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Abstract

In this paper, the authors use a highly disaggregate general equilibrium model to analyze the feasibility of a wage subsidy to unskilled workers in South Africa, isolating and estimating its potential employment effects and fiscal cost. They capture the structural characteristics of the labor market with several labor categories and substitution possibilities, linking the economy-wide results on relative prices, wages, and employment to a micro-simulation model with occupational choice probabilities in order to investigate the poverty and distributional consequences of the policy. The impact of a wage subsidy on employment, poverty, and inequality in South Africa depends greatly on the elasticities of substitution of factors of production, being very minimal if unskilled and skilled labor are complements in production. The desired results are attainable only if there is sufficient flexibility in the labor market. Although the impact in a low case scenario can be improved by supporting policies that relax the skill constraint and increase the production capacity of the economy especially towards labor-intensive sectors, the gains from a wage subsidy are still modest if the labor market remains very rigid.

This paper—a product of the Office of the Chief Economist, Africa Region, in collaboration with the Povert Reduction & Economic Management Unit for Southern Africa—is part of a larger effort in the Africa Region to improve economic analysis of important policy issues. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The corresponing author may be contacted at dgo@worldbank.org.

Wage Subsidy and Labor Market Flexibility In South Africa♦

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♦ The framework used in the paper is based on a World Bank technical assistance project to develop a CGE-micro simulation model for the South African National Treasury in a collaboration with IDS and the US Naval Academy. The purpose of the exercise is to illustrate the potential use of the framework for analysis of policy change. The views expressed are those of the authors and do not necessarily reflect those of their respective institutions or affiliated organizations. The authors would like to thank Rita Almeida, Rob, Davis, Shantayanan Devarajan, Lawrence Edwards, David.Faulkner, Johannes Fedderke, M. Louise Fox, Jeffrey D. Lewis, Christopher Loewald, Konstantin Makrelov, Kuben Naido, Kalie Pauw, Ritva Reinikka, Matthew Simmonds, Rogier van den Brink, and Theo van Rensburg for helpful comments and suggestions. We also thank B. Essama-Nssah and Konstantin Makrelov in helping to formulate the CGE-micro framework.

1. Introduction

Despite a recent improvement in economic growth, unemployment in South Africa is still high. While the unemployment rate has declined from 29.4 percent in 2001 to 26.7 percent in 2005 (Statssa, 2006),[1] employment growth is, on average, only 2.1 percent per year (see, for example, Bhorat, 2005). That level of employment growth is slow relative to labor force growth and therefore insufficient to deal with the severity of the unemployment problem. Using a broader definition of unemployment to include discouraged workers, unemployment in South Africa is approximately 30 percent for men and 38 percent for women, and has almost doubled since the transition from Apartheid (Levinsohn, 2008). Reducing unemployment is therefore a major policy concern in South Africa and one policy option being debated is a wage subsidy scheme - see, for example, recommendations made by the Harvard Center for Interntional Ddevelopment (CID) South Africa Initiative and, in particular, the summary report of the International Panel on Growth in Hausmann (2008) as well as the policy options to alleviate unemployment in Levinsohn (2008).

The South African labor market presents an interesting economic issue - if there are wage and labor market rigidities in an economy, would a wage subsidy be able to reduce high structural unemployment? Using the particular institutional situation of South Africa, this paper investigates the circumstances by which a wage subsidy would generate significant employment effects. The methodology employed is a disaggregative economic framework – which combines a general equilibrium model commonly used in public finance to look at fiscal, welfare, and economy-wide effects of a policy change, and a micro-simulation model with occupational choice probabilities to examine the employment and distributional consequences at the micro level. In what follows, we briefly review the unemployment issues in South Africa and describe the approach adopted in the context of the paper's objectives.

Why unemployment is high in South Africa. There is an extensive literature about South Africa's labor market issues, which are selectively summarized below. Three major and interrelated causes of unemployment are often cited – (i) insufficient economic growth, particularly in the tradable sectors; (ii) high real wages or labor cost; and (iii) labor market rigidities and other structural problems in the labor markets. In addition, other related factors cited include the participation pattern in the labor force, the level of reservation wages, job search issues, and the impact of transfer payments. Bhorat and Leibbrant (1996), Bhorat and Oosthuizen (2005), and Banerjee, Galiani, Levinsohn, and Woolard (2007) provide a good overview.

A significant cause of unemployment in the past was the lack of economic growth during the 1970s, 1980s and 1990s (Fallon and Pereira da Silva (1994) and Lewis (2001)). Employment growth was therefore low (Standing, Sender, and Weeks (1996), Bhorat (2001)). Recently, however, unemployment has been high despite higher economic growth, suggesting that there are other underlying factors.

[1] The rate is dependent on whether a "strict" or "expanded" definition is used. The quoted numbers are for the former, which are more conservative or lower. Even then, the unemployment rate is still high.

As South Africa liberalized and opened its economy to trade, production in agriculture and mining declined and production shifted towards capital-intensive manufacturing and high-skilled services, exacerbating the weak demand for less-skilled labor. See Edwards (2001) and Fedderke, Shin, and Vase (1999) among others for a more detailed discussion. A key factor in the economic transformation and structural change of the South African economy is the relative decline of the tradable sectors, particularly the manufacturing sector but also agriculture and mining, where employment is traditionally generated. The absolute number of jobs in the three sectors declined between 1994 and 2004. Employment fell by 12 percent in the agricultural sector, by 29 percent in the mining sector, and by about 12 percent in the manufacturing sector. The non-tradable sectors such as finance and business services grew the most, but they primarily are primarily skilled labor-intensive. See, for example, Hausmann (2008) as well as Rodrik (2006).

Another significant factor is the rise in real wages, which directly dampens labor demand. This rise is not a recent phenomenon and has persisted for several decades. The average growth of real wages was about 1.3 percent per year in the 1980s and 1.5 percent per year in the 1990s. Lewis (2001) estimates that real wages for unskilled and semi-skilled workers in particular have risen by 150% from 1970 to 1999. At the same time, unemployment among unskilled and semi-skilled workers rose significantly from less than 10 percent in 1970 to over 50 percent in 1999. The evolution of real wages is, however, subject to measurement and interpretation issues. Banerjee *et al.* (2007), for example, measure employed hours worked in "efficiency units" and find instead that "real wages per unit of human capital" have increased only slightly from 1995 to 2005. On the other hand, labor policy and minimum wage legislation since 1994, which were designed to correct the inequities and disparity of the Apartheid era, have significantly increased the indirect non-wage labor cost.

The protection of labor has the indirect consequence of increasing labor market rigidities through reduced labor mobility, increased frictions to exits from employment, as well as the additional cost of compliance to labor regulations and of the negotiation processes with labor unions – see, for example, Nattrass (2000) and Moolman (2003). In addition to the implied wage premia arising from unions and labor market institutions, it is plausible that the high concentration ratios in the output markets noted by Fedderke, Kularatne, and Mariotti (2006), Aghion, Bruan, and Federkke (2006), and Hausmann (2008) limited competition and investment, thus reinforcing the slow growth of employment in the formal sector. In a survey of 325 large South African manufacturing firms, Chandra, Moorty, Rajaratman, and Schaefer (2001) document the behavioral consequences of the various labor market legislations – firms tend to hire fewer workers, substitute capital for labor when expanding, employ temporary workers as opposed to hiring permanent workers, and rely more on sub-contracting services.

There are also structural issues underlying the South African economy and labor markets. A key manifestation of the structural problem is the complementarity or lack of substitution between skilled and unskilled workers, with the skills constraint dampening the employment growth of less-skilled workers – see Hausmann (2008) and Levinsohn (2008). Significant factors include the dualistic structure of the South African economy and the economic shifts towards more high-skilled and capital-intensive economic activities. Implicit in the shift towards capital-intensive sectors and their demand for skilled labor is the relative complementarity

between capital and skilled labor, which adds to the rigidities in the factor markets. Furthermore, Aparteid left South Africa with a mismatch in the supply and demand of skills as a generation of workers did not receive the benefit of higher education. In this situation, equilibrium unemployment in the face of supply-side shocks and shifts would tend to be higher because the degree of coordination in wage-setting as well as real wage inflexibility would lead to less efficient supply-demand matching in South Africa (i.e. the Beveridge curve approach to unemployment). Moreover, factors such as hysteresis and persistence mechanisms, which were used to explain high unemployment in OECD countries, also point to the likelihood that a sustained period of high unemployment caused by weak aggregate demand can in turn cause a deterioration in the supply side of the economy, resulting in the long-term unemployed being detached from the labor force and a higher equilibrium unemployment rate.[2]

The nonparticipation of the less-skilled who are jobless is a possible consequence of the structural problems in South Africa. A vestige of Apartheid is the geographical distance between where many of the unemployed reside and where firms are located. As a result, transportation cost is a deterrent to employment for less skilled labor; in effect, it creates a high threshold in their reservation wage. Various factors mitigate the necessity for immediate employment; these include income differences in the dual economic structure combined with within-household income transfers due to the availability of the old age pension or the employment of a family member in the formal sector also mitigate the necessity for immediate employment. See, for examples, Banerjee *et al.* (2007), Poswell (2002) and Dinkelman and Pirouz (2000), and Moll (1993).

Why a wage subsidy? Because of these structural issues in South Africa's labor market, policy intervention such as a wage subsidy has become increasingly attractive. Using a careful empirical analysis of individual-level changes and transitions in the labor market status observed from an extensive nationally representative panel of individual labor data, Banerjee *et al.* (2007) conclude that, because of the structural changes in the economy, South Africa's high level of unemployment is an "equilibrium" phenomenom; the decade-long high levels of unemployment appear to be a structural rather than a temporary aberration. Such structural unemployment cannot be solved by macroeconomic management or temporary swings in aggregage demand, but must be addressed by policy interventions affecting labor demand or supply such as wage subsidy, search subsidy, reduced regulations for first jobs and government employment. Banerjee *et al.* also note that there is much more churning in the South African labor market than would be observed under the conventional view that the market is rigid. However, much of the churning may reflect transitions or boundaries between searching and non-searching that are more fluid between being not economically active and informally employed than between any of those states entering into formal employment. Part of the reason noted by others is the small size of the informal sector, which does not provide a buffer between formal jobs and unemployment – Kingdon and Knight (2000) and Fallon and Lucas (1998). Another factor is the mismatch of skills noted above.

A basic justification for a wage subsidy is that it directly intervenes in the factor market to stimulate demand for less-skilled labor. Although a wage subsidy creates jobs in the short run,

[2] See, for example, Nickell *et. al.* (2003). For a more general discussion, see Chapters 4 and 11 in Carlin and Soskice (2006).

in the long run, less skilled labor will be substituted for capital and skilled labor as less-skilled labor becomes relatively cheaper. Like any relative price change, there will be substitution and output/income effects from a wage subsidy, and the secondary or general equilibrium effects from the interaction of various goods and factor markets in the economy may be important. In this study, policy intervention occurs through factor demand for the less skilled formal labor, with a wage subsidy going directly to the producers. In this context, the substitution or complementarity of labor types affects the employment-generating capacity of the wage subsidy.

Alternatively, the wage subsidy can be given directly to employees if the structural problems are related to the supply of less-skilled labor. That is, the supply of less-skilled labor is hampered by a high reservation wage or "minimum" wage level that individuals are willing to accept in order to work. Labor supply and "unemployment" of the less-skilled are therefore in equilibrium and the measured high unemployment rates include the inactive (voluntary unemployment). In this context, a subsidy to individuals would affect their reservation wage and induce a higher proportion of less-skilled labor to participate in the labor market. This assumes, however, that factor demand, factor input complementarity, and real wage flexibility are not the major constraints in the labor market in South Africa.[3] In this study, the demand side will be the main area of investigation; we leave issues such as the estimation of a reservation wage and the labor market participation of the less-skilled worker for future research.

