Gender-specific effects of Russia-Ukraine conflict - Evidence from South Africa

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Abstract

In this study, we use macro CGE simulation and a theoretical model combined with econometric estimations to evaluate the gender-specific impact of the Russia-Ukraine war on the South African economy. We compute individual equivalence scales and intrahousehold gender-specific allocation of the household expenditure to measure food and non-food poverty and inequality resulting from increase in crude oil, fertilizer, maize and vegetable oil prices between March 2022 and March 2023. We analyse panel survey data from the fifth round of National Income Dynamics Study 2017 and construct a static CGE model based on the PEP 1-1 model to measure changes in South African women's employment, consumption, levels of food poverty, lower and upper poverty bounds, and income distribution. We find that the South African women are affected more by the price shock than men. Our findings are five-fold: First, Women accounted for 58 percent of the jobs lost. The demand for unskilled male labour decreased relatively more than for female labour, whereas the demand for skilled female labour fell more than their male counterparts. Second, men's per capita food spending fell by 0.81 percent while that of women by 1 percent. Similarly, the increase in food poverty head count, depth and severity was higher among women than among men. Based on lower poverty bound, the impact on women (0.8 percentage point) was higher than that on men (0.6 percent). Third, more rural females were affected (109.2 thousand) than rural males (88.4 thousand). The increase in the depth and severity of poverty was greater among rural females (1.5 and 1.6 percentage point) than among rural males (1.4 percentage point). Fourth, Coloured and White females were affected the most in terms of food poverty with an increase of 1.3 and 0.6 percentage points, while the impact among the Black Africans and Asians was

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similar across genders. Finally, inequality among rural women increased more than among rural men, while inequality in urban areas decreased for both genders. The income share of Black African women fell relative to women from other racial groups.

Keywords: Ukraine war, trade, women, poverty, inequality, food security

JEL-code:

C68 Computable General Equilibrium Models

I32 Measurement and Analysis of Poverty

F16 Trade and Labor Market Interactions

J16 Economics of Gender

N40 General, International, or Comparative

1 Introduction

Starting from February 2022, market distortions resulting from the Russia-Ukraine war (RUW) began increasing international prices for energy, fertilizers and food (Arndt et al., 2023; Ayaz et al., 2023). In many emerging and developing countries, far away from the war zone, increasing consumer prices disproportionately hit the poor population, compounding the economic hardness caused by Covid19 pandemic in 2020 and 2021 (Bentley et al., 2022; Deng et al., 2022; Arndt et al., 2023; Devadoss and Ridley, 2024). These consecutive crises have particularly affected women who constitute a major share of the vulnerable and poor segment of the population. Women form half of the population, represent a substantial part of the labour force in important sectors (e.g. agriculture), and perform inter-generational responsibilities (e.g. childcare and nutrition). The negative impact of RUW trade shock on women's welfare can have important implications at the individual, household and country level, particularly in countries where women face high poverty and inequality (Kappel, 2022).

Global trade shocks affect African women in their economic triple role as workers, business owners and consumers (Korinek et al., 2021). In sub-Saharan Africa, 52 percent of women work in agriculture (ILO, 2024). The overall uncertainty is mainly caused by increased energy prices and inflation that depreciate local currencies and decrease foreign capital inflows. In fact, following the increase in American interest rates, 88 developing countries recorded a depreciation of their currencies in 2022. For net cereal importing countries, the impact on prices has been particularly severe. For example, in Ethiopia, wheat became 180% more expensive in 2022 relative to the previous year, half of which due to the depreciation of its currency (UNCTAD, 2022).

In this paper we assess the gender-specific impact of the RUW on the South African economy by using macroeconomic simulations and a theoretical model combined with econometric estimations.

South Africa is an interesting case as it is considered as one of the most unequal countries in the world (Sulla et al., 2022; Chatterjee 2019). More than 50 percent of its population lives in poverty (Salahuddin et al., 2020; Francis and Webster, 2019). Poverty is higher for rural than for urban residents and higher for black Africans than for other racial groups. Women and female-headed households, particularly those living in rural areas, have lower access to adequate food than their male counterparts (Sulla and Zikhali, 2018). Unemployment is higher among women of every age group compared to men (Stats SA, 2019). Women are more likely to work in a narrower range of sectors and in vulnerable sectors where they occupy lower-paid jobs and more elementary tasks, e.g., domestic workers (Espi et al., 2019; Gradín, 2021; Mosomi, 2019).

Poverty levels among female-headed households were already 20 percentage points (pp) higher than male-headed households before the onset of the Covid19 pandemic (Sulla and Zikhali, 2018), while individual women faced a 4 to 6 percentage point higher poverty headcount rate than men. During the COVID-19 pandemic, domestic chores disadvantaged women in the labour market. Gender inequalities were exacerbated as South African women bore the brunt of the crisis (Casale and Posel, 2021). While South Africa seems less exposed than other developing countries in terms of food security, around 15 percent of the population still suffers from inadequate access to food, while for 6 percent of the population, access to food is severely inadequate (Stats SA, 2023). Rural households are particularly affected by inadequate access to food, and among them, female-headed households face a higher share of inadequate access. According to NIDS (2017), female-headed households of all sizes have significantly lower total and per capita food, non-food, and total expenditure as compared to that of male-headed households.

Furthermore, the country suffers from volatility in its currency which makes its imports more expensive and decreases capital inflows. Since the beginning of the RUW, South Africa has been significantly affected by the increase in fuel prices that increased the cost of road transport, which is important for domestic food transportation, particularly in rural areas. This higher cost is ultimately transmitted to farmers and consumers (Matebeni, 2022). Most South African female workers are involved in trade, logistics, transport and food supply services (Competition Commission South Africa, 2023), and are hit by increased costs of transportation and agricultural commodities. The increased prices of energy, transportation, agricultural inputs and food commodities threaten the food affordability of South African households (Matebeni, 2022; Tshitiza, 2022).

Since the 2000s, the gendered impacts of international trade have gained increasing interest. Early studies describe different aspects of the effects of trade on women's empowerment (e.g., Darity, 1995; Elson, 1999; Elson et al., 2007; Kabeer, 2001; Seguino, 2000; van Staveren, 2007). Trade shocks affect female employment and labour force participation (Baliamoune-Lutz, 2007; Borrowman and Klasen, 2020; Wamboye and Seguino, 2015) depending on the sectors exposed (Bussmann, 2009; Connolly, 2022). Trade shocks can also influence female wage rate and alter the gender wage gap (Ben Yahmed, 2023;

Domínguez-Villalobos and Brown-Grossman, 2010; Gupta, 2021; Latorre, 2016; Menon and van der Meulen Rodgers, 2009; Siddiqui, 2009). Like for employment, the concrete impact depends strongly on the situation of markets and sectors in the specific case. Studies on developing countries find evidence of both effects of trade liberalization: widening gender wage gap (Ben Yahmed, 2023; Menon and van der Meulen Rodgers, 2009; Papyrakis et al., 2012), and falling wage gaps (Latorre, 2016; Siddiqui, 2009).

While the trade shocks affect women's income through labour market, the commodity markets affect women as consumers. Increased prices reduce women's affordability for the impacted commodities and can decrease their purchasing power. The impact on women's consumption is determined in part by the financial situation of the women's household (Arndt et al., 2011; Filipski et al., 2011; Fontana and Wood, 2000). More recent studies analyse specific aspects of gendered effects of trade reforms (Juhn et al., 2014; Shepherd and Stone, 2017; Vhumbunu, 2022), gender inequalities in labour markets (Connolly, 2022), and decision-making processes (Deschênes et al., 2020). Since the worldwide recession of the late 2000s, the gendered impacts of global crises and trade shocks have elicited more interest (Botreau and Cohen, 2020; Horn, 2010; Quisumbing et al., 2021) or Chitiga et al. (2022) and Mabugu et al. (2023) for the COVID-19 pandemic.

To date, only a few studies have examined the impact of the RUW on women in developing countries. Literature provides evidence for RUW-related trade distortion and its consequences, as it applies to commodities such as food, fuel and fertilizer that are particularly important for the population (food and fuel), for rural households (fuel and fertilizer) and for food supply chains or other production chains (fuel, fertilizer) (Arndt et al., 2023). Some studies have identified the reasons for the price increase, whether they come from a reduction in production capacity, trade restrictions or speculation in stock market (Abu Hatab and Lagerkvist, 2024; Ben Hassen and El Bilali, 2022), or sanctions imposed by the European Union or the United States on energy imports from Russia (natural gas, oil, and coal) (Hosoe, 2023). The latter has contributed to an increase in energy prices across the countries (Liadze et al., 2023; Korkmaz and Karacan, 2024; Schropp and Tsigas, 2023; Sedrakyan, 2022; Estrada and Koutronas, 2022; Movchan et al., 2023; Rose et al., 2023). The increase in energy prices causes ripple effects in many economic sectors including the agrifood sector due to higher production cost for fertilizer and other agricultural input factors. (Abu Hatab and Lagerkvist, 2024). This cascade effect reaches all households as final consumers but doubly affects the rural farm households as agricultural producers (Arndt et al., 2023).

Other studies have assessed the consequences of rising world prices on food security in low- and middle-income countries (Ayaz et al., 2023;Bentley et al., 2022; Devadoss and Ridley, 2024, Arndt et al., 2023; Daley et al., 2023; Hatab, 2022; Kappel, 2022; Mhlanga and Ndhlovu, 2023; Mottaleb et al., 2022; Xu et al., 2024), pointing out the vulnerabilities of the countries either to food price (Devadoss and Ridley, 2024) or energy price increase (Nadimi et al., 2024; Siksnelyte-Butkiene, 2022; Song et al., 2024; Zhang, 2023a; Zhang et al. 2023b). Rising fuel and fertilizer prices drive the vulnerability of poverty (agricultural income) and production of agrifood systems. Rising food prices directly impact food security and the quality of diet (Arndt et al., 2023). Poverty particularly affects the poor rural population through higher prices of agricultural inputs (fertilizer, fuel, feed) (Arndt et al., 2023; Kappel, 2022).

Only a handful of studies analyse in more detail the impacts of RUW on poverty (e.g., Arndt et al., 2023; Ayaz et al. 2023, Rudolfsen et al., 2024) or on women as vulnerable population. Boman (2023) analyses the vulnerability of women emigrated from Ukraine to escape the RUW; Wignaraja (2024) considers reduced women's employment in Sri Lanka. Sawadogo and Maisonnave (2024) find that COVID19 pandemic, RUW and climate change result in more job losses for women in Burkina Faso than for men. Papadavid (2023) examines the impact of economic shocks on African women and describes qualitatively how trade shocks spillover to African women in the form of price increase, exchange rate depreciations and disturbed cross-border trade.

In this study, we combine a gendered computable general equilibrium (CGE) model with behavioural microeconomic analysis to examine RUW's price- and labour market-effects on South African women. We assess the impact on women's employment, food and non-food poverty, and inequality. Concretely, (i) we use a gendered CGE model to simulate the transmission channels and quantify the macroeconomic impacts of RUW on women. (ii) We link a behavioural micro-econometric model based on data from the fifth wave of the National Income Dynamics Study (NIDS) to the CGE model to analyse the gender differential impact of RUW on food- and non-food poverty and income distribution across regions (rural/urban) and population subgroups (Black African, Coloured, White, and Asian). (iii) Using a Browning et al (2013) consumption function, we make gender differential intra-household allocation of shared or joint consumption to its private equivalent of the individual members of the household. We estimated gender differential equivalence scales that account for disparities in food and non-food expenditure across households or various sizes and gender composition to produce accurate and precise estimates of poverty and food insecurity. Finally, we identify the women from regional and racial groups that are most vulnerable to the RUW shock.

The following two sections present the methodological framework of the CGE model followed by the behavioral microeconomic model and the underlying data. Section 4 describes the data. Section 5 reports the results and discusses them. Section 6 concludes and provides policy recommendations.

2. The CGE model and macro data

To simulate the macroeconomic impacts of the RUW-caused trade distortions on the South African economy, we apply a gendered static single-country CGE model. CGE models are appropriate tools to evaluate the impact of external shocks' impacts on the national economy and different economic agents, such as world price increases. This paper focuses on the effects of the the increase in world prices due to the RUW on the South African economy and on South African women. We calibrate the static single-country standard model from Decaluwé et al. (2013) to South Africa's Social Accounting Matrix (SAM) for the year 2017 (van Seventer and Davis, 2019). We modify both the SAM and the standard model to include the gender dimension as well as the specificities of the South African economy. From the initial SAM, we disaggregate the labour market by gender using the labour market shares obtained from the microeconomic panel data of the NIDS survey. The gendered model[a] considers ten activities and twenty-four commodities. For the ten selected activities (Agriculture, Mining, Manufacturing, Water and Electricity, Construction, Transport and communication, Hotel and Restaurants, Financial services, Administration, Other private services)[b] information regarding the payroll according to qualifications and gender in the micro data is available.

To operationalise the model, we apply income elasticities from Burger et al. (2017) and trade elasticities from Ntombela et al. (2018). The production function is a four-level nested function. At the top level, a Leontief function combines intermediate consumption and value added to produce output. At the second level, a Constant Elasticity of Substitution

[a] For a review of gender in CGE models, please refer to Fontana et al. (2020).
[b] See Appendix B for the list of equations, variables and sets used in the CGE model.

(CES) function combines composite labour and capital. Labour is mobile across sectors, while capital is sector-specific. At the third level, composite labour is a CES function for skilled and unskilled labour (equations 5 and 6 in the Appendix B). At the bottom level, each labour type is disaggregated by gender (equations 7 and 8 for skilled workers and 9 and 10 for unskilled workers).

To reflect the rigidity of gender roles, we follow Fontana and Wood (2000) and limit the substitution between female and male workers in the model by using a low value for the elasticity of substitution[a]. Each activity demands capital, labour and intermediate commodities to produce output in different proportions. For instance, the manufacturing sector uses intermediate commodities to produce 70 percent of its production. The agricultural sector intensively uses labour, accounting for 41.2 percent of its wage bill. Some sectors differ in their demand for male and female labour. For example, in South Africa, the construction sector is highly male-intensive while the service sector (i.e., community, social and personal services) is female labour intensive with major demand for unskilled female labour[b].

The model distinguishes between four institutions: households, firms, government, and the rest of the world. Households are disaggregated by income deciles. They receive their income from labour, capital and transfers from other institutions. The structure of households' income widely differs across deciles. The poorest households mainly receive transfers from the government (69 percent of their income) and unskilled labour income: 14.1 percent from male unskilled labour and 10.8 percent from female unskilled labour. In contrast, the richest households in the two top deciles receive income mainly from male skilled (35 per cent) and female labour (23 per cent) income and dividends from firms[c]. Thus, if the industries most affected by the increase in world prices employ and lay off skilled workers, then the richer households will suffer relatively more than the poorer households. Indeed, the richest households receive more than 50 percent of the total skilled wages in South Africa. Households also differ in the share of consumption taxes, transfers to other institutions, spending and saving. The household consumption behaviour is modelled as a Linear Expenditure System (LES), subject to the household's budget constraint. The poorest households spend more than 99 percent on consumption with the highest share for food, e.g., more than 10 percent of their consumption budget on cereals (e.g., maize, wheat) and less

[a] The sensitivity analysis on the value of elasticity is given in the appendix G.
[b] See Table C3 in the Appendix C for the wage bill intensity per skill and gender
[c] See Table C2 in the Appendix C to know more about transfers received by households.

than 1 percent on petroleum products. In contrast, the richest households spend only 55 percent on consumption, with less than 2 percent of the consumption spent on cereals and more than 5 percent on petroleum products.

Firms receive income from capital and transfers from other institutions. They pay corporate tax and dividends to other institutions and save the remainder. The government collects direct taxes from households and firms, accounting for 35 percent of its total income. It collects indirect taxes (on production, consumption and import duties) and receives transfers from other institutions (e.g., dividends and social contributions). Import taxes (e.g., levies on manufactured and transport commodities) account for less than 3 percent of the total government income. The government spends its income on non-tradable services (education, health, public administration) and pays transfers to firms and households (e.g., social assistance, pensions, grants). Government savings is the difference between the government's income and what it consumes.

To link South Africa and the rest of the world, we assume imperfect substitutability[a] of of commodities given their origin, i.e., the *Armington Assumption* (Armington, 1969). South African producers decide either to supply the local market or to export. To increase their world market share, they need to be more competitive in international markets. This is represented by a finite demand elasticity for exports (equation 66 in the appendix B). South Africa mainly imports manufactured commodities (49.7% of its total imports), transport services (18.16%) and petroleum products (5.05%), and mainly exports mining and manufactured commodities (38.47% of its total exports). A little less than 60% of oils and fats sold on the South African market come from imports. For fertilizers, this share is 41.5%, illustrating higher dependence of the South African economy for these products (see Table C1 in the appendix C).

In terms of closure rules, the government's spending is considered exogenous. Saving by the rest of the world is likewise exogenously given. Finally, applying the small country assumption, world prices for exports and imports are taken as exogenous. We define the nominal exchange rate as the numeraire. Following the Blanchflower and Oswald (1995) approach, we model unemployment with a negative slope between unemployment rates and wage rates. Similar to the results of Blanchflower and Oswald (1995), Kingdon and Knight (2007, 2004) found that in South Africa, a 10 percent increase in the unemployment rate leads

[a] The sensitivity analysis on trade elasticities is given in the appendix G

to a 1 percent decrease in wages. We take female unemployment rates to be systematically higher than men at any age and skill level (Stats SA, 2019).

The resulting customised static model for South Africa simulates the macroeconomic impact for the gendered labour market and households from ten different income groups. Following a top-down approach, we complement the CGE model by linking a micro-econometric model to better represent the heterogeneity among South African households and compute various indicators of poverty, inequality and food adequacy. Combining these two models can help acquire a more complete picture of the impact of a global price shock on the economy and the households. Technically, we implement the shocks on world prices for crude oil (+ 41%), fertiliser (+ 27%), maise (+20%), and vegetable oil (+7%) in the CGE model. The CGE model results on commodity prices and wages are transmitted to the micro model.

3. The micro model

In the micro model, we simulate two channels transmitting the global commodity price shocks on households' poverty and income distribution: the price channel and the labour market channel. We developed a theoretical model and empirically estimate the impact of the shocks using the 5th wave of South Africa's nationally representative National Income Dynamics Study (NIDS,2017) to determine the disparity in the gender-specific impact of shock on poverty, food insecurity, and income distribution.

3.1. Household Programme:

The shared or joint household consumption can be allocated to the individual members of the household using consumption function $f(x)$, which converts joint consumption to its private equivalent (see for example, Browning et al, 2013; Browning et al, 2009; Dunbar et al, 2010; Browning et al., 1998; Browning et al., 1994). Let assume a household h of size s members living jointly in a common house either owned or rented. We take the household size $s = 2$, with one male $i = m$ and one female $i = f$. For simplicity sake, we restrict our model to household size $s = 2$. The subscript of the variable denotes the goods and superscripts refers to household h or its members i. The direct utility function of a member i is denoted by $U^i(x^i)$, where x is the vector of goods (x_1^i, $x_2^i, x_3^i, \dots\dots\dots x_n^i$) consumed by that individual. Specifically, the utility function for males is denoted as $U^m(x^m)$ and for females as $U^f(x^f)$. Each family member aims to maximise their utility U^i subject to price vector (p) and total expenditure E^i. The utility maximisation program can be described as follows:

$$\max_{x^i} U^i\left(x^i\right) \text{ subject to } \acute{p}x^i = E^i \qquad (1)$$

The optimization solution for a demand vector of goods x^i for each individual can be expressed as:

$$x^i = h^i\left(p/E^i\right) \qquad (2)$$

Equation (2) can be expressed in terms of indirect utility function as:

$$V^i\left(p/E^i\right) = U^i\left[h^i\left(p/E^i\right)\right] \qquad (3)$$

Assumption1*: The utility function $U^i\left(x^i\right)$ for each household member is monotonically increasing and strictly quasi concave.*

3.2. Household decision making:

We assume that the distribution of resources among family members is pareto efficient. This means that the household members collaboratively allocate the household resources z (vector of products consumed) among themselves, resulting in a pareto efficient outcome. In this model, household is a decision-making unit. The decision-making process inside the household is collaborative, depending on the power sharing that each member holds. The authority to make decisions and allocate resources among members is determined by a variety of factors k, such as income earning of a member (Browning et al., 1994), gender (Chiappori et al., 2002), Demographic factors, education, etc (Browning et. al.,2013). The utility of one household member may be influenced by another, depending on how much they love and care for each other. For example, a wife can benefit from her husband's happiness, and the other way round. Similarly, mothers and fathers gain utility from their children's happiness. Therefore, it is reasonable to assumed that intra-household resource allocation is pareto efficient. This means that the allocation of household's consumption vector z into the private equivalent consumption of male x^m and female x^m members maximise the weighted sum of joint utility $\widetilde{U} = \delta U^m(x^m) + U^f(x^f)$. Where, δ and $(1-\delta)$ are the resource sharing parameters of female and male members of the household respectively, which depend on the above-mentioned attributes k.

Assumption2*: Allocating x^m and x^f within a household yields a pareto-efficient weighted sum of household welfare (utility), taking into account the consumption technology and budget constraints.*

3.3. Consumption Technology and Economies of Scale:

In a household some goods are shared by household members due to their public nature while others are completely private. For example, housing, utilities, kitchen appliances such as microwave and an oven are completely public goods that can be shared equally by both members of a household, yet a skirt is completely private good and can only be assigned to a female. Still others, such as Automobiles are neither completely private nor completely public.

For simplicity, we use linear consumption technology to convert a public good into a private equivalent, similar to the one used by Gorman (1976) and Barten (1964) scaling, such as $z = f(x) = \tau(x) + a$. More specifically the consumption technology for commodity j can be expressed as $z_j = \tau x_j^i = \frac{\left(x_j^m + x_j^f\right)}{1+c}$. Where, $0 \leq c \leq 1$ represents economies of scale, or the extent to which the good j is shared between household members. Only household members that live together enjoy economies of scale. For totally private commodities, this function returns $z_j = x_j^m + x_j^f$, while for completely public goods, $z_j = \frac{\left(x_j^m + x_j^f\right)}{2}$. τ is $n \times n$ vector that converts joint household consumption $(z = \ x^m + x^f)$ to the private equivalent consumption required by an individual to live separately while attaining the same level of utility. Depending on the consuming technology and the public/private nature of goods z, the value of τ varies from 0.5 (completely public) to 1 (completely private). If the model is extended to include households with more than two members, the minimum τ value could be lower than 0.5. τ=0.5 indicates that the good is equally shared by both male and female, resulting in half the cost for a member living together in a joint house compared to living alone. On the other hand, τ=1 indicates the good is completely private in nature; in such a case, the product cost is the same for a member living together or alone (no economies of scale). This model can be extended to account for diseconomies of scale due to negative externalities, when the diagonal element of matrix τ is bigger than 1.

3.4. Resource allocation to household members:

Based on whether a good z is private or public, we can use the Engel curve to estimate the share of expenditure for each good consumed by each household member (male and female) (see, for example, Dunbar et al., 2010). Living in a joint household allows for economies of scale in consumption, resulting in lower shadow prices θ compared to market prices p. Using Lindahl's (1919) type shadow pricing vector θ, we can estimate each member's shadow expenditure $E^{i*} = \acute{\theta} x^i$ and his/her share $\lambda = \frac{\acute{\theta} x^i}{\acute{\theta}(x^m + x^f)}$ in the overall household shadow expenditure $E^{h*} = \acute{\theta}(x^m + x^f)$ based on her/his weighted $r = \acute{\theta} x_j^i / E^{i*}$consumption share of goods vector x_j^i.

