



## Skilled labour emigration in South Africa – exploring the long-term implications

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### ABSTRACT

This paper simulates the long-term implications of skilled labour emigration for South Africa, using a recursive dynamic general equilibrium framework. It examines the effects of skilled emigration with or without offsetting measures, specifically the projected changes in productivity, growth, government revenue, and welfare over a 20-year period. The model includes three regions and eight sectors, an endogenous specification of productivity partly driven by emigration, and three labour categories differentiated by skill. Three scenarios are considered: skilled emigration without offsetting measures, skilled emigration with remittances, and skilled emigration in the presence of offsetting skill support subsidies. The aggregate results suggest that, in the absence of offsetting measures, skilled emigration will reduce long-term growth by 1.2% and primary factor productivity by 15.8% by 2040. In contrast, whereas remittances reinforce productivity losses in the short term and reduce growth by 0.4%, they reverse productivity losses in the long term and raise growth by 3.5%. Government skill subsidies have an immediate positive effect on productivity and growth. However, they adversely affect growth and welfare over the medium-to-long term. At the sectoral level, mining and manufacturing experience the largest losses from skilled emigration.

*Keywords:* Skilled emigration, CGE, productivity, growth

*JEL classification:* F22, J24, D58, O33, O47, O5e

## 1 INTRODUCTION

Migration has become a central theme in the development debate, especially for skill-constrained economies like South Africa. The loss of skilled workers has far-reaching implications for growth, income distribution, and structural change.<sup>1</sup> Recent data from the United Nations Department of Economic and Social Affairs (UNDESA) reveals an upward trend in South African emigration since 2015. This lends support to the anecdotal evidence which suggests that South Africa is currently experiencing a third wave of emigration that is significantly different from the immediate post-apartheid wave. As international labour markets become more accessible, and the global economy more integrated and knowledge-based, the reallocation of skilled labour to developed countries is likely to increase.

If we ignore migrant characteristics, this trend might appear trivial for South Africa, which is both a receiving and source country for migrants. In 2019 it was a net receiver of migrants, with immigrants accounting for 5.3% of its population (IMO, 2020). But when migrant characteristics are considered, the profile and composition of South Africa's immigrants and emigrants differ significantly. South African immigrants are a diverse group comprising workers of all skill levels. Estimates suggest that of the 4.2 million foreign-born nationals residing in South Africa in 2019, only 294 417 working immigrants were skilled. In contrast, emigrants tend to be highly educated with above-average skills. Applying Organization for Economic Co-operation and Development (OECD) estimates to the most recent emigration statistics from UNDESA reveals that there were approximately 410 550 highly skilled South Africans in the OECD alone in 2019. These numbers suggest that South Africa loses more skilled workers to emigration than it receives. Furthermore, unlike immigrants, who tend to be temporal residents, South African emigrants are unlikely to return.<sup>2</sup> Also, while 75% of the immigrants are from within Africa, particularly the Southern African region, emigrants tend to be trained in South Africa. According to the 2020 US-news global rankings, Africa's top five universities were all South African. This implies that the quality of skilled workers entering and leaving South Africa is not comparable.

Understanding the potential long-term implications of skilled labour emigration for South Africa is limited by the lack of empirical studies. Early literature such as Bhagwati and Hamada (1974) suggested that the skilled transfers from the source to the destination country presented a significant loss for the source region. This is because it reduces the stock of human capital, lowers growth and constrains a country's ability to innovate and adapt new technologies. Notwithstanding, views on skilled labour are shifting. A growing body of literature, including Khadria (2012), Bhate and Sharma (2014), and Beine, Docquier, and Rapoport (2001) suggests that, if carefully managed, skilled emigration can be beneficial to the source country. According to these recent studies, the early studies found skilled emigration to be detrimental because they ignored the positive spillover effects of skilled migration, such as knowledge transfer, technology spillover, network effects, and the effect of emigration on incentives to acquire human capital. Indeed, countries with historically high levels of skilled emigration, such as India, Korea, and China, have managed to build strong and technology-driven emergent economies. Because of this observed potential, most source countries are now embracing emigrants as development partners. In light of this, South Africa made migration a central part of its development strategy in its 2016 Green Paper (GP) on International Migration. Although skilled emigration is central to the development debate, empirical studies on its effects on the source country are limited and inconclusive.

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<sup>1</sup> Skilled labour refers to workers with high-level skills indicated by an academic degree or equivalent qualifications.

<sup>2</sup> For South Africa, attitudes towards return emigration are likely race-specific. While no study has been undertaken to study emigrant attitudes by race, a 1998 survey discussed in Crush et al., of which 88% of respondents were white, found that only 6% expressed interest in returning.

The differing positions on the effects of skilled emigration highlight its complexity. Understanding the potential country-specific effects of skilled emigration is essential for the design and implementation of targeted policy. It is also necessary for long-term budgetary planning and social-economic development. For South Africa, studies on skilled emigration are limited. In fact, the most recent study on skilled emigration was by Bohlman in 2010. The aim of the present study is to quantify the long-term effects of skilled emigration for South Africa. It uses a recursive computable general equilibrium (CGE) framework to simulate the long-term implications of skilled labour emigration with or without offsetting measures. It includes endogenously determined primary factor productivity, skill- and sector-specific emigration, remittance inflows, and offsetting government subsidies. A key objective of this research is to contribute to the discussion on South Africa's strategies for inclusive growth by quantifying the long-term effects of skilled emigration. This is in line with the acknowledgment of the need for more research on outmigration and the diaspora outlined in South Africa's Green Paper.

The results are consistent with findings of earlier studies that skilled emigration has adverse long-term effects. They reveal that, in the absence of offsetting measures, skilled emigration lowers South Africa's long-term growth by 1.2%. But, unlike in the findings of recent literature, remittances are shown to initially reinforce primary-factor productivity losses and lower growth. The benefits of remittances for both productivity and growth evolve over time. The model projects that a 2% rise in household income from remittances will raise growth by 3.5% over a 20-year period. In contrast, skill support subsidies reverse the productivity losses caused by emigration in the first five years. By the end of the 20-year period, primary-factor productivity will increase by 24%. However, whereas growth initially rises by 0.4%, in the long term it is 1.1% lower than the baseline. These results suggest that, although government subsidies improve productivity, they only partially offset output losses. They also project that the largest welfare losses of 2.98% occur under the skill subsidy. This is because the policy is assumed to be not revenue-neutral; the subsidy scheme reduces government revenue and aggregate demand. Also, accommodating the subsidies requires a reduction in government expenditure of social services and public investments. At the sectoral level, skilled emigration adversely affects the mining and manufacturing sectors.

The paper is organized as follows. Section 2 presents the background to the study and discusses the literature on skilled emigration and its implications for the source country. Section 3 presents the modelling framework. The model data sources and simulation design are explained in section 4. Section 5 presents and discusses the simulation results. Section 6 concludes the study and offers suggestions for future research.

## 2 BACKGROUND AND LITERATURE REVIEW

### 2.1 Background

South Africa is positioned as both a source and a recipient of international migrants. In 2019, 4.2 million immigrants were residing in South Africa and there were 824 000 South African emigrants in other countries (IMO, 2020; UNDESA, 2020). For a long time, South Africa has been a net recipient of migrants; in 2017 South Africa's net migration was 727 000 (IMO, 2020). However, the characteristics of South African immigrants and emigrants are markedly different. Immigrants are a diverse group, but a significant proportion work in low-skill occupations and in the informal sector. Budlender (2014: Table 16) found that only 24% of employed immigrants were skilled. When applied to the most recent immigration numbers, this proportion suggests there were approximately 294 417 skilled immigrants in South Africa in 2019. Furthermore, unlike emigrants who tend to be trained in South Africa and permanently reside in destination countries, immigrants tend to be temporal. Also, 75% of them derive from within Africa, particularly the Southern African region which accounts for 67% of South African immigrants (Meny-Gibert, & Chiumia, 2016).

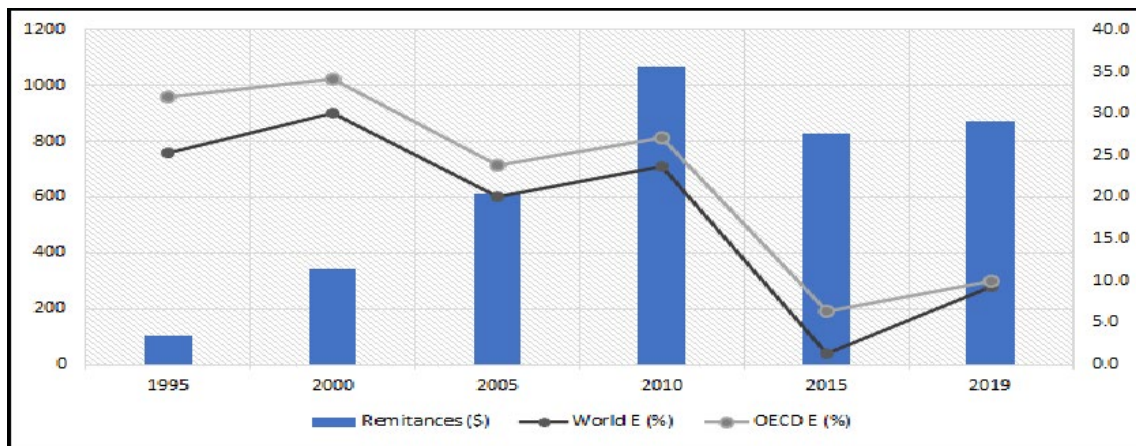
In contrast, because international migration is positively selective, the bulk of emigrants tend to be highly educated with above-average skills. A 2019 study by the OECD found that in 2015–16, 54% of South Africans residing in OECD countries were highly skilled. When applied to the 2019 emigration numbers, this proportion suggests there were 410 550 highly skilled South Africans in just the OECD countries in 2019. This number suggests that South Africa loses more skilled workers to emigration than it gains from immigration. For individual countries in the OECD, the proportion of highly skilled emigrants is higher. For instance, the Australian government estimates that 67% of South Africans residing in the country have a tertiary education. Similarly, a 2013 survey by Crush et al. found that 54% of South African respondents residing in Canada had a university degree and that a third of the respondents were healthcare professionals. Notwithstanding the numbers, the OECD (2004: 117) contends “that official emigration statistics underestimate the scale of outflows, though they do reflect the rising trend in the numbers of skilled workers leaving” source countries.<sup>3</sup>

Almost 90% of emigrants reside in the OECD region; Table A1 in the appendix shows the distribution of emigrants in the top seven receiving countries. According to the OECD (2019), South Africa ranked fourth among migrant source countries to the OECD. The number of South African emigrants increased from 362 000 in 2000 to 635 000 in 2016, an increase of 42%. Most emigrants are natural scientists, engineers, and healthcare professionals. According to the OECD, compared with other occupations, healthcare drew the most emigrant labour. In a survey of foreign-born physicians in the U.S., Duvivier et al., (2017) found that there were 1 709 South African-trained medical doctors there. The same study showed that, between 2005 and 2015, the number of African-trained doctors in the U.S. increased by 27.1%. In 2015, 76% of the African-trained doctors practising in the U.S. came from five countries: Egypt, Nigeria, South Africa, Ethiopia, and Ghana, with South Africa ranking third. South African emigrants are also less inclined to migrate for economic reasons; the main push factor is quality of life, especially safety and security. Emigrants tend to be trained in South Africa and are more likely to permanently reside in their adoptive countries. A 2013 study by Crush et al. found that over time a significant proportion of South Africans progressively disinvested and cut economic links to South Africa.