We also examine the sensitivity of the impact of a wage subsidy to two complementary policies aimed at alleviating labor market problems in South Africa – i) increasing the supply of skilled workers by removing restrictions on skilled immigrants or through training programs; and ii) facilitating the growth of economic activities (e.g. tradable sectors) where skill is less intensive. Levisohn (2008) recommended a wage subsidy and an immigration reform to encourage the immigration of skilled individuals as two key policy responses to alleviate unemployment in South Africa. We consider the worst case scenario, high complementarity between labor types, and examine whether the marginal or net impact of the wage subsidy would be greater in combination with either policy alternative.

Although this paper will not address design and implementation modalities of a wage subsidy in detail, there are several key elements that are important – i) targeting; ii) lowering of labor cost; iii) enhancement of the operation of the labor markets; and iv) ease of administration. Among alternative schemes that are publicly debated, a voucher scheme appears promising. The vouchers would go only to the unemployed or any subgroups being targeted such as new hires or entrants. A voucher scheme should reduce labor costs since producers eventually get the subsidy as the unemployed enter the market and seek jobs; it creates a missing market, enhancing interactions between producers and those still unemployed. Producers are still able to choose among voucher holders regarding who best fits their hiring needs. A voucher system should be easy to administer by making use of South Africa's existing transfer system. In particular, Levinsohn (2008) outlines what a well-targeted wage subsidy could constitute:

a) Since unemployment is highest among the young, a targeted wage subsidy could facilitate the school-to-work transition, targeting recent school leavers. It should be

[3] In addition, it will entail a very different labor market closure in that wages have to be flexible with labor supply responding to the changes in the market wage and its distance to the reservation wage of workers.

available to all South Africans after the age of 18 or as soon as they have completed schooling (to minimize the number of students that would leave school for a subsidized job). The subsidy would not expire to ensure that those who stay in school after the age of 18 are not penalized.

b) Upon turning 18, each South African receives an account ("Subsidy Account") into which the government places a sum of money (each person receiving the same amount). This money can only be used to subsidize the monthly wage that the individual receives while working for a registered firm. When the individual takes a job in the formal sector (in a registered firm), a fraction of the individual's wage would be drawn from the individual's Subsidy Account. The subsidy would be entirely portable and tied to the individual, not the firm.

c) A critical component of the targeted wage subsidy is a probationary period during which subsidized workers may be dismissed at will. The period should allow the employer enough time to learn whether the employee is job-worthy but shorter than the total duration of the subsidy to ensure that workers can find an alternative job if the first one does not work.

Relative to various suggestions regarding a wage subsidy like Levinsohn (2008), this paper is therefore complementary in attempting to quantify the likely employment effects of a wage subsidy.

The approach of the paper. To look at the employment effects of a wage subsidy, the distinguishing feature of the analysis is a disaggregative framework, which combines a multi-sector and multi-labor computable general equilibrium (CGE) model with a micro simulation model of South Africa along the line of work such as Bourguignon, Robilliard, and Robinson (2002), Savard (2006, 2003) and Essama-Nssah, Go, Kearney, Korman, Robinson, and Thierfelder (2007). Specifically, we use this framework to assess the likely impact of a wage subsidy on unemployment and its sensitivity to the relative complementarity or lack of substitution among factors of production and to the labor market conditions in South Africa. The paper examines several issues – i) Under what circumstances will a wage subsidy be effective or ineffective in reducing unemployment, particularly in the labor categories of unskilled or semi-skilled workers where unemployment is concentrated? ii) How significant are the welfare and equity impacts on heterogenous households and on particular groups of labor and households? iii) What are the fiscal and economy-wide repercussions? And in a worst case scenario, iv) can the employment effects of a wage subsidy be enhanced with other supporting measures such as an increase in the supply of skilled labor or an increase in output of low-skill labor-intensive sectors?

Relative to a recent CGE application of the wage subsidy issue in South Africa in Pauw and Edwards (2006), the present analysis contributes the following additional features – i) cross substitution among labor categories is differentiated using a translog (instead of a traditional nested CES) formulation, which will allow for different degrees of complementarity between higher skilled and lower skilled labor in various sectors, closer but different substitution among lower skilled labor in different sectors, and greater but different degrees of complementarity between high skilled labor and capital in various sectors; ii) the addition of the micro simulation model also allows for the welfare and equity analysis of a policy reform with the full

heterogeneous information contained in the household and labor force surveys; and iii) combination of the wage subsidy and complementary policies. To deal with parameter uncertainty due to the lack of reliable empirical estimates of the elasticity of substitution among factors of production, we evaluate the impact of wage subsidy over alternative sets of low, medium, and high elasticities. The CGE cum micro-simulation framework has the wage earnings equations and multi-nomial logit functions of occupational choices from the micro data linked to the CGE model like Bourguignon, Robilliard, and Robinson (2002). The link and reconciliation between the two models is essentially a recursive top-down iteration similar to Savard (2006, 2003) and Essama-Nssah *et al.* (2007).[4]

The model is used as a "measuring instrument" rather than a forecasting or planning model. By abstracting from other policy issues or the temporal aspects of South Africa's recent growth (e.g., terms of trade shocks, investment growth etc.), it holds everything else constant and focuses on measurement of the marginal employment effects of a wage subsidy and the sensitivity to alternative degrees of labor market flexibility and to some supporting measures suggested to alleviate the labor market problems. The model does not address the design and implementation elements of a wage subsidy.

Organization. The paper is structured as follows: section 2 provides an overview of the economic framework, a CGE cum micro-simulation model, with emphasis on its distinctive aspects and structural features imposed to portray the South African economy and its labor market situation; section 3 discusses the simulations and the results as well as suggestions for further research; and section 4 draws general conclusions.

2. The Economic Framework and its Applications to South Africa

The economic framework is an extension of the CGE cum micro-simulation model in Essama-Nssah *et al.*, (2007). The top layer is a CGE model for South Africa with data for 2003, using the modeling approach described in Lofgren, Harris, and Robinson (2001). See Kearney (2004) for a detailed description of the model features. The bottom layer is a micro-simulation described in Korman (2006), which pulls together the micro observations of the Labor Force Survey (LFS: 2000) and Income and Expenditure surveys (IES: 2000).[5] In what follows, we focus on the features relevant for analysis of the economy, labor market, degrees of complementarity among labor types and capital, closure rules, and the micro behavior of labor and households.

[4] A bottom-up iteration is possible but not employed in the present study. A two-way iteration is best used if there are dynamic feedbacks from factor accumulation as well as changes in the demand structure, which are planned for future applications.

[5] These surveys are nationally representative and conducted by Statistics South Africa. Both surveys are mostly based on the same sample of households; therefore, we combined data from these two surveys using individual's unique identification code.

Economic structure of South Africa. The CGE model has 43 production activities.[6] For reporting purposes, the output results by activity are aggregated into three categories: agriculture, industry, and services (see table 1 for the composition of the aggregate categories). [7]

Table 1: CGE Model Sectors

AGRICULTURE	INDUSTRY	SERVICES
Agriculture	Coal Mining	Electricity & Gas & Steam
	Gold & Uranium Ore Mining	Water Supply
	Other Mining	Construction & Civil Engineering
	Food	Catering & Accommodation
	Beverages & Tobacco	Wholesale & Retail Trade
	Textiles	Transportation & Storage
	Wearing Apparel	Communication
	Leather & Leather Products	Financial Services
	Footwear	Business Services
	Wood & Wood Products	Health & Community & Social & Personal Services
	Paper & Paper Products	Other Producers
	Printing & Publishing & Recorded Media	Government Services
	Coke & Refined Petroleum Products	
	Basic Chemicals	
	Other Chemicals & Man-Made Fibers	
	Rubber Products	
	Plastic Products	
	Glass & Glass Products	
	Non-metallic Minerals	
	Basic Iron & Steel	
	Basic Non-ferrous Metals	
	Metal Products Excluding Machinery	
	Electrical Machinery	
	TV & Radio & Communication Equip	
	Professional & Scientific Equip	
	Motor Vehicles Parts & Accessories	
	Other Transport Equipment	
	Furniture	
	Other Industries	

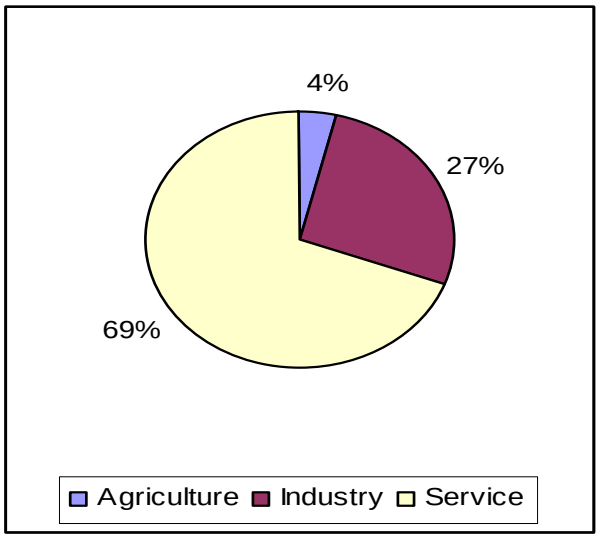
Source: CGE model social accounting matrix (SAM) database.

Agriculture accounts for 4 percent of value added, industry accounts for 27 percent, and service accounts for 69 percent (Figure 1).

[6] Full detail of the South Africa CGE model can be found in Essama *et. al.* (2007) and Kearney (2004); for a version of the model used to analyze Value Added Taxes (VAT) see Go et al. (2005). In this description we comment on new features of the model important for an analysis of a wage subsidy.

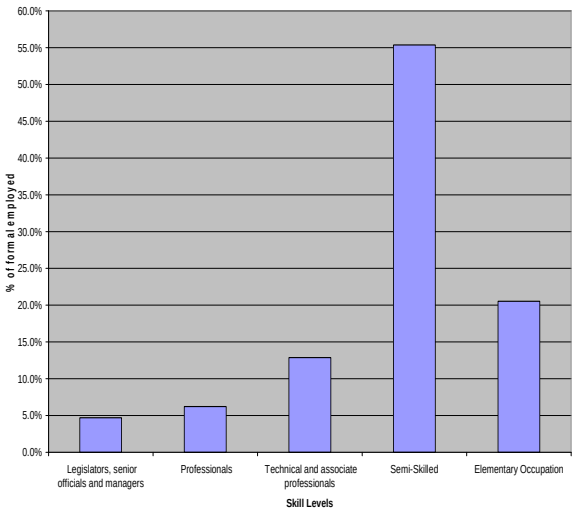
[7] Note, we disaggregate crude oil from other mining, as described in Essama et al (2007).

Figure 1: Aggregate Activity Share of Value Added



Source: Authors' calculations from a Social Accounting Matrix (SAM) for South Africa, 2003.

Figure 2: Formal Employment by Skill Level (2000)



Source: Authors' calculations from LFS 2000.

Labor in South Africa. There are three types of labor (formal, self-employed, and informal) and three skill levels (high-skilled, semi-skilled, and low-skilled) within each type of labor. Value added is allocated to primary factors and summarized in Table 2.

