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RESEARCH ARTICLE

The redistribution effect of taxation in emerging economies: Evidence from a microsimulation exercise in Zambia

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Abstract The study investigates taxation, poverty, and income inequality in Zambia, aiming to identify fiscal reforms that boost revenue, alleviate poverty, and reduce inequality. It examines the effects of Personal Income Tax (PIT), Value-Added Tax (VAT), Turnover Tax (TOT), and Excise Duties using the MicroZamod microsimulation model and STATA modelling from 2010 to 2019.Key findings show that taxes increased the poverty rate by an average of 2 percentage points, with VAT as the main contributor (72.6%), followed by TOT (19.3%), PIT (4.2%), and Excise Duties (3.8%). VAT, though a major revenue source, fails to reduce poverty, while PIT significantly reduces inequality, contributing 70% of the reduction in the Gini coefficient.This study assesses the cost-effectiveness of various taxes in relation to poverty reduction and inequality by calculating welfare multipliers per 1 billion Kwacha of revenue generated. By doing so, it significantly contributes to the existing literature and advances our understanding of how cost-effectiveness indices can inform the formulation of optimal tax policy. VAT increases the national poverty rate by 0.45 percentage points per billion Kwacha raised, whereas PIT raises poverty by only 0.04 percentage points but reduces the Gini coefficient by 0.68 percentage points. Excise Duties slightly improve income distribution with a 0.05 percentage point reduction in the Gini coefficient, while TOT marginally worsens inequality with a 0.06 percentage point increase per billion Kwacha raised.The research emphasises PIT's potential in reducing inequality and proposes tax reforms to reduce poverty and inequality. Policymakers can use these insights to optimize tax policies, balancing revenue generation with the goals of reducing poverty and inequality.
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1. Introduction

In the latter half of the 20th century and the early 21st century, a pressing issue emerged in many developing economies: the coexistence of high poverty levels and income inequality. This period, spanning from the 1970s to the 2020s, saw significant attention directed towards the challenges posed by economic disparity and widespread poverty (***World Bank, 2019***). These welfare metrics have been influenced by numerous factors, including the levels of economic growth, taxation burden, education, technological innovation, and globalization. A particularly striking fact is the substantial variation in average disposable income across countries and regions, driven in part by the level and the structure of taxation and spending policies, especially in developing countries (see e.g. ***Jha, 2000***). The interplay between taxation, economic growth, poverty, and inequality has sparked extensive debate among researchers, yielding mixed results in several studies. Most research in developing countries on these topics has concentrated on panel studies with combined datasets from several countries. This approach to economic research in developing countries has left a gap in understanding the full redistributive and budgetary effects of taxation, with Zambia being no exemption.

While extensive research has examined the distributional effects of taxes in high-income countries, such studies remain relatively limited in low and middle income country contexts, largely due

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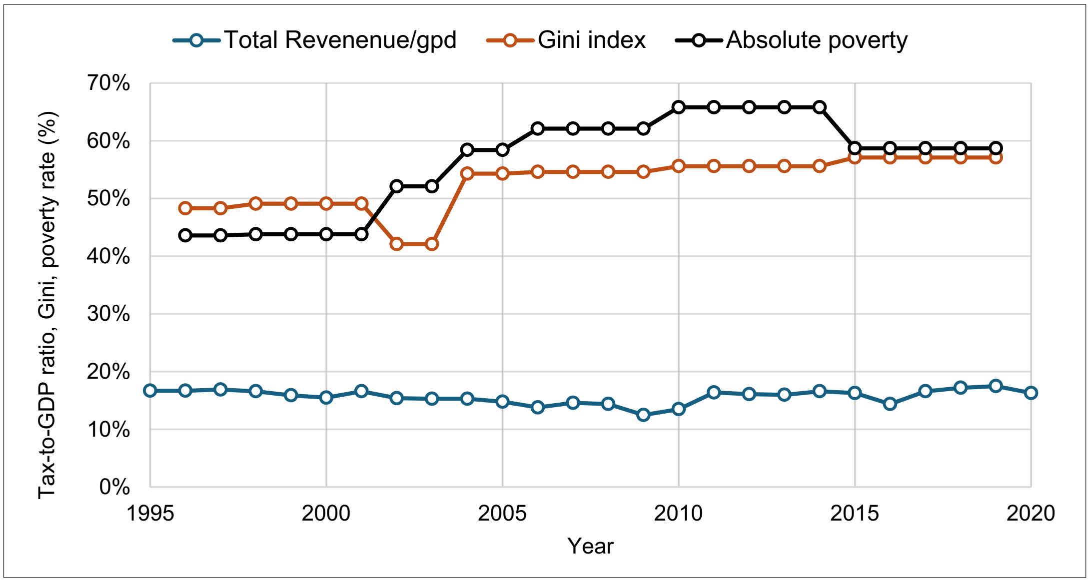

Figure 1. The trends for the tax-to-GDP ratio, Gini index, and absolute poverty, 1995–2020.

Source: constructed by the author using data from ZRA and ZamStats.

to data constraints and the absence of a standardized framework for tax incidence analysis (***Warren, 2008***). However, the development and continuous refinement of static microsimulation models such as EUROMOD (initiated in 1996) have significantly advanced the field by providing a harmonized approach to assessing income-related tax and benefit policies across countries (see e.g., ***Decoster et al., 2011***; ***Gcabo et al., 2019***, ***Immervoll et al., 2007***; ***Kleven and Waseem (2013),Jara and Tumino, 2013***).

Since 2015, the SOUTHMOD models, used in this study, have been produced for developing countries that utilize the EUROMOD framework and also benefit from rich microdata available in local household surveys. SOUTHMOD models have been used for both cross-country comparative research on tax-benefit systems (see e.g. ***Lastunen et al., 2023***; ***Gasior et al. (2021a)*** and similar country-specific work. Examples of the latter include ***Gasior et al. (2021)*** who use the Zambian model to study the distributional effects of the COVID-19 pandemic and related fiscal policies, as well as ***Waiswa et al. (2021)*** and ***Byaruhanga (2020)***, who use the Ugandan model to analyze the distributional effects of specific taxes in Uganda.

Sub-Saharan Africa remains the region with the largest number of economies below the minimum desirable tax-to-GDP ratio of 15%. At that level, revenues are typically considered inadequate to finance basic state functions (***World Bank, 2019***). Mobilizing tax revenue is critical if developing countries are to finance crucial investments in human capital, health, and infrastructure necessary to achieve the UN's Sustainable Development Goals and World Bank Group's goals of ending extreme poverty and boosting shared prosperity by 2030.

While insufficient revenues pose a challenge for many countries in Sub-Saharan Africa, this study focuses on tax revenues and their welfare impacts in Zambia. As shown in ***Figure 1***, the country's average tax-to-GDP ratio has been relatively stable, at around 15.6 % from 1995 to 2015 and 16.4% from 2015 to 2019. Despite this, the levels of absolute poverty and inequality as measured by the Gini index have remained high, with an average of 56.5 % and 52.1 %, respectively. These indices have also exhibited increasing trends over the period from 1995 to 2019.

Low tax revenues combined with high poverty and inequality necessitate further investigation to inform policymakers about the linkages. To this end, this paper uses the MicroZAMOD to unveil the redistributive effects of taxation in Zambia and to propose alternative policy reforms based on the results. The study adds to existing literature by providing evidence on the design of cost-effective fiscal policy in Zambia.

The analysis involves computing cost-effectiveness indices to identify the direct and indirect taxes that lead to positive (or not overly negative) redistributive outcomes per unit of revenue raised. The results suggest that raising revenue from value-added tax (VAT) is particularly detrimental for poverty, while additional revenue from personal income tax (PIT) tends to mitigate inequality. Excise taxes have a relatively neutral effect on both poverty and inequality. The results show that VAT is associated with a 0.45 percentage point increase in the national poverty rate for every billion Kwacha raised, while PIT is linked to a 0.04 percentage point increase in poverty for every 1 billion Kwacha raised. The analysis further accentuates the potential of PIT in reducing inequality, with 1 billion Kwacha of PIT revenue associated with an average reduction of 0.68 percentage points in the Gini coefficient. Excise Duties contribute marginally to a 0.05 percentage point reduction, indicating a slight enhancement in income distribution. Conversely, TOT is associated with a 0.06 percentage point increase in the Gini coefficient for every billion Kwacha raised during the same period.

The results also show that, in Zambia, the total tax elasticity on poverty is 2.0 and on income inequality -3.8. This means that, overall, the imposition of additional taxes is associated with a 2 % increase in poverty and a 3.8 % reduction in income inequality. VAT emerging as the most significant contributor to poverty, with an average contribution share of approximately 72.6%. TOT followed, contributing around 19.3% on average, while PIT and Excise Duties played comparatively smaller roles, with average contribution shares of about 4.2% and 3.8%, respectively. These findings are broadly in line with the cost-effectiveness analysis conducted in this paper and with Jansen (2023), who finds that setting optimal uniform rates (for VAT and PIT) reduces the Gini coefficient by 3 % in low-income countries.

Alternative policy proposals are then devised and simulated based on the cost-effectiveness analysis and the results of analysing taxpayer bunching on PAYE (***Bryson et al. (2023)***, VAT, and excise taxes; Jansen, 2023, ***Byaruhanga, 2020***). Drawing on these results, we formulate and evaluate two revenue-neutral policy reforms and a two other reforms, which produces additional revenue that is used to increase social protection benefits. In the first scenario, we propose a revenue-increasing change in the PAYE tax schedule, directing the additional revenues to reduce VAT from 16.0 % to 15.0 %. In the second reform, we reduce VAT to 15.5 % and increase excise duties accordingly to render the reform revenue neutral. In the third alternative reform, we combine the adjustments in the first two scenarios and also increase the benefit amounts to poor households under the Social Cash Transfer (SCT) program in Zambia. The third reform is also revenue-neutral after accounting for the increased spending on social benefits. In reform 4 TOT is adjusted from 800,000 Kwacha to 1.2 million Kwacha, and the tax rate was increased from 4% to 5.5%. This adjustment reflects the fact that the threshold has not been updated over time, and inflation may have diminished the real value of the original upper limit.

The proposed PAYE reforms are informed by our earlier work on bunching in Zambia (***Bryson et al., 2023***). The study shows evidence of bunching, with an average elasticity of 0.07 at the first kink in the PAYE data for Zambia. Thus, we do not reduce the lower tax brackets than the initial K61,200 per annum. In addition, we provide slight relief for the earnings between K61,200 and K90,000 and tax them at 25% and further increase the upper bracket from K110,400 to K144,400 and tax it at a marginal tax rate of 37.5% from the initial 37%. In the reform 4 we propose the hike in the lower bracket to K66, 000 and a hike in the tax rate of the upper limit from 37% to 38%. Apart from PAYE schedule adjustments, the excise duty and VAT adjustments in Reforms 2, 3 and 4 are proposed based on the cost-effectiveness analysis discussed above as well as results by Jansen (2023) and ***Byaruhanga (2020)***.

In Zambia large segments of the population engaged in informal employment, non-employment, or agriculture often fall outside the personal income tax (PIT) system due to limited formal incomes and weak enforcement. However, they are still subject to value-added tax (VAT) through consumption. This creates an imbalance, as PIT excludes many low-income earners while VAT remains broadly applied, highlighting the need to consider employment structure when assessing tax equity and disposable income differences.

The simulations show that Reforms 1 and 2, only including revenue-neutral tax changes, lead to modest reductions in poverty and inequality. The third reform produces more notable improvements in redistributive outcomes, again at no net cost to the government. According to the simulations, the adjustments in the PAYE tax schedule generate an additional K273 million of revenue from direct taxes (+4.1 %). The revenue is used to reduce direct taxes by K135 million from the baseline (-2.9 %) and to channel K133 million to improvements in social protection. As for the overall welfare effects,

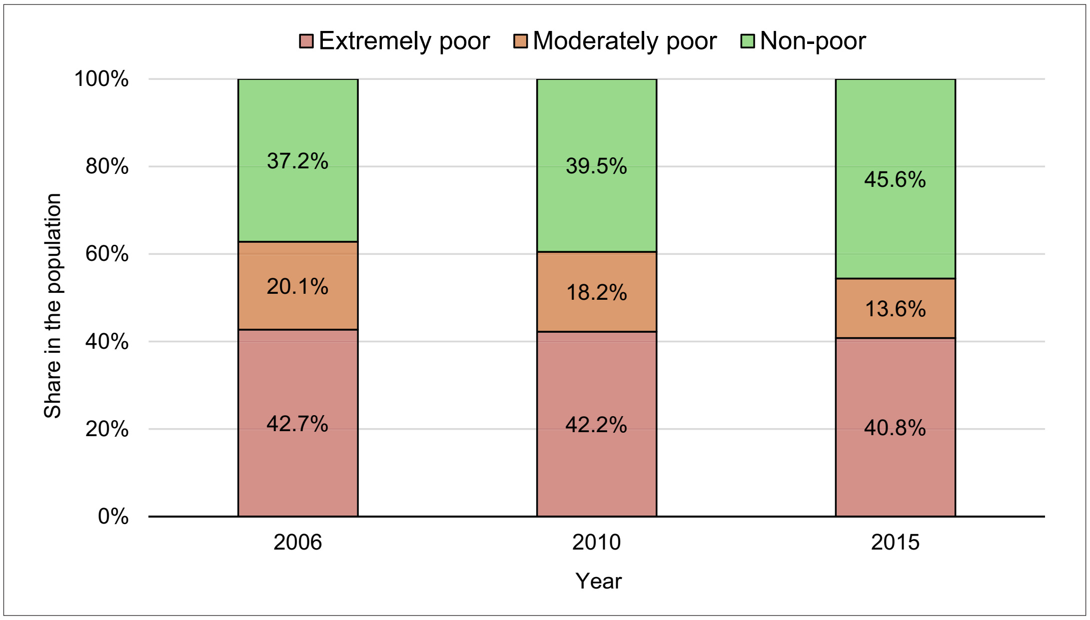

Figure 2. Poverty trends in Zambia, 2006, 2010 and 2015 .