South African emigration tends to be nonlinear. In fact, South Africa has experienced three waves of emigration since 1995. Figure 1 shows that in the immediate post-apartheid period, emigration increased by 25%, peaking at 30% in 2000. Between 2001 and 2005, emigration fell by 10%. The second wave struck between 2005 and 2010, when migration increased by 23%. Following 2010, emigration grew by only 1.3%. Duvier et al. (2017) found that the number of South Africa doctors practising in the U.S. fell by 7.2% between 2005 and 2015. Emigration has risen by 9.2% since 2015. The latest data from UNDESA (2020) suggests that South Africa will lose an annual average of 11 800 skilled workers between 2016 and 2021. This trend supports anecdotal evidence that South Africa is experiencing a third wave of emigration. Unofficial data suggests the current wave is distinctively different from the immediate post-apartheid wave. The post-apartheid wave consisted mainly of white South Africans, whereas the current wave has seen an increase in the number of nonwhite professionals, and high-income South Africans of all races leaving the country.

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<sup>3</sup>Similarly, Bhorat et al. (2000) noted that South Africa’s out-migration is significantly higher than that reported in the official data.



**Figure 1: Remittances inflows and changes in emigration flows, 1995–2019.**

Sources: World Bank (2020); UNDESA (2020)

There are several concerning implications of the current surge in skilled emigration. The narrow view suggests that the reduction in the skilled labour supply will have adverse effects on South Africa’s long-term growth. This is because growth is driven by a country’s productivity, and productivity depends on the economy-wide stock and quality of human capital. The loss of human capital also constrains a country’s capacity to innovate and adopt new technologies. In addition to worsening the skill deficit, the emigration of skilled workers reduces savings and tax revenue, which constrains the country’s ability to provide basic social services and critical public infrastructure. Lower savings affect future growth because the amount available for private sector investment is reduced. For a country with an acute skills shortage, skilled emigration weakens efforts to reduce the skills gap. Between 2005 and 2015, South Africa had an average annual skills gap of 239 000 (Foko, 2015). While more skilled South Africans have entered the job market, the 64 000 yearly average has not been enough to narrow the gap.

Nonetheless, views on skilled emigration are changing. A recent and broader perspective suggests that, if managed effectively, emigration can benefit the source country. For this reason, governments are increasingly embracing emigrants as developmental partners. The developmental impact of skilled emigration is likely to arise from knowledge transfer, remittances, investments, and the eventual return to the source country (Bharte, 2014). Remittances in particular are taking centre stage in the poverty and development discourse. A World Bank study found that a 1% increase in the share of remittances in GDP can reduce poverty and inequality by 0.37% and 0.08% respectively. Also, if remittances are spent on investment goods such as education and housing, remittances can have a positive effect on human capital.

Studies estimate 70% of non-resident South Africans send remittances. Figure 1 shows the remittance inflows since 1995. Since 2005, remittances have been correlated to emigration trends. But while the average remittance from emigrants is approximately USD 1000, remittances account for only 0.2% of South Africa’s GDP. Furthermore, return migrants can bring skills, experience, knowledge, and resources that can support development. Return migration plays a critical role in today’s knowledge-based development. The challenge is that a significant proportion of non-resident South Africans are reluctant to return. A study by Crush et al. (2013) found that 80% of South Africans surveyed in Canada stated that they had no interest in returning, while a sizeable proportion had no interest in supporting South Africa’s developmental process.

## 2.2 The literature

The literature on skilled emigration in South Africa is limited; this subsection offers a generalised discussion on the topic. Furthermore, because the determinants of emigration are well documented, the focus here is on the effects of skilled emigration on the source country. While research on skilled out-migration is extensive, there is a lack of consensus about its effects on source countries. Skilled emigration has long been perceived as detrimental to the source country, but, as mentioned above, views are changing. Recent literature suggests that, if carefully managed, skilled emigration can confer sizeable benefits on source countries. The technological advancement and growth performance of major sending countries like China, India, and South Korea lends credence to changing views. According to Campos-Vazquez and Sobarzo (2012), the effects of emigration vary according to demographic and socioeconomic characteristics of emigrants, the economic and political environment of the source country, and the household unit (household, local or national).

### 2.2.1 Labour market effects

The law of diminishing returns dictates that, all things being equal, the reduction in the supply in a factor endowment will increase its marginal productivity and associated return. Therefore, one would expect wages for non-emigrant skilled workers in source countries to rise relative to other labour categories. Studying the effects of emigration in Mexico, Mirsha (2006) found that a 10% reduction in labour supply induced by emigration increases wages on non-emigrants by 4–6%. In a similar study, Campos-Vazquez and Sobarzo (2012) found that between 1990 and 2000 the wages of Mexicans rose by 8%, with pronounced effects among unskilled workers. Additionally, Beine et al.'s (2008) results suggested that skilled emigration can raise wages of remaining skilled workers by 3.7%. Modeling the long-term effects of emigration on several countries, Docquier et al. (2010) confirmed these earlier findings: for instance, that emigration increased wages of non-emigrant skilled workers by 1.3% in Mexico and 1.3 % in South Africa.

Notwithstanding, the net effect of skilled emigration on source country wages depends on several competing factors. For example, Freedman (2006) noted that, when education is exogenous, the reduction in skilled labour associated with emigration raises the wages of remaining skilled workers but reduces the wages of unskilled workers. In addition, labour efficiency changes are likely to affect wages in source countries. These studies did not consider the interaction between decreased labour supply, productivity changes, and other factors such as the existing stock of skilled workers and the skill intensity of production.

### 2.2.2 Implications for growth and productivity

The literature on the productivity effects of skilled out-migration has been inconclusive. Early studies by Bhagwati and Hamada (1974) suggested that skilled emigration depletes the stock of human capital and reduces productivity. Likewise, Djiofack et al. (2013) posited that the loss of human capital through emigration can reduce productivity and growth because it constrains innovation and the adoption of new technologies. This is particularly detrimental when the source country has pre-existing skill shortages. Djiofack et al. modelled the effects of skilled emigration on Cameroon and found that the negative effects on productivity outweigh positive effects than can arise from remittances and productivity gains from unskilled workers. Results from an empirical evaluation of the growth effects of skilled labour emigration on source countries by Beine et al. (2002: 6) suggested that the migration of highly skilled labour has a positive impact on human capital formation in source countries.

Several studies have found that, without offsetting measures and factors, skilled emigration reduces output and growth. Marchiori et al. (2012) used a CGE model to simulate the effects of skilled labour demographic shocks on GDP per capita, national income, and capital accumulation. They found that in the absence of induced effects from migration incentives, a 20% shock to skilled labour emigration reduces per-capita GDP by 0.2 to 7% over a 40-year period. Nonetheless, when they allowed for the positive emigration incentive effect, the effect on per-capita GDP is positive, but small. Their results

suggested that the potential rise in human capital from increased emigration incentives can offset negative growth effects of skilled emigration.<sup>4</sup>

In a study on South Africa, Bohlman (2010) found that direct and indirect skilled emigration shocks unambiguously reduced South Africa's GDP. Unlike Marchiori et al. (2012), he used a static CGE model to simulate both the direct and indirect effects of skilled labour emigration. In the former case, he applied a negative shock to skilled labour; in the latter he simulated a 1% reduction in primary factor productivity. His third simulation combined both the direct labour shock and the reduction in factor productivity. He found that GDP declines under all three scenarios, with the largest decline when the reduction in labour is combined with a reduction in productivity. His results unambiguously suggest that at the macro level skilled labour emigration has a negative effect on growth, exports, and competitiveness. While insightful, his analysis does not consider the distributional effects of migration, which, for a country like South Africa, might be significant. Furthermore, his analysis does not distinguish between skill-intensive industries.<sup>5</sup> Finally, his analysis does not address the effects of remittances and the possibility of skills transfers.

### **2.2.3 Spillover effects**

The studies in the preceding subsection suggested that ignoring the potential spillover effects often presents a narrow and often distorted picture of the implications of skilled emigration for source countries. Several studies suggested that skilled emigration can raise growth and productivity on source countries through its effect on incentives to acquire human capital, technology diffusion, and capital flows.

Docquier and Rappaport (2012) explained that skilled emigration does not always deplete a source country's human capital stock; it can generate positive network externalities. Higher return to education in developed countries and increased migration opportunities can raise the expected return to human capital and induce more people to invest in education (Egger & Felbermayr, 2009; Beine et al., 2008; Di Maria & Stryszowski, 2006). Overall, expectations to emigrate can raise the stock of human capital because not everyone gets to emigrate. Beine et al. (2008) found that doubling the rate of emigration increases human capital formation by 5%. For South Africa, they find that when emigration prospects are the same for skilled and unskilled workers, human capital formation increases by 0.4%. Egger and Felbermayr (2009) noted that if only a small fraction emigrates skilled workers who remain in the source country are better off.

The authors, however, cautioned that increased migration opportunities could distort incentives and be detrimental to growth. Similarly, Di Maria and Stryszowski (2006) found that the possibility of emigration can distort incentives for agents to invest in education and skills development appropriate for the source country, given its level of development. During the early stages of development, increased migration possibilities can be detrimental to growth. Furthermore, in contrast to Beine et al. (2008), Egger and Felbermayr (2009) found that when migration prospects are the same across skill categories and education is endogenous, incentives to invest in education decline. However, when emigration prospects vary, with higher prospects for skilled labour, increased migration opportunities engender incentives to invest in education. Because current international migration is positively selective, increased migration prospects are likely to motivate higher private educational attainment in sending countries.

