

Article

Reimagining Value-Added Tax Reform Through Digital Rebates and Advanced Simulation for Inclusive Fiscal Policy

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Abstract

This paper examines the regressive nature of the value-added tax and proposes an integrated framework combining a uniform value-added tax rate with progressive, digitally administered rebates. The model was performed using household- and firm-level microsimulations with Monte Carlo methods. It demonstrates that equity can be reached without revenue neutrality being undermined. Simulation results for a calibrated 2024–2025 economy show the proposed rebate structure reduces the effective tax burden on the lowest income quintile from 13.5% to 5.4% of income, delivering a net cash benefit of USD 786.88 and a welfare gain of 6.10%. The policy is projected to generate a robust average VAT revenue of USD 17.44 million, with a 97.8% probability of a positive fiscal impact, while reducing the poverty rate by 2.6% and lowering inequality (Gini coefficient of utility to 0.199). The outcomes present a welfare gain for the poor, a small firm-level effect, and a decrease in poverty and inequality. The results suggest a feasible policy route towards a more equitable tax system, thus promoting indirectly to the United Nations Sustainable Development Goals (SDGs), specifically SDG 8 (decent work and economic growth) and SDG 10 (reduced inequalities).

Keywords: value-added tax; progressive rebates; microsimulation; Monte Carlo simulation; redistributive impact; inequality reduction

1. Introduction

In many developing and middle-income countries, taxation is not an abstract fiscal mechanism but a daily reality that shapes household welfare. A typical case would be a single mother who enters a local grocery store; her little income must cover rent, utilities, and the most necessary foodstuffs. Each of her purchases of rice, milk, or medicine is silently contributing to tax payment. Still, the part of her income that goes to value-added tax (VAT) is much higher than that of the wealthiest citizens. Such cases, which are common in different nations, highlight a fundamental policy dilemma: the tension between the efficiency and revenue productivity of VAT and its regressive distributional impact. VAT is widely praised for its economic neutrality and administrative efficiency, which make it a robust source of government revenue. However, because consumption as a share of income falls as income rises, VAT imposes a disproportionately heavier burden on low-income households (R. Bird & Gendron, 2007; Tait, 1988). This equity–efficiency trade-off poses a central challenge for policymakers: how to preserve the revenue and efficiency



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advantages of VAT while mitigating its regressive effects. This dilemma is particularly acute in developing and emerging economies, where VAT often constitutes an even larger share of total tax revenue due to challenges in collecting direct taxes (OECD, 2024a). Consequently, the very contexts that rely most heavily on VAT for fiscal stability are also those where its regressive impact is most severe.

Table 1 indicates that, in the first place, governments have taken up compensatory measures to lessen the impact of VAT on lower income groups (Ebrill et al., 2001). The four basic methods that have been observed are as follows: direct cash transfers, targeted vouchers or coupons, reduced VAT for essentials, and threshold-based exemptions (R. M. Bird, 2013; IMF, 2021; Warwick et al., 2022). Each of these processes has its own advantages and disadvantages, which are often influenced by the level of administration and the limits of financial resources.

Table 1. Key VAT statistics (OECD and global context).

Statistic	Value
Share of VAT in total tax revenue (OECD countries)	32% (20.8%)
Average VAT burden on the lowest income quintile (as % of income)	12–15% (varies by country)
Average VAT burden on the highest income quintile (as % of income)	5–9%
Reduction in poverty rate with targeted VAT rebates	8–12%
% of countries exempting basic goods from VAT	71%

Source: Authors' estimates from (Eurostat, 2025a; EY Global, 2025; IMF, 2021; OECD, 2024a, 2024b).

Table 2 demonstrates that the trade-offs are reflected in the global evidence. For instance, Canada's GST credit and Singapore's GST voucher scheme both take the form of direct transfers to mitigate VAT burdens, thus increasing fairness while maintaining a consistent VAT base. On the other hand, exemptions and lowered rates usually lead to disputes over classification, impair neutrality, and offer benefits disproportionate to more affluent households whose consumption patterns include a wider variety of goods (Cnossen, 2019). Moreover, a substantial body of research criticizes broad exemptions as an inefficient tool for redistribution, noting they are fiscally costly, distort economic neutrality, and often provide disproportionate benefits to affluent households who consume more of the exempted goods (Cnossen, 2019; IMF, 2014, 2024). However, it is acknowledged that, in contexts with severe administrative constraints, exemptions on a narrow basket of staples may serve as a rudimentary, if imperfect, form of relief for the poorest, though they remain inferior to well-targeted direct transfers where feasible (R. Bird & Gendron, 2007; Lustig et al., 2023).

Table 2. Classification of VAT rebate mechanisms.

Rebate Mechanism	Target Group	Effect on Tax Burden
Direct Cash Transfers	Low-income households	Lowers net tax incidence for the poorest consumers
Vouchers/Coupons	Specific vulnerable groups	Earmarked relief on essential goods/services
Reduced VAT Rates (Necessities)	Purchases of basic goods	Lowers VAT paid on essentials for all buyers
Threshold-Based Exemptions	Households below the poverty line	Eliminates VAT on minimal consumption

Source: (IMF, 2021; Jenkins et al., 2011).

This study addresses three gaps. To begin with, there are just a handful of models that bring together household and firm behavioral responses under one analytical framework, which results in an incomplete policy analysis. Secondly, most incidence studies are conducted under deterministic settings, thus ignoring the uncertainties related to compliance, elasticities, and welfare outcomes. Lastly, digital rebates are often brought up in policy discussions, yet empirical modeling regarding their design, targeting accuracy, and cross-country scalability has not yet reached a considerable extent. The proposed VAT reform model, which blends theoretical rigor with empirical simulation, is the one that fills these gaps in the current literature.

The model develops the field through four combined elements, which exceed typical methods of testing. First, our system enables concurrent microeconomic and macroeconomic modeling of two sectors through its dynamic modeling platform. The system measures household spending patterns and work capacity together with their subsequent effects on business income and product costs, which leads to changes in household economic status because of its integrated system of dynamic analysis that uses multiple variables, which typical VAT research studies do not employ. Second, we use a complete Monte Carlo simulation with 10,000 simulation runs to measure fiscal and distributional uncertainty, which results from variations in compliance rates, elasticity values, and rebate usage. This method gives policymakers two types of results, which include probabilistic outcomes with confidence intervals, together with point estimates.

Third, we develop a digital tax credit system that turns progressive rebates from theoretical research into a practical application (Figure 1). The system provides an operational framework for biometric verification, together with eligibility checks and digital disbursement, which allows for scalability and fraud prevention. Fourth, we create a simulation framework that uses OECD and World Bank data to establish reproducible testing procedures for various scenarios. The cross-country adaptation models provide specific methods for implementing the policy according to different administrative systems and economic conditions, which increases its practical effectiveness.

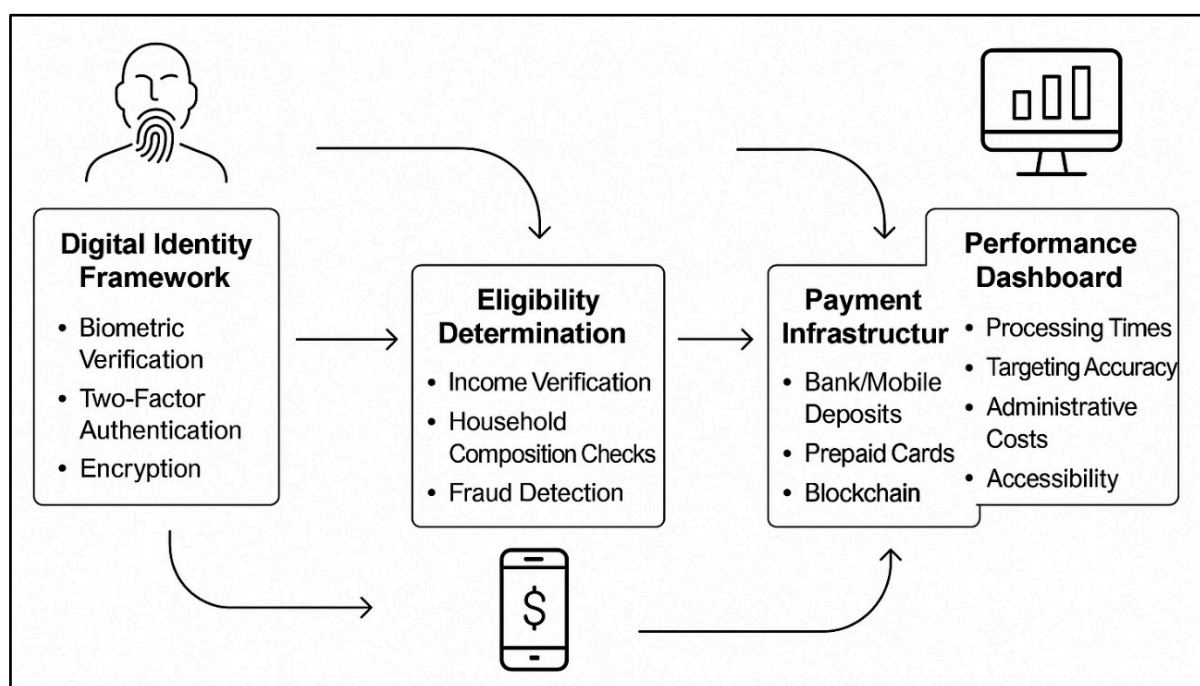


Figure 1. Digital tax credit architecture. Source: Developed by the authors.

By embedding Pigouvian principles (Pigou, 1920), Ramsey's efficiency conditions (Ramsey, 1927), and Mirrlees' equity–efficiency trade-off (Mirrlees, 1971) within a digital-age framework, this study bridges theoretical and policy domains. It shows that VAT, often criticized as inherently regressive, can be transformed into a more equitable fiscal instrument while maintaining revenue adequacy and efficiency. This paper does not estimate a fully structured general equilibrium model, but it adopts a reduced form approach that captures household and firm behavior responses under uncertainty.

Guided by the theoretical foundations of optimal taxation and to address the identified research gaps, this study formally tests the following hypotheses:

H1. *A policy combining a uniform VAT rate with digitally administered, income-quintile-based progressive rebates will significantly reduce the effective tax burden and increase the net welfare of the lowest income households (Q1) compared with a baseline uniform VAT system without rebates.*

H2. *The proposed reform will achieve revenue neutrality or a positive net fiscal impact, as the revenue generated by the broad-based VAT will offset the cost of the targeted rebates.*

H3. *The progressive rebate mechanism will lead to a measurable reduction in poverty rates and inequality (as measured by the Gini coefficient), thereby mitigating the inherent regressivity of the VAT.*

H4. *Firm-level impacts will be heterogeneous by size, with micro and small enterprises experiencing positive demand-side effects that outweigh compliance costs, leading to a positive net cash effect across all firm categories.*

The remainder of this paper is organized as follows. Section 2 reviews the theoretical framework and the literature. Section 3 details the integrated methodology of microsimulation and Monte Carlo analysis. Section 4 presents the empirical results, and Section 5 discusses the policy implications, limitations, and future research. Section 6 concludes.

