SA-TIED

Southern Africa – Towards Inclusive Economic Development

Youth unemployment hysteresis in South Africa

Macro-micro analysis

Asiya Maskaeva and Mgeni Msafiri

SA-TIED Working Paper #159 | January 2021

UNITED NATIONS UNIVERSITY UNU-WIDER

national treasury Department: National Treasury REPUBLIC OF SOUTH AFRICA

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE IFPRI

planning, monitoring & evaluation Department: Planning, Monitoring and Evaluation REPUBLIC OF SOUTH AFRICA

the dtic Department: Trade, Industry and Competition REPUBLIC OF SOUTH AFRICA

SARS

TIPS

About the project

Southern Africa –Towards Inclusive Economic Development (SA-TIED)

SA-TIED is a unique collaboration between local and international research institutes and the government of South Africa. Its primary goal is to improve the interface between research and policy by producing cutting-edge research for inclusive growth and economic transformation in the southern African region. It is hoped that the SA-TIED programme will lead to greater institutional and individual capacities, improve database management and data analysis, and provide research outputs that assist in the formulation of evidence-based economic policy.

The collaboration is between the United Nations University World Institute for Development Economics Research (UNU-WIDER), the National Treasury of South Africa, the International Food Policy Research Institute (IFPRI), the Department of Monitoring, Planning, and Evaluation, the Department of Trade and Industry, South African Revenue Services, Trade and Industrial Policy Strategies, and other universities and institutes. It is funded by the National Treasury of South Africa, the Department of Trade and Industry of South Africa, the Delegation of the European Union to South Africa, IFPRI, and UNU-WIDER through the Institute's contributions from Finland, Sweden, and the United Kingdom to its research programme.

Corresponding author: asiyamask@hotmail.com

UNITED NATIONS
UNIVERSITY
UNU-WIDER

WIDER Working Paper 2021/20

Youth unemployment hysteresis in South Africa

Macro-micro analysis

Asiya Maskaeva and Mgeni Msafiri*

January 2021

Abstract: This study simulates the macro-micro economic impacts of the employment policy, focusing on hysteresis in youth unemployment in South Africa. Specifically, we apply a dynamic computable general equilibrium model to calibrate the 2015 South African Social Accounting Matrix to estimate, compare, and determine the impact of employment policy on youth unemployment as well as on aggregate economic outcomes. We simulate two scenarios where we reduce the import price of fuel by 20 per cent. Then, the total government savings from the reduced transport subsidy are reallocated to the education sector to support the unemployed youth. The research findings indicate that demand for youth labour increases in the long run, resulting in a decline in the unemployment rate. Moreover, the consumer price index decreased more than nominal income, thereby increasing household purchasing power and, potentially, easing poverty.

Key words: computable general equilibrium model, hysteresis, youth unemployment, employment policy, South Africa

JEL classification: C68, E30, J64, J68, O55

Acknowledgements: This study was facilitated by UNU-WIDER whose support is duly appreciated. The authors graciously thank Laurence Harris and Rob Davies for their comments and guidance. The authors also thank Andre Lemelin for his suggestions in CGE modelling. All errors are our own.

---

* University of Dodoma, Dodoma, Tanzania; corresponding author: asiyamask@hotmail.com

This study has been prepared within the UNU-WIDER project Southern Africa—Towards Inclusive Economic Development (SA-TIED).

Information and requests: publications@wider.unu.edu

ISSN 1798-7237 ISBN 978-92-9256-954-9

https://doi.org/10.35188/UNU-WIDER/2021/954-9

Typescript prepared by Mary Lukkonen.

1 Introduction

Africa has the fastest-growing youth population in the world. The number of young people aged 15–34 years is projected to double to 400 million by 2045 (UN 2015). According to the World Bank, youth under the age of 25 represent 62 per cent of Sub-Saharan Africa's unemployed population (Filmer et al. 2014).

South Africa is among the countries with the worst youth unemployment rates in the world. In 2018, 52.9 per cent of the youth were unemployed, up from 41.8 per cent recorded in 2014 (StatsSA 2019a). The most vulnerable youth are those aged 15–24 years with an unemployment rate of about 55.2 per cent, which was recorded in the first quarter of 2019 (StatsSA 2019b). However, the unemployment rate among graduated youth is lower compared to those with low education levels. This implies that education is still a matter of concern for growing youth unemployment rates in South Africa (Bhorat et al. 2016). The low absorption rate of youth (a measure of the proportion of working-age adults that are employed) in the labour market is among the other reasons for high youth unemployment in South Africa.

Age is cited as an important labour market segmentation factor in South Africa (Lam et al. 2008; Mlatsheni 2007). Youth are more uncertain about their abilities, lack of financial resources for job searching, and lack social capital or strong networks that hinder their employability (Lam et al. 2008). On the other side, for those who are able to find jobs, they tend to have higher reservation wages, making them less attractive to employers compared to their adult counterparts (Mlatsheni 2007; Bhorat et al. 2016). This is because these youth are poorly skilled and lack experience.

The South African government has implemented several programmes in the labour market focusing on both demand-side [e.g., Expanded Public Works Programme (EPWP), National Treasury's Jobs Fund, and the youth wage subsidies] and supply-side interventions (e.g., initiatives promoting and enhancing the employability of the unemployed). For instance, in the early 2000s, the government of South Africa introduced a sectoral minimum wage policy with the aim of enforcing reasonable wage rates in the sectors where workers were believed to be vulnerable or where collective bargaining was difficult to implement. However, until 2007, studies estimated that about 45 per cent of workers were paid less than the set minimum wage (Isaacs 2016). Thus, in January 2019 the national minimum wage bill of ZAR20 per hour for all employees was passed in South Africa (South African Government 2020). This policy intervention is expected to reduce the wage gap and thereby improve the living standards of the people.

High unemployment rates in South Africa date back to the 1970s when unemployment rose sharply and continued rising through the 1980s and 1990s (Standing et al. 1996). The increase continued after the democratic elections of 1994, attributed to the after-effects of the former Apartheid regime and the financial crisis of 2008 (Banerjee et al. 2008; Pikoko and Phiri 2018). The natural economic forces and government efforts have not been able to reverse the situation and therefore pose a significant concern regarding the persistent nature of unemployment, known as unemployment hysteresis in South Africa.

The experience of developed countries (O'Shaughnessy 2011) shows that countries with a high rate of unemployment are facing steep social-economic costs that may be long-lasting and with difficult recovery from their economic recession. Hysteresis in unemployment plays a leading role when the unemployment rate continues to grow even after the economy has recovered.

In the labour economics literature, the notion of hysteresis became popular through a paper by Blanchard and Summers (1986a). They used this term to describe very high persistence in unemployment. There are some empirical works that test different unemployment data for the hysteresis hypothesis in the majority of the countries (Khim-Sen et al. 2012; León-Ledesma and McAdam 2004; Meng et al. 2017) including South Africa (Pikoko and Phiri 2018; Olanipekun et al. 2017). Much of the literature on unemployment is oriented to the assessment of the actual wage system in South Africa and the challenges encountered in the national labour market. Over the last decade, computable general equilibrium (CGE) models have increasingly been used to evaluate economic reforms with a focus on the labour market in South Africa (Pauw and Edwards 2005; Kinyondo and Mabugu 2009; Chitiga et al. 2010; Erero 2016; Mbanda and Chitiga-Mabugu 2017).

We follow this practice in our analysis of the hysteresis in youth unemployment for the labour market in South Africa.

We propose to use a CGE model and the minimum wage policy to explain youth unemployment hysteresis in South Africa. Since the introduction of the sectoral minimum wage policy in 1999, youth unemployment has steadily increased (Bhorat et al. 2013, 2016), hence supporting our choice of the minimum wage policy to model the unemployment hysteresis. This study builds on previous studies (Caporale and Gil-Alana 2018; Nsenga et al. 2019; Olanipekun et al. 2017; Pikoko and Phiri 2018) done in South Africa, which confirmed the hysteresis hypothesis. Therefore, given the presence of unemployment hysteresis in South Africa, we propose and analyse the impacts of different policy scenarios that may be used to reduce youth unemployment.

This study differs from other studies focusing on unemployment hysteresis because it focuses particularly on youth unemployment rather than overall unemployment. Moreover, this study employs a CGE approach in which the wage determination process is modelled by the minimum wage policy rather than a traditional unit root test approach.

The study considers the following research questions:

- What will be the economy-wide effects of a reduction in world oil price?
- What is the impact on youth employment and the overall economy when savings from transport subsidies are reallocated to the education sector?
- What is the income distribution effect of simulated policy options?
- Do other policies exist that can decrease the number of unemployed youth?

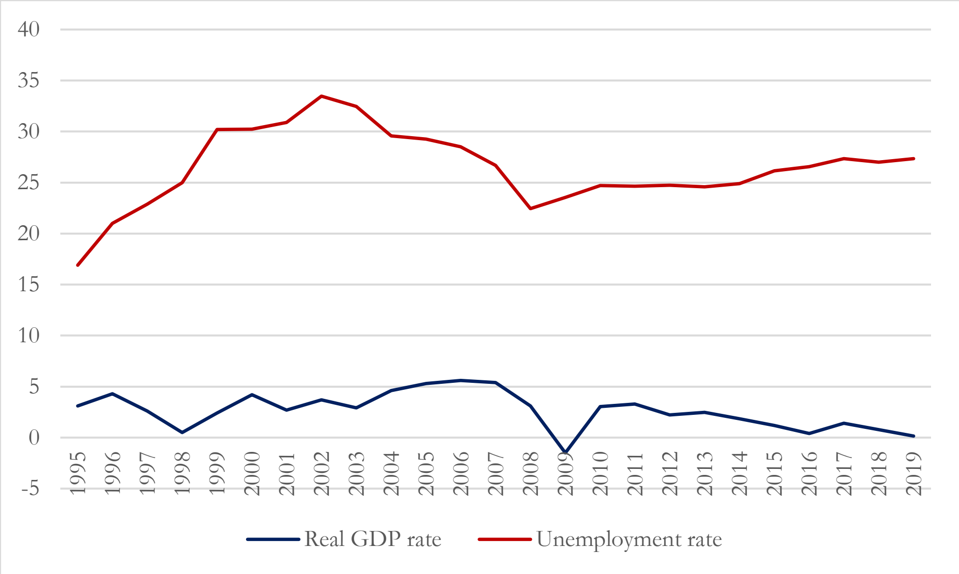
A recursive dynamic CGE model with elaborate labour market disaggregation and alternative funding options for youth unemployment scale-down is used. The rest of the paper is structured as follows. Section 2 presents empirical evidence of youth unemployment in South Africa. Section 3 reviews the literature to situate the study, followed by a presentation of the model and data in Section 4. Section 5 presents the simulations and implications of introducing the alternative policy options in such a framework. We close the paper with concluding remarks and policy recommendations in Section 6.

2 Youth unemployment: empirical evidence for South Africa

The labour market situation in South Africa is characterized by a high rate of unemployment for many years. It is driven by several reasons. For the most part, this situation originated when the

African National Congress came to power after South Africa's first democratic elections in 1994. Unemployment doubled between 1995 and 2003, going from an already high unemployment rate of 16.9 per cent to 32.5 per cent. Since then, it has declined but was still 27.3 per cent in 2019—substantially higher than in 1995 (Figure 1).

Figure 1: South Africa unemployment and real GDP rate fluctuation from 1995 to 2019



Source: authors' illustration based on data from Statista 2020, World Bank Statistics, https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2018&locations=ZA&start=2006

The economic and financial crises of 1997–98, 2008–09, 2016, and 2018–19 are the second reason for the increase in unemployment in South Africa (Banerjee et al. 2008). For example, the economic recession during 2008–09 caused a rapid growth of unemployment. Figure 1 shows that starting in 2008, the unemployment rate rose more than 1 per cent every year, this increase was permanent. Almost one million jobs were lost in 2009 alone, and the unemployment rate continued to remain high at 23.5 per cent (Rena and Msoni 2014). The unemployment rate dramatically increased further after a new recession hit (i.e. in 1999, 2009, and 2017). However, the unemployment rate does not show a clear trend towards granting some constant long-run equilibrium value.

Despite the slump in the average growth rate after the financial and economic crises of 2008–09, which slowed South Africa's growth, the country's growth has since slightly recovered (Figure 1). A noticeable pattern with the South African GDP is the volatility and significant decline that doubled from 2015 to 2019.

However, despite these growth rates, in seven out of 10 industries the output declined, namely transport (-7.2 per cent), trade and accommodation (-3.8 per cent), construction (-5.9 per cent), utilities (-4 per cent), manufacturing (-1.8 per cent), agriculture (-7.6 per cent), and government services (-0.4 per cent). It should be noted that these sectors employ the majority of workers including youth.

Despite a slight economic recovery, South Africa is potentially the most unequal society in the world (Bhorat et al. 2020). The South African economy still shows high poverty and inequality, particularly among the youth, because growth does not result in high employment. High unemployment is a major factor behind the inequality levels. For instance, in 2006, 28.4 per cent of the country was found to be living in extreme poverty. That number had only inched downwards to 25.2 per cent by 2015. The Gini index was only reduced from 0.65 to 0.577 between 2014 and 2018 (Bhorat et al. 2020).