The shadow price θ can be estimated using the consumption economies of scale parameters τ. We limit the model to similar shadow pricing at the household level, but it can be extended to varied shadow prices among household members.

Assumption3*: The function/technology of converting joint household consumption (z) to its private equivalent* x^i *is linear in nature:* $z = f(x) = \tau(x^m + x^f) + a$.

Based on the above assumptions, the household programme of a specific form can be described as follows:

$$\max_{x^m, x^f} \delta U^m(x^m) + U^f(x^f) \text{ subject to } z = f(x) = f(x^m + x^f), \text{ and } \acute{p} z = E^h \quad (4)$$

The optimization solution for a demand vector of goods x^i for each individual can be expressed as:

$$x^f = h^f\left(\frac{\theta(p/E^h)}{\lambda(p/E^h)}\right) \quad (5)$$

$$x^m = h^m\left(\frac{\theta(p/E^h)}{1 - \lambda(p/E^h)}\right) \quad (6)$$

3.5. Equivalence scale:

The equivalence scale estimates the amount of money (expenditure) required by the members of a household to attain the same level of utility (welfare) as an individual living alone. It is defined as the ratio of household expenditure to individual's expenditure while living alone. The scale adjusts the consumption level depending on the size and composition of the household. However, the equivalent scale raises the issue of interpersonal utility comparison, as it compares a household's utility to that of an individual. Following Browning et al. (2013), we define the equivalence scale metric as the amount of income required for an individual member of a collective household to live alone and purchase the goods privately from the market while retaining the same level of utility (indifference curve) as a member of the collective household. In this scenario, we look at the utility of the same individual living in two different situations (collective household vs solo). This solves the issue of interpersonal utility comparison.

In other words, equivalent expenditure is defined as the total expenditure $\widetilde{E^{\iota}}$ required by an individual member of a household h to purchase the same consumption bundles of goods privately (or to be as well off) as she/he enjoyed in a joint household with total expenditure level E^h (see e.g., Browning et al., 2013).

An individual member i of a household h consumes x^i bundle of goods in a joint household consumption bundle of goods z^h with total household expenditure E^h. The x^i bundle consumed by an individual depends on the consumption technology and sharing rule, which we will discuss later in the model. Where, $\widetilde{E^{\iota}}$ is the expenditure required for an individual to buy the same x^i bundle of goods privately in the market and attain the same indifference curve (utility level) as she/he enjoyed in a collective household. Hence, the indifference scale for an individual member of a household is denoted by $Q^i = \widetilde{E^{\iota}}/_{E^h}$, the proportion of household expenditure required by an individual member i to be on the same indifference curve as in the collective household. Inverting the above equation yields an equivalent scale $E^h/_{\widetilde{E^{\iota}}}$ for all household members jointly, which implies that a joint household of size s requires that much times more expenditure for all members of the household to be equally well off as if they lived alone and consumed x^i bundle privately.

Equation (5) can be expressed in terms of indirect utility for female $V^f(p/E^f)$ and the corresponding equivalence scale is $Q^f = \widetilde{E^f}/_{E^h} = (p/E^h, \lambda)$.

Table 1: Equivalence scales based on food, non-food and total expenditure.

Equivalence scales based on:	**Mean**	**Min**	**Max**
HH Size	4.23	1	33
Food Expenditure	2.11	1	6.94
Non-Food Expenditure	3.55	1	22.93
Total Expenditure	2.71	1	12.01
Weighted Total Expenditure	2.37	1	11.81
Ratio of Equivalence scales by gender			
Female/Male Ratio in food	1.02	1.02	1.02

Female/Male Ratio in Non-food	.988	.988	.988
Female/Male Ratio in Total Expenditure	1.063	1.063	1.063
Female/Male Ratio in Weighted Total Expenditure	1.029	0.293	1.544

Source: Authors' estimates using NIDS 2017.

The equivalence scale metric has numerous practical applications, including among others the ability to adjust a household's observed expenditure for the purpose of estimating poverty or food insecurity metrics. Due to economies of scale associated with collective households, the true nature of poverty and food insecurity cannot be determined for the members of collective household unless the economies of scale associated with larger household are properly accounted for using the equivalence scale metrics (Klasen & Lahoti, 2021). Table 1 shows the equivalence scales based on food, non-food, and total expenditure (with and without individual goods weight). Greater household size is associated with the greater economies of scales in consumption which are mainly associated with food as compared to non-food expenditure. Besides, female share in food expenditure is slightly greater than the male share but lower in case of non-food expenditure. The negative sign of female-proportion coefficient in the estimation of equivalence scales of a good by gender indicates that females spend relatively less within household on that good as compared to males (for details, see table 2).

The results of estimating equivalence scales based on the weighted average of household consumption basket are presented in table 2. The results show that the negative sign of female-proportion coefficient in the estimation of equivalence scales of a good by gender indicates that females spend relatively less within household on that good as compared to males. The income elasticity of all food commodities is low and ranges from 0.02 to 0.26 while that of commodities such as Petroleum products, Restaurant, Business Services, Manufacturing, Admin, and Transport is higher, ranging from 0.30 to 0.67. The coefficient of the HH Size is positive in all cases, which indicates that larger household size is associated with greater economies of scale in consumption. The economies of scale is relatively greater for non-food (0.90) as compared to food expenditure (0.55).

Table 2: Regression Results for equivalence-scale calculations.

Dependent variable in Log	Log of Income PC	S. E	Log of HH Size	S. E	Female-proportion	S. E	Obs
Agri-product	0.07**	0.02	0.38***	0.03	-0.06	0.08	942
Livestock	0.59***	0.14	0.60**	0.18	-1.23**	0.44	677

Veg &Fruits	0.27***	0.03	0.40***	0.04	-0.13	0.1	919
Meat	0.09	0.08	0.31**	0.11	0.44	0.24	1347
Fish	0.18***	0.03	0.34***	0.05	0.03	0.11	570
Oil & Fats	0.20***	0.03	0.31***	0.04	0.16	0.08	812
Dairy Products	0.19***	0.04	0.26***	0.06	0.04	0.12	548
Grain Mill	0.11**	0.04	0.45***	0.05	-0.04	0.12	600
Starches	0.21***	0.04	0.1	0.07	-0.02	0.13	308
Bakery Products	0.26***	0.06	0.32**	0.1	0.06	0.2	237
Sugar	0.10**	0.03	0.44***	0.05	-0.05	0.11	609
Pasta	0.02	0.04	0.22**	0.07	-0.18	0.13	266
Petrol Products	0.41***	0.02	0.43***	0.03	-0.32***	0.06	2201
Fertilizers	0.34**	0.11	0.14	0.13	-0.88**	0.32	215
Mining	0.26***	0.02	0.29***	0.03	0.05	0.07	2883
Manufacturing	0.67***	0.02	0.63***	0.02	-0.16***	0.05	7602
Electricity & water	0.44***	0.01	0.52***	0.01	0.04	0.03	8414
Transport	0.60***	0.01	0.67***	0.02	0.02	0.04	9228
Restaurant	0.61***	0.06	0.54***	0.1	-0.01	0.2	689
Business Service	0.57***	0.01	0.61***	0.02	0.11**	0.03	8397
Admin	0.65***	0.01	0.83***	0.02	0.31***	0.04	9240
Others	0.46***	0.01	0.48***	0.02	0.01	0.04	7301
Food Expenditure	0.35***	0.01	0.55***	0.01	0.01	0.02	10833
Non-food Expenditure	0.76***	0.01	0.90***	0.01	-0.01	0.03	10830
Total Expenditure	0.61***	0.01	0.70***	0.01	0.06***	0.03	10833

Note: The dependent variable is the log of household expenditures on the goods listed in the first column. 'Log of income PC' signifies the log of household income per capita. The 'log of HH size' is the log of household size, whereas the 'Female-proportion' is the ratio of females to HH size. Other factors used to control heterogeneity in preferences across households include race, region, province, and education dummies; the coefficients of the controls are not reported. S.E. stands for the Standard Error. *, **, and *** show the t-values are statistically significant at less than 10%, 5%, and 1%, respectively.

Source: Authors' estimates using NIDS 2017.

3.6. Preference variations across households:

The above model is based on a single household with a male and a female member. In our empirical analysis, we estimate the model parameters using data from different households, which may lead to a difference in preferences across households. We can assume that this difference in preferences across households is driven by observable factors such as age, education and region. Controlling for these factors across households may resolve this issue to the extent that it depends on observable characteristics. Still, there remains the possibility of unobserved variability in preferences. According to Lewbel (2001), the conditional mean function of a consumer's demand with heterogeneous preferences is equivalent to the utility-maximizing demand function of a single individual. We include a stochastic term in the equation to account for random variation in preferences across households.

3.6. Transmission channels of the RUW shock

a) Price transmission channel

The extent to which a global price shock affects the male and female members of a household relies on their private equivalent consumption basket x^i and the corresponding change in price index p after the shock. The price increase reduces demand $h^f(.)$, $h^m(.)$ and consumption bundle of commodities x^i, resulting in decreased utility and welfare of individuals. Individuals are assumed not to suffer from money illusion (Pendakur, 2010; Browning, 2013). Thus, any price increase lowers individuals' real purchasing power, resulting in lower real expenditure and increased poverty. In the absence of post-RUW household survey data, the analysis is based on the latest available pre-RUW data (Static analysis), assuming that the (r_j^i) of individuals' consumption vector of goods x^i before and after RUW remains unchanged.

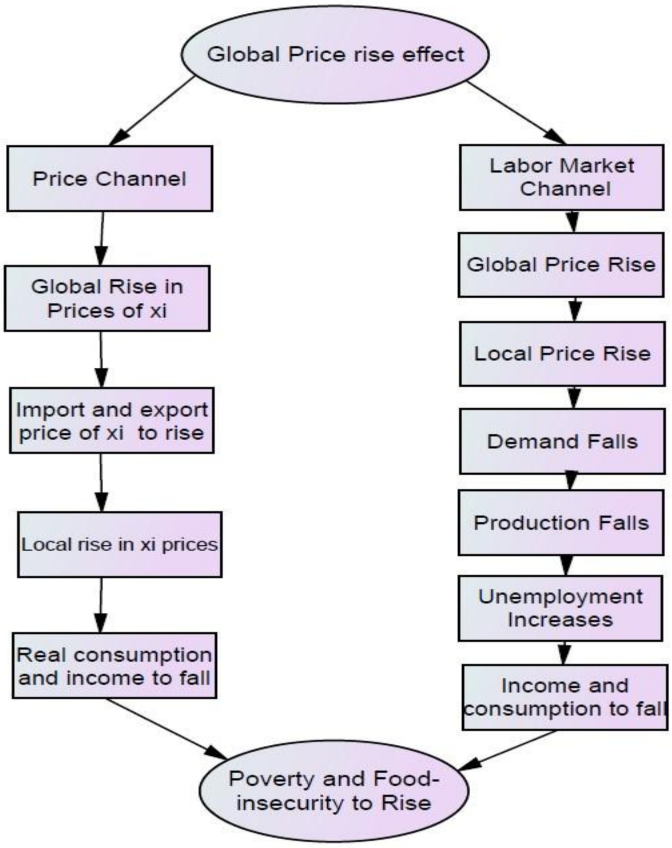
The varying degrees of price change across households can affect households' members real purchasing power and consumption and poverty situation differently. Individuals close to the poverty line fall below the poverty line if real consumption (or income) decreases and move above the poverty line if real consumption (or income) increases. To simulate the impact of a price shock on poverty and income inequality across various social and income groups, we estimate the extent of price change $\Delta\, p^i$ for each household member i. We compute $\Delta\, p^i$ based on the consumption share (r_j^i) of the commodity $'j'$ out of private equivalent expenditure E^{i*} (obtained from the micro model), and the price change (P_j) (obtained from the CGE model). The $\Delta\, p^i$ estimation for each household can be described as follows[a]:

$$\Delta\, p^i = \prod_{j-1}^{n} \left(\frac{p_{1j}}{p_{0j}}\right)^{r_{j,i}} \qquad (7)$$

[a] See for instance Ayaz et al. (2023).

p_{0j} denotes the price of commodity $'j'$ before the shock, and p_{1j} represents the corresponding price after the shock. We use the extent of price change of each member ($\Delta\, p^i$) to simulate the impact of price shock on poverty and income distribution of various social and income groups. Figure 1 describes transmission channels of the RUW shocks.

Figure 1: Transmission channels of RUW's impact



b) Labour market channel

We use propensity score matching (PSM) to model the impact of an international price shock via the labour market channel. The labour market is divided into four groups: skilled male, skilled female, unskilled male, and unskilled female. We compute the propensity scores for each of the above-mentioned groups to be employed or unemployed. Those who are currently employed and have the lowest propensity scores are more likely to be laid off when employment decreases. In the NIDS (2017) data set, we identify individual workers in each of the four groups who were initially employed but were most likely to lose their jobs. We simulate the number of laid off workers in each of the four categories to match the simulated increased unemployment.

Using the queuing technique, we simulate the scenario in which the workers who were initially employed but with the lowest propensity score (i.e. the one most likely to lose their job) are laid off first. The process continues until the level of unemployment matches the simulated increase in unemployment. Given that the economic shocks affect both the formal and informal sectors, we assume that unemployed individuals do not find work in the informal sector. Consequently, all laid off workers lose all their labour income. Synchronously to the decreased income, we reduce spending on food and total household expenditure by the corresponding marginal propensity to consume. Thus, we adjust individuals' food consumption and total spending according to the changes in real income to assess changes in food and non-food poverty metrics.

3.7. Indicators and weighting

Poverty and inequality metrics

Based on food and total expenditure, we compute the Foster Greer Thorbecke (FGT) metrics (Foster et. al., 2010) to estimate the status and changes in food and non-food poverty. The FGT poverty index is a commonly used tool for evaluating poverty, in particular food poverty. In addition to the headcount ratio (P0), it allows us to quantify the depth (P1) and severity (P2) of food poverty[a]. Estimating food poverty using food spending per capita allows us to identify those who may not have enough resources to afford a nutritionally adequate diet. Estimates of non-food poverty (lower and upper bounds) are generated based on individuals' private equivalent total expenditure (food and non-food). We use the poverty lines provided by South Africa's Department of Statistics for the year 2017. The food poverty threshold for 2017 is 531 South African Rand (ZAR), while the lower and upper bounds for overall poverty are 758 and 1183 Rand (Stats Sa, 2021). We assess overall poverty based on private equivalent per capita expenditure rather than food expenditure. Individuals with private equivalent per capita expenditure of less than 758 Rands fall below the lower poverty bound and need to choose between purchasing food and important non-food items. Households with private equivalent per capita spending above 758 but below 1,138 Rands fall below the upper poverty line and cannot afford the minimum desired lifestyle by most South Africans. Likewise, individuals with private equivalent food expenditure less than 531 Rands (the amount of money required to purchase the minimum required daily energy intake) are

[a] The poverty and inequality measures are generated using the Stata DASP package (Araar and Duclos, 2007).

regarded as food poor. We evaluate the change in income distribution by computing the Gini index and percentiles ratio for various social and income groups.

4. Data Description and poverty profile

NIDS (2017) provides information on the labour market, wages, household income and employment, and food and non-food consumption patterns. The list of commodities (food and non-food) consumed at the household level that are taken from this database for the micro model is comparable to that of the CGE model. The NIDS (2017) data set includes information on 39,400 individuals from 10,800 households, with women accounting for 51 percent of the sample. The average per capita food expenditure is 781 Rand, ranging from 975 for men to 646 Rand for women. Similarly, men's total expenditure (food and non-food) per capita of 5,435 Rand is higher than 3,161 Rand for women. Table 3 describes the difference in food, non-food, and total expenditure by gender across various household groups. The table shows that all female-headed household groups have significantly lower total and per capita food, non-food, and total expenditure as compared to that of male-headed households, except single member households among whom this difference is statistically insignificant.

Table 3: Gender differences in food, non-food, and total spending by household size.

HH Headed by:	HH Size	Children	Food Expenditure		Non-food Expenditure		Total Expenditure		Obs.
			HH level	Per capita	HH level	Per capita	HH level	Per capita	
Male	1	0	1256	1256	3518	3518	6737	6737	1287
Female	1	0	1177	1177	3252	3252	6250	6250	699
Total	1	0	1228	1228	3424	3424	6565	6565	1986
T-test	1	0	0.36	0.36	0.61	0.61	0.84	0.84	1986
Male	2	0	2016	1303	7247	4661	13332	8589	809
Female	2	0	1448	931	4222	2690	8034	5135	846
Total	2	0	1726	1113	5701	3654	10624	6823	1655
T-test	2	0	5.38***	5.52***	5.27***	5.39***	5.99***	6.12***	1655
Male	3	1	1640	823	5947	2954	9792	4871	353
Female	3	1	1338	668	3309	1607	6084	2982	436
Total	3	1	1473	737	4489	2210	7743	3827	789
T-test	3	0	3.51***	3.62***	3.61***	3.68***	4.05***	4.13***	789
Male	4	2	2143	877	8739	3547	14028	5702	374
Female	4	2	1636	672	5770	2322	9479	3838	407
Total	4	2	1879	770	7192	2908	11658	4731	781

T-test	4	2	3.9***	3.96***	2.04**	2.06**	2.62***	2.63***	781
Male	5	3	2206	784	6894	2390	11499	4005	149
Female	5	3	1382	485	4053	1443	6735	2389	226
Total	5	3	1709	604	5182	1819	8628	3031	375
T-test	5	3	4.79***	5.05***	2.25**	2.01**	3.1***	2.9***	375
Male	3	0	1959	1002	6076	3011	11365	5709	244
Female	3	0	1539	770	4251	2093	7947	3929	235
Total	3	0	1753	888	5181	2560	9688	4836	479
T-test	3	0	2.61***	2.73***	2.12**	2.21**	2.62***	2.78***	479
Male	Overall	Overall	1752	957	5751	3084	9974	5435	4715
Female	Overall	Overall	1416	646	3340	1608	6505	3161	6127
Total	Overall	Overall	1562	781	4389	2250	8013	4150	10842
T-test	Overall	Overall	7.02***	7.71***	11.04***	12.45***	11.92***	13.46***	10842

Note: Male and female denote that the household head is male and female, respectively. All estimates are based on the equivalence scale. T-tests show the t-values of tests for gender differences (male-female) in compare various types of expenditures. *, **, and *** indicate the t-values are statistically significant at less than 10%, 5%, and 1%, respectively.

Source: Authors' estimates using NIDS (2017).

56.9 percent of South Africa's population (32.1 million individuals) is food insecure.[a] 67.4 percent of South African women (15.7 million) are food poor compared to 60 percent of men (13.4 million). Women are more likely to be food poor than men in all regions (Rural and Urban) as well as among all racial groups (except for the Asians in which women are relatively less food poor (11.8%) as compared to men (14.2%)). Table 4 presents the food poverty rates by gender, region, age and race.

Table 4: Food poverty by gender, region, and race.

	Food Poverty			Non-food Poverty	
Group	P0	P1	P2	Lower Bound	Upper Bound
Gender					
Male	53.7	21	10.9	18.4	33.6
Female	59.3	24	12.6	22.1	38.5
Region					
Male rural	71.3	29.2	15.5	34.8	56.3

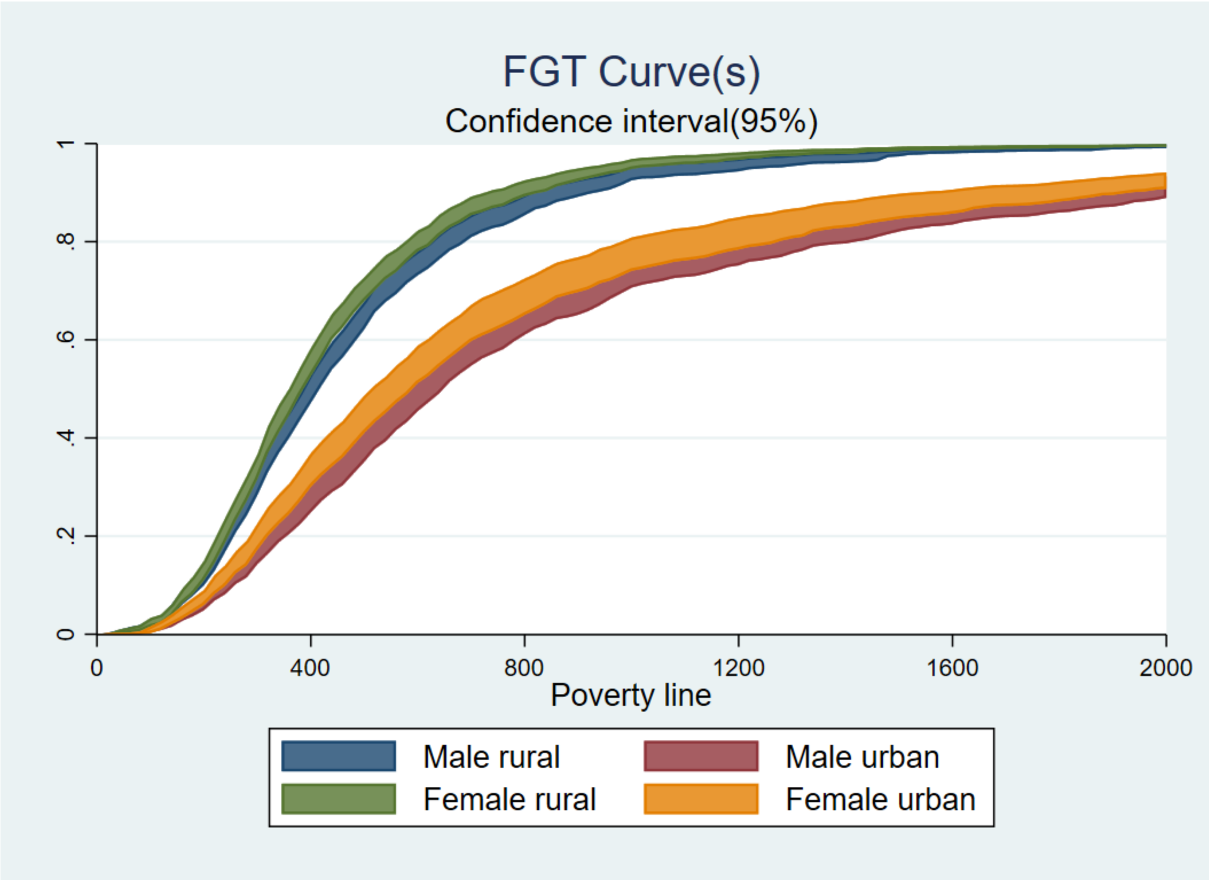
[a] In South Africa, the amount of money required to purchase the minimum required daily energy intake is taken as 531 Rand of food expenditure.

Male urban	44	16.5	8.4	9.5	21.1
Female rural	75.1	31.9	17.1	38.7	61.3
Female urban	49.7	19.2	9.8	12	24.5
Race					
Male-African	60	23.6	12.2	21.5	38.4
Male-Colored	47	17.9	9.3	10.3	26.2
Male-White	3.5	0.9	0.3	0	0
Male-Asian	14.2	6	3.9	0.1	0.3
Female-African	67.4	27.4	14.4	25.9	44.3
Female-Colored	52.5	17.5	9	11	26.6
Female-White	3.7	1.1	0.4	0	0
Female-Asian	11.8	2.4	1.4	0.2	0.5
Overall	56.9	22.7	11.9	20.5	36.3

Source: Authors estimates using NIDS (2017).