2. Theoretical Framework and Literature Review

2.1. Theoretical Framework

The VAT reform proposed in this study is based on both classical and modern public finance theories. Pigou (1920) pointed out the role of taxation as the remedy for welfare distortions, whereas Ramsey (1927) opened the door for the use of consumption taxes, having no effects on efficiency, if they were applied to the whole population and through minimal distortion. Nonetheless, Mirrlees (1971) showed that, in the case of an efficient tax, the equity aspect would always be the counterweight; thus, one would need corrective transfers or rebates to not increase the gap between the rich and poor. Recently, especially by Saez and Zucman (2023), researchers underline the importance and usefulness of distributional simulations that experiment with the existing incidence and reform scenarios.

These theoretical pillars support the integrated model propped up in this paper. The difference between our model and the typical VAT reforms, which either use exemptions or multiple rates, is that the latter methods are subject to inefficiency, lobbying pressure, and disputes over classification. Our framework keeps the uniform statutory VAT rate throughout the plan. The digital implementation of progressive rebates based on the verification of biometrics, as well as the automatic determination of eligibility, all in line with the innovations recommended by UNTC (2024) and OECD (2022b), will be the method through which the tax will be redistributed. The proposed model, by introducing behavioral aspects in the study of incidence and applying stochastic robustness checks, not only upholds the efficiency principles of Ramsey (1927) and the equity goals of Mirrlees (1971)

but also adapts to the challenges presented by digital governance. In short, the contribution lies in translating these theoretical ideas into a small, administratively feasible VAT reform model suited for the digital era.

2.2. Literature Review

The academic literature confirms that VAT is a regressive tax. Reports from the United Kingdom, France, and sub-Saharan Africa have put effective VAT rates in the bottom deciles at almost three times the level of the richest deciles (Ian et al., 2010; Ruiz & Trannoy, 2008; Thomas, 2020). In the majority of countries, VAT makes up about 20% of tax revenue (OECD, 2021), thereby making the situation for people with low incomes worse due to its broad coverage (R. Bird & Gendron, 2007; Ebrill et al., 2001; OECD, 2024a; Tait, 1988). Cnossen (2019) pointed out the inadequacy of the reduced VAT rates and suggested that the government should provide better targeted alternatives. Advani et al. (2023) and Blanchet et al. (2022) came to the same conclusions, stressing that direct transfers are superior to exemptions in terms of their distributional impact. Lustig et al. (2023) elaborated this argument by tying VAT reform to broader fiscal policy frameworks aimed at strengthening redistribution.

Besides the distributional debates, discussion on behavioral effects has emerged in the literature. Lowe (2024) reported that the increase in VAT in the Netherlands resulted in 83% of the tax being passed on to consumer prices, while the big firms took in less of the tax due and thus had their profits before interest and taxes lower than the pre-tax point. Benzarti and Carloni (2019) showed that VAT movements not only direct consumers but also affect firms' profits, especially in the case of industries having a great demand and thus being able to pass the cost over to consumers. This was the case with Benedek et al. (2020) and Jacob et al. (2019), who backed the previous finding. Besides the sector-level studies, it has ultimately been macroeconomic research showing that VAT policy has a significant impact on the economy in general. For instance, Mgammal et al. (2023) employed the ARIMA model in an assessment of Saudi Arabia's VAT increase, the result being the awareness of sectoral volatility and long-term risks. Saez and Zucman (2023) not only supported the case for distributional tax analysis based on optimal tax theory but also gave emphasis to the need for a clear-cut understanding between current and future incidence.

Digital technologies have gained prominence in tax administration during the past few years. The evaluation of HMRC's "Making Tax Digital" showed an increase in compliance and a decrease in administrative costs (HMRC, 2023). Rwanda's e-invoicing system resulted in an increase in the efficiency of tax audits and a corresponding rise in VAT collections (Kotsogiannis et al., 2025), while the European Commission (2022) issued recommendations for VAT collection through marketplaces in the case of e-commerce. The UNTC (2024) likewise put forward innovations such as identity verification through biometrics and AI-powered fraud detection. However, limitations on the majority of simulation models have not been removed. EUROMOD is one example of a platform that, while providing beneficial data regarding the distribution of indirect taxes in Europe, still operates on the assumption that household behavior will not change (Bargain et al., 2014). Warwick et al. (2022) have looked at the comparison between VAT exemptions and transfers across developing countries, but they have not taken stochastic variation and behavioral dynamics into account. More sophisticated integrated CGE-microsimulation techniques, like ITAXCGE, are still rare and usually fail to incorporate the modeling of progressive rebate systems (Bayar et al., 2021).

Japan's consumption tax rebate system serves as an effective targeted VAT relief program because it enables tax refunds that depend on household income and the essential goods that people purchase (MOF, 2023). The system establishes a dual-rebate structure,

which enables individuals to receive both financial support and essential goods because essential goods represent their fundamental needs according to their financial status. The method needs comprehensive household information because its precise targeting method requires advanced operational systems, which not all settings can support. The model uses an income-quintile-based method, which achieves both precise targeting and straightforward administrative procedures. The first quintile rebate system needs to extend its coverage because economic vulnerability exists throughout the population, and people need assistance to escape poverty traps that happen at specific income levels (Barrientos, 2013). The selection of the most effective targeting method requires an understanding of how each nation handles its administrative needs and data accessibility, while our future model updates will incorporate spending behavior to achieve better accuracy.

The Devolve-ICMS program in Brazil checks electronic invoice records from the Nota Fiscal Eletrônica (NF-e) system against household registration databases to confirm eligibility and analyze consumption patterns (Bachas et al., 2025). Singapore's GST voucher employs real-time data from various government agencies to determine citizens' income and housing information. The simulation model of our study abstracts from specific implementation details to study core behavioral patterns and distributional principles, but the digital system architecture (Figure 1) we designed enables organizations to use available integrated data systems.

The existing body of the literature has established personalized VAT (PVAT) as a direct solution to the equity–efficiency dilemma, which requires a fair distribution of resources. The research study bases its model on this method, which achieves progressivity through consumption-based digital rebate systems that operate with a standard efficient VAT rate (A. Barreix et al., 2012). The personalized ICMS system for Brazil (ICMS-P), which da Silva (2017) developed through his theoretical work, creates a modern system that provides efficient and fair consumption taxation. The current empirical studies, together with policy assessments, deliver essential proof that supports this methodology. The research studies that examine Brazil's indirect tax system provide valuable educational resources for study purposes. Bachas et al. (2025) present an authentic assessment of the Devolve-ICMS cashback initiative in Rio Grande do Sul, which includes measurement data about its execution and effects on households.

The study conducted by Tonetto et al. (2023) applies a difference-in-differences approach to evaluate the impact of Brazil's consumption tax refunds for low-income users on their economic well-being, which produces strong evidence of causation between these two variables. The research performed by A. D. Barreix et al. (2025) on Brazil's ongoing reform discussions shows that modern tax system development uses new PVAT functions as its primary building block. Huesca and Llamas (2025) present a social-based reform pathway for Mexico's indirect taxes, which shows how specific mechanisms can improve citizens' well-being. The research we conduct establishes our foundation on the existing PVAT framework. The existing works demonstrate the basic idea, together with their detailed analysis for specific instances, whereas our research unites these findings into one complete stochastic simulation model. This research expands through three methods, which include microsimulation for modeling household and firm joint behavioral patterns, Monte Carlo methods for measuring fiscal and distributional uncertainty, and cross-country models for creating an adjustable implementation system of digital progressive rebates.

3. Data and Methodology

3.1. Empirical Methodology and Simulation Logic

The approach links theoretical knowledge and empirical simulation in such a way that the benefits of both deep analysis and policy relevance are enjoyed.

The three integrated stages of our methodology reach their summary in Table 3. The first stage of our research analyzes VAT incidence according to income quintiles by using data from OECD and World Bank, and national surveys that we conducted between 2023 and 2024 to create a VAT regressivity index. The second stage of our study assesses existing rebate mechanisms that operate in ten different jurisdictions according to four distinct criteria, which include coverage, administrative cost, targeting accuracy, and poverty reduction effectiveness. Our third step creates a progressive VAT model through three methods that include (1) household and firm microsimulation of behavioral responses; (2) Monte Carlo analysis (10,000 iterations) to quantify uncertainty in compliance, elasticities, and adjustments; and (3) redistributive impact assessment of a progressive rebate scheme (Gale, 2020; IMF, 2024; Toder et al., 2011)

Table 3. Model flow summary.

Model/Stage	Objective	Key Methods	Contribution to Final Model
Microsimulation	Estimate household- and firm-level VAT burden and behavioral shifts	Household elasticities, consumer ΔP , firm pass-through, operational adjustments	Captures realistic responses to VAT changes for both consumers and firms
Monte Carlo Simulation	Assess uncertainty in compliance, pass-through, and poverty outcomes	Beta and normal distributions; 10,000 iterations	Adds robustness and probabilistic insight into fiscal and distributional outcomes
Progressive VAT Rebate Impact	Evaluate the equity and redistributive effects of the rebate policy	Quintile-based rebate function applied to VAT Paid	Demonstrates how policy design affects fairness and social welfare, emphasizing Q1 benefits

3.2. Household and Firm Microsimulation Design

Our distributional analysis uses the consumer viewpoint because VAT economic effects reach households through their spending patterns and actual income changes. The research model's household behavioral responses are our primary focus while treating firm responses as mechanisms that control consumer pricing and workforce employment results. The initial phase uses microsimulation to represent the reactions of both the households and the firms in terms of behavior. This dual perspective is critical because VAT reforms affect not only the patterns of consumption, labor supply, and household welfare but also firm compliance, pricing, investment, and employment. Incorporating both sides leads to a broader range and more realistic maturing of equity and efficiency effects (Bargain et al., 2014; Chetty et al., 2011; Keane, 2011). The responses of the households are analyzed by means of five income quintiles. There are two behavioral margins that are taken into account.

Consumption response:

$$\Delta C = \varepsilon_c \times \Delta P + \text{Rebate Share}$$

where ΔP is the VAT-induced, compliance-adjusted price change; ε_c is the quintile-specific consumption elasticity; rebate share reflects the targeted VAT relief.