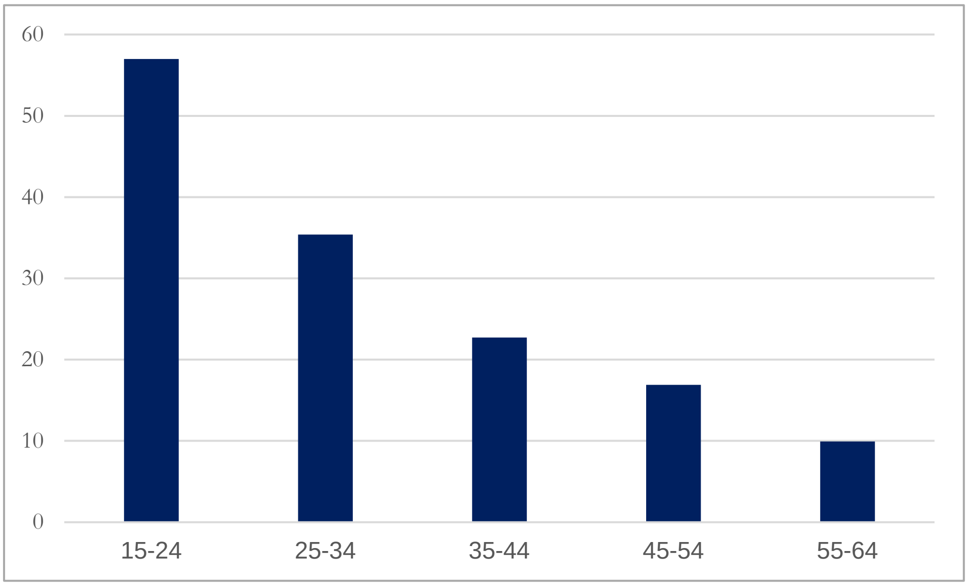
Earnings from labour are the main driver of this inequality in South African society. Despite an increase in average earnings (e.g., an annual increase of 4.5 per cent in 2019), inequality in household labour market income remained stuck at the very high Gini of 0.73 (Bhorat et al. 2020).

Demographic changes are the third reason for the high rate of unemployment in South Africa. The growth in the economically active population does not correlate with the growth in the number of jobs created year-on-year (Pela 2014). According to the Department of Labour's Annual Labour Market Bulletin, the economically active population increased by 18 per cent between 2012 and 2019 (StatsSA 2017; StatsSA 2020).

Along with unequal labor earnings distribution in South Africa's labour market, another challenge is the high rate of youth unemployment. For example, according to the International Labour Organisation (ILO) between 2015 and 2017 Africa's average youth unemployment rate was estimated at 13.3 per cent, which was just above the global rate of 12.5 per cent. In South Africa, the youth unemployment rate was estimated at over 50 per cent (StatsSA 2020). South Africa's youth are trapped in poverty from an early age, with 43.5 per cent of citizens under the age of 17 living in households that earn less than the median income of South African Rand (ZAR) 797 (USD$60) per month.

Unemployment generally disproportionately affects the youth labour force. The result is that the unemployment rate of young people is almost invariably higher than that of adults (Figure 2). The unemployment rate generally decreases with age—the highest rate being 56.9 per cent among those aged 15–24, followed by 35.4 per cent among the 25–34 age group.

Figure 2: Unemployment rate by age group in South Africa, 2019Source: authors' illustration based on data from



StatsSA 2019b.

It is instructive to note that the ratio of youth to the national unemployment rate is more than one in 2018 and 2019. While the national unemployment rate has slightly increased between 2018 and 2019, the youth unemployment rate has increased by 2.3 per cent during that period (Table 1).

Table 1: Ratio of national and youth unemployment rates, 2018–19

Labour force data	2018	2019
Youth unemployment rate (15–34 years), %	43.9	46.2
National unemployment rate (15–64 years), %	27.1	28.7
Ratio of youth to national unemployment rate	1.62	1.61

Source: authors' compilation based on StatsSA 2019b.

The problems with a high level of youth unemployment is extensively researched in South Africa compared to other advanced countries (Lam et al. 2008; Mlatsheni and Rospabé 2002; Mkandawire et al. 2001; Fourie 2011). However, considering the pattern of youth unemployment in the country, its high persistent nature cannot be overlooked. The topic has gained the attention of many authors over the past two decades, going back to the most influential hysteresis paper by Blanchard and Summers (1986b).

The unemployment rates are not uniform among population[1] and age groups. The White youth unemployment rate, at just 1.2 per cent, is nearly eight and a half times lower than that of Black African (Table 2).

It is found that youth unemployment is higher than adult unemployment. Youth unemployment is double adult unemployment, especially for Black African and Coloured population groups.

Table 2: Status of youth (people aged 15–34 years old) on the labour market, by population, gender, and age (youth and adults) groups, 2019, %

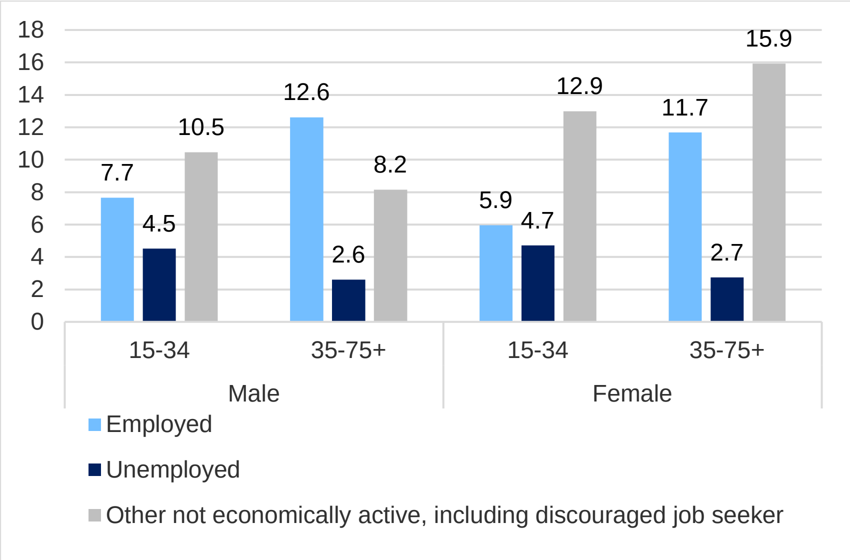
	Black African		Coloured		Indian/Asian		White	
	15–34	35–75+	15–34	35–75+	15–34	35–75+	15–34	35–75+
Employed	13.2	22.7	17.07	25.4	17.3	28.9	11.9	39.5
Unemployed	10.2	5.8	8.11	4.7	2.5	2.9	1.2	1.9
Discouraged job seeker	4.8	3.2	2.23	1.6	0.9	0.8	0.3	0.7
Other, not economically active	20.8	19.3	14.84	26.1	15.1	31.7	9.6	34.8

Source: authors' compilation using data from StatsSA 2019b.

The rates of youth unemployment among women are higher than among men (Figure 3), indicating lower youth labor force participation rates among women. Unemployment is a structural issue in South Africa, with a mismatch between the excess of unskilled workers and a shortage of the skilled workers that firms are looking for.

[1] According to the 1998 Employment Equity Act (South Africa 1998), the population in South Africa is classified into discreet groups, for the purpose of census enumeration: Black African, Coloured, Indian/Asian, and White.

Figure 3: Employment status by sex and age groups, 2019, %



Source: authors' illustration based on data from StatsSA 2019b.

3 Literature review

3.1 Hysteresis in unemployment: theories and empirical practice

For the last 50 years, the issue of unemployment hysteresis has been studied by many economists. The hysteresis in unemployment can be explained in several contemporary theories. The economic situation of many countries in the 70s–80s was characterized by stagflation—a simultaneous high rate of unemployment and high rate of inflation. The phenomenon of hysteresis in unemployment made its first appearance in the labour market of the European countries in the 80s. The rapid growth of unemployment in selected European countries (e.g., Netherlands, German, France, and the United Kingdom) was caused by the international recession of 1979–83 (Graafland 1988).

This seems to contradict the Phillips curve theory that a high rate of unemployment is matched by a lower rate of inflation (Philips 1958). However, Phelps (1967) and Friedman (1968) hypothesized the relationship between real wage inflation and unemployment. Phelps (1994) later explained that sustainable growth of unemployment is the result of persistent shocks in the economy that increase the natural rate of unemployment.

Phelps (1967) and Friedman (1968) defined two groups of factors that have an impact on the natural rate of unemployment. These are labour supply-side factors, such as differences in age, gender, race, and mismatched skills, and demand-side, such as differential job creation, flexibility of the labour market, and changes in technologies.

Therefore, the first theory that explains the phenomenon of hysteresis in unemployment follows from the concept in neoclassical labour economics and macroeconomics as the natural rate of unemployment (NRU) hypothesis.

Subsequently, Blanchard and Summers (1986a) developed an alternative theory known as the hysteresis hypothesis. According to this theory, the equilibrium rate of unemployment (the so-called natural rate of unemployment) depends on the historical fluctuations of the actual unemployment rate. They argue that during prolonged economic recession, hysteresis in unemployment may occur in the labour market. In this case, the real rate of unemployment perhaps never fully returns to its initial natural rate.

The third theory of unemployment encountered in the scientific works is the persistence theory of unemployment and wage rigidity mainly developed by Hall (1975). Empirically, he attributes the relationship between the rigidity of wage and the long-run persistence of the equilibrium unemployment rate caused by the slow information flows in the labour market.

Another view that is used to explain hysteresis in unemployment is based on the theory of wage bargaining discussed by Lindbeck and Snower (1988a, 1988b), Blanchard and Summers (1986b), and Layard and Nickell (1985).

The insider-outsider theory assumes the division of all employees of the company into two groups—insiders (those who already work in the firm) and outsiders (job applicants). This presumes that the monopoly power that insiders have (e.g., because of the expenses already made for professional training and the additional costs of hiring and firing workers) allows them to receive a higher wage. In other words, this market economic condition makes it expensive for companies to employ additional workers from the unemployed persons (i.e. outsiders). Moreover, unions exercise market power in determining better working conditions including higher wages (Neudorfer et al. 1990). As a result, unemployed people appear in the economy who are formed at the expense of outsiders.

Based on the model in which unemployment carries a stigma effect (Hughes and Hutchinson 1998), Graafland and Huizinga (1990) offered another perspective on the relationship between age-related minimum wages and hysteresis in unemployment. The consequence of this theory is that rational employers can screen their new hires, and the unemployment duration would have no effect on labour productivity. However, if wages depend on the age of workers, then hysteresis in unemployment may occur.

Our paper belongs to the latter theory of research and explains the patterns of hysteresis in unemployment in a combination of age-related minimum wage and employment policy. This paper takes a new look at the hysteresis hypotheses and provides new insights to evaluate the youth unemployment problem in South Africa.

3.2 Studies on the South African labour market in the context of CGE modelling and hysteresis

There exists a very wide range of literature related to unemployment, particularly youth unemployment for South Africa. However, the unemployment hysteresis area has not been very well researched, especially in the context of CGE modelling. At least to our knowledge, this is the first paper to address questions regarding youth unemployment hysteresis using CGE modelling.

In the literature, a number of studies exist on unemployment hysteresis in the majority of countries (León-Ledesma and McAdam 2004; Liew et al. 2012; Meng et al. 2017) including South Africa (Caporale and Gil-Alana 2018; Nsenga et al. 2019; Olanipekun et al. 2017; Pikoko and Phiri 2018), most of them using time-series techniques.

Caporale and Gil-Alana (2018) analysed the unemployment behaviour in about 11 African countries including South Africa using a fractional integration approach. The authors suggest that hysteresis models mostly explain the persistent nature of unemployment in these African countries. This is because of the low level of economic and financial development and rigidities in the labour market.

Similarly, a conventional unit root test was applied to quarterly unemployment rate data of eight newly industrialized economies (NIE), including South Africa (Nsenga et al. 2019). The study aimed at determining whether what conforms to unemployment rates in these countries is a natural rate of hypothesis or hysteresis. Except for Thailand and the Philippiness, the authors concluded that the unemployment rate of the other countries studied confirm the hysteresis hypothesis.

Olanipekun et al. (2017) also studied hysteresis in the labour market, applying unit root techniques on data for Nigeria and South Africa. While the results indicated that the hysteresis hypothesis does not hold for Nigeria, it is the opposite case for South Africa. The authors suggested that a positive macroeconomic reform implemented in South Africa is expected to bring negative shock to unemployment, and consequently, the effects will be permanent, thereby confirming the hysteresis hypothesis.

In another study by Pikoko and Phiri (2018), eight categories of unemployment were investigated for hysteresis applying unit root tests to quarterly data of the post-recession period of 2008. Except for unemployment of adult persons aged 55–64 years, other unemployment, including youth unemployment, cofirmed the hysteresis hypothesis in South Africa.

Over the last decades, CGE models have increasingly been used to evaluate economic reforms in South Africa. These research works could be divided into two types of CGE studies.

The first group of studies analyses macroeconomic shocks that indirectly hit the South African labour market but nevertheless have impacts on employment issues. For example, to understand the increasing costs in oil price in the economy, both structural and distributional, McDonald and Van Schoor (2005) and Essama-Nssah et al. (2007) employed a macro-micro CGE model. A similar study by Fofana et al. (2009) found that economy and household welfare are negatively affected by an increase in oil price. On the other hand, to analyse the impact that protection on the textile industry has on poverty, Chitiga and Mabugu (2007) used a dynamic macro-micro CGE model. The results show that the increase in protection of this sector has negative effects on the overall economy with increasing poverty and decreasing household welfare. Henseler and Maisonnave (2018) simulate the reduction in world oil prices and fuel subsidies and two policy options for reallocation of these subsidies to support the transport sector. The research findings show a positive effect on the whole economy, reduction in unemployment, and rise of household income.

The second group of studies focuses on the analysis of economic shocks that directly hit the South African labour market. For example, Chitiga et al. (2010) and Thurlow (2006) analyse how trade liberalization has affected gender inequality in the labour market. Kinyondo and Mabugu (2009) utilize a CGE model to examine the effects of economywide and partial productivity increases on the economy, gender employment, wages, income, and welfare in South Africa. They introduced six types of labour identified by skills and gender. Bohrat et al. (2013), Adelzadeh and Alvillar (2016), and Storm and Isaacs (2016) model the impact of minimum wage on the South African labour market and the whole economy. Faulkner et al. (2013) evaluate policy options for the South African economy, focusing on employment issues. Maisonnave and Decaluwe (2010) measure the impacts of the positive discrimination policy on employment as well as the short-run and long-run effects on income distribution using a dynamic CGE model. Chitiga et al. (2016) model economywide employment impacts of infrastructure investment funded with different fiscal tools.