Source: constructed by the author using the 2006, 2010, and 2015 LCMS.

the national poverty rate is reduced by an estimated 0.14 % percentage points (pp.), the poverty gap by 0.17 pp., and the Gini coefficient by 0.16 points (on a scale of 0 to 100). The reform benefits the bottom 80 % of households. The fourth reform produces more additional revenue (K525 million) than the third reform leading to more revenues being channeled to social protection payments. This study significantly contributes to the body of literature and enhances our understanding of optimal tax policy formulation by employing cost-effective indices. It proposes revenue-neutral policy reforms and revenue generating reforms within the tax mix, with the overarching objective of reducing the poverty rate and improving overall inequality in emerging economies. Additionally, the study methodically calculates poverty and inequality multipliers for Zambia, shedding light on the aftermaths of each additional 1 billion Kwacha in tax revenue.

2. Trends in Poverty, Inequality, and Tax Revenue in Zambia

2.1. Poverty and inequality

According to the results of the 2006, 2010 and 2015 Living Conditions Monitoring Surveys (LCMS) presented in ***Figure 2***, the poverty rate in Zambia remained high, standing at 62.8 % in 2006, 60.5 % in 2010 and 54.5 % in 2015 (***ZamStats, 2015*** & (***ZamStats, 2010***). In 2006 and 2010 , 42.7 % and 42.2 % of the population lived in extreme poverty, respectively. In 2015, this share had reduced to 40.8 %. Poverty has been consistently higher in rural regions (around 76.6 %) compared to cities (23.4 %). Similar to the trends of extreme poverty, the total poverty rate has gradually declined from 62.8 % in 2006 to 54.4 % in 2015, the most recent figure available from LCMS data at the time of writing this paper.

The high inequality in Zambia has largely overshadowed its recent economic progress. In countries with substantial baseline income disparities, economic growth becomes less effective in reducing poverty, according to ***Okojie and Shimeles (2006)***; a combination of economic growth and inequality reduction is required to significantly impact poverty levels. According to the findings of the Living Conditions Monitoring Surveys between 1996 and 2015, consumption-based income inequality in Zambia fell substantially from Gini coefficient of 61 in 1996 to 57 in 2004, before rising to a record-high level of 69 in 2015 (ZamStats, 2016). As shown in ***Figure 3***, the share of income earned by those belonging to the top ten percent of households climbed consistently from 50% to 55 % from 1996 to 2010 but then fell to 50 % in 2015. In 2015, the proportion of income received by the bottom 50% as well as the share of the medium-income group (deciles 6–8) decreased compared to 1996. In contrast,

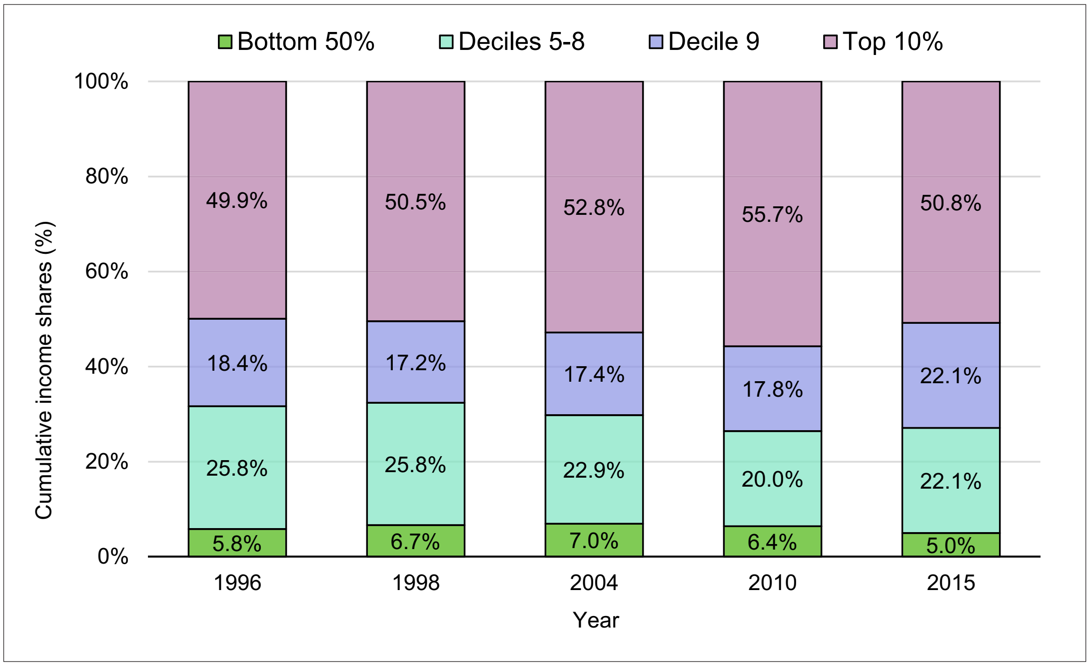

Figure 3. Income share across the population distribution 1996–2015.

Source: constructed by the author using data from ZAMSTATS (see also ***International Growth Centre, 2017***).

over the last five years, the income share of the 9th decile has expanded dramatically (***International Growth Centre, 2017***).

2.2. Structure of tax revenue

Since the establishment of the Zambia Revenue Authority (ZRA), the structure of tax revenues in the country has changed substantially, as illustrated in ***Figure 4***. See also ***Figure 5***, which illustrates tax revenues by tax type as a percentage of GDP between 1995 and 2019.

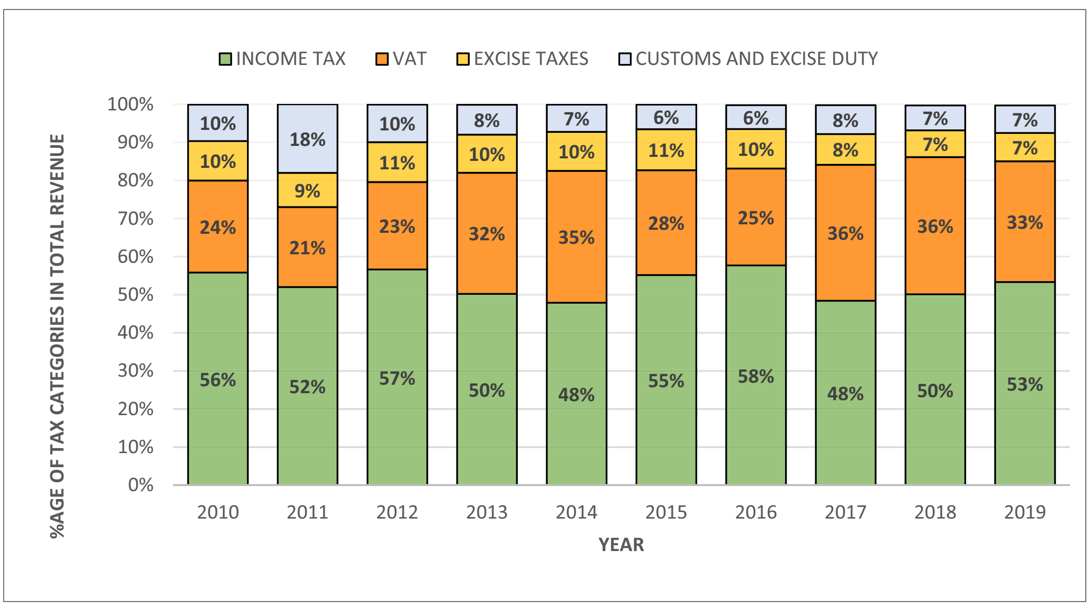

Figure 4. Structure of public tax revenues in Zambia, 2010–2019.

Source: constructed by the author using ZRA data.

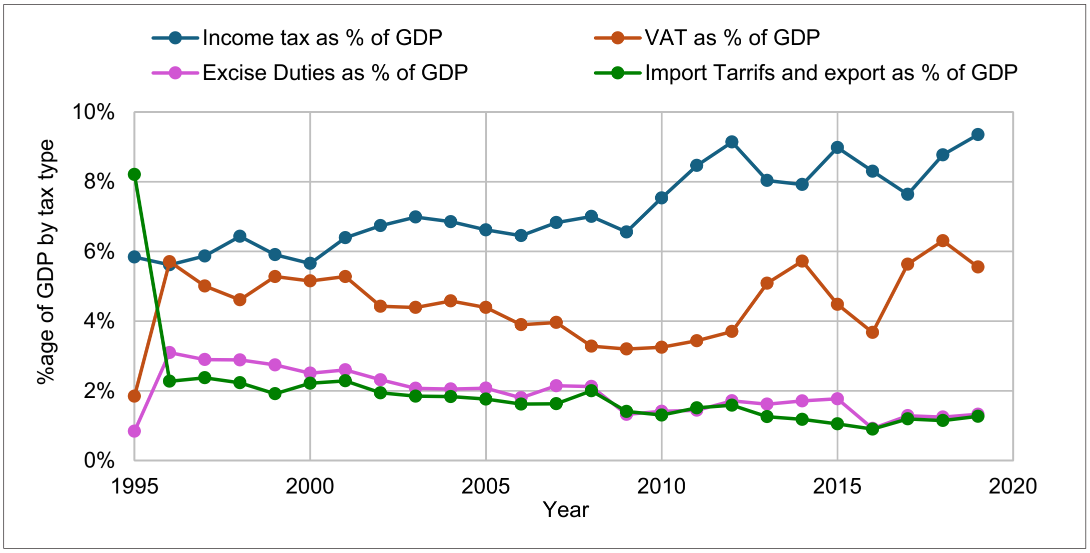

Figure 5. Tax revenues by selected tax type as a percentage of GDP.

Source: author's elaboration of data from ZRA.

From 2010 to 2013, income taxes contributed the largest share of tax revenue, with an average contribution of 50.0%, while VAT accounted for an average of 26.7%. Excise taxes and customs and export duties remained relatively stagnant during this period, contributing an average of 10.1% and 9.6%, respectively. Between 2014 and 2019, the structure of tax revenues remained broadly similar, with income taxes continuing to dominate, averaging 51.9% of total tax revenue. VAT followed, contributing an average of 31.9%. Excise duties accounted for an average share of 10.9%, while customs and export duties declined further to an average of 6.4%. Notably, revenue from excise taxes exhibited a steady decline throughout the decade ***Figure 6***

Notably, the share of income taxes of total revenue has been rising consistently during the period, with an average of 51 %. Income tax revenues were highest in 2012 at 56.6 % of total tax revenue and lowest in 2005 at 41.6 %. The four taxes which make up most income tax revenue – company tax, Pay-As-You-Earn (PAYE), withholding tax, and the mineral royalty – have been increasing steadily over the

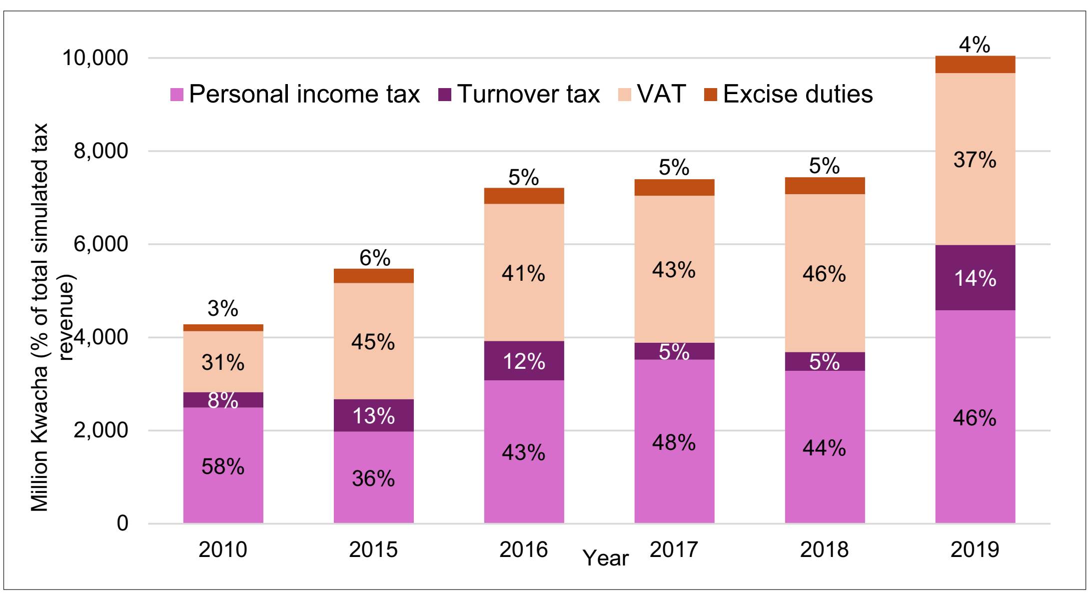

Figure 6. Contributions of different taxes to simulated tax revenue in Zambia, 2010–2019.