Table 3 shows the distribution of employment by sector and occupation. About 6 people out of ten are employed in the services sector. About the same ratio are engaged in formal sector work. With respect to the distribution of skills, the data show that about 12 percent of those employed are highly skilled; over 45 percent of labor in South Africa is employed in the low-skilled and medium-skilled formal sector and another 19 percent in the informal sector.

Table 2: Value Added Shares

	Agriculture	Industry	Services
Capital	0.76	0.54	0.45
High-skilled formal labor	0.03	0.12	0.25
Semi-skilled formal labor	0.02	0.12	0.18
Low-skilled formal labor	0.11	0.15	0.04
Self-employed labor*	0.04	0.03	0.04
Informal labor*	0.04	0.04	0.04

*Self-employed and informal labor are further distributed by skill (not shown).

Source: Authors' calculations from a SAM for South Africa, 2003.

Table 3: Employment by Sector and Occupation

Occupational Types	Agriculture	Industry	Services	Total
1. Formal Low –Skilled Workers	6.0	2.9	5.7	14.6
2. Formal Semi –Skilled Workers	6.2	8.7	16.5	31.3
3. Formal High- Skilled Workers	0.7	1.3	9.6	11.6
4. Informal Sector Workers*	2.7	2.5	13.9	19.2
5. Self-employed*	9.1	2.8	11.5	23.4
Total	24.6	18.2	57.2	100.0

Notes: *Self-employed and informal labor are further distributed by skill (not shown).
Source: Authors' calculations from LFS 2000.

Self-employed and informal sector workers make up about 43 percent of the total employed labor force. A large proportion of informal labor (including domestic workers) and self-employed are working in the services sector, which is the biggest employer of the work force and also employs the largest share of the high-skilled workers.

Table 4: Formal Wage Employment by Economic Sector, 2000 (%)

Economic Sector	Working,Very Poor*	Working,Poor**	Non-Poor***
Agriculture	36.5	16.0	1.1
Mining	2.1	8.0	7.3
Manufacturing	11.0	18.0	18.8
Electricity, gas and water supply	0.5	1.0	1.6
Construction	5.6	6.0	2.8
Wholesale and retail trade	23.3	23.0	12.1
Transport	2.3	5.0	6.8
Financial Services	5.2	9.0	13.9
Community, Social and Personal Services	9.8	14.0	35.6
Private households	3.6	2.0	0.2
Overall (all sectors)	100	100	100

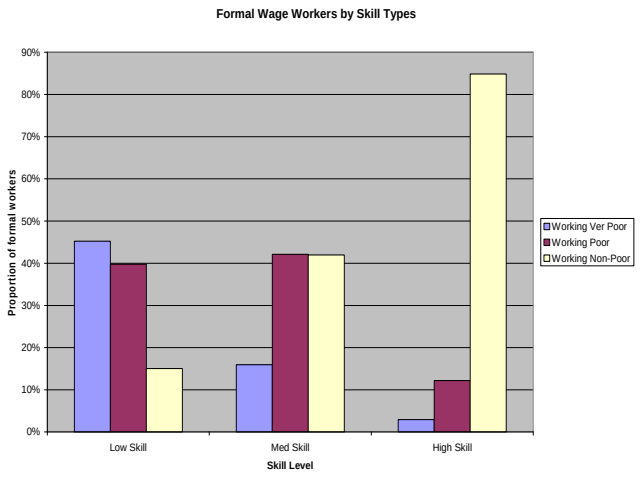
Notes:
*Working, very poor: annual wage for working very poor is calculated using R1000 per month (2004).Using the CPI for 2004 and 2000, the annual wage of working very poor comes to about R9,695. [1000/(123.8/100)]*12.
**Working, Poor: annual wage for working poor is calculated using R2500 per month (2004) benchmark In 2000 prices, the annual wage for this group is about R24,233.[2500/(123.8/100)]*12.
***Non poor: Formal workers are those with an annual income higher than R24,233.

Source: Authors' calculations from LFS 2000.

Since the wage subsidy is given to employers of formal wage workers, we describe briefly the characteristics of the formal labor market from the LFS (2000) and IES (2000) surveys. Figure 2 shows formal employment by skill level. High-skilled formal workers[8] constitute 24 percent of the total formal work force. Semi-skilled workers[9] constitute 55 percent of the total formal employment and low-skilled workers that are defined as elementary occupations[10] constitute about 21 percent of the formal wage labor market. Overall about 72 percent of formal employment is characterized by either low- or semi-skilled workers.

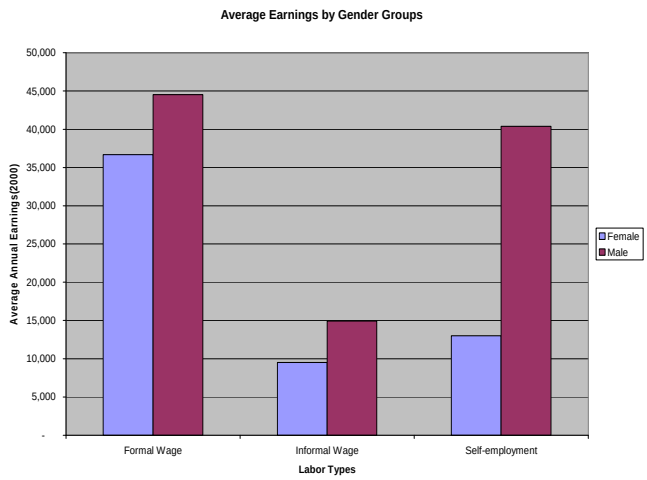
Formal wage workers in agricultural and retail trade sectors are relatively poor. Based on income thresholds from a recent study on South Africa (Altman, 2007), formal workers can be classified into three groups: i) very poor, ii) working poor, and iii) not poor. The working poor refers to anyone who is employed by the definition of the South African Labor force survey (also in line with the International Labor Organization (ILO) definition), working and earning less than R2,500 per month. This threshold is close to that chosen by National Treasury as the minimum level below which workers are exempt from income tax.[11] Table 4 reflects only formal employment by economic sectors. Agricultural and trade sectors hold the largest share of very poor or poor workers. Manufacturing sectors also have relatively large shares of working poor formal workers (18 percent). On the other hand, non-poor workers are mainly employed in services although manufacturing and financial sectors also have significant shares of non-poor workers, with 19 and 14 percent respectively.

Figure 3: Poverty Profile of Formal Wage Workers by Skill Types



Source: Authors' calculations from LFS 2000.

Figure 4: Earnings by Gender (2000 prices)



Source: Authors' calculations from LFS 2000.

[8] High skilled formal workers include legislators, senior officials, professionals, technical and associate professionals.

[9] Semi skilled workers are: clerks, service workers and shop and market sales workers, skilled agricultural and fishery workers, craft and related trades workers, plant and machine operators and assemblers.

[10] Low-skilled workers include elementary jobs.

[11] The minimum level of annual income subject to income tax was R32,000 in 2004. We converted this value in 2000 prices using CPI to make it comparable to our study. In 2000 prices, the minimum annual income would be about R25, 848.

Evidence confirms that low-skilled, low-wage, individuals are trapped in poverty. About 85 percent of low-skilled workers in the formal economy are either very poor or working poor (Figure 3). On the other hand, almost 85 percent of people with high-skill levels are non-poor. Skill level is an important determinant of poverty within the working population.

Table 5: Average Earnings of Labor Market by Education Level

Education Level	Annual Average Earnings(rand-2000 prices)		
	Formal Labor	Informal Labor	Self-employed
No Schooling	15,028	5,942	8,367
Grade 0-6	16,710	6,773	9,400
Grade 7-9	22,983	10,614	12,776
Grade 10-12	44,327	16,139	35,696
National Technical Certificate [12]	60,628	43,417	72,725
Degree and Post Graduate	119,939	124,957	147,296
Overall Average	41,582	11,728	25,829

Source: Authors' calculations from LFS 2000.

To explore further the link between skill level and poverty, Table 5 reports three types of earnings by different level of education. For all three types of workers, earnings increase sharply with education, an attribute closely linked with skill level. For example, a worker with a college degree in the formal sector earns, on average, about 8 times as much as a worker with no schooling. The disparity between a degree-holder and a worker with no schooling is even larger in the informal sector or for the self-employed sector.

As the education level rises, average annual earnings also rise. On average, individuals with higher education earn more than twice that of individuals who have graduated from grades 10-12. When compared with different types of labor, self-employed with higher education earn the most compared to the formal and informal labor with the same level of education. On the other hand, at lower levels of education, formal workers earn more until grade 12. There are other dimensions of earning disparity among formal sector workers. Two most commonly discussed aspects are: rural/urban disparity and disparity based on gender. For instance, average earnings are significantly higher for those who are working in urban areas. The differential is largest for the self-employed.

Table 6: Average Earnings of Labor Market by Regions (2000 prices)

Region	Annual Average Earnings(rand)		
	Formal Labor	Informal Labor	Self-employed
Rural	21,872	9,360	13,299
Urban	48,028	13,310	41,692
Overall Average	41,582	11,728	25,829

Source: Authors' calculations from LFS 2000.

[12] National Technical Certificate includes three levels, NTCi- NTCiii, which are equivalent to high school grades 10-12.

The data show significant gender differences in average earnings (Figure 4). Differentials are three times more prominent in the self-employed group than in other labor types. Male workers earn, on average, about 60 percent more than female workers in informal labor. Wage differentials are smallest for formal wage workers, where male workers earn, on average, about 20 percent more than female workers. Although income differences due to gender or education are not distinguished explicitly in the CGE model, they are captured in the earnings or wage functions of the micro-simulation.

Relative complementarity or low substitution among factors of production – is a key assumption in the model. Each economic activity can use nine labor categories plus capital in production. For reporting purposes, all skill levels of the self-employed are aggregated into a single input, self-employed labor; likewise for informal labor. In the production technology, it is assumed that substitution possibilities among inputs differ and the following structure is used: (1) it is difficult to substitute low-skilled labor for high-skilled labor in any of the three labor categories; (2) it is easy to substitute across labor categories for the same skill (i.e. a high-skilled formal worker is a good substitute for a high-skilled informal worker or a high-skilled self-employed worker); and (3) as the skill level of labor increases, it is more difficult to substitute capital for labor. In the CGE model, this behavior is represented using a translog production function.[13] The degree of substitution among labor inputs in production is important when measuring what impact a wage subsidy for low- and medium-skilled formal workers will have on unemployment.

Table 7: Translog Elasticity Multipliers

	Capital	High-skilled formal	Med-skilled formal	Low-skilled formal	High-skilled self	Med-skilled self	Low-skilled self	High-skilled informal	Med-skilled informal	Low-skilled informal
Capital	0	0.5	1	1.5	0.5	1	1.5	0.5	1	1.5
High-skilled formal		0	1	0.25	1.5	1	0.25	1.5	1	0.25
Med-skilled formal			0	1	1	1.5	1	1	1.5	1
Low-skilled formal				0	0.25	1	1.5	0.25	1	1.5
High-skilled self					0	1	0.25	1.5	1	0.25
Med-skilled self						0	1	1	1.5	1
Low-skilled self							0	0.25	1	1.5
High-skilled informal								0	1	0.25
Med-skilled informal									0	1
Low-skilled informal										0

Source: CGE model database.

[13] All activities except coal, gold, other mining, and refined petroleum use a translog production function; coal, gold, other mining, and refined petroleum use a constant elasticity of substitution (CES) production function with the assumption that it is difficult to substitute among inputs so the elasticity of substitution is low (0.2).