Majority of South Africa's population lives in urban areas, with rural population accounting for 36 percent of the population. The higher food poverty rate (73 percent) and higher upper (59 percent) and lower (37 percent) thresholds for non-food poverty indicate that rural households have a lower standard of living compared to urban households, whose corresponding values are 47, 11, and 23 percent, respectively. Figure 2 shows that the poverty headcount rate (P0) is significantly higher in rural areas at all levels of poverty with poverty lines from 400 to 2,000 Rand. The female poverty headcount is with about 5 percentage points higher than the male rate.

Figure 2: Food poverty incidence curves by region and gender.



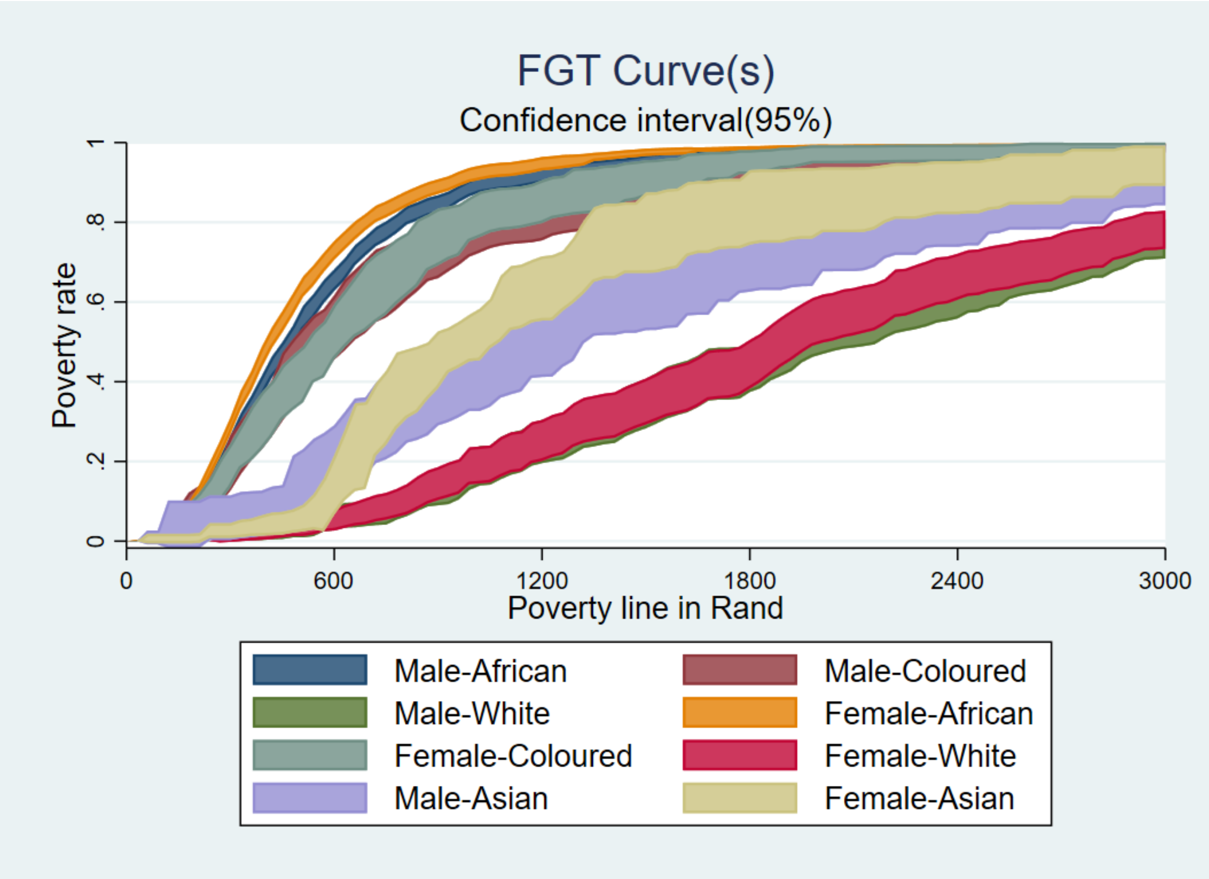
Source: Authors' estimates using NIDS 2017.

South Africa has a long history of racial segregation and apartheid, with important consequences on the economic and social well-being of various ethnic groups. The population of the country can be classified into four racial groups: Black African (80 percent), Coloured (8.8 percent), Indian/Asian (2.5 percent), and White (8 percent). Black Africans have historically endured institutional prejudice and economic disadvantage. They have a far higher food poverty rate (63 percent) compared to the Coloured (46 percent), Indian/Asian (12 percent) and the White population (3 percent). The difference between the male and female poverty rate is the greatest among the Black African population (67.4 percent for female, 60 percent for male). Surprisingly, food poverty is higher among the Indian/Asian males than among females[a], a trend that inverses above the 600 Rand poverty line (Figure 3). The disparity in poverty between racial groups is more pronounced than that between regions. The disparity in food poverty head count between the Black Africans and the Whites and Indians/Asians is 60 percent and 51 percent, respectively, compared to 8 percent between the Black Africans and the Coloured. This disparity persists at all levels, peaking at the poverty

[a] Indians/Asians account for only 1.7 percent of the sample size (754 individuals out of 45,273). Splitting the sample by gender renders the data non-representative. These results should therefore be read with caution.

threshold of 1,000 Rands. Even though poverty is highest among Black African women, the disparity between the Coloured, Asian and White females is more visible than that between corresponding males (Figure 3).

Figure 3: Food poverty incidence curves by race and gender.



Source: Authors' estimates using NIDS 2017.

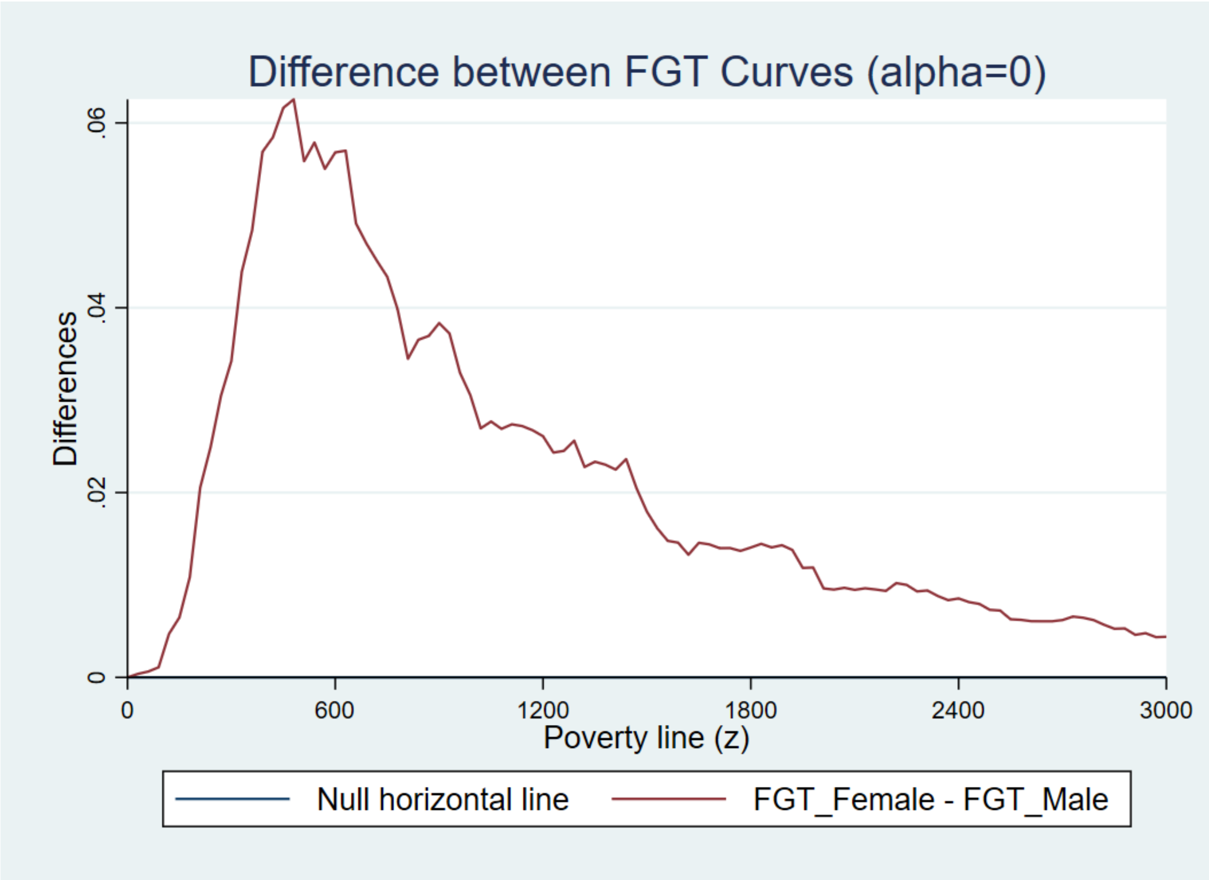
Next, we assess non-food poverty based on total expenditure per capita rather than food expenditure. We utilise the poverty bounds defined by the South African Department of Statistics. Individuals with per capita total expenditures of less than 758 Rands fall below the lower poverty bound, while households with a total spending above 758 but below 1,138 Rands fall below the upper poverty line. According to estimates, overall poverty headcount is 20.5 percent on the lower poverty bound and as high as 36.3 percent on the upper poverty bound. On the basis of the lower and upper poverty bounds, female poverty rates are 22.1 and 38.5 percent, which are substantially higher than those of male (18.4 and 33.6 percent).

Again, females in rural areas are more likely to be poor than all other segments of the society, with lower and upper bounds non-food poverty levels of 38.7 and 61.3 percent, respectively. In rural areas, female poverty rate is 3.9 and 5 percentage points higher than men on the basis of lower and upper poverty bounds, respectively. This gap is smaller in the urban areas (2.5 to 3.4 percentage points). More importantly, because approximately 36 percent of the population lives in below the upper poverty bound, a sizable percentage of the population is vulnerable to any profound economic shock. Black African and Coloured population groups are less secure (around 41 and 26 percent) than that of white and Indian/Asian population, which has an upper poverty bound rate below 1 percent. However, the Black African population, particularly women in rural areas representing the majority of the population, are the most vulnerable group of the society in terms of both food and non-food poverty.

Gendered food poverty

According to the poverty statistics mentioned above, females are more vulnerable than males in every group of society (except for the Asians/Indians). Figure 4 shows that female food poverty is always higher than that of men. This male-female poverty gap reaches a maximum of 5.7 percent at the poverty threshold of 531 Rands, which is statistically significant at the 1 percent level (p-value=0.000). According to NIDS (2017), 47 percent of women are economically inactive, compared to 32 percent of men. Even among those who are economically active, only 38 percent of women work compared to 56 percent of men. Furthermore, female labour has a lower average monthly income (5,731 Rands) than male labour (6,912 Rands). Correspondingly, men have higher food spending and lower poverty rates at all levels of poverty than women. According to the NIDS 2017 data, men in all the ten deciles have a higher food, non-food, and total spending per capita than women in the corresponding deciles (Figures 5 and 6). Furthermore, male-headed households of all sizes had significantly higher food, non-food, and total spending than female-headed households (Table 3).

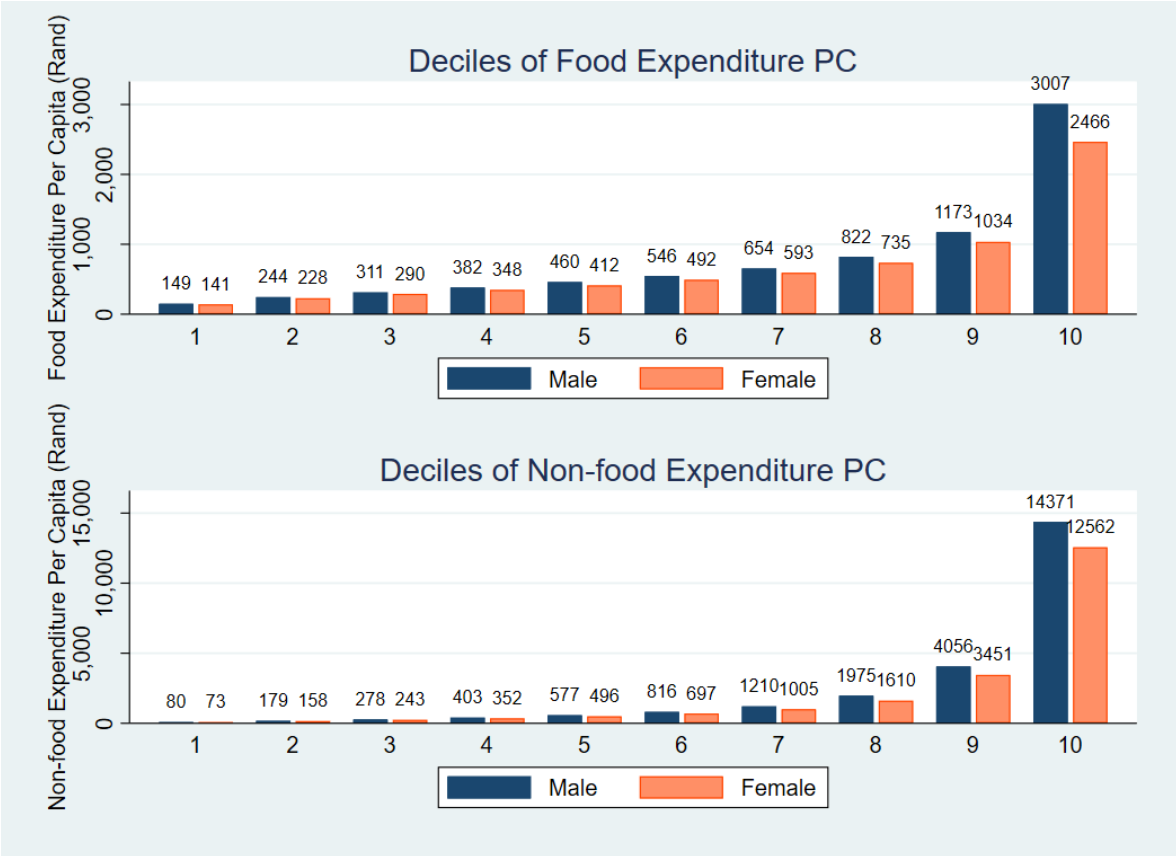
Figure 4: Estimated difference between male and female food poverty



Note: *y-axis represents the pp difference in Female – Male poverty rates and x-axis shows various poverty lines in ZAR.*

Source: Authors' estimates using NIDS 2017.

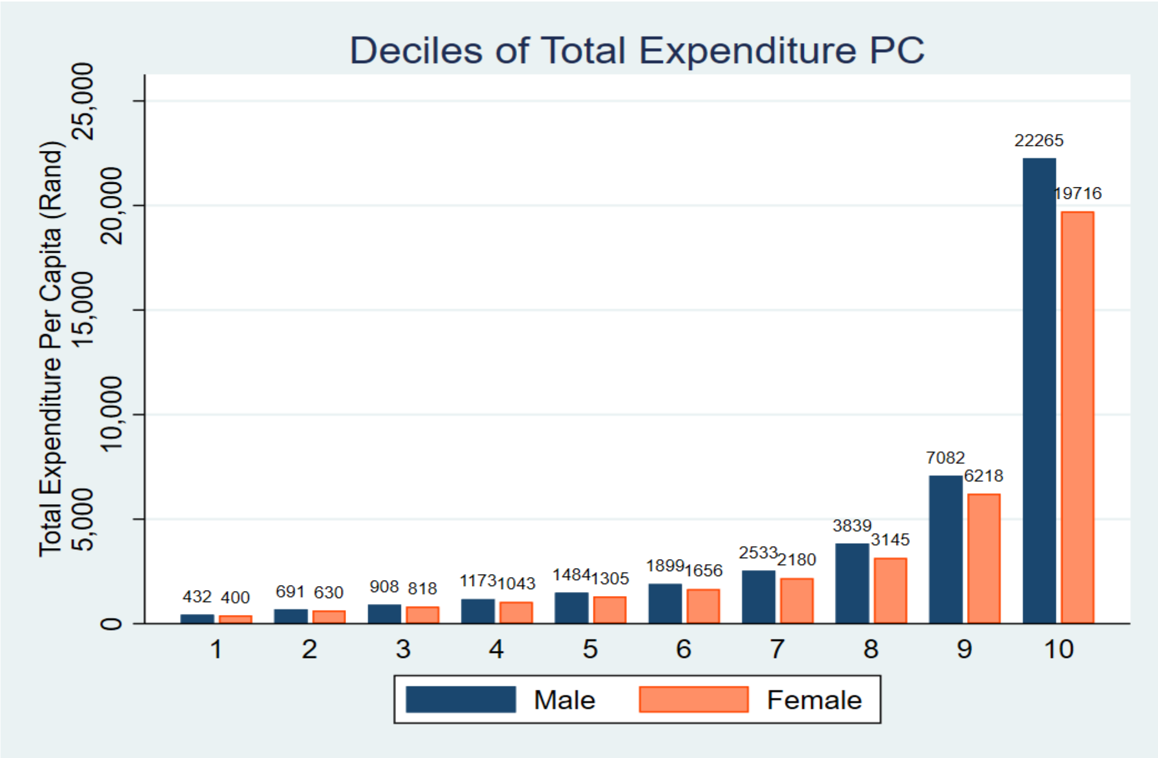
Figure 5: Per capital food and non-food expenditure deciles by gender.



Note: The y-axis shows the per capita food and non-food expenditure in Rands while the a-axis shows the deciles by food expenditure.

Source: Authors' estimates using NIDS 2017.

Figure 6: Per capital food and non-food expenditure deciles by gender.



Note: The y-axis shows the per capita total expenditure in Rands while the a-axis shows the deciles by food expenditure. *Source: Authors' estimates using NIDS 2017.*

5. Results and discussion

5.1 Macro and sectoral results

Using the CGE model, we simulate the increase of world prices for crude oil (+ 41 percent), fertiliser (+ 27 percent), maise (+20 percent), and vegetable oil (+7 percent). These price increases were observed between March 2023 and March 2022 (World Bank, 2023). The rise in global prices affects South Africa's economy through two key channels. First, it drives up the cost of imports. Given the country's dependence on these products, this leads to higher expenses for both consumers and industries that rely on them as inputs. For instance, a significant portion of vegetable oil is used by households, while petrol and fertilizer are mainly consumed by the industry. As production costs rise, businesses may scale back production and lay off workers, negatively affecting households' incomes. Second, if South Africa exports any of these products, higher global prices may prompt local producers to focus more on international markets. In this case, companies in the affected sectors are likely to increase production and hire more workers, leading to a positive impact on incomes.

Table 5 presents the macroeconomic impacts caused by the price increase. The large increase in import prices and South Africa’s dependency on crude oil and fertiliser imports dramatically affects the South African economy, translating into a decrease in GDP by 0.26 percent (Table 5). First, given the economy's dependency on imported oil, there is an increase in production costs for different activities, particularly in sectors with high fuel consumption. For instance, prices for intermediate commodities increase by 2 percent in the transport sector. Consequently, firms reduce their production and lay off workers. This reduction of workers leads to a decrease in their wage rate. At the same time, households face an increase in the consumer price index, leading to a drop in their real consumption.

Table 5: Macroeconomic impact (in percent)

Economic indicators	Percentage Change
Total labour demand	-0.48
Real Gross Domestic Product (GDP)	-0.26
Consumer Price Index (CPI)	1.32
Total investment	0.78

Source: Results from the CGE model.

Almost all sectors in South Africa are negatively affected by the increased import prices of oil. For example, the transport sector faces a decline in production by 0.7 percent. When decreasing production, firms lay off workers and reduce their intermediate consumption from other sectors, reinforcing the negative impact of rising world prices. The increase in fertiliser and fuel prices raises the production costs for the agricultural sector. Nevertheless, agricultural production expands because of increased export prices for agricultural commodities. Consequently, agriculture hires more workers to supply the increased export demand. The agriculture sector spends 26 percent of its intermediate consumption on manufactured goods and thus stimulates the demand for manufacturing industries.

The net effect of reduced labour demand from the contracting sectors and increased labour demand from the expanding sectors is negative, with a drop of 0.48 percent in total hired labour. The demand for unskilled workers decreases relatively more (0.6 percent) than that for skilled workers (0.5 percent). The gender impact differs by skill level. For unskilled labour, the demand for male labour force decreases relatively more than for female labour. Contraction of the male labour-intensive transport and construction sectors drives the decrease in demand for unskilled male labour. For skilled labour, however, the demand for female labour falls more than that of their male counterparts.

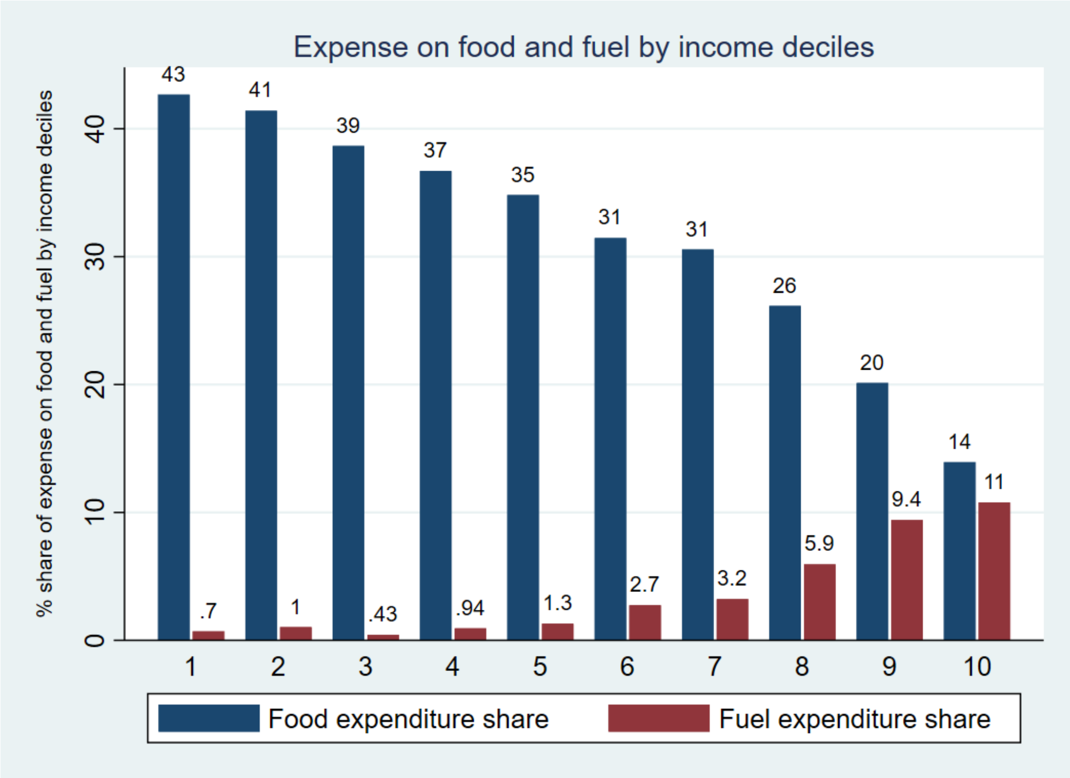
Table 6: Impact on household consumption (in percent)

Income deciles	Consumption
hhd0	-0.23
hhd1	-0.29
hhd2	-0.35
hhd3	-0.43
hhd4	-0.52
hhd5	-0.64
hhd6	-0.78
hhd7	-0.85
hhd8	-0.93
hhd9	-0.94

Source: Results from the CGE model.