Source: Constructed by the author based on MicroZAMOD simulations.

period under review. PAYE is by far the highest contributor to income tax revenue. As a percentage of GDP, income tax revenues have been increasing steadily from 6.2 % in 1995 to 8.6 % in 2019.

The share of VAT as a percentage of total tax revenue increased from about 10 % in 1995 to about 35 % in 1996. Similarly, it decreased from 26.9 % in 2005 to 22.8 % in 2008 before increasing again to 34.6 % in 2014. The VAT as a percentage of total revenue was highest in 2018, standing at 36 %. The contribution of VAT on imports has been increasing steadily, with much of the fluctuations stemming from domestic VAT. More than half (63.7%) of VAT collected came from VAT on imports. As a percentage of GDP, VAT has been stable, standing between 3 % and 6 %.

The share of customs and export duties as the percentage of total tax revenue increased between 2005 and 2008 from 18.4 % to 29.1 %. The share decreased to 20.2% in 2010 before increasing steadily to 26.7 % by 2013. Customs and export duties were at their highest as a percentage of total tax revenue in 2008, at 29.1 %. Customs duties have been the largest contributor and have been rising gradually over the period under review. As a percentage of GDP, customs and export duties have remained consistently at around 4%.

The share of excise duties as a percentage of total tax revenue increased from about 4% in 1995 to about 17% in 1996 thereafter, it has been steady from 2005 to 2015 averaging 11 %. Between 2016 and 2019 it fluctuated and only averaged 7.3 %. Until 2017 excise duty was being managed collectively under customs before being split into domestic excise and import excise duty. As a percentage of GDP, excise duty has been decreasing steadily from 2.1 % in 2005 to 1.2 % in 2019.

3. Literature Review: Taxation, Poverty, and Inequality

A substantial body of empirical literature explores the relationship between taxation and its redistributive effects on poverty and inequality, particularly in developing countries. Evidence shows that the composition and structure of tax systems significantly shape income distribution. ***Lustig (2018)*** underscores that regressive indirect taxes, especially VAT, tend to exacerbate poverty unless adequately offset by targeted social transfers. This concern is echoed by ***Inchauste and Lustig (2017)***, who find that in many low and middle-income countries, indirect taxes often outweigh the benefits of transfers for the poor, leading to a net increase in poverty. Similarly, ***Martinez-Vazquez et al. (2012)*** highlight that developing countries with high reliance on consumption taxes generally experience weaker redistributive outcomes.

Studies focusing on Sub-Saharan Africa further reinforce this pattern. In their analysis of Ghana ***Younger et al. (2017)*** demonstrate that indirect taxes have regressive impacts, while direct taxes and transfers are too limited in scale to reverse these effects. In Uganda ***Jellema et al., 2018*** find that the fiscal system's impact on poverty is negligible, and inequality reduction is modest at best. Evidence from Ethiopia by (***Hill et al., 2017***) points to similar conclusions, where indirect taxes increase poverty despite the progressive nature of certain subsidies and spending programs.

The dominant methodological approach in this literature involves fiscal incidence analysis and microsimulation using household survey data. The CEQ (Commitment to Equity) methodology developed by ***Lustig and Higgins (2018)*** has become a standard framework, enabling decomposition of tax and transfer impacts on poverty and inequality indices such as the Gini coefficient, FGT measures, and Atkinson indices. The tools allow for rigorous distributional analysis under different policy scenarios.

Findings across various contexts converge on the importance of expanding progressive taxation especially personal income tax and scaling up well-targeted transfer programs to counterbalance the regressive effects of indirect taxes (***Coady and Prady, 2018***; ***Fuente et al., 2020***). Additionally, ***Cuesta and Martinez-Vazquez (2012)*** stress the need for tax systems that can be both efficient and equitable, with an emphasis on administrative feasibility and political sustainability. Evidence from Bolivia (***Paz Arauco et al., 2014***) and Brazil (***Higgins and Pereira, 2014***) shows that when combined with effective transfers, even regressive taxes can be part of a broadly progressive fiscal system.

Overall, the literature suggests that while taxation in developing countries tends to have limited direct redistributive capacity due to narrow tax bases and institutional constraints, its impact can be significantly improved through strategic reform and integration with social protection policies.

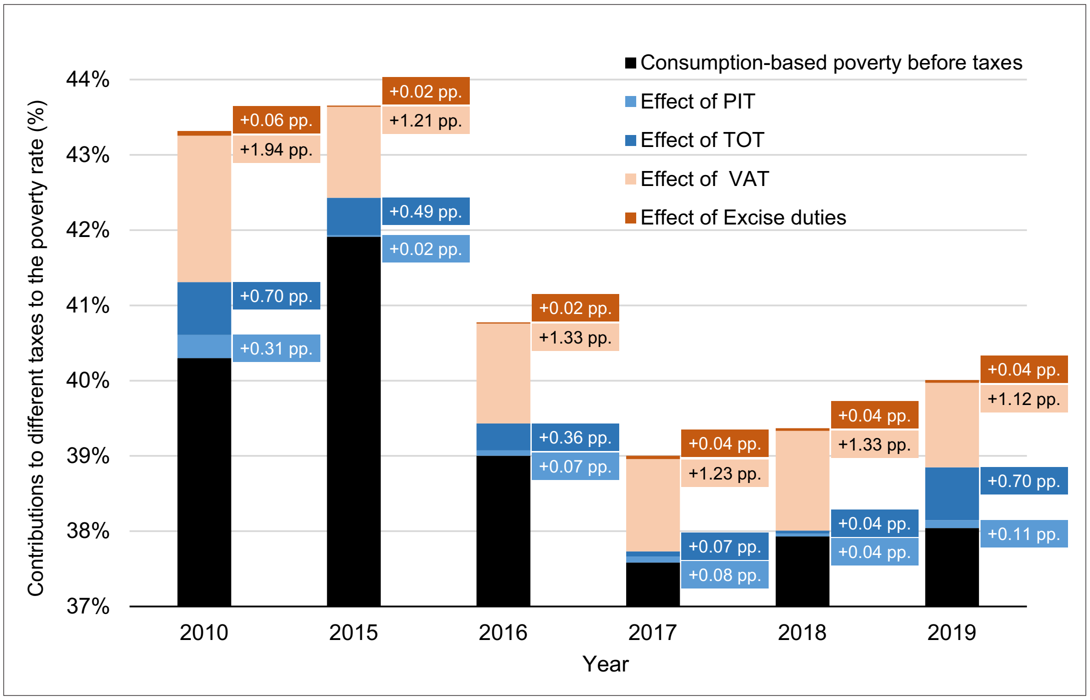

Figure 7. Contributions of different taxes to the national consumption-based severe poverty rate in Zambia, 2010–2019.

Source: Author's elaboration based on MicroZAMOD simulations.

4. Methodology and application of tax-benefit microsimulation modelling

The methodology of this study begins by establishing the conceptual and empirical relationship between taxation, poverty, and inequality. Taxation plays a dual role in economic systems: it is a primary tool for mobilizing public revenue and a key instrument for redistributive policy. In developing countries, however, tax systems often exhibit regressive features, especially where reliance on consumption taxes outweighs direct taxes. This can exacerbate poverty and income inequality if lower-income households bear a disproportionate tax burden. Conversely, well-targeted progressive tax and transfer mechanisms can reduce poverty and narrow income disparities. This study employs a microsimulation model to trace the incidence of taxation across different income groups and assess the distributional effects of tax reforms. The robustness tests are done outside the model in STATA using the output file from the model. By linking household-level income data with tax policy parameters, the model evaluates how specific tax instruments affect welfare outcomes, measured through poverty indices and inequality metrics such as the Gini coefficient and Generalized Entropy indices. ***Figure 6 Figure 8*** shows the research idea of the study.

4.1. Data and Tax-benefit microsimulation modeling

MicroZAMOD is a static tax-benefit microsimulation model for Zambia, developed based on the EUROMOD framework and as part of the SOUTHMOD (***UNU-WIDER, 2023***) project at UNU-WIDER. MicroZAMOD may be used to evaluate the extent to which the current (or a hypothetical) system of social benefits and taxes reduce poverty and inequality in Zambia. Tax revenues and social protection expenditures for the government can also be assessed, at large or for specific taxes or benefits.

One of the main uses of MicroZAMOD, similar to all tax-benefit microsimulation models, is the evaluation of tax and benefit policy reforms, namely changes in tax-benefit parameters from the baseline; the success of a given policy reform is evaluated in comparison to the current situation. As discussed by ***Navicke (2017)***, the parameter changes may include, for instance, changes to eligibility requirements, tax rate structures, or benefit levels.

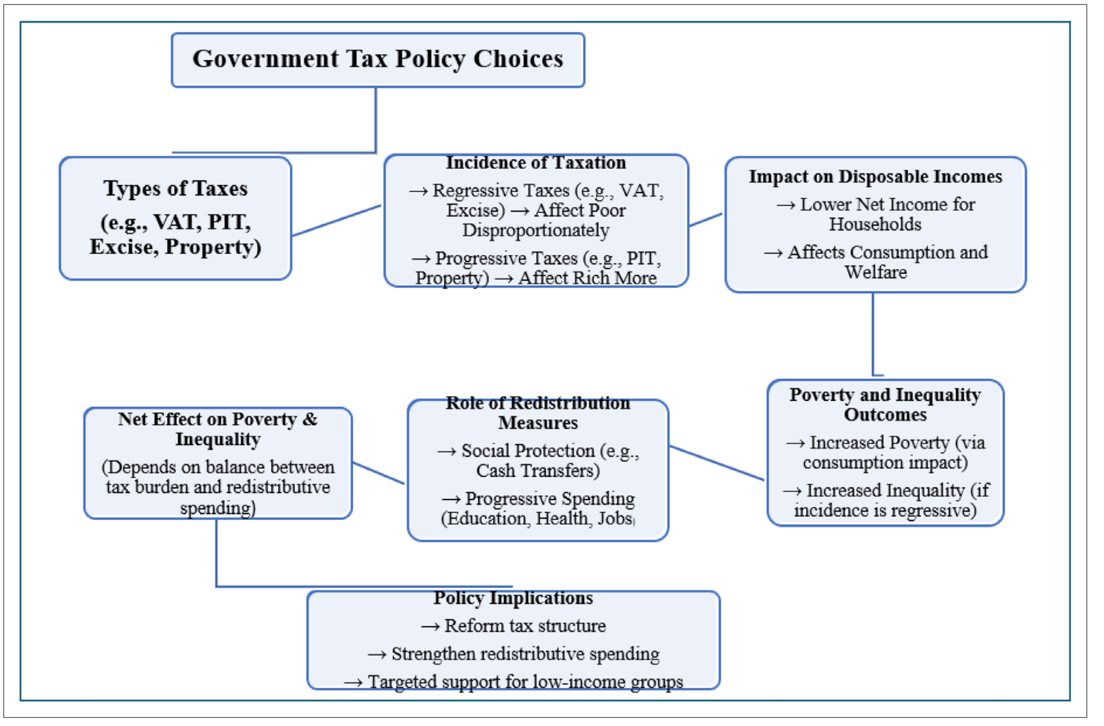

Figure 8. Research process flow.

Source: Constructed by the author.