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4 They also observed that capital flows are not sensitive to the changes in relative returns induced by emigration and that the negative effect on GDP per capita is smaller.

5 It ignores important sectoral effects that arise when skill-intensive sectors experience a decline in labour and skills.

The extent to which skilled emigration increases capital and enhances growth in source countries depends on whether emigration results in technology diffusion. Marchiori et al. (2012) observed that, from a static theoretical point of view, the exogenous outflow of capital from developing to developed regions raises the productivity of capital in destination countries. The associated increase in the return to capital causes an outflow of capital from source countries. Conversely, emigration and foreign capital flows can be complementary when emigration induces technology diffusion. With technology, enhancement raises improvements in capital productivity, which can attract capital inflows to source countries.

#### **2.2.4 Fiscal implications**

Other spillover effects include lower government revenues and the potential reduction in the provision of infrastructure, public health, and other social services. Skilled labour accounts for a significant proportion of the middle class and the tax base. Early studies by Bhagwati and Hamada (1974, 1982) explained that skilled labour emigration generates a tax externality associated with the distortion of the tax system in two ways. First, because skilled labour income is a significant source of tax revenue, a reduction in skilled labour results in a loss in government revenue and limits its revenue redistribution potential. Second, educational investments in most countries are publicly funded. These investments cannot be recovered when skilled professionals emigrate. In South Africa, education is publicly funded, so emigration constitutes a loss in public investment. Moreover, when the social return in education exceeds the private return, a loss in human capital can result in a reduction in welfare. For specific skill categories like healthcare professionals, emigration hinders the ability of the government to remedy pre-existing imbalances in healthcare.

Campos-Vazquez and Sobarzo (2012) offered an empirical perspective on the fiscal implications of emigration for Mexico. Using an applied general equilibrium model, they simulate the 6% in the emigration rate on GDP growth and tax revenue. They found that, in the absence of remittances, a 6% labour shock reduces GDP and tax revenue by 3.6% and 3%, respectively. However, when labour shock is combined with an 18% increase in capital stock (a proxy for remittances), GDP increases by 8.8% while tax revenues increase by 7.4%. Notwithstanding, the authors do not explain the significantly larger positive capital shock.

#### **2.2.5 The role of remittances**

Remittances are a widely debated issue in migration literature. In some countries, remittances account for a sizeable proportion of GDP. In 2010, remittances accounted for 19% and 15% of GDP in El Salvador and Honduras, whereas in absolute terms remittances totaled USD 22 billion in Mexico (Campos-Vazquez & Sobarzo, 2012). Yet, like other issues associated with emigration, research on the net effect of remittances on source countries is inconclusive. In theory, remittances can offset some of the negative effects of migration, including human capital losses, productivity, income distribution, and poverty. They play an important role in food security and education because they flow to immediate and extended family members. By facilitating the education of family members, remittances contribute to the development of human capital and skill acquisition. The World Bank found that a percentage point increase in remittances reduces inequality and poverty by 0.8% and 0.37% (Campos-Vazquez & Sobarzo, 2012). Similarly, Campos-Vazquez and Sobarzo (2012) found that remittances have an observable impact on extreme poverty, but suggested that the effects are temporary. Comparing remittances from skilled and unskilled emigrants in Cameroon, Djiofack et al. (2013) found that remittances from skilled emigrants tend to be regressive, whereas those from unskilled emigrants are more likely to reduce inequality. Furthermore, they found that the effects of remittances on poverty are marginal. Bussolo and Medvedev (2007) asserted that remittance inflows can raise reservation wages, reduce labour supply, and lead to an appreciation of the exchange rate and worsening export performance. And, in some instances, remittances can influence savings and investment behavior and affect long-term growth.



Campos-Vazquez and Sobarzo (2012) found that, while remittances improve access to healthcare and basic education, they can create disincentives to invest in higher education. Other studies suggest that the net effect of remittances depends on the type of emigrant and the effect of remittances on the incentives of the recipients. Beine et al. (2012) contended that skilled emigrants have a lower propensity to remit than unskilled emigrants. This position was supported by Crush et al. (2013), who found that skilled South Africans are less likely to remit money to their home country. In contrast, Bollard et al. (2011) surveyed 33 000 migrant households in the OECD and found no difference between remittances by the two labour categories. They found that, whereas unskilled emigrants remit more frequently, on average, skilled migrants tend to remit larger amounts. Similarly, Bredtmann et al. (2019) found that level of education does not affect the propensity to remit, but, like Crush et al. (2013), they found that the size of remittances is higher for educated/skilled emigrants.

### **2.2.6 Emigrants as partners in development**

Source countries are increasingly becoming aware of the central role that emigrants can play in national development. Bharte and Sharma (2014) noted that emigrants can transfer knowledge and its associated benefits without an actual presence in the source country. Skilled diaspora plays a unique role in promoting technology diffusion, which enhances total factor productivity in source countries (Marchiori et al., 2012; Kerr, 2008; Lodigiani, 2008). Similarly, Kadir (2012) posited that members of diasporas can act as a conduit for the transfer of technology, skills finance and networks from host countries. Furthermore, a large and engaged diaspora can help reduce information-related transaction costs and facilitate investment inflows (Marchiori et al., 2012). Countries like India have implemented policies to actively engage Indians in the diaspora. For instance, non-resident Indians have been given voting rights. In addition, the government has created an organisation to build a social philanthropy network, and they have a Prime Minister’s advisory council that draws on the expertise of highly skilled emigrants (Bharte & Sharma, 2012).

Return migration plays a catalytic role in knowledge-based development. Return migrants can bring skills, experience, knowledge, and resources that can support development. However, the realisation of the potential contribution of returnees to development requires certain social and institutional apparatus to be in place. Klagge and Klein-Hitpaß (2010) explained that the catalytic impact of return migrants crucially depends on social networks facilitating their integration into source country labour markets, and an institutional framework that can support their investment and innovation endeavours. Moreover, “in order for returnees to invest their financial resources productively, they have to be able to identify investment opportunities and assess the associated risk” (p. 1637). In China, high-tech zones have been established for entrepreneurial migrants (Sternberg & Muller, 2007).

South Africa’s policy on migration, as outlined in the 2016 Green Paper on International Migration in South Africa (GP), states that international migration policy must engage non-resident South Africans in national development (Crush et al., 2017). However, unlike other emerging economies, South Africa does not have the infrastructure or institutional framework to harness the development potential of non-resident South Africans. According to a survey of South Africans living in Canada by Crush et al. (2013), 50% of South Africans residing in Canada participated in some kind of economic activity in their source country (p. 2). 10% engaged in research partnerships, while 11% participated in investment-generated employment. The same study found that, while their perception of post-apartheid South Africa was negative, 40% held South African bank accounts. Notwithstanding, the study showed that over time the majority of respondents had progressively disinvested and severed ties with South Africa.

Building on this background and literature, this study seeks to answer the four questions specific to South Africa. First, what are the long-term implications of skilled labour emigration for growth, productivity and government revenue? Second, what are the long-term labour market and distributional effects? Third, can remittances offset the potential negative effects of the loss of skilled

labour? And, finally, are government subsidies an effective instrument to counter the negative effects of emigration?

The emigration of skilled professionals presents a major challenge for a skill-constrained nation like South Africa. Importantly, it is a key policy issue. Like many scholars, Crush et al. (2017) asserted that “the development and inclusive growth impacts of migration for source and destination countries are less well understood” (p. 34). By quantifying the long-term effects of skilled labour emigration for South Africa, the present study aims to clarify the complex issue of emigration as it pertains to South Africa. In addition, it will ascertain whether the South African government should be proactive in engaging South Africans living abroad as partners in development.

### 3 METHODOLOGY

The preceding discussion reveals that South Africa loses more skilled workers to migration than it receives. For this reason, the analysis focuses on the effects of skilled emigration only. It does not address the causes of emigration because these are well documented in the literature. The literature in the preceding section has also established that the effects of skilled emigration on the source country depend on a complex interaction of several factors. The computable general equilibrium (CGE) modeling framework is currently the best analytical tool to capture these complex interactions and the multidimensional and long-term effects of skilled emigration. A CGE model is a simplified representation of the economy that accommodates the interlinkages between different agents, sectors, and markets. Its advantages lie in its ability to accommodate several shocks and to capture economy-wide effects.

The CGE model used in this study the model is recursive dynamic. A dynamic framework is necessary to capture the long-term effects of skilled emigration and assess how it affects South Africa’s growth trajectory. It is recursive because it traces the growth trajectory as a set of inter-connected static equilibria linked by capital accumulation. The modelling framework includes structural features of South Africa’s labour market. Because that market is central to understanding the model projections, this section begins with a brief discussion of it and its position relative to those of other emerging economies.

#### 3.1 South Africa’s labour market

South Africa’s labour market is dominated by semi-skilled workers. This is illustrated in Table 1, which shows the structure of the market between 2004 and 2019. It shows that it is dominated by workers with low and intermediate skills. In 2019, unskilled and semiskilled workers accounted for 54.4% of the labour force, and skilled workers 16.4%. It also shows that the proportion of skilled workers declined from 19% in 2014 to 16.4% in 2019. Furthermore, the composition of the skilled work category has changed. For instance, the number of professionals increased from 458 000 to 917 000 between 2004 and 2014, and technicians were the largest group of skilled workers in 2004 but fell behind managers in 2019.

Notwithstanding the small proportion of skilled workers, South Africa’s labour market is biased toward them. Skilled workers have low employment elasticity and face significantly lower unemployment rates; the opposite is true for both semi-skilled and unskilled workers.