4 Methodology and data

4.1 Model specification

The PEP 1-t dynamic CGE model

This study uses the recursive dynamic CGE model 'Partnership for Economic Policy 1-t' (PEP 1-t, 2.1 version) developed by Decaluwé et al. (2013). The model is abbreviated as the PEP-UNSA model. The PEP-UNSA CGE model is used to calibrate the 2015 social accounting matrix (SAM) for South Africa (Seventer et al. 2019).

In the model, there are two factors of production, capital and labour. According to our SAM, labour is disaggregated by age and skills. Therefore, a total of eight categories, high-skilled youth, high-skilled adult, skilled youth, skilled adult, semi-skilled youth, semi-skilled adult, unskilled youth, and unskilled adult, are included in the model. The domestic production function is assumed to be of constant returns to scale and presented in a four-level production process. At the first level, output is a Leontief function of value added and intermediate consumption. At the second level, it is assumed that composite labour and composite capital are substitutes following a constant elasticity of substitution (CES) function. At the third level, a CES function is used to represent the substitution between composite youth and composite adult labour. At the fourth level, the composite youth labour demand is an aggregate function of youth of different skills represented by a CES function having low elasticity. Similarly, the composite adult labour is a CES function of adults of different skills.

Agents in the model include households disaggregated by income deciles, firms, government, and the rest of the world (ROW). Each household receives capital, labour income, and transfers from institutions. Firms' income is derived from capital owned and transfers from other institutions, while they spend on dividends and direct taxes and make savings. The government collects taxes (direct, indirect taxes, and import duties) and provides subsidies (negative tax) on commodities and activities. On the other hand, it spends on commodities, makes transfers, and saves. The ROW obtains its income from capital, labour, imports, and transfers from firms and government. ROW spending consists of commodities purchases (from exports) and transfers to the households (remittance). Current account balance represents the difference between ROW spending and income. Several amendments were introduced to better account for the South African situation and to focus on our study on youth unemployment.

First, following the methodology of Kinyondo and Mabugu (2009), Maisonnave and Decaluwe (2010), and Ochoa et al. (2019), some modifications were introduced for the labour market equations.

Labour was broken down into subsets that captured different skills and age groups. To do so, the two broad categories of labour were considered as follows (equation 1):

$$L = \{LY, LA\} \tag{1}$$

where LY =youth labour and LA=adult labour.

The composite youth and adult labour was further disaggregated according to skills (see equations 2 and 3).

$$LY \in L = \{LY_{usk}, LY_{ssk}, LY_{sk}, LY_{hsk}\} \tag{2}$$

$$LA \in L = \{LA_{usk}, LA_{ssk}, LA_{sk}, LA_{hsk}\} \quad (3)$$

Therefore, the SAM has a total of eight labour categories. Given this labour disaggregation, the composite labour demand equation was modified to take into account youth and adult labour (see equation 4).

$$LDC_{j,t} = B_j^{LDC}[\beta_j^{LDC} LDY_{j,t}^{-\rho_j^{LDC}} + (1-\beta_j^{LDC}) LDA_{j,t}^{-\rho_j^{LDC}}]^{\frac{-1}{\rho_j^{LDC}}} \quad (4)$$

where

$LDC_{j,t}$ is the composite demand of labour at time t;

$LDY_{j,t}$ is the demand for youth labour at time t;

$LDA_{j,t}$ is the demand for adult labour at time t;

B_j^{LDC} is the scale parameter (CES - composite labour);

β_j^{LDC} is the share parameter (CES - composite labour);

ρ_j^{LDC} is the elasticity parameter (CES - composite labour).

At the next level, the composite youth and adult labour was also modelled using CES functions with substitution possibilities among different skills groups (see equations 5 and 6).

$$LDY_{j,t} = B_j^{LDY} \sum_y [\beta_{y,j}^{LD} LD_{y,j,t}^{-\rho_j^{LDY}}]^{\frac{-1}{\rho_j^{LDY}}} \quad (5)$$

$$LDA_{j,t} = B_j^{LDA} \sum_{ad} [\beta_{ad,j}^{LD} LD_{ad,j,t}^{-\rho_j^{LDA}}]^{\frac{-1}{\rho_j^{LDA}}} \quad (6)$$

Second, one of the assumptions of the PEP 1-t CGE model is full employment in the labour market. Although unemployment does not seem to fit a general equilibrium framework, we introduce the rate of involuntary unemployment to make the model a more realistic picture of the South African economy. We extend the PEP-UNSA model by including endogenous unemployment through a minimum wage policy (Henseler and Maisonnave 2018).

Initially, we add the endogenous variable UN (number of unemployed people) to the labour-supply equation. In doing so, the equilibrium condition for the labour market (equation 7) is adjusted.

$$LS_l = \left(\sum_j LD_{j,l}\right) + UN_l \quad (7)$$

where

LS_l is the labour supply by a specific type of worker;

$LD_{j,l}$ is the labour demand for a particular type of worker denoted by l within a specific sector j;

UN_l is the number of people in the economy who are unemployed by the type of worker.

Then, we replace the number of unemployed people in the economy with the unemployment rate. This is presented in equation 8.

$$LS_l = \frac{(\sum_j LD_{j,l})}{1-UNR_l} \quad (8)$$

Finally, we introduce the minimum wage equations (see equations 9 and 10).

$$W_l > W_l^{MIN} \quad (9)$$

$$(W_l - W_l^{MIN})UNR_l = 0 \quad (10)$$

where

W_l is the wage rate of a specific type of labour;

W_l^{MIN} is the minimum wage rate of a specific type of labour;

UNR_l is the unemployment rate by the type of labour.

Finally, following the methodology of Henseler and Maisonnave (2018), we introduce equation (8), which shows the reallocation of subsidies saved from transport commodity because of lower oil prices to the education sector. The difference between the initial value of land transport subsidies (which corresponds to the negative indirect tax in the SAM), $TICO_{cltrp}$, and the total land transport subsidy after the shock, TIC_{cltrp}, is allocated as a subsidy to the education sector, $ttsub_{ceduc}$.

$$ttsub_{ceduc} = \frac{TICO_{cltrp} - TIC_{cltrp}}{(PL_{ceduc} + \sum_{ij} PC_{ij} tmrg_{ij,ceduc})DD_{ceduc} + (PWM_{ceduc} e + \sum_{ij} PC_{ij} tmrg_{ij,ceduc})IM_{ceduc} + TIM_{ceduc}} \quad (11)$$

where

$ttsub_{ceduc}$ is the subsidy rate on commodity education;

TIC_{cltrp} is the government revenue from indirect taxes on product land transport;

PL_{ceduc} is the price of local product education (excluding all taxes on products);

PC_{ij} is the purchaser price of composite commodity education (including all taxes and margins);

e is the exchange rate—the price of foreign currency in terms of local currency;

$tmrg_{ij,ceduc}$ is the rate of margin education applied to commodity ij;

DD_{ceduc} is the domestic demand for commodity education produced locally;

PWM_{ceduc} is the world price of imported product education (expressed in foreign currency);

IM_{ceduc} is the quantity of product education imported;

TIM_{ceduc} is the government revenue from import duties on product education.

The parameter values used in this study include trade parameters from Gibson (2003), export and demand elasticities from Behar and Edwards (2004), and household demand and industry production from Annabi et al. (2006). The unemployment rates for all labour categories were obtained from the 2015 labour force survey (StatsSA 2016).

In terms of closure rules, our CGE model specifies the equilibrating mechanisms for three macroeconomic variables: government, savings-investment, and the balance of payments. The model is savings driven—all non-governmental savings rates are fixed while investment adjusts. Regarding the world trade, we assume that world prices are fixed, and we consider South Africa is a small, price-taker country. Depending on variations in the foreign savings account, the real exchange rate is flexible—it could appreciate or depreciate—and the current account balance is considered exogenous. Further, we assume that capital is fully employed and mobile across sectors. Unemployment exists in each segment of the labour market, and the labour supply is endogenous. Labour demand, employment, and wages can vary after a shock, but wage differentials are fixed at their initial level. The consumption of goods and services by the government and transfers between different agents are fixed at the base year and grow at the population growth rate. ROW savings are assumed to be a fixed proportion of gross domestic product (GDP), meaning that there is a limit to what South Africa can borrow from other countries.

To carry out the household income distribution analysis, we follow the top-down approach. Micro-data from the 2014–15 Living Condition and Expenditure Survey of South Africa (StatsSA 2017b) are used. In order to estimate the overall income distribution change, we compare the percentage of the total income of the aggregated household types in the simulations with the base period. In our effort to measure income inequality in South Africa, we used specific statistical coefficients for estimating the overall personal income distribution, such as the range (R), standard deviation (SD), coefficient of variation (CV), and coefficient of differentiation (CD).

The range (R) is the simplest measure of income inequality. It obtains the ratio of the difference between the maximum and the minimum income shares and the mean income share.

Simulation scenario assumptions

According to South Africa's latest macro policy, 'the New Growth Path,' the government's priorities aim to develop effective strategies to reduce poverty, inequality, and unemployment by means of making job creation the focal point of the policy. Thereby, we propose simulation scenarios that have impacts on the labour market.

In South Africa, public transport subsidy amounts to over ZAR17 billion per year, which is equivalent to about ZAR30 per month for every person living in South Africa or ZAR690 per subsidy beneficiary per month—or about 1,380 km of 'free' travel per month for the beneficiaries. These subsidies are paid to rail and bus modes that have a limited coverage compared to minibus taxis, which are mainly used by poor and working-class commuters and are therefore regressive (FFC 2014). Moreover, the available evidence indicates that current public urban transport subsidy policies in many countries do not make the poorest better off, and for the most part, these subsidies are neutral or regressive (Estupinan et al. 2007).

On the other hand, the average world crude oil prices have had a fluctuating trend for the past decade but are forecasted to decrease sharply to average US$35/barrel this year (2020) and US$42/barrel in 2021 from US$96.2/barrel in 2014 (more than 50 per cent decrease) compared to a previously forecasted price of US$80.0/barrel in 2030 (World Bank Group 2020). This decrease is exacerbated by the worsened situation of the COVID-19 pandemic. With this decrease, the transport sector will benefit from both the subsidies from the government and the decrease in oil price.

Therefore, we propose to decrease the world oil price by 20 per cent because the SAM used is based on the year 2015, which is consistent with the predictions. Because subsidies are modelled as fixed shares of consumer price, we fix the consumer price of land transport and vary the subsidy rate so that the decrease in the price of oil is not passed to consumers of land transport. The subsidy savings are then used to subsidize the commodity education. Three simulations are run in this paper: two main simulations plus a third that performs a sensitivity analysis function.

In the first scenario, we simulate a reduction in world oil price by 20 per cent, while in the second scenario we simulate both a reduction in world oil price by 20 per cent and a total removal of transport subsidies, which are then reallocated to the education sector. This reallocation is expected to increase access to educational services and reduce the skills gap among youth jobseekers and ultimately improve labour market outcomes. Various studies (Bhorat et al. 2016; Graham and Mlatsheni 2015; Lam et al. 2008) indicate that completion of secondary and tertiary education are important factors that facilitate movement of youth to employment. That is to say, high skills are a necessary prerequisite for youth employment given the high-productivity and technology-led economy of South Africa and, hence, our motive to support the education sector. The third simulation involves varying elasticity of substitutions in the world oil prices by 2 per cent, 6 per cent, and 8 per cent (sensitivity analysis is presented in Appendix Table A5).

4.2 Data

Social accounting matrix: benchmark statistics and analysis

South African's 2015 SAM, which was developed by United Nations University World Institute for Development Economics Research (UNU-WIDER) researchers and completed in 2019, is used for this study (Seventer et al. 2019). It has been formatted into a dynamic PEP 1-t CGE model format. The SAM developed in this section serves two purposes. Firstly, it helps in understanding the structure of the South African economy and its main labour market characteristics in the reference year 2015; secondly, it provides a database for the PEP 1-t CGE model.

The 2015 SAM for South Africa consists of 62 distinct sectors and 104 commodities that have been aggregated into 53 sectors and 49 commodities (Appendix Table A1). During the transformations of the original 2015 SAM into PEP format, in the domestic supply accounts, some cells had negative values. Therefore, four agricultural sectors were aggregated into three sectors; 34 industrial sectors were aggregated into 28 sectors; and 24 service sectors were aggregated into 22 sectors. The principle of aggregation was that sectors with similar production technologies were grouped together. The name of the sector indicates the predominant production commodity. Appendix Table A2 indicates aggregated sectors.

According to the structure of the South African economy sectors, as shown in Table 3 and in Appendix Table A2, the service sector contributes about 70.2 per cent of the GDP, which is the highest of all the sectors, while the agricultural and industrial sectors are 2.3 per cent and 27.5 per cent, respectively.

Table 3: Composition of the South African economy, by selected subsectors and main sectors, 2015, %

Sector	Share of GDP	Value-added share	Export share	Import share
Agricultural	2.3	2.3	2.5	1.3
Agriculture	1.9	2	2.3	1.2
Other agricultural sectors	0.3	0.3	0.2	0.1
Industrial	27.5	28	84.6	84.5
Mining of gold, uranium, and metal ores	5.9	6	28.1	11.1
Construction	3.4	3.6	0.04	0.03
Other industrial sectors	18.2	18.4	56.5	73.4
Service	70.2	69.7	12.9	14.2
Wholesale trade, commission trade	8.9	8.9	0.1	0.07
Land transport, transport via pipelines	5.7	5.9	2.4	2.8
Financial intermediation	4.5	4.5	0.3	0.6
Insurance and pension funding	2.3	2.3	1.5	0.07
Activities to financial intermediation	2.7	2.6	0.6	0.14
Real estate activities	5.7	5.1	1	0.7
Public administration	17.3	17.4	0.1	0.05
Other services sectors	28.8	23	6.84	9.8
Total	100	100	100	100

Source: authors' calculations based on the 2015 South Africa SAM (Seventer et al. 2019).

In the agricultural sector, the highest contribution to GDP is from agriculture (i.e. 1.98 per cent). This account is aggregated with the livestock sector. For these sectors, the aggregation is over closely related industries. The industrial subsector is the main contributor to the GDP within the mining of gold, uranium, and metal ores and accounts for about 5.9 per cent of the GDP.