The household income increases because of the increase in wages and government transfers. The income of the poorest households increases more than that of the richer households, thanks to increased indexed transfers from the government which contribute to more than 60 percent of their income. However, given the sharp increase in consumer prices, households consumption decreases for all the household income categories. Interestingly, the consumption of the richest households decreases more relative to the poorer households. Rich households receive a greater share of income from labour and capital which are negatively affected. Furthermore, richer household have different structure of spending than poor households, with higher shares for petroleum products and lower share for food (Figure 7).

Figure 7: Percentage share of expenditure on food and fuel by income deciles.



Source: Authors' estimates using NIDS 2017.

5.2 Micro results

5.2.1 Effects of price shocks on poverty

Table 7 shows the food- and overall-poverty effects (lower and upper bounds) of the global price shock. The results suggest that the aggregate (price and labour market) impact of the shock causes food poverty to increase by 0.7 percentage points, implying that approximately 0.4 million additional persons fall below the food poverty line. The impact on poverty head count (P0) for females is somewhat higher than males, with males and females experiencing 0.7 and 0.8 percentage point increase, respectively. Similarly, the impact on the depth (P1) and severity (P2) of food poverty is greater for females than males (Table 7). Furthermore, there is an increase of 0.6 and 0.4 percentage point in the lower and upper poverty bounds, respectively, which corresponds to pushing an additional 0.34 and 0.23 million persons below the lower and upper poverty bounds. Based on the lower poverty bound, the impact on women is 0.2 percentage point higher than that of men (0.8 percentage points for women, 0.6 percentage points for men). Nonetheless, the impact based on the higher poverty bound is the same for both genders, i.e., an increase of 0.3 percentage point. The impact of the shock on both genders is statistically significant at less than 1%.

Moreover, with a 1 percentage point increase in food poverty, rural population (both male and female) is more affected than urban population (0.6 percentage point). Though the change is the same for both genders (1 percentage point), rural women are affected in greater numbers (0.11 million) than rural men (0.098 million). Furthermore, the increase in depth and severity of poverty is slightly higher for women (1.5 to 1.6 percentage point) than for men (1.4 percentage point). In urban areas, women have a similar relative increase in poverty head count and depth, but a higher increase in poverty severity than men.

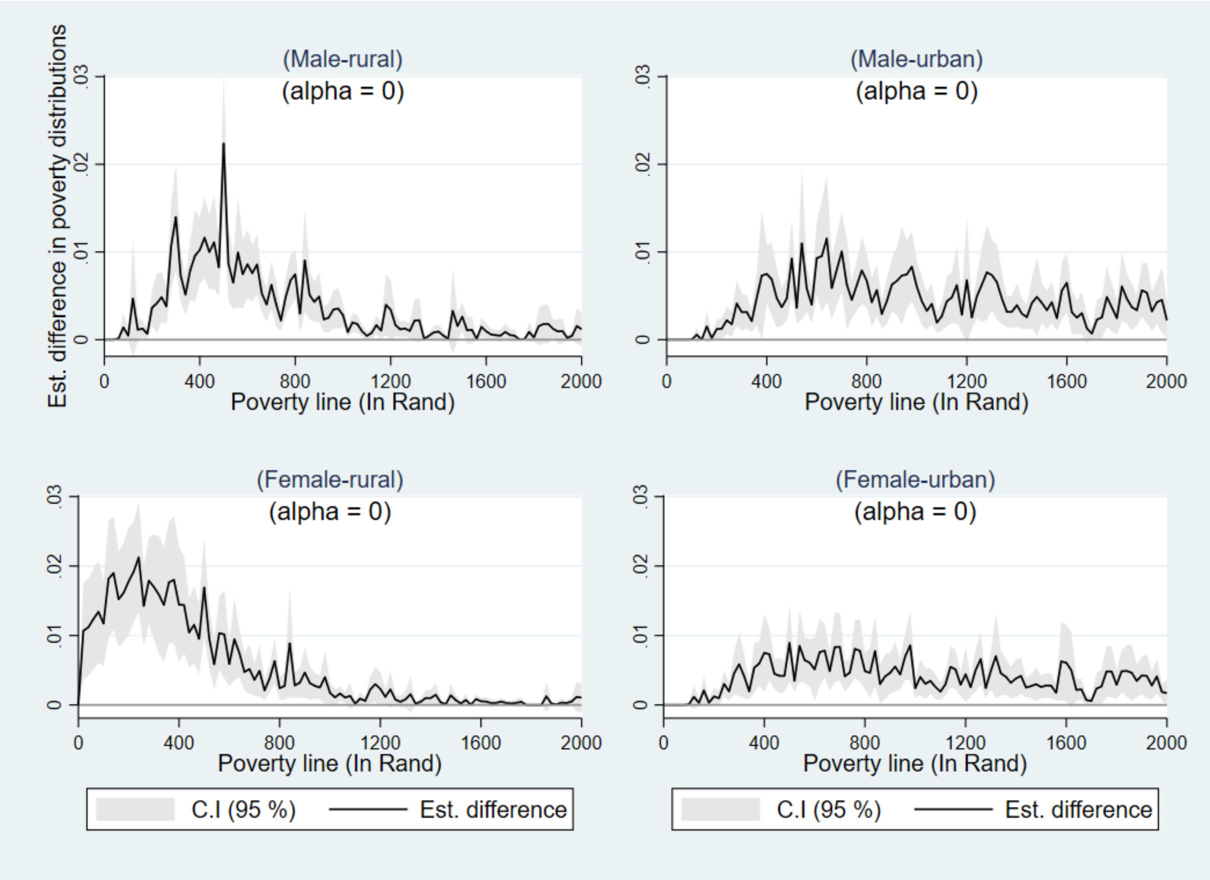
Table 7: Percentage point change in poverty rate due to the shock's aggregate impact

	Food Poverty			Non-food Poverty	
Group	P0	P1	P2	Lower Bound	Upper Bound
Gender					
Male	0.7***	0.7***	0.6***	0.6***	0.3***
Female	0.8***	0.8***	0.7***	0.8***	0.3***
Region					
Male rural	1***	1.4***	1.4***	1.1**	0.6***
Male urban	0.6***	0.3***	0.1***	0.2**	0.2**
Female rural	1***	1.5***	1.6***	1.5***	0.4***
Female urban	0.6***	0.3***	0.2***	0.3***	0.3**
Race					
Male-African	0.8***	0.8***	0.7***	0.6***	0.4***
Male-Colored	1.1**	0.4***	0.2***	0.2	0.2**
Male-White	0.4*	0	0	0	0
Male-Asian	0	0.2***	0.1**	0	0
Female-African	0.8***	0.9***	0.8***	0.9***	0.4***
Female-Colored	1.3**	0.4***	0.3***	0.4*	0.2**
Female-White	0.6*	0.03	0.01	0	0
Female-Asian	0	0.1**	0	0	0
Overall	0.7***	0.7***	0.6***	0.6***	0.4***

Source: Authors estimates using NIDS 2017.

Figure 8 substantiates these findings in terms of food poverty head count, demonstrating that rural women and men are the most affected by the shock, with the impact being the greatest (about 2 percentage points) for the 300-to-500 Rand per capita food expenditure poverty line. The impact diminishes beyond 800 Rand. The impact on females is somewhat higher than males, specifically at poverty threshold below 400 Rands. The impact in urban areas is lower at all poverty levels, reaching a maximum of about 1 percentage point around 600 Rands. Women in both regions, rural and urban, are much poorer in terms of lower poverty bound than men. Furthermore, based on lower poverty bound, the increase in rural poverty (1.4 percentage point) is significantly greater than that of urban (0.2 percentage point). This suggests that rural areas are more affected than urban areas; females are affected more in terms of depth and severity of poverty as well as the lower poverty bounds. Nonetheless, in rural areas, the impact on food poverty headcount is similar for both genders, with a somewhat lower impact on females at the upper poverty bound. Similarly, females in the urban areas are affected more than males in terms of non-food poverty and food-poverty depth, while the impact on food-poverty head count is similar for both genders. The gender and region-wise estimates for all the three poverty thresholds are statistically significant at less than 1% in most of the cases (Table 7).

Figure 8: Impact on food poverty by gender and region.



Note: the y-axis represents the estimated difference in poverty distribution (in pp) before and after the shock while x-axis shows the various poverty lines in Rands.

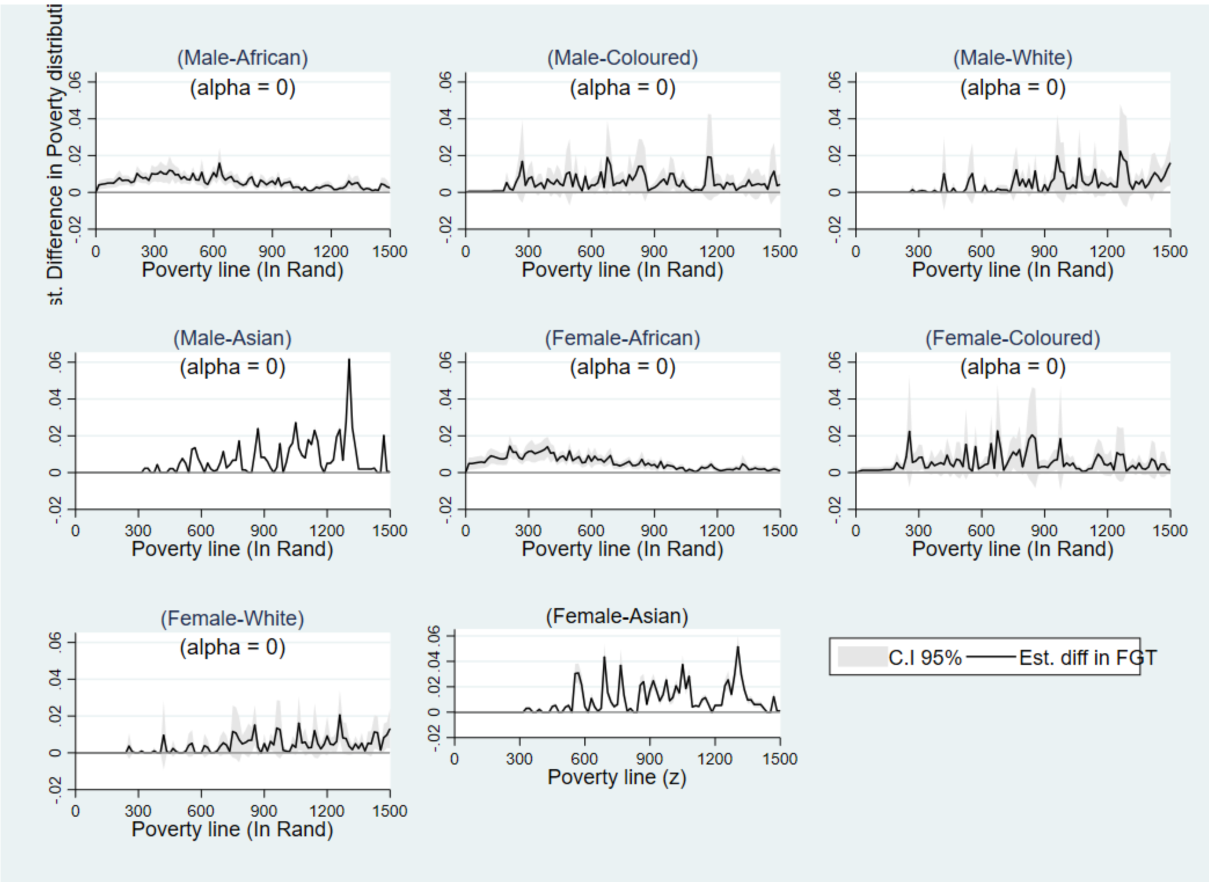
Source: Authors' estimates using NIDS (2017).

The labour market shock affects women disproportionately more than men. Men's per capita food spending decreases by 0.81 percent while that of women decreases by 1 percent. About 0.41 million women (58 percent of the overall affected population) lose their jobs because of the labour market shock compared to 0.28 million men (42 percent).

The impact on the labor market is most significant among women in the first decile, with an average decrease of 2.7 percent in employment as a share of the total active labor force, compared to a 1.7 percent decrease for men. Furthermore, the rural population is disproportionately affected by the global price shock (Figure 8 and Table 7). Prices in rural areas increase by 1.3 percent, while in urban areas by 1.21 percent. The negative labour market effect reduces the real average food spending in rural areas by 1.67 percent and in urban areas by 0.05 percent.

In terms of population groups, we find that the RUW shock's impact on food poverty is greatest on the Coloured population (1.2 percentage points), followed by Black Africans (0.8 percentage points), Whites (0.5 percentage points), and Asians with no change (Table 7). The impact is minimal among the Whites and Asian/Indians in the lower income deciles (both male and female). In contrast, the impact is more widespread among the Black Africans (both male and female), persisting as high as 800 Rand per capita (Figure 9). Only a small proportion of Whites and Asians lives with a per capita food spending below 500 Rands (3.7 and 9 percent, respectively), compared to Black Africans and Coloured (67 and 46 percent). Black African men and women are similarly affected in terms of food poverty head count (0.8 percentage points) and upper poverty bound (0.4 percentage points), but women are more affected in terms of depth and severity of food poverty, and lower poverty bounds (Table 7). The Coloured population is the most affected, with a greater impact on women (1.3 percentage points) than men (1.1 percentage points). The impact is significant at less than 1 percent for the Black African and Coloured groups, but almost insignificant for the White and Asian/Indian population.

Figure 9: Impact on food poverty by gender and race.



Note: the y-axis represents the estimated difference in poverty distribution (in percentage points) before and after the shock, while the x-axis shows various poverty lines in Rands.

Source: Authors' estimates using NIDS 2017.

The food and non-food poverty estimates numbers by region, gender, and race before and after the RUW shock are presented in tables 8 and 9.

Table 8: Food poverty numbers before and after the shock (in thousands)

Group	Pop share	Population in thousand	Initial poverty numbers	Poverty changes due to transmission channel	
				Price	Aggregate
Gender					
Male	48.9	27649.58	14847.8	193.5	193.5
Female	51.1	28847.32	17106.5	201.9	230.8
Region					
Male rural	17.4	9824.511	7004.9	88.4	98.2
Male urban	31.7	17923.64	7886.4	107.5	107.5
Female rural	19.3	10924.92	8204.6	87.4	109.2
Female urban	31.5	17823.64	8858.4	106.9	106.9
Race					

Male-African	39.6	22350.17	13410.1	156.5	178.8
Male-Colored	4.3	2401.118	1128.5	26.4	26.4
Male-White	3.8	2169.481	75.9	8.7	8.7
Male-Asian	1.3	711.8609	101.1	0.0	0.0
Female-African	41.3	23338.87	15730.4	140.0	163.4
Female-Colored	4.5	2553.66	1340.7	33.2	33.2
Female-White	1.2	683.6125	25.3	4.1	4.1
Female-Asian	4.1	2288.124	270.0	0.0	0.0
Overall	100.0	56496.9	32146.7	395.5	395.5

Source: Authors estimates using NIDS 2017

Table 9: Lower and upper poverty bounds numbers before and after the shock (in thousands)

Group	Pop share	Population shares in thousand	Lower Bound			Upper Bound		
			Poverty changes due to transmission channel			Poverty changes due to transmission channel		
			Initial	Price	Combine	Initial	Price	Combine
Gender								
Male	48.9	27649.58	5087.5	110.6	165.9	9290.3	82.9	82.9
Female	51.1	28847.32	6375.3	144.2	201.9	11106.2	57.7	86.5
Region								
Male rural	17.4	9824.511	3418.9	68.8	108.1	5531.2	49.1	58.9
Male urban	31.7	17923.64	1702.7	17.9	35.8	3781.9	35.8	35.8
Female rural	19.3	10924.92	4227.9	87.4	152.9	6697.0	21.8	43.7
Female urban	31.5	17823.64	2138.8	35.6	53.5	4366.8	53.5	53.5
Race								
Male-African	39.6	22350.17	4805.3	89.4	134.1	8582.5	89.4	89.4
Male-Colored	4.3	2401.118	247.3	4.8	4.8	629.1	4.8	4.8
Male-White	3.8	2169.481	0.0	0.0	0.0	0.0	0.0	0.0
Male-Asian	1.3	711.8609	0.7	0.0	0.0	2.1	0.0	0.0
Female-African	41.3	23338.87	6044.8	140.0	186.7	10339.1	70.0	93.4
Female-colored	4.5	2553.66	280.9	7.7	10.2	679.3	5.1	5.1
Female-White	1.2	683.6125	0.0	0.0	0.0	0.0	0.0	0.0
Female-Asian	4.1	2288.124	4.6	0.0	0.0	11.4	0.0	0.0
Overall	100.0	56496.9	11581.9	226.0	339.0	20508.4	169.5	226.0

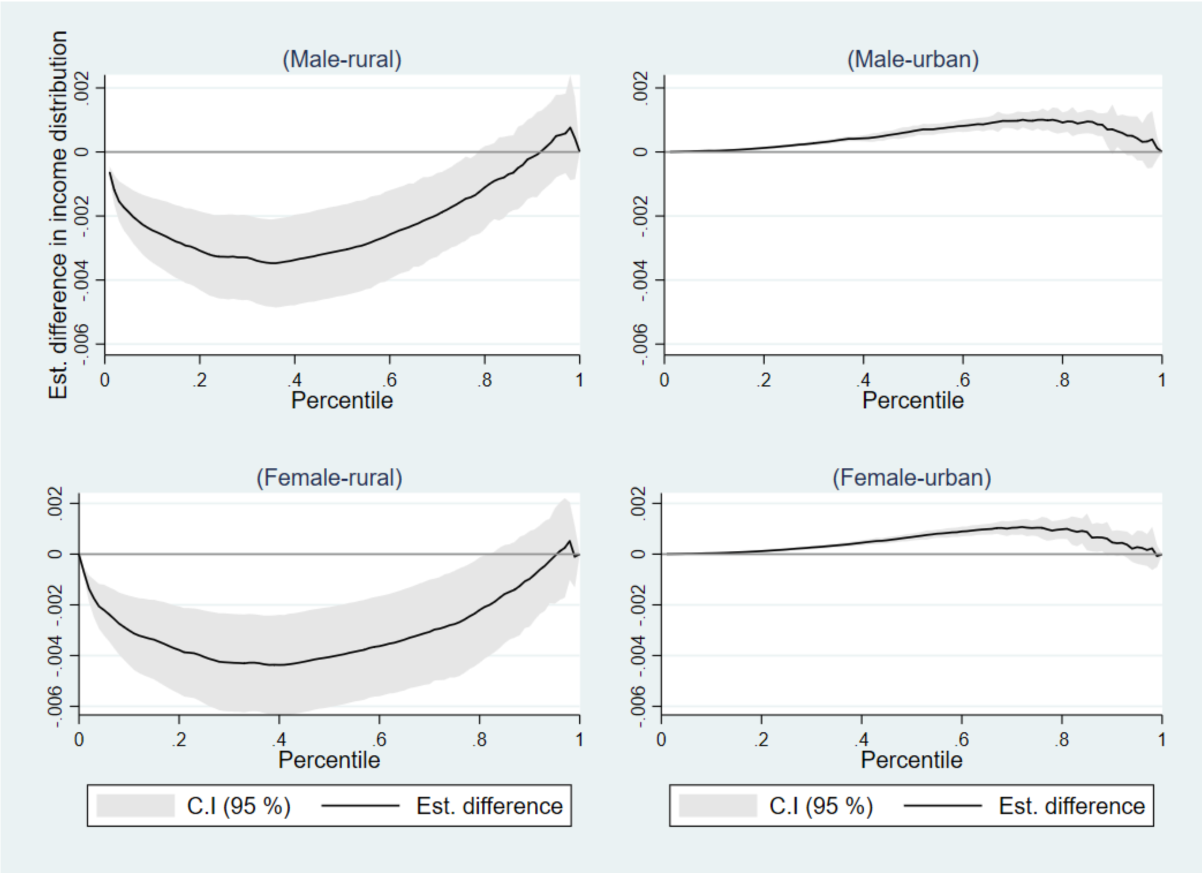
Source: Authors estimates using NIDS 2017

5.2.2 Effects on income inequality

South Africa has one of the highest levels of income inequality in the world, with a Gini of 0.6251 (0.6256 among males, 0.6223 among females). While the RUW price shock exacerbated income inequality across both genders, the increase is statistically significant at less than 10 percent for females but insignificant for males (Table 10). Females are more affected by the shock than males, particularly those who fall in the lower income deciles.

Figure 10 shows the impact on the income distribution by location. Although the real income of all sections of the society declined as a result of the price shock, the relative change in income distribution for various income groups exhibits a new picture. The fall in relative income share is the biggest between the 20th and 50th percentiles of the rural population. Rural women experience a greater relative decline in income than men. Rural females, with a Gini increase of 0.006, are more affected by the shock than rural males with a Gini increase of 0.004, particularly those who fall in the lower and lower-middle income deciles. The difference is statistically significant at less than 1 percent significance level (Table 10).

Figure 10: Relative change in income by percentile before and after the shock.



Source: Authors' estimates using NIDS 2017.

Table 10: Difference in Gini values before and after the shock by region and gender.

Gini Index	Male		Female	
	Estimate	P-value	Estimate	P-value
Gender				
Before	0.626	0.000	0.622	0.000
After	0.626	0.000	0.623	0.000
Difference in Gini	0.000	0.780	0.001	0.092

Region (Rural)				
Before	0.511	0.000	0.500	0.000
After	0.515	0.000	0.506	0.000
Difference in Gini	0.004	0.000	0.006	0.000
Region (Urban)				
Before	0.617	0.000	0.615	0.000
After	0.616	0.000	0.614	0.000
Difference in Gini	-0.001	0.000	-0.001	0.000

Source: Authors' estimates using NIDS 2017.

We observe the change in income distribution across racial groups to understand the source of increasing inequality in the rural areas. Black Africans with 74 percent poverty rate are the most impoverished group in rural areas, with females worse off than males. Black Africans account for around 97 percent of the rural population (tables 11 and 12). The biggest source of rise in inequity in rural areas is an increase in the income gap between rural Africans and other groups. On the one hand, the RUW shock reduces the relative income shares of Black Africans (both male and female), with females experiencing a bigger fall than males. On the other hand, the relative income shares of the other three racial groups increase. This indicates that the relative income share of only one percentage point of the rural population comprising of White, Asian, and Coloured has increased significantly, while that of the majority of the population consisting of Black Africans has decreased, resulting in an overall increase in income inequality in rural areas (Figure 11).

Table 11: Percentage share of population and corresponding food poverty rate by race and region.

	Population share			Food poverty rate	
Groups	Rural	Urban	Total	Rural	Urban
African	35.8	46.1	81.9	74.3	55.6
Coloured	0.7	7.8	8.5	48.2	45.7
Asian	0.2	2.1	2.3	28.7	10.6

White	0.1	7.1	7.3	2.6	3.6
sub total	36.8	63.2	100.0	73.4	47.2

Source: Authors' estimates using NIDS 2017.