**Table 1: Structure of South Africa's labour force: employed labour by occupation**

	2004	2014	2019	2004	2014	2019
	'000	'000	'000	%	%	%
Working age population	29 305	35 489	38 582			
Size of labour force	15 778	20 268	23 109			
Manager	910	1 358	1 436	5.8	6.7	6.2
Professional	458	917	962	2.9	4.5	4.2
Technician	1 149	1 568	1 395	7.3	7.7	6.0
Total skilled	2 517	3 843	3 793	16.0	19.0	16.4
Clerk	169	1 601	1 696	1.1	7.9	7.3
Sales and Services	1 453	2 296	2 777	9.2	11.3	12.0
Skilled agriculture	326	86	66	2.1	0.4	0.3
Craft and trade related	1 538	1 816	1 912	9.7	9.0	8.3
Plant and machine operator	1 113	1 270	1 343	7.1	6.3	5.8
Total semi-skilled	4 599	7 069	7 794	29.1	34.9	33.7
Elementary	2 619	3 242	3 759	16.6	16.0	16.3
Domestic work	881	961	1 027	5.6	4.7	4.4
Total unskilled	3 500	4 203	4 786	22.2	20.7	20.7
Unspecified	23	2	2	0.1	0.0	0.0
<b>Total</b>	<b>10 639</b>	<b>15 117</b>	<b>16 375</b>	<b>67.4</b>	<b>74.6</b>	<b>70.9</b>

Source: South Africa's Quarterly Labour Force Survey 2004, 2014 and 2019.

South Africa's demand for skilled workers is high and growing. However, the misalignment of skills and the persistently low and lagging supply of skilled workers has caused a continuous and acute skills shortage. Between 2005 and 2014, South Africa had a net increase of 2.15 million highly skilled jobs (Foko, 2015) or an annual average of 239 222 net new highly skilled jobs. During the same period, the supply of skilled workers grew by an annual average of 64 000 (QLFS, 2004, 2015). This implies that the loss of 11 800 skilled workers per year to emigration limits the effectiveness of policies aimed at closing the skills gap.

**Table 2: Selected development indicators, South Africa and rest of BRICS, 2017**

	GDP per capita <sup>1</sup> Growth (%)	Total factor productivity <sup>2,3</sup> Relative to US	Human capital index <sup>2</sup>	Doctors <sup>4</sup> (per 10 000)	RD researchers <sup>1</sup> per 1 000 000	Hightech exports <sup>1</sup> % of total manufactured
S. Africa	-0.003	0.53	2.81	9.05	517.72	5.68
Brazil	0.51	0.47	2.95	21.65		13.86
China	6.35	0.38	2.57	19.8	1224.78	30.91
India	5.91	0.45	2.12	7.8	252.7**	7.39
Russia	1.71	0.53	3.40	37.5*	2821.53	12.44

Notes:

1. Source: World Bank Indicators; 2. Source: Penn World Tables 9.1. Feenstra et al (2015); 3. TFP relative to the US; 4. Source: WHO (2020)  
\*2015, \*\*2018

To gauge South Africa's level of human capital development, it is important to compare it with other emerging economies. Here, a comparison is made with the other four BRICS countries (Brazil, Russia, India and China), which are also important sources of international skilled labour. China, India, and Russia have all harnessed the potential of citizens living abroad and returnees to support technological progress and development. Table 2 shows that, unlike the other four BRICS countries that had per-capita GDP growth rates exceeding 1%, South Africa's per-capita GDP growth was negative.

Still, the labour market indicators suggest that South Africa is by some measures similar to or even better than other BRICS countries. For instance, in 2017, the level of human capital development in South Africa as measured by the human capital index was better than in China (2.57) and India (2.12), though worse than in Brazil (2.95) and Russia (3.40). Likewise, total factor productivity relative to the U.S. was comparable to Russia but higher than the other three BRICS countries. The last three columns of Table 2 offer insights into how South Africa's stock of skills compare to the rest of BRICS. The table shows that there were nine doctors for every 10 000 South Africans in 2017; this is close to the one per every 1 100 recommended by the World Health Organization (WHO). But compared to Brazil, China, and Russia, South Africa's doctor-to-population ratio is low. The proportion is an indicator of a country's capacity to innovate and generate ideas. The data in Table 2 suggests that South Africa lags behind the other BRICS countries. Similarly, the proportion of high-tech exports is an indicator of technological intensity. Compared to other emerging economies, South Africa's technological intensity is low.

### 3.2 The model

The model is a set of linear and nonlinear equations describing the structure of each economy in the three regions. It is a three-region dynamic model with an eight-sector dynamic and six factors of production based on GDyn, the Global Trade Analysis Project's recursive dynamic model (Ianchovichina & McDougall, 2001; Ianchovichina & Wamsley, 2012). It is used to simulate the evolution in South Africa's economy over a 20-year period (2020–2040) in response to a skilled emigration shock. It is solved as a sequence of four five-year static equilibria linked through capital accumulation. To achieve the objectives of this study, the underlying model is augmented to include sector and skill-specific emigration rates, endogenous skill biased technical change partly driven by emigration, and three categories of labour: skilled, semi-skilled and unskilled.

The model preserves the standard features of the core model, including perfect competition, constant returns to scale, the Armington structure of internationally traded goods, a single representative household, and internationally mobile capital (see Armington 1969). However, as a departure, it relaxes the assumptions about exogenous labour supply and internationally immobile labour supply. Within each period, it is assumed that four skill-intensive sectors are subject to emigration shock: manufacturing, finance and communication, health, and education. It is assumed that the structure of each economy is the same and that the price system drives the responses to the emigration shocks. The following section offers an abridged version of the model, focusing on the parts directly associated with emigration.

#### 3.2.1 Production and supply

In each period, every firm seeks to minimize the costs of producing a certain target output level subject to a nested Constant Elasticity of Substitution (CES) production technology. Production technology in all eight sectors exhibits Constant Returns to Scale (CRTS), and firms integrate within competitive markets. The nested technology has the advantage of allowing for input combinations with varying degrees of substitutability. For instance, to produce gross output,  $X_{i,r}$ , firms combined a composite intermediate input and a composite primary input, the two composites are used in fixed proportions, here the elasticity of substitution, which measures the extent to which firms can substitute one input for another as relative productivity changes, is zero. Because the focus is on the shock to primary

inputs, I focus on the primary input nest. The second level nest describes the technology for each input composite. The primary factor composite is a CES combination of a physical capital/land/natural resource composite (K) and a labour composite (L) consisting of three types of labour. Here, the assumption is that the capital and labour composites are gross complements ( $\sigma_{va} < 1$ ). Finally, the third sub-nest defines the CES composite of the three labour classes. To allow for skill-biased technical change, the three labour categories are gross substitution ( $\sigma_L > 1$ ) and the elasticity of substitution  $\sigma_L = 3$ .

The nesting structure is described by equations (1) through (3). The first-level nest, described by Equation 1, defines the technology underlying gross output. According to Equation 1, gross output is a function of the quantity of intermediate and primary inputs and total factor productivity, denoted by  $A_{va,jr}$ . Gross output produced using a cost-minimizing combination of intermediate inputs ( $X_{j,r}$ ) and primary factors (VA). The two inputs are used in fixed proportions; an increase in the price of one input class will reduce demand for both primary factors and secondary inputs produced by firms. Intermediate inputs are sourced from both domestic and international markets using the Armington structure. Similarly, capital is sourced both domestically and internationally. Because the specific focus of this study is the migration of skilled labour, further elaboration is given to the primary inputs, particularly labour.

*Level 1: Gross output nest*

$$X_{ir} = \left[ \alpha_x X_{jr}^{\frac{\sigma_x - 1}{\sigma_x}} + (1 - \alpha_x) [A_{va,jr} V A_{ijr}]^{\frac{\sigma_x - 1}{\sigma_x}} \right]^{\frac{\sigma_x}{\sigma_x - 1}} \quad (1)$$

$$\sigma_x = 0$$

*Level 2 sub nest: Value added (primary inputs)*

$$V A_{ijr} = \left[ \alpha_L [A_{L,jr} L_{ijr}]^{\frac{\sigma_{va} - 1}{\sigma_{va}}} + (1 - \alpha_L) [A_{K,jr} K_{ijr}]^{\frac{\sigma_{va} - 1}{\sigma_{va}}} \right]^{\frac{\sigma_{va}}{\sigma_{va} - 1}} \quad (2)$$

$$\sigma_{va} < 1$$

*Level 3 sub nest: Composite labour*

$$L_{ijr} = \left[ \varphi_{sl} [A_{L,jr} s l_{ijr}]^{\frac{\sigma_L - 1}{\sigma_L}} + \varphi_{ssl} [A_{L,jr} s s l_{ijr}]^{\frac{\sigma_L - 1}{\sigma_L}} + (\varphi_{sl} + \varphi_{ssl} - 1) [A_{L,jr} u l_{ijr}]^{\frac{\sigma_L - 1}{\sigma_L}} \right]^{\frac{\sigma_L}{\sigma_L - 1}} \quad (3)$$

$$\sigma_L > 1$$

where  $\alpha_x$  and  $\alpha_L$  are the shares of the intermediate composite in gross output, and the labour composite in value added (primary inputs). Similarly,  $\varphi_{sl}$  and  $\varphi_{ssl}$  refer to the share of skilled and semi-skilled labour in total labour.  $A_{va,jr}$ ,  $A_{K,jr}$  and  $A_{L,jr}$  are productivity shift parameters for total primary factors, capital and labour, respectively.  $\sigma$  is the elasticity substitution between each input combination. And sl, ssl and ul refer to skilled, semiskilled and unskilled labour.

The primary input sub-nest is defined by Equation 2. Here, the factor K is a composite of physical capital, natural resources, and land. Similarly, L, labour, is a composite of three categories of labour, skilled, semi-skilled, and unskilled. It shows that the primary factor sub-nest is a CES function of the capital and labour composite inputs, and capital augmenting technical change  $A_K$  and labour augmenting technical change  $A_L$ . The assumption of gross complementarity between the two composite inputs implies that a fall in the demand for labour requires the demand for the capital composite to fall and vice versa.

Equation 3 defines the contribution of labour to value-added (primary factors) as a CES composite of skilled, semi-skilled, and unskilled labour. Here, labour is a function of skill-biased technical change, denoted by  $A_L$  and the relative shares of the three labour types. The technology shifter,  $A_L$

differentiates the productivity across the three labour types. The relative shares,  $\phi$ , which measure the importance of each labour type in a firm's production are sector-specific. For instance, skill-intensive sectors such as healthcare education, and finance have larger labour shares.<sup>6</sup> Because the three labour categories are imperfect substitutes, a rise in the relative price of one labour types causes firms to change their labour mix depending on the output elasticity of the labour type. The assumption that labour technical change is skill-biased implies that labour-augmenting technical change increases the productivity of skilled workers or favours skilled workers over the lower-skilled workers. The labour mix that firms employ is determined by costs minimizing choices.