According to the data in Table 3, the service sector accounted for the bulk of the economy (69.7 per cent of value added) with the major contribution of the public administration subsector (17.3 per cent), while the total industrial sector and agricultural sector represent 2.3 per cent and 28 per cent of value added, respectively.

As the data in Table 3 show, mining of gold, uranium, and metal ores is the most important exporting sector, and it was responsible for around 28 per cent of exports in 2015, followed by basic iron and steel and casting of metals with 8.5 per cent. On the import side, industry (84.5 per cent) including motor vehicles, trailers, and parts (14.1 per cent); machinery and equipment (12.6 per cent); and mining of gold, uranium, and metal ores (11.1 per cent) are responsible for the majority of imports.

For the purpose of this study, we make two main adjustments to the labour factors of the original structure of the 2015 South African SAM. First, we reclassify labour into four labour categories based on their education level. The first group is *unskilled* low educated labour with grades from 1 to 7; the second group is *semi-skilled* workers with medium education from grades 7 to 10; the third group includes *skilled* workers with secondary education who completed grade 12; the fourth group refers to *higher-skilled* workers with tertiary education with academic diplomas and degrees.

Second, the four labour categories were split by age group (youth and adult). The Labour Force Survey (LFS) (StatsSA 2016) provided data that supplied proportions of age groups in different sectors. This enabled the mapping of all groups to value added to their respective households. Consequently, we have eight labour categories, namely youth and adult unskilled, youth and adult semi-skilled, youth and adult skilled, and youth and adult high-skilled workers.

Table 4 reflects the factors of production in the total value added of all sectors. The total agricultural sector is intensive in the use of capital (67.9 per cent). For instance, the agricultural sector, as agriculture and forestry, has a relatively higher degree of unskilled labour intensity for adult than for youth labour. On the other hand, the fishery sector is relatively intensive in the use of skilled and high-skilled labour for both age groups.

Table 4: Production factors' contribution to main sectoral value added, %

Sector	Labour categories								Capital	Total
	Unskilled		Semi-skilled		Skilled		High-skilled			
	Youth	Adults	Youth	Adults	Youth	Adults	Youth	Adults		
Agricultural	1.3	6.4	2.6	3.8	3.3	3.5	3.7	7.4	67.9	100
Industrial	0.5	2.4	2.7	3.9	6.9	7.3	10.0	19.6	46.7	100
Service	0.5	2.4	1.9	2.8	6.5	6.9	11.5	22.3	45.5	100

Note: youth—the age group from 15 to 34 years. Adults—the age group from 35 to 65+ years.

Source: authors' calculations based on the 2015 South Africa SAM (Seventer et al. 2019).

The industrial sector is more intensive in the use of labour (53.3 per cent) than in capital (46.7 per cent). Most of the industrial subsectors are relatively intensive in the use of skilled and high-skilled workers from both age groups compared with unskilled workers. However, compared to high-skilled youth, adults are relatively more labour-intensive in all industrial sectors. Among high-skilled adults and youth, the difference is 100 per cent. Thus, we can expect that a simulated reform, which targets youth unemployment, will impact the labour market.

The service sector is the most labour-intensive sector (54.5 per cent). For instance, the other service activity subsectors intensively employ youth unskilled and semi-skilled labourers. The other sectors, mainly related to services, depended heavily on skilled labour for both age groups.

In addition, we specified income distribution among household categories and then calculated remuneration for youth and adult age group labour categories (Table 5). There are 14 household categories in the SAM, which are disaggregated based on income decile groups.

Table 5: Household participation in income remuneration, 2015 (% of total)

Household categories	Wage for different labour categories: Unskilled		Semi-skilled		Skilled		High-skilled		Capital income	Firms transfers (dividends)	Public transfers	Foreign transfers	Total
	Youth	Adult	Youth	Adult	Youth	Adult	Youth	Adult					
hhd-0	2.6	12.8	3.8	5.6	0.8	0.9	0.0	0.1	2.8	1.5	68.9	0.2	100
hhd-1	2.4	11.8	3.8	5.7	2.3	2.5	0.3	0.6	5.3	2.3	62.7	0.2	100
hhd-2	1.6	7.9	4.5	6.7	4.0	4.3	0.6	1.1	7.4	4.3	57.2	0.3	100
hhd-3	1.5	7.4	4.8	7.1	5.9	6.3	0.5	1.1	9.8	5.8	49.4	0.4	100
hhd-4	1.3	6.2	5.5	8.0	7.1	7.6	1.3	2.6	12.9	6.7	40.3	0.5	100
hhd-5	1.2	5.6	5.6	8.2	9.5	10.1	2.8	5.4	14.7	7.5	28.9	0.5	100
hhd-6	0.7	3.5	3.9	5.7	12.8	13.7	4.4	8.6	18.5	10.5	17.0	0.7	100
hhd-7	0.4	2.0	3.7	5.5	10.7	11.4	8.0	15.7	18.1	13.2	10.4	0.8	100
hhd-8	0.2	0.8	1.7	2.5	8.5	9.1	13.1	25.6	15.4	16.2	6.0	0.9	100
hhd-91	0.2	0.8	1.2	1.7	6.2	6.6	14.0	27.4	18.9	18.3	3.8	1.0	100
hhd-92	0.1	0.2	1.1	1.6	6.5	7.0	13.0	25.3	14.6	24.7	4.7	1.2	100
hhd-93	0.3	1.5	0.4	0.6	5.2	5.5	16.4	32.0	17.4	15.8	4.1	0.9	100
hhd-94	0.1	0.4	0.4	0.5	3.6	3.8	17.3	33.6	11.6	22.9	4.7	1.2	100
hhd-95	0.0	0.1	0.1	0.1	2.7	2.9	16.6	32.3	15.4	23.9	4.8	1.2	100

Note: hhd-0=poorest household with the lowest income (income decile up to 10%); hhd-1=poorest household with the lowest income (income decile 10–20%); hhd-2=poor household with low income (income decile 20–30%); hhd-3=poor household with low income (income decile 30–40%); hhd-4=household with medium income (income decile 40–50%); hhd-5=household with medium income (income decile 50–60%); hhd-6=rich household with high income (income decile 60–70%); hhd-7=rich household with high income (income decile 70–80%); hhd-8=rich household with high income (income decile 80–90%); hhd-8=richest household with highest income (income decile 90–92%); hhd-8=richest household with highest income (income decile 92–94%); hhd-8=richest household with highest income (income decile 94–96%); hhd-8=richest household with highest income (income decile 96–98%); hhd-8=richest household with highest income (income decile 98–100%); y=youth age group; a=adult age workers' group.

Source: authors' calculations based on the 2015 South Africa SAM (Seventer et al. 2019).

Table 5 shows that the main source of income for the poorest and poor households is public transfers while labour earnings in both household groups come from adult and youth unskilled and semi-skilled workers. The middle-income household receives a greater proportion of income as a transfer from the government, capital, firm's dividends, and wages from all labour categories. The rich households receive most of their income from the wage of skilled and high-skilled workers of both age groups, capital, and firm's transfers, while the richest households receive their highest share of income from the wage of high-skilled workers, firm's dividends, and meagre income from direct transfers from the government and the rest of the world.

5 Simulation results

This section presents simulation results when we reduce the import price for fuel by 20 per cent, and then the total government savings from the reduced transport subsidy are reallocated to the education sector. This reallocation represents a policy option that targets increased access to the educational service of youth associated with the job search and could improve labour market outcomes. The model is solved recursively for a period of 10 years following the principle that the economy grows naturally in the absence of shocks.

The shock simulated in the same direction as the real shock that affected the South African economy between 2014 and 2015 when world oil prices dropped. Between 2014 and 2015, fuel prices showed a year-on-year decline, boosted by a much lower global oil price, which dropped below US$50/barrel, with little hope that it would balloon past that level in the near future.

In that case, import prices in fuel decreased and later returned to historical levels. Moreover, the total unemployment rate increased extraordinarily up to 26.2 per cent in 2015 from 24.9 per cent in 2014. This shock in fuel prices transformed labour composition in different regions of South Africa. Therefore, we want to identify some of these effects in our simulation.

5.1 Macroeconomic impacts

The impact of both simulations on major macroeconomic variables is shown in Table 5. Immediately, we can see that a reduction in world oil prices has a very small effect on the macroeconomy of South Africa. Although the price for import fuel dropped substantially, its impact on overall real GDP growth is relatively small. Taking 2015 as the short run, Table 5 shows that shocks increase real GDP at market prices by only 1.2 per cent in the short run and lead to small but positive increases in GDP over the rest of the policy period (2015–24), mainly because of accumulation effects. Both simulation scenarios lead to a reduction in the production price, leading to a lower consumer price index, especially for sectors that are dependent on fuel prices. This then leads to an increase in demand.

Table 6: Impact on selected macroeconomic variables, %

Year	Simulation 1					Simulation 2				
	GDP	CPI	I	G	YG	GDP	CPI	I	G	YG
2015	1.2	0.16	0.65	2.07	1.04	1.2	0.14	0.65	2.09	0.99
2016	0.02	-0.03	-0.01	0.01	-0.01	0.02	-0.02	-0.01	0.04	0.01
2017	0.01	-0.02	-0.01	0.01	-0.01	0.01	-0.02	-0.01	0.03	0.005
2018	0.01	-0.02	-0.01	0.01	-0.01	0.01	-0.02	-0.01	0.03	0.004
2019	0.01	-0.02	-0.01	0.01	-0.01	0.01	-0.02	-0.01	0.03	0.004
2020	0.01	-0.02	-0.01	0.01	-0.01	0.01	-0.01	-0.01	0.03	0.004
2021	0.01	-0.02	-0.01	0.01	-0.01	0.01	-0.01	-0.01	0.02	0.003
2022	0.01	-0.01	-0.01	0.01	-0.01	0.01	-0.01	-0.01	0.02	0.003
2023	0.01	-0.01	-0.01	0.01	-0.004	0.01	-0.01	-0.01	0.02	0.003
2024	0.01	-0.01	-0.01	0.01	-0.004	0.01	-0.01	-0.01	0.02	0.002

Note: GDP=gross domestic product at market prices; CPI=consumer price index; I=total investments; G=government expenditure; YG=total government income.

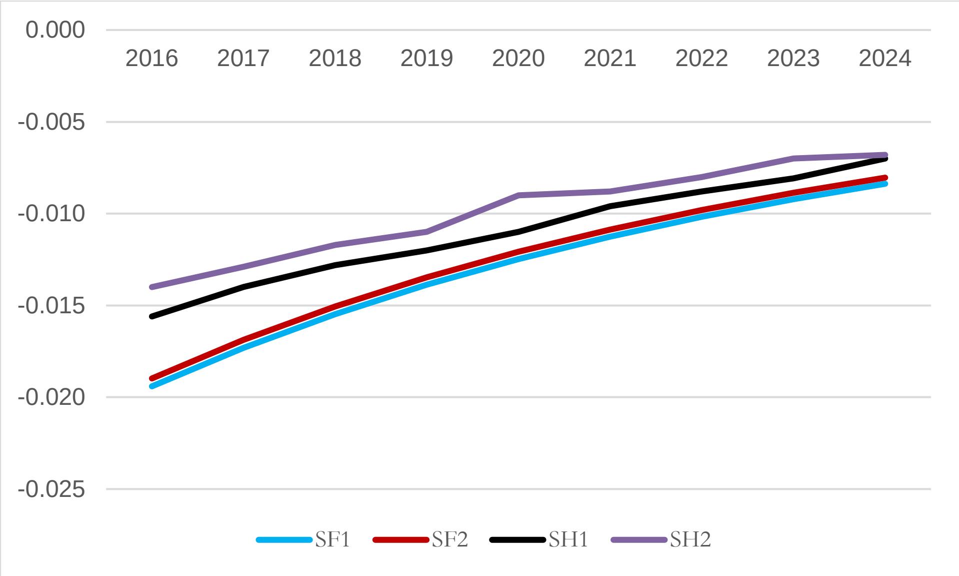
Source: authors' calculations based on PEP-UNSA CGE model.

Reduced government income lowers the total investment expenditures in Simulation 1. As government savings are fixed, the total investment expenditure is determined by firms' and households' savings. These savings decrease an average of 0.07 per cent for firms and 0.1 per cent for households, thereby decreasing the total investment expenditure in the economy.

5.2 Impacts on savings

In terms of savings, the closure implemented in the simulation involves fixing government savings while expenditure is determined endogenously. In both simulations, in the short run, savings of all agents increase; firms' savings increase by 1.11 per cent and households' savings by 1.12 per cent. This can be attributed to the rise in income for firms and households because of a fall in world oil prices. Unfortunately, the same mechanisms do not determine the long-run impacts on firms' and households' savings. Firms' and average households' savings fall because of income reduction (Figure 4).

Figure 4: Percentage change in savings by households and firms (Simulation 1 and 2)



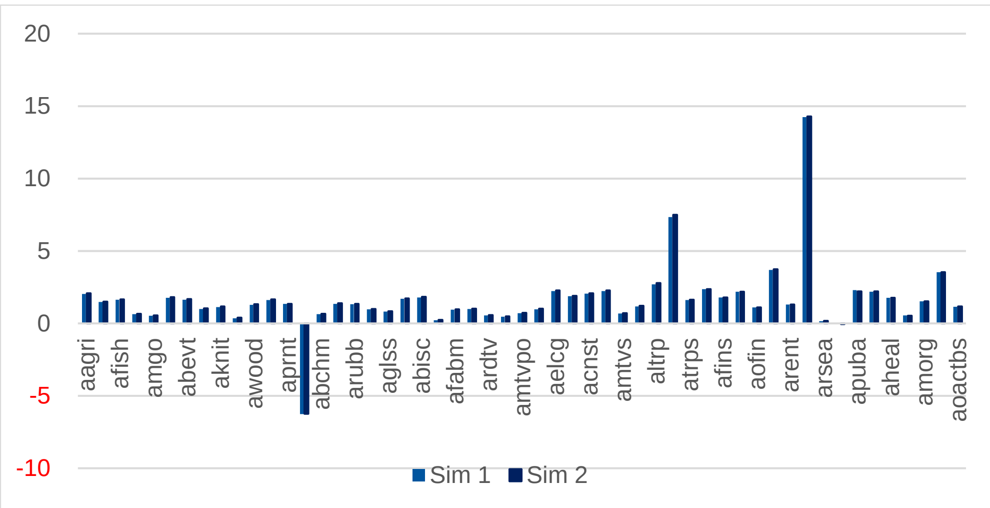
Note: SF1=firms' savings in Simulation 1; SF2=firms' savings in Simulation 2; SH1=households' savings in Simulation 1; SH2=households' savings in Simulation 2.