Table 8: Reference elasticity of substitution in production, by activity

Activity	Elasticity	Activity	Elasticity
Agriculture, Forestry, and Fisheries	0.60	Metal Products Excluding Machinery	0.60
Coal Mining	0.20	Machinery and Equipment	0.25
Gold and Uranium Ore Mining	0.20	Electrical Machinery	0.60
Other Mining	0.20	TV, Radio, and Communication Equip	0.60
Food	0.60	Professional and Scientific Equip	0.60
Beverages and Tobacco	0.40	Motor Vehicles Parts and Accessories	0.25
Textiles	0.30	Other Transport Equipment	0.25
Wearing Apparel	0.60	Furniture	0.25
Leather and Leather Products	0.60	Other Industries	0.60
Footwear	0.29	Electricity, Gas, and Steam	0.60
Wood and Wood Products	0.25	Water Supply	0.60
Paper and Paper Products	0.60	Construction and Civil Engineering	0.60
Printing, Publishing, and Recorded Media	0.34	Wholesale and Retail Trade	0.60
Coke and Refined Petroleum Products	0.44	Catering and Accommodation	0.60
Basic Chemicals	0.60	Transportation and Storage	0.60
Other Chemicals and Man-Made Fibers	0.60	Communication	0.60
Rubber Products	0.44	Financial Services	0.60
Plastic Products	0.44	Business Services	0.60
Glass and Glass Products	0.35	Health, Community, Social, and Personal Services	0.60
Non-metallic Minerals	0.61	Other Producers	0.60
Basic Iron and Steel	0.25	Government Services	0.60
Basic Non-ferrous Metals	0.25		

Source: CGE model database.

Input substitution possibilities vary by production activity. A set of multipliers (Table 7) are applied to all sectors, providing similar "structure"or "nesting"of elasticities; however, sectors have different reference elasticities (Table 8). Given the lack of empirical estimates regarding the exact magnitudes of factor substitution, we provide sensitivity tests and consider three cases - low substitution elasticities, base substitution elasticities, and high substitution elasticities. In the base case, the reference elasticities of substitution in Table 8 are multiplied directly by the factors in Table 7. The resulting base case numbers correspond generally to conservative numbers found in various CGE works, including Essama-Nssah *et al.*, (2007) and Kearney (2004). Low substitution elasticity values are one half those reported in Table 7, high substitution elasticity values are two times those reported in Table 7. When the production process is assumed to be constant elasticity of substitution (CES), the values in Table 8 are used.

Macroeconomic closures. At the macro level, we assume that government's real spending, real investment, and aggregate foreign savings are constant. Private savings adjust in order to maintain a fixed total investment in the economy and all changes affect household consumption. This is a standard approach in public finance analysis of revenue and welfare issues as it provides the results of the wage subsidy in isolation of other macroeconomic adjustment shocks, e.g., from any changes in investment or government expenditure.[14] Domestic

[14]The crowding out of private investment is therefore not the focus. The other option of adjusting government expenditure in the budget, while feasible, is constrained by the indirect links between public services and household

savings (savings by institutions or households) are assumed to adjust and the economic and welfare effects are driven primarily by changes in net household income and consumption as the cost of higher wage subsidies filter through the economy.

Unlike traditional tax models, however, there will be a resource effect as the subsidy will lower wage cost and raise employment given the labor market behavior of the model. The structural features of the labor markets in South Africa are treated in a similar fashion as in Essama *et al.* (2007), Go *et al.* (2005) and Lewis (2001). Structural unemployment is specified for low-skilled and semi-skilled formal workers, with sticky real wages, while the other labor markets clear in equilibrium. All other factors are mobile across all production activities and are fully employed, with the exception of capital in agriculture, coal, gold, and other mining which are treated as activity specific.[15] The wage subsidy is introduced much like a "negative wage tax" that lowers the labor cost to employers; it affects only the low-skilled and semi-skilled workers where significant unemployment exists, but covers employers in all activities except coal, gold, other minerals, petroleum, and government services. Although there are already great details in terms of sectors and labor categories, the CGE model cannot target further the wage subsidy to the young or new job entrants, as for example formulated by Levinsohn (2008), without the additional complexity of adding a demographic component to labor market behavior. Likewise, at the micro-simulation level explained below, an increase in employment is drawn from the pool of unemployed among the low- and semi-skilled based primarily on their economic and individual characteristics (such as education, experience, gender, etc.) that affect their probabilities of being hired. The incorporation of demographic dynamics is clearly an area for future research.

In the government budget, government savings are 'flexible', but with investment and government spending fixed, this is just a modeling device to shift the adjustment to the households. It is in fact equivalent to the imposition of a lump-sum tax on household income. The wage subsidy is therefore not free and the fiscal cost will depend on the interaction among the resource effects of increased employment and gross domestic product (GDP), the dampening effects on household income from the implied lump-sum tax, and their economy-wide effects on the revenue of existing taxes. One advantage of a general equilibrium approach is that all the economy-wide or direct and indirect effects are observed. Since tax revenue from other sources will likely adjust upward, the net cost of the program is not the full expenditure on wage subsidies. What is not financed from the revenue effect of existing taxes is the net fiscal cost; it is also the size of the implied lump-sum tax on households. Because the first best option of lump-sum taxation is normally not feasible, we also look at a real or existing tax instrument like the social security tax and examine the implications for changes in household income taxes following a wage subsidy as well as possible distributional impacts.

Micro-behavior of labor and households. A micro-simulation model is used to explain the income generation processes and the expenditure patterns at the household level based on parameterization of the information contained in the household survey data. The LFS provides

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income/consumption/welfare. To examine the impact on household income and welfare, those links will need to be spelled out.

[15] With this specification, we present a long run view of the adjustment process, achieving equilibrium sectoral employment except those sectors in which capital is assumed to be sector-specific.

detailed information on labor supply, employment, unemployment, formal wages, informal wages, and self-employed income, and a number of socio-economic characteristics of individuals and households. The IES survey contains detailed data on household expenditure patterns, labor and non-labor incomes of household, and a number of socio-economic characteristics of households. When the two databases are combined and observations with missing sampling weights are dropped, the number of individuals in our database is 103,732 from 26,214 households. We rely on household weights from the IES data to generate economy-wide results.

The specification of our model of the income-generation process at the individual or household level is described in more details in Essama *et. al.* (2007) and Korman (2006). The model has three components: (a) a multinomial logit model of the allocation of individuals across occupational states, based on individual and labor characteristics; (b) a model of the determinants of earnings (such as education, gender, union membership, urban-rural location, head of household, marital status, etc.); and (c) an aggregation rule for computing household income from the contribution of its employed members. We assume that other types of non-labor income, such as interest and rent incomes or transfers, are exogenous. The sum of formal and informal wages and self-employment income by all wage earners and self-employed people in a household and other non-labor income make up total household income. The econometric modeling of the income generation processes includes the estimation of wage functions and occupational probability functions for formal labor, informal labor, and self-employed workers by skill-type and by economic sectors (see the Annex for details).

Macro-micro links. The communication between the CGE model and the micro-simulation model is a top-down approach. The CGE model translates the impact of the shocks and policies through changes in relative prices of commodities and factors, and through levels of employment. The micro-simulation model takes these changes as exogenous and translates them into changes in household behavior which underpins changes in earnings, occupational status, and gains and losses of per capita income as indicative measures of welfare. A series of steps are taken to ensure outcomes from the micro-simulation model are consistent with the aggregate results from the CGE model both before and after the shock. In particular, the consistency constraints require that the occupational choices predicted by the micro-simulation model match the employment shares in the CGE model. Similarly, simulated earnings at the micro level must match macro predictions.[16] Because the base years for the social accounting matrix (SAM,2003) and the survey data (2000) in our study of South Africa are different, we employ percent changes to communicate changes in employment, wages, and prices from the CGE to the micro simulation. This allows us to retain the more recent numbers in the macro accounts as well as the familiar poverty and inequality measurements of the micro data.[17]

In the case of employment changes, the CGE model provides estimates of the percent change in employment by category for each simulation. The micro simulation model generates exactly the same percent changes in the individual labor force data set by moving individuals into (or out of) that specific labor category. For example, when a labor category expands, the

[16] Bourguignon, Robilliard and Robinson (2002) explain that benchmark consistency could be achieved by ensuring that the calibration of the CGE is compatible with the consistency constraints.
[17] See Essama *et. al.* (2007) for details. Savard (2006) and Robillard and Robinson (2006) also discussed approaches for achieving consistency between household survey data and the national accounts.

micro simulation model uses unemployed individual's estimated maximum utilities (i.e., summation of predicted probabilities plus the error or unobservable term) of being in each employment category (including the unemployed group). When moving individuals from the unemployed pool to the employed group, we used the following information about unemployed people: (i) their skill type, and (ii) the economic sector in which they were previously employed before they became unemployed. This information is utilized in the process of moving individuals into labor market.

3. Simulations

The employment impact of a wage subsidy to low and medium-skilled formal labor largely depends on two sets of factors: i) the relative complementarity of the factors of production; and ii) labor market constraints due to either a limited amount of skilled labor and capital or the size of the unskilled and medium-skilled intensive sectors in the economy. We devise two sets of simulations to test the sensitivity of a wage subsidy to key factors. We also look at the microeconomic impact of a wage subsidy on households assuming the middle range of substitution elasticities in production.

Set 1 of Simulations: *Sensitivity of the Impact of Wage Subsidy to the Relative Complementarity of the Factors of Production*

The magnitude of the employment gains from a wage subsidy depends upon the assumptions about factor substitution in production. Three scenarios assuming low, medium, and high elasticities of substitution between factors of production are performed to illustrate the employment creating potential of a wage subsidy. In the presence of technological constraints and labor market rigidities, the elasticities of substitution would be rather low—as may be the case in South Africa. As technology improves and/or labor market rigidities are removed, the elasticities of substitution should increase and the employment creating potential of a wage subsidy would be larger.

We consider a range of values for a wage subsidy to all production activities except coal, gold, other mining, refined petroleum, and government services. As seen in Table 9, for a 10 percent wage subsidy, the employment gains range from 1.9 percent when the economy is assumed to be inflexible in production to 7.2 percent when the economy is assumed to be flexible in production. The wage subsidy expands employment of low and medium-skilled formal labor in all three sectors. The agricultural sector shows a large percentage increase in employment, but given the sector's relatively small share in total employment, the contribution to the change in total employment is relatively low. The agricultural sector's employment creation potential rises rapidly as the elasticities of substitution rise (for example, employment of low-skilled formal labor increases from 5.1 percent to 21.2 percent). Further research is needed on the agricultural sector to assess its true employment potential, given the seasonality of the sector's employment as well as the existing institutional rigidities such as land reform and minimum wages. The factors in fixed total supply (high-skilled formal labor, informal labor, and self-employed labor) are released from the services sector as the economy adjusts to the wage subsidy.