Productivity is modelled endogenously to account for this emigration effect. Emigration affects input choices and labour demand through its effects on labour productivity and relative prices. Equation 4 describes the link between sectoral labour productivity and emigration rates. This specification derives from Djiofack et al. (2013), which shows that labour productivity is determined by  $H$ , which represents productivity changes arising from factors other than emigration, and the term in brackets, which is the part of productivity efficiency influenced by emigration. The latter is a weighted product of skill specific emigration rates denoted by  $emRate_{L,jr}$ . Each emigration rate is weighted by the elasticity of productivity of labour with respect to emigration,  $\gamma$ .

$$A_{L,jr} = H \left[ \prod_{L \in \{1,2,3\}} emRate_{L,jr}^{\gamma_{L,jr}} \right] \quad (4)$$

The effect of skill-augmenting technical change on relative wages and demand depends crucially on the elasticity of substitution. For technical change to be skill-biased, the elasticity of substitution has to be greater than unity ( $\sigma > 1$ ). Equations 5 and 6 describe the relationship between relative skilled wage, skill-biased technical change and the relative inputs.

$$w_{jr} = \frac{\omega_{sl,jr}}{\omega_{ssl,jr}} = \frac{\varphi_{sl,jr}}{\varphi_{ssl,jr}} \left[ \frac{A_{sl,jr}}{A_{ssl,jr}} \right]^{\frac{\sigma_L-1}{\sigma_L}} \left[ \frac{sl_{jr}}{ssl_{jr}} \right]^{-\frac{1}{\sigma_L}} \quad (5)$$

$$w_{jr} = \frac{\omega_{sl,jr}}{\omega_{ul,jr}} = \frac{\varphi_{sl,jr}}{1 - \varphi_{sl,jr} - \varphi_{ssl,jr}} \left[ \frac{A_{sl,jr}}{A_{ul,jr}} \right]^{\frac{\sigma_L-1}{\sigma_L}} \left[ \frac{sl_{jr}}{ul_{jr}} \right]^{-\frac{1}{\sigma_L}} \quad (6)$$

Following the marginal productivity of labour, a reduction in skilled labour raises the marginal productivity of skilled labour. This specification embodies two effects: the change in the relative wage due to a change in the ratio of the quantity of one labour type to another,  $\frac{\partial w_{jr}}{\partial (sl_{jr}/ssl_{jr})}$ , and the change in the relative wage due to skill biased technical change,  $\frac{\partial A_{sl}}{\partial A_{ssl}}$ . Equation 5 implies that, given the assumption of imperfect substitutability between the labour types, a reduction in the supply of skilled workers increases the wage of skilled workers, reduces the demand and wages for semi-skilled workers. In contrast, skill-biased technical change implies that a reduction in labour efficiency due to a fall in the supply of skilled workers reduces the relative wage of skilled workers. The overall effect of emigration on the relative wages depends on which of the two effects is stronger.

### 3.2.2 Final demand

Skilled emigration affects final demand through changes in relative prices, real factor income, and government revenue. Final domestic demand derives from a regional representative household. The

<sup>6</sup> Skill-intensive implies that a firm employs a larger proportion of skilled labour than other skill types.

regional household maximization and aggregate utility function subject to regional income. The utility function is a Cobb-Douglas function of per-capita private household utility, government utility, and savings. Both the representative private household and the government spend income on both domestic and foreign commodities.

### **Representative regional household**

The representative private household derives income from selling labour services, and renting out land and natural resources. In addition, it receives equity income by owning in firms (the private household does not directly physical capital). This income is complemented by transfers from the government and remittance inflows. Emigration affects private household income through labour income, remittances, and government transfers. The private household's consumption choices are constrained by income. A rise in income through remittances raises disposable income and allows the consumer to purchase more of both domestic goods and imports. The household's preferences are explained by the constant difference elasticity of substitution (CDES) function, and the associated demand function is described by Equation 7. This specification makes it possible to capture changes in budgetary allocation as income changes. This property of the CDES preference structure allows for a richer analysis of the effects of remittances on household consumption decisions.

$$X_{hi} = \frac{\left( \beta_{ir} U_i^{e_i(1-\theta_i)} (1 - \theta_i) \left( \frac{P_i}{e_o(p, U)} \right)^{-\theta_i} \right)}{\sum \left( \beta_{jr} U_j^{e_j(1-\theta_j)} (1 - \theta_j) \left( \frac{P_j}{e_o(p, U)} \right)^{-\theta_j} \right)} \quad (7)$$

where  $X_{hr}$  is the private household demand for composite commodity  $i$ ;  $\beta$ , the distribution parameter;  $\theta$ , the shift parameter; and  $e_o$  is the minimum expenditure required to maintain a given level of utility,  $U$ .

The government is a key driver of economic activity, which it influences through revenue mobilization and expenditure. In this model, government revenue mobilization is restricted to the collection of taxes on input use, output, exports, and imports. The government uses its revenue to finance its consumption expenditure and transfers to households (public investment is part of government consumption expenditure). Emigration influences government behavior through its impact on the tax base, and incentives to counter the effects of human capital depletion and spend on public services.

Because the model is dynamic, the propensity to save is determined within the model through adjustments in wealth and income. In each period, the regional household decides how much income to save to achieve and attain the required growth in the wealth-to-income ratio (Golub & McDougall, 2006). This specification implies that the household savings rate falls as the household reaches its required wealth-to-income ratio. Because skilled emigration and remittances affect household income, they will affect savings decisions over time.

### **International trade**

International trade is modelled on the standard assumption of imperfect substitution between domestic and imported goods and imperfect transformation between exports and domestic goods. The allocation of imports and domestic goods in domestic demand is determined by a nested constant of elasticity of substitution (CES) preference structure. Firms allocate their output between domestic and foreign markets to maximize sales based on a constant elasticity of transformation (CET) function. In this model, the small country assumption is imposed on South Africa. This implies that dynamics in the South African economy have no effect on global prices. The parameters that drive these allocations derive from the GTAP or are calibrated in the model. Migration affects the relative allocation of exports and imports by changing domestic prices.

### **Investment**

The key driver of the dynamic model is capital accumulation, which links each period equilibrium. Through capital accumulation, old capital is replaced over time through investment. In the dynamic GTAP model, investment is a composite of domestic and foreign investment driven by savings and the expected rate of return. Given the objectives of this study, a long-run scenario is assumed where investment adjusts until the expected rates of return are equalized across regions. In each period, investment responds to a deviation from the target rate of return. Investment adjusts to equalize regional rates of return and eventually equal the global rate. Within each region, investment is determined by the amount of savings in the global bank and the expected rate of return. Capital flows to regions with high expected returns and vice versa. These flows continue until the expected rate of returns and actual rates of returns are equalized across the regions.

The dynamic specification of the core model allows us to capture changes in capital flows resulting from demographic shocks. It also includes shifting parameters that can be shocked to capture the effects of other emigration factors mentioned in the literature that can cause capital to increase in response to a reduction in skilled labour supply or policy that facilitates the flow of investment.

#### **3.2.3 Model closure**

The model closure rules refer to the association of a particular endogenous variable to a binding constraint. The closure rules for this model reflect the questions underlying this study and some structural features of South Africa's economy.

#### **Micro closure**

The micro closure defines constraints placed on factor endowments. Land and natural resources are held constant at full employment. The constraint is such that the aggregate supply of each of these endowments equals their respective demands. The closure rules for capital and labour depart from the standard specification because both endowments are internationally mobile. Labour supply is endogenous, partly determined by emigration flows. Equation 8 describes the closer condition for regional labour markets.

$$\sum_{L=1}^3 \sum_{j=1}^8 L_{L,jr}^S - \sum_{L=1}^3 \sum_{j=1}^8 emRate_{L,jr} L_{L,jr}^S = \sum_{L=1}^3 \sum_{j=1}^8 L_{L,jr}^d \quad (8)$$

#### **Macro closure**

One of the objectives of this analysis is to ascertain the long-term effects of skilled emigration on macro variables, including the fiscal balance. The macro-closure rules are adopted to reflect certain structural features of the South African economy. The closure is based on the current account/savings investment identity ( $S_r - I_r = X_r - M_r$ ). South Africa has maintained a budget deficit since 2008. The model reflects this by endogenizing government savings and holding taxes fixed. Similarly, South Africa attracts a significant amount of foreign direct investment (FDI) and is also a source of FDI (foreign borrowing). This is captured by an endogenous current account and a fixed real exchange rate. The latter is the model numeraire price. This closure also is consistent with the underlying assumption of endogenous capital accumulation. Finally, investment is driven by savings, it adjusts to savings through the expected rate of return. Savings are equal to the sum of savings of private households, firms, government and foreign agents. Foreign savings are the sum of world savings and regional savings.

#### **3.2.4 General equilibrium**

To achieve an equilibrium, three conditions must be satisfied. First, there are no excess profits. Firms exhaust their revenue through purchasing intermediate and primary inputs (the zero-profit condition). Second, all markets are assumed to clear. There is no excess demand or supply (the market clearance condition). And, third, the representative regional household operates on its budget constraint. A



rational agent will maximize utility by spending all its disposable income on goods and services (the income balance). When all three conditions are met simultaneously, the general equilibrium is achieved as a set of prices and quantities that clear that markets. A shock to this equilibrium will result in a new set of market-clearing prices and quantities.

### 3.2.5 Dynamics

The model is solved as a sequence of single-period equilibria. The transition from one period to the next occurs through capital accumulation. Within each period, capital corresponds to the previous period's capital stock, new capital (investment) adjusted for capital consumption (depreciation).

The evolution of South Africa's population is endogenous, determined by migration flows. Equation 9 describes the determination of the population within each period. The population in each period is the difference between the base population adjusted for projected natural growth minus the aggregate number of emigrations from all the sectors. The emigration rate is exogenously determined.

$$Pop_{r,t+1} = P_{r,t}(1 + pgrow_r) - \sum_{L=1}^3 \sum_{j=1}^8 emRate_{L,jr} L_{L,jr} \quad (9)$$

## 4 DATA AND CALIBRATION

### 4.1 Data

The underlying database for the model is the GTAP vol. 10 database, which, for the purposes of this analysis, captures the world economy in 2014. It is comprehensive, covering 141 regions/countries, 65 sectors, and five factors of production. The database, compiled by Aguiar et al. (2019), includes values of production, intermediate and final consumption, and imports and exports. For this analysis, the 141 GTAP regions are aggregated into three: South Africa (Zar), the rest of Southern Africa (RSafr), and the rest of the world (ROW). The 65 sectors are aggregated into eight, to allow for the simulation of changes in skill-intensive sectors. These sectors include key drivers of South African economy, (Agric), food processing (FoodPrc), mining (MinMet), manufacturing (Manfc) and skill sensitive service sectors, finance (FinCom), health (Health), education (Educ), and other services (Osvcs). Finally, an additional endowment class, semi-skilled labour, is added to the five GTAP endowments of skilled (Sklab) unskilled (Usklab) labour, land, capital, and natural resources (NatRes).