Source: authors' calculations based on PEP-UNSA CGE model.

5.3 Impacts on demand for labour and unemployment

Both simulations result in an increase in demand for all types of labour categories in the short term, excluding sectors such as coke oven, petroleum refineries, and other business activities (Figure 5). The total demand for labour decreases in these sectors by an average rate of 6.3 per cent and 0.1 per cent, respectively, in both simulations. This reduction connects with an increase in the wage rate for both youth and adult workers and the rise of the return of capital in these sectors. Overall, the decline in an average wage rate increases the labour demand as it becomes relatively cheaper than capital. Moreover, in most sectors, the wage rate decreased more than the return of capital. These impacts on labour demand also have consequences with respect to unemployment.

Figure 5: Percentage change in composite demand for labour in short run (Simulation 1 and 2)



Source: authors' calculations based on PEP-UNSA CGE model.

The unemployment rate increases for all labour categories in the short run. This is because of a high decrease in labour demand of 6.6 per cent in the petroleum and business service sectors, which employ the highest share of labour (Table 7).

Table 7: Percentage change in unemployment in the short run (Simulations 1 and 2)

Labour categories	Variation of unemployment rate in Simulation 1	Variation of unemployment rate in Simulation 2
Unskilled adults	1.58	1.56
Unskilled youth	1.45	1.42
Semi-skilled adults	1.54	1.53
Semi-skilled youth	1.46	1.44
Skilled adults	1.52	1.52
Skilled youth	1.50	1.47
High-skilled adults	1.57	1.58
High-skilled youth	1.47	1.46

Source: authors' calculations based on PEP-UNSA CGE model.

According to the impacts of simulated policies over the long term, we found the following results. Demand for youth labour increases in all sectors in both simulations (Table 8). This increase in demand holds across all skill categories of workers as well as adult workers. The total labour demand increases by 0.02 per cent in Simulation 1 and by 0.01 per cent in Simulation 2. However, this effect is much lower than in the short term.

Table 8: Percentage change in demand for youth labour in the long run (Simulations 1 and 2)

Year	Demand for youth labour in Simulation 1	Demand for youth labour in Simulation 2
2016	0.021	0.013
2017	0.019	0.012
2018	0.017	0.011
2019	0.016	0.010
2020	0.015	0.009
2021	0.014	0.009
2022	0.014	0.009
2023	0.013	0.009
2024	0.013	0.009

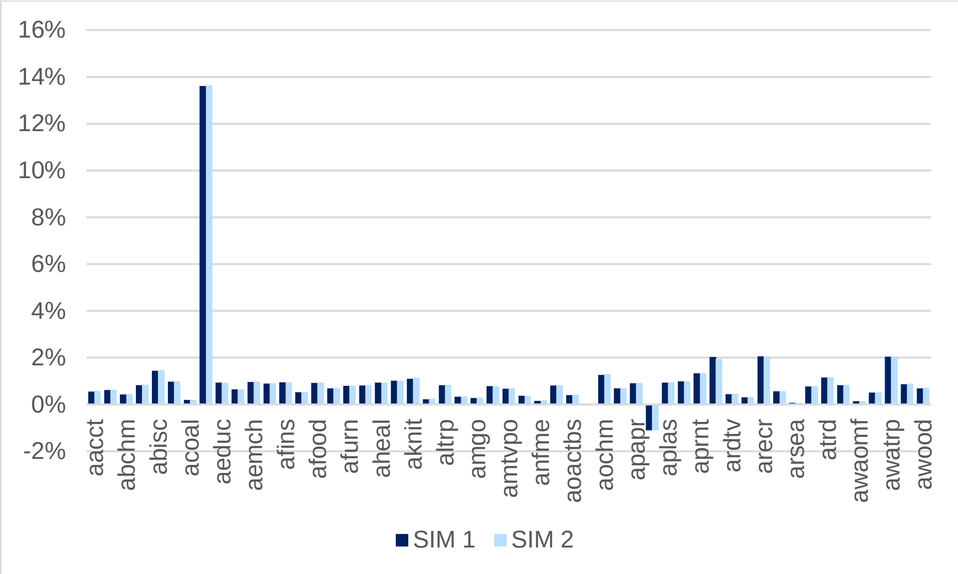
Source: authors' calculations

The unemployment rate for youth labour decreases in the long-run period in Simulation 1. In Simulation 2, the unemployment rate declines except for high-skilled workers in both age groups. This is a very important result because, as previously stated, unemployment is a major problem in South Africa, particularly among unskilled and semi-skilled workers. The average wage rate for youth workers across all sectors slightly rises in the long term as well as for adult workers.

5.4 Impacts on production

The impacts on production are similar for both Simulations 1 and 2. A decline in domestic prices from reduced world oil prices stimulates consumption and induces domestic demand. This leads to an increase in production in most sectors such as computer and related activities (highest increase) and manufacturing and service sectors (Figure 6), except for the decline of production in petroleum. Because of a decline in world oil prices, the relative price of domestically produced oil increases, making imports cheaper and leading to a decline in domestic production.

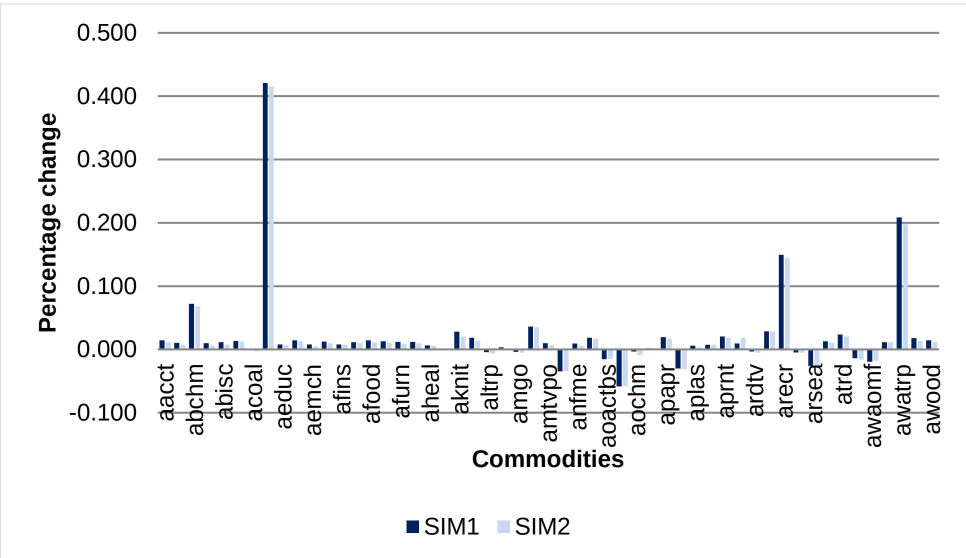
Figure 6: Percentage change in total domestic production in different sectors in 2015



Source: authors' calculations based on PEP-UNSA CGE model.

In the long run, computers and related activities continue to record the highest increase in production, for both Simulations 1 and 2. However, production decreases for some sectors in the long run (Figure 7).

Figure 7: Percentage change in total domestic production in different sectors in 2024

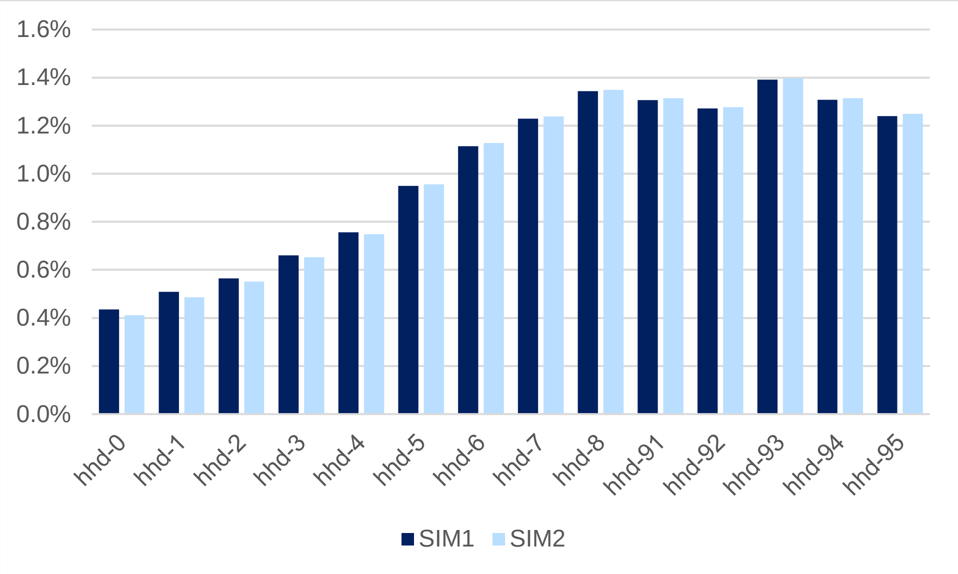


Source: authors' calculations based on PEP-UNSA CGE model.

5.5 Impacts of household consumption

In both simulations, a decrease in world oil price reduces the domestic prices of oil, transport, and other commodities. As a result, households reduce their spending on fuel and reallocate their income to other commodities. This leads to an increase in consumption of most commodities (agriculture, food, services), especially for higher-income households (Figure 8).

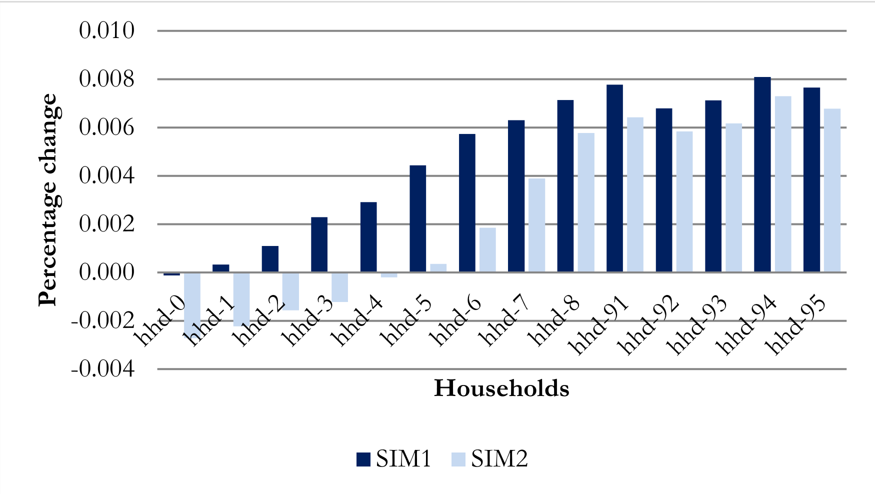
Figure 8: Percentage change in household consumption, 2015 (Simulations 1 and 2)



Source: authors' calculations based on PEP-UNSA CGE model.

In the long run, the increase in consumption is stronger in Simulation 1 for all households, while the lower income groups have a drop in consumption in Simulation 2 (Figure 9). This is the effect of a relatively higher consumer price of land transport and the removal of subsidies because land transport is among the most consumed commodities by the lower income households. Therefore, despite a decrease in oil price, land transport is expensive and therefore takes a larger part of their income.

Figure 9: Percentage change in household consumption for the year 2024 (Simulation 1 and 2)

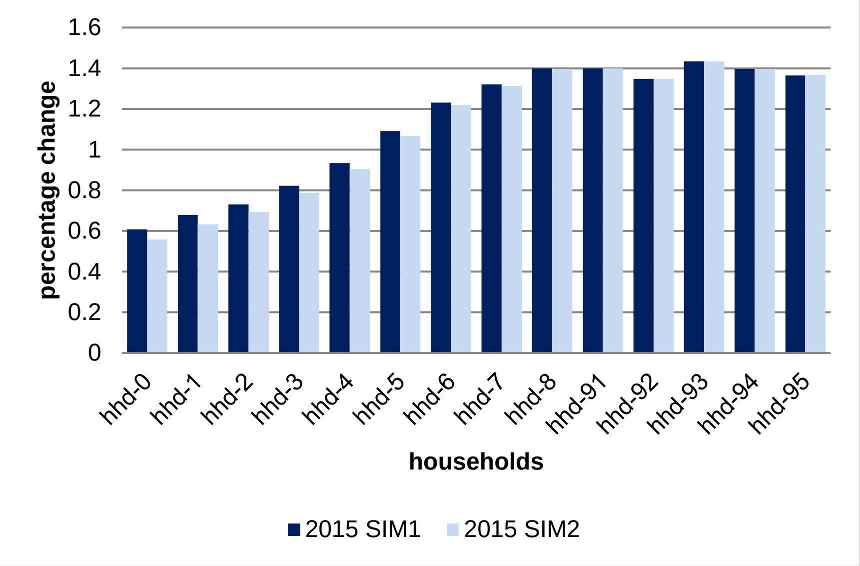


Source: authors' calculations based on PEP-UNSA CGE model.

5.6 Impacts on household income

In both simulations, household income increases in the first year (2015) with a reduction in world oil price (Figure 10).