Table 9: Employment change (%) of 10% wage subsidy to low-skilled and medium-skilled formal labor

	Base	Low	Medium	High
Low-skilled formal labor	3451.5	3.3	6.7	12.2
Agriculture	761.6	4.9	10.8	21.2
Industry	1069.7	2.1	4.1	7.1
Services	1620.2	3.3	6.5	11.2
Medium-skilled formal labor	3207.0	3.0	6.2	12.2
Agriculture	34.7	3.8	8.6	18.4
Industry	432.2	2.5	5.0	9.8
Services	2740.1	3.1	6.4	12.5
High-skilled formal labor	1300.7	0.0	0.0	0.0
Agriculture	16.4	0.3	1.0	2.5
Industry	133.4	0.2	0.3	0.4
Services	1150.9	0.0	0.0	-0.1
Informal labor	2913.4	0.0	0.0	0.0
Agriculture	301.8	0.0	1.8	5.0
Industry	357.3	0.1	0.2	0.3
Services	2254.3	0.0	-0.3	-0.7
Self-employed labor	346.3	0.0	0.0	0.0
Agriculture	18.2	0.3	1.4	3.8
Industry	43.1	0.1	0.1	0.0
Services	285.1	0.0	-0.1	-0.3
Total labor force	11218.9	1.9	3.8	7.2

Source: CGE model simulations.

Increased employment from the wage subsidy leads to increased GDP. For a 10 percent wage subsidy, GDP increases from 0.6 percent (low substitution elasticities) to 2.4 percent (high substitution elasticities), see Table 10.

Table 10: Percent Change in Real GDP given 10% wage subsidy to low-skilled and medium-skilled formal labor

	Base	Low	Medium	High
	(Billion R)	10%	10%	10%
Absorption	1231.0	0.6	1.3	2.4
Household Consumption	786.3	1.0	2.0	3.8
Fixed investment	200.3	0.0	0.0	0.0
Inventory	5.3	0.0	0.0	0.0
Government consumption	239.1	0.0	0.0	0.0
Exports	339.8	0.6	1.1	2.1
Imports	-319.4	0.6	1.2	2.3
GDP at market prices	1251.5	0.6	1.3	2.4

Source: CGE model simulations.

The modeling results estimate that a 10 percent wage subsidy with low elasticities of substitution will cost R19.7 billion (in 2003 rand, see Table 11). However, real GDP increases as employment increases, and tax revenues will also increase, offsetting the cost of the wage subsidy. As a result, the effective cost of the wage subsidy is 75 percent of the total wage subsidy bill, in the low elasticity case. If one assumes the economy is more flexible, the effective net cost of the wage subsidy falls to 55 percent of the wage subsidy bill. The wage subsidy per job

created is relatively high, at R90,758 per job created for the low elasticity case, because the wage subsidy is provided to all low-skilled formal and medium-skilled formal labor hired, not just to the additional workers. The cost per job created declines dramatically as the economy becomes more flexible.

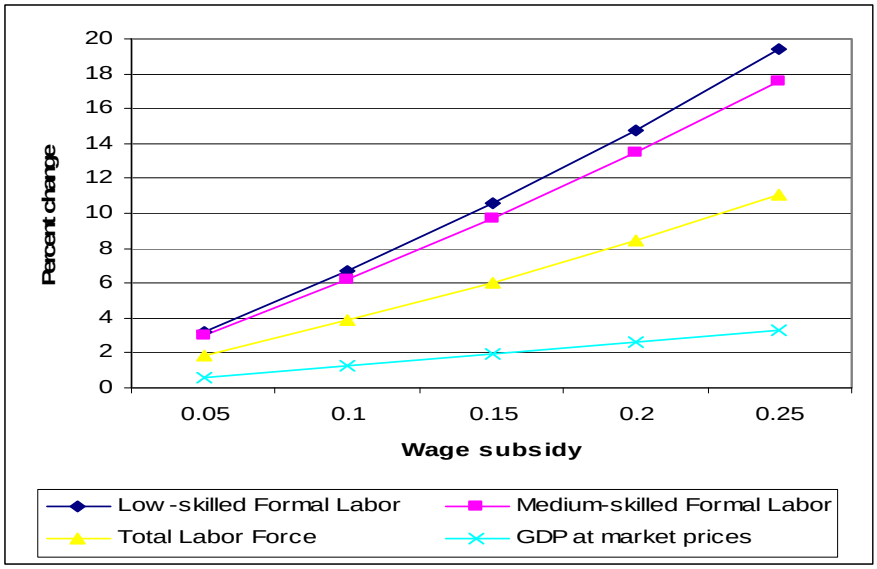
Table 11 Government revenue (billion rand) and fiscal cost of wage subsidy
(10% wage subsidy to low-skilled and medium-skilled formal labor)

	Base	Low	Medium	High
		10%	10%	10%
Direct tax	169.0	172.7	173.5	174.9
Indirect tax				
Tariffs	8.3	8.3	8.4	8.5
Domestic	62.5	63.1	63.5	64.3
Net VAT	69.6	70.2	70.7	71.7
Total tax revenue	309.4	314.3	316.1	319.3
Additional tax revenue (revenue effect from existing taxes due to increased employment and GDP)		4.9	6.8	10.0
Wage subsidy cost	0.0	-19.7	-20.5	-21.9
Net wage subsidy cost (implied lump sum tax)		-14.7	-13.7	-11.9
Effective wage subsidy rate (percent of the cost not covered by the revenue effect)		74.9	67.0	54.5
Wage subsidy cost per job created (R per job)		90758.4	47406.5	27039.8

Source: CGE model simulations.

The employment and GDP effects increase as the subsidy rate increases. Here we report the changes for the base case. As seen in Figure 5, total employment growth ranges from 1.8 percent for a 5 percent wage subsidy to 11 percent for a 25 percent wage subsidy. GDP growth ranges from 0.6 to 3.3 percent.

Figure 5: Employment and GDP changes in response to wage subsidies, medium elasticity case



Source: CGE model simulations.

The current model specification assumes that the wage subsidy only affects the number employed without affecting the market wages. Alternatively, the presence of labor unions means that some of the wage subsidy is collected by union workers in the form of higher wages. To

show the sensitivity of our results to union behavior, we consider the case in which the union claims half of the wage subsidy in the form of higher wages. Using the medium elasticity values and a 10 percent wage subsidy, we find that the employment gains are 1.7 percent, compared to 3.8 percent in the absence of unions—the employment gains are more than twice as large in the absence of increased wages.

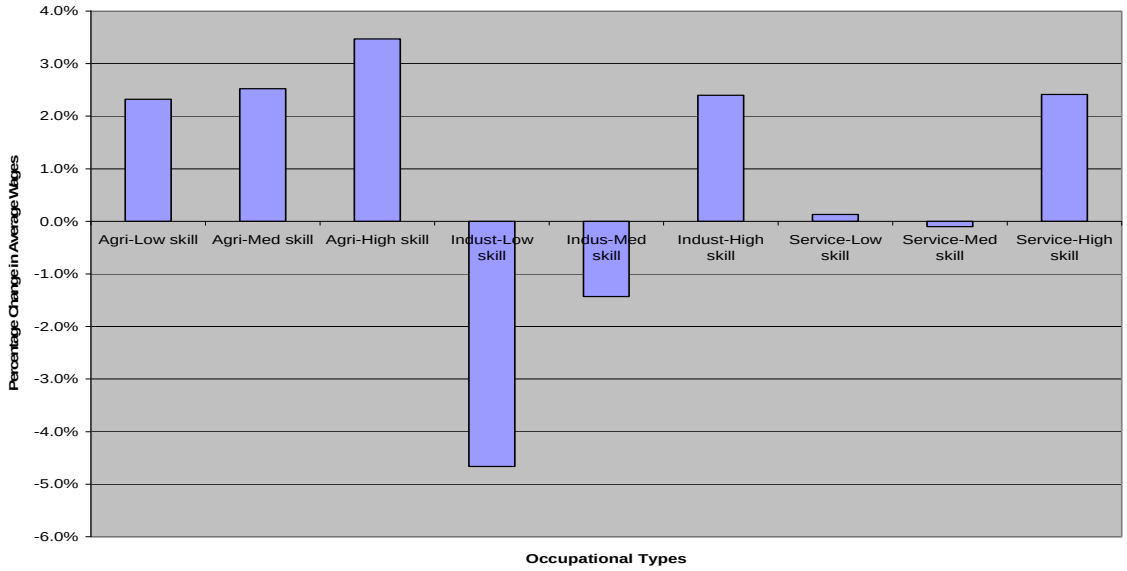
Replacing the implied lump-sum tax with a real tax, we impose a social security tax to finance about two-thirds of the wage subsidy cost. It this scenario, the social security tax (sst) pushes the cost of the program to a subset of household income groups—it is imposed on income groups earning R24,000 and R100,000 to partially finance the wage subsidy. These households are primarily from the income deciles 7 to 9. Lower household deciles do not fall in the tax base and are therefore excluded, while the uppermost household deciles are not considered because the incomes are mainly non-wage. The social security tax is implemented as a direct tax with no incentive effects on the employer; it effectively replaces the implied lump-sum tax necessary to finance the wage subsidy. The direct income tax rate, including the social security tax, goes from 0.087 to 0.117 for the seventh income decile group, 0.108 to 0.146 for the eight income decile group, and 0.136 to 0.182 for the ninth income decile group; other direct taxes are raised further to finance the rest of the wage subsidy cost, but do not have to increase as much as would be the case without the social security tax. The impact of the financing scheme is evident when looking at household welfare—there is a dramatic decline in the net gains income for the households paying the social security tax. Next, we look at the more detailed impact on households for the medium case of the elasticities of substitution.

Impact on households – medium elasticity case. Looking at the medium case in Table 9, a wage subsidy to the formal sector employers leads to an increase in employment in the formal sector, particularly in the agricultural sector. The importance of wage subsidy policy is to create new jobs for low-skill and medium-skill formal unemployed individuals in the labor force while encouraging employers to hire new employees with these skill groups and reducing their wage bill. As a result, employment increases by 3 percent and the new workers are making non-zero wages. While there are differences in earnings of newly employed workers depending on their age, racial composition, and regional disparities, they are beneficiaries of the subsidy scheme since they start making non-zero earnings, are out of the unemployed pool, and, as a result their welfare increases.

Although a wage subsidy is primarily focused on increasing jobs, the average wage may be affected by the wages of new entrants, depending on their level of experience, education etc. For low- and medium-skill workers in the industrial sector, new entrants are drawn primarily from unemployed young black Africans, who tend to have less work experience and less education than a college degree. As a result, there is a decline in the average wage because new entrants earn much lower than average wages (Figure 6). Regardless of skill level, workers in agriculture gain from implementation of a 10 percent *ad-volerem* wage subsidy policy. Average wage gains vary from 2.3 percent for low skill workers to 3.3 percent increase for high skill workers in the agricultural sector. On the other hand, for low- and medium-skill workers in the

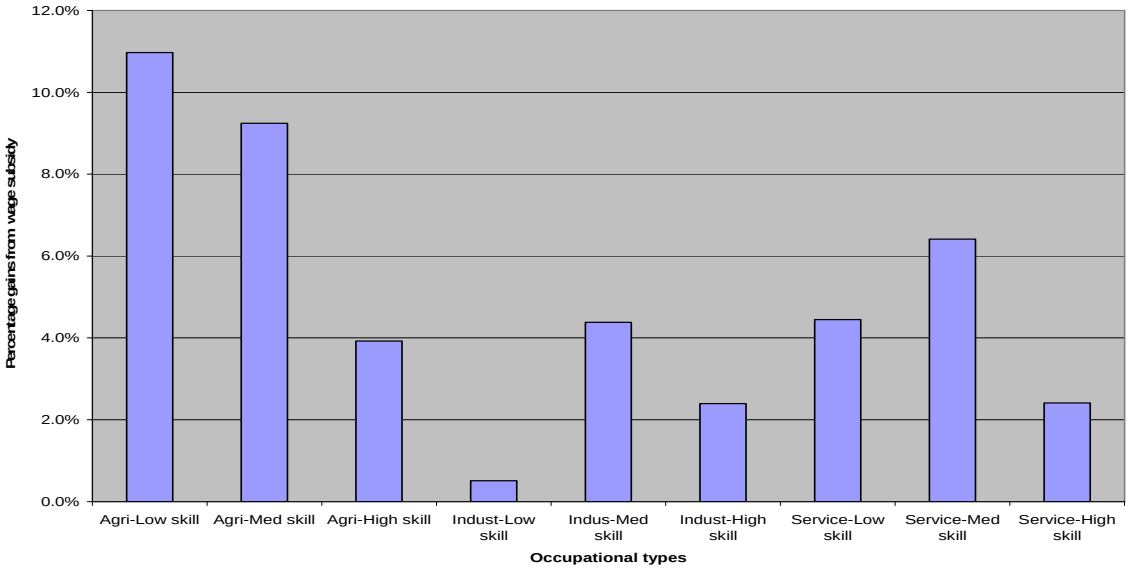
service sector, average wage increases are negligible, while high-skill workers gain above 2 percent in the same sector (Figure 6).[18]