The choice of sectoral classification is based on the premise that some sectors are more susceptible to skilled emigration than others. For instance, health, ICT, and educational sectors tend to have higher-skilled emigration rates than others because of higher global demand. For instance, Singer (2012) of the Brookings Institute showed that, in the U.S., sectors such as healthcare, high-tech manufacturing, information technology, and life sciences had a higher proportion of foreign-born skilled emigrants than skilled natives. Similarly, she found a high representation of foreign skilled emigrants (17%) in post-secondary teaching. In contrast, sectors such as agriculture, construction and food services had a lower proportion of foreign skilled workers relative to native-born workers. The categorization of labour into skilled, semi-skilled and unskilled corresponds with the three labour classes defined in South Africa's labour force surveys. Table 3 shows how occupations are distributed across the three categories.

## 4.2 Parameterization and calibration

Parameterization is the process of choosing parameters. Parameters in the model are either predetermined or calibrated.<sup>7</sup> The predetermined parameters derive from several sources, including the GTAP database, econometric studies, and international databases and surveys. Estimates for elasticities of substitution for the three-labour types are taken from Waugh (2017), and Aydemir and Borjas (2007) estimated the elasticity of substitution for different skill levels in Mexico as 3.1. The key parameter in the determination of the effects of skill-specific emigration on productivity, the productivity elasticity of emigration, derives from Djiofack et al. (2013).<sup>8</sup>

Data on skilled migration stock and rates derive from the Institute for Employment Research's (IAB) brain drain database compiled by Brücker et al. (2013). The database was created under the temporary migration, integration and the role of policies (TEMPO) project financed by NORFACE (New Opportunities for Research Funding Agency Co-operation in Europe) and compiled emigration data from 20 OECD countries. For the expected returns to capital, data from the Schroder's global investment trends survey (GITS) from 2015 to 2020 is used. Normal growth rates of capital derive from Penn World Table v.9.1 (Feenstra et al., 2015). Similarly, the human capital indicators, return to capital and the internal rate of return derive from Feenstra et al. (2015). GDP growth rates and expected rates of return, baseline population, and labour force projections are taken from the World Bank Indicators (WB, 2020) and the United Nations population projections, respectively. Finally, calibration is used to determine the share of labour for each skill and baseline labour productivity.

## 4.3 Simulation design and model implementation

The counterfactual baseline scenario depicts the likely trajectory of the economy in the absence of emigration. The baseline scenario is used as the benchmark to analyze the effects of emigration. It is projected over 20 years from 2020 to 2040. In the baseline, all non-accumulating endowments are fixed and GDP, population, and labour-force growth are shocked at their projected rates to establish the long-run growth trajectory. Baseline population projections and labour-force growth derive from the United Nations population projections.

### 4.3.1 Factual scenarios

The factual experiments simulate the effects of skilled emigration over a period of 20 years. The model considers three scenarios:

#### **Scenario 1: Positive sector and skill-specific emigration rates**

Within each period, skill and sector-specific emigration rates are applied as demographic shocks. The shocks are specific to the skill-intensity of the sector. In this scenario, remittances are zero, and government responses are excluded.

#### **Scenario 2: Emigration combined with net remittances inflows**

The second scenario simulates the effects of skilled emigration and region-specific remittance shocks. Because the reference region is South Africa, only South African remittance inflows are increased. The other two regions have predetermined positive remittances.

#### **Scenario 3: Emigration with offsetting labour market support subsidies**

The third scenario combines skilled emigration with a labour market policy measure to encourage skilled labour employment. Assuming that skilled labour supply is demand driven, the effects of a 20% employment subsidy are simulated to offset the losses in skilled labour.

<sup>7</sup> Calibration is the process of determining parameter values given prices, parameters and functional forms such that the model replicates the baseline equilibrium.

<sup>8</sup> They estimated the productivity elasticities for skilled and unskilled labour. Like the author, they used the elasticities of 0.12 and -0.075 for skilled and unskilled labour respectively.

The model is implemented using the General Equilibrium Modeling Package (GEMPACK) created by the Centre of Policy Studies (CoPS) at Victoria University.

## 5 RESULTS AND DISCUSSION

The results are driven by the model assumptions and the structure of South Africa’s labour market. The assumption of gross complementarity between the capital composite input and labour has significant implications for the outcome of the simulations. Similarly, the assumption of non-revenue neutral skill support subsidies affects the long-term outcomes of the policy. Changes in industrial structure and relative wages depend on the skill composition of production in each sector. The results are interpreted relative to the baseline equilibrium. This section begins with an examination of the productivity and growth effects under the three model scenarios.

### 5.1 Productivity effects

The productivity changes can be decomposed into two parts (a) direct effects due to changes in output production and (b) indirect effects due to the reallocation of labour. The latter depends on the elasticity of labour demand and the existing labour market distortions. Table 3 outlines the effects of skilled emigration on the productivity of the three labour categories in the skill- intensive and emigration-sensitive sectors. An emigration rate of 13% in manufacturing reduces skilled labour productivity by 7%, whereas a rate of 11% in the finance and communication sector reduces skilled labour productivity by 5.9%. Similarly, skilled emigration rates of 15% and 17% in the education and health sectors reduce skilled labour productivity by 8.1% and 9.2%, respectively.

**Table 3: South Africa: Migration induced changes in labour productivity (%)**

	Manfc	FinCom	Educ	Health
UnSkLab	5	2.3	4.5	2.3
SemiSklab	2.7	0.7	1.8	2.7
SkLab	-7	-5.9	-8.1	-9.2

Source: Author’s simulation results

A migration-induced reduction in skilled labour reduces the efficiency of the non-emigrant labour. The assumptions of skill-biased technical change and imperfect sustainability between the three skill categories imply that the productivity of semi-skilled and skilled workers in the emigration sensitive sectors increases. The results suggest that the productivity gains for unskilled workers are higher than for semi-skilled workers, and the gains are largest in the manufacturing sector. Larger gains for unskilled workers are due to a higher elasticity of productivity with respect to emigration,  $\gamma$  in equation 4. Furthermore, the productivity of unskilled labour increases because in the underlying database the proportion of unskilled workers in manufacturing is significantly higher than the semiskilled.

**Table 4: South Africa: Changes in primary factor productivity, 2020–2040**

	5-year				20-year
	2025	2030	2035	2040	2040
Sim 1	-0.8	-3.1	-5.3	-7.5	-15.8
Sim 2	-12.2	-6.5	-0.3	1	-17.2
Sim 3	3.9	2.6	7.8	10	24.3

Source: Author’s simulation results

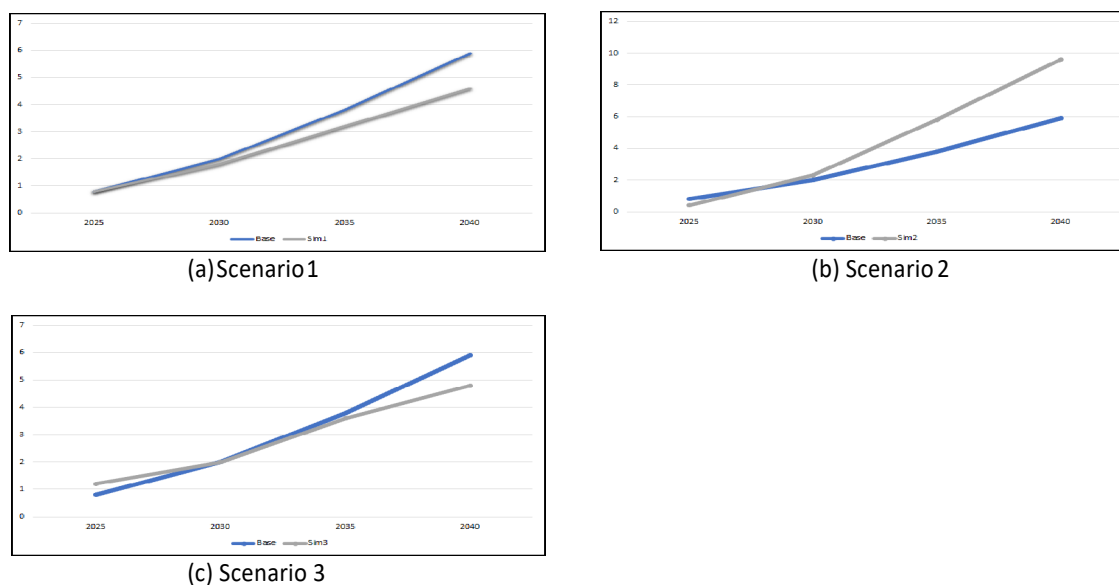
Total primary factor productivity falls with the reduction in the efficiency of skilled labour. These changes are shown in Table 4. The numbers reflect the combined changes in the productivity of capital, and the three labour types. The results suggest that skilled emigration reduces total primary factor productivity and the losses increase overtime. According to Table 4, in the first five years the loss in total primary factor productivity is 0.8% but in the last five years productivity losses increase to 7.5%. Cumulatively, the results reveal that skilled emigration will cause total primary-factor productivity to fall by 15.8% by 2040.

Table 4 also shows that the presence of remittances initially reinforces losses in primary factor productivity in the short-to-medium term (the first ten years). This result is consistent with Djiofack et al. (2013), who found that negative productivity effects can outweigh potential gains from remittances and productivity gains from unskilled workers. However, in the medium-to-long term, remittances offset productivity losses. But the cumulative effect productivity losses of 17.2% are larger than the 15.8% under the emigration-only case. In contrast, skill support subsidies reverse the productivity losses associated with skilled emigration. The lower panel shows that the cumulative productivity gains are 24.3% over the 20-year period. Changes in productivity effect growth and relative output prices and real factor returns.