Figure 10: Percentage change in household income, 2015 (Simulations 1 and 2)

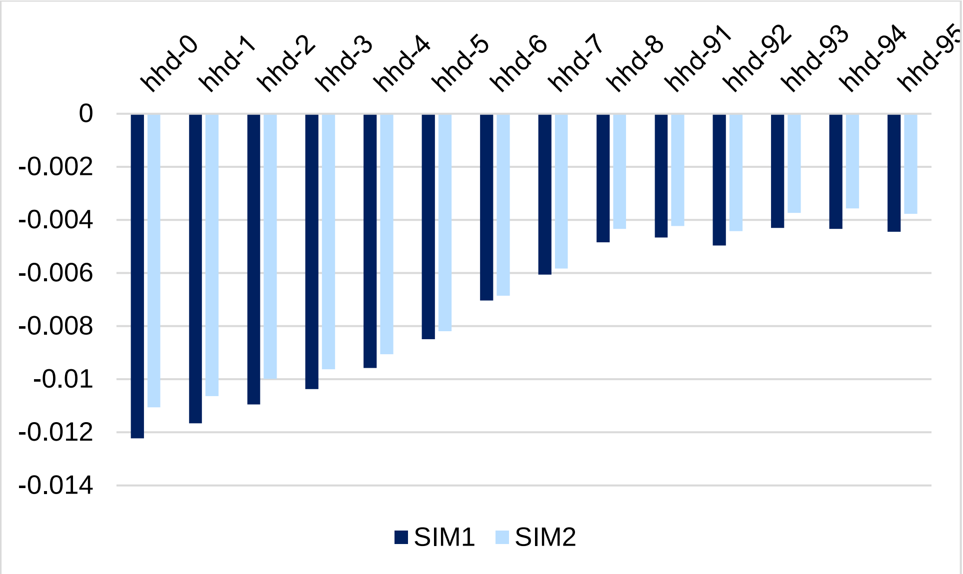


Source: authors' calculations based on PEP-UNSA CGE model.

This is expected because a lower world oil price stimulates domestic production, which in turn raises wages and returns from capital owned by households. The increase in income is higher for lower income households in Simulation 1 because in Simulation 2 this household income is negatively affected by a relatively higher price of land transport commodity that they highly consume.

The results are different in the long run. The income of all household categories decreases in both simulations (Figure 11). An increase in production because of lower oil prices induces more domestic production, which induces demand for factors of production. In both simulations, capital is more demanded than labour because of the prevalence of minimum wage, leading to the decline in wage income in the long run. Thus, the total household income declines in the long run as wage income forms the largest part of their income. Further, the decrease in income is less for households in Simulation 2 than in Simulation 1 because of consumption of a subsidized education commodity. Moreover, the consumer price index decreased more than nominal income (Table 6), thereby increasing household purchasing power and, potentially, easing poverty.

Figure 11: Percentage change in household income, 2024 (Simulations 1 and 2)



Source: authors' calculations based on PEP-UNSA CGE model.

5.7 Microsimulation analysis of household income distribution

To check the statistical significance of changes in income share distribution, we estimated statistical coefficients. Overall, results in both simulations show that the range in the level of income distribution for low-income and high-income households decreased slightly. This means that the gap between the income share of the bottom and top income groups decreased, which could indicate the smoothing of the level of economic inequality.

Another key measure that confirms the narrowing of income inequality is the reduction of the standard deviation values. As income inequality analysis requires comparisons, additionally, we estimated two indicators: the coefficient of range (CR) and the coefficient of variation (CV). Results in both simulations show that the value of these coefficients decreased slightly, which could mention redistributing income from the richest to the poorest. Finally, the decrease in the level of income inequality confirms the reduction in the coefficient of differentiation.

6 Conclusion

The overall objective of this work was to evaluate the hysteresis in youth unemployment using a CGE approach in which a wage rate is modelled by the minimum wage policy. Two simulation scenarios were developed that can impact the reduction of youth and total unemployment in South Africa.

Particularly, we applied simulations of the reduction of import of fuel price and then reallocation to the education sectors to support unemployed youth in South Africa.

The simulation results showed that implementing policies targeted at youth unemployment and labour market issues has a positive impact on the South African economy.

The policy in favour of import oil price reduction and transport subsidy reallocation to the education sector brings better results for economic growth with beneficial effects appearing from the first years, while a reduction in the unemployment rate, especially for youth, has delayed effects that do not appear until after 2016.

In the case of production, most sectors record positive growth in the short run, while the removal of transport subsidies affects some sectors that depend heavily on land transport, thereby reducing their production in the long run.

Total consumption increases for all households in both simulations in the short run. However, lower-income households experience a reduction in consumption in the second scenario in the long run. This is because of a relatively higher price of land transport commodity, which takes a significant part of their income.

Overall, the results of the simulations showed that, standing alone, the reduction of import oil prices had only a small redistributive effect on income inequality. In the short run, incomes increase because of a sharp increase in labour demand, while in the long run, all incomes decrease. Less decrease in income for households in Simulation 2 is contributed by a relatively low price of education commodity, which is subsidized. While reductions in oil prices can be effective as an industry-specific subsidy, they are not an instrument of income redistribution or poverty alleviation.

References

Adelzadeh, A., and C. Alvillar (2016). *The Impact of a National Minimum Wage on the South Africa Economy*. Working Paper Series No. 2. Johannesburg: University of the Witwatersrand.

Annabi, N., J. Cockburn, and B. Decaluwé (2006). *Functional Forms and Parameterization of CGE Models*. MPIA Working Paper 2006-04. Nairobi: Partnership for Economic Policy.

Banerjee, A., S. Galiani, J. Levinsohn, Z. McLaren, and I. Woolard (2008). 'Why Has Unemployment Risen in the New South Africa?' *Economics of Transition*, 16(4): 715–40.

Behar, A., and L. Edwards (2004). *Estimating Elasticities of Demand and Supply for South African Manufactured Exports Using a Vector Error Correction Model*. CSAE Working Paper Series 2004-04. Oxford: Centre for the Study of African Economies, University of Oxford.

Bhorat, H., A. Cassim, R. Kanbur, B. Stanwix, and D. Yua (2016). 'Minimum Wages and Youth: The Case of South Africa'. *Journal of African Economies*, 25(1): i61–i102. https://doi.org/10.1093/jae/ejv029

Bhorat H., K. Lilenstein, M. Oosthuizen, and A. Thornton (2020). *Wage Polarization in a High-Inequality Emerging Economy: The Case of South Africa*. WIDER Working Paper 2020/55. Helsinki: UNU-WIDER.

Bhorat, H., R. Kanbur, and B. Stanwix (2013). *Estimating the Impact of Minimum Wages on Employment, Wages, and Non-Wage Benefits: The Case of Agriculture in South Africa*. Working Paper No. 180095. Department of Applied Economics and Management. Ithaca, NY: Cornell University.

Blanchard, O., and L. Summers (1986a). *Hysteresis and the European Unemployment Problem*. NBER Macroeconomic Annual, Volume 1. Cambridge: MIT Press.

Blanchard, O., and L. Summers (1986b). *Hysteresis in Unemployment*. Working Paper N 2035. Cambridge: National Bureau of Economic Research.

Caporale, G.M., and L.A. Gil-Alana (2018). 'Unemployment in Africa: A Fractional Integration Approach'. *South African Journal of Economics*, 86(1): 76–81. https://doi.org/10.1111/saje.12178

Chitiga M., and R. Mabugu (2007). *Poverty and Inequality Effects of a High Growth Scenario in South Africa: A Dynamic Microsimulation CGE Analysis*. Working paper 2007-16. Pretoria, South Africa: University of Pretoria

Chitiga, M., J. Cockburn, B. Decaluwe, I. Fofana, and R. Mabugu (2010). 'Case Study: A gender-focused macro-micro analysis of the poverty impacts of trade liberalization in South Africa'. *International Journal of Microsimulation*, 3(1): 104-108.

Chitiga, M., R. Mabugu, and H. Maisonnave (2016). 'Analysing Job Creation Effects of Scaling Up Infrastructure Spending in South Africa'. *Development Southern Africa*, 33(2): 186–202. https://doi.org/10.1080/0376835X.2015.1120650

Decaluwé, B., A. Lemelin, V. Robichaud, and H. Maisonnave (2013). 'Pep-1-1t: The PEP Standard Single-Country, Dynamic CGE Model'. Nairobi: Partnership for Economic Policy (PEP) Research Network.

Erero, J. (2016). *National Minimum Wage in South Africa: A Computable General Equilibrium Model Analysis*. ERSA working paper 650. Cape Town, South Africa: Economic Research Southern Africa.

Essama-Nssah, B., D.S. Go, M. Kearney, V. Korman, S. Robinson, and K. Thierfelder (2007). *Economy-wide and Distributional Impacts of an Oil Price Shock on the South African Economy*. Policy Research Working Paper No. 4354. Washington, DC: World Bank https://openknowledge.worldbank.org/bitstream/handle/10986/7350/wps4354.pdf?sequence=1&isAllowed=y

Estupinan, N., A. Gómez-Lobo, R. Munoz-Raskin, and T. Serebrisky (2007). *Affordability and Subsidies in Public Urban Transport: What Do We Mean, What Can Be Done?* Policy Research Working Paper Series. Washington, DC: The World Bank.

Faulkner, D., C. Loewald, and K. Makrelov (2013). *Achieving Higher Growth and Employment: Policy Options for South Africa*. Working Paper 13/03. Pretoria: South African Reserve Bank.

FFC (Financial and Fiscal Commission) (2014). *Aligning Public Transport Subsidies to Policy*. Policy Brief. Cape Town: FFC.

Filmer, D., L. Fox, K. Brooks, A. Goyal, T. Mengistae, P. Premand, and D. Ringold (2014). *Youth Employment in Sub-Saharan Africa*. Washington, DC: AgenceFrançaise de Développement and the World Bank.

Fofana, I., M. Chitiga, and R. Mabugu (2009). 'Oil Prices and the South African Economy: A Macro–Meso–Micro Analysis'. *Energy Policy*, 37(12): 5509–18. https://doi.org/10.1016/j.enpol.2009.08.030

Fourie, F.C.V.N. (2011). The South African Unemployment Debate: Three Worlds, Three Discourses. SALDRU Working Paper 63. Cape Town: Southern Africa Labour and Development Research Unit, University of Cape Town.

Friedman, M. (1968). 'The Role of Monetary Policy.' *The American Economic Review,* 58(1): 1–17.

Gibson, K.L. (2003). *Armington Elasticities for South Africa: Long- and Short-Run Industry Level Estimates*. Working Paper 12–2003. Johannesburg: Trade and Industrial Policy Strategies.

Graafland, J. (1988). 'Hysteresis in Unemployment in the Netherlands'. *De Economist,* 136(4).

Graafland, J., and F. Huizinga (1990). 'Age-Related Minimum Wages and Hysteresis in Unemployment'. *Economic Letters*, 32(3): 289–94. doi.org/10.1016/0165-1765(90)90114-G

Graham, L., and C. Mlatsheni (2015). 'Youth Unemployment in South Africa: Understanding the Challenge and Working on Solutions'. Child Gauge 2015: Youth and the intergenerational transmission of poverty. Cape Town: Children's Institute, University of Cape Town.

Hall, R. (1975). 'The Rigidity of Wages and the Persistence of Unemployment'. *Brookings Papers on Economic Activity*, 6(2): 301–50.

Henseler, M., and H. Maisonnave (2018). 'Low World Oil Prices: A Chance to Reform Fuel Subsidies and Promote Public Transport? A Case Study for South Africa'. *Transportation Research*, Part A 108: 45-62.

Hughes, P., and G. Hutchinson (1988). 'Is Unemployment Irreversible?' *Applied Economics*, 20: 31–42.

Isaacs, G. (2016). 'A National Minimum Wage for South Africa'. National minimum wage research initiative: Summary report N1. Johanesburg: University of the Witwatersrand.

Khim-Sen, V., R. Chia, and C. Puah (2012). 'Does Hysteresis in Unemployment Occur in OECD Countries? Evidence from Parametric and Non-Parametric Panel Unit Roots Tests'. *International Journal of Economics and Management*, 6(2): 446–58.

Kinyondo, G., and M. Mabugu (2009). 'The General Equilibrium Effects of a Productivity Increase on the Economy and Gender in South Africa'. *South African Journal of Economic and Management Sciences,* 12(3): 307–26.

Lam, D., M. Leibbrandt, and C. Mlatsheni (2008). *Education and Youth Unemployment in South Africa*. Working Papers Series No 22. Cape Town: South African Labour and Development Research Unit, UCT, 1–2.

Layard, R., and S. Nickell (1985). 'The Causes of British Unemployment. National Institute Economic Review'. *National Institute of Economic and Social Research*, 111(1): 62–85.

Lam, D., M. Leibbrandt, and C. Mlatsheni (2008). *Education and Youth Unemployment in South Africa*. Working Papers Series No 22. Cape Town: South African Labour and Development Research Unit, UCT, 1–2.

León-Ledesma, M., and P. McAdam (2004). 'Unemployment, Hysteresis and Transition'. *Scottish Journal of Political Economy* 51(3).

Liew, V. K. Sen, R.C.J. Chia, and C.H. Puah (2012). 'Does Hysteresis in Unemployment Occur in OECD Countries? Evidence from Parametric and Non-Parametric Panel Unit Roots Tests'. *International Journal of Economics and Management,* 6(2): 446–58.

Lindbeck, A., and D.J. Snower (1988a). 'Cooperation, Harassment, and Involuntary Unemployment: An Insider-Outsider Approach'. *American Economic Review*, 78(1): 167–89.

Lindbeck, A., and D.J. Snower (1988b). *The Insider-Outsider Theory of Employment and Unemployment*. Cambridge: MIT Press.

Maisonnave, H., and B. Decaluwe (2010). *Is South Africa's Affirmative Action Policy Efficient*? Working paper 2010/23. Dakar: Consortium pour la recherche Economique et Sociale. https://media.africaportal.org/documents/south_africa_1.pdf

Mbanda, V., and M. Chitiga-Mabugu (2017). 'Growth and Employment Impacts of Public Economic Infrastructure Investment in South Africa: A Dynamic CGE Analysis'. *Journal of Economic and Financial Sciences*, 10(2): 235–52.

McDonald, S., and M. Van Schoor (2005). *A Computable General Equilibrium (CGE) Analysis of the Impact of an Oil Price Increase in South Africa*. Working Paper Series 15633, PROVIDE Project. Elsenburg: Western Cape Government, Department of Agriculture.