Labor supply response:

$$\Delta L = \varepsilon_l \times \text{Real Wage Change}$$

where ε_l denotes quintile-specific labor supply elasticity.

Household welfare change is then calculated using a Cobb–Douglas utility function.

$$\Delta U = \alpha \Delta C + (1 - \alpha) \Delta L$$

$$U = U_0 \times (1 + \Delta U/100)$$

where α is the consumption share of each quintile, and U_0 is the baseline utility index.

VAT liabilities are expressed as

$$VAT\ Paid = VAT\ Rate \times Compliance \times Consumption$$

$$Net\ Cash\ Effect = VAT\ Paid - Rebate$$

This structure allows household behavior to respond endogenously to tax changes.

The Table 4 structure shows that the lower income groups, which are characterized by having higher consumption elasticities, are the ones that suffer from larger distortions, but, at the same time, they are protected by higher rebates in absolute terms, which is in line with the equity goals. The quintile-specific parameters in Table 4 are drawn from the empirical microeconomics literature to reflect well-established behavioral gradients. Higher consumption shares (α) and more elastic consumption responses (ϵ_c) for lower-income quintiles are consistent with estimates from household expenditure studies (Chetty et al., 2011; Bargain et al., 2014). Similarly, the pattern of labor supply elasticities (ϵ_l) aligns with meta-analyses showing lower responsiveness for primary earners and higher income groups (Keane, 2011). The non-compliance gradient reflects the established inverse relationship between informality and income. Collectively, these calibrated parameters aim to create a representative, empirically grounded behavioral foundation for the microsimulation. Consequently, the welfare results derived from them should be interpreted as central estimates based on current economic evidence.

Table 4. Household behavioral parameters for VAT microsimulation.

Parameter	Q1	Q2	Q3	Q4	Q5	Source/Reference
Initial Consumption (USD)	12,065.24	18,686.44	24,935.09	29,977.00	36,824.72	(OECD, 2024a, 2025)
α (Consumption Share)	0.95	0.92	0.90	0.85	0.80	(Baqae & Burstein, 2023; Deaton & Zaidi, 2002)
$1 - \alpha$ (Labor Share)	0.05	0.08	0.10	0.15	0.20	(Baqae & Burstein, 2023; Deaton & Zaidi, 2002)
ϵ_c (Consumption Elasticity)	−0.7	−0.6	−0.5	−0.4	−0.3	(Chetty et al., 2011; European Commission, 2022)
ϵ_l (Labor Elasticity)	0.6	0.5	0.4	0.3	0.2	(Chetty et al., 2011; McClelland & Mok, 2012)
Non-Compliance (%)	15	12	10	8	5	(Benkovskis & Fadejeva, 2022; Putnins & Sauka, 2015)
VAT (Decimal)	0.001	0.001	0.001	0.001	0.001	(IMF, 2025; OECD, 2025)
Rebate (USD)	797.14	568.57	300.00	74.29	0.00	(Gale, 2020)
U_0 Baseline Utility (Computed)	0.549	0.813	1.057	1.224	1.423	(Baqae & Burstein, 2023; Deaton & Zaidi, 2002)

Responses of Firm Behavior

Firms respond to VAT reform by changing prices, revenues, compliance, employment, and investment strategies. The model takes into account the heterogeneity of firm size;

thus, the pass-through rates, the level of compliance, and the digital adoption will differ between micro, small, medium, and large enterprises (Chetty et al., 2011; IMF, 2025).

Firm responses are modeled through the following set of equations.

$$\Delta P_{Firm} = \Delta P_{Consumer} \times \text{Pass through Rate}$$

$$\Delta P_{Revenue} = \Delta P_{Firm} \times (1 + \varepsilon_c) \times \text{Consumption Share}$$

$$\text{VAT Paid} = \text{VAT Rate} \times \text{Compliance} \times \text{Revenue}$$

$$\text{Net Cash Effect} = \text{VAT Paid} - \text{Rebate Applied}$$

$$\Delta L_{Firm} = \Delta L_{Consumer} \times \text{Labour Share}$$

Table 5 represents a model that not only focuses on fiscal compliance but also considers modernization as an issue of model structural adjustment through the integration of digital investment and formalization rates. On the one hand, revenue shocks are more likely to hit smaller firms with lower compliance and digital adoption. On the other hand, larger firms undergo smoother adjustments as a result of their higher pass-through rates and stronger compliance.

Table 5. Firm behavioral parameters for VAT microsimulation.

Parameter	Micro	Small	Medium	Large	Source/Reference
Baseline Employment	12	25	50	150	(ILO, 2023; World Bank, 2023)
Average Revenue per Employee, RPE_2024 (USD)	94,950	189,900	316,500	505,600	(OECD, 2017) (SME 2017 extrapolated to 2024 (3.5% annual growth))
Pass-Through Rate	0.6	0.7	0.8	0.9	(Beyer et al., 2024; Chetty et al., 2011)
ε_c (Household Consumption Elasticity) Average	0.275	0.225	0.175	0.125	(Bargain et al., 2014; OECD, 2024a)
VAT Rate (Decimal)	0.193	0.193	0.193	0.193	(IMF, 2025; OECD, 2024a)
Compliance Rate	0.7	0.8	0.9	0.95	(Beyer et al., 2024; Hobijn & Nechio, 2017)
Labor Share	0.3	0.4	0.5	0.6	(World Bank, 2023)
Digital Investment (%)	2	5	8	12	(UNCTAD, 2024; World Bank, 2025)
Formalization (%)	5	10	15	20	(World Bank, 2023)
Rebate Policy (θ_{Rebate} , Decimal) Average	0.5	0.7	0.9	0.975	(OECD, 2024a)
VAT Registration Rates (Simulated Based on the Surveyed Literature)	60%	75%	85%	95%	(Harju et al., 2016; Liu et al., 2019, 2024; OECD, 2024a)

3.3. Monte Carlo Simulation of Fiscal Uncertainty

The second step, rolling out stochastic analysis, extends the microsimulation through 10,000 Monte Carlo iterations as the calibration stage. This not only entails parameter uncertainty but also reflects randomness of the compliance behavior, consumption responses, and firm adaptation (Chetty et al., 2011; Keane, 2011). The main design elements involve distributions with compliance rates that follow either Beta (IMF, 2021; Tait, 1988) or truncated normal distributions, which mimic the diversity that is seen (Inchauste et al., 2015; McClelland & Mok, 2012). Normal random draws are applied to elasticities and parameters for households to perturb their respective baseline estimates. Household/firm mapping assigns the lower income quintiles (Q1–Q2) to micro and small firms, while the middle-

to-higher income quintiles are allocated to medium and large enterprises, thus capturing demand-side feedback loops. Outputs include changes in welfare, VAT liabilities, rebate transfers, Gini coefficients, poverty rates, and firm-level outcomes (revenue, employment, net cash flow). By setting a statutory VAT rate of 19.3%, policy relevance is assured, and probabilistic aggregation yields distributions instead of point estimates, thus providing confidence intervals for fiscal and equity outcomes.

Monte Carlo Simulation of VAT Reform Impacts

Utilizing the microsimulation framework as a basis, Stage 2 employs Monte Carlo techniques to assess the distributional and welfare consequences of VAT reform while responding to households and firms in a stochastic manner. The model generates not just point estimates but also probability distributions for incidence, welfare, and fiscal outcomes by conducting 10,000 iterations, thus giving strong policy insights under uncertainty.

At the household level, final utility is modeled as:

$$Final_U = U_0(1 + \alpha\Delta C_{pct} + (1 - \alpha)\Delta L_{pct})$$

where ΔC_{pct} captures consumption changes due to VAT-induced price adjustments, and ΔL_{pct} reflects labor supply responses. VAT liabilities and rebate transfers are drawn probabilistically, incorporating compliance uncertainty and heterogeneity in rebate uptake across quintiles.

The probabilistic draws at the firm level are applied to the productivity multipliers (RPEs), compliance rates, and rebate pass-throughs. The results are probabilistic estimates of revenue, VAT liabilities, net cash flow, employment changes, and price adjustments. The demand responses of the households are a direct factor in the firm revenue trajectories, which means there is a complete integration of micro–macro feedback loops. This feature of the model gives it the capability to handle the uncertainties of volatilities in behavior and policies. The results would not be just a single figure but a range of values indicating the different possibilities that come with the confidence intervals for VAT revenue, household welfare, inequality indices, and employment outcomes. These probabilistic ranges form the analytical foundation for the redistributive evaluation in the next stage.

3.4. Redistributive Impact Assessment of Progressive VAT Rebate

The third stage of the evaluation process assesses the change in effective VAT burdens through the rebate given to the lowest quintile and how it affects the highest one and the others in between. Poverty outcomes are assessed using the international poverty line of USD 3.20 per day (2011 PPP). For each country in our sample, we obtain the baseline poverty headcount from [World Bank \(2023\)](#) data ([Aron et al., 2023](#)). In our microsimulation, we compute the post-rebate disposable income for each household and compare it with the poverty line to estimate the change in the number of individuals living in poverty. Inequality is measured using the Gini coefficient, both at the country level (baseline from [World Bank, 2023](#)) and for our simulated population. The country-specific Gini coefficients allow us to contextualize the redistributive impact of the rebate in different settings. This process is based on a gradually increasing involvement of the earlier-mentioned methods and the outputs of Stage 1 microsimulation (household and firm behavioral responses) and Stage 2 Monte Carlo results. The rebate given is for Q1: 60%, Q2: 40%, Q3: 20%, Q4: 10%, and Q5: 0, following the policy guidance ([Gale, 2020](#); [IMF, 2024](#); [Toder et al., 2011](#)).

The effective VAT burden is calculated as:

$$Effective\ VAT\ Burden = VAT\ Paid - Rebate\ Applied$$

Redistribution is assessed through household utility, poverty rates, and inequality indicators, recalculated post-rebate. Firm-side responses feed back into household demand, ensuring consistency between micro and macro levels.