## 5.2 Output effects

Several studies have found that, without offsetting measures such as remittances and government policies, skilled labour emigration reduces output and growth. The results of this study support this assertion. Figure 2 illustrates the cumulative growth effects of skilled emigration under the three scenarios. Figure 2a compares output changes relative to the baseline when emigration is not combined with offsetting measures. It shows that in the short term, the growth effects of skilled emigration are negligible but worsen over time. In the first 10 years, adverse growth effects of 0.2% are marginal. However, over a 20-year period, aggregate output growth declines by 1.2% relative to the baseline. This is shown in Figure 2a by the widening gap between the projected growth path (the blue curve) and the simulated path (grey curve).

The adverse growth effects fall within the range of an earlier dynamic CGE-based study by Marchiorie et al. (2012), who found growth effects to range from 0.2% to 7% over a 40-year period. Figures 2b and 2c illustrate the growth effects of skilled emigration in the presence of remittances and government skill support subsidies. According to Figure 2b, remittances reinforce the adverse effects of emigration in the short term by reducing growth by 0.4%. However, remittances more than offset the long-term adverse effects skilled emigration. Over time, remittances raise growth by 3.5%; this is illustrated by the widening gap between the baseline and the simulated growth path in Figure 2.b. Unlike remittances, which initially worsen growth, skill support subsidies raise growth by 0.4% in the first five-year period. Over time, skill support subsidies reduce growth below the projected rates as illustrated by Figure 2c. But they partially offset the negative growth effects of skilled emigration; the 20-year change in growth is  $-1.1\%$  compared to  $-1.2\%$  in the emigration only case.



**Figure 2: Growth effects: Deviations from baseline, 2020–2040**

Source: Author's simulations

Output losses under the emigration-only scenario are driven by the direct effect of lower labour supply on production and the changes in productivity and capital. Standard trade theory dictates that skilled labour outflows are accompanied by capital flight. The fact that growth in the first few years coincides with the projected baseline rate suggests a lower output elasticity with respect to productivity. Similarly, because of the combined effects of lower primary factor productivity and capital outflows, one would expect the long-term adverse growth effects to be significantly larger than 1.2%. However, the results reveal that capital inflows increase and partly offset the adverse growth effects associated with productivity losses.

To further understand the factors driving output, the next subsection discusses sectoral dynamics. In the case of remittances, larger disposable income increases domestic absorption and imports relative to exports. Also, higher demand raises average price index causing the real factor returns to fall. For the subsidies, the initial positive growth effects are due to positive productivity gains and the reduction in production costs in subsidy-receiving sectors. The adverse growth effects over time are mainly due to a fall in government revenue, which reduces government consumption and investment expenditures. This result occurs because the model assumes the subsidies are not revenue-neutral.

### 5.2.1 Sectoral effects

Understanding the sectoral dynamics requires an examination of the structure of production (share of capital and labour type in production and the complementarity between capital and labour) and the trade exposure of the sector or its sensitivity to terms of trade. The structure of production varies considerably across the sectors. In the underlying database, sectors with the share of capital greater than 50% are agriculture (55%), food-processing (56%), mining (56%), manufacturing (50%), and finance and communication (64%). Comparing labour usage by skill shows that skilled labour accounts for 44% of the wage bill in manufacturing, 60% in finance/communication, and 74% in both the education and health sectors. In contrast, unskilled labour accounts for 62.5% of the wage bill in the agriculture sectors, 45% in food-processing, and 48% and 44% in mining and manufacturing respectively. Sectoral effects are driven in part by the relationship between capital and the labour category, used intensively, and the elasticity of labour demand.

Table 5 outlines the cumulative deviations of sectoral value added from the baseline values. It shows that skilled emigration has adverse effects on sectoral value added, particularly in the medium to long term. By the end of the 20-year period, all sectors apart from food processing and health care contract. Sectoral effects are driven by changes in the relative prices of inputs, product prices, as well as productivity and its effect on output and the demand for factor inputs.

**Table 5: Changes in sectoral value added, 2020–2040**

	Scenario 1				Scenario 2				Scenario 3			
	2025	2030	2035	2040	2025	2030	2035	2040	2025	2030	2035	2040
Agric	-0.1	-0.3	-0.7	-1.1	-0.4	2.5	4.9	6.7	0.7	-9.9	-11.4	-12.4
FoodPrc	0	0	0	0.2	1.1	1.7	3.2	4	0.7	0.5	0.7	0.1
MinMet	-0.3	-1.3	-3	-5.2	1.2	2.7	4.1	5.4	0.5	0.5	0.6	-0.5
Manfc	-0.1	-0.6	-1.7	-3.1	-3.8	-5.4	-3.3	-1.6	1.6	2.4	4.5	7.2
FinCom	0	-0.1	-0.3	-0.6	0.1	1.2	2.9	4.7	0.2	-0.2	-0.7	-2.1
Educ	0	0	-0.1	-0.2	-0.2	-1.1	-0.8	-0.3	0	-0.1	-0.6	-1.8
Health	0	0	0	0	-0.1	-0.6	-0.1	0.6	0	-0.1	-0.6	-1.7
Osvcs	0	-0.1	-0.4	-0.9	-0.4	0.5	2.1	3.9	0.3	0	-0.3	-1.4

Source: Author's simulations

The negative emigration shock to skilled labour supply reduces the quantity of skilled labour and the productivity of non-emigrant workers. In sectors where capital and skilled labour are complementary, a fall in skilled labour supply will result in a reduction in the quantity of capital employed and, subsequently, a fall in value added. This in part explains why manufacturing value added falls by 3.2% over the 20-year period, as shown in Table 5. Similarly, finance and education contract by 0.6% and 0.2% respectively, suggesting weak complementarity between capital and skilled labour in these sectors. Surprisingly, the largest contraction in value added is in the non-emigrant mining sector, which declines by 5.2%. Also, losses in the cumulative reduction of agriculture value added of 1.1% exceed the losses in emigration-sensitive sectors of education and finance/communication. The spillover effects to other sectors are due to a combination of the decline in total factor productivity, reduction in capital, and the terms of trade.

The sectoral impacts of emigration combined with remittances are shown in columns 6 to 9 of Table 5. In the first five years, the table shows that manufacturing losses are reinforced by the presence of remittances. The losses are largest in the first ten years, when manufacturing value added falls by 5.2% compared to 0.6% under the emigration-only scenario. The losses are larger because higher disposable income increases the demand for imports.<sup>9</sup> The results reveal the manufacturing trade deficit will be USD 2.2 billion. The cumulative gains in the agriculture and food processing sectors of 6.7% and 4% respectively are expected because these two sectors generally cater to the domestic market.

The last four columns of Table 5 show how skill-support subsidies influence sectoral value added in the presence of skilled labour emigration. The columns show that skill-support subsidies boost manufacturing value added. Over 20 years, manufacturing expands by 7.2%. In contrast, other skill-/emigration-sensitive sectors of finance, education and health care contract by 2.1%, 1.8%, and 1.7% respectively. Value added in these sectors falls because government skill-support subsidies reduce

<sup>9</sup>This result supports earlier findings by Atamanov et al. (2009), who found that remittances increase domestic absorption and imports but decrease exports.

capital demand. Even though capital enhances productivity, skilled labour accounts for 64% of primary factor payments in the health and education sectors. And because capital is a substitute, skill subsidies cause a substitution of capital for skilled labour. Similarly, skill-support subsidies adversely affect agriculture over the long term. This could suggest a reallocation of capital and skilled labour to sectors receiving skill support subsidies. These results reveal an important insight: skill subsidies targeted at manufacturing can result in output gains for South Africa.

**5.2.2 Implications for public revenues**

Skilled workers affect public revenues through two channels. First, they are a significant source of government revenue; second, because education in South Africa is publicly funded, they are recipients of government public investments. A loss in skilled workers therefore implies low revenue and a loss in public investment than cannot be recouped.

Table 6 compares the cumulative effects of skilled emigration under the three scenarios on public revenues. It shows that, in the absence of remittances and skill support subsidies, skilled emigration has a positive but marginal effect on government revenues of 0.6% over a period of 20 years. This occurs in spite of lower GDP and a contraction in manufacturing and mining value added because of the increase in productivity and employment of unskilled and semi-skilled workers. Similarly, returns for factors such as land, capital, and natural resources increase. The combined effects of these changes, and the fact that semi-skilled workers account for close to half of South Africa’s employed, offset potential revenue losses from a reduction in skilled labour.

**Table 6: Change in government income (%)**

	2025	2030	2035	2040
Sim 1	0.00	0.1	0.3	0.6
Sim 2	0.1	1.5	3.5	5.6
Sim 3	-1.4	-2.4	-5	-8.1

Source: Author’s simulation

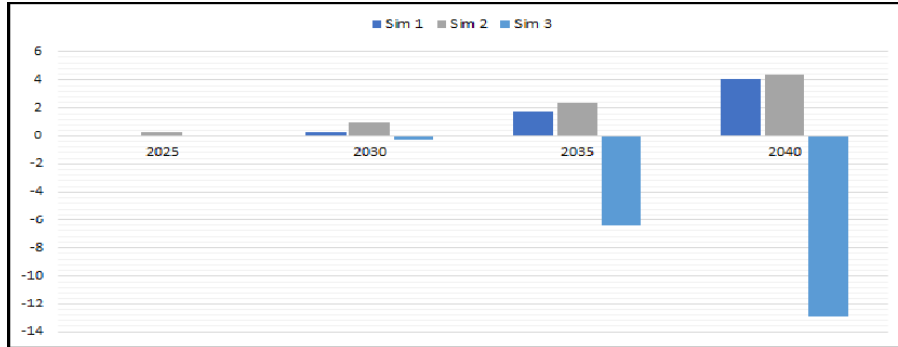
Table 6 also shows how remittances modeled as a 2% shock to private household income affect government revenues. It shows that in the first five years the effect on government revenues is positive but marginal, whereas over a period of 20 years revenue increases by 5.6%. In the first five years revenues are slightly higher than the case of emigration alone, because a surge in import demand increases tariff revenues. However, the difference is small because the GDP contracts by 0.4% in the first five years. Beyond five years revenues gradually increase, resulting in a cumulative gain of 5.2%. This is because key sectors like mining expand and lead to a higher GDP. This result is consistent with Campos-Vazquez and Sobardzo (2012), who found that in Mexico remittances reverse revenue losses from emigration. In contrast, when the government provides non-revenue-neutral subsidies to sectors affected by emigration, revenues fall by 1.4% in the first five years and by 8.1% over 20 years. Revenue falls mainly because the subsidy policy is non-revenue-neutral. Higher revenue losses constrain government expenditures, hence the lower-than-baseline GDP over the long term.