Meng, M., M. Strazicich, and J. Lee (2017). 'Hysteresis in Unemployment? Evidence from Linear and Nonlinear Unit Root Tests and Tests with Non-Normal Errors'. *Empirical Economics*, 53(4).

Mkandawire, R.M., T.M. Mkhatshane, and K.M. Sikhitha (2001). *Youth Livelihoods in the Northern Province Post Apartheid South Africa*. Ottawa: International Development Research Centre.

Mlatsheni, C. (2007) 'A Survey of Youth Labour Market Trends'. Human Sciences Research Council. Cape Town: HSRC Press.

Mlatsheni, C., and S. Rospabé (2002). *Why Youth Unemployment is High and Unequally Spread in South Africa*? Working Paper no. 02, 65. Cape Town: University of Cape Town.

Neudorfer, P., K. Pichelmann, and M. Wagner (1990). 'Hysteresis, Nairu and Long-Term Unemployment in Austria'. *Empirical Economics*, 15(2): 217–29.

Nsenga, D., M. Nach, H. Khobai, C. Moyo, and A. Phiri (2019). 'Is It the Natural Rate Hypothesis or the Hysteresis Hypothesis for Unemployment Rates in Newly Industrialized Economies?' *Comparative Economic Research*, 22(4): 39–55. https://doi.org/10.2478/cer-2019-0031

Ochoa, E., L. Enrique, M. Chitiga, and H. Maisonnave (2019). 'Impact of Economic Policies in South Africa on Women's Work'. *22nd Annual Conference on Global Economic Analysis*, Warsaw, Poland.

Olanipekun, I., S. Akadiri, O. Olawumi, and F. Bekun (2017). 'Does Labor Market Hysteresis Hold in Low Income Countries?' *International Journal of Economics and Financial Issues*, 7(1).

O'Shaughnessy, T. (2011). 'Hysteresis in Unemployment'. *Oxford Review of Economic Policy*, 27(2).

Pauw, K., and L. Edwards (2005). *Evaluating the General Equilibrium Effects of a Wage Subsidy Scheme for South Africa*. Working Paper 21. Cape Town: Economic Research Southern Africa.

Pela, M. (2014). 'South Africa's Economically Active Population Rising Amidst Depressed Growth in Jobs'. Available at: https://www.gov.za/south-africa%E2%80%99s-economically-active-population-rising-amidst-depressed-growth-jobs-%E2%80%93-department (accessed 18 December 2020).

Phelps, W. (1967). 'Phillips Curves, Expectations of Inflation and Optimal Employment Over Time'. *Economica*, 34(3): 254–81.

Phelps, E. (1994). 'Low-Wage Employment Subsidies Versus the Welfare State'. *The American Economic Review*, 84(2): 54–8.

Philips, A. (1958). 'The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957'. *Economica*, 25(100): 283–99.

Pikoko, V., and A. Phiri (2018). *Is There Hysteresis in South African Unemployment? Evidence From the Post-Recessionary Period*. Working Paper 1803. Port Elizabeth: Department of Economics, Nelson Mandela University.

Pratt, S., A. Blake, and P. Swann (2013). 'Dynamic General Equilibrium Model with Uncertainty: Uncertainty Regarding the Future Path of the Economy'. *Economic Modelling,* 32: 429–39.

Rena, R., and M. Msoni (2014). 'Global Financial Crises and its Impact on the South African Economy: A Further Update'. *Journal of Economics*, 5(1): 17–25. https://doi.org/10.1080/09765239.2014.11884980

Storm, S., and G. Isaacs (2016). *Modelling the Impact of a National Minimum Wage in South Africa: Are General Equilibrium Models Fit for Purpose*? Research Brief No. 1. National Minimum Wage Research Initiative. Johannesburg: University of the Witwatersrand.

Seventer, D., S. Bold, S. Gabriel, and R. Davies (2019). A 2015 Social Accounting Matrix (SAM) for South Africa. SA-TIED Working Paper. Helsinki: United Nations University World Institute for Development Economics Research. Available at: https://www.wider.unu.edu/database/2015-social-accounting-matrix-south-africa (accessed 30 March 2020).

South African Government (2020). 'Employment and Labour on New National Minimum Wage Rate'. Available at: https://www.gov.za/speeches/new-nmw-base-rate-come-effect-march—-department-employment-and-labour-24-feb-2020-0000 (accessed 18 December 2020).

South Africa (1998). Government Gazette no 19370, 19 October, Employment Equity Act.

Standing, G., J. Sender, and J. Weeks (1996). *Restructuring the Labour Market: The South African Challenge*. An ILO Country Review. Geneva: ILO.

StatsSA (2016). 'Quarterly Labour Force Survey 2015: Quarter 4'. Pretoria: Statistics South Africa. https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/574/download/8272

StatsSA (2017a). 'Labour Market Dynamics in South Africa 2015'. Pretoria: Statistics South Africa. https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/598

StatsSA (2017b). 'Living Conditions of Households in South Africa: An Analysis of Household Expenditure and Income Data Using the LCS 2014/2015'. Pretoria: Statistics South Africa. https://www.statssa.gov.za/publications/P0310/P03102014.pdf

StatsSA (2019a). 'Quarterly Labour Force Survey 2018: Quarter 4'. Pretoria: Statistics South Africa. https://microdata.worldbank.org/index.php/catalog/3491/download/46801

StatsSA (2019b). 'Quarterly Labour Force Survey 2019: Quarter 1'. Pretoria: Statistics South Africa. https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/764/get_microdata

StatsSA (2020). 'Quarterly Labour Force Survey 2020: Quarter 1'. Pretoria: Statistics South Africa. https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/823/download/11163

Taylor, L. (2016). 'CGE Applications in Development Economics'. *Journal of Policy Modeling,* 38(3): 495–514.

Thurlow, J. (2006). 'Has Trade Liberalization in South Africa Affected Men and Women Differently?' DSGD discussion paper 36. Washington, DC: International Food Policy Research Institute (IFPRI).

UN (2015). *World Population Ageing*. Report ST/ESA/SER.A/390. New York: United Nations, Department of Economic and Social Affairs Population Division.

Van Ha, P., and T. Kompas (2016). 'Solving Intertemporal CGE Models in Parallel Using a Singly Bordered Block. *Economic Modelling*, 52.

World Bank Group (2020). *Commodity Markets Outlook – April 2020 (A World Bank Quarterly Report)*. Washington, DC: World Bank.

Appendix A

Table A1: Sectoral production structure

Sectors	GDP at basic prices, % of total
Agriculture	2.3
Agriculture	1.98
Forestry	0.19
Fishing	0.14
Industry	27.5
Mining of coal and lignite	1.85
Mining of gold and uranium ore	5.94
Food	2.44
Beverages and tobacco	0.98
Spinning, weaving, and finishing textiles	0.15
Knitted, crouched fabrics, wearing apparel, fur articles	0.16
Tanning and dressing of leather	0.09
Sawmilling, planing of wood, cork, straw	0.53
Paper	0.52
Publishing, printing, recorded media	0.39
Coke oven, petroleum refineries	1.15
Nuclear fuel, basic chemicals	0.58
Other chemical products, manmade fibres	0.78
Rubber	0.17
Plastic	0.35
Glass	0.08
Non-metallic minerals	0.35
Basic iron and steel, casting of metals	0.52
Basic precious and non-ferrous metals	0.25
Fabricated metal products	0.74
Machinery and equipment	0.87
Electrical machinery and apparatus	0.21
Radio, television, communication equipment, and apparatus	0.11
Motor vehicles, trailers, parts	0.09
Other transport equipment	0.86
Furniture	0.14
Electricity, gas, steam, and hot water supply	2.97

Collection, purification, and distribution of water	0.80
Construction	3.41
Services	70.2
Wholesale trade, commission trade	8.93
Sale, maintenance, repair of motor vehicles	2.15
Hotels and restaurants	0.87
Land transport, transport via pipelines	5.70
Water transport	0.05
Air transport	0.43
Auxiliary transport	1.15
Post and telecommunication	1.90
Financial intermediation	4.53
Insurance and pension funding	2.28
Activities to financial intermediation	2.67
Real estate activities	5.69
Renting of machinery and equipment	0.22
Computer and related activities	0.22
Research and experimental development	0.29
Other business activities	3.46
Government	17.29
Education	1.06
Health and social work	1.97
Sewerage and refuse disposal	0.59
Activities of membership organisations	0.05
Recreational, cultural, and sporting activities	0.32
Other activities	8.37
GDP	100

Source: authors' calculations based on 2015 South Africa SAM (Seventer et al. 2019).

Table A2: Commodity and economic activity aggregation from micro-SAM

N	INDUSTRIES (55)		COMMODITIES (49)	
	CODE	**NAME**	**NAME**	**CODE**
	aagri	Agriculture	Agriculture (aggregated: agriculture, live animal)	cagri
	afore	Forestry	Forestry	cfore
	afish	Fishing	Fishing	cfish
	acoal	Mining of coal and lignite	Mining of coal and lignite	ccoal
	amgo	Mining of gold and uranium ore	Mining of gold and uranium ore (aggregated: mining of gold and uranium ore, mining of metal ores, other mining and quarrying	cmore
	afood	Food	Food (aggregated: meat, fish, vegetables, fruit and nuts, oil and fats, dairy product, grain mill products, starches products, animal products, bakery products, sugar, confectionary products, pasta products)	cfood
	abevt	Beverages and tobacco	Luxury foodstuff (aggregated: alcohol, beverages, soft drinks, tobacco products, natural water)	cbevt
	aweav	Spinning, weaving, and finishing textiles	Spinning, weaving, and finishing textiles (aggregated: textile fabrics, made-up textiles, articles, carpets, textile)	cweav
	aknit	Knitted, crouched fabrics, wearing apparel, fur articles	Knitted and other fabrics (aggregated: knitting fabrics, clothing)	cknit
	aleaft	Footwear and tanning and dressing of leather (aggregated: footwear and tanning and dressing of leather)	Tanning and dressing of leather	cleaft
	awood	Sawmilling, planing of wood, cork, straw	Sawmilling, planing of wood, cork, straw	cwood
	apapr	Paper	Paper	cpapp
	aprnt	Publishing, printing, recorded media	Publishing, printing, recorded media	cprnt
	apetr	Coke oven, petroleum refineries	Coke oven, petroleum refineries	cpetr
	abchm	Nuclear fuel, basic chemicals	Nuclear fuel, basic chemicals	cbchm
	aochm	Other chemical products, manmade fibres	Other chemical products (aggregated: chemicals, paint, related products, pharmaceutical products, soap, cleaning, perfume)	coachm
	arubb	Rubber	Rubber (aggregated: rubber tyres, other rubber products)	crubb
	aplas	Plastic	Plastic	cplas
	aglss	Glass	Glass	cglas
	anmmi	Non-metallic minerals	Non-metallic minerals (aggregated: non-structural ceramic, structure non-refractory clay, plaster, cement, articles of concrete, non-metallic products)	cnmmi
	abisc	Basic iron and steel, casting of metals	Basic iron and steel, casting of metals	cirst

anfme	Basic precious and non-ferrous metals	Basic precious and non-ferrous metals (aggregated: non-ferrous metals, jewellery)	cnfme
afabm	Fabricated metal products	Fabricated metal products (aggregated: structural metal products, tanks, reservoirs, reservoirs, other fabricated metal)	cfabm
amach	Machinery and equipment	Machinery and equipment (aggregated: general machinery, special machinery, domestic appliances, engines, turbines, pumps, compressors, bearings, gears, lifting equipment, office machinery)	cmach
aemch	Electrical machinery and apparatus	Electrical machinery and apparatus	celcm
ardtv	Radio, television, communication equipment and apparatus	Radio, television, communication equipment and apparatus	crdtv
amopt	Medical, precision, optical instruments, watches, and clocks	Medical, precision, optical instruments, watches, and clocks	cmeda
amotvp	Motor vehicles, trailers, parts, and other transport equipment (aggregated: motor vehicles, trailers, parts, and other transport equipment)	Motor vehicles, trailers, parts, and other transport equipment (aggregated: motor vehicles, trailers, parts, and other transport equipment)	cmotvp
afurn	Furniture	Furniture	cfurn
aomnfw	Manufacturing and sewage and refuse disposal (aggregated: manufacturing recycling and sewage and refuse disposal)	Manufacturing and sewage and refuse disposal (aggregated: manufacturing, recycling and sewage, and refuse disposal)	comnfw
aelcg	Electricity, gas, steam, and hot water supply	Electricity, gas, steam and hot water supply (aggregated: electricity distribution, electricity, and gas)	celcd
awatd	Collection, purification, and distribution of water	Collection, purification, and distribution of water	cwatd
acnst	Construction	Construction	ccnst
atrad	Wholesale trade, commission trade	Wholesale trade, commission trade (aggregated: retail trade and wholesale trade, commission trade)	ctrad
amtvs	Sale, maintenance, repair of motor vehicles		
aacct	Hotels and restaurants	Catering and hotels (aggregated: catering services, accommodation)	cacct
altrp	Land transport, transport via pipelines	Land transport (aggregated: passenger transport, freight transport)	cltrp
awatrp	Aggregated: water transport and air transport	Air transport (aggregated: air transport and auxiliary transport)	ctrps
apost	Post and telecommunication	Post and telecommunication (aggregated: postal, courier services, telecommunications)	cpost
afins	Financial intermediation	Financial intermediation	cfins
ainsp	Insurance and pension funding	Insurance and pension funding	cinsp
aofin	Activities to financial intermediation	Activities to financial intermediation	cofin
areal	Real estate activities	Real estate activities	creal

arent	Renting of machinery and equipment	Renting of machinery and equipment	crent
acomp	Computer and related activities	Computer and related activities	
arsea	Research and experimental development	Research and experimental development	crsea
aobus	Other business activities	Other business activities (aggregated: other business activities, legal, accounting)	cobus
apuba	Government	Government	cpuba
aeduc	Education	Education	ceduc
aheal	Health and social work	Health and social work	cheal
amorg	Activities of membership organizations		
arecr	Recreational, cultural, and sporting activities		
aoactbs	Other activities (aggregated: support services, manufactured services n.e.c., other services n.e.c., construction services, non-observed, informal, non-profit, households)	Other activities (aggregated: support services, manufactured services n.e.c., other services n.e.c., construction services, non-observed, informal, non-profit, households)	coactbs

Source: authors' calculations based on 2015 South Africa SAM (Seventer et al. 2019).