Similar to all tax-benefit microsimulation models, MicroZAMOD is underpinned by a micro dataset that contains the economic and socio-demographic characteristics of a sample of individuals and households in the country. The most recent dataset (Living Condition Monitoring Survey 2015) used in the model represents the economic and socio-demographic characteristics of the Zambian population in 2015. The final 2015 dataset used in the model contains information on 62,879 individuals in 12,251 households. Weights from the LCMS 2015 are used to calculate national figures from the simulations. Due to this, all results presented in this paper use 2015 as the baseline calibrated to 2022 using the consumer price index (CPI) multipliers.

The tax-benefit policies incorporated in MicroZAMOD include the following:

1. Direct and indirect taxes; *Personal income tax (PIT), turnover tax (TOT), value-added tax (VAT), selected excise duties, and the medical levy (2010 only);*
2. Social Contributions; *Employee and employer pension contributions, national health insurance contribution for employees and employers;*
3. Social assistance and social insurance; *Social Cash Transfer (SCT), COVID Emergency Cash Transfer, Supporting Women's Livelihood (SWL) program, Keeping girls in school (KGS) program, Community skills development and training, Home-Grown School Meal Programme (HGSM), Electronic-Farmer Input Support Programme (E-FISP), and Food Security Pack (FSP*).

In this study, the focus is on the analysis and policy reforms to social protection, direct and indirect taxes.

4.2. Analysis of the impact of specific taxes

The analysis focuses on the following welfare measures: public tax revenues, consumption-based headcount severe poverty rate (FGT0) and poverty gap (FGT1), and the Gini coefficient of inequality, also based on consumption.

The first part of the analysis entails standard simulations of policy systems for the years 2010 and 2015–19 using MicroZAMOD. The model starts with individual-level data on market incomes and household-level data on consumption expenditures. Based on year-specific policy rules, it applies taxes and benefits to individuals and households in the data and then calculates the resulting disposable income and simulated consumption for each individual and household, along with total taxes levied and benefits provided.

In Section 5.1, these simulations are used simply to calculate the total tax revenues collected from each of the four taxes incorporated in the model.

In Section 5.2, the same simulations are then used to analyse the impact of each tax on the severe poverty rate. This analysis is carried out by first calculating the final simulated consumption for each household in five cases, which account for all benefits but not all taxes. The cases include (i) consumption before any taxes and (ii) consumption after each of the four taxes, which are subtracted from pre-tax income one by one. In the final setting, consumption is derived after all taxes (in addition to all benefits). Having obtained these outcomes, we calculate hypothetical poverty rates based on the five consumption measures. Comparing the outcomes illustrates the extent to which each tax contributes to increasing or reducing the national poverty rate.

Section 5.3 repeats the analysis above but uses the Gini coefficient of inequality as the main welfare measure, illustrating the extent to which each tax contributes to changing it.

In Section 5.4, we combine the results from Section 5.1 (revenues generated from each tax) and Sections 5.2 and 5.3 (static poverty and inequality impacts of each tax). In brief, we compute the change in the poverty rate and Gini associated with raising one billion Kwacha from a given tax. A tax can be considered cost-effective from a distributional standpoint if it reduces the poverty rate (or Gini) substantially (or increases it marginally) for a given amount of revenue raised.

4.3. Analysis of hypothetical scenarios

In Section 5.5, the analysis discussed above is then used to devise hypothetical policy reforms that aim to maximize revenue while at the same time reducing poverty and income inequality. The reform scenarios are evaluated by comparing the simulated outcomes (tax revenues, consumption-based headcount poverty and poverty gap, and the Gini coefficient) to those in the 2022 baseline. The parameters altered in the reforms are explained in Section 5 and only consider changes in social protection, direct and indirect taxes.

For each reform and each outcome measure, we compare the *baseline* level to the counterfactual *reform* situation. Defining h as the demographic and socio-economic characteristics of individuals and households, y as their baseline gross market income, $t\left(y,h\right)$ as taxes, and $b\left(y,h\right)$ as government transfers, household disposable income in the baseline equals $D = y - t\left(y,h\right) + b\left(y,h\right)$. Similarly, disposable income under a reform is defined as $D^{'} = y - t^{'}\left(y,h\right) + b'\left(y,h\right)$, where $t^{'}\left(y,h\right)$ denotes the reformed taxes and $b'\left(y,h\right)$reformed benefits in the reform scenario. Note that simulated taxes and benefits depend on income and the demographic and socio-economic characteristics of individuals and households, and that tax changes can trigger changes in benefit eligibility and receipt. Additionally, instead of disposable income, this study relies on simulated consumption; income changes are translated into consumption changes with a one-to-one ratio (see ***Navicke, 2017***, for details).

The total difference Δ in a given welfare index I is then:

$$\Delta = \underbrace{\mathrm{I}\left[\mathrm{y} - \mathrm{t}'\left(\mathrm{y,h}\right) + \mathrm{b}'\left(\mathrm{y,h}\right)\right]}_{\textit{reform scenario}} - \underbrace{\mathrm{I}\left[\mathrm{y} - \mathrm{t}\left(\mathrm{y,h}\right) + \mathrm{b}\left(\mathrm{y,h}\right)\right]}_{\textit{baseline scenario}}$$

Welfare indices I, namely the poverty rate and Gini coefficient, can be estimated based on the simulated distributions of disposable income and thereby simulated consumption in the baseline and reform scenarios. In Section 5.5, we compare tax revenues, poverty and inequality in the baseline scenario (T_0) with four reform scenarios (T_1, T_2, T_3 and T_4) relying on the 2022 system as the baseline and making any reform adjustments to that system. For more detailed decomposition approaches, see ***Bargain and Callan (2007)*** and ***Navicke, 2017***.

As previously stated, assuming that individual behavior remains constant, this mathematical microsimulation modeling in the field of redistributive economics simulates variations in the rules for computing tax or benefit payments, resulting in changes in the real disposable income of individuals or households. Using a straightforward income indicator to measure variations in welfare resulting from budget restriction modifications, ***Bourguignon and Spadaro (2006)*** demonstrate the theory of consumer behavior, which provides the theoretical underpinning for arithmetical microsimulation.

5. Results and Discussion

5.1. Contribution of simulated taxes to revenues

Figure 6 illustrates revenues from different taxes as simulated using MicroZAMOD in 2010 and from 2015 to 2019. The outcomes differ slightly from those presented in Section 2; for more information on the discrepancies and validation against external statistics, see the most recent country report (***Kalikeka et al., 2023***).

Source: constructed by the author based on MicroZAMOD simulations.

The main conclusion is that personal income tax (PIT) and value-added tax (VAT) account for most of the simulated revenue, similar to the estimates presented earlier. Furthermore, the revenue share from PIT decreased from 58% in 2010 to 46% in 2019, while the share from VAT increased from 2010 to 2019. This consistent upward trend underscores the pivotal role of consumption-based taxation in the fiscal strategy. The share of simulated turnover tax has increased to 14% in 2019 from 8% in 2010. Simulated excise duties, though representing a smaller share of the overall tax revenue, have remained relatively stable, ranging from 3% to 6% over the period.

5.2. Effect of taxes on poverty

The rest of this analysis focuses on evaluating the impact of different taxes on consumption-based poverty and inequality over the 2010–2019 period (see Section 4 for the methodology). As discussed in the methodology, ***Figure 7*** computes several, hypothetical consumption-based measures of poverty, where each of the four simulated taxes are incorporated one at a time. Consumption-based poverty before all taxes (but including benefits) starts at 40.30 % in 2010, peaks at 41.91 % in 2015, and gradually tapers to 38.04 % in 2019. Poverty after all taxes (and benefits) also decreases over time. Taken together, taxes effectively increase the consumption-based poverty rate – by around 3 percentage points in 2010 but by less than 2 percentage points in 2019, indicating that taxes have become slightly better for the poor over time. The main conclusion here is that the tax-benefit system at large increases consumption-based poverty in Zambia, but slightly less in 2019 (+1.9 %) than in 2010 (+3.0 %).

The main conclusion is that VAT has the largest poverty-increasing effect among the four taxes (57 % of the total effect in 2019), followed by the turnover tax (TOT) (36 % in 2019). Personal Income Tax (PIT) and excise duties only marginally increase poverty. This said, the results point to substantial fluctuations in the contribution shares over the years, especially for PIT, VAT, and TOT. The main conclusion is that VAT, in particular, appears to hurt the poorest segments of the population, while excise duties could be raised with limited impact on the poor. Alternative reforms considered in Section 5 are based on these lessons.

Table 1. Effects of taxes on the Gini coefficient.

	2010	2015	2016	2017	2018	2019
Consumption-based Gini before taxes	57.03	57.16	55.63	54.99	55.11	55.22
Effect of PIT	-2.35	-1.02	-1.29	-1.37	-1.22	-1.51
Effect of TOT	+0.09	+0.13	+0.11	-0.12	-0.11	+0.15
Effect of VAT	-0.29	-0.34	-0.38	-0.42	-0.41	-0.42
Effect of Excise Duties	-0.15	-0.16	-0.15	-0.15	-0.14	-0.13
Consumption-based Gini after taxes	54.33	55.78	53.92	52.94	53.23	53.30
Contribution shares						
Effect of PIT	-87.2%	-73.9%	-75.1%	-66.7%	-64.8%	-78.8%
Effect of TOT	+3.5%	+9.7%	+6.5%	-5.6%	-6.1%	+7.7%
Effect of VAT	-10.9%	-24.5%	-22.4%	-20.5%	-21.7%	-21.9%
Effect of Excise Duties	-5.4%	-11.4%	-9.0%	-7.2%	-7.4%	-7.0%
Effect of all taxes on consumption-based Gini	-100%	-100%	-100%	-100%	-100%	-100%

Source: Author's elaboration based on MicroZAMOD simulations.

Table 2. Cost-effectiveness of different taxes in terms of changes in poverty.

	2010	2015	2016	2017	2018	2019
Effect of PIT	+0.12 pp.	+0.01 pp.	+0.03 pp.	+0.03 pp.	+0.01 pp.	+0.04 pp.
Effect of TOT	+0.28 pp.	+0.20 pp.	+0.14 pp.	+0.03 pp.	+0.02 pp.	+0.28 pp.
Effect of VAT	+0.78 pp.	+0.49 pp.	+0.53 pp.	+0.49 pp.	+0.53 pp.	+0.45 pp.
Effect of Excise Duties	+0.03 pp.	+0.01 pp.	+0.01 pp.	+0.02 pp.	+0.01 pp.	+0.02 pp.

Source: Author's elaboration based on MicroZAMOD simulations.

Note: the cells indicate the increase in the national poverty rate (in percentage points) associated with raising 1 billion Kwacha of revenue from a specific tax. Larger estimates (red) hence point to cases where raising tax revenue leads to larger relative increases in poverty.

5.3. Effect of taxes on income inequality

Similar to poverty, while this research mainly focuses on consumption-based economic outcomes. ***Table 1*** repeats the analysis in ***Figure 7*** for the Gini coefficient, computing several, hypothetical consumption-based measures of the Gini, where each of the four simulated taxes are incorporated one at a time. The simulated Gini coefficient for consumption before taxes has consistently decreased over the years, from 57.03 in 2010 to 55.22 in 2019. When considering consumption patterns after accounting for the four taxes, the Gini coefficient also exhibits a declining trend, from 54.33 in 2010 to 53.30 in 2019. Taken together, and as opposed to poverty, taxes decrease the consumption-based Gini index – by around 2.7 points in 2010 but by less than 2 points in 2019, indicating that taxes have become slightly worse in reducing inequality over time.

5.4. Cost-effectiveness of raising different taxes with respect to revenue and distributional impacts

The analysis presented in this section investigates the cost-effectiveness of different taxes in terms of their impact on poverty rates and the Gini coefficient, utilizing the provided information that links revenue changes to variations in distributional outcomes. The assessment is grounded in the understanding that not all tax revenues contribute equally to reductions in inequality or poverty. As above, the analysis considers the efficiency of PIT, TOT, VAT, and Excise Duties in terms of their associated impact on poverty rates and the Gini index, per unit of one billion Kwacha generated from each respective tax (see Section 3 for the methodology). This analysis will further help us devise policy reform scenarios that maximize revenue while reducing poverty and inequality at the same time.

Table 2 shows the estimated cost-effectiveness of different taxes in terms of poverty changes associated with raising revenue from them. The main conclusions are clear and in line with the previous analysis not accounting for revenues: Raising revenue from VAT leads to large increases in poverty, with the other types of taxes paling in comparison. Raising revenue from TOT also increases poverty

Table 3. Cost-effectiveness of different taxes in terms of changes in the Gini index.

	2010	2015	2016	2017	2018	2019
Effect of PIT	-0.95 pp.	-0.41 pp.	-0.52 pp.	-0.55 pp.	-0.49 pp.	-0.60 pp.
Effect of TOT	+0.04 pp.	+0.05 pp.	+0.04 pp.	-0.05 pp.	-0.05 pp.	+0.06 pp.
Effect of VAT	-0.12 pp.	-0.14 pp.	-0.15 pp.	-0.17 pp.	-0.16 pp.	-0.17 pp.
Effect of Excise Duties	-0.06 pp.	-0.06 pp.	-0.06 pp.	-0.06 pp.	-0.06 pp.	-0.05 pp.