3.5. Data Sources and Variable Construction

All the data are obtained from openly accessible institutional sources (OECD, World Bank, IMF, ILO, WBES), supporting full replication (Bourguignon & Spadaro, 2006; Savard, 2005). The analysis uses two separate samples, first to study cross-country incidence, which includes 17 countries (Hungary, Poland, Greece, Spain, Slovakia, Mexico, Brazil, South Africa, India, China, United States, France, Germany, Sweden, Japan, Canada, United Kingdom) and uses the most current national accounts data and household survey data that existed when the study was conducted. The VAT regressivity index is calculated for this consistent set of economies to provide a contemporary benchmark. Second, the core microsimulation parameters with behavioral parameters for households and firms are combined from Tables 4 and 5, which contain the econometric literature published between 2010 and 2024, to create current empirical estimates. The baseline financial values (e.g., initial consumption, revenue per employee) are converted to 2024 US dollars through calibration, using IMF and World Bank growth projections together with PPP adjustments. The simulation creates a synthetic economy that researchers will use to test institutional stress across various scenarios. Fiscal incidence modeling requires parameters that researchers develop from peer-reviewed studies and international datasets. The simulation code and datasets become available for request, which enables users to replicate the study while extending its application to new environments. While we report OECD averages for context, we acknowledge significant heterogeneity within this group. Our model's adaptability to specific national contexts is demonstrated in the cross-country adaptation models.

3.6. Methodological Approach Contribution

This integrated approach advances VAT reform analysis by (1) modeling bidirectional household/firm behavioral feedback; (2) incorporating stochastic robustness via Monte Carlo simulation; (3) designing a digitally enabled progressive rebate mechanism; and (4) ensuring transparency and cross-country adaptability through open data and reproducible code. Together, these elements create a scalable framework that bridges theoretical optimality with policy feasibility.

4. Results and Theoretical Findings

4.1. Empirical Results: Descriptive and Comparative Evidence

The first step of the empirical analysis is to use the OECD and World Bank household survey data in order to evaluate the incidence of VAT on different income quintiles. The results are in line with the regressive character of VAT: the lower income households pay a larger percentage of their disposable income in VAT, whilst the higher income ones, although paying more in absolute figures, still bear less of the total burden proportionally (Atkinson & Stiglitz, 1976; Musgrave, 1959).

The VAT incidence values presented in Table 6 are derived from a microsimulation framework that uses PPP-adjusted average incomes and synthetic quintile shares. For this cross-country comparative analysis, and in the absence of harmonized microdata for all countries, we follow the standard simplifying assumption used in comparable fiscal incidence studies that households allocate a fixed, high proportion of their income to consumption (OECD, 2022a). We set this proportion at 90%, reflecting the higher marginal propensity to consume among low- and middle-income households, which are the primary

focus of redistribution analysis. This assumption is applied uniformly across quintiles for baseline comparability, though it naturally overstates absolute consumption for the highest quintile. We then apply country-specific PPP adjustments and scale VAT burdens accordingly. While our method shares the objective of detailed microsimulation models like VATSIM-DF (Cirillo et al., 2021b, 2021a), which uses actual household consumption data for a single country, our approach is necessarily more aggregated and assumption-driven to enable broad cross-country comparison. This is a recognized limitation of comparative multi-country studies, but it provides a consistent and transparent benchmark for analyzing relative burdens across income groups and nations.

Table 6. VAT incidence by income quintile for selected countries (2020–2024).

Country	Lowest Quintile	2nd Quintile	Middle Quintile	4th Quintile	Highest Quintile	VAT Regressivity Index
Hungary	19.2%	—	—	—	~8.5%	~2.26
Poland	4.9%	—	—	—	~3.2%	~1.53
Greece	~14.5%	—	—	—	~6.9%	~2.10
Spain	~13.8%	—	—	—	~6.5%	~2.12
Slovakia	~12.9%	—	—	—	~5.8%	~2.22
Mexico	19.5%	16.2%	13.8%	10.5%	7.2%	2.71
Brazil	22.3%	17.8%	14.1%	10.9%	6.8%	3.28
South Africa	18.7%	15.2%	12.4%	9.8%	6.1%	3.07
India	21.8%	18.1%	14.9%	11.3%	7.5%	2.91
China	17.5%	14.7%	12.2%	9.6%	6.3%	2.78
United States	8.6%	7.2%	6.3%	5.4%	3.8%	2.26
France	13.4%	10.8%	9.1%	7.3%	4.5%	2.98
Germany	12.1%	10.2%	8.7%	7.1%	4.9%	2.47
Sweden	11.9%	10.1%	8.8%	7.6%	5.2%	2.29
Japan	10.8%	9.1%	7.9%	6.8%	4.7%	2.30
Canada	9.7%	8.3%	7.1%	6.0%	4.2%	2.31
United Kingdom	14.8%	11.6%	9.3%	7.8%	5.1%	2.90

VAT regressivity index: Ratio of VAT burden (as % of income) between the lowest and highest quintile, sales tax data used for the United States. Source: Authors' calculations based on data from (Eurostat, 2025b; EY Global, 2025; McLure, 2024; OECD, 2023, 2024b) for the period 2020–2024.

Table 6 indicates that the lowest quintile's average effective VAT rate is close to the highest quintile's average effective VAT rate multiplied by three. Such a scenario is observed in both high- and middle-income countries where the regressivity index remains above 2.0. The VAT regressivity index, reported in the final column of Table 6, quantifies this disproportionate burden. It is calculated as the ratio of the VAT burden (as a percentage of income) borne by the lowest income quintile (Q1) to that borne by the highest quintile (Q5). An index value of 1.0 would indicate proportionality, while a value greater than 1.0 indicates regressivity, with higher values signifying a more severe equity concern. For example, Hungary's index of ~2.26 means the poorest households bear a VAT burden more than twice as large, relative to their income, as the richest households.

These results contribute to the body of research that VAT is still a significantly heavy burden for low-income households even after the implementation of specific corrective measures (Advani et al., 2023; Blanchet et al., 2022; Ian et al., 2010; Ruiz & Trannoy, 2008; Thomas, 2024). The situation is in line with the classical tax incidence theory, which believes that a uniform consumption tax is a violation of the vertical equity rule unless offset by compensatory measures (Musgrave & Musgrave, 1989). It is also in accordance with the optimal tax theory that encourages differing treatment to achieve the right balance between equity and efficiency (Atkinson & Stiglitz, 1976). Some empirical studies report that VAT burdens in Belgium are on the lower deciles, while in South Africa, the exemption measures

have not been successful in stopping the regressive trend (Decoster et al., 2010; Inchauste et al., 2015). The comparison between countries shows the difference in their policies. Canada's GST credit scheme proves to be an effective tool for reducing regressivity, while the French approach of offering cut-price VAT rates generates little redistributive effect due to leakage to the higher quintiles (Cnossen, 2019; IMF, 2024; Lustig et al., 2023).

Table 7 provides a comparative overview of equity-oriented VAT relief mechanisms across selected jurisdictions. For instance, Canada's GST credit and Singapore's GST voucher scheme are direct transfers designed to mitigate VAT burdens. In contrast, Brazil's state-level Devolve-ICMS represents a targeted digital cashback program explicitly linked to consumption tax paid (Bachas et al., 2025), illustrating a more direct PVAT application.

Table 7. Comparative overview of equity-oriented VAT/GST relief mechanisms.

Country	Program Name	Implementation Year	Core Mechanism	Target Group	Key Design Feature	Primary Source
Canada	GST/HST Credit	1991	Quarterly refundable tax credit	Low- to moderate-income households	Integrated with the income tax system, automatic assessment and payment.	Government of Canada
Singapore	GST Voucher Scheme	2012	Annual cash transfers and utility/health savings rebates	Citizens across income groups, scaled by income and asset ownership	Multi-component structure (cash, MediSave, U-Save, S&CC).	Ministry of Finance, Singapore
Brazil (State Level, Rio Grande do Sul)	Devolve-ICMS	2020	Digital cashback on VAT paid for essential goods	Low-income households in Rio Grande do Sul	Subnational PVAT pilot using app-based registration and electronic disbursement.	Bachas et al. (2025)
New Zealand	Working for Families Tax Credits	2004	In-work and family-based tax credits	Families with dependent children	Credits offset income tax liabilities and indirectly compensate for GST incidence.	Inland Revenue, New Zealand
United Kingdom	VAT Relief for Persons with Disabilities and Over 60s	1972 (with subsequent updates)	Zero-rating or reduced VAT rates at the point of sale	Persons with disabilities and older adults	Relief applies to specified goods and services and requires an eligibility declaration.	HM Revenue & Customs
Bahrain	Cost of Living Adjustment (Cash Transfer)	2019	Quarterly cash transfers via the e-government portal	Citizen households	Broad-based compensatory transfer linked to fiscal reforms, including VAT introduction.	Government of Bahrain

Note: This table summarizes key design features of selected equity-oriented VAT/GST relief mechanisms. Tourist refund schemes and general social transfers not explicitly linked to offsetting consumption tax burdens are excluded. The Brazilian case reflects the operational Devolve-ICMS cashback program implemented at the state level.

4.2. Integrated Taxation Model Suggested

The empirical results reveal that the traditional VAT correction mechanisms are not enough. This study proposes an integrated framework combining four interdependent components, built upon the following findings: (i) a uniform statutory VAT, (ii) a pro-

gressive rebate structure, (iii) a digital tax credit mechanism, and (iv) behavioral response modeling. The proposed framework is not only theoretically coherent but also practically feasible, as it operationalizes the Pigouvian principles, Ramsey’s efficiency rule, and Mirrlees’ equity–efficiency trade-offs (Mirrlees, 1971; Pigou, 1920).

4.2.1. Uniform Value-Added Tax and Progressive Rebates

The core simulation assumes a single, uniform statutory VAT rate. For the primary analysis, we set this rate at 15%. This value is selected for three principal reasons. First, it closely approximates the unweighted average standard VAT rate across OECD countries (OECD, 2024b) and is a common benchmark in emerging economies, ensuring the model’s relevance to a broad range of real-world contexts. Second, it provides a clear, round number baseline for illustrating the redistributive mechanics of the proposed rebate system, facilitating interpretation and cross-country comparison. Third, it is administratively feasible and aligns with rates commonly discussed in the fiscal reform literature (e.g., Gale, 2020). It is important to distinguish this from the effective or compliance-adjusted rate. The firm-side parameters in Table 5 use a different baseline rate (19.3%) derived from a specific country context for illustrative revenue calculations; however, the key household incidence and rebate results in Tables 8 and A1, and A4 are generated using the 15% standard rate for consistency and clarity in presenting the core redistributive logic. The model’s design allows this rate to be scaled to any national context as shown in the adaptation models.

Table 8. Proposed progressive VAT rebate structure and projected impact.

