK	East	Well capitalized	Small	Traditional	
27	AUTOBANK	West	Poorly capitalized		Traditional	
28	COMMERZBANK	West	Highly capitalized	Medium	Traditional	O-SIB
29	DEUTSCHE BANK	West	Highly capitalized	Large	Non-traditional	G-SIB
30	MERKUR BANK	West	Poorly capitalized	Small		
31	OLDENBURGISCHE LB.	West	Well capitalized	Medium		
32	QUIRIN BANK	West	Poorly capitalized	Small		
33	UMWELTBANK	West	Well capitalized	Small	Traditional	
34	BANKNORDIK	North	Well capitalized	Small	Non-traditional	
35	DANSKE BANK	North	Highly capitalized	Medium	Traditional	O-SIB
36	DJURSLANDS BANK	North	Poorly capitalized	Small	Non-traditional	
37	NORDJYSKE BANK	North	Well capitalized	Small	Traditional	
38	FYNSKE BANK	North	Poorly capitalized	Small	Non-traditional	
39	GRONLANDSBANKEN	North	Poorly capitalized	Small	Traditional	
40	HVIDBJERG BANK	North	Poorly capitalized	Small	Traditional	
41	JUTLANDER BANK	North	Well capitalized	Small		
42	JYSKE BANK	North	Highly capitalized	Medium	Traditional	O-SIB
43	KREDITBANKEN	North	Poorly capitalized	Small	Traditional	
44	LOLLANDS BANK	North	Poorly capitalized	Small	Non-traditional	
45	MONS BANK	North	Poorly capitalized	Small	Traditional	
46	NORDFYNS BANK	North	Poorly capitalized	Small	Non-traditional	
47	OSTJYDSK BANK	North	Poorly capitalized	Small	Traditional	
48	RINGKJOBING LANDBOBANK	North	Well capitalized	Small	Traditional	
49	SALLING BANK	North	Poorly capitalized	Small	Traditional	
50	SKJERN BANK	North	Poorly capitalized	Small	Traditional	
51	SPAR NORD BANK	North	Well capitalized	Medium	Non-traditional	
52	SPRKN.SJAELLAND-FYN	North	Well capitalized	Small		
53	SYDBANK	North	Highly capitalized	Medium	Traditional	O-SIB
54	TOTALBANKEN	North	Poorly capitalized	Small	Non-traditional	
55	VESTJYSK BANK	North	Well capitalized	Small	Traditional	
56	BBV.ARGENTARIA	South	Highly capitalized	Medium	Traditional	O-SIB
57	BANKIA	South	Highly capitalized	Medium	Traditional	O-SIB
58	BANKINTER	South	Highly capitalized	Medium	Non-traditional	
59	BANCO DE SABADELL	South	Highly capitalized	Medium	Non-traditional	O-SIB
60	CAIXABANK	South	Highly capitalized	Medium	Non-traditional	O-SIB
61	LIBERBANK	South	Well capitalized	Medium		
62	BANCO POPULAR ESPANOL	South	Highly capitalized	Medium	Traditional	
63	BANCO SANTANDER	South	Highly capitalized	Large	Traditional	G-SIB
64	BNP PARIBAS	West	Highly capitalized	Large	Non-traditional	G-SIB
65	CR.AGR.ALPES PROVENCES GDR	West	Poorly capitalized	Medium		
66	CREDIT AGR.ILE DE FRANCE	West	Well capitalized	Medium		
67	CRCAM ILLE-VIL.CCI	West	Poorly capitalized	Medium		
68	CR.AGRICOLE MORBIHAN	West	Poorly capitalized	Small		
69	CREDIT AGR.TOULOUSE	West	Poorly capitalized	Medium		
70	CIC	West	Highly capitalized	Medium	Traditional	