Source: Author's elaboration based on MicroZAMOD simulations.

Note: The cells indicate the change in the Gini coefficient (in percentage points) associated with raising 1 billion Kwacha of revenue from a specific tax. Larger estimates (red) hence point to cases where raising tax revenue leads to larger relative increases in the Gini.

substantially, although mainly in 2010 and 2019. This strongly suggests that poverty could be cost-effectively reduced by decreasing the VAT rate, while other taxes can be safely increased without large increases in poverty. These lessons are considered when devising alternative policy proposals in Section 6.

Table 3 shows the estimated cost-effectiveness of different taxes in terms of inequality changes associated with raising revenue from them.

The main conclusions are again clear and in line with the previous analysis not accounting for revenues: Raising revenue from PIT leads to large reductions in inequality. 1 billion Kwacha of PIT revenue is associated with a substantial 0.95-point reduction in the Gini in 2010, although it is noteworthy that this impact has diminished over the years, with an estimated 0.60-point effect in 2019.

This said, the effects of other taxes, especially TOT and excise duties, are substantially more limited. Raising revenue from VAT also reduces the Gini coefficient to an extent, 17 percentage points for a billion Kwacha in 2019.

The finding that Personal Income Tax (PIT) has the least poverty-increasing effect, despite some fluctuations when its share is reduced, warrants closer examination. PIT is generally progressive in nature, affecting higher-income individuals more than the poor, who often fall below the taxable threshold. Therefore, increases in PIT tend to have limited direct impact on poverty levels. In contrast, Value Added Tax (VAT) is inherently regressive, as it is uniformly applied to goods and services consumed by all income groups. Since low-income households spend a higher proportion of their income on consumption, any increase in VAT directly raises their cost of living, thereby intensifying poverty. This intuitive relationship is supported by the results, which show VAT having a more pronounced effect on poverty measures. The dynamics suggest that while PIT reforms may offer a relatively equitable path for revenue mobilization, increased reliance on VAT without compensatory measures such as targeted transfers can undermine welfare outcomes and widen inequality. This underscores the need for a balanced tax mix that safeguards equity while ensuring fiscal sustainability.

These findings strongly suggest that inequality could be cost-effectively reduced via the PIT, for example by increasing the PIT rates or taxing higher-income individuals more. Especially excise duties can be safely increased without large increases in inequality. As above, these lessons are considered when devising alternative policy proposals in Section 5.

Even without the tax-benefit analysis, policymakers can utilise the findings outlined above to optimize tax policies, ensuring a balance between revenue generation and objectives to reduce inequality and poverty.

5.5. Alternative scenarios

Specification of hypothetical scenarios

Based on the cost-effectiveness analysis in Section 4, we make the following four tax policy proposals, each with the goal of reducing poverty and inequality at no cost:

- Reform 1 (*revenue neutral*): Increases direct taxes (via the PIT/PAYE schedule) while slightly adjusting indirect taxes (VAT from 16% to 15.0%).
- Reform 2 (*revenue neutral*): Maintains direct taxes at baseline and adjusts indirect taxes (VAT from 16% to 15.5%, along with increases in excise duties, with no change in net revenue from indirect taxes).
- Reform 3 (*revenue increasing after tax adjustments and revenue neutral after channeling additional revenues to social benefits*): Increases direct taxes (as in Reform 1) and adjusts indirect taxes (as in Reform 2). Additional revenue is directed to an increase in the benefit amount of the Social Cash Transfer (SCT) from K90 to K106 Kwacha. The Social Cash Transfer (SCT) programme in Zambia is a government-led social protection initiative aimed at reducing extreme poverty and vulnerability among the country's poorest households. It provides regular, unconditional cash payments to eligible individuals, particularly those who are incapacitated or caring for orphans, the elderly, or persons with disabilities.
- Reform 4 (*revenue increasing after tax adjustments and revenue neutral after channeling additional revenues to social benefits*): Increases direct taxes (via the PIT/PAYE schedule and the Turnover Tax schedule) and adjusts indirect taxes (as in Reform 2). Additional revenue is directed to an increase in the benefit amount of the Social Cash Transfer (SCT) by from K90 to K155 Kwacha.

Table 4. Baseline and proposed policy reforms.

Parameter	Baseline	Reform 1	Reform 2	Reform 3	Reform 4
PAYE/PIT Band 1	61,200–85,200	61,200–90,000		61,200–90,000	66,000-92,400
PAYE/PIT Band 1 Rate	20.0%	25.0 %	Same as baseline	25.0 %	25.0%
PAYE/PIT Band 2	85,200–110,400	90,000–144,400		90,000–144,400	92,400-130,000
PAYE/PIT Band 2 Rate	30%	34.0%	Same as baseline	34.0%	33%
PAYE/PIT Band 3	Over 110,400	Over 144,400		Over 144,400	Over 144,000
PAYE/PIT Band 3 Rate	37.0%	37.5%	Same as baseline	37.5%	38%
Clear beer excise duty (ad valorem rate)	40.0%	Same as baseline	65.0%	65.0%	65%
Wine and spirits excise duty (ad valorem rate)	60.0%	Same as baseline	80.0%	80.0%	80%
Opaque beer excise duty (Kwacha per litre)	0.25	Same as baseline	0.6	0.6	0.6
Tobacco excise duty (Kwacha per single piece)	0.4	Same as baseline	0.75	0.75	0.75
VAT rate	16%	15.0%	15.5%	15.0%	15.5%
Turnover Tax Upper Limit	800,000	Same as baseline	Same as baseline	Same as baseline	1,200,00
Turnover Tax Rate	4%	Same as baseline	Same as baseline	Same as baseline	5.5%

Source: Constructed by the author using ZRA practice notes.

Source: note that PIT/PAYE rates for those under the first band are 0% (e.g. those earning under K61,200 in the baseline). Only parameters that are changed in one or more of the scenarios are included.

A full picture of the proposed policy scenarios is presented in ***Table 4***.

In the policy proposals outlined above, Reforms 1 to 3, the lower band of PAYE is maintained at 61,200 Kwacha. In addition, according to ***Adu-Ababio et al. (2023)***, there is evidence of bunching behavior around the first income band, and about 65 % of the PAYE population distribution is below this band. However, Reform 4 proposes a hike of the lower band to 66,000 Kwacha.

The standard rate for VAT is proposed to be reduced from 16 % to 15.0 % in Reform 1 and to 15.5 % in Reforms 2, 3and 4. The reasoning behind this reduction is again based on the cost-effective results, which show that VAT is regressive in the Zambian context. Further, a reduction of the VAT rate can be expected to increase (or at least maintain) the levels of tax compliance among firms. This may further address the VAT refund challenges that Zambia has been facing in recent times. In addition, VAT compliance is expected to improve with the improvements of mechanisms in this tax type such as the fiscalisations, electronic invoicing, and enhanced audit by the ZRA.

Excise tax rates for selected products have been increased in Reforms 2, 3 and 4. This follows (***Byaruhanga, 2020***) as well as the cost-effective results presented earlier. Further, by their nature, excisable products are inelastic to price changes.

The upper limit for Reform 4's TOT was adjusted from 800,000 Kwacha to 1.2 million Kwacha, and the tax rate was increased from 4% to 5.5%. This adjustment reflects the fact that the threshold has not been updated over time, and inflation may have diminished the real value of the original upper limit. This tax is associated with non compliance as found by ***Jessen and Mwale (2017)*** .Finally, in Reform 3 and 4, the benefit amount for the Social Cash Transfer (SCT) is increased. This is motivated by the need for cashflow by households with the aged persons were the poverty levels are higher compared to the household without the aged as reported in the baseline year.

5.6. Results of the reforms

Table 5 shows the outcomes of the proposed reforms and related changes from the baseline.

5.6.1. Reform 1

Reform 1 aims at enhancing government revenue in a revenue-neutral manner. The reduction of VAT to 15% reduces tax revenue by 268 million Kwacha, while the reform in PAYE increases revenue by 273 million Kwacha.

As expected, distributional outcomes are generally improved with no net cost to the government. Especially the poverty results are noteworthy. While the share of the poor population reduced from 41.72% to 41.70%, poverty is marginally reduced among female-headed households and households with older people. In terms of inequality, the Gini coefficient exhibits a slight decrease of 0.06 points, indicating a minor improvement in the income distribution. The P80/P20 ratio remains unchanged at 4.98, again indicating that especially the very poorest segments of the population benefit from the reform.

5.6.2. Reform 2

Similar to Reform 1, the aim of Reform 2 is to improve distributional outcomes through a revenue-neutral approach. The reduction of VAT to 15.5% reduces tax revenue by 119.3 million Kwacha, while reform in excise taxes increases revenue by a corresponding amount. Similar to Reform 1, Reform 2 leads to minor improvements in poverty. The overall share of the poor population exhibits a marginal decrease of 0.01 percentage points, with the largest benefits obtained by female-headed households. The poverty gap experiences a minimal decrease of 0.01 points to 18.07. In terms of inequality, the Gini coefficient decreases by 0.01 points, reflecting a slim improvement in income distribution. The P80/P20 ratio remains stable at 4.98.

5.6.3. Reform 3

The tax changes in Reform 3 stands out from Reforms 1 and 2, leading to a substantial increase in simulated government revenue by 133 million Kwacha. The simulations show that the adjustments in the PAYE tax schedule generate an additional 273 million Kwacha of revenue from direct taxes. This revenue is used in two ways: to offset the revenue loss of 139 million Kwacha from indirect taxes and channel the additional revenue of 133 million Kwacha to expand social protection. Compared to the first two reforms, the third reform entails a more aggressive approach to reshaping the tax landscape, in addition to supplementing existing social cash transfers.

Accordingly, the third reform produces more notable improvements in redistributive outcomes, again at no net cost to the government. The national poverty rate is reduced by an estimated 0.16 percentage points, and the Gini coefficient by 0.16 points. The P80/P20 ratio decreases slightly to 4.95. The reform benefits the bottom 80 % of households in terms of income, and it is paid for by the top 20 % of households.

Analyzing poverty specifically among different household types, the poverty rates for female-headed and old-age households decrease significantly, by 0.45 and 0.63 percentage points, respectively.

5.6.4. Reform 4

Reform 4 stands out distinctly from the other proposed reforms, generating a substantial increase in simulated government revenue amounting to K525 million. The K525 million is directed toward

Table 5. Simulation results of the hypothetical policy reforms.

	Baseline	Reform 1		Reform 2		Reform 3		Reform 4	
	Results	Results	*Change*	Results	*Change*	Results	*Change*	Results	*Change*
Tax-benefit policy (million Kwacha)									
Government revenue	15,043.59	15,048.13	*+4.54*	15,039.18	*-4.41*	15,177.14	*+133.55*	*15,569.14*	*+525.55*
... direct taxes	5,074.75	5,347.25	*+272.50*	5,074.75	*0.00*	5,347.25	*+272.50*	*5,613.22*	*+538.47*
... indirect taxes	4,688.62	4,420.66	*-267.96*	4,684.21	*-4.41*	4,549.67	*-138.95*	*4,675.70*	*-12.92*
... social security contributions	5,280.23	5,280.23	*0.00*	5,280.23	*0.00*	5,280.23	*0.00*	*5,280.23*	*0.00*
Gov. expenditure on social transfers	3,964.93	3,964.93	*0.00*	3,964.93	*0.00*	4,095.06	*+130.14*	*4,485.48*	*+520.55*
Poverty									
Share of poor population, in %, FGT (0)	41.72*** (0.0069)	41.70*** (0.0072)	*-0.03*	41.70*** (0.0068)	*-0.02*	41.56*** (0.0074)	*-0.16*	41.54*** (0.0068)	-0.18
... male-headed households	41.80	41.78	*-0.02*	41.79	*-0.02*	41.71	*-0.09*	41.85	+0.05
... female-headed households	41.40	41.36	*-0.04*	41.37	*-0.03*	40.95	*-0.45*	40.27	-1.12
... households with children	43.15	43.13	*-0.02*	43.14	*-0.02*	43.00	*-0.16*	43.05	-0.11
... households with older persons	46.02	46.00	*-0.02*	46.02	*0.00*	45.39	*-0.63*	44.13	-1.89
Poverty gap, FGT (1)	0	0	*0*	0	*0*	0	*0*	0.00	0.00

Continued

Table 5. Continued

	Baseline	Reform 1		Reform 2		Reform 3		Reform 4	
Inequality and household income									
Gini coefficient (0–100)	54.24*** (0.0044)	54.19*** (0.0046)	*-0.06*	54.24*** (0.0046)	*-0.01*	54.08*** (0.0045)	*-0.16*	53.96*** (0.0046)	-0.003
P80/P20 ratio	4.98	4.98	*0.00*	4.98	*0.00*	4.95	*-0.03*	4.90	-0.08
Quantiles of distribution and median									
20th	1,764.99	1,766.71	*+1.72*	1,766.28	*+1.28*	1,777.85	*+12.86*	*1,792.14*	*+27.15*
40th	2,978.38	2,986.27	*+7.89*	2,979.90	*+1.52*	2,994.20	*+15.82*	*3,012.41*	*+34.03*
50th	3,812.19	3,818.94	*+6.75*	3,815.05	*+2.85*	3,828.21	*+16.02*	*3,839.29*	*+27.10*
60th	4,934.12	4,947.87	*+13.75*	4,933.12	*-1.00*	4,941.18	*+7.06*	*4,950.22*	*+16.10*
80th	8,781.77	8,791.08	*+9.31*	8,790.14	*+8.37*	8,798.51	*+16.74*	*8,778.92*	*-2.86*
Absolute national poverty line, per year	3,127.68	3,127.68	-	3,127.68	-	3,127.68	-	3,128.00	0.00

Note: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Source: Constructed by the author based on MicroZAMOD simulations.

scaling up social protection programmes. Unlike the other reforms, Reform 4 adopts a more assertive strategy both in altering the tax structure and enhancing existing social cash transfers.