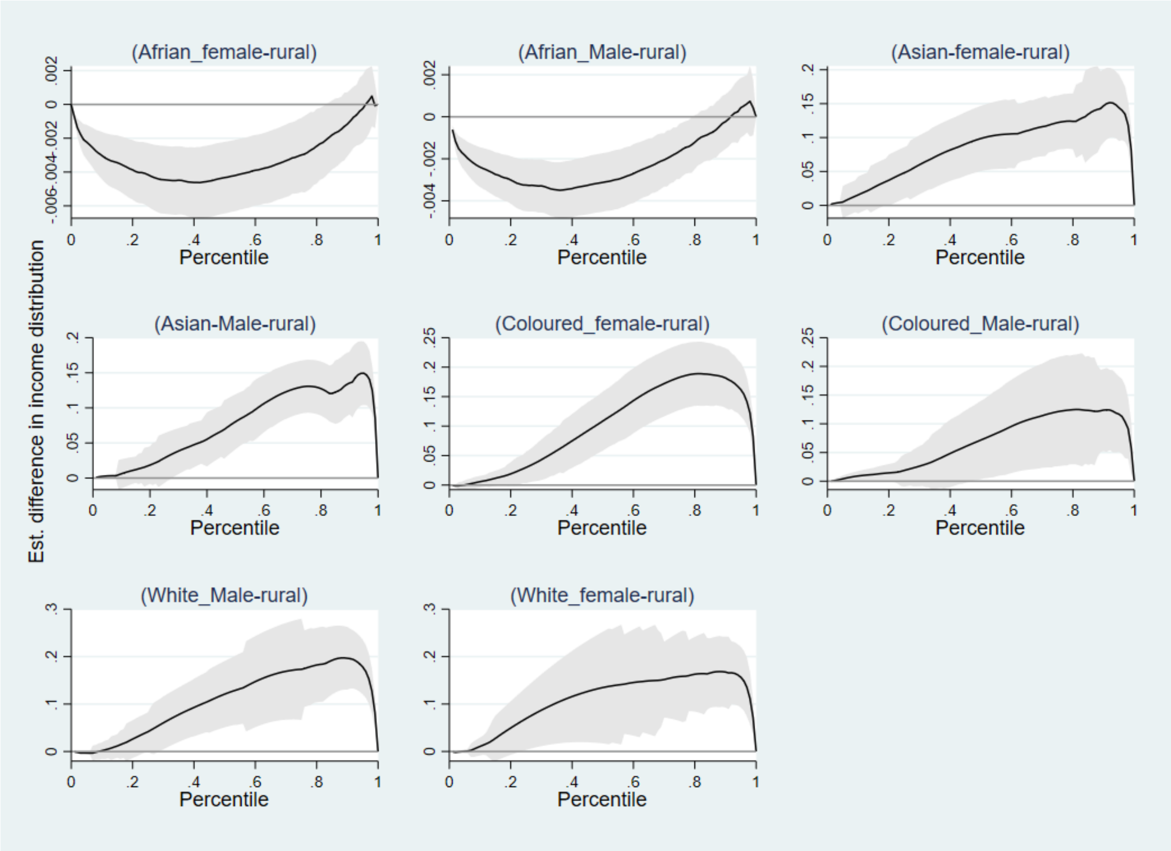
Though the real income of all deciles in the urban areas decreased, the relative income share of individuals in the upper half of the income distribution marginally increased, both for men and women. Income inequality increased more noticeably among rural women (increase in Gini = 0.011 points) than among rural men (increase in Gini = 0.009 points). In contrast, income inequality decreased marginally among urban men and women (decrease in Gini = 0.001). This can partly be attributed to the lower share in fuel expenditure and smaller rise in CPI for the lower income deciles compared to higher deciles (Figure 12).

Table 12: Food poverty rate by race region and gender

Group	Rural	Urban
Male-African	72.4	51.1
Female-African	75.9	60.2
Male-Coloured	45.2	44.3
Female-Coloured	51.6	47.2
Male-White	2.3	3.4
Female-White	3	3.8
Male-Asian	35	15.4
Female-Asian	22.3	5.6
Population	73.4	47.2

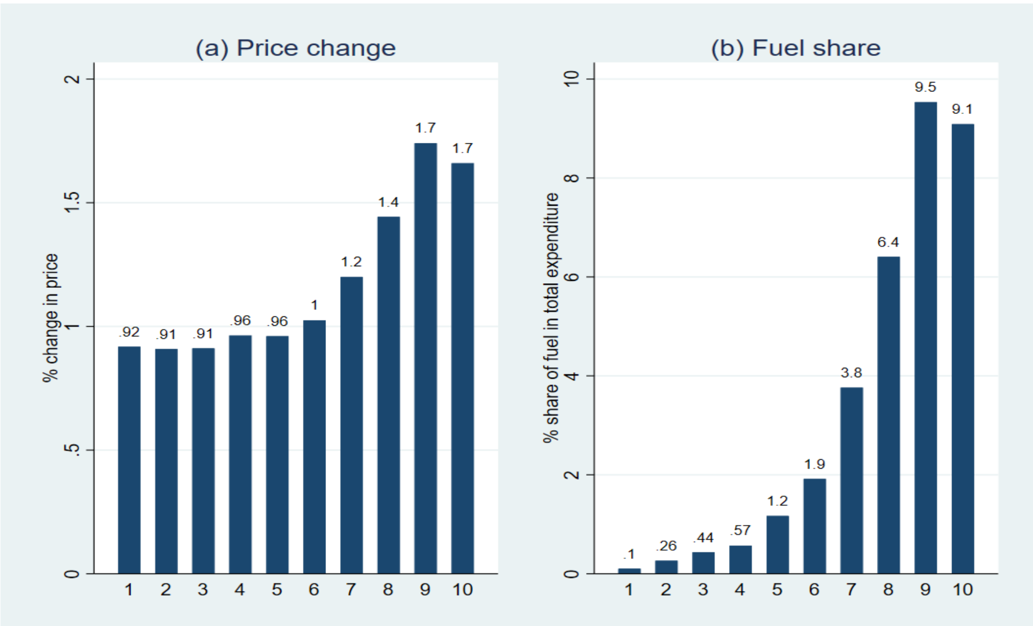
Source: Authors' estimates using NIDS 2017.

Figure 11: The source of increase in inequality among rural population.



Source: Authors' estimates using NIDS 2017.

Figure 12: Relative change in price and share of fuel in urban region by expenditure deciles.



Note: The y-axis shows the percentage change in prices and share of fuel in total expenditure while the a-axis shows the deciles by total expenditure.

Source: Authors' estimates using NIDS 2017.

5.3. Sensity and Robustness analysis

We carry out sensitivity and heterogeneity analysis in four distinct ways (for details, see Appendix-A and Appendix C). First, we estimate the outcomes by increasing the elasticity of substitution between males and females from 0.3 to 0.8. Second, we use an equivalence scale based on total household expenditure rather than spending on individual commodities. Third, we alternately increase and decrease the trade elasticity by 10 percent. Appendix A1 reports the sensitivity analysis results for percentage point change in food and non-food poverty. Appendixes A2 and A3 show the results of sensitivity and heterogeneity analysis for gender differentials by region and race. Finally, Appendix-A4 shows the results of sensitivity analysis for relative income distribution by gender. Appendix C shows the results of sensitivity analysis for the macroeconomic variables reported in tables 5 and 6.

All the sets of estimations corroborate the baseline findings. We find no discernible variation in results across gender, race, and region.

6. Conclusion and policy recommendations

The latest war between Russia and Ukraine began in February 2022 when Russian forces invaded parts of the Ukrainian territory. Given that both countries are important suppliers of several commodities (e.g. crude oil, cereals, vegetable oil, fertilizers), the conflict had a direct impact on consumers worldwide through supply shortages and price hikes. The effect was more acutely felt by vulnerable populations of the importing countries. This is particularly the case of countries such as South Africa in which inequalities are high and poverty is concentrated in specific segments of the population. In this study, we use macroeconomic model (CGE model) simulations combined with a micro model and econometric estimations to evaluate the impact of the Russia-Ukraine war (RUW) on South African women by measuring changes in food poverty, non-food poverty, and income distribution.

Our key findings are as follows:

First, women accounted for 58 percent of jobs lost due to the labour market effect; men's per capita food spending fell by 0.81 percent and that of women by 1 percent as a result of the labour market effect. Second, approximately 0.4 million persons (0.7 percent of the total population) fell below the food poverty line following the shock. The impact on head count (P0), depth (P1) and severity (P2) of food poverty is greater among females than among males.

Third, more rural females were affected (109.2 thousand) than rural males (88.4 thousand). The increase in the depth and severity of poverty is significantly greater among rural females (1.5 and 1.6 percentage point) than among rural males (1.4 percentage point).

Fourth, Coloured and White females were affected the most in terms of food poverty, with an increase of 1.3 and 0.6 percentage points, while the impact among the Black Africans and Asians is similar across genders. Finally, while the shock exacerbated income inequality for both genders, the increase in income inequality among males is statistically insignificant. Inequality among rural females increased more than among rural males, while inequality in urban areas decreased for both genders.

If we compare the effects of this crisis in terms of poverty compared to that of Covid-19 and the financial crisis of 2008, we notice that it affected more people than that of 2008, but much less than that of Covid-19 which pushed 2.5 million South Africans into poverty (World Bank, 2021).

These findings highlight the need to protect women, particularly those belonging to the more deprived groups and those living in rural areas, to better fight the price and labour market shocks arising from a major international conflict such as the Russia Ukraine war. The social protection programme can be made more responsive and better targeted to assist the segments of the population more at risk at falling into poverty and food insecurity due to rising prices and deteriorating labour market. An extension of this work should assess the impact of fiscal policies put in place to reduce the worsening of the public deficit following this crisis. Indeed, this type of measure may well not be neutral in terms of gender.

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Appendix A: Sensity analysis

Appendix-A1: Sensitivity Analysis for Percentage point change in poverty

Table A1: Estimated Percentage point change in poverty (Elasticity=0.8).

Group	Food Poverty			Non-food Poverty	
	P0	P1	P2	Lower	Upper
Male	0.7	0.7	0.6	0.6	0.3
Female	0.8	0.8	0.7	0.8	0.3
Rural	1	1.5	1.5	1.4	0.5
Urban	0.6	0.3	0.2	0.2	0.3
Male rural	1	1.4	1.4	1.2	0.6
Male urban	0.6	0.3	0.1	0.2	0.2
Female rural	1	1.5	1.6	1.5	0.5
Female urban	0.6	0.3	0.2	0.3	0.3
Male-African	0.8	0.8	0.8	0.6	0.4
Male-Coloured	1.1	0.4	0.2	0.2	0.2
Male-White	0.4	0	0	0	0
Female-African	0.7	0.9	0.9	0.9	0.4
Female-Coloured	1.3	0.4	0.3	0.4	0.2
Female-White	0.6	0	0	0	0
Male-Asian	0	0.2	0.1	0	0
Female-Asian	0	0.1	0	0	0
Population	0.7	0.7	0.7	0.6	0.4

Note: The estimated impact is the aggregate impact (Price and Labour Market).

Source: Authors' estimates using NIDS 2017.

Table A2: Estimated Percentage point change in poverty (Elasticity=0.3).

Group	Food Poverty			Non-food Poverty	
	P0	P1	P2	lower	upper
Male	0.7	0.7	0.6	0.6	0.3
Female	0.8	0.8	0.7	0.7	0.3
Male rural	1	1.4	1.4	1.1	0.6
Male urban	0.6	0.3	0.1	0.2	0.2
Female rural	1	1.5	1.5	1.4	0.4
Female urban	0.6	0.3	0.2	0.3	0.3
Male-African	0.8	0.8	0.8	0.6	0.4
Male-Coloured	1.1	0.4	0.2	0.2	0.2
Male-White	0.4	0	0	0	0
Female-African	0.8	0.9	0.8	0.8	0.4
Female-Coloured	1.3	0.4	0.3	0.4	0.2
Female-White	0.6	0	0	0	0
Male-Asian	0	0.2	0.1	0	0
Female-Asian	0	0.1	0	0	0
Population	0.7	0.7	0.6	0.6	0.4

Note: Estimates based on aggregate impact (Price and Labour Market).

Source: Authors' estimates using NIDS 2017.

Table A3: Estimated Percentage point change in poverty (Trade-up).

Group	Food Poverty			Non-food Poverty	
	P0	P1	P2	Lower	Upper
Male	0.7	0.7	0.6	0.6	0.4
Female	0.8	0.8	0.7	0.8	0.4
Rural	1.1	1.5	1.5	1.4	0.7
Urban	0.7	0.3	0.2	0.3	0.3
Male rural	1.1	1.4	1.4	1.2	0.7
Male urban	0.6	0.3	0.1	0.2	0.2
Female rural	1	1.5	1.6	1.4	0.6
Female urban	0.6	0.3	0.3	0.3	0.3
Male-African	0.8	0.8	0.8	0.7	0.5
Male-Coloured	1.1	0.4	0.2	0.2	0.2
Male-White	0.4	0	0	0	0
Female-African	0.7	0.9	0.9	0.9	0.4
Female-Coloured	1.4	0.4	0.3	0.4	0.2
Female-White	0.6	0	0	0	0
Male-Asian	0	0.2	0.1	0	0
Female-Asian	0	0.1	0	0	0
Population	0.8	0.8	0.7	0.7	0.4

Note: Estimates based on aggregate impact (Price and Labour Market).

Source: Authors' estimates using NIDS 2017.

Table A4: Estimated Percentage point change in poverty (Trade-down).

Group	Food Poverty			Non-food Poverty	
	P0	P1	P2	Lower	Upper
Male	0.7	0.7	0.6	0.6	0.3
Female	0.7	0.8	0.7	0.7	0.3
Rural	0.9	1.4	1.5	1.3	0.5
Urban	0.6	0.3	0.2	0.2	0.3
Male rural	0.9	1.4	1.4	1.1	0.6
Male urban	0.6	0.3	0.1	0.2	0.2
Female rural	0.8	1.5	1.5	1.4	0.5
Female urban	0.6	0.3	0.2	0.3	0.3
Male-African	0.8	0.8	0.8	0.6	0.4
Male-Coloured	1.1	0.4	0.2	0.2	0.2
Male-White	0.4	0	0	0	0
Female-African	0.6	0.9	0.8	0.8	0.4
Female-Coloured	1.3	0.4	0.3	0.4	0.2
Female-White	0.6	0	0	0	0
Male-Asian	0	0.2	0.1	0	0
Female-Asian	0	0.1	0	0	0
Population	0.7	0.7	0.6	0.6	0.4

Note: Estimates based on aggregate impact (Price and Labour Market).

Source: Authors' estimates using NIDS 2017.

Table A5: Estimated Percentage point change in poverty (Aggregate expenditure equivalence scale).

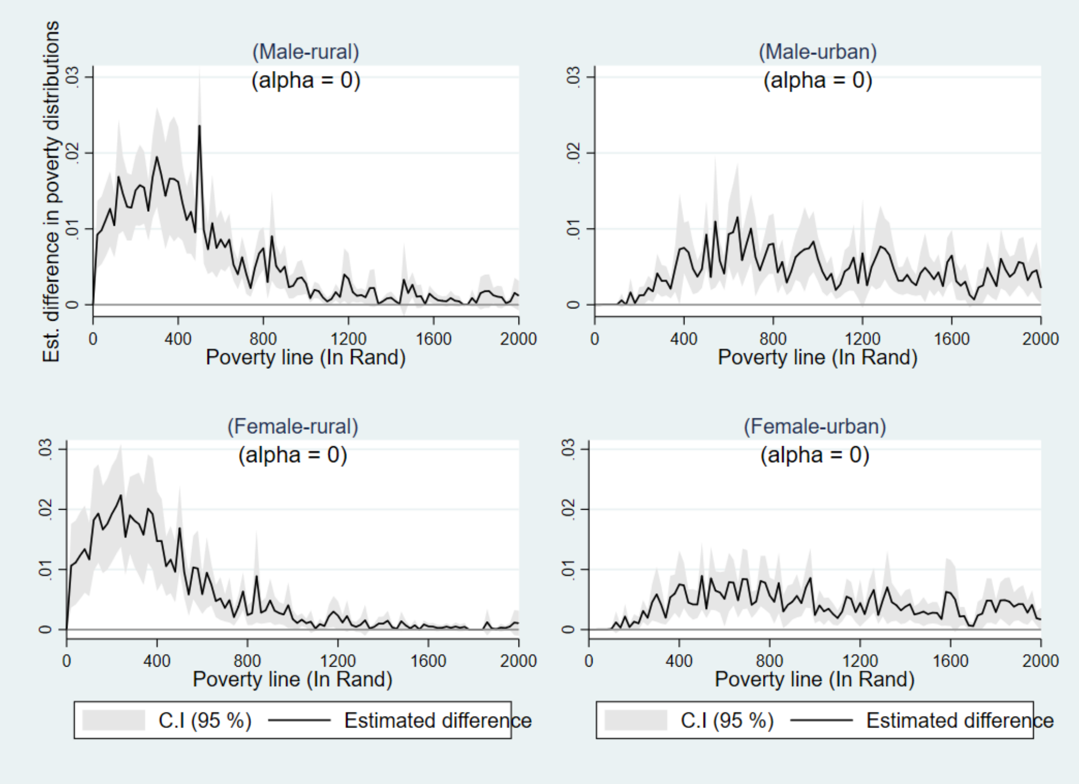
Group	Food Poverty			Non-food Poverty	
	P0	P1	P2	Lower	Upper
Male	0.5	0.6	0.6	0.4	0.6
Female	1.1	0.8	0.8	0.5	0.5
Male rural	0.3	1.2	1.3	0.7	0.7
Male urban	0.6	0.3	0.2	0.2	0.5
Female rural	0.8	1.5	1.6	1	0.6
Female urban	1.3	0.4	0.2	0.1	0.3
Male-African	0.5	0.8	0.7	0.4	0.6
Male-Coloured	1	0.4	0.3	0.2	0.1
Male-White	0	0.1	0	0	0
Female-African	1	0.9	0.9	0.6	0.6
Female-Coloured	1.7	0.4	0.3	0.2	0.2
Female-White	0.7	0.1	0	0	0
Male-Asian	0.6	0.2	0.1	0	0
Female-Asian	1.6	0.3	0.1	0	0
Population	0.8	0.7	0.7	0.4	0.5

Note: Estimates based on aggregate impact (Price and Labour Market).

Source: Authors' estimates using NIDS 2017.

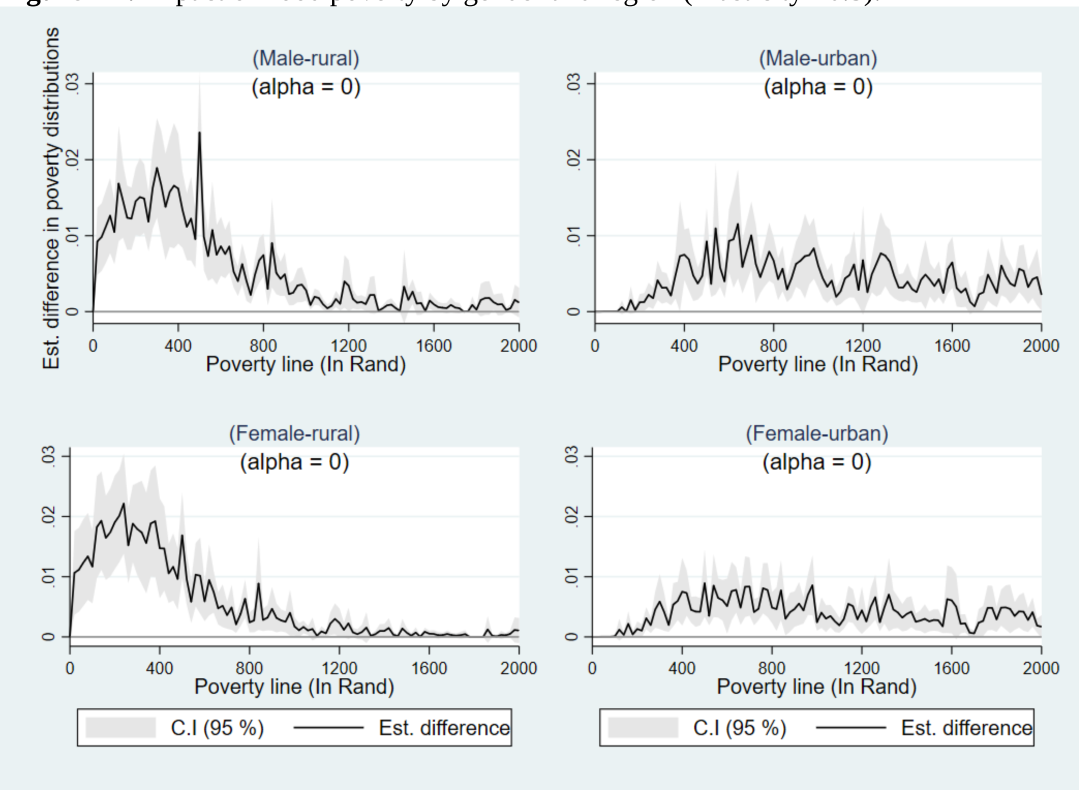
Appendix-A2: Sensitivity Analysis for Impact on Food-Poverty by Gender and Region.

Figure A1: Impact on food poverty by gender and region (Elasticity =0.8).



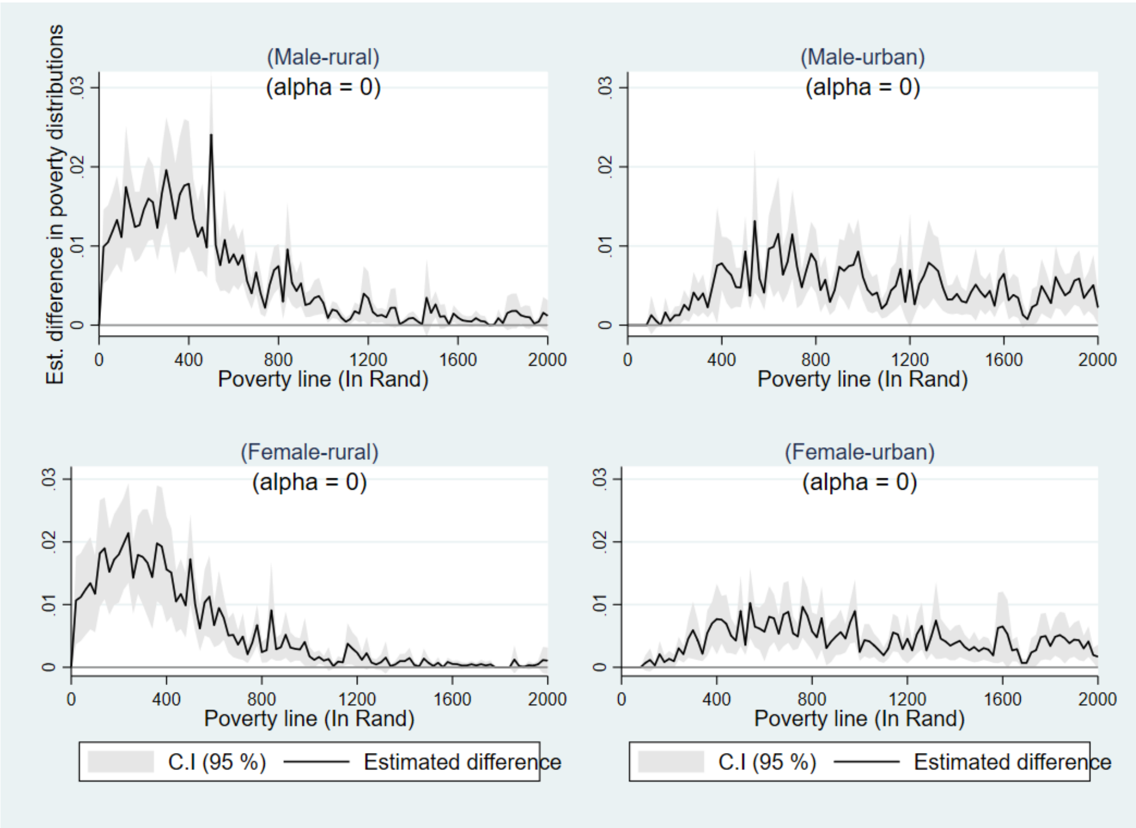
Source: Authors estimates using NIDS 2017

Figure A2: Impact on food poverty by gender and region (Elasticity =0.3).