**5.2.3 Welfare and distributional implications**

Figure 3 illustrates the cumulative effects of skilled emigration on employment. It shows that for South Africa skilled emigration has positive effects on aggregate employment. In the first five years, employment changes are negligible. This is in part because the labour gaps left by skilled workers are filled by semi-skilled workers who account for approximately 50% of South Africa’s labour force. In the long term, employment increases by 4.1% under the emigration-only scenario. This is because skilled emigration opens up opportunities for lower-skilled workers, particularly semi-skilled workers, who

are cheaper than skilled workers. When remittances are considered employment, effects are stronger because the higher disposable incomes and associated rise in demand cause firms to hire more workers. Employment also expands because semi- and unskilled labour-intensive sectors such as food processing, agriculture, and mining expand. According to Figure 3, in the first five years the employment effect is a marginal 0.3%. Over the medium-to-long term, the cumulative employment effect rises from 1% to 4.4% in 2020.

**Figure 3: Employment: Deviation from the baseline, 2020-2040**



Source: Author's simulations

In contrast, skill support subsidies cause sizeable employment effects over the medium-to-long term. Figure 3 illustrates this: the cumulative employment effects in 2035 and 2040 are equal to –6.4% and 12.2%, respectively. Although this might seem counterintuitive, it is a plausible outcome given the structure of the South African labour market. As mentioned in the methodology section, semi-skilled workers account for approximately 50% of the workforce. Subsidizing skill-intensive sectors opens opportunities for skilled workers and reduces demand for lower-skill categories. The adverse employment effects of skill support subsidies are largely due to the decline in opportunities for semi-skilled and skilled workers.

The distributional impacts are discussed in the context of the gap between skill-specific wages. Table 7 presents the changes in real factor returns under the three scenarios. The upper panel shows cumulative changes in real returns in the absence of remittances and skill support subsidies. In the short-to-medium term (the first ten years), returns of all factors other than skilled workers rise relative to the baseline. Changes for semi- and unskilled labour range from 0.1% to 0.2% for semi-skilled workers and 0.3% to 0.4% for unskilled workers. The largest gains accrue to land. Several studies posit that skilled emigration raises the relative wages for non-emigrant skilled workers. This is based on the premise that the reduction in the supply of an input raises its marginal productivity and its associated return. If we ignore productivity spillovers, then we would expect the real return to skilled workers to rise relative to lower-skill categories. In contrast, when productivity spillovers are considered, the net effect on real returns depends on whether the direct effect on marginal productivity is greater than the indirect primary-factor productivity effect.

The second panel of Table 7 shows that, with remittances, wages for skilled workers are lower than the baseline over the whole 20-year period. The cumulative fall in skilled worker real wages is 4.4%. Conversely, wages for semi- and unskilled workers fall in the first five years but rise in the last five-year period. In the first five years, real wages are compressed because higher output demand raises prices and real wages fall. But as GDP rises, increased demand for workers raises the nominal and real wages for lower-skilled workers. In the long term, real wages for both skilled and semi-skilled workers rise because of the gains in total primary-factor productivity. This productivity effect explains in part why the losses in skilled labour returns are lower under the remittance scenario.

**Table 7: Factor returns: Deviations from baseline, 2020–2040**



	2025	2030	2035	2040
<b>Scenario 1</b>				
Land	1.1	8.8	15.4	26.3
UnSkLab	0.3	0.4	0	-0.6
SemiSklab	0.2	0.1	-0.2	-0.9
SkLab	-1	-2.3	-3.7	-5.3
Capital	0.3	0.6	0.8	1
NatRes	0.1	0.6	1.2	3.1

**Scenario 2**

Land	21.2	-3.9	-2.9	-6.9
UnSkLab	-1.2	0	0.3	0.8
SemiSklab	-1.4	-0.3	-0.1	0.2
SkLab	-2.5	-2.8	-3.7	-4.4
Capital	1.7	1.7	2.2	2.6
NatRes	5.6	-0.5	-1	-2.9

**Scenario 3**

Land	-4.5	-34	-36.3	-38.2
UnSkLab	0.6	0.9	1.7	2.6
SemiSklab	0.2	0.2	0.4	0.9
SkLab	3.4	5.6	11	17.3
Capital	-0.2	-0.2	-0.8	-1.6
NatRes	0.4	-2.7	-3.5	-4.5

Source: Author's simulations

Comparing wages in the upper and middle panels of Table 7 suggests that the rise in primary-factor productivity of 1% has positive distributional effects as it raises wages for the lower-skill categories relative to the skilled labour category. Finally, the lower panel of Table 8 shows how skill subsidies affect wage distribution. It shows that subsidizing skilled labour in emigrant-sensitive sectors reverses the losses in skilled wages associated with productivity losses. Skilled worker wages are 3.4% higher than the baseline in the first five years and rise by 17.3% over the 20-year period. But because the relative gains for skilled workers are significantly higher than for both semi- and unskilled workers, skill support subsidies increase wage inequality.

Table 8 shows the cumulative welfare deviations from the baseline. Here, welfare effects are measured as the equivalent variation (EV) as a percentage of GDP. The welfare effects result from the direct impact of demographic or policy shocks and the indirect impact arises through the interaction of several factors. According to Table 8, skilled emigration is welfare-reducing, but the losses are inconsequential because the 20-year loss in welfare is 0.11%. The welfare effect is marginal because the adverse growth and productivity effects are partially offset by gains in employment and real wages

for semi- and unskilled workers. Also, the results in the previous section suggest that skilled emigration marginally raises government revenues, which can be welfare-enhancing if the revenues are used to support social services or public infrastructure.

**Table 8: Welfare effects, 2020-2040**

	2025	2030	2035	2040
Sim 1	-0.06	-0.11	-0.14	-0.11
Sim 2	-0.31	1.18	2.58	4.43
Sim 3	-0.19	-0.68	-1.54	-2.98

Source: Author’s simulations

In the medium-to-long term, the effects of remittances on welfare are consistent with several studies that suggest that remittances are welfare-enhancing Table 8 shows that the welfare loss of 0.31% is marginally larger than losses under the emigration-only and skill subsidy scenarios. This is because, of all the three scenarios, remittances reduce GDP and worsen productivity losses in the first five years. However, the cumulative gain in welfare in the subsequent five-year period ranges from 0.18% to 4.43% in the medium to long term. These gains are driven by higher output, employment, and public revenues stimulated by higher demand. Cumulative welfare losses are largest when the government subsidizes skill development. According to Table 8, the 20-year welfare loss is 2.98% or USD 6.8 billion. Although one would expect marginal welfare losses in the short term and gains in the long term, these welfare losses are plausible because the subsidy policy is nonrevenue neutral; the government does not offset revenue losses from subsidies by raising other taxes. To finance the subsidies, the government reallocates resources from social programs and public investments. Also, the results from the previous paragraphs show that the subsidy policy reduces employment in the long term and increases the skill-wage gap.

## 6 CONCLUSION

The preceding analysis examines South Africa’s skilled labour emigration’s long-term effects using a recursive dynamic equilibrium model. The models include three classes of labour, sector- and skill-specific emigration rates and an endogenous specification of labour. To understand the effects of emigration and potential offsetting measures, three scenarios are simulated. In the first scenario, skilled emigration alone is simulated, along with sector- and skill-specific emigration rate shocks. After that, the analysis considers the effects of emigration with remittances. The last scenario models the effects of emigration in the presence of government skill support subsidies to emigration-sensitive/skill-sensitive sectors.

The model projects that, over 20 years, skilled emigration without offsetting measures will reduce South Africa’s growth and primary factor productivity by 1.6% and 14.8% . In addition, the results suggest that skilled emigration will have adverse effects on the industrial base, particularly manufacturing and mining, which contract by 3.1% and 5.2% respectively. A key implication of the latter finding is that skilled emigration will weaken South Africa’s manufacturing base and its link to GVCs. In contrast to most studies on skill emigration, the results suggest that skilled emigration reduces wage inequality because it reduces skilled worker wages relative to other skill categories. The overall effect on welfare is negative but marginal.

Allowing for remittances reverses the adverse effects of skilled emigration in the medium-to-long term. In the short term, remittances reinforce negative growth and productivity effects. Higher disposable income increases demand, but the demand for imports is greater than the demand for

domestic goods. The higher demand also raises the overall price index and, as a result, depresses real wages for all labour types. However, higher import demand increases government revenue. Combining emigration with a 10% skill support subsidy reverses the adverse growth and productivity effects of emigration but only in the short term. Over time, because the skills support subsidies are not supported by raising revenue from other taxes, lower government revenue depresses aggregate demand. In the long term, skill support subsidies lower growth by 1.1%.

A key result is that skill support subsidies reverse manufacturing losses. The short-term impacts of skilled emigration are crucial because they constrain firms' ability to innovate and adopt new technologies. In this context, skill-support subsidies offer the necessary short-term intervention to lessen the effects of skilled emigration. For skill-support subsidies to be effective at offsetting long-term adverse growth effects, they should be revenue-neutral.

From a distributional perspective, this study finds skilled emigration to affect the wage premium positively. However, the overall welfare effect is negative because of lower growth. In contrast, the results reveal that government subsidies are regressive because they raise skilled workers' wages relative to other skill subsidies. Furthermore, they cause unemployment because the demand for skilled workers reduces opportunities for semi- and unskilled workers, who account for a significant proportion of South Africa's workforce. The effects on wages, unemployment, and lower growth result in long-term welfare losses more considerable than in the emigration-only scenario. A key implication of this is that a skill-support policy should include enhancing skills for all three labour categories. Furthermore, the reduction in adverse welfare effects requires that any skill support intervention be revenue-neutral. Although this analysis offers important insights, they are driven by the model assumptions and specifications.

### 6.1 Study limitations and suggestions for future research

This study is by no means exhaustive, and there are various interacting issues presented in the literature that have not been addressed. Also, because of the complexity of the dynamic model, this study considers distributional effects by examining changes in the relative wages of different categories of workers. Deeper distributional insights could be gained by examining the effects of skilled emigration on various income categories (households). Recent studies suggest that migration is gendered, but time and data constraints prevented this study from exploring this dimension. To get a clearer picture of skilled emigration in South Africa, and to better understand and effectively engage South Africans living abroad, such as the survey on India exemplified in Bharte (2014) is essential. For targeted policies, it is important to survey perceptions about participating in South Africa's development before and after returning to South Africa. This can offer insights into the challenges that returning migrants face.

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### About the author

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