As a result, Reform 4 yields more significant redistributive gains and revenue generating. It reduces the national poverty rate by an estimated 0.18 percentage points and brings about a modest decline in the Gini coefficient. Additionally, the P80/P20 income ratio drops slightly to 4.9. The benefits of the reform are concentrated among the bottom 80% of income earners, funded by increased contributions from the top 20% of households.

When examining poverty outcomes across household types, the reform delivers especially strong results for female-headed households and older persons, reducing their poverty rates by 1.12 and 1.89 percentage points, respectively. The significant boost in social transfer spending financed from the additional tax revenue underscores the reform's comprehensive and progressive approach. This commitment to targeted redistribution reinforces the aim of tackling social inequalities and providing support to the most vulnerable segments of the population

5.7. Sensitivity Analysis and Robustness Checks

To ensure the robustness of the results presented in this study, a sensitivity analysis was conducted by varying the order in which different taxes are introduced into the model. This approach was critical to examining whether the sequence of tax introduction could influence the outcomes in tax modeling. The sequence of tax implementation might affect the overall results, and this analysis was aimed at assessing the model's sensitivity to such changes.

As detailed in ***Table A1*** of the appendix, we altered the order of tax introductions within the model and assessed whether different sequences would lead to significant variations in the results. Despite these variations, the results in ***Table A2*** remained consistent with those in ***Table 5***, which presents the original model configuration. This suggests that the model is robust to changes in the sequence of tax introductions, indicating that the outcomes are not significantly influenced by the order in which taxes are introduced in the model.

The robustness checks were done in STATA for poverty incidence and inequality indices, presented in ***Table A5*** (Poverty Incidence) and ***Table A6*** (Inequality Indices), provide further confirmation that the results are stable across various model specifications. The bootstrap results, based on 250 replications with 12,251 observations, show minimal variations in the findings across different reforms.

For poverty incidence, the FGT indices (FGT0, FGT1, and FGT2) demonstrated stability across all reforms. The FGT0 (poverty headcount) remained around 0.417 in all reform scenarios, with bootstrap confidence intervals consistently ranging from 0.403 to 0.430. The results for FGT1 and FGT2, which measure poverty depth and severity, were similarly stable, with slight changes observed between reforms, such as a reduction in FGT1 from 0.1804 in the baseline to 0.1767 in Reform 4. However, these changes remained statistically significant with p-values consistently at 0.000. This indicates that while the poverty levels exhibit minor fluctuations, they are consistent across different policy reforms.

Regarding inequality, the robustness checks for the Gini coefficient and the GE(0) index show stability across all reforms. The Gini coefficient decreased slightly from 0.5424 in the baseline to 0.5396 in Reform 4, with bootstrap confidence intervals consistently ranging from 0.5337 to 0.5511. The GE(0) index, which complements the Gini coefficient, remained stable around 0.5429 in the baseline, with slight variations observed across reforms, reaching 0.5342 in Reform 4. These small changes were statistically significant, but not large enough to indicate a substantial shift in income inequality, reinforcing the robustness of the inequality results across different reform scenarios.

The consistency in the results for both poverty and inequality measures, even with varying model specifications, suggests that the observed trends reflect genuine patterns in the data rather than being driven by model choice or assumptions.

Further analysis of income inequality using the Generalized Entropy (GE) and Atkinson indices, presented in ***Table A3*** (GE indices) and ***Table A4*** (Atkinson indices) of the appendix, provides a comprehensive view of income disparities. The Generalized Entropy indices show significant inequality, particularly at the lower end of the income distribution, with GE(-1) = 1.0494 indicating a large gap among low-income households. The Mean Log Deviation (MLD) index at 0.5429 suggests moderate inequality, while the Theil Index of 0.5897 confirms a high concentration of income among a small proportion of the population. The GE(2) and GE(3) indices, at 1.3742 and 10.1342, respectively, highlight rising inequality among high earners, signaling extreme wealth concentration at the top.

The Atkinson indices, which reflect societal preferences for equality, further illustrate disparities in income. A(0.5) = 0.2445 suggests moderate inequality, where about 24.45% of income would need to be redistributed to achieve perfect equality. A(1) = 0.4189 indicates substantial inequality, while higher levels of inequality aversion reveal even more severe disparities, with A(1.5) = 0.5557, A(2) = 0.6773, and A(2.5) = 0.7905, suggesting that nearly 79% of total income would need to be redistributed to achieve full equality.

The results from both the GE and Atkinson indices are consistent across different model specifications, reinforcing the robustness of the findings. This analysis highlights significant income disparities, with pronounced inequality at both the lower and upper ends of the income distribution, underscoring the need for targeted redistributive policies.

6. Conclusion

Government fiscal policy is guided by a range of objectives that go beyond the goal of maximizing revenue. While increasing domestic revenue to reduce poverty and inequality remains a central aim particularly in low and middle-income countries like Zambia. Fiscal policy also seeks to promote macroeconomic stability, stimulate inclusive growth, and ensure efficient and equitable allocation of public resources. In Zambia's context, a significant portion of government revenue is currently directed toward external and domestic debt servicing, which places additional pressure on the budget and limits the fiscal space available for pro-poor spending. This underscores the need for a balanced fiscal strategy that not only enhances revenue mobilization but also supports long-term debt sustainability. Achieving these objectives requires careful calibration of tax and expenditure policies to stimulate productive investment, protect vulnerable populations, and maintain public confidence in fiscal governance.

To unearth the effect of taxation and its redistributive effect on poverty and inequality in Zambia, this study uses the MicroZAMOD to analyze the effect of taxation on revenues and its redistributive impact on poverty and inequality in Zambia from 2010 to 2019. This study analyses the dynamics linking taxation, poverty, and income inequality in Zambia, offering proposals for informed policy formulation. Key findings emphasize the pivotal role of specific taxes, notably Personal Income Tax (PIT), in mitigating inequality, contributing substantially to the reduction of the Gini coefficient. Conversely, while Value-Added Tax (VAT) serves as a significant revenue source, its efficacy in poverty alleviation appears comparatively limited. The results suggest that raising revenue from value-added tax (VAT) is particularly detrimental for poverty, while additional revenue from personal income tax (PIT) tends to mitigate inequality. Excise taxes have a relatively neutral effect on both poverty and inequality. The implications of these findings are profound for policymakers, advocating for a targeted approach to tax policy. The study emphasizes the necessity of reevaluating the role of VAT, advocating for alternative strategies that leverage PIT to concurrently alleviate poverty and diminish income inequality.

The analysis in this paper suggests an increase in Personal Income Tax (PIT) as a potential policy measure for addressing poverty and inequality. However, it is crucial to recognize that the effects of PIT on economic activity, particularly in terms of employment and indirect poverty reduction through job creation and multiplier effects, fall outside the scope of this analysis. Future research avenues may dig into the intricate mechanisms through which PIT achieves its inequality-reducing effects. A deeper understanding of PIT dynamics across diverse income strata may hold the promise of refining tax structures in developing economies. Additionally, exploring synergies between targeted social protection measures and tax reforms, as exemplified in Reform 4, presents fertile ground for further investigation in the future.

Extending beyond Zambia, this study provides a methodological framework serving as a valuable resource for policymakers navigating the complex interplay between revenue generation, poverty alleviation, and inequality mitigation. In summary, this paper constitutes a significant contribution to the debate on optimal tax policy in emerging economies and also furnishes a robust foundation for informed decision-making, and advancing social welfare leveraging a microsimulation model and cost-effective indices.

The findings of this study make an important contribution to both the existing literature and the policy landscape in Zambia, shedding light on the intricate relationship between tax policy, poverty, and inequality. The results underscore the varied effects of different taxes, such as personal income tax (PIT) and value-added tax (VAT), on economic outcomes and poverty levels in the Zambian context.

For policymakers, the study highlights the need for careful consideration of the distributional impacts of tax reforms, especially in a country like Zambia, where the poor are highly sensitive to price changes driven by VAT. The study also emphasizes the importance of balancing fiscal policy objectives, such as maximizing revenue and reducing inequality, in light of Zambia's economic challenges, including debt sustainability and inflation. Looking ahead, further research is needed to explore the long-term effects of tax reforms on Zambia's development, particularly in relation to job creation, social welfare, and inclusive economic growth. This study provides a solid foundation for future policymaking and research aimed at strengthening Zambia's tax system while promoting sustainable poverty reduction and addressing inequality.

7. Recommendations

The paper offers the following recommendations:

– Strengthen Social Protection and Support Low-Income Groups

The high Generalized Entropy (GE(−1)) and Atkinson index for $\varepsilon \geq 1.5$ indicate significant disadvantage among the poorest. To address high inequality at the lower end of the income distribution, targeted interventions like social cash transfers, food subsidies, and improved access to essential services (e.g., healthcare and education) are critical. Expanding minimum wage policies and supporting the informal sector will further boost the incomes of vulnerable groups.

– Implement Progressive Taxation and Improve Revenue Distribution

Elevated GE(2) and GE(3) values point to growing inequality among the rich. The analysis highlights significant wealth concentration, necessitating progressive taxation measures. Increasing income taxes on the wealthiest individuals, enhancing compliance in property taxes, and introducing capital gains taxes will help redistribute wealth. Additionally, closing tax loopholes and enhancing corporate tax compliance will ensure fairer contributions from high earners. This would generate revenue to fund poverty-reduction programs.

– Promote Education, Skills Development, and Job Creation

Persistent inequality, as revealed by Mean Log Deviation (MLD) and Theil indices, underscores the need for inclusive human capital investment. To reduce persistent inequality, investing in quality education, vocational training, and financial literacy programs is essential. Improving access to higher education and job training will reduce wage disparities.

– Address Regional Disparities and Strengthen Public Services

Spatially concentrated inequality, particularly among low earners (GE (−1), Atkinson $\varepsilon \geq 2.0$), calls for targeted regional development. Policies should prioritize regional development, improving infrastructure and increasing investment in underserved areas. Strengthening public services such as healthcare, education, and transportation will help reduce regional inequalities. Expanding social safety nets, including and food security programs, will protect vulnerable groups from economic shocks.

– Revise the Exemption and Zero-Rating Schedules

Revise the exemption and zero-rating schedules by limiting VAT exemptions to essential goods and narrowing the list of zero-rated supplies to retain only export supplies, in line with international best practices. Reforms 3 and 4, which propose reducing the VAT rate from 16% to 15% and 15.5%, respectively, indicate that such adjustments can significantly reduce the national poverty rate. However, to sustain the much-needed revenue, these reforms must be complemented by a more targeted approach to exemptions and zero-rating.

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Data and code availability
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Appendix

Sensitivity analysis by altering the introduction of taxes in the model

Table A1. Baseline and proposed policy reforms.