Table A3: Impacts on household consumption

		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
hhd-0	SIM1	0.436	-0.004	-0.003	-0.002	-0.002	-0.001	-0.001	-0.001	0.000	0.000
	SIM2	0.411	-0.009	-0.008	-0.007	-0.006	-0.005	-0.004	-0.004	-0.003	-0.003
hhd-1	SIM1	0.509	-0.003	-0.002	-0.001	-0.001	-0.001	0.000	0.000	0.000	0.000
	SIM2	0.486	-0.008	-0.007	-0.006	-0.005	-0.004	-0.004	-0.003	-0.003	-0.002
hhd-2	SIM1	0.565	-0.001	-0.001	0.000	0.000	0.001	0.001	0.001	0.001	0.001
	SIM2	0.552	-0.007	-0.006	-0.005	-0.004	-0.003	-0.003	-0.002	-0.002	-0.002
hhd-3	SIM1	0.660	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	SIM2	0.653	-0.006	-0.005	-0.004	-0.003	-0.003	-0.002	-0.002	-0.001	-0.001
hhd-4	SIM1	0.756	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
	SIM2	0.749	-0.003	-0.003	-0.002	-0.002	-0.001	-0.001	-0.001	0.000	0.000
hhd-5	SIM1	0.949	0.006	0.006	0.006	0.006	0.005	0.005	0.005	0.005	0.004
	SIM2	0.956	-0.002	-0.002	-0.001	-0.001	-0.001	0.000	0.000	0.000	0.000
hhd-6	SIM1	1.114	0.009	0.008	0.008	0.007	0.007	0.007	0.006	0.006	0.006
	SIM2	1.128	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002
hhd-7	SIM1	1.230	0.010	0.009	0.009	0.008	0.008	0.007	0.007	0.007	0.006
	SIM2	1.238	0.005	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004
hhd-8	SIM1	1.343	0.012	0.011	0.010	0.009	0.009	0.008	0.008	0.007	0.007
	SIM2	1.350	0.009	0.008	0.008	0.007	0.007	0.007	0.006	0.006	0.006
hhd-91	SIM1	1.306	0.014	0.012	0.011	0.011	0.010	0.009	0.009	0.008	0.008
	SIM2	1.314	0.011	0.010	0.009	0.009	0.008	0.008	0.007	0.007	0.006
hhd-92	SIM1	1.271	0.011	0.010	0.009	0.009	0.008	0.008	0.007	0.007	0.007
	SIM2	1.276	0.009	0.009	0.008	0.008	0.007	0.007	0.006	0.006	0.006
hhd-93	SIM1	1.392	0.011	0.010	0.010	0.009	0.009	0.008	0.008	0.007	0.007
	SIM2	1.397	0.009	0.009	0.008	0.008	0.007	0.007	0.007	0.006	0.006
hhd-94	SIM1	1.308	0.015	0.014	0.013	0.012	0.011	0.010	0.009	0.009	0.008
	SIM2	1.315	0.014	0.013	0.012	0.011	0.010	0.009	0.008	0.008	0.007
hhd-95	SIM1	1.240	0.014	0.013	0.012	0.011	0.010	0.009	0.009	0.008	0.008
	SIM2	1.250	0.013	0.011	0.010	0.009	0.009	0.008	0.008	0.007	0.007

Source: authors' calculations based on PEP-UNSA CGE model.

Table A4: Impacts on production

	2015		2016		2017		2018		2019		2020		2021		2022		2023		2024	
	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2	SIM1	SIM2
aacct	0.56	0.58	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
aagri	0.62	0.64	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
abchm	0.42	0.45	0.22	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07
abevt	0.82	0.84	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
abisc	1.44	1.47	0.00	-0.01	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
acnst	0.98	0.99	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
acoal	0.19	0.20	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00
acomp	13.61	13.64	0.42	0.41	0.43	0.42	0.43	0.42	0.43	0.42	0.43	0.42	0.43	0.42	0.43	0.42	0.42	0.42	0.42	0.42
aeduc	0.93	0.93	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
aelcg	0.64	0.65	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01
aemch	0.96	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00
afabm	0.89	0.90	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
afins	0.95	0.95	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
afish	0.53	0.53	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
afood	0.92	0.94	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01
afore	0.69	0.70	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
afurn	0.80	0.82	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
aglss	0.81	0.82	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
aheal	0.93	0.93	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ainsp	1.02	1.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
aknit	1.09	1.14	0.05	0.03	0.04	0.03	0.04	0.03	0.04	0.03	0.04	0.03	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02
aleaft	0.22	0.25	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01

altrp	0.82	0.84	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	-0.01
amach	0.33	0.34	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
amgo	0.28	0.29	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01
amorg	0.78	0.77	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04
amtvpo	0.68	0.70	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
amtvs	0.37	0.38	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
anfme	0.16	0.18	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01
anmmi	0.82	0.83	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
aoactbs	0.40	0.41	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
aobus	-0.04	-0.03	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
aochm	1.27	1.31	-0.03	-0.04	-0.02	-0.04	-0.02	-0.03	-0.01	-0.02	-0.01	-0.02	-0.01	-0.02	-0.01	-0.01	0.00	-0.01	0.00	-0.01
aofin	0.68	0.68	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
apapr	0.91	0.93	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
apetr	-1.11	-1.10	-0.18	-0.19	-0.15	-0.15	-0.12	-0.12	-0.10	-0.10	-0.08	-0.08	-0.06	-0.06	-0.05	-0.05	-0.04	-0.04	-0.03	-0.03
aplas	0.93	0.95	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00
apost	0.99	0.98	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
aprnt	1.34	1.34	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
apuba	2.03	1.95	0.01	0.04	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02
ardtv	0.45	0.46	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.00	-0.01	0.00	-0.01
areal	0.31	0.31	0.10	0.10	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
arecr	2.06	2.06	0.14	0.13	0.14	0.13	0.14	0.14	0.14	0.14	0.14	0.14	0.15	0.14	0.15	0.14	0.15	0.14	0.15	0.14
arent	0.57	0.56	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01
arsea	0.07	0.08	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03
arubb	0.77	0.79	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
atrd	1.16	1.17	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02

atrps	0.82	0.84	-0.05	-0.05	-0.04	-0.05	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02
awaomf	0.14	0.14	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
awatd	0.52	0.52	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
awatrp	2.04	2.05	0.24	0.23	0.24	0.22	0.23	0.22	0.23	0.21	0.22	0.21	0.22	0.21	0.21	0.20	0.21	0.20	0.21	0.20
aweav	0.87	0.90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01
awood	0.69	0.71	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Source: authors' calculations based on PEP-UNSA CGE model.

Table A5: Sensitivity analysis for variation in world oil price

Decrease in world oil price by	**2%**		**4%**		**6%**		**8%**	
	2015	**2024**	**2015**	**2024**	**2015**	**2024**	**2015**	**2024**
Real GDP	0.141	0.000	0.178	0.001	0.268	0.002	0.571	-0.002
Total investment	0.062	-0.001	0.124	-0.001	0.187	-0.002	0.251	-0.002
Unemployment rate, high-skilled youth	-0.643	0.000	-1.292	0.000	-1.947	0.000	-2.608	0.000
Unemployment rate, skilled youth	-1.284	0.002	-2.581	0.005	-3.890	0.007	-5.211	0.010
Unemployment rate, semi-skilled youth	-0.899	0.005	-1.806	0.011	-2.722	0.016	-3.648	0.022
Unemployment rate, unskilled youth	0.982	-0.007	1.973	-0.015	2.974	-0.022	3.985	-0.030
Unemployment rate, high-skilled adult	5.678	0.002	11.408	0.003	17.193	0.005	23.032	0.007
Unemployment rate, skilled adult	-0.986	0.002	-1.982	0.005	-2.987	0.007	-4.002	0.010
Unemployment rate, semi-skilled adult	-0.349	0.003	-0.701	0.006	-1.056	0.009	-1.415	0.013
Unemployment rate, unskilled adult	-0.386	0.005	-0.776	0.009	-1.170	0.014	-1.568	0.018
Consumer price index	0.013	-0.001	0.025	-0.002	0.038	-0.003	0.052	-0.004
Change in production of petroleum	-0.106	-0.003	-0.213	-0.006	-0.321	-0.009	-0.430	-0.013
Change in production of land transport	0.081	-0.001	0.162	-0.001	0.244	-0.002	0.327	-0.003
Change in production of education	0.090	0.001	0.180	0.001	0.271	0.002	0.363	0.003
Labour demand by petroleum	-0.613	0.018	-1.229	0.036	-1.847	0.053	-2.467	0.071
Labour demand by land transport	0.265	-0.007	0.532	-0.014	0.803	-0.022	1.076	-0.029
Labour demand by education	0.211	-0.003	0.425	-0.005	0.640	-0.008	0.857	-0.011
Income, hhd-0	0.053	-0.001	0.107	-0.002	0.161	-0.003	0.216	-0.004
Income, hhd-1	0.060	-0.001	0.121	-0.002	0.183	-0.003	0.245	-0.004
Income, hhd-2	0.066	-0.001	0.133	-0.002	0.200	-0.003	0.268	-0.004
Income, hhd-3	0.075	-0.001	0.151	-0.002	0.228	-0.003	0.305	-0.004
Income, hhd-4	0.086	-0.001	0.173	-0.002	0.261	-0.003	0.350	-0.004

Income, hhd-5	0.102	-0.001	0.205	-0.002	0.309	-0.002	0.414	-0.003
Income, hhd-6	0.116	-0.001	0.234	-0.001	0.353	-0.002	0.472	-0.003
Income, hhd-7	0.126	-0.001	0.252	-0.001	0.380	-0.002	0.509	-0.002
Income, hhd-8	0.134	0.000	0.268	-0.001	0.404	-0.001	0.542	-0.002
Income, hhd-91	0.134	0.000	0.269	-0.001	0.405	-0.001	0.543	-0.002
Income, hhd-92	0.129	0.000	0.259	-0.001	0.390	-0.001	0.523	-0.002
Income, hhd-93	0.137	0.000	0.276	-0.001	0.416	-0.001	0.557	-0.001
Income, hhd-94	0.134	0.000	0.268	-0.001	0.404	-0.001	0.542	-0.001
Income, hhd-95	0.131	0.000	0.263	-0.001	0.396	-0.001	0.530	-0.001
Real consumption, hhd-0	0.041	0.000	0.081	0.000	0.123	0.000	0.164	0.000
Real consumption, hhd-1	0.048	0.000	0.096	0.000	0.145	0.000	0.194	0.000
Real consumption, hhd-2	0.054	0.000	0.107	0.000	0.162	0.000	0.217	0.000
Real consumption, hhd-3	0.063	0.000	0.126	0.000	0.189	0.000	0.253	0.000
Real consumption, hhd-4	0.074	0.000	0.148	0.000	0.223	0.000	0.299	0.000
Real consumption, hhd-5	0.089	0.000	0.180	0.000	0.271	0.001	0.362	0.001
Real consumption, hhd-6	0.104	0.000	0.209	0.001	0.314	0.001	0.421	0.001
Real consumption, hhd-7	0.113	0.000	0.227	0.001	0.342	0.001	0.458	0.002
Real consumption, hhd-8	0.121	0.001	0.243	0.001	0.366	0.002	0.490	0.002
Real consumption, hhd-91	0.121	0.001	0.244	0.001	0.367	0.002	0.491	0.002
Real consumption, hhd-92	0.116	0.001	0.233	0.001	0.352	0.002	0.471	0.002
Real consumption, hhd-93	0.125	0.001	0.250	0.001	0.377	0.002	0.505	0.003
Real consumption, hhd-94	0.121	0.001	0.243	0.001	0.366	0.002	0.490	0.003
Real consumption, hhd-95	0.118	0.001	0.237	0.001	0.357	0.002	0.479	0.003

Source: authors' calculations based on PEP-UNSA CGE model.

Appendix B

Debugging history after further developments of the SAM

2015 South African SAM transformations

1. The trade margins in the original SAM contained in the cells ("trc",i) and counterbalanced with the values in the cells ("ctrad",trc) and ("cltrp",trc) were written in the cells ("ctrad", i) and (ctran, ctrad), the rows ("trc",*) and columns (*,"trc") were deleted. This means that the trade margins in the new PEP-SAM are located in the trade and transport commodities rows and under each respective commodity.

2. The export demand in the original SAM found in cells (i,"row") were taken to cells (x,"row") in the PEP-SAM. Then, these export values were reflected in the diagonal for the industries (j), which deliver to the export market (x). To differentiate the production for the local markets (j,i) and the export markets (j,x), the values for (j,x) found in the diagonals of the (j,x) were subtracted from the values (j,i). This means that industries (j) deliver a share into the local market (j,i) and another to the export market (j,x).

3. In the domestic supply accounts, some cells had negative values, so the following accounts were aggregated.

4. Transfers from ROW to factor labour were transferred to cells that represent transfers from ROW to households according to the shares these households contribute to the total labour supply.

5. The transfer from ROW to factor capital fcap was transferred to the cell representing transfers from ROW to the firm. This is because PEP1-1 model SAM does not define transfers made by the ROW to factor capital. To do this, the value in the cell SAM (K,fcap,AG,ROW) was deleted and moved to SAM (AG,FIRM,AG,ROW). This same value was subtracted from SAM (AG, FIRM, K, fcap) to rebalance the SAM.

6. (ROW,Labor) transferred to (ROW, HHDS) according to shares of labour income received by Households (HHds)

7. (GVT,GVT) transferred to (GVT, Firm) and (GVT,HHds) and added to (Firm,GVT) and (HHds,GVT) to rebalance the SAM.

8. Production taxes contained in the cells (TP, J*) were moved to (GVT,J*), and row (TP,*) and column (*,TP) were deleted.