Income Group	Lowest Quintile (Q1)	Second Quintile (Q2)	Middle Quintile (Q3)	Fourth Quintile (Q4)	Highest Quintile (Q5)
Mean Annual Income	13,405.82	20,762.71	27,705.66	33,307.77	40,916.36
Mean Consumption (90% Assumed)	12,065.24	18,686.44	24,935.09	29,977	36,824.72
Standard VAT Burden (15%)	1809.79	2802.97	3740.26	4496.55	5523.71
Rebate Rate (Proposed)	60%	40%	20%	5%	0%
Rebate Amount	1085.87	1121.19	748.05	224.83	0
Effective VAT Burden	723.91	1681.78	2992.21	4271.72	5523.71
Effective Tax Burden (on Income)	5.40%	8.10%	10.80%	12.83%	13.50%
Benefit (Due to Reduction in VAT) %	9.60%	6.90%	4.20%	2.17%	1.50%

Note: Simulation based on average-consumption assumptions.

Table 8 shows that the outcome of the model is remarkable in terms of redistributive impact. The income share of the first quintile (Q1) is attributed to the tax decreases from 13.5% to 5.4% (with a reduction of 9.6 points), while 6.9 points decrease the share of Q2. The middle and fourth quintiles are lightly taxed, and the top quintile still pays the full amount of the tax; hence, revenue adequacy is maintained. The gradual removal of the tax applied to people experiencing poverty ensures vertical equity among them, and at the same time, revenue neutrality and administrative simplicity are also achieved.

4.2.2. Digital Tax Credit Mechanism

To put the rebates into action, the model utilizes a digital tax credit system. Conventional rebate methods carry the risk of leakage, delays, and errors in estimating who qualifies for the rebates (Chetty et al., 2011; Jenkins et al., 2011). By employing real-time digital delivery, consisting of biometric verification, linked databases, and mobile disbursement systems, governments will be able to execute fast, accurate, and open distributions.

The digital-first strategy shown in Figure 1 reduces administrative costs to a minimum, increases the accuracy of targeting, and the process becomes more scalable, especially in developing countries where traditional cash transfer systems are still weak.

4.2.3. Cross-Country Adaptation Models

Recognizing the diversity of institutions, the framework is built in such a way that it can easily be adapted to the different national contexts. For example, a model of an advanced economy might highlight such things as fully automated eligibility checks, real-time delivery of benefits, and advanced AI-based fraud detection systems. On the other hand, a model of an emerging economy may take a more hybrid digital/physical method of delivery, give priority to mobile platforms for access, and set up simple eligibility criteria for broader reach. The adaptation for a development context model would focus on community-based verification methods and slow incremental rollouts to build up the capacity, and so on. Finally, a federal system model would include specific modules that would deal with the complicated arrangements for revenue-sharing, systems that federate eligibility and harmonize regional data, and strong cooperation mechanisms for coordination between jurisdictions to guarantee seamless implementation across government at different levels.

Table 9 shows that this flexibility in the system keeps vertical equity and revenue sufficiency intact in various economic and institutional situations, while at the same time giving policymakers a choice of ways for the implementation.

Table 9. Comparative analysis of cross-country adaptation models.

Characteristic	Advanced Economy Model	Emerging Economy Model	Development Context Model	Federal System Model
Implementation Complexity	High	Medium	Low	Very High
Digital Infrastructure Requirements	Advanced	Moderate	Basic	Variable
Administrative Cost (% of Value)	1.2%	2.5%	4.8%	3.2%
Expected Coverage	>95%	85–90%	70–80%	80–90%
Targeting Accuracy	>95%	85–90%	75–80%	85–90%
Fraud Risk	Low	Medium	High	Medium
Implementation Timeline	1–2 years	2–3 years	3–5 years	2–4 years
Prerequisite Reforms	Minimal	Moderate	Extensive	Coordination-focused

Note: The figures in this table are stylized, reflecting relative operational demands across country contexts. They are informed by global trends in digital tax maturity, as documented in OECD (2025) tax administration digital transformation data; IMF (2025) findings on the revenue-boosting impact of firm-level and GovTech digitalization; and IMF (2023) analysis of digital tool adoption and VAT compliance outcomes. Source: (Nose et al., 2025; Nose & Mengistu, 2023).

4.3. Household Simulation Results

The analysis of microsimulation gives an instant picture of the influence of VAT reform on consumption and labor supply. The behavioral reactions are modeled through the use of quintile-specific elasticities, which represent a wide variation between consumption adjustments and labor participation.

As shown in Appendix A Table A1, simulations reveal that the effective VAT burden on the poorest households (Q1) reduces dramatically from 13.5% to 5.4% of income under the proposed rebate system. This provides strong, direct support for H1, confirming that digitally administered progressive rebates significantly reduce the tax burden and increase net welfare (a gain of 6.10% for Q1) for the lowest income households. The results demonstrate that the rebate mechanism not only neutralizes the negative price effect on consumption for Q1–Q2 but also delivers a substantial net positive cash transfer (e.g., USD

786.88 for Q1). The negligible labor supply responses align with the empirical literature on inelasticity among low-income groups, indicating the reform does not create undesirable work disincentives. Collectively, these findings validate the core proposition of H1 and illustrate the precise equity–efficiency trade-off modeled in our framework, i.e., significant welfare gains for the poor are achieved with minimal behavioral distortion.

4.4. Firm-Side Simulation Results

The analysis conducted through firm-level simulations has gone further in reviewing the VAT reform implications on the government’s revenue, employment, compliance, and investment behavior.

Appendix A Table A2 highlights the findings that disclose size-dependent dynamics. Large corporations that could afford to comply with the law and pass through the tax to the customers have remained relatively unaffected, with stable revenue and little or no changes in employment. On the contrary, micro and small enterprises are under tighter liquidity constraints, where the VAT compliance and rebate uptake are critical in determining their net cash flow. However, the reform seems to promote digital investment and formalization rates as indicated by the provisional adoption of the VAT rebate scheme, which is progressive at the lower end of the tax bracket. This corroborates Lowe’s (2024), who concluded that VAT pass-through is almost complete for the largest firms but only partial for the smaller ones. It is also in agreement with Benedek et al. (2020), who pointed out firm heterogeneity as a decisive factor in the analysis of VAT incidence. Critically, the positive net cash effect across all firm sizes (Appendix A Table A2) confirms H4. The reform does not place a net financial burden on the business sector; instead, the demand stimulus from rebates to low-income consumers (who patronize micro and small enterprises) appears to offset compliance costs, supporting the reform’s overall economic feasibility.

The firm-level analysis highlights important distributional considerations. Our pass-through analysis shows that indirect taxes, which operate as statutory business obligations, create economic costs that ultimately affect consumers. The primary impact on firms is therefore through compliance costs, cash flow implications from rebate processing, and demand-side effects. From a distributional standpoint, our analysis maintains a consumer perspective, as VAT burdens ultimately fall on households through price changes and income effects. The results demonstrate that all firm sizes experience positive net cash effects according to Appendix A Table A2 because the rebate system does not create undesired limitations on their ability to obtain funds. Micro-enterprises that primarily provide services to low-income communities will experience higher sales volumes because their customers from the Q1 to Q3 income brackets will spend more money.

4.5. Monte Carlo Simulation Outputs

Using the Monte Carlo method, variables are characterized by their probability distributions coming from the main risk factors in the simulation, i.e., compliance, elasticities, and rebate uptake. Poverty outcomes are assessed using the international poverty line of USD 3.20 per day (2011 PPP). Baseline poverty headcounts and country-specific Gini coefficients are drawn from World Bank (2023) data for context.

Appendix A Table A3 summarizes the robust, probabilistic results of the Monte Carlo simulation. These findings provide compelling evidence in support of H2 and H3. The model projects a robust mean VAT revenue of USD 17.44 million with a 97.8% probability of positive fiscal impact, strongly confirming H2 on revenue neutrality. Simultaneously, the reduction in the poverty rate by 2.6% and the lowering of the Gini coefficient of utility to 0.199 directly validate H3, demonstrating the policy’s significant redistributive power. The minimal employment impact (−0.684%) further underscores that these equity gains are

achieved without precipitating labor market disruptions. In essence, the stochastic analysis confirms that the policy successfully navigates the equity–efficiency trade-off with high confidence; it is highly likely to be both revenue-positive and inequality-reducing.

Apart from that, the policy showed significant redistributive efficiency, as it was marked by a decrease of 2.6% in the overall poverty rate. Thus, the findings not only reveal the defense of the model against such behavioral uncertainties on the part of the taxpayers but also affirm the possibility that well-planned VAT rebates could serve the purpose of social equity without causing any upheavals in the fiscal or labor markets. These simulations indicate the ranges of uncertainty for VAT revenue, net cash flow, welfare, and employment, which are the basis for the redistribution effects assessment in Stage 3.

4.6. Simulation of Progressive VAT Rebate Impact

The concluding part of the analysis determines the progressive distributional result of VAT rebate throughout the income quintiles. By merging the behavioral responses of both households and firms from the microsimulation in Stage 1 plus the stochastic variations included in the Monte Carlo simulation in Stage 2, we can make a realistic estimate of the policy scenario concerning both welfare and monetary impact. The rebate program intends to elevate equity among the population without disregarding fiscal sustainability. The results indicate that a progressive VAT rebate is an effective tool not only for utility gains of the lower income but also for their compensation in terms of income. At the same time, the fiscal impact is negligible with the higher income groups. Thus, the model's goal is consistent with enhancing redistributive outcomes without interfering with the operations of firms or the labor market.

Appendix A Table A4 illustrates that the welfare gains analysis by income quintiles further asserts the potency and fairness of the policy. The gradual rebate plan results in the most significant welfare uplift for the lowest income families (Q1), a consequence of not only the direct rebate amount but also their very high marginal propensity to consume ($\alpha = 0.95$). The more affluent income categories get to gain less and less, thus confirming the redirection aspect of the policy more explicitly. The utility alterations for the top income families (Q5) are, nevertheless, not important, which means that the rebate has met its equity targets without putting too much of a fiscal load on the wealthy or causing them to withdraw from the economy to a large extent.

Appendix A Table A5 synthesizes the final distributive and monetary outcomes of the integrated model. The results deliver conclusive evidence across our research hypotheses. The steeply progressive welfare gains (Q1: +6.10%, Q5: −0.03%) and net cash benefits provide definitive proof for H1, illustrating the targeted nature of the relief. The preservation of substantial VAT payments from higher quintiles (Q5 pays USD 34.98 net) alongside substantial aggregate revenue buttresses the claim of H2. The resulting reduction in practical tax burdens across the lower half of the income distribution (Table 8) materializes the equity objective central to H3. Therefore, the integrated analysis confirms that the proposed reform is not a zero-sum game; rather, it systematically transforms a uniform, regressive consumption tax into a progressive fiscal instrument by channeling resources via digital rebates, achieving the dual goals of equity and revenue adequacy posited at the outset.