Figure 6: Changes in Relative Wages from a Wage Subsidy in Formal Sector



Source: Author's calculations

Figure 7: Income Gains from a Wage Subsidy for Workers in Formal Sector



Source: Author's calculations

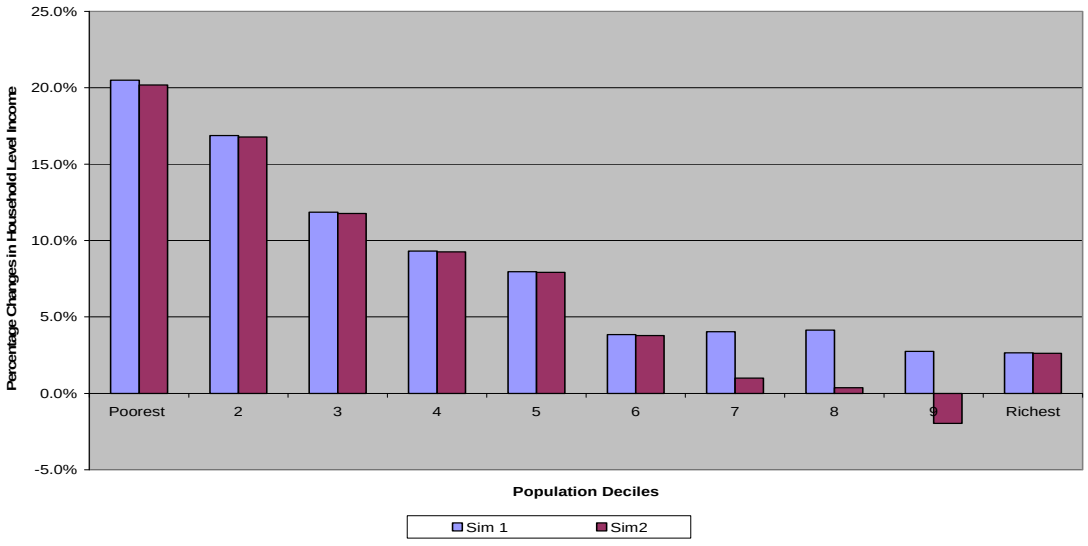
[18] In the CGE model, the average real wage for low- and medium- skilled formal labor type is fixed economy wide, but wage differences exist by activities by activity.

Overall aggregate income gains for formal sector workers are still substantial, ranging from 0.6% to 11%, particularly for those in the agricultural and service sectors (Figure 7). The total income gains reflect both changes in employment and changes in average wages.

We also examine the impact of a social security tax imposed on households with income between R24 000 and R100 000 to partially finance the wage subsidy with the proceeds. The households subject to the new tax are in high income deciles (mainly the top 3 deciles - except the richest decile where the primary income sources are non-wage). As the social security tax is not likely to affect employers' behavior, there is little impact on the employment level and the structure of the economy from the macro results. As expected, however, there are differences at the household level.

Households are generally better off and their welfare increases with a wage subsidy with or without a social security tax (Figure 8). Relative to the baseline, the imposition of a social security tax affects mainly those households subjected to the new tax - the upper income deciles (7, 8, 9 deciles). Income gains by household income group range from 2% (for the richest group) to 20% (for the poorest). But with a social security tax imposed on the top 3 deciles (excluding the richest), the gains will likely disappear for households in these higher 3 income deciles. For example, households in the ninth decile become net losers from the imposition of social security tax.

Figure 8: Income gains and Loses at the Household Level from simulations



Source: Author's calculations.
Notes:
Simulation 1:10 percent wage subsidy given to employers for low and semi skill in formal sector.
Simulation 2: Adding social security tax to simulation 1

Overall poverty and inequality decline. Tables 12 and 13 report the Foster-Greer-Thorbecke (FGT) poverty headcount ratio and general entropy indices with particular focus on the Gini coefficient. About 1.6 percent of households move out of poverty with the implementation of the wage subsidy, with the head count ratio declining from 49.1 to 47.6 percent.[19] The employment effect also offsets the addition of a social security tax with a 1.5 percent reduction in the poverty rate.

Table 12: Poverty Indicators, by Region, Population Deciles, and Education Level

	Poverty Indicators (%)			Variation from Base		Difference
	Base	**Sim1**	**Sim2**	**Sim1**	**Sim2**	**Sim2-Sim1**
1. National Headcount Ratio						
Proportion of Poor	0.491	0.476	0.477	-1.6	-1.46	0.09
2. Regional Decomposition (Headcount ratio)						
Urban	0.335	0.319	0.320	-1.6	-1.51	0.08
Rural	0.721	0.706	0.707	-1.5	-1.39	0.09
3. Population Deciles						
Poorest	0.952	0.929	0.929	-2.3	-2.24	0.03
2	0.934	0.909	0.909	-2.5	-2.53	0.01
3	0.884	0.859	0.860	-2.5	-2.39	0.07
4	0.796	0.768	0.769	-2.8	-2.69	0.11
5	0.561	0.538	0.539	-2.2	-2.15	0.07
6	0.351	0.343	0.343	-0.8	-0.80	0.00
7	0.186	0.179	0.183	-0.7	-0.29	0.42
8	0.114	0.107	0.108	-0.7	-0.54	0.12
9	0.078	0.074	0.074	-0.5	-0.45	0.02
Richest	0.085	0.050	0.050	-3.6	-3.55	0.03
4. Level of Education of Head of the Household (Headcount Ratio)						
No Schooling	0.783	0.774	0.774	-0.9	-0.86	0.01
Grade 0-6	0.620	0.605	0.606	-1.5	-1.36	0.17
Grade 7-9	0.479	0.447	0.448	-3.2	-3.09	0.13
Grade 10-12	0.257	0.241	0.241	-1.6	-1.57	0.05
NTC Level	0.146	0.126	0.126	-2.0	-1.99	0.00
Degree and Post Graduate	0.078	0.066	0.067	-1.2	-1.05	0.10

Notes: Poverty line is taken as 1 dollar per day. Exchange rate is rand 6.95 /1 dollar in 2000 prices. Per capita income is used as a welfare measure of household.
Simulation 1: 10 percent wage subsidy given to employers for low- and semi-skill in formal sector.
Simulation 2: A social security tax is introduced relative to simulation 1.

[19] These results are based on using $1 as a poverty line per day per person.

Table13: Generalized Entropy Indices-Inequality Indicators

	Inequality Indicators			Variation from Base		Difference
	Base	**Sim1**	**Sim2**	**Sim1**	**Sim2**	**Sim2-Sim1**
1. National Level						
General Entropy (0)	1.22	1.19	1.19	-0.02	-0.02	0.00
General Entropy (1)	1.20	1.18	1.19	-0.02	-0.02	0.01
Gini Coefficient	0.72	0.71	0.72	-0.4	-0.4	0.1
2. Regional Decomposition						
Urban						
General Entropy (0)	1.02	1.00	1.00	-0.02	-0.02	0.00
General Entropy (1)	1.01	0.99	1.00	-0.02	-0.02	0.01
Gini Coefficient	0.67	0.67	0.67	-0.5	-0.5	0.3
Rural						
General Entropy (0)	1.13	1.12	1.11	-0.01	-0.01	-0.01
General Entropy (1)	1.46	1.43	1.43	-0.02	-0.02	0.00
Gini Coefficient	0.71	0.71	0.70	-0.5	-0.5	-0.2
3. Population Deciles (Gini Coefficient)						
Poorest	0.55	0.57	0.57	2.0	2.0	0.0
2	0.52	0.55	0.55	3.2	3.2	0.0
3	0.52	0.53	0.53	1.5	1.5	0.0
4	0.43	0.45	0.45	1.8	1.8	0.0
5	0.37	0.39	0.39	2.0	2.0	0.0
6	0.39	0.39	0.39	0.4	0.4	0.0
7	0.40	0.40	0.40	0.3	0.3	0.0
8	0.34	0.35	0.35	0.8	0.8	0.0
9	0.32	0.32	0.32	-0.1	-0.1	0.0
Richest	0.44	0.44	0.44	-0.2	-0.2	0.0
4. Level of Education of head of the household (Gini Coefficient)						
No Schooling	0.62	0.62	0.61	0.00	-0.4	-0.4
Grade 0-6	0.61	0.61	0.60	-0.01	-0.6	-0.4
Grade 7-9	0.62	0.61	0.60	-0.01	-0.8	-0.2
Grade 10-12	0.60	0.59	0.60	-0.01	-0.7	0.3
NTC Level	0.50	0.46	0.47	-0.03	-3.3	0.5
Degree and Post Graduate	0.53	0.53	0.53	0.00	-0.4	0.3

Notes:

Simulation 1: 10 percent wage subsidy given to employers for low- and semi-skill in formal sector.
Simulation 2: Adding social security tax to simulation 1.

In addition to overall poverty, rural poverty also decreases about 1.5 percent from 72.1 percent to 70.6 percent; urban poverty declines 1.6 percent. Poorer households gain more than richer households. The decomposition of headcount poverty ratio by population deciles shows that poorer households on average gain more than richer households (see Table 12). For instance, the poverty rate falls on average by more than 2 percentage points for lower deciles of

the population. Other potential winners in terms of poverty levels include – i) households with heads completing an education level of grade 7-9; individuals with technical and vocational school degrees; iii) higher skilled workers. Overall, the differences in poverty rates between the two simulations are very minimal.

All inequality indicators improve (Table 13). The Gini coefficient declines about half a percentage point from 72 to 71.5 percent. A similar decline is also observed at the regional level. The magnitudes of these changes are similar in both simulations. While we observe variations from the base case in both simulations, the differences are not significant.

Set 2 of Simulations: *Sensitivity of the Employment Effects of a Wage Subsidy to Measures That Ease the Skill Constraint or Promote Labor Intensive Activities, Assuming Low Elasticity of Substitution among Factors of Production*

The positive impact of the wage subsidy on employment, poverty, and inequality hinges on a critical assumption – that the elasticities of substitution among factors of production are those of the medium case. In the low case, the impact will likely be minimal (see employment effects in Table 9 for example). Lowering the cost of less-skilled labor to employers with a wage subsidy will not generate an employment kick when factors of production are relatively complementary and the constraint is the supply of skilled workers (or capital). Given some uncertainty regarding the degree of labor market rigidity, we consider further sensitivity tests for the low elasticity scenario. In particular, we consider the effect of a wage subsidy given: (i) a 5% increase in the supply of skilled labor; (ii) a 5% increase in the supply of skilled labor and capital; (iii) a 5% increase in the supply of skilled labor and capital and a 10% production subsidy to activities with high value added shares in low-skilled and medium-skilled labor; and (iv) for each of the three interventions from (i) to (iii), a marginal increase in the low substitution elasticities among factor inputs.