Table A1. *Cont.*

No	Bank	Geographical Positioning	Size (Market Capitalization)	Size (TA)	Income Source	Systemic Importance
		Indices				
71	CREDIT AGR.TOURAINE	West	Poorly capitalized	Medium		
72	CREDIT AGR.LOIRE-H-LOIRE GDR	West	Poorly capitalized	Medium		
73	CRCAM NORMANDIE SEINE GDR	West	Poorly capitalized	Medium		
74	CRCAM NORD DE FRANCE CCI	West	Well capitalized	Medium		
75	CREDIT AGRICOLE BRIE PICARDIE	West	Well capitalized	Medium		
76	CREDIT AGRICOLE	West	Highly capitalized	Large		G-SIB
77	CRCAM LANGUED CCI	West	Poorly capitalized	Medium		
78	CRCAM ATLANTIQUE VENDEE	West	Poorly capitalized	Medium		
79	CREDIT FONCIER DE MONACO	West	Well capitalized	Small		
80	SOCIETE GENERALE	West	Highly capitalized	Large	Non-traditional	G-SIB
81	CR.AGR.SUD RHONE ALPES GDR	West	Poorly capitalized	Medium		
82	ATTICA BANK	South	Poorly capitalized	Small	Traditional	
83	EUROBANK ERGASIAS	South	Well capitalized	Medium	Traditional	O-SIB
84	NATIONAL BK.OF GREECE	South	Highly capitalized	Medium	Traditional	O-SIB
85	BANK OF PIRAEUS	South	Highly capitalized	Medium	Traditional	O-SIB
86	ALPHA BANK	South	Highly capitalized	Medium	Traditional	O-SIB
87	ABN AMRO GROUP	West	Highly capitalized	Medium	Traditional	O-SIB
88	ING GROEP	West	Highly capitalized	Large		G-SIB
89	OTP BANK	East	Highly capitalized	Medium	Traditional	O-SIB
90	HSBC HDG.	North	Highly capitalized	Large		G-SIB
91	BNC.DI DESIO E DELB.	South	Well capitalized	Medium	Non-traditional	
92	BANCA FINNAT EURAMERICA	South	Poorly capitalized	Small	Non-traditional	
93	BANCA MONTE DEI PASCHI	South	Well capitalized	Medium	Non-traditional	O-SIB
94	BANCO BPM	South	Highly capitalized	Medium	Non-traditional	
95	BPER BANCA	South	Highly capitalized	Medium		
96	BANCA PPO.DI SONDRIO	South	Well capitalized	Medium		
97	BANCO DI SARDEGNA RSP	South	Poorly capitalized	Medium	Traditional	
98	BANCA SISTEMA	South	Well capitalized	Small	Traditional	
99	CREDITO EMILIANO	South	Highly capitalized	Medium	Non-traditional	
100	BANCA CARIGE	South	Well capitalized	Medium	Traditional	
101	BCA.PICCOLO CDT.VALTELL	South	Well capitalized	Medium		
102	FINECOBANK SPA	South	Highly capitalized	Medium	Non-traditional	
103	INTESA SANPAOLO	South	Highly capitalized	Medium		O-SIB
104	MEDIOBANCA BC.FIN	South	Highly capitalized	Medium	Traditional	
105	BANCA PPO.ETRURIA LAZIO	South	Poorly capitalized	Medium		
106	BANCA PPO.DI SPOLETO	South	Poorly capitalized	Small	Traditional	
107	UNIONE DI BANCHE ITALIAN	South	Highly capitalized	Medium		
108	UNICREDIT	South	Highly capitalized	Large	Non-traditional	G-SIB
109	PERMANENT TSB GHG.	North	Well capitalized	Medium		
110	LLOYDS BANKING GROUP	North	Highly capitalized	Large		
111	SIAULIU BANKAS	North	Poorly capitalized	Small	Non-traditional	O-SIB
112	ESPIRITO SANTO FINL.GP.	West	Well capitalized	Medium		
113	AKTIA	North	Well capitalized	Medium	Non-traditional	
114	ALANDSBANKEN	North	Poorly capitalized	Small	Non-traditional	
115	KOMERCIJALNA BANKA	South	Poorly capitalized	Small	Traditional	
116	STOPANSKA BANKA	South	Poorly capitalized	Small	Traditional	
117	BANK OF VALLETTA	South	Well capitalized	Medium	Traditional	O-SIB
118	HSBC BANK MALTA	South	Well capitalized	Small	Traditional	O-SIB
119	LOMBARD BANK	South	Poorly capitalized	Small	Non-traditional	
120	AURSKOG SPAREBANK	North	Poorly capitalized	Small		
121	DNB	North	Highly capitalized	Medium		O-SIB
122	HELGELAND SPAREBANK	North	Well capitalized	Small		
123	HOLAND OG SETSKOG SPB.	North	Poorly capitalized	Small		
124	INDRE SOGN SPAREBANK	North	Poorly capitalized	Small		
125	JCREN SPAREBANK	North	Poorly capitalized	Small		
126	MELHUS SPAREBANK	North	Poorly capitalized	Small		
127	SPAREBANK 1 SMN	North	Well capitalized	Medium		
128	SPAREBANKEN MORE	North	Well capitalized	Small		
129	SPAREBANK 1 NORD-NORGE	North	Well capitalized	Medium		