Parameter	Baseline	Reform 1	Reform 2	Reform 3	Reform 4
Turnover Tax Upper Limit	800,000	Same as baseline	Same as baseline	Same as baseline	1,200,00
Turnover Tax Rate	4%	Same as baseline	Same as baseline	Same as baseline	5.5%
VAT rate	16%	15.0%	15.5%	15.0%	15.5%
Opaque beer excise duty (Kwacha per litre)	0.25	Same as baseline	0.6	0.6	0.6
Clear beer excise duty (ad valorem rate)	40.0%	Same as baseline	65.0%	65.0%	65%
Tobacco excise duty (Kwacha per single piece)	0.4	Same as baseline	0.75	0.75	0.75
Wine and spirits excise duty (ad valorem rate)	60.0%	Same as baseline	80.0%	80.0%	80%
PAYE/PIT Band 1	61,200–85,200	61,200–90,000	Same as baseline	61,200–90,000	66,000-92,400
PAYE/PIT Band 1 Rate	20.0%	25.0 %		25.0 %	25.0%
PAYE/PIT Band 2	85,200–110,400	90,000–144,400	Same as baseline	90,000–144,400	92,400-130,000
PAYE/PIT Band 2 Rate	30%	34.0%		34.0%	33%
PAYE/PIT Band 3	Over 110,400	Over 144,400	Same as baseline	Over 144,400	Over 130,000
PAYE/PIT Band 3 Rate	37.0%	37.5%		37.5%	38%

Table A2. Simulation results of the hypothetical policy reforms.

	Baseline	Reform 1		Reform 2		Reform 3		Reform 4	
	Results	Results	*Change*	Results	*Change*	Results	*Change*	Results	*Change*
Tax-benefit policy (million Kwacha)									
Government revenue	15,043.59	15,048.13	*+4.54*	15,039.18	*-4.41*	15,177.14	*+133.55*	*15,569.14*	*+525.55*
... direct taxes	5,074.75	5,347.25	*+272.50*	5,074.75	*0.00*	5,347.25	*+272.50*	*5,613.22*	*+538.47*
... indirect taxes	4,688.62	4,420.66	*-267.96*	4,684.21	*-4.41*	4,549.67	*-138.95*	*4,675.70*	*-12.92*
... social security contributions	5,280.23	5,280.23	*0.00*	5,280.23	*0.00*	5,280.23	*0.00*	*5,280.23*	*0.00*
Gov. expenditure on social transfers	3,964.93	3,964.93	*0.00*	3,964.93	*0.00*	4,095.06	*+130.14*	*4,485.48*	*+520.55*
Poverty									

	Baseline	Reform 1		Reform 2		Reform 3		Reform 4	
Share of poor population, in %, FGT (0)	41.72	41.70	*-0.03*	41.70	*-0.02*	41.56	*-0.16*	41.54	-0.18
... male-headed households	41.80	41.78	*-0.02*	41.79	*-0.02*	41.71	*-0.09*	41.85	+0.05
... female-headed households	41.40	41.36	*-0.04*	41.37	*-0.03*	40.95	*-0.45*	40.27	-1.12
... households with children	43.15	43.13	*-0.02*	43.14	*-0.02*	43.00	*-0.16*	43.05	-0.11
... households with older persons	46.02	46.00	*-0.02*	46.02	*0.00*	45.39	*-0.63*	44.13	-1.89
Poverty gap, FGT (1)	0	0	*0*	0	*0*	0	*0*	0.00	0.00
Inequality and household income									
Gini coefficient (0–100)	54.24	54.19	*-0.06*	54.24	*-0.01*	54.08	*-0.16*	0.5396	-0.0029
P80/P20 ratio	4.98	4.98	*0.00*	4.98	*0.00*	4.95	*-0.03*	4.90	-0.08
Quantiles of distribution and median									
20th	1,764.99	1,766.71	*+1.72*	1,766.28	*+1.28*	1,777.85	*+12.86*	*1,792.14*	*+27.15*
40th	2,978.38	2,986.27	*+7.89*	2,979.90	*+1.52*	2,994.20	*+15.82*	*3,012.41*	*+34.03*
50th	3,812.19	3,818.94	*+6.75*	3,815.05	*+2.85*	3,828.21	*+16.02*	*3,839.29*	*+27.10*
60th	4,934.12	4,947.87	*+13.75*	4,933.12	*-1.00*	4,941.18	*+7.06*	*4,950.22*	*+16.10*
80th	8,781.77	8,791.08	*+9.31*	8,790.14	*+8.37*	8,798.51	*+16.74*	*8,778.92*	*-2.86*
Absolute national poverty line, per year	3,127.68	3,127.68	-	3,127.68	-	3,127.68	-	3,128.00	0.00

Model Robustness Check

Table A3. Complex survey estimates of Generalized Entropy inequality indices.

	GE(-1)	1.049384	0.047619	22.04	0.000	0.956052	1.142715
	MLD	0.542851	0.010005	54.26	0.000	0.523241	0.56246
	Theil	0.589716	0.014859	39.69	0.000	0.560593	0.618838
	GE(2)	1.374182	0.099984	13.74	0.000	1.178218	1.570147
Baseline	GE(3)	10.13423	2.16161	4.69	0.000	5.897555	14.37091
	GE(-1)	1.045456	0.047423	22.05	0.000	0.952509	1.138402
	MLD	0.541628	0.010006	54.13	0.000	0.522016	0.56124
	Theil	0.588791	0.014898	39.52	0.000	0.559591	0.617991
	GE(2)	1.374785	0.100439	13.69	0.000	1.177928	1.571641
Reform 1	GE(3)	10.18034	2.177292	4.68	0.000	5.912928	14.44776

	GE(-1)	1.048209	0.047524	22.06	0.000	0.955064	1.141353
	MLD	0.542627	0.01	54.26	0.000	0.523029	0.562226
	Theil	0.589402	0.014842	39.71	0.000	0.560312	0.618493
	GE(2)	1.371418	0.099579	13.77	0.000	1.176247	1.56659
Reform 2	GE(3)	10.07179	2.143049	4.7	0.000	5.871496	14.27209
	GE(-1)	1.030026	0.046737	22.04	0.000	0.938422	1.121629
	MLD	0.53854	0.009958	54.08	0.000	0.519022	0.558059
	Theil	0.58638	0.014851	39.48	0.000	0.557273	0.615487
	GE(2)	1.366659	0.099702	13.71	0.000	1.171246	1.562072
Reform 3	GE(3)	10.06418	2.148857	4.68	0.000	5.852493	14.27586
Reform 4	GE(-1)	1.00002	0.045593	21.93	0.000	0.910659	1.089381
	MLD	0.534232	0.009902	53.95	0.000	0.514826	0.553639
	Theil	0.584206	0.014812	39.44	0.000	0.555175	0.613236
	GE(2)	1.361715	0.099264	13.72	0.000	1.167162	1.556269
	GE(3)	9.998477	2.129615	4.69	0.000	5.824507	14.17245

Notes: Number of obs = 12250, Number of strata = 1, Number of PSUs= 12250, Population size=15473850, GE(-1): Focuses on inequality among the poorest. MLD (Mean Log Deviation): Measures lower-end inequality (α = 0). Theil: Includes: · Theil T (GE(1)): Entire income distribution. Theil L (GE(0)): Same as MLD. GE(2): Highlights inequality among the wealthiest. GE(3): Stronger emphasis on top-end inequality.

Table A4. Complex survey estimates of Atkinson inequality indices.

	Index	Estimate	Std.Err.	z	P>|z|	[95% Conf.Interval]	
	A(0.5)	0.244544	0.004384	55.78	0.000	0.235952	0.253136
	A(1)	0.418911	0.005814	72.05	0.000	0.407516	0.430306
	A(1.5)	0.555707	0.00696	79.84	0.000	0.542065	0.569348
	A(2)	0.677291	0.009918	68.29	0.000	0.657852	0.69673
Baseline	A(2.5)	0.790498	0.013498	58.57	0.000	0.764043	0.816953
	A(0.5)	0.244103	0.004392	55.58	0.000	0.235495	0.252711
	A(1)	0.4182	0.005822	71.84	0.000	0.40679	0.42961
	A(1.5)	0.554894	0.006966	79.65	0.000	0.54124	0.568547
	A(2)	0.676471	0.009928	68.14	0.000	0.657013	0.695928
Reform 1	A(2.5)	0.789801	0.013547	58.3	0.000	0.763249	0.816353
	A(0.5)	0.244456	0.004382	55.79	0.000	0.235869	0.253044
	A(1)	0.418781	0.005812	72.06	0.000	0.40739	0.430172
	A(1.5)	0.555527	0.006957	79.85	0.000	0.541892	0.569163
	A(2)	0.677046	0.009913	68.3	0.000	0.657616	0.696476
Reform 2	A(2.5)	0.790229	0.01351	58.49	0.000	0.76375	0.816708
	A(0.5)	0.243093	0.004382	55.47	0.000	0.234505	0.251682
	A(1)	0.416401	0.005812	71.65	0.000	0.40501	0.427791
	A(1.5)	0.552332	0.006955	79.42	0.000	0.538701	0.565963
	A(2)	0.673208	0.009982	67.44	0.000	0.653643	0.692773
Reform 3	A(2.5)	0.786693	0.013891	56.63	0.000	0.759466	0.813919

	Index	Estimate	Std.Err.	z	P>|z|	[95% Conf.Interval]	
Reform 4	A(0.5)	0.24193	0.004373	55.32	0.000	0.233358	0.250501
	A(1)	0.413881	0.005804	71.32	0.000	0.402506	0.425256
	A(1.5)	0.548151	0.006966	78.69	0.000	0.534498	0.561803
	A(2)	0.666671	0.010132	65.8	0.000	0.646814	0.686529
	A(2.5)	0.776982	0.014157	54.88	0.000	0.749234	0.80473

Notes: Number of obs = 12250, Number of strata = 1, Number of PSUs = 12250, Population size = 15473850, A(0.5): Moderate sensitivity to lower-end inequality, A(1): Stronger focus on lower-end disparities, A(1.5): Increased inequality aversion, A(2): High sensitivity to the poorest individuals. A(2.5): Extreme focus on lower-end inequality.

Table A5. Bootstrap results robustness checks for Poverty incidence.

		Observed coefficient	Bootstrap std.err	z	P>|z|	Normal-base [95% Conf.Interval]	
	fgt0[1]	0.4172189	0.006894	60.52	0.000	0.403706	0.430731
	fgt1	0.1804008	0.003562	50.65	0.000	0.173419	0.187382
Baseline	fgt2	0.1023088	0.002563	39.93	0.000	0.097286	0.107331
	fgt0	0.4170619	0.007152	58.32	0.000	0.403045	0.431079
	fgt1	0.1799028	0.003592	50.08	0.000	0.172863	0.186943
Reform 1	fgt2	0.1019693	0.002501	40.76	0.000	0.097067	0.106872
	fgt0	0.4170422	0.006848	60.9	0.000	0.40362	0.430465
	fgt1	0.1803269	0.003726	48.39	0.000	0.173023	0.18763
Reform 2	fgt2	0.1022465	0.00265	38.59	0.000	0.097053	0.10744
	fgt0	0.4156818	0.007402	56.16	0.000	0.401174	0.43019
	fgt1	0.178704	0.003784	47.22	0.000	0.171287	0.186121
Reform 3	fgt2	0.1009785	0.002639	38.26	0.000	0.095805	0.106152
Reform 4	fgt0	0.4154426	0.006795	61.14	0.000	0.402125	0.42876
	fgt1	0.1766634	0.003453	51.16	0.000	0.169895	0.183432
	fgt2	0.0993168	0.002445	40.62	0.000	0.094524	0.104109

Notes: Number of obs = 12,251, Replications =250, (Replications based on 12,251 clusters in idhh).

Table A6. Bootstrap results robustness check for Inequality Indices.

		Observed coefficient	Bootstrap St. Err	z	P>|z|	Normal-based [95%- Conf.Interval]	
	gini	0.542417	0.004442	122.11	0.000	0.533711	0.551123
Baseline	ge0	0.542851	0.009705	55.94	0.000	0.52383	0.561871
	gini	0.541855	0.004571	118.55	0.000	0.532896	0.550814
Reform 1	ge0	0.541628	0.010218	53.01	0.000	0.521602	0.561654
	gini	0.542341	0.004584	118.32	0.000	0.533357	0.551325
Reform 2	ge0	0.542627	0.009945	54.56	0.000	0.523136	0.562119
	gini	0.540778	0.004539	119.13	0.000	0.531882	0.549675
Refrom 3	ge0	0.53854	0.010202	52.79	0.000	0.518546	0.558535
Refrom 4	gini	0.539561	0.00461	117.06	0.000	0.530527	0.548596
	ge0	0.534232	0.01007	53.05	0.000	0.514496	0.553969

Notes: Number of obs = 12,251, Replications=250, (Replications based on 12,251 clusters in idhh), fgt0: Proportion of people below the poverty line (headcount ratio), fgt1: Average income shortfall below the poverty line (poverty gap), fgt2: Emphasizes severe poverty by weighing larger shortfalls more heavily, gini: Measures overall income inequality (0 = equality, 1 = inequality), ge(0): Focuses on lower-end inequality; also called Mean Log Deviation (MLD).

Table A7. Quantile group shares, cumulative shares (Lorenz ordinates), generalized Lorenz ordinates, and Gini (Baseline).