4.7. Application in Low-Income Countries

This study tests our model in low-income countries because VAT in these nations shows both higher regressivity and greater fiscal impact. The representative low-income country simulation used parameters that included micro-firm compliance set at 0.6, a formalization rate estimated between 5 and 15 percent, and essential goods consumption

share established at 95 percent. The results indicate that the progressive rebate remains effective in reducing inequality, with the Gini coefficient declining by 1.8–2.2 points, and poverty headcount falling by 4.5–5.5 percentage points. The administrative costs increase to 4.8 to 5.5 percent of disbursed value because the organization lacks sufficient digital infrastructure and capacity, which the development context model shows in Table 9. The 100 million population country with a 30 percent poverty rate shows that 4.5 to 5.5 million people will escape international poverty according to the USD 3.20 daily threshold. The study results show that Table 9 adaptation models serve an essential function because they enable organizations to implement their systems gradually while using digital and physical methods in areas with low-resource availability.

4.8. Macroeconomic Implications: Demand-Side Effects of Increased Disposable Income

The progressive VAT rebate system leads to significant financial gains, which benefit low-income households who spend their income at higher rates ($\alpha = 0.95$ for Q1 vs. 0.80 for Q5, Table 4). Our simulation parameters indicate that the Q1–Q3 households will receive net rebates of approximately USD 1.07 million, which will result in an immediate consumption increase between USD 0.9 million and USD 1.0 million because their marginal propensities to consume range between 0.85 and 0.95. The demand increase mainly affects essential products and services that local businesses provide, which creates economic multiplier effects throughout the national economy. The rebate effects on aggregate demand will partially counteract the contractionary effects of VAT collection, according to our findings, which show the rebate effects will increase demand, particularly in consumption-focused economies.

4.9. Integrated Findings and Theoretical Linkages

The outcomes are in accordance with both classical and modern tax theories. The model conforms to the Ramsey efficiency criterion (Ramsey, 1927) by keeping the statutory VAT rate uniform. It applies Mirrlees' principle of equity–efficiency balance (Mirrlees, 1971) by redistributing through progressive rebates. Pigouvian welfare corrections (Pigou, 1920) are done via targeted compensation for those who are the most unfairly affected. The integrated framework reduces regressivity, alleviates poverty, and keeps revenue, thus demonstrating how VAT can change into a socially inclusive fiscal instrument that connects the theoretical optimality with the practical reform.

5. Discussion

The findings showcased in the prior section validate the claim that VAT can be turned into a fiscal instrument that is more equitable, despite being criticized for its regressive nature for a long time, without losing its revenue-generating capacity. The Monte Carlo simulation shows that the overall VAT revenue is still substantial, with an average collection of USD 17.4 million and a 97.8% probability of gaining in the fiscal year. At the same time, the redistributive results are considerable: the Gini coefficient drops to 0.199, and 2.6% of the population goes out of poverty. The redistribution analysis points out that the poorest quintile (Q1) is the most favored one, getting more than 6% in utility and over USD 780 in net cash terms. This is in line with the rule of vertical equity, which stipulates that those with the least ability to pay should be granted the most significant relief.

The system of our model uses digital technology for rebate distribution yet fails to deliver complete solutions to fundamental problems that exist in tax policy development and tax fairness matters. The establishment of such systems in numerous low-income countries faces substantial institutional and political constraints that impede their development. The existing situation contains four major obstacles, which include national identification

system shortcomings, disorganized administrative data collection, insufficient internet access, and data privacy and security issues. The combination of political opposition to digitalization, insufficient institutional capabilities, and expensive initial investment requirements creates obstacles that prevent organizations from implementing advanced tax technologies. The development context model from our cross-country adaptation models in Table 9 handles these difficulties through its design, which requires basic digital infrastructure and total administrative expenses of 4.8 percent of disbursed funds and all necessary educational reforms. The implementation process at such sites requires a step-by-step approach, which begins with basic mobile payment solutions and offline verification methods and progresses to complete digital platform integration. Digital rebate programs achieve their objectives through technology, but they also require trust development, institutional capacity enhancement, and continuous dedication from political leaders.

On the other hand, wealthier quintiles will experience only minor shifts, thus protecting revenue neutrality and strengthening the policy's long-term viability. Employment effects and labor supply, however, are still negligible. The reduction in employment is under 1%, while the net cash positions of firms improve due to demand-side adjustments. All in all, the uniform VAT rate, together with the progressive, digitally administered rebates, has been confirmed as the combination that can effectively balance efficiency and equity, which is a feature that the conventional approaches of exemptions and reduced rates cannot offer. Thus, the integrated VAT model is positioned as a government-friendly budgeting reform among the alternatives that the fiscal reforms of the future will still be inclusive.

5.1. Policy Recommendations

The empirical data have provided a solid foundation for this entire research study, which in turn has produced many important policy suggestions. The first of these suggestions is that progressive digital rebates should be given priority over VAT rate cuts as the primary redistributive measure, since they are much better at directing assistance to people experiencing poverty. Governments must use robust digital tax credit systems that have biometric verification and integrated databases so that efficiency is at its best and leakage is at its lowest. Furthermore, the reform will serve as an opportunity to promote the digitalization and formalization of firms on a larger scale since the granting of rebates will be dependent on compliance, which in turn will lead to the tax base being strengthened. Moreover, the implementation of these should be context-specific; developed countries can use automated systems, while in less developed areas a combination of digital and physical or mobile-first methods may be needed, and in federal systems a coordination framework must be established. At the same time, the thoroughly discussed redistributive goals must be achieved through a broad-based, uniform VAT rate that preserves revenue sufficiency and prevents the economic distortions caused by exemptions or multiple rates.

5.2. Limitations and Future Research

The suggested framework does show the potential for good results; nevertheless, its limitations at the moment point the way to future research that is directly critical. The model's dependence on literature-based behavioral assumptions for household consumption and labor supply, along with income distribution data limitations that are cross-country, implies the necessity to calibrate countries using microdata specifically to validate and refine these parameters. In order to overcome the compliance risk and better reflect the actual firm behavior, future research needs to bring in more complex firm heterogeneity that includes sector-specific elasticities and credit constraints. Furthermore, the framework's reliance on digital readiness emphasizes the necessity to conduct research in digital gover-

nance, citizen trust, and the political feasibility of the application of large-scale digital rebate systems. It is essential to bring the analysis of the model's dynamics to the level where one would take into consideration intertemporal decision making, assess the combining of VAT rebates with other tax measures, and take into account broader non-monetary welfare metrics, all of which are steps that will not only help in making the model more robust but also in increasing its relevance to policy.

A key limitation is the model's dependence on specific behavioral parameters, whose empirical justification, while literature-based, warrants a formal sensitivity analysis. The welfare and revenue results are particularly sensitive to the assumed consumption elasticities (ϵ_c) and labor supply elasticities (ϵ_l) shown in Table 4. For instance, if the consumption elasticity for Q1 was less negative (e.g., -0.5 instead of -0.7), the negative price channel effect would be smaller, potentially altering the net welfare calculation. Similarly, the progressivity of the final outcome is sensitive to the gradient of the rebate amounts. While the direction and qualitative ranking of welfare gains across quintiles are robust to the model's structure, the precise magnitude of the gains for Q1 (6.10%) is a central estimate that would vary within a range under alternative, empirically plausible parameter sets. Future research should systematically test this robustness by implementing a comprehensive sensitivity analysis, such as a Monte Carlo procedure that draws key elasticities and shares from defined probability distributions rather than using fixed values. This would allow the presentation of confidence intervals around all welfare and fiscal outcomes, further strengthening the policy relevance of the findings.

6. Conclusions

This study demonstrates that the progressive VAT model, which is based on theory and executed through the use of modern technologies, can be a solution for both efficiency and fairness. By keeping a single VAT rate and reallocating through specific rebates, the governments can mitigate the regressive nature, support people with low incomes, and at the same time keep the revenues coming. The Monte Carlo analysis highlights the strength of these results, giving decision makers probabilistic confidence instead of deterministic predictions. Even though there are still issues left in the areas of behavioral assumptions, data availability, and digital readiness, the suggested structure provides a large-scale way for inclusive tax reform. If such models are adopted, decision makers can change VAT from a regressive burden into a progressive social equity instrument. This aligns directly with the aims of sustainable economic development by addressing key United Nations Sustainable Development Goals: promoting inclusive economic growth (SDG 8) and reducing inequality within countries (SDG 10).

Current technological solutions provide organizations with vital efficiency improvements but require organizations to implement these solutions according to their established tax policies and their dedication to achieving equitable fiscal distribution. Our model shows that digital infrastructure leads to fairer results. However, its effectiveness depends on solving three main issues, which include bringing more people into the formal economy through better compliance processes, building public trust through transparent government spending, and using taxation as a means to teach citizens about fiscal responsibilities. The proposed rebate mechanism, by making the link between tax payment and social benefits more visible, could potentially contribute to all three objectives.

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Appendix A

Table A1. Elasticity-Based Simulation of Household Behavioural Responses to VAT Reform.

Household Behavioural Response Variable	Q1	Q2	Q3	Q4	Q5
Initial consumption (\$)	12,065.24	18,686.44	24,935.09	29,977	36,824.72
α (Cobb–Douglas consumption share)	0.95	0.92	0.9	0.85	0.8
$1-\alpha$ (Cobb–Douglas consumption share)	0.05	0.08	0.1	0.15	0.2
ε_c (consumption elasticity)	−0.7	−0.6	−0.5	−0.4	−0.3
ε_l (labour elasticity)	0.6	0.5	0.4	0.3	0.2
Non-compliance (%)	15.00%	12.00%	10.00%	8.00%	5.00%
Rebate (\$)	797.14	568.57	300.00	74.29	0.00
VAT (decimal)	0.001	0.001	0.001	0.001	0.001
RealWagePct	−3.87	−3.23	−2.59	−1.95	−1.31
U0 (Initial utility)	0.517	0.793	1.046	1.221	1.423
Compliance = 1 − Noncomp	85.00%	88.00%	90.00%	92.00%	95.00%
ΔP (%) = VAT $\times$ Compliance $\times$ 100	0.085	0.088	0.09	0.092	0.095
ΔC (price channel) (%) = $\varepsilon_c \times \Delta P$ (%)	−0.0595	−0.0528	−0.0450	−0.0368	−0.0285
Rebate share (%) = Rebate/Consumption $\times$ 100	6.607	3.043	1.203	0.248	0.000
Total ΔC (%) = ΔC (price) + Rebate share	6.547	2.930	1.270	0.389	0.025
ΔL (%) = $\varepsilon_l \times \text{RealWagePct}$	−2.322	−1.615	−1.036	−0.585	−0.262
Net welfare ΔU (%) = $\alpha \cdot (\text{Total } \Delta C) + (1 - \alpha) \cdot (\Delta L)$	6.104	2.566	1.040	0.243	−0.033
Final utility (U) = U0 $\times$ (1 + NetWelfare%/100)	0.549	0.813	1.057	1.224	1.423
VAT paid (\$) = VAT $\times$ Compliance $\times$ Consumption	10.255	16.444	22.442	27.579	34.983
Net cash effect (\$) = VAT paid − Rebate	−786.887	−552.127	−277.558	−46.707	34.983

Note: Authors' microsimulation model calculations using parameters listed in Table 4.