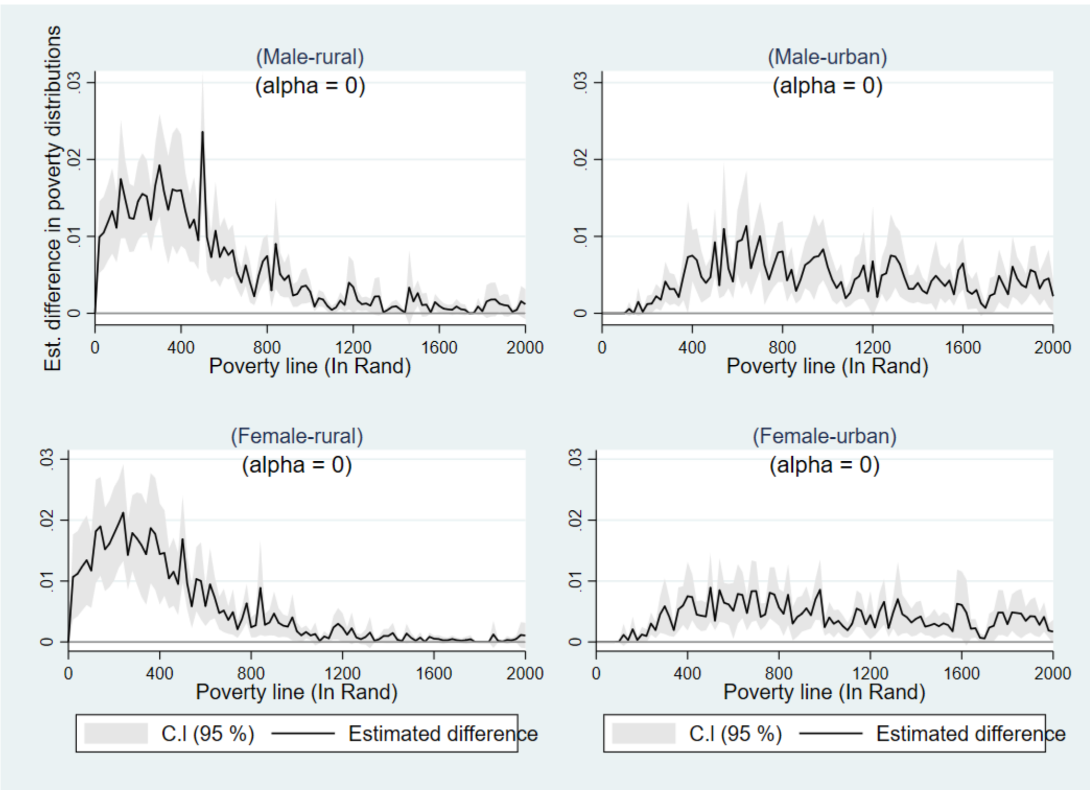
Source: Authors estimates using NIDS 2017

Figure A3: Impact on food poverty by gender and region (Trade-up).



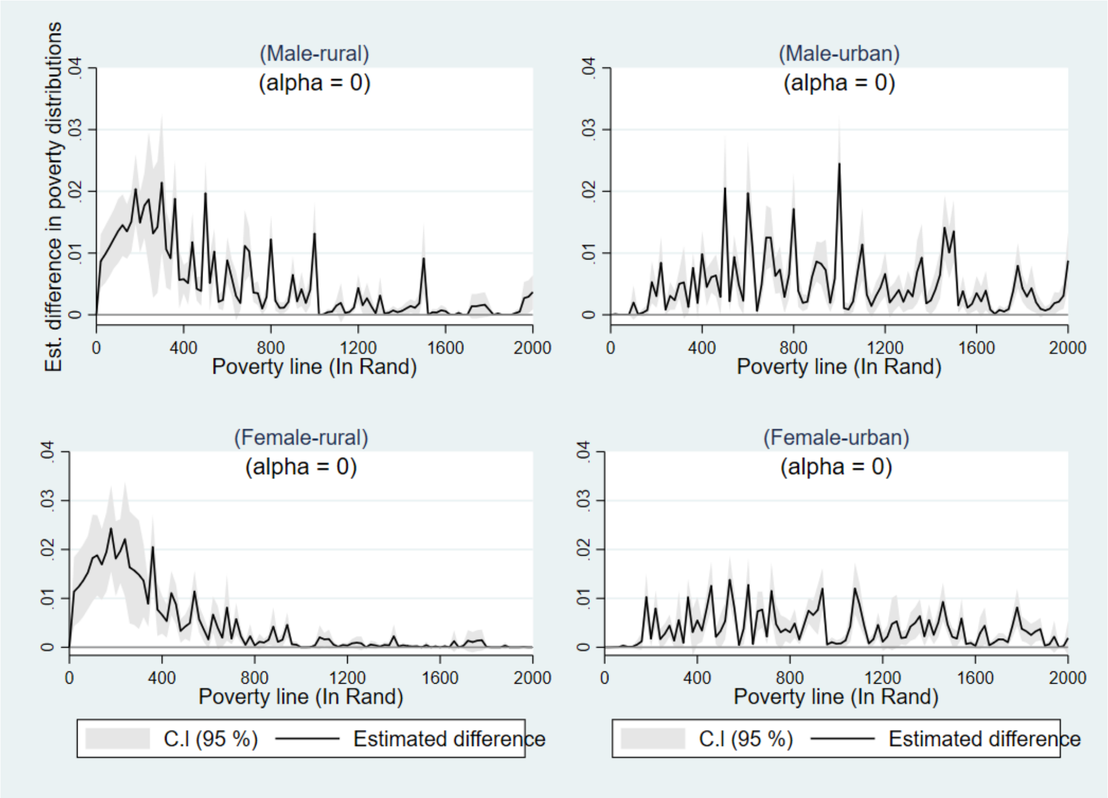
Source: Authors estimates using NIDS 2017

Figure A4: Impact on food poverty by gender and region (Trade-down)



Source: Authors estimates using NIDS 2017

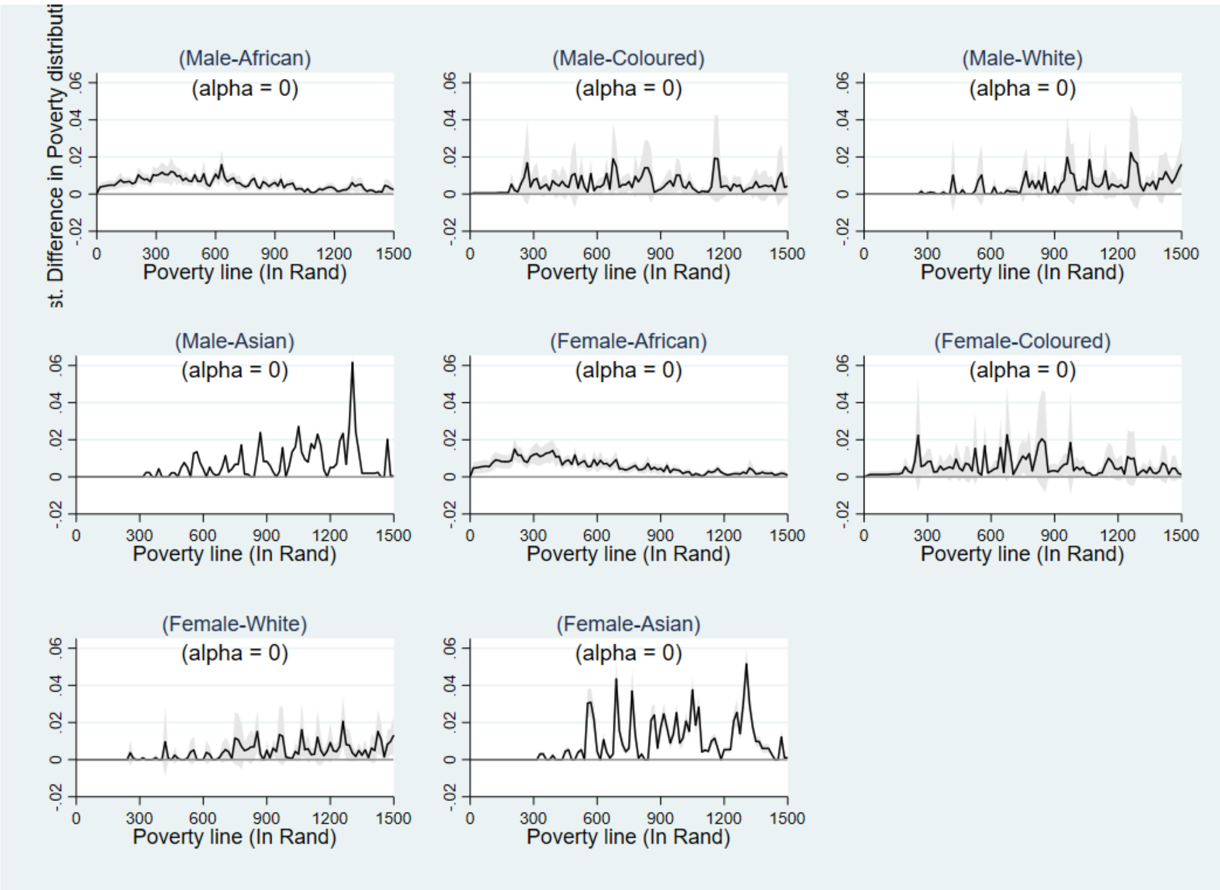
Figure A5: Impact on food poverty by gender and region (Aggregate expenditure equivalence scale)



Source: Authors estimates using NIDS 2017

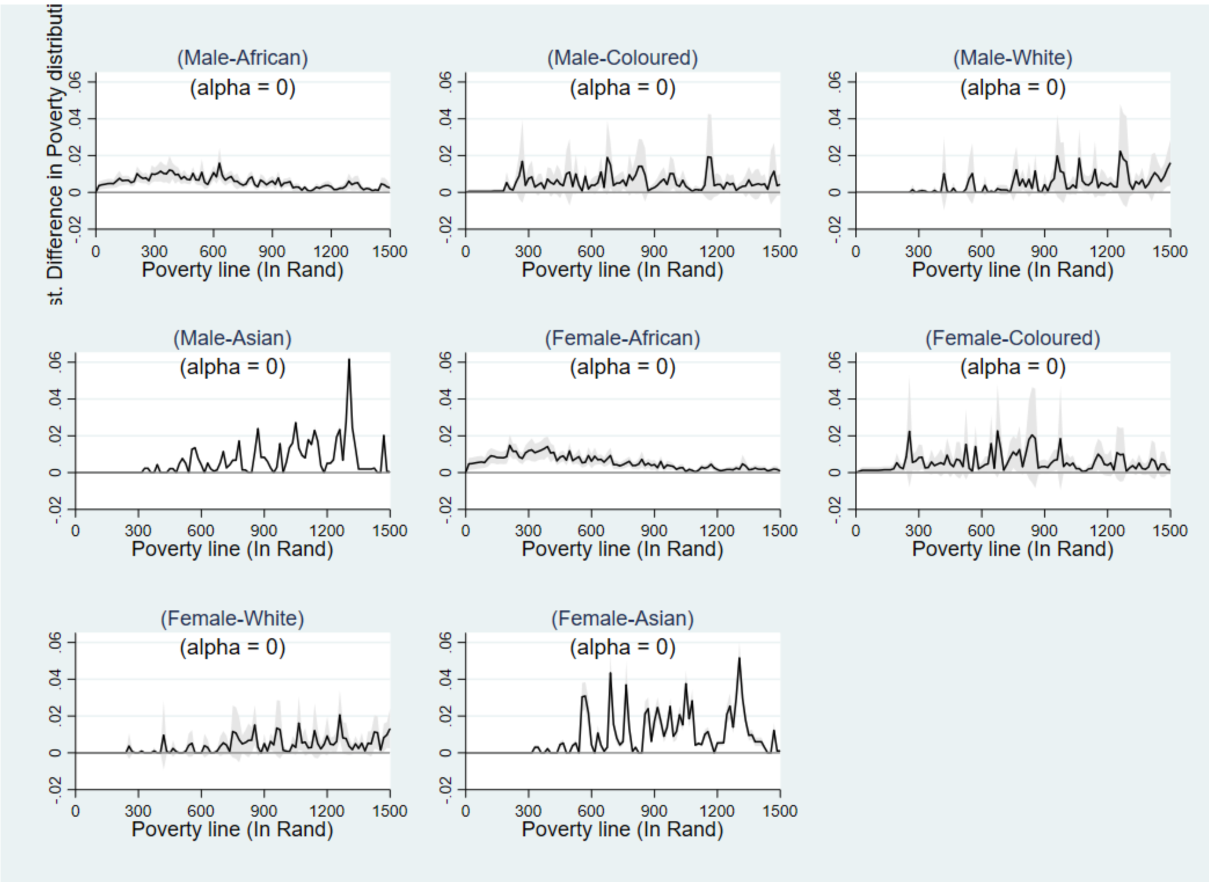
Appendix-A3: Sensitivity Analysis for Impact on Food-Poverty by Gender and Race.

Figure A6: Impact on food poverty by gender and race (Elasticity =0.8).



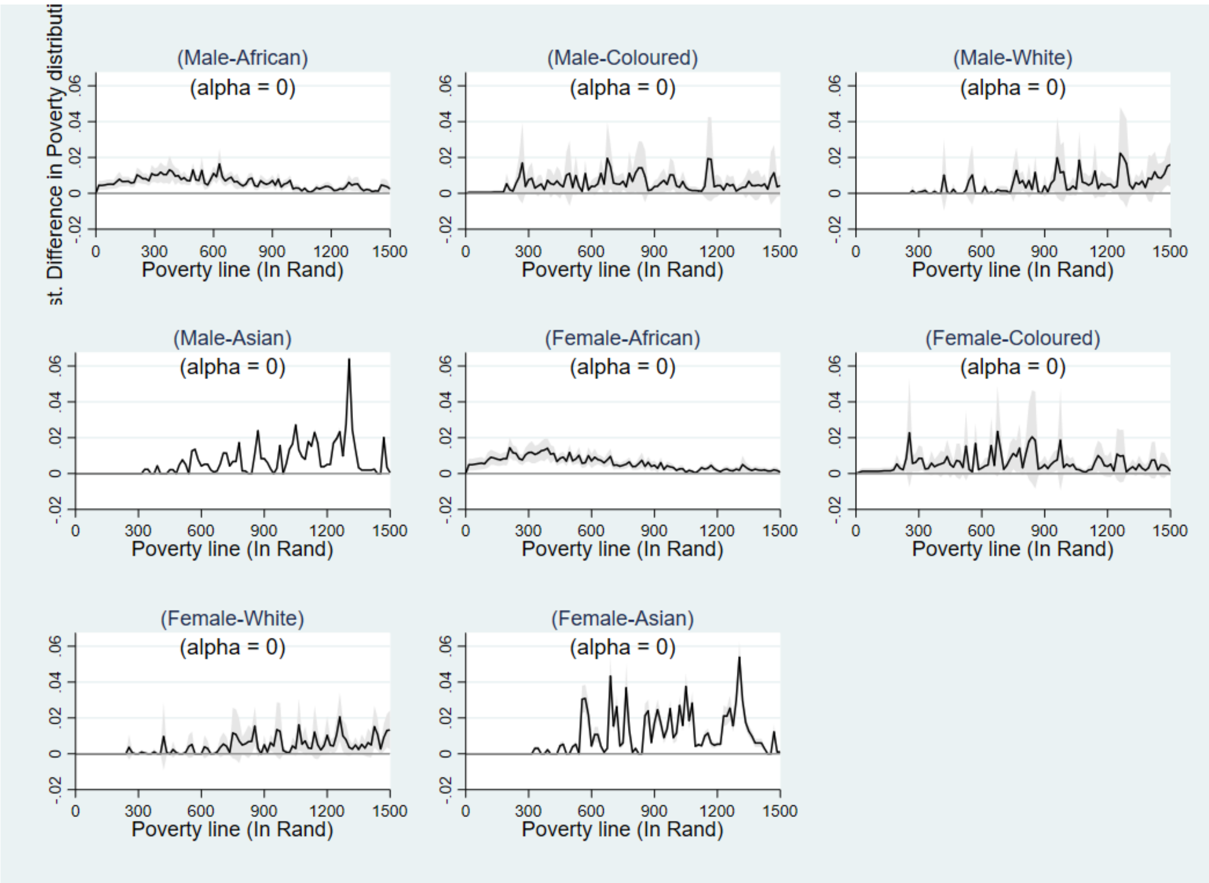
Source: Authors estimates using NIDS 2017

Figure A7: Impact on food poverty by gender and race (Elasticity =0.3).



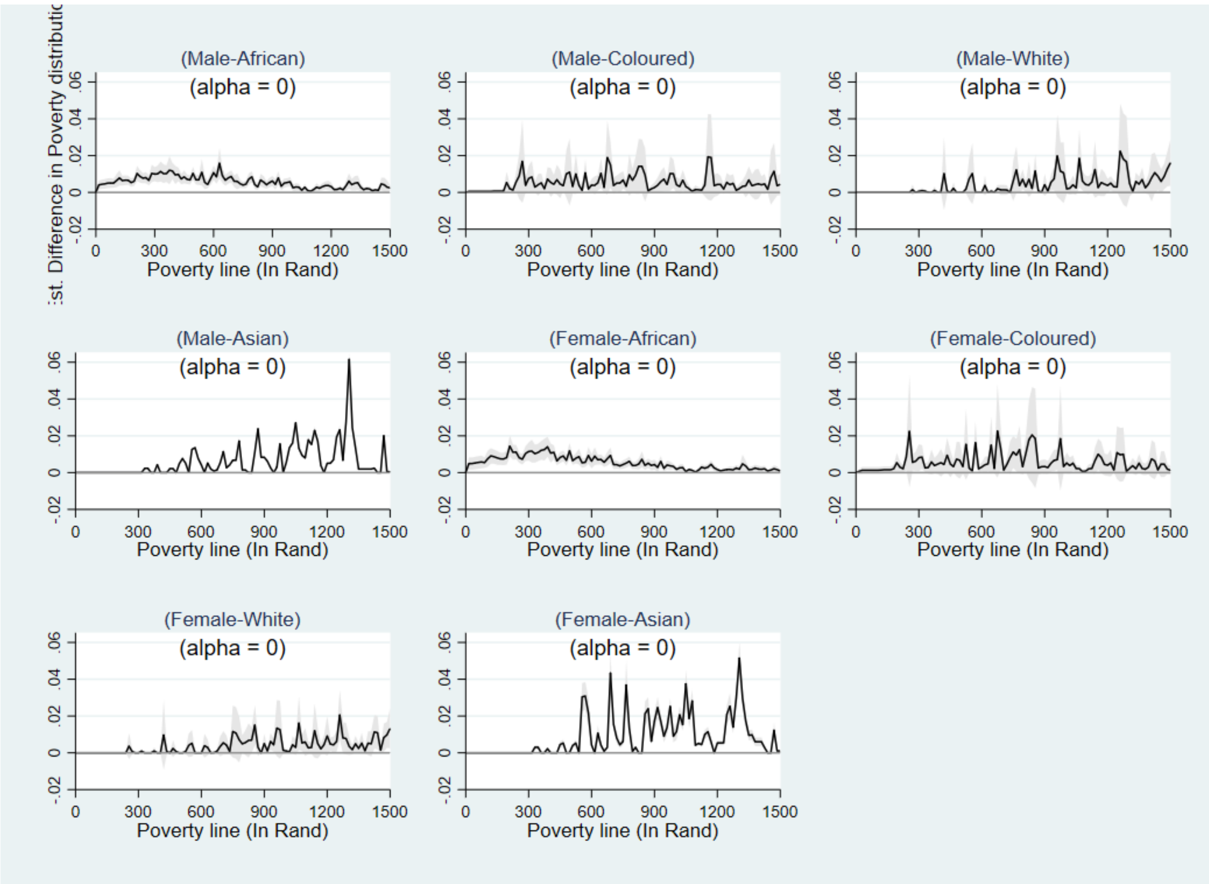
Source: Authors estimates using NIDS 2017

Figure A8: Impact on food poverty by gender and race (Trade-up).



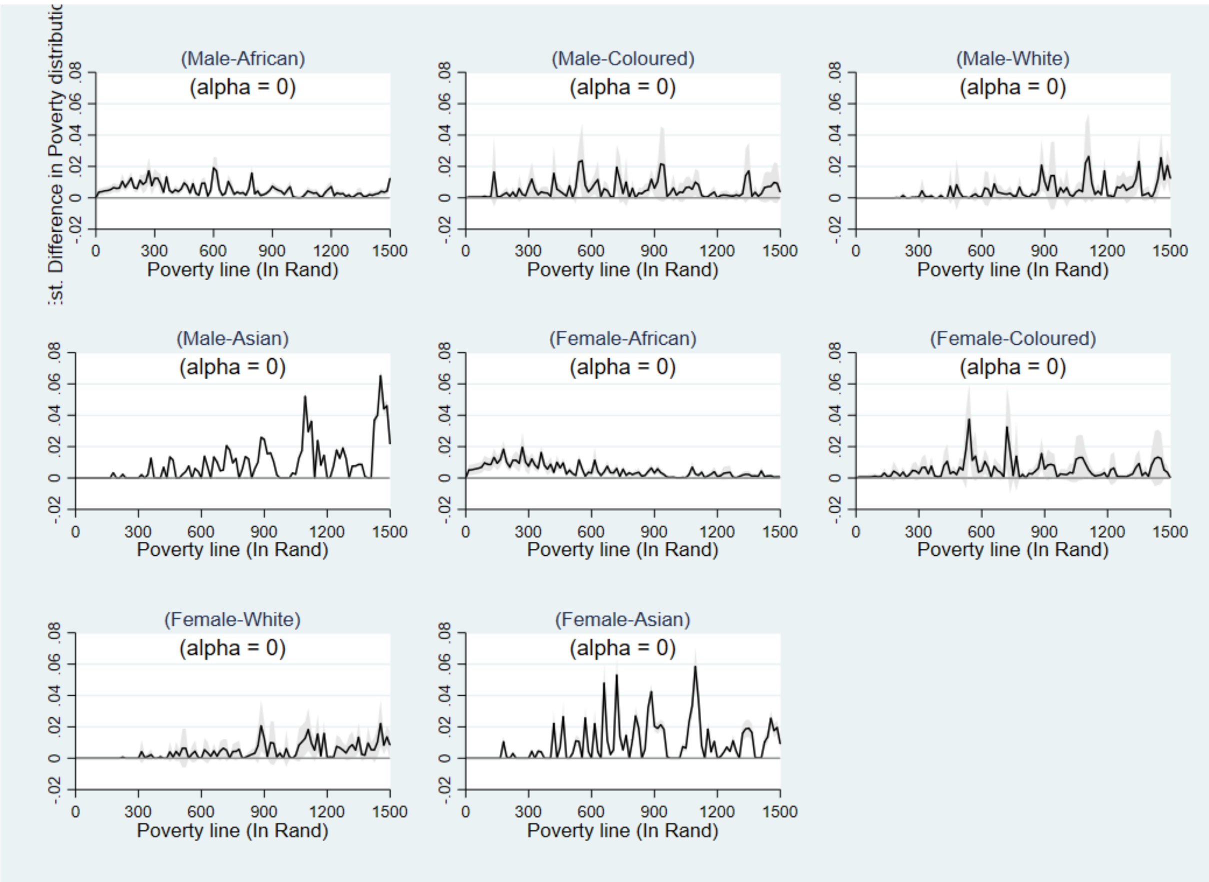
Source: Authors estimates using NIDS 2017

Figure A9: Impact on food poverty by gender and race (Trade-down).