Introducing the measures above also addresses, in a partial or simplified way, some of the second-best effects of a wage subsidy—a wage subsidy essentially introduces a distortion to offset other distortions that have resulted in high unemployment of low-skilled and medium-skilled labor in South Africa. A wage subsidy can be viewed as a short term solution, while the increase in the availability of skilled-labor and capital and the increased substitution possibility among factor inputs addresses the longer term adjustments. By design, however, the accumulation of skills and capital as well as changes in the substitution elasticities in the simulations are limited to what may be easily attained in the short term in order to test the sensitivity of the wage subsidy to these factors and examine any interesting interactions.

Policy intervention I – under the original low elasticity case (Set A in Table 14), the constraint that there are too few skilled workers is relaxed and the supply is increased by 5 percent. The amount of change or actual measures for bringing this about are not the focus, but the measures could range from the removal of restrictions on skilled immigrants in the short-term or through training programs in the longer run. For simplicity, we assume that existing public expenditures or training programs can be realigned to bring this about without additional fiscal cost. The employment impacts of a 10 percent wage subsidy, summarized in Table 14, are indeed positive. However, looking at the marginal employment effects of the wage subsidy

given the policy intervention (column iv) and comparing them with the reference case of a wage subsidy alone (without the policy intervention), the employment gains (column v) are negligible – very slightly positive for medium-skilled labor and slightly negative for low–skilled labor. This is likely due to the fact that skilled workers are also highly complementary to capital, which is kept constant.

The low elasticity case, which is half the multipliers of Table 7 times the reference elasticities of Table 8, is close to a Leontief fixed-coefficient technology in some activities. The implicit substitution elasticities, for example, between high-skilled and low-skilled workers and between capital and high-skilled workers in mining, metal products, machinery, vehicles and transport equipment, etc., are close to 0.12 – a high degree of complementarity among these factors or a fairly rigid factor market.

Policy intervention II involves policy intervention I plus 5 percent growth in capital. This mimics the increase in productive capacity in the economy through capital accumulation or productivity change. Relaxing the capital constraint in addition to skills will bring about a higher marginal employment of a wage subsidy and the employment gains relative to the reference case are clearly positive.

Policy intervention III involves policy intervention II plus a 10 percent production subsidy to production activities with high value added shares to low- and medium-skilled formal labor. The output subsidy, in effect, redirects the increase in capital towards more labor intensive sectors. The targeted sectors are the ones with 40 percent of value added to either low-skilled formal labor or medium-skilled formal labor, except gold which does not get a wage subsidy. They are: textiles, apparel, wood and wood products, printing, publishing, and recorded media, rubber products, plastic products, machinery and equipment, other transport equipment, furniture, and other producers.

The results are in line with the expected outcomes in most cases. The marginal employment gains relative to the reference case improve with additional policy interventions (and note the policy interventions are cumulative). The only two exceptions are in the low elasticity case. The marginal effect of a wage subsidy on employment, given a 5 percent increase in skilled labor (intervention I) is not better than the effect of a wage subsidy alone—employment for low-skilled labor does increase by 3.3 percent when there is a wage subsidy in addition to the expansion of the supply of skilled labor. However, this is slightly below the employment gains of a wage subsidy alone. In the model, skilled labor and low-skilled labor are poor substitutes in production (see Table 7). When it is difficult to substitute skilled labor for low-skilled labor, the employment response to a wage subsidy is not as great when there is an additional supply of skilled labor. When the labor market is less rigid (Set B), the wage subsidy has a bigger marginal effect on the employment of low-skilled labor given an increased supply of skilled labor.

A similar situation arises for medium-skilled labor in policy intervention III for low production substitutability (Set A). In this case, the question is, “why is the marginal effect of a wage subsidy smaller in the case of policy intervention III compared to policy intervention II?” Since policy intervention III is policy intervention II plus a production subsidy to low and

medium-skilled formal labor, one would expect that the marginal employment gains would be highest with policy intervention III. As seen in Table 7, it is difficult to substitute medium-skilled formal labor and capital; as a result, the employment response to a production subsidy to medium-skilled intensive sectors is dampened. When it is easier to substitute medium-skilled formal labor and capital, as is the case in Set B, the results show that the marginal employment effects of a wage subsidy for medium-skilled labor are higher as policy interventions expand. This is not the case for low-skilled formal labor; it is easier to substitute capital for low-skilled labor and the marginal effects of a wage subsidy are higher in policy intervention III than policy intervention II.

Improving Labor Market Flexibility at the Margins (Set B). For each supporting measure, we also examine the sensitivity of the impact of the wage subsidy under a slight improvement in the labor market flexibility by reducing somewhat the degree of complementarity among factors of production. We do not consider how this may be brought about but suggestions by many include reduction of regulations for new job entrants and for government employment.

More specifically, Set B in Table 14 provides a slightly higher low elasticity case with elasticities computed as 0.75 times the reference values instead of 0.50 times the reference values. The results now show that the marginal employment effects of a wage subsidy are all higher. The employment gains relative to the reference case are also now clearly higher for the increase in skills or other measures. The employment gains of a production subsidy over intervention II are also now established.

Labor market flexibility matters a great deal in determining the employment impact of a wage subsidy, especially in the lower elasticity range. Moreover, for the two sets of lower values of the elasticity of substitution between high-skilled and low-skilled labor and between high-skilled labor and capital, the improvement ranges of 0.1-0.2 to 0.2-0.3 at the lowest end and from 0.2-0.3 to 0.3-0.4 in the next level - all still below 0.50 or the Cobb-Douglas case of 1.0. The increase in labor market flexibility being considered in Set B is very modest.

Table 14: Sensitivity Of Wage Subsidy Effect On Employment To Supporting Measure that Ease Skill Constraint or Promote Labor Intensive Activities

% change in employment	10% wage subsidy (reference case)* (i)	Policy Intervention (ii)	10% wage subsidy plus policy intervention (iii)	Marginal effect of wage subsidy, given policy intervention (iv)=(iii) -(ii)	Employment gains of wage subsidy plus policy over wage subsidy alone (v)=(iv)-(i)
I. Intervention: 5% Increase in the Supply of Skilled Labor					
Set A. Low elasticity case (0.5*Reference Elasticities)					
medium-skilled formal	3.086	1.146	4.297	3.151	0.068
low-skilled formal	3.464	3.173	6.508	3.335	-0.130
Set B. Slightly higher low elasticity case (0.75*Reference Elasticities)					
medium-skilled formal	4.814	0.828	5.766	4.938	0.124
low-skilled formal	5.360	2.830	8.348	5.518	0.158
II. Intervention: Intervention I plus 5% Increase in Capital					
Set A. Low elasticity case (0.5*Reference Elasticities)					
medium-skilled formal	3.086	4.929	8.277	3.348	0.265
low-skilled formal	3.464	5.530	9.099	3.569	0.104
Set B. Slightly higher low elasticity case (0.75*Reference Elasticities)					
medium-skilled formal	4.814	4.767	9.920	5.183	0.339
low-skilled formal	5.360	6.154	11.897	5.743	0.383
III. Intervention: Intervention II plus 10% production subsidy to Activities with High Value Added Shares in Low-Skilled and Medium-Skilled Labor					
Set A. Low elasticity case (0.5*Reference Elasticities)					
medium-skilled formal	3.086	6.644	9.915	3.271	0.188
low-skilled formal	3.464	7.927	11.498	3.571	0.106
Set B. Slightly higher low elasticity case (0.75*Reference Elasticities)					
medium-skilled formal	4.814	6.998	12.175	5.177	0.363
low-skilled formal	5.360	9.023	14.870	5.847	0.487

Source: CGE model simulations.

4. Conclusions

The impact of a wage subsidy on unemployment very much depends on the elasticities of substitution of factors of production and on the structural characteristics of the labor market. In the medium elasticity case, a wage subsidy will have the intended impact on employment of low and semi-skilled formal labor and will generate improvements in terms of poverty and inequality. Depending on the elasticities, we find that overall employment gains range from 1.9 to 7.2 percent. Although a wage subsidy to employers is expensive per job created, because the subsidy goes to all low- and medium-skilled formal labor, the expansion of the labor supply will increase GDP and generate some offsetting tax revenue from existing tax instruments, particularly in the medium and high elasticity cases. The net cost may be financed by a lump-sum such associal security tax in order to maintain its employment effects, which would have no incentive effects on the employer.

However, there is much uncertainty regarding the degree of labor market flexibility in South Africa and the impact on employment, poverty, and inequality will likely to be minimal if factors of production turn out to be highly complementary to one another, as would be expected with labor market rigidities and structural problems. Under the low range of elasticity values, the employment gains of a wage subsidy may be improved somewhat by supporting policies to relax the skill constraint, to increase the productive capacity of the economy, or to redirect production increases through economic incentives towards labor-intensive sectors.

Nonetheless, the employment gains from the introduction of complementary measures to the wage subsidy in the low elasticity case still appear modest relative to the medium elasticity case. Hence, our view is that labor market flexibility is a critical factor. In fact, the combination of a wage subsidy and some marginal easing of the skills and capital constraints and of policies to improve labor market flexibility appears promising as a short-term package of measures towards the long-term solution of the unemployment problem. It is, however, still an interim step and any enduring effort will require tackling the underlying factors to the unemployment in South Africa.

In addition to labor market flexibility, several fundamental factors are suggested by the literature review in the introduction. The presence of high mark-ups and concentration ratios in industries point to the significance of imperfect competition, scale economies, and trade policies in affecting labor market outcomes. The decline of the tradable sector and its employment impact also suggest the importance of Dutch disease or the real exchange rate in a resource rich country. Temporal or dynamic effects of schooling and training on human capital are another set of issues. To this end, the inclusion of imperfect competition and scale economies in a general equilibrium framework is feasible but it will require significant changes in the analysis as elaborated, for examples, by Harris (1984), Devarajan and Rodrik (1989), and Willenbockel (1994). The same is true with introducing dynamics, particularly at the micro-simulation level. Since no model, no matter how elaborate, will be able to address all these factors, these are areas suggested for future research.

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Annex - The Microsimulation Model and Its Links to the CGE Model

Given that both the LFS and IES surveys are based mostly on the same sample of households, the combined data set provides comprehensive information on household expenditures, labor and non-labor income, labor supply, employment, and several socioeconomic characteristics of individuals and households. The IES sample contains 26,687 households and 104,153 individuals. The LFS sample consists of 105,792 individuals. When the two data sets are combined and observations with missing sampling weights are dropped, the remaining number of individuals in our combined database drops to 103,732 from 26,214 households. The final database for the micro-simulation model includes 17 categories of food and non-food consumption expenditures, formal wage for employees in formal sector, informal wage for informal market[20], income for self-employees, employment status for all the individuals in the sample, information on the unemployed individuals, a large number of socio-economic and demographic characteristics of individual members of households, and non-labour incomes at the household level. A list of the variables used in the micro-simulation model and their description is provided in Table A4.