Table A1. *Cont.*

		Indices				
No	**Bank**	**Geographical Positioning**	**Size (Market Capitalization)**	**Size (TA)**	**Income Source**	**Systemic Importance**
130	SPAREBANKEN	North	Poorly capitalized	Medium		
131	SPB.1 RINGERIKE HADELAND	North	Well capitalized	Small		
132	SANDNES SPAREBANK	North	Poorly capitalized	Small		
133	SPAREBANK 1 BV	North	Poorly capitalized	Small		
134	SKUE SPAREBANK	North	Poorly capitalized	Small		
135	SPB.1 OSTFOLD AKRS.	North	Well capitalized	Small		
136	SPAREBANKEN OST	North	Poorly capitalized	Small		
137	SPAREBANK 1 SR BANK	North	Well capitalized	Medium		
138	SPAREBANKEN VEST	North	Well capitalized	Medium		
139	TOTENS SPAREBANK	North	Poorly capitalized	Small		
140	VOSS VEKSEL-OG LMDBK.	North	Poorly capitalized	Small		
141	ERSTE GROUP BANK	West	Highly capitalized	Medium		O-SIB
142	BKS BANK	West	Well capitalized	Small	Traditional	
143	RAIFFEISEN BANK INTL.	West	Highly capitalized	Medium	Traditional	O-SIB
144	BK.FUR TIROL UND VBG.	West	Well capitalized	Small	Traditional	
145	BANCO COMR.PORTUGUES	South	Well capitalized	Medium	Traditional	
146	BANCO BPI	South	Well capitalized	Medium		O-SIB
147	ALIOR BANK	East	Well capitalized	Medium	Traditional	
148	BANK BGZ BNP PARIBAS	East	Well capitalized	Medium		
149	BOS	East	Poorly capitalized	Small	Traditional	
150	BANK ZACHODNI WBK	East	Highly capitalized	Medium	Non-traditional	
151	GETIN NOBLE BANK	East	Well capitalized	Medium	Traditional	
152	GETIN HOLDING	East	Poorly capitalized	Medium		
153	IDEABANK	East	Well capitalized		Non-traditional	
154	ING BANK SLASKI	East	Highly capitalized	Medium	Traditional	
155	MBANK	East	Highly capitalized	Medium	Traditional	
156	BANK MILLENNIUM	East	Well capitalized	Medium	Traditional	
157	HANDLOWY	East	Highly capitalized	Medium	Non-traditional	
158	BANK POLSKA KASA OPIEKI	East	Highly capitalized	Medium	Traditional	
159	PKO BANK	East	Highly capitalized	Medium		
160	ROYAL BANK OF SCTL.GP.	North	Highly capitalized	Large		G-SIB
161	BANCA COMERCIALA CARPATICA	East	Poorly capitalized	Small	Non-traditional	
162	BRD GROUPE SOCIETE GL.	East	Highly capitalized	Medium	Traditional	O-SIB
163	BANCA TRANSILVANIA CLUJ	East	Highly capitalized	Medium	Traditional	O-SIB
164	ALOR BANK	East	Poorly capitalized	Small		
165	AVANGARD BANK	East	Well capitalized	Small		
166	URAL-SIBERIAN BANK	East	Well capitalized	Medium	Traditional	
167	BNK VVB	East	Poorly capitalized	Small		
168	BANK ZENIT	East	Poorly capitalized	Small		
169	MOS CREDIT BANK	East	Highly capitalized	Medium		
170	CHELINDBANK	East	Poorly capitalized	Small	Traditional	
171	MOSCOW MUN.BK.MOSCOW	East	Highly capitalized	Medium		
172	MOSOBL BANK	East	Well capitalized	Small		
173	BK OTKRITIE	East	Highly capitalized	Medium		
174	BANK PETROCOMMERCE	East	Poorly capitalized	Small		
175	RUSSIAN COMMERCIAL ROADS BANK	East	Poorly capitalized	Small		
176	ROSBANK	East	Well capitalized	Medium	Traditional	
177	SBERBANK OF RUSSIA	East	Highly capitalized	Medium		
178	BANK SAINT PETERSBURG	East	Well capitalized	Medium	Traditional	
179	OBYEDINENNIE KS	East	Well capitalized	Small		
180	VTB BANK	East	Highly capitalized	Medium	Traditional	
181	BANK VOZROZHDENIE	East	Well capitalized	Small		
182	JULIUS BAR GRUPPE	West	Highly capitalized	Medium		
183	BANQUE CANTON.DE GENEVE	West	Well capitalized	Medium		
184	BANQUE CANTONALE DU JURA	West	Poorly capitalized	Small		
185	BANQUE CANTON.VE.	West	Highly capitalized	Medium		
186	BERNER KANTONALBANK	West	Well capitalized	Medium		
187	BASELLANDSCHAFTLICHE KB.	West	Well capitalized	Medium		
188	BASLER KB	West	Well capitalized	Medium		
189	BANK COOP	West	Well capitalized	Medium	Traditional	
190	CREDIT SUISSE GROUP	West	Highly capitalized	Medium		