Source: Authors estimates using NIDS 2017

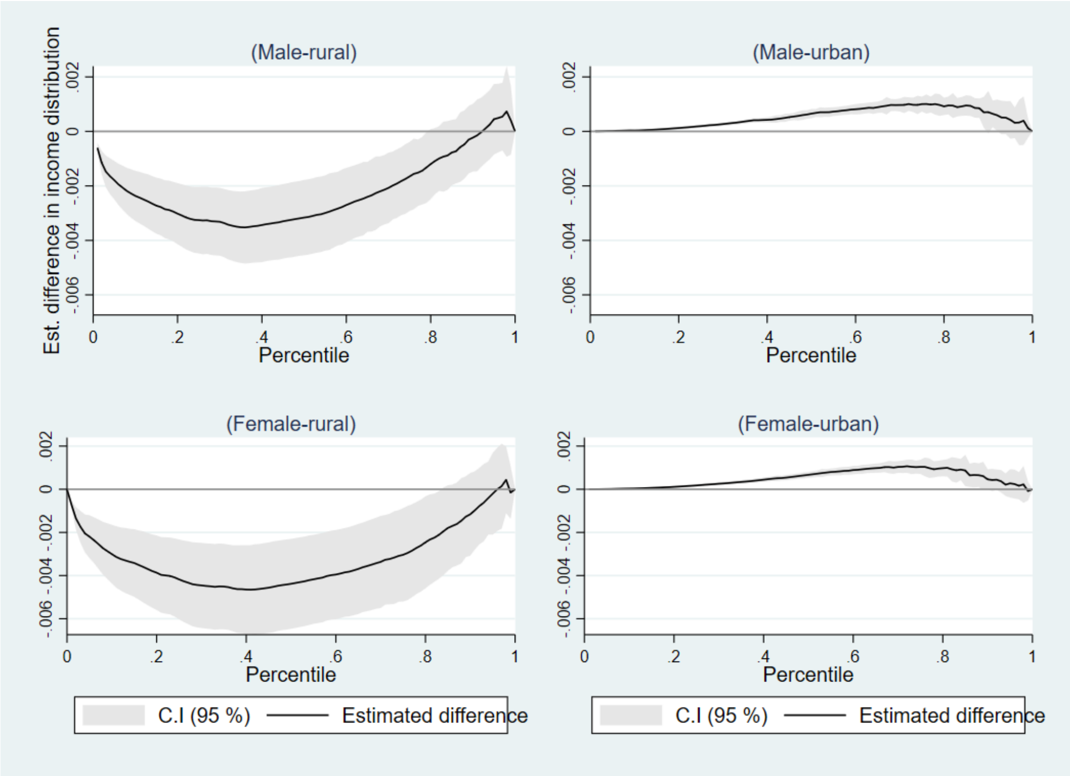
Figure A10: Impact on food poverty by gender and race (Aggregate expenditure equivalence scale).



Source: Authors estimates using NIDS 2017

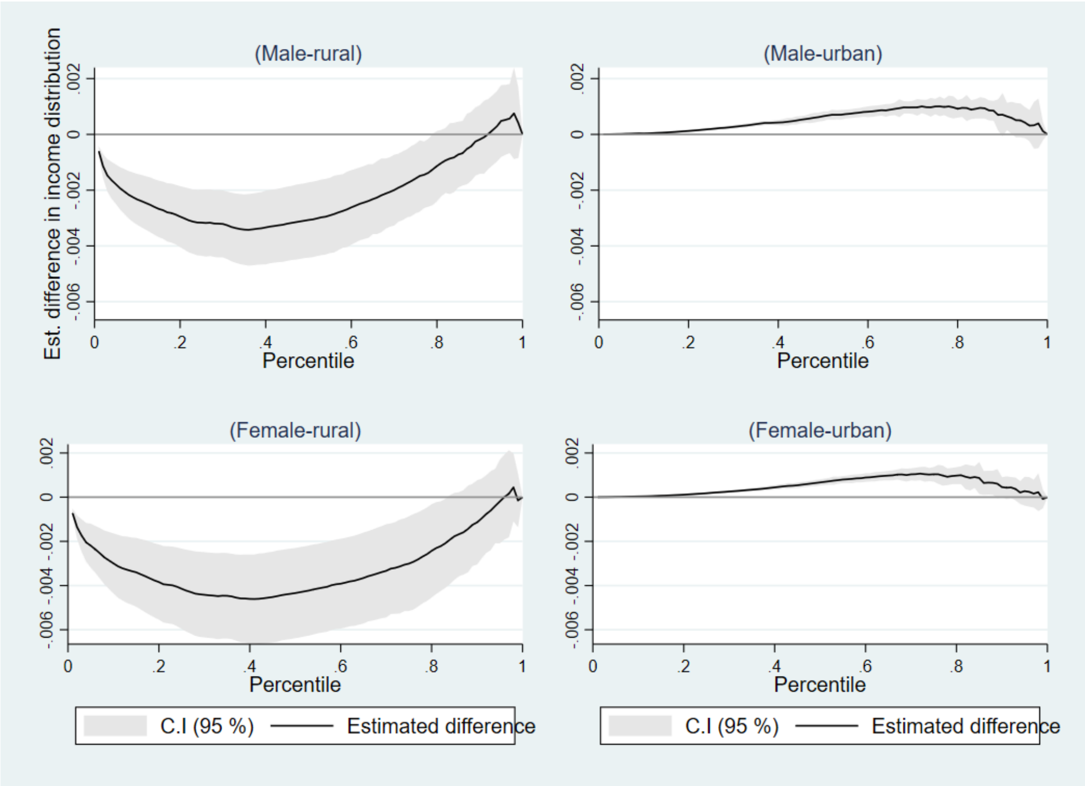
Appendix-A4: Sensitivity Analysis for Relative change in income distribution.

Figure A11: Relative change in income by percentile before and after shock (Elasticity =0.8).



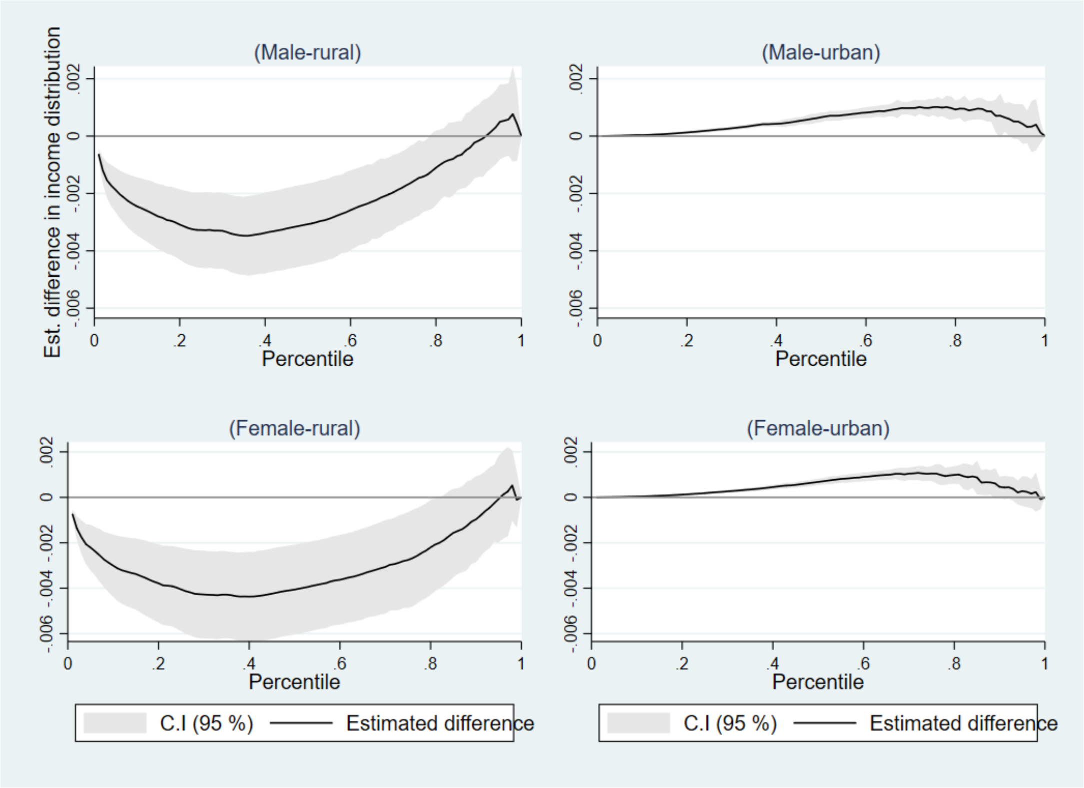
Source: Authors estimates using NIDS 2017

Figure A12: Relative change in income by percentile before and after shock (Elasticity =0.3).



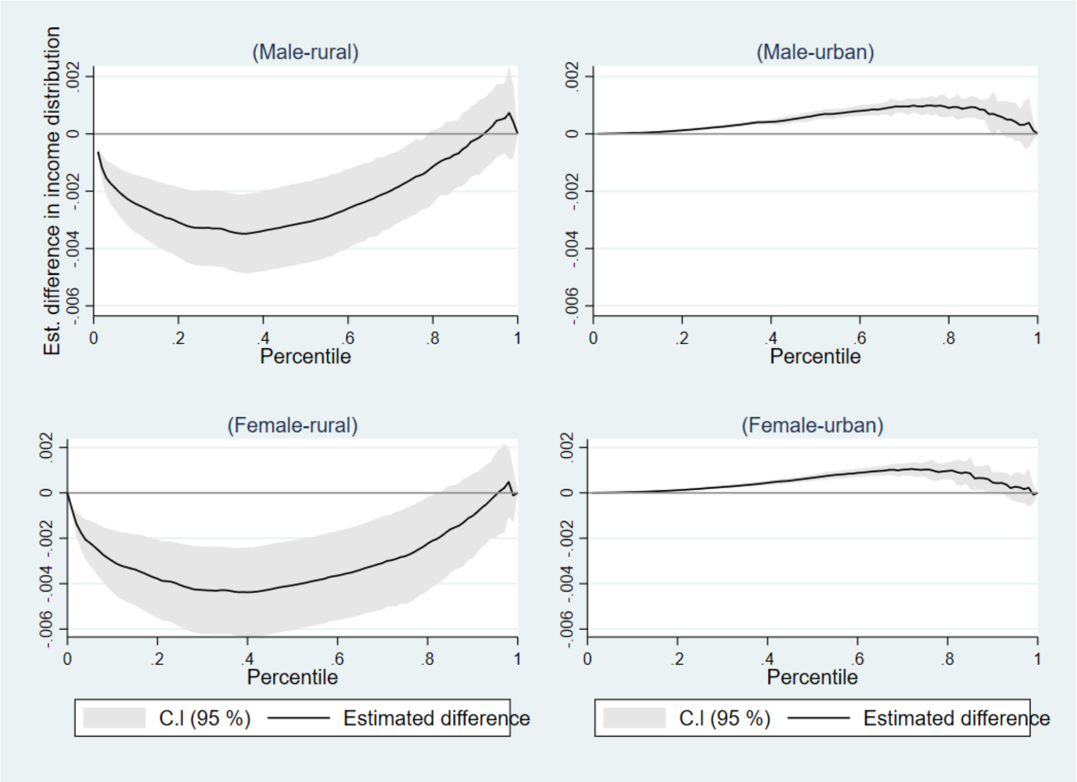
Source: Authors estimates using NIDS 2017

Figure A13: Relative change in income by percentile before and after shock (Trade-up).



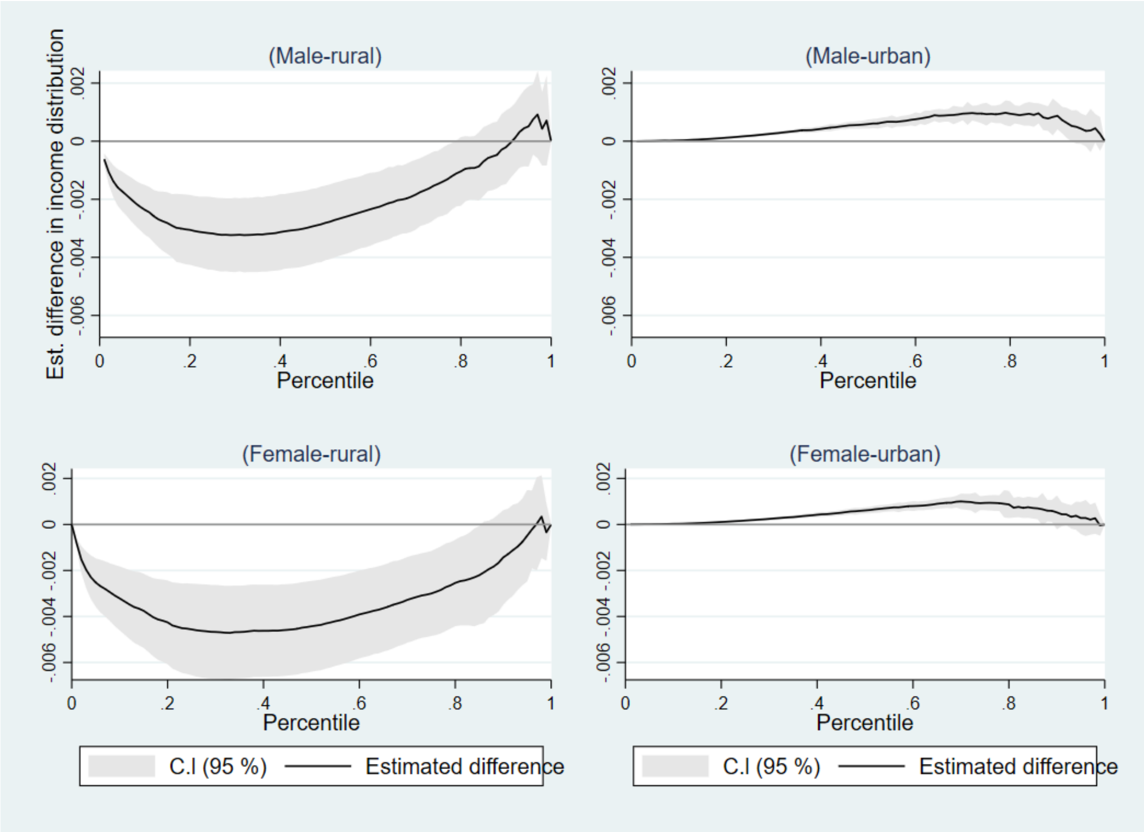
Source: Authors estimates using NIDS 2017

Figure A14: Relative change in income by percentile before and after shock (Trade-down).



Source: Authors estimates using NIDS 2017

Figure A15: Relative change in income by percentile before and after shock (Aggregate expenditure equivalence scale).



Source: Authors estimates using NIDS 2017

Appendix B: Equations, sets, variables and parameters in the CGE model

S1. Equations

S1.1 Production

1. $VA_j = v_j XST_j$
2. $CI_j = io_j XST_j$

3. $VA_j = B_j^{VA}\left[\beta_j^{VA} LD_j^{-\rho_j^{VA}} + \left(1-\beta_j^{VA}\right) KD_j^{-\rho_j^{VA}}\right]^{-\frac{1}{\rho_j^{VA}}}$

4. $LDC_j = \left\{\left[\frac{\beta_j^{VA}}{\left(1-\beta_j^{VA}\right)}\right]\left[\frac{RC_J}{WC_J}\right]\right\}^{\sigma_j^{VA}} KDC_j$

5. $LDC_j = B_j^{LD}\left[\beta_j^{LD} LQ_j^{-\rho_j^{LD}} + (1-\beta_j^{LD}) LNQ_j^{-\rho_j^{LD}}\right]^{-1/\rho_j^{LD}}$

6. $LQ_j = \left\{\left[\frac{\beta_j^{LD}}{\left(1-\beta_j^{LD}\right)}\right]\left[\frac{WNQ_J}{WQ_J}\right]\right\}^{\sigma_j^{LD}} LNQ_j$

7. $LQ_j = B_j^{LQ}\left[\sum_{sk} \beta_j^{LQ} LD_{sk,j}^{-\sigma_j^{LQ}}\right]^{-1/\sigma_j^{LQ}}$

8. $LD_{sk,j} = \left[\frac{\beta_j^{LQ} WQ_j}{WTI_{sk,j}}\right]^{\sigma_j^{LQ}} B_j^{LQ\left(\sigma_j^{LQ}-1\right)} LQ_j$

9. $LNQ_j = B_j^{LNQ}\left[\sum_{usk} \beta_j^{LNQ} LD_{usk,j}^{-\sigma_j^{LNQ}}\right]^{-1/\rho_j^{LNQ}}$

10. $LD_{usk,j} = \left[\frac{\beta_j^{LNQ} WNQ_j}{WTI_{usk,j}}\right]^{\sigma_j^{LNQ}} B_j^{LNQ\left(\sigma_j^{LNQ}-1\right)} LNQ_j$

11. $KDC_j = B_j^{KD}\left[\sum_k \beta_j^{KD} KD_{k,j}^{-\sigma_j^{KD}}\right]^{-1/\sigma_j^{KD}}$

12. $KD_{k,j} = \left[\frac{\beta_j^{KD} RC_j}{RTI_{k,j}}\right]^{\sigma_j^{KD}} B_j^{KD\left(\sigma_j^{KD}-1\right)} KDC_j$

13. $DI_{i,j,} = aij_{i,j} CI_j$

S1.2 Income and Savings

S1.2.1 Households

14. $YH_h = YHL_h + YHK_h + YHTR_h$
15. $YHL_h = \sum_l \lambda_h^{WL} W_l \sum_j LD_{l,j}$
16. $YHK_h = \sum_k \lambda_k^{RK} \left(\sum_j R_{k,j} KD_{k,j}\right)$
17. $YHTR_h = \sum_{ag} TR_{h,ag}$
18. $YDH_h = YH_h - TDH_h - TR_{\prime gvt\prime,h}$
19. $CTH_h = YDH_h - SH_h - \sum_{agng} TR_{agng,h}$
20. $SH_h = sh1_h YDH_h$

S1.2.2 Firms

21. $YF = YFK + YFTR$
22. $YFK = \sum_k \lambda_f^{RK} \left(\sum_j R_{k,j} KD_{k,j}\right)$
23. $YFTR = \sum_{ag} TR_{f,ag}$
24. $YDF = YF - TDF$
25. $SF = YDF - \sum_{ag} TR_{ag,f}$

S1.2.3 Government

26. $YG = YGK + TDHT + TDF + TPRODN + TPRCTS + YGTR$
27. $YGK = \lambda_{\prime gvt\prime}^{RK} \left(\sum_j R_j KD_j\right)$
28. $TDHT = \sum_h TDH_h$
29. $TDFT = \sum_f TDF_f$
30. $TPRODN = TIPT + TIWT + TIKT$

31. $TIWT = \sum_{l,j} TIW_{l,j}$
32. $TIKT = \sum_{k,j} TIK_{k,j}$
33. $TIPT = \sum_{j} TIP_{j}$
34. $TPRCTS = TICT + TIMT + TIXT$
35. $TICT = \sum_{i} TIC_{i}$
36. $TIMT = \sum_{i} TIM_{i}$
37. $TIXT = \sum_{i} TIX_{i}$
38. $YGTR = \sum_{agng} TR_{gvt,agng}$
39. $TDH_{h} = PIXCON^{n} ttdh0_{h} + ttdh1_{h} YH_{h}$
40. $TDF_{f} = PIXCON^{n} ttdf0_{h} + ttdh1_{f} YFK_{f}$
41. $TIW_{l,j} = ttiw_{l,j} W_{l} LD_{l,j}$
42. $TIK_{k,j} = ttik_{k,j} R_{k,j} kD_{k,j}$
43. $TIP_{j} = ttip_{j} PP_{j} XST_{j}$
44. $TIC_{i} = ttic_{i} \left[\left(PL_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i} \right) DD_{i} \left((1 + ttim_{i}) PWM_{i} e + \sum_{ij} PC_{ij} tmrg_{ij,i} \right) IM_{i} \right]$
45. $TIM_{i} = ttim_{i} PWM_{i}\ e\ IM_{i}$
46. $TIX_{i} = ttix_{i}\ \left(PE_{i} + \sum_{ij} PC_{ij} tmrg_{ij,i}^{x} \right)\ EXD_{i}$
47. $SG = YG - \sum_{agng} TR_{agng,gvt} - G$

S1.2.4 Rest of the world

48. $YROW = e \sum_{i} PWM_{i} IM_{i} + \lambda_{row}^{RK}\ \left(\sum_{j} R_{j} KD_{j} \right) + \sum_{agd} TR_{row,agd}$
49. $SROW = YROW - \sum_{i} PE_{i}^{FOB} EX_{i} - \sum_{agd} TR_{agd,row}$
50. $SROW = -CAB$

S1.2.5 Transfers

51. $TR_{agng,\prime h} = \lambda_{agng,h\prime}^{TR} YDH_{h}$
52. $TR_{gvt,h} = PIXCON^{n} tr0_{h} tr1_{h} YH_{h}$
53. $TR_{ag,f} = \lambda_{ag,f}^{TR}\ YDF_{f}$
54. $TR_{agng,gvt} = PIXCON^{n} TR_{agng,gvt}^{0}$
55. $TR_{agd,row} = PIXCON^{n} TR_{agd,row}^{0}$

S1.3 Demand

56. $PC_{i}\ C_{i,h} = PC_{i} C_{i,h}^{MIN} + \gamma_{i,h}^{LES} \left(CTH_{h} - \sum_{ij} PC_{ij} C_{ij,h}^{MIN} \right)$
57. $GFCF = IT - \sum_{i} PC_{i} VSTK_{i}$
58. $PC_{i} INV_{i} = \gamma_{i}^{INV} GFCF$
59. $PC_{i} CG_{i} = \gamma_{i}^{GVT} G$
60. $DIT_{i} = \sum_{j} DI_{i,j}$
61. $MRGN_{i} = \sum_{ij} tmrg_{i,ij} DD_{ij} + \sum_{ij} tmrg_{i,ij} IM_{ij} + \sum_{ij} tmrg_{i,ij}^{x} EXD_{ij}$