Table A2. Projected Firm Behavioural Responses by Firm Size and Sector.

Firm Behavioural Response Variable	Micro Enterprises	Small Enterprises	Medium Enterprises	Large Enterprises
Revenue (\$)	1,139,400.00	4,747,500.00	15,825,000.00	75,840,000.00
Employment (#) (input)	12	25	50	150
$\Delta \text{Price}_{\text{firm}}$ (%)	11.58%	13.51%	15.44%	17.37%
$\Delta \text{Revenue}$ (%)	14.76%	16.55%	18.5416%	19.54%
VAT Paid (\$)	153,932.94	733,014.00	2,748,802.50	13,905,264.00
Rebate Applied (\$)	76,966.47	513,109.80	2,473,922.25	13,557,576.00
Net Cash Effect (\$)	76,966.47	219,904.20	274,880.25	347,688.00
Employment Impact (%)	−0.15%	−0.20%	−0.25%	−0.30%
Price Adjustment (%)	10.78%	12.16%	13.59%	14.76

Note: Authors' Computation based on key parameters suggested in Table 5.

Table A3. Monte Carlo Simulation Results for Fiscal Uncertainty and for VAT Reform Impacts.

Outcome Variable	Mean	Standard Deviation	5th Percentile	95th Percentile	Probability of Positive Impact
Total VAT collected (Firms)	17,436,805	2,179,815	14,070,447	17,303,348	21,199,856
Total Net Cash (Firms)	1,065,502	—	—	—	—
Employment Change	−0.684	0.064	—	—	—
Gini coefficient of U	0.199	—	—	—	—
Poverty Rate	1	—	—	—	—
Quantile	Q1	Q2	Q3	Q4	Q5
VAT Paid	1980	3171	4329	5326	6591

Source: Authors' Monte Carlo simulation model based on [Bayar et al. \(2021\)](#).

Table A4. Household Final Utility by Quintile (Post-Rebate).

Quintile	U ₀ (Initial Utility)	Final Utility (U)	Net Welfare ΔU (%)
Q1	0.517	0.549	6.10
Q2	0.793	0.813	2.57
Q3	1.046	1.057	1.04
Q4	1.221	1.224	0.24
Q5	1.423	1.423	−0.03

Source: Authors' simulation results from integrated microsimulation model.

Table A5. Monetary Impact of Progressive VAT Rebate by Quintile.

Quintile	VAT Paid (\$)	Rebate Applied (\$)	Net Cash Effect (\$)
Q1	10.26	797.14	786.88
Q2	16.44	568.57	552.13
Q3	22.44	300.00	274.88
Q4	27.58	74.29	46.71
Q5	34.98	0.00	34.98

Note: Figures illustrate shifts in quintile-level effective VAT burden, poverty reduction, and Gini coefficient pre- and post-rebate. Source: Authors' simulation results (see Appendix A Table A3).

References

- Advani, A., Hughson, H., & Summers, A. (2023). How much tax do the rich really pay? Evidence from the UK. *Oxford Review of Economic Policy*, 39, 406–437. [\[CrossRef\]](#)
- Aron, D. V., Castaneda Aguilar, R. A., Diaz-Bonilla, C., Farfan Betran, M. G., Foster, E. M., Fujs, T. H. M. J., Jolliffe, D., Krishnan, N., Lakner, C., Lara Ibarra, G., Mahler, D. G., Moreno Herrera, L., Nguyen, M. C., Sanchez Castro, D. M., Tetteh-Baah, S. K., Viveros Mendoza, M. C., Wu, H., & Yonzan, N. (2023). *September 2023 update to the poverty and inequality platform (PIP): What's new*. World Bank. [\[CrossRef\]](#)
- Atkinson, A. B., & Stiglitz, J. E. (1976). The design of tax structure: Optimal commodity and income taxes. *Journal of Public Economics*, 6(1–2), 55–75. [\[CrossRef\]](#)
- Bachas, P., Flores, T., Lara Ibarra, G., Mantovani, A. A., de Oliveira, E. S., Padilha, G., & Scot, T. (2025). *VAT cashback programs in practice: The case of devolve-ICMS in Rio Grande do Sul, Brazil*. World Bank. [\[CrossRef\]](#)
- Baqae, D. R., & Burstein, A. (2023). Welfare and output with income effects and taste shocks. *The Quarterly Journal of Economics*, 138(2), 769–834. [\[CrossRef\]](#)
- Bargain, O., Dolls, M., Neumann, D., Peichl, A., & Siegloch, S. (2014). Comparing labor supply elasticities in Europe and the United States: New results. *Journal of Human Resources*, 49(3), 723–838. [\[CrossRef\]](#)
- Barreix, A., Bes, M., & Roca, J. (2012). Solving the impossible trinity of consumption taxes personalized VAT. In *Fiscal reform in Latin America*. Inter-American Development Bank Group.
- Barreix, A. D., De Souza Rocha Lukic, M., & Barroso Tostes Neto, J. (2025). *The three innovative features of VAT in Brazil's indirect tax reform*. Inter-American Development Bank Group. [\[CrossRef\]](#)
- Barrientos, A. (2013). Does vulnerability create poverty traps? In A. Shepherd, & J. Brunt (Eds.), *Chronic poverty* (pp. 85–11). Palgrave Macmillan. [\[CrossRef\]](#)

- Bayar, A., Bratta, M., Carta, F., Di Caro, P., Manzo, M., & Orecchia, G. (2021). *Assessing the effects of VAT policies with an integrated CGE-microsimulation approach: Evidence on Italy*. Ministry of Economy and Finance, Department of Finance.
- Benedek, D., De Mooij, R. A., Keen, M., & Wingender, P. (2020). Varieties of VAT pass through. *International Tax and Public Finance*, 27(4), 890–930. [CrossRef]
- Benkovskis, K., & Fadejeva, L. (2022). VAT compliance and tax evasion in the Baltic States. *Baltic Journal of Economics*, 22(1), 1–20.
- Benzarti, Y., & Carloni, D. (2019). Who really benefits from consumption tax cuts? *American Economic Journal: Economic Policy*, 11(3), 315–344. [CrossRef]
- Beyer, R. C. M., Chen, R., Misch, F., Li, C., Ozturk, E. O., & Ratnovski, L. (2024). *Monetary policy pass-through to interest rates: Stylized facts from 30 European countries* (2024/009). International Monetary Fund. [CrossRef]
- Bird, R., & Gendron, P.-P. (2007). *The VAT in developing and transitional countries*. Cambridge University Press. [CrossRef]
- Bird, R. M. (2013). Foreign advice and tax policy in developing countries. In R. Bird, & M. Smart (Eds.), *Taxation and development: The weakest link?* (pp. 103–144). Edward Elgar Publishing. [CrossRef]
- Blanchet, T., Chancel, L., & Gethin, A. (2022). Why is Europe more equal than the United States? *American Economic Journal: Applied Economics*, 14(4), 480–518. [CrossRef]
- Bourguignon, F., & Spadaro, A. (2006). Microsimulation as a tool for evaluating redistribution policies. *Journal of Economic Inequality*, 4(1), 77–106. [CrossRef]
- Chetty, R., Guren, A., Manoli, D., & Weber, A. (2011). Are micro and macro labor supply elasticities consistent? A review of evidence on the intensive and extensive margins. *American Economic Review*, 101(3), 471–475. [CrossRef]
- Cirillo, C., Imperioli, L., & Manzo, M. (2021a). Investigating the incidence of value added tax on households income: New evidence from Italy. *International Journal of Microsimulation*, 14(3), 85–118. [CrossRef]
- Cirillo, C., Imperioli, L., & Manzo, M. (2021b). *The value added tax simulation model: VATSIM-DF (II)*. Ministry of Economy and Finance, Department of Finance.
- Cnossen, S. (2019). On the direction of tax harmonization in the european community. In *Reforming capital income taxation* (pp. 209–227). Erasmus University Rotterdam. [CrossRef]
- da Silva, G. P. (2017). *Personalized ICMS (ICMS-P) a modern, efficient and equitable VAT*. University of Alcalá.
- Deaton, A., & Zaidi, S. (2002). *Guidelines for constructing consumption aggregates for welfare analysis* (Issue LSMS Working Paper No. 135). The World Bank. Available online: <https://hdl.handle.net/10986/14101> (accessed on 19 August 2025).
- Decoster, A., Swerdt, K. D., & Orsini, K. (2010). *A Belgian flat income tax: Effects on labour supply and income distribution* (pp. 23–55). Institute for Social and Economic Research. Available online: <https://ideas.repec.org/a/sen/rebelj/vlvy2010i1p23-55.html> (accessed on 12 October 2025).
- Ebrill, L., Keen, M., Bodin, J.-P., & Summers, V. (2001). *The modern VAT*. International Monetary Fund. [CrossRef]
- European Commission. (2022). *VAT in the digital age: A proposal to modernise and improve the EU's VAT system*. European Commission Taxation and Customs Union. Available online: https://taxation-customs.ec.europa.eu/taxation/vat/vat-digital-age-vida_en (accessed on 8 September 2025).
- Eurostat. (2025a). *Joint distribution of household income, consumption and wealth—Statistics on taxation—Statistics Explained—Eurostat*. Statistics Explained. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Joint_distribution_of_household_income_consumption_and_wealth_-_statistics_on_taxation (accessed on 10 November 2025).
- Eurostat. (2025b). *Joint distribution of household income, consumption and wealth—Statistics on taxation*. Available online: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Main_Page (accessed on 10 October 2025).
- EY Global. (2025). *Worldwide VAT, GST and sales tax guide*. Available online: <https://www.ey.com/content/dam/ey-unified-site/ey-com/en-gl/technical/tax-guides/documents/en-gl-vat-guide-2025.pdf> (accessed on 10 November 2025).
- Gale, W. G. (2020). Raising revenue with a progressive value-added tax. In M. Furman, K. Pomerleau, & R. Williams (Eds.), *Tackling the tax code: Efficient and equitable ways to raise revenue* (pp. 191–236). Brookings Institution.
- Harju, J., Matikka, T., & Rauhanen, T. (2016). *The effects of size-based regulation on small firms: Evidence from VAT threshold* (6115; CESifo Working Paper No. 6115). Available online: https://www.ifo.de/DocDL/cesifo1_wp6115.pdf (accessed on 19 August 2025).
- HMRC. (2023). *Making tax digital for VAT: Final evaluation*. HM Revenue and Customs. Available online: <https://www.gov.uk/government/publications/making-tax-digital-for-vat-final-evaluation/making-tax-digital-for-vat-final-evaluation> (accessed on 8 November 2025).
- Hobijn, B., & Nechio, F. (2017). *Sticker shocks: Using VAT changes to estimate upper-level elasticities of substitution* (2017–10). Available online: <https://www.frbsf.org/research-and-insights/publications/working-papers/2017/10/sticker-shocks-using-vat-changes-to-estimate-upper-level-elasticities-of-substitution/> (accessed on 19 August 2025).
- Huesca, L., & Llamas, L. (2025). A reform path with social well-being against indirect taxes in Mexico. *The Economic Quarter*, 92(366), 309–346. [CrossRef]
- Ian, C., Keen, M., & Smith, S. (2010). Value added tax and excises. In J. A. Mirrlees (Ed.), *Dimensions of tax design: The mirrlees review* (Vol. 1, pp. 275–362). Oxford University Press.