Group Share	Linearized Std.Err	Estimate	z	P>|z|	[95% Conf.Interval]	
1	0.011232	0.000333	33.731	0.000	0.010579	0.011885
2	0.02185	0.000421	51.878	0.000	0.021024	0.022675
3	0.030284	0.000497	60.984	0.000	0.029311	0.031258
4	0.038959	0.000625	62.348	0.000	0.037734	0.040184
5	0.050331	0.000768	65.499	0.000	0.048825	0.051837
6	0.064566	0.000952	67.829	0.000	0.062701	0.066432
7	0.08433	0.001155	73.008	0.000	0.082066	0.086594
8	0.111215	0.00143	77.786	0.000	0.108413	0.114017
9	0.164839	0.00221	74.593	0.000	0.160507	0.16917
10	0.422395	0.005543	76.201	0.000	0.41153	0.433259
Cumul.						
share						
1	0.011232	0.000333	33.731	0.000	0.010579	0.011885
2	0.033082	0.000698	47.411	0.000	0.031714	0.034449
3	0.063366	0.001124	56.399	0.000	0.061164	0.065568
4	0.102325	0.001645	62.185	0.000	0.0991	0.10555
5	0.152656	0.002283	66.868	0.000	0.148181	0.15713
6	0.217222	0.003027	71.75	0.000	0.211288	0.223156
7	0.301552	0.003881	77.703	0.000	0.293946	0.309158
8	0.412767	0.004744	87.001	0.000	0.403468	0.422066
9	0.577605	0.005543	104.201	0.000	0.566741	0.58847
10	1					
Gen.						
Lorenz						
1	75.59	2.18	34.672	0.000	71.317	79.863
2	222.637	4.414	50.441	0.000	213.986	231.287
3	426.447	6.959	61.277	0.000	412.807	440.088
4	688.639	10.444	65.939	0.000	668.17	709.108
5	1027.363	15.065	68.194	0.000	997.836	1056.891
6	1461.891	21.226	68.872	0.000	1420.288	1503.493
7	2029.427	29.069	69.813	0.000	1972.452	2086.402
8	2777.896	39.312	70.662	0.000	2700.846	2854.947
9	3887.25	56.32	69.021	0.000	3776.865	3997.634
10	6729.94	98.554	68.287	0.000	6536.777	6923.102
Gini	0.54242	0.004598	117.971	0	0.533408	0.551431

Notes: Number of orbs = 12251, Population size=154,739,35.69, Design df=1225.

Table A8. Quantile group shares, cumulative shares (Lorenz ordinates), generalized Lorenz ordinates, and Gini (Reform 1).

Group share	Linearized Std.Err	Estimate	z	P>|z|	[95% Conf.Interval]	
1	0.011234	0.000334	33.676	0.000	0.01058	0.011888
2	0.021901	0.000421	52.042	0.000	0.021076	0.022726
3	0.030362	0.000498	60.939	0.000	0.029386	0.031339
4	0.038988	0.000627	62.184	0.000	0.037759	0.040217
5	0.050621	0.000769	65.8	0.000	0.049113	0.052129
6	0.064614	0.000956	67.568	0.000	0.06274	0.066488
7	0.084086	0.00115	73.142	0.000	0.081833	0.08634
8	0.111535	0.001435	77.742	0.000	0.108723	0.114347
9	0.164679	0.002194	75.049	0.000	0.160378	0.16898
10	0.42198	0.005554	75.976	0.000	0.411094	0.432866
Cumul.						
share						
1	0.011234	0.000334	33.676	0.000	0.01058	0.011888
2	0.033135	0.000698	47.476	0.000	0.031767	0.034503
3	0.063497	0.001125	56.422	0.000	0.061291	0.065703
4	0.102485	0.001649	62.158	0.000	0.099253	0.105716
5	0.153105	0.002288	66.926	0.000	0.148622	0.157589
6	0.217719	0.003034	71.752	0.000	0.211772	0.223666
7	0.301806	0.003885	77.681	0.000	0.294191	0.30942
8	0.413341	0.004751	87.002	0.000	0.404029	0.422652
9	0.57802	0.005554	104.07	0.000	0.567134	0.588906
10	1					
Gen.						
Lorenz						
1	75.608	2.185	34.605	0.000	71.326	79.89
2	223.008	4.412	50.54	0.000	214.36	231.656
3	427.355	6.969	61.32	0.000	413.696	441.015
4	689.758	10.473	65.863	0.000	669.232	710.284
5	1030.453	15.088	68.297	0.000	1000.882	1060.025
6	1465.327	21.287	68.837	0.000	1423.605	1507.048
7	2031.259	29.069	69.877	0.000	1974.284	2088.233
8	2781.929	39.339	70.717	0.000	2704.826	2859.031
9	3890.278	56.182	69.244	0.000	3780.163	4000.393
10	6730.354	98.549	68.294	0.000	6537.201	6923.508
Gini	0.541858	0.004608	117.59	0	0.532826	0.550889

Notes: Number of obs = 12251, Population size = 15,473,935.69, Design df =12250.

Table A9. Quantile group shares, cumulative shares (Lorenz ordinates), generalized Lorenz ordinates, and Gini (Reform 2).

Group Share	Estimate	Linearized Std.Err	z	P>|z|	[95% Conf.Interval]	
1	0.011243	0.000333	33.731	0.000	0.01059	0.011897
2	0.021854	0.000421	51.891	0.000	0.021028	0.022679
3	0.030309	0.000496	61.049	0.000	0.029336	0.031282
4	0.038914	0.000625	62.277	0.000	0.03769	0.040139
5	0.050335	0.000769	65.486	0.000	0.048829	0.051842
6	0.064484	0.000949	67.915	0.000	0.062623	0.066345
7	0.0842	0.001154	72.973	0.000	0.081939	0.086462
8	0.111554	0.001435	77.725	0.000	0.108741	0.114367
9	0.165098	0.002185	75.548	0.000	0.160815	0.169381
10	0.422008	0.005548	76.058	0.000	0.411133	0.432883
Cumul.						
share						
1	0.011243	0.000333	33.731	0.000	0.01059	0.011897
2	0.033097	0.000698	47.418	0.000	0.031729	0.034465
3	0.063406	0.001123	56.44	0.000	0.061204	0.065608
4	0.10232	0.001645	62.187	0.000	0.099095	0.105545
5	0.152656	0.002283	66.865	0.000	0.148181	0.15713
6	0.217139	0.003026	71.762	0.000	0.211209	0.22307
7	0.30134	0.003879	77.683	0.000	0.293737	0.308942
8	0.412894	0.004745	87.026	0.000	0.403595	0.422193
9	0.577992	0.005548	104.171	0.000	0.567117	0.588867
10	1					
Gen.						
Lorenz						
1	75.671	2.183	34.67	0.000	71.393	79.949
2	222.752	4.416	50.442	0.000	214.097	231.407
3	426.738	6.96	61.31	0.000	413.096	440.38
4	688.642	10.45	65.902	0.000	668.161	709.123
5	1027.412	15.079	68.137	0.000	997.859	1056.966
6	1461.406	21.219	68.874	0.000	1419.818	1502.994
7	2028.096	29.052	69.809	0.000	1971.155	2085.037
8	2778.884	39.346	70.627	0.000	2701.767	2856
9	3890.039	56.13	69.305	0.000	3780.027	4000.051
10	6730.267	98.527	68.309	0.000	6537.158	6923.376
Gini	0.542343	0.004597	117.98	0.000	0.533334	0.551353

Notes: Number of obs = 10344, Population size = 13165710.22, Design df = 10343.

Table A10. Quantile group shares, cumulative shares (Lorenz ordinates), generalized Lorenz ordinates, and Gini (Reform 3).

Group share	Estimate	Linearized Std.Er	z	P>|z|	[95% Conf.Interval]	
1	0.011365	0.000333	34.124	0.000	0.010712	0.012018

Group share	Estimate	Linearized Std.Er	z	P>|z|	[95% Conf.Interval]	
2	0.022042	0.000424	51.951	0.000	0.02121	0.022874
3	0.030494	0.000497	61.337	0.000	0.029519	0.031468
4	0.039152	0.000628	62.365	0.000	0.037921	0.040382
5	0.050583	0.000769	65.794	0.000	0.049076	0.05209
6	0.064647	0.000947	68.254	0.000	0.062791	0.066504
7	0.084688	0.001159	73.042	0.000	0.082415	0.08696
8	0.11128	0.00143	77.827	0.000	0.108477	0.114082
9	0.164583	0.002173	75.726	0.000	0.160323	0.168843
10	0.421167	0.005549	75.899	0.000	0.410291	0.432043
Cumul. share						
1	0.011365	0.000333	34.124	0.000	0.010712	0.012018
2	0.033407	0.000701	47.683	0.000	0.032034	0.03478
3	0.0639	0.001127	56.708	0.000	0.061692	0.066109
4	0.103052	0.001651	62.415	0.000	0.099816	0.106288
5	0.153635	0.002289	67.122	0.000	0.149149	0.158121
6	0.218283	0.003031	72.023	0.000	0.212342	0.224223
7	0.30297	0.003887	77.952	0.000	0.295353	0.310588
8	0.41425	0.004747	87.264	0.000	0.404946	0.423554
9	0.578833	0.005549	104.312	0.000	0.567957	0.589709
10	1					
Gen. Lorenz						
1	76.488	2.176	35.147	0.000	72.223	80.754
2	224.837	4.427	50.782	0.000	216.159	233.514
3	430.066	6.968	61.723	0.000	416.41	443.722
4	693.569	10.475	66.21	0.000	673.038	714.1
5	1034.006	15.096	68.494	0.000	1004.417	1063.594
6	1469.1	21.208	69.272	0.000	1427.533	1510.666
7	2039.07	29.089	70.099	0.000	1982.057	2096.082
8	2788.011	39.319	70.908	0.000	2710.948	2865.074
9	3895.697	55.961	69.615	0.000	3786.016	4005.378
10	6730.264	98.328	68.447	0.000	6537.545	6922.984
Gini	0.540781	0.004607	117.383	0	0.531752	0.549811

Notes: Number of obs = 12251, Population size = 15473935.69, Design df = 12250.

Table A11. Quantile group shares, cumulative shares (Lorenz ordinates), generalized Lorenz ordinates, and Gini (Reform 4).

Group share	Estimate	Linearized Std.Err	z	P>|z|	[95% Conf.Interval]	
1	0.011577	0.00034	34.06	0.000	0.010911	0.012243
2	0.02228	0.000421	52.874	0.000	0.021454	0.023106

Group share	Estimate	Linearized Std.Err	z	P>|z|	[95% Conf.Interval]	
3	0.030642	0.000497	61.593	0.000	0.029667	0.031617
4	0.039481	0.000634	62.25	0.000	0.038238	0.040724
5	0.05074	0.000765	66.285	0.000	0.04924	0.052241
6	0.064658	0.000945	68.401	0.000	0.062806	0.066511
7	0.084248	0.001144	73.674	0.000	0.082006	0.086489
8	0.111196	0.00143	77.771	0.000	0.108394	0.113998
9	0.164158	0.002178	75.375	0.000	0.159889	0.168426
10	0.42102	0.005535	76.07	0.000	0.410172	0.431867
Cumul. share						
1	0.011577	0.00034	34.06	0.000	0.010911	0.012243
2	0.033857	0.000704	48.092	0.000	0.032477	0.035237
3	0.064499	0.001131	57.042	0.000	0.062283	0.066715
4	0.10398	0.001661	62.607	0.000	0.100725	0.107235
5	0.15472	0.002295	67.409	0.000	0.150222	0.159219
6	0.219379	0.003035	72.29	0.000	0.213431	0.225327
7	0.303626	0.003882	78.217	0.000	0.296018	0.311234
8	0.414822	0.004741	87.492	0.000	0.40553	0.424115
9	0.57898	0.005535	104.611	0.000	0.568133	0.589828
10	1					
Gen. Lorenz						
1	77.93	2.225	35.023	0.000	73.569	82.291
2	227.903	4.436	51.38	0.000	219.21	236.597
3	434.165	6.963	62.355	0.000	420.519	447.812
4	699.923	10.513	66.578	0.000	679.318	720.528
5	1041.472	15.084	69.046	0.000	1011.909	1071.036
6	1476.709	21.174	69.741	0.000	1435.209	1518.21
7	2043.808	28.894	70.735	0.000	1987.176	2100.439
8	2792.305	39.124	71.371	0.000	2715.624	2868.987
9	3897.306	55.82	69.819	0.000	3787.9	4006.711
10	6731.328	98.214	68.537	0.000	6538.832	6923.825
Gini	0.539564	0.004607	117.112	0	0.530534	0.548594

Notes: Number of obs = 10338, Population size = 13156031.80, Design df = 10337.