S1.4 Producer supplies of products and international trade

62. $XST_{j} = B_{j}^{XT} \left[\sum_{i} \beta_{j,i}^{XT} XS_{j,i}^{\rho_{j}^{XT}} \right]^{\frac{1}{\rho_{j}^{XT}}}$
63. $XS_{j,i} = \frac{XST_{j}}{\left(B_{j}^{XT} \right)^{1+\sigma_{j}^{XT}}} \left[\frac{P_{j,i}}{\beta_{j,i}^{XT}\ PT_{j}} \right]^{\sigma_{j}^{XT}}$
64. $XS_{j,i} = B_{j,i}^{X} \left[\beta_{j,i}^{X} EX_{j,i}^{\rho_{j,i}^{X}} + \left(1 - \beta_{j,i}^{X} \right)\ DS_{j,i}^{\rho_{j}^{X}} \right]^{\frac{1}{\rho_{j}^{X}}}$
65. $EX_{j,i} = \left[\frac{1-\beta_{j,i}^{X}}{\beta_{j,i}^{X}} \frac{PE_{i}}{PL_{i}} \right]^{\sigma_{j,i}^{X}}\ DS_{j,i}$
66. $EXD_{i} = EXD_{i}^{O} \left(\frac{e\ PWX_{i}}{PE_{i}^{FOB}} \right)^{\sigma_{i}^{XD}}$
67. $Q_{i} = B_{i}^{M} \left[\beta_{i}^{M} IM_{i}^{-\rho_{i}^{M}} + (1 - \beta_{i}^{M})\ DD_{i}^{-\rho_{i}^{M}} \right]^{\frac{-1}{\rho_{i}^{M}}}$

68. $IM_i = \left[\frac{\beta_i^M}{1-\beta_i^M}\frac{PD_i}{PM_i}\right]^{\sigma_i^M} DD_i$

S1.5 Prices

S1.5.1 Production

69. $PP_j XST_j = PVA_j VA_j + PCI_j CI_j$
70. $PT_j = \left(1 + ttip_j\right) PP_j$
71. $PCI_j CI_j = \sum_i PC_i DI_{i,j}$
72. $PVA_j VA_j = WC_j LDC_j + RC_j KDC_j$
73. $WC_j = \frac{LQ_j WQ_j + LNQ_j WNQ_j}{LDC_j}$
74. $WTI_j = W_l\left(1 + ttiw_{l,j}\right)$
75. $RTI_j = R_{k,j}\left(1 + ttik_{k,j}\right)$
76. $R_{k,j} = Rk_k$

S1.5.2 International trade

77. $P_{j,i} = \frac{PE_i EX_{j,i} + PL_i DS_{j,i}}{XS_{j,i}}$
78. $PE_i^{FOB} = \left(PE_i + \sum_{ij} PC_{ij} tmrg_{ij,i}^x\right)(1 + ttix_i)$
79. $PD_i = \left(1 + ttic_{i,}\right)\left(PL_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$
80. $PM_i = (1 + ttic_i)\left((1 + ttim_i)\ e\ PWM_i + \sum_{ij} PC_{ij} tmrg_{ij,i}\right)$
81. $PC_i = \frac{PM_i IM_i + PD_i DD_i}{Q_i}$

S1.5.3 Price indexes

82. $PIXGDP = \sqrt{\frac{\sum_j\left(PVA_j + \frac{TIP_j}{VA_j}\right) VA_j^O AO_j}{\sum_j\left(PVA_j^O\ VA_j^O + TIP_j^O\right)} \frac{\sum_j\left(PVA_j VA_j + TIP_j\right)}{\sum_j\left(PVA_j^O + \frac{TIP_j^O}{VA_j^O}\right) VA_j}}$
83. $PIXCON = \frac{\sum_i PC_i \sum_h C_{i,h}^O}{\sum_i PC_{i,h}^O \sum_h C_{ij,h}^O}$
84. $PIXINV = \prod_i \left(\frac{PC_{i,}}{PC_i^O}\right)^{\gamma_i^{INV}}$
85. $PIXGVT = \prod_i \left(\frac{PC_i}{PC_i^O}\right)^{\gamma_i^{GVT}}$

S1.6 Equilibrium

86. $Q_i = \sum_h C_{i,h} + CG_i + INV_i + VSTK_i + DIT_i + MRGN_i$
87. $LS_l = \left(\sum_j LD_{l,j}\right)/(1/un_l)$
88. $\sum_j KD_{k,j} = KS_j$
89. $IT = \sum_h SH_h + \sum_f SF_f + SG + SROW$
90. $\sum_j DS_{j,i} = DD_i$
91. $\sum_j EX_{j,i} = EXD_i$

S1.7 Gross domestic product

92. $GDP^{BP} = \sum_j PVA_j VA_j + TIPT$
93. $GDP^{MP} = GDP^{BP} + TPRCTS$
94. $GDP^{IB} = \sum_j W_l LD_{l,j} + \sum_{k,j} R_{k,j} KD_{k,j} + TPRODN + TPRCTS$
95. $GDP^{FD} = \sum_i PC_i [C_i + CG_i + INV_i] + \sum_i PE_i^{FOB} EXD_i - e \sum_i PWM_i IM_i$

S1.8 Volume variables computed from price indeces

96. $CTH_h^{REAL} = \frac{CTH_h}{PIXCON}$
97. $G^{REAL} = \frac{G}{PIXGVT}$
98. $GDP^{BP\_REAL} = \frac{GDP^{BP}}{PIXGDP}$
99. $GDP^{MP\_REAL} = \frac{GDP^{MP}}{PIXCON}$
100. $GFCF^{REAL} = \frac{GFCF}{PIXINV}$

S1.9 Wage curve

101. $\frac{W_l}{PIXCON} = A_l^{WC} un_l{}^{\sigma^{WC}}$

S2. Sets

S2.1 Industries and Commodities

All industries:

$i, ij \in J =$ { aagcu, aminp, amanu, aelwa, acons, atrco, ahotl, afibu, aadmi, apriv}

aagcu: Agriculture

aminp: Mining

amanu: Manufacturing

aelwa: Water and electricity

acons: Construction

atrco: Transport and communication

ahotl: Hotel and restaurants

afibu: Financial business

aadmi: Administration

a apriv: Other private services

All commodities:

$i, ij \in I =$ { c_agri, c_laniforefish, c_vegefrui, c_meat, c_pfis, c_fats, c_dair, c_grai, c_star, c_bake, c_suga, c_past, c_petr, c_fert, cminp, cmanu, celwa, ccons, chotl, cfibu, cadmi, cpriv}

c_agri:	Cereals
c_laniforefish,:	Live animals, forestry, fishing
c_vegefrui:	Vegetables and fruits
c_meat:	Meat
c_pfis:	Fish
c_fats:	Oils and fats
c_dair:	Dairy products
c_grain:	Grain mil products
c_star:	Starches products
c_bake:	Bakery products
c_suga:	Sugar
c_past:	Pasta products
c_petr:	Petroleum products

c_fert: Fertilizers

c_minp: Other chemicals

c_manu: Other manufacturing

c_elwa: Electricity and water distribution

c_cons: Construction

c_trco: Transport and communication services

c_hotl: Hotel and restaurant

c_fibu: Financial and business services

c_admi: cadmi

c_priv: Other private services

S2.2 Production factors

Labour categories: $l \in L = \{flap_{MALE}, flap_{FEMA}, flas_{MALE}, flas_{FEMA}\}$

Capital categories: $k \in K = \{CAP\}$

Note: FLAP_MALE = unskilled workers male, FLAS_MALE = skilled workers male, FLAP_FEMA = unskilled workers female, FLAS_FEMA = skilled workers female, CAP = capital

S2.3 Agents

All agents: $ag, agj \in AG = H \cup \{F, GVT, ROW\} = \{H_1, \ldots, H_h, F, GVT, ROW\}$

Households categories:
$h, hj \in H \subset AG = \{hhd0, hhd1, hhd2, hhd3, hhd4, hhd5, hhd6, hhd7, hhd8, hhd9\}$

Non-governmental agent: $agng \in AGNG \subset AG = H \cup \{F, ROW\} = \{\{H_1, \ldots, H_h, F, ROW\}\}$

Domestic agents: $agd \in AGD \subset AG = H \cup \{F, GVT\} = \{\{H_1, \ldots, H_h, F, GVT\}\}$

Note: firm = firms, gvt = government, row = rest of the world, hhd0 = HH belonging to the first decile of income, hhd1 = HH belonging to the second decile of income, hhd2=HH belonging to the third decile of income, hhd3 = HH belonging to the fourth decile of income, hhd4 = HH belonging to the fifth decile of income, hhd5 = HH belonging to the sixth decile of income, hhd6 = HH belonging to the seventh decile of income, hhd7 = HH belonging to the eighth decile of income, hhd0 = HH belonging to the first decile of income, hhd1 = HH belonging to the second decile of income

S3. Variables

S3.1 Volume variables

$C_{i,h}$: Consumption of commodity i by type h households
$C_{i,h}^{MIN}$: Minimum consumption of commodity i by type h households
CG_i: Public consumption of commodity i
CI_j: Total intermediate consumption of industry j
CTH_h^{REAL}: Real consumption expenditures of household h
DD_i: Domestic demand for commodity i produced locally
$DI_{i,j}$: Intermediate consumption of commodity i by industry j
DIT_i: Total intermediate demand for commodity i
$DS_{j,i}$: Supply of commodity i by sector j to the domestic market

$EX_{j,i}$: Quantity of product i exported by sector j
EXD_i: World demand for exports of product i
G^{REAL}: Real government expenditures
$GDP^{BP,REAL}$: Real GDP at basic prices
$GDP^{MP,REAL}$: Real GDP at market prices
$GFCF^{REAL}$: Real gross fixed capital formation
IM_i: Quantity of product i imported
INV_i: Final demand of commodity i for investment purposes (GFCF)
$KD_{k,j}$: Demand for type k capital by industry j
KDC_j: Industry j demand for composite capital
KS_k: Supply of type k capital
$LD_{l,j}$: Demand for type l labour by industry j
LQ_j: Industry j demand for skilled labour
LNQ_j: Industry j demand for unskilled labour
LDC_j: Industry j demand for composite labour
LS_l: Supply of type l labour
$MRGN_i$: Demand for commodity i as a trade or transport margin
Q_i: Quantity demanded of composite commodity i
VA_j: Value added of industry j
$VSTK_i$: Inventory change of commodity i
$XS_{j,i}$: Industry j production of commodity i
XST_j: Total aggregate output of industry j

S3.2 Price variables

e: Exchange rate (price of foreign currency in local currency)
$P_{j,i}$: Basic price of industry j's production of commodity i
PC_i: Purchaser price of composite commodity i (including all taxes and margins)
PCI_j: Intermediate consumption price index of industry j
PD_i: Price of local product i sold on the domestic market (including all taxes and margins)
PE_i: Price received for exported commodity i (excluding export taxes)
PE_i^{FOB}: FOB price of exported commodity i (in local currency)
$PIXCON$: Consumer price index
$PIXGDP$: GDP deflator
$PIXGVT$: Public expenditures price index
$PIXINV$: Investment price index
PL_i: Price of local product i (excluding all taxes on products)
PM_i: Price of imported product i (including all taxes and tariffs)
PP_j: Industry j unit cost including taxes directly related to the use of capital and labour but excluding other taxes on production
PT_j: Basic price of industry j's output
PVA_j: Price of industry j value added (including taxes on production directly related to the use of capital and labour)
PWM_i: World price of imported product i (expressed in foreign currency)
PWX_i: World price of exported product i (expressed in foreign currency)
$R_{k,j}$: Rental rate of type k capital in industry j
RC_j: Rental rate of industry j composite capital
RK_k: Rental rate of type k capital (if capital is mobile)
$RTI_{k,j}$: Rental rate paid by industry j for type k capital including capital taxes
W_l: Wage rate of type l labour
WQ_j: Wage rate of industry j skilled labour
WNQ_j: Wage rate of industry j unskilled labour
WC_j: Wage rate of industry j composite labour
$WTI_{l,j}$: Wage rate paid by industry j for type l labour including payroll taxes

S3.3 Nominal (value) variables

CAB: Current account balance
CTH_h: Consumption budget of type h households
G: Current government expenditures on goods and services

GDP^{BP}: GDP at basic prices
GDP^{FD}: GDP at purchasers' prices from the perspective of final demand
GDP^{IB}: GDP at market prices (income-based)
GDP^{MP}: GDP at market prices
$GFCF$: Gross fixed capital formation
IT: Total investment expenditures
SF: Savings of type f businesses
SG: Government savings
SH_h: Savings of type h households
$SROW$: Rest-of-the-world savings
TDF_f: Income taxes of type f businesses
$TDFT$: Total government revenue from business income taxes
TDH_h: Income taxes of type h households
$TDHT$: Total government revenue from household income taxes
TIC_i: Government revenue from indirect taxes on product i
$TICT$: Total government receipts of indirect taxes on commodities
$TIK_{k,j}$: Government revenue from taxes on type k capital used by industry j
$TIKT$: Total government revenue from taxes on capital
TIM_i: Government revenue from import duties on product i
$TIMT$: Total government revenue from import duties
TIP_j: Government revenue from taxes on industry j production (excluding taxes directly related to the use of capital and labour)
$TIPT$: Total government revenue from production taxes (excluding taxes directly related to the use of capital and labour)
$TIW_{l,j}$: Government revenue from payroll taxes on type l labour in industry j
$TIWT$: Total government revenue from payroll taxes
TIX_i: Government revenue from export taxes on product i
$TIXT$: Total government revenue from export taxes
$TPRCTS$: Total government revenue from taxes on products and imports
$TPRODN$: Total government revenue from other taxes on production
$TR_{ag,agj}$: Transfers from agent agj to agent ag
YDF_f: Disposable income of type f businesses
YDH_h: Disposable income of type h households
YF_f: Total income of type f businesses
YFK_f: Capital income of type f businesses
$YFTR_f$: Transfer income of type f businesses
YG: Total government income
YGK: Government capital income
$YGTR$: Government transfer income
YH_h: Total income of type h households
YHK_h: Capital income of type h households
YHL_h: Labour income of type h households
$YHTR_h$: Transfer income of type h households
$YROW$: Rest-of-the-world income

S3.4 Rates and intercepts

$sh0_h$: Intercept (type h household savings)
$sh1_h$: Slope (type h household savings)
$tr0_h$: Intercept (transfers by type h households to government)
$tr1_h$: Marginal rate of transfers by type h households to government
$ttdf0$: Intercept (income taxes of type f businesses)
$ttdf1$: Marginal income tax rate of type f businesses
$ttdh0_h$: Intercept (income taxes of type h households)
$ttdh1_h$: Marginal income tax rate of type h households
$ttic_i$: Tax rate on commodity i
$ttik_{k,j}$: Tax rate on type k capital used in industry j
$ttim_i$: Rate of taxes and duties on imports of commodity i
$ttip_j$: Tax rate on the production of industry j

$ttiw_{l,j}$: Tax rate on type l worker compensation in industry j
$ttix_i$: Export tax rate on exported commodity i
un_l: Unemployment rate by type of labor l

S4. Parameters

$aij_{i,j}$: Input-output coefficient
B_j^{KD}: Scale parameter (CES - composite capital)
B_j^{LD}: Scale parameter (CES - composite labour)
β_i^M: Scale parameter (CES - composite commodity)
B_j^{VA}: Scale parameter (CES - value added)
$B_{j,i}^X$: Scale parameter (CET - exports and local sales)
B_j^{XT}: Scale parameter (CET - total output)
$\beta_{k,j}^{KD}$: Share parameter (CES - composite capital)
β_i^M: Share parameter (CES - composite commodity)
β_j^{VA}: Share parameter (CES - value added)
$\beta_{j,i}^X$: Share parameter (CET - exports and local sales)
η: Price elasticity of indexed transfers and parameters
$frish_h$: Frisch parameter (LES function)
γ_i^{GVT}: Share of commodity i in total current public expenditures on goods and services
γ_i^{INV}: Share of commodity i in total investment expenditures
$\gamma_{i,h}^{LES}$: Marginal share of commodity i in household h consumption budget
io_j: Coefficient (Leontief - intermediate consumption)
K^{MOB}: Flag parameter (1 if capital is mobile)
$\lambda_{ag,k}^{RK}$: Share of type k capital income received by agent ag
$\lambda_{ag,agj}^{TR}$: Share parameter (transfer functions)
$\lambda_{h,l}^{WL}$: Share of type l labour income received by type h households
ρ_j^{KD}: Elasticity parameter (CES - composite capital)
ρ_i^M: Elasticity parameter (CES - composite commodity)
ρ_j^{VA}: Elasticity parameter (CES - value added)
$\rho_{j,i}^X$: Elasticity parameter (CET - exports and local sales)
ρ_j^{XT}: Elasticity parameter (CET - total output)
σ_j^{KD}: Elasticity (CES - composite capital)
σ_i^M: Elasticity (CES - composite commodity)
σ_j^{VA}: Elasticity (CES - value added)
$\sigma_{j,i}^X$: Elasticity (CET - exports and local sales)
σ_j^{XT}: Elasticity (CET - total output)
σ_i^{XD}: Price elasticity of the world demand for exports of product i
$\sigma_{i,h}^Y$: Income elasticity of consumption
$tmrg_{i,ij}$: Rate of margin i applied to commodity ij
$tmrg_{i,ij}^X$: Rate of margin i applied to exported commodity i
v_j: Coefficient (Leontief - value added)
β_j^{LD}: Share parameter (CES - composite labour)
ρ_j^{LD}: Elasticity parameter (CES - composite labour)
σ_j^{LD}: Elasticity (CES - composite labour)
B_j^{LQ}: Scale parameter (CES - Skilled labour)
$\beta_{sk,j}^{LQ}$: Share parameter (CES - Skilled labour)
ρ_j^{LQ}: Elasticity parameter (CES - Skilled labour)
σ_j^{LQ}: Elasticity (CES - - Skilled labour)
B_j^{LNQ}: Scale parameter (CES - unskilled labour)
$\beta_{usk,j}^{LNQ}$: Share parameter (CES - unskilled labour)
ρ_j^{LNQ}: Elasticity parameter (CES - unskilled labour)
σ_j^{LNQ}: Elasticity (CES - unskilled labour)

Appendix C: Tables from the Social Accounting Matrix

Table C1: Trade relations for South Africa:

Commodities	Import penetration rate	Share of import/total import	Share of export/total export
c_agri	9,94	1,26	2,00
c_laniforefish	3,49	0,20	0,52
c_vegefrui	11,44	0,33	0,68
c_meat	13,65	0,70	0,38
c_pfis	19,40	0,35	0,50
c_fats	59,57	0,95	0,36
c_dair	7,60	0,21	0,37
c_grai	14,65	0,39	0,26
c_star	8,93	0,12	0,17
c_bake	3,66	0,20	0,32
c_suga	12,39	0,28	0,25
c_past	28,40	0,03	0,10
c_petr	29,55	5,05	3,22
c_fert	41,50	1,05	0,61
cminp	22,08	11,41	32,29
cmanu	33,27	49,71	38,47
celwa	0,47	0,04	0,37
ccons	1,11	0,32	0,11
ctrco	11,53	18,16	10,26
chotl	25,61	1,03	1,01
cfibu	4,08	6,14	5,63
cadmi	0,90	0,83	0,90
cpriv	8,06	1,23	1,22

Source: Social Accounting Matrix

Note: c_agri:Cereals; c_laniforefish,: Live animals, forestry, fishing; c_vegefrui: Vegetables and fruits

c_meat: Meat; c_pfis: Fish; c_fats: Oils and fats; c_dair: Dairy products; c_grain: Grain mil products

c_star: Starches products; c_bake: Bakery products; c_suga: Sugar; c_past: Pasta products

c_petr: Petroleum products; c_fert: Fertilizers; c_minp: Other chemicals; c_manu: Other manufacturing

c_elwa: Electricity and water distribution; c_cons: Construction; c_trco: Transport and communication services

c_hotl: Hotel and restaurant; c_fibu: Financial and business services ; c_admi: public sectors; c_priv: Other private services

Table C2: Share of transfers paid to households (in %)

Income deciles	Firm	Government	Rest of the World	Total
hhd0	2,12	97,80	0,08	100,00
hhd1	3,60	96,26	0,14	100,00
hhd2	7,05	92,68	0,27	100,00
hhd3	10,46	89,15	0,39	100,00
hhd4	14,36	85,10	0,54	100,00
hhd5	20,98	78,23	0,79	100,00
hhd6	39,36	59,16	1,48	100,00
hhd7	59,10	38,68	2,22	100,00
hhd8	82,06	14,86	3,08	100,00
hhd9	94,00	2,47	3,53	100,00

Source: Social Accounting Matrix
Note: hhd0 = HH belonging to the first decile of income, hhd1 = HH belonging to the second decile of income, hhd2=HH belonging to the third decile of income, hhd3 = HH belonging to the fourth decile of income, hhd4 = HH belonging to the fiftf decile of income, hhd5 = HH belonging to the sixth decile of income, hhd6 = HH belonging to the seventh decile of income, hhd7 = HH belonging to the eighth decile of income, hhd8 = HH belonging to the ninth decile of income, hhd9 = HH belonging to the tenth decile of income.

Table C3: Wage bill intensity per sector of activity (in %)

	aagcu	aminp	amanu	aelwa	acons	atrco	ahotl	afibu	aadmi	apriv
flap_MALE	32,20	17,38	10,92	6,71	22,67	17,04	8,46	1,16	3,69	2,44
flap_FEMA	11,77	2,65	5,85	0,87	3,01	0,06	8,49	0,46	3,04	66,32
flas_MALE	41,19	64,60	57,23	72,48	64,82	70,21	42,71	53,56	41,09	0,77
flas_FEMA	14,83	15,37	26,00	19,94	9,50	12,69	40,34	44,82	52,19	30,48
Total	100,00	100	100	100	100	100	100	100	100	100

Source: Social Accounting Matrix. Note: aagcu:Agriculture; aminp: Mining; amanu:Manufacturing; aelwa: Water and electricity; acons: Construction; atrco: Transport and communication; ahotl: Hotel and restaurants; afibu: Financial business; aadmi: Administration; a apriv: Other private services ; FLAP_MALE = unskilled workers male, FLAS_MALE = skilled workers male, FLAP_FEMA = unskilled workers female, FLAS_FEMA = skilled workers female

Annex D: Sensitivity analysis results for the CGE model

We carried out sensitivity tests on two specific elasticity values. The first is the elasticity of substitution between the work of men and women in the production function. We evaluated values ranging from 0.3 to 0.8 and present the results for the two tables relating to macroeconomic results (tables 1 and 2 of the text). The second set of sensitivity analysis concerns the Armington elasticities for which we increased them by 10% then decreased by 10%. For each of the scenarios, once the simulations were done at the macro level, the estimates were made at the micro level.

D1: Impacts on macro variables (in % change):

	sigma=0,3	sigma=0,8	trade -10%	trade +10%
Total labour demand	-0,47	-0,48	-0,47	-0,46
Real GDP	-0,25	-0,26	-0,25	-0,25
CPI	1,31	1,32	1,31	1,39
Total investment budget	0,77	0,79	0,80	0,98

D2: Impacts on households' consumption (in % change)

	sigma=0,3	sigma=0,8	trade -10%	trade +10%
hhd0	-0,19	-0,24	-0,23	-0,21
hhd1	-0,26	-0,30	-0,29	-0,28
hhd2	-0,32	-0,36	-0,35	-0,33
hhd3	-0,40	-0,43	-0,42	-0,41
hhd4	-0,49	-0,52	-0,51	-0,49
hhd5	-0,61	-0,65	-0,63	-0,61
hhd6	-0,76	-0,78	-0,77	-0,75
hhd7	-0,84	-0,85	-0,84	-0,82
hhd8	-0,94	-0,93	-0,92	-0,91
hhd9	-0,95	-0,94	-0,93	-0,92