- ILO. (2023). *ILOSTAT: Employment by enterprise size* (pp. 1–10). International Labour Organization. Available online: <https://ilostat.ilo.org/topics/employment/> (accessed on 19 August 2025).
- IMF. (2014). *Fiscal policy and income inequality*. International Monetary Fund. [CrossRef]
- IMF. (2021). *2021 Financial sector assessment program review—Towards a more stable and sustainable financial system*. International Monetary Fund. [CrossRef]
- IMF. (2023). *World economic outlook 2023: Navigating global divergences*. International Monetary Fund. Available online: <https://www.imf.org/-/media/files/publications/weo/2023/october/english/text.pdf> (accessed on 19 August 2025).
- IMF. (2024). *Designing a progressive VAT* (Issue Working Paper No. 2024/078). International Monetary Fund. [CrossRef]
- IMF. (2025). *IMF VAT database* (pp. 1–10). International Monetary Fund. Available online: <https://www.imf.org/external/np/fad/tpaf/pages/vat.htm> (accessed on 14 October 2025).
- Inchauste, G., Lustig, N., Maboshe, M., Purcell, P., & Woolard, I. (2015). *The distribution of income and consumption in South Africa* (Issue CEQ Working Paper No. 25). Econ3x3. Available online: <https://www.polity.org.za/article/how-much-is-inequality-reduced-by-progressive-taxation-and-government-spending-oct-2015-2015-10-28> (accessed on 19 August 2025).
- Jacob, M., Michaely, R., & Müller, M. A. (2019). Consumption taxes and corporate investment. *The Review of Financial Studies*, 32(8), 3144–3182. [CrossRef]
- Jenkins, G. P., Kuo, C.-Y., & Harberger, A. C. (2011). The integrated analysis of investment projects. In *Cost-benefit analysis for investment decisions* (1st ed., pp. 1–21). Independent Publisher. Available online: https://jdintl.econ.queensu.ca/publications/qed_dp_194.pdf (accessed on 10 April 2025).
- Keane, M. P. (2011). Labor supply and taxes: A survey. *Journal of Economic Literature*, 49(4), 961–1075. [CrossRef]
- Kotsogiannis, C., Salvadori, L., Karangwa, J., & Murasi, I. (2025). E-invoicing, tax audits and VAT compliance. *Journal of Development Economics*, 172, 103403. [CrossRef]
- Liu, L., Lockwood, B., Almunia, M., & Tam, E. H. F. (2019). *VAT notches, voluntary registration, and bunching: Theory and U.K. evidence* (2019/205; Working Paper No. 2019/205). IMF. [CrossRef]
- Liu, L., Lockwood, B., & Tam, E. H. F. (2024). *Small firm growth and the VAT threshold evidence for the UK* (2024/033; Working Paper No. 2024/033). IMF. [CrossRef]
- Lowe, M. (2024). *Who is most affected by a VAT change? Impact of VAT changes on consumer prices and EBIT* (Issue Oxford Tax Working Paper No. 24/003). Oxford Press.
- Lustig, N., Pabon, V. M., & Pessino, C. (2023). *Fiscal policy, income redistribution, and poverty reduction in Latin America* (1530; IDB Working Paper Series). Available online: <https://publications.iadb.org/publications/english/document/Fiscal-Policy-Income-Redistribution-and-Poverty-Reduction-in-Latin-America.pdf> (accessed on 12 July 2025).
- McClelland, R., & Mok, S. (2012). *A review of recent research on labor supply elasticities*. Available online: <https://www.cbo.gov/publication/43036> (accessed on 19 August 2025).
- McLure, C. E. J. (2024). *VAT, income distribution, and tax incidence*. World Bank. Available online: <http://documents.worldbank.org/curated/en/266361468181506533> (accessed on 29 September 2025).
- Mgammal, M. H., Al-Matari, E. M., & Alruwaili, T. F. (2023). Value-added-tax rate increases: A comparative study using difference-in-difference with an ARIMA modeling approach. *Humanities and Social Sciences Communications*, 10, 1–17. [CrossRef]
- Mirrlees, J. A. (1971). An exploration in the theory of optimum income taxation. *Review of Economic Studies*, 38(2), 175–208. [CrossRef]
- MOF. (2023). *Material on consumption taxation*. Ministry of Finance, Japan. Available online: https://www.mof.go.jp/english/policy/tax_policy/tax_system/consumption/index.html (accessed on 12 October 2025).
- Musgrave, R. A. (1959). *The theory of public finance*. American Economic Association.
- Musgrave, R. A., & Musgrave, P. B. (1989). *Public finance in the theory and practice* (5th ed.). McGraw-Hill Book Co.
- Nose, M., & Mengistu, A. (2023). *Exploring the adoption of selected digital technologies in tax administration: A cross-country perspective* (pp. 1–18). International Monetary Fund.
- Nose, M., Pierri, N., & Honda, J. (2025). *Leveraging digital technologies in boosting tax collection* (IMF Working Papers, 2025(089)). International Monetary Fund. [CrossRef]
- OECD. (2017). *Financing SMEs and entrepreneurs 2017*. OECD. [CrossRef]
- OECD. (2021). *Revenue statistics 2021: The initial impact of COVID-19 on OECD tax revenues*. OECD Publishing. [CrossRef]
- OECD. (2022a). *Consumption tax trends 2022: VAT/GST and excise, core design features and trends*. OECD Publishing. [CrossRef]
- OECD. (2022b). *Digital transformation maturity model*. OECD Publishing. Available online: <https://www.oecd.org/en/topics/sub-issues/comparative-analysis-of-tax-administrations/tax-maturity-models.html> (accessed on 15 September 2025).
- OECD. (2023). *Revenue statistics 2023*. OECD Publishing. [CrossRef]
- OECD. (2024a). *Consumption tax trends 2024: VAT/GST and excise, core design features and trends*. OECD. [CrossRef]
- OECD. (2024b). *Revenue statistics 2024: Health taxes in OECD countries*. OECD. [CrossRef]
- OECD. (2025). *Global revenue statistics database*. Available online: <https://data.oecd.org/> (accessed on 20 October 2025).
- Pigou, A. C. (1920). *The economics of welfare* (1st ed.). Macmillan.

- Putniņš, T. J., & Sauka, A. (2015). Measuring the shadow economy using company managers. *Journal of Comparative Economics*, 43(2), 471–490. [CrossRef]
- Ramsey, F. P. (1927). A contribution to the theory of taxation. *Economic Journal*, 37(145), 47–61. [CrossRef]
- Ruiz, D., & Trannoy, A. (2008). VAT incidence in France. *Revue Économique*, 59(3), 497–517. [CrossRef]
- Saez, E., & Zucman, G. (2023). *Distributional tax analysis and optimal taxation* (Issue NBER Working Paper No. 31912). Available online: <https://www.nber.org/papers/w31912> (accessed on 12 July 2025).
- Savard, L. (2005). Poverty and inequality analysis within a CGE framework: A comparative analysis of the representative agent and microsimulation approaches. *Development Policy Review*, 23(3), 313–331. [CrossRef]
- Tait, A. A. (1988). *Value added tax: International practice and problems*. International Monetary Fund. [CrossRef]
- Thomas, A. (2020). *Reassessing the regressivity of the VAT*. OECD. [CrossRef]
- Thomas, A. (2024). *VAT rate structures in theory and practice* (10677; Policy Research Working Papers). World Bank. Available online: <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/9352> (accessed on 22 June 2024).
- Toder, E., Nunns, J., & Rosenberg, J. (2011). *Methodology for distributing a VAT*. Available online: https://www.pewtrusts.org/-/media/legacy/uploadedfiles/wwwpewtrustsorg/reports/economic_mobility/executivesummarymethodologydistributing_vat-april2011pdf.pdf (accessed on 18 August 2025).
- Tonetto, J. L., Fochezatto, A., & da Silva, G. P. (2023). Refund of consumption tax to low-income people: Impact assessment using difference-in-differences. *Economies*, 11(6), 153. [CrossRef]
- UNCTAD. (2024). *World Investment Report 2024: Investment facilitation and digital government*. Available online: https://unctad.org/system/files/official-document/wir2024_en.pdf (accessed on 20 October 2025).
- UNTC. (2024). *The use of new technologies to improve value added tax (VAT) compliance*. United Nations. Available online: <https://docs.un.org/en/E/2024/45> (accessed on 20 October 2025).
- Warwick, R., Harris, T., Phillips, D., Goldman, M., Jellema, J., Inchauste, G., & Goraus-Tańska, K. (2022). The redistributive power of cash transfers vs. VAT exemptions: A multi-country study. *World Development*, 151, 105742. [CrossRef] [PubMed]
- World Bank. (2023). *World Bank enterprise surveys: Data and methodology* (pp. 1–10). World Bank. Available online: <https://www.enterprisesurveys.org/en/data> (accessed on 20 October 2025).
- World Bank. (2025). *World Bank enterprise surveys: Innovation and technology/innovation activity* (World Bank Enterprise Surveys). World Bank. Available online: <https://www.enterprisesurveys.org/en/data/exploretopics/innovation-and-technology?subGroup=-1&subto=&subtopic=79> (accessed on 20 October 2025).

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