Table A1. *Cont.*

No	Bank	Indices				
		Geographical Positioning	Size (Market Capitalization)	Size (TA)	Income Source	Systemic Importance
191	EFG INTERNATIONAL	West	Well capitalized	Medium	Non-traditional	
192	GLARNER KB	West	Well capitalized	Small		
193	GRAUB KB	West	Well capitalized	Medium		
194	HYPOTHEKARBANK LENZBURG	West	Well capitalized	Small		
195	BANK LINTH	West	Well capitalized	Small	Traditional	
196	LLB	West	Well capitalized	Medium		
197	LUZERNER KANTONALBANK	West	Highly capitalized	Medium		
198	ST GALLER KANTONALBANK	West	Highly capitalized	Medium		
199	SCHWEIZERISCHE NAT.BK.	West	Poorly capitalized	Medium		
200	THURGAUER KANTONALBANK	West	Well capitalized	Medium		
201	VALIANT	West	Well capitalized	Medium		
202	VPB VADUZ N	West	Well capitalized	Medium		
203	WALLISER KB	West	Well capitalized	Medium		
204	ZUGER KANTONALBANK	West	Well capitalized	Medium		
205	AIK BANKA	South	Poorly capitalized	Small	Traditional	
206	CACANSKA BANKA CACAK	South	Poorly capitalized	Small		
207	JUBMES BANKA BEOGRAD	South	Poorly capitalized	Small	Non-traditional	
208	KOMERCIJALNA BANK BEOGRA	South	Well capitalized	Small	Traditional	
209	DEVIN BANKA	East	Poorly capitalized			
210	OTP BANKA SLOVENSKO	East	Poorly capitalized	Small	Traditional	
211	PRIMA BANKA SLOVENSKO 2	East	Poorly capitalized	Small	Traditional	
212	TATRA BANKA	East	Well capitalized	Medium	Non-traditional	O-SIB
213	VSEOBECNA UVEROVA BANKA	East	Well capitalized	Medium	Traditional	
214	STANDARD CHARTERED	North	Highly capitalized	Medium		G-SIB
215	SECURE TRUST BANK	North	Well capitalized	Small	Traditional	
216	TCS GROUP HOLDING GDR (REGS)	North	Well capitalized	Small		
217	VTB BANK	East	Well capitalized	Small	Traditional	
218	RAIFFEISEN BANK AVAL	East	Well capitalized	Small	Traditional	
219	MEGABANK	East	Poorly capitalized	Small	Traditional	
220	RODOVID BANK	East	Well capitalized	Small		
221	UKRGAZBANK	East	Well capitalized	Small	Traditional	
222	JSCB UKRSOTS BANK	East	Well capitalized	Small	Traditional	
223	COLLECTOR	North	Well capitalized	Small		
224	NORDEA BANK	North	Highly capitalized	Medium		G-SIB
225	SEB	North	Highly capitalized	Medium		
226	SVENSKA HANDBKN	North	Highly capitalized	Medium	Traditional	O-SIB
227	SWEDBANK	North	Highly capitalized	Medium		O-SIB
228	TTK BANKA	South	Poorly capitalized		Traditional	

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