The Occupational Component contains 16 categories: (1) inactive and unemployed; (2) formal sector workers, low-skilled in agriculture; (3) formal sector workers, semi-skilled in agriculture; (4) formal sector workers, high-skilled in agriculture; (5) formal sector workers, low-skilled in industry; (6) formal sector workers, semi-skilled in industry; (7) formal sector workers, high-skilled in industry; (8) formal sector workers, low-skilled in services; (9) formal sector workers, semi-skilled in services; (10) formal sector workers, high-skilled in services; (11) informal sector workers, agriculture; (12) informal sector workers, industry; (13) informal sector workers, services; (14) self-employed workers, agriculture; (15) self-employed workers, industry; and (16) self-employed workers, services.

The probability $\mathbf{P_{ij}}$ for observing an individual **i** engaged in activity **j** is expressed as:

$$P_{ij} = \frac{\exp(z_i \gamma_j)}{\left[1 + \sum_{j=2}^{16} (\exp(z_i \gamma_j)\right]} \qquad (1)$$

where $\mathbf{z_i}$ is a vector of observable characteristics of individual **i.** The category selected as a reference is the inactive and unemployed. The multinomial logit model is motivated in terms of a utility maximising behaviour, with the utility[21] associated with activity **j** given as: $z_i \gamma_j + \varepsilon_{ij}$. The second term ε_{ij} represents the unobserved determinants of the utility of activity **j**. The utility of the reference activity is set to zero. It is assumed that the random component of the

[20] LFS explicitly asks individuals their main activity including informal sector. More precisely, each employed individual including informal workers are asked their organisation/business/enterprise/branch where she/he works in the labor market (including domestic workers).

[21] This is the latent variable that governs occupational choice to the extent that people are believed to move to the activity with the highest level of utility. However, Bourguignon and Ferreira (2005) note that such an interpretation would not be valid in cases where occupational choices are constrained by the demand side of the market.

activity-utility follows the law of extreme values and is independently distributed across individuals and activities.

In principle, the participation component (1) of the earnings-generation model should be estimated jointly with the earnings equations defined in the next sub-section. However, to avoid the difficulties associated with joint estimation, we follow Bourguignon and Ferreira (2005) in their reduced-form interpretation of the framework. Thus, the components are estimated separately with the possibility of testing for selection bias at the level of earning equations. The reduced-form estimates for the occupational model are presented in Table A1.

The results show some interesting and expected patterns. Gender has a significant impact on probability of being employed in different sectors. However, gender is not statistically significant for being employed as formal low-skilled and formal high-skilled individuals in the service sector. Among formal workers, people in industry and services sectors are more likely to be living in the urban areas than people in the agricultural sector. It is also true for informal and self-employed sectors. Similarly, the number of children (9 years at most) has a significant impact in the choice of participating in the labour force. People are less likely to participate as formal workers. They are more likely to be self-employed. Similarly, individuals living in households owning a family business are more likely to be self-employed than paid workers. Being head of a household also plays a significant role for participating in the labour force. Married people are more active in the labour force than non-married couples.

Table A1: Occupational Choice Models for Individuals

	Formal Employees									Informal Employees			Self Employees		
	Agriculture			Industry			Services			Agriculture	Industry	Services	Agriculture	Industry	Services
Variables	Low-Skill	Semi-Skill	High-Skill	Low-Skill	Semi-Skill	High-Skill	Low-Skill	Semi-Skill	High-Skill						
Gender	0.82	2.442	1.563	0.909	1.192	1.043	-0.057	0.583	-0.102	0.993	1.762	-0.78	0.123	0.25	-0.321
	[14.06]**	[24.12]**	[7.22]**	[11.31]**	[22.85]**	[7.31]**	[1.01]	[15.74]**	[1.75]	[11.88]**	[17.31]**	[19.00]**	[2.70]**	[2.88]**	[6.24]**
Education (years)	-0.01	-0.086	-0.222	0.062	0.07	-0.055	0.071	0.002	0.221	-0.072	0.035	-0.038	-0.073	-0.144	-0.143
	[0.43]	[3.40]**	[3.16]**	[1.85]	[3.22]**	[0.77]	[2.99]**	[0.14]	[3.68]**	[2.25]*	[1.02]	[2.60]**	[4.18]**	[4.81]**	[7.78]**
Education-squared	-0.009	0.003	0.029	-0.003	0.002	0.023	-0.002	0.011	0.021	-0.003	-0.004	0.001	0.009	0.015	0.015
	[4.44]**	[2.11]*	[8.67]**	[1.29]	[1.31]	[7.45]**	[0.95]	[10.82]**	[8.74]**	[1.04]	[1.57]	[0.78]	[6.92]**	[8.02]**	[12.76]**
Experience (years)	0.124	0.221	0.215	0.18	0.214	0.219	0.19	0.167	0.254	0.132	0.212	0.184	0.032	0.205	0.168
	[14.39]**	[20.72]**	[7.62]**	[15.19]**	[27.79]**	[10.63]**	[22.19]**	[30.57]**	[26.83]**	[10.93]**	[16.12]**	[32.38]**	[5.37]**	[15.69]**	[24.11]**
Experience-squared	-0.003	-0.004	-0.004	-0.003	-0.004	-0.004	-0.003	-0.003	-0.005	-0.003	-0.004	-0.003	0	-0.003	-0.003
	[18.58]**	[23.53]**	[7.30]**	[15.48]**	[27.53]**	[9.77]**	[21.48]**	[29.52]**	[23.27]**	[12.93]**	[16.53]**	[32.70]**	[0.53]	[14.91]**	[22.26]**
Urban	-2.181	-1.119	-0.366	0.781	0.891	1.549	0.691	0.816	0.449	-1.91	-0.237	0.408	-2.468	-0.108	0.128
	[26.83]**	[18.97]**	[2.21]*	[9.13]**	[16.14]**	[7.57]**	[11.37]**	[18.94]**	[6.95]**	[17.41]**	[2.91]**	[10.41]**	[33.99]**	[1.29]	[2.51]*
Nchild09	-0.292	-0.485	-0.332	-0.08	-0.084	-0.129	-0.07	-0.107	-0.049	-0.172	-0.063	-0.204	0.107	-0.159	-0.071
	[12.96]**	[16.55]**	[4.04]**	[2.69]**	[4.45]**	[2.35]*	[3.31]**	[7.10]**	[2.11]*	[5.91]**	[2.04]*	[13.49]**	[8.39]**	[5.00]**	[4.06]**
Married	0.903	1.282	1.297	0.526	0.711	1.248	0.283	0.663	0.656	0.657	0.222	0.236	0.274	0.488	0.503
	[14.45]**	[18.18]**	[6.55]**	[6.37]**	[13.80]**	[9.03]**	[4.91]**	[16.85]**	[11.29]**	[7.53]**	[2.45]*	[5.98]**	[5.41]**	[5.48]**	[9.46]**
Own family business	-1.081	-0.624	-0.567	-0.333	-0.197	-0.223	-0.242	0.004	-0.427	-0.661	-0.135	-0.08	0.685	4.088	4.845
	[7.42]**	[5.05]**	[1.98]*	[2.47]*	[2.55]*	[1.26]	[2.51]*	[0.07]	[5.01]**	[3.80]**	[0.98]	[1.28]	[12.03]**	[38.58]**	[66.28]**
Education for head	-0.026	0.04	0.058	-0.025	-0.01	0.05	-0.03	0.035	0.045	-0.036	-0.006	-0.013	0.003	-0.005	0.005
	[2.64]**	[2.62]**	[1.75]	[2.02]*	[1.22]	[2.10]*	[3.31]**	[6.22]**	[5.12]**	[2.53]*	[0.43]	[2.11]*	[0.43]	[0.35]	[0.70]
Dummy for head	1.44	2.11	1.27	1.073	1.279	1.316	1.349	1.237	1.292	1.26	1.294	1.342	0.708	1.946	1.976
	[21.86]**	[23.83]**	[5.89]**	[12.12]**	[22.83]**	[8.76]**	[21.47]**	[29.83]**	[20.11]**	[13.47]**	[13.05]**	[32.23]**	[12.89]**	[19.72]**	[33.48]**
Constant	-3.485	-7.37	-10.084	-6.969	-7.324	-11.818	-6.223	-6.268	-11.408	-4.552	-7.326	-4.059	-3.474	-8.943	-7.735
	[26.98]**	[41.28]**	[20.77]**	[35.02]**	[54.59]**	[24.27]**	[43.17]**	[59.43]**	[29.90]**	[24.12]**	[33.54]**	[44.72]**	[34.49]**	[38.92]**	[57.81]**
Sample Size	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113	65113

Notes:Absolute value of z statistics in brackets. * significant at 5%; ** significant at 1%

Source: Authors' calculations. See Essama *et al.* (2007).

Earnings. The earnings block of the micro-simulation model consists of three equations explaining formal wages, informal wages, and self-employment income in terms of observable and non-observable individual characteristics. The specification of these equations follows the Mincerian model. The wage equation is written as:

$$\log w_i = x_i \beta_w + u_{iw} \qquad (2)$$

The set of observable characteristics, $\mathbf{x_i}$, used as explanatory variables includes: gender, years of education, education squared, experience, experience squared, and a set of dummy variables indicating head of household, residence in the urban area, union membership, and marital status. The equations for the primary, secondary and tertiary sectors are estimated separately using OLS (Table A2).[22]

Looking at the results in Table A2, variables such as education and experience have expected signs and are consistent with standard human capital approach and economic theory. The relationship between education variable and wage is mostly non-linear and the estimated coefficients for education (eduyear squared) are statistically significant at 1 percent, except for the primary high-skill group. In the agricultural low-skill segment, three years of additional schooling will increase formal wage income by 5.7 percent. In the manufacturing sector, three years of additional schooling will bring 2.4 percent more wage income for the low-skill formal workers. The returns to education are the highest in the tertiary sector medium-skill segment - three years of additional schooling will increase wage income by 9.6 percent.

Union membership has a strong positive impact on income of members, except for high-skill individuals across economic sectors. The associated coefficient is very significant statistically (at the 1 percent level). In agriculture, membership to a labor union brings about 60 percent more income than non-membership (low-skill in tertiary sector and 37 percent for medium-skill formal workers), other things being equal in the same sectors with similar characteristics. The pattern is similar in the other sectors (e.g., about 40 percent in the manufacturing low–skill group and 28 percent for manufacturing medium-skill, and 62 percent in the tertiary sector low–skill group).

Another interesting result relates to the effect of urbanisation on wages. People living in the urban areas earn, on average, 30 percent higher wages. This may be partly due to relatively higher costs of living in urban areas as well as the structure of the labour markets, e.g., higher skills in urban and non-agricultural sectors.

Another important determinant of wages is gender. Inferring from the gender dummy variable (=1 for male; =0 for female) in Table A2, the higher pay of male employees ranges, on average, from 9 to 51 percent.

[22] We also tried the Heckman method on both the wage and self-employment equations to account for possible selection bias due to the fact that estimation is based on sub-samples of individuals with observed earnings in the given activity. There was no significant difference in the results. We therefore stick with OLS.

Table A2: OLS Estimates of the Formal Wage Equation

	Agriculture Sector			Industry Sector			Services Sector		
Variables	Low Skill	Medium Skill	High Skill	Low Skill	Medium Skill	High Skill	Low Skill	Medium Skill	High Skill
gender	0.227	0.154	0.512	0.298	0.29	0.233	0.245	0.142	0.092
	[6.34]**	[2.08]*	[1.99]*	[5.83]**	[8.69]**	[1.97]*	[5.89]**	[5.76]**	[2.70]**
eduyear	0.007	-0.03	0.107	-0.01	-0.077	-0.002	-0.015	0.014	-0.047
	[0.57]	[2.15]*	[1.20]	[0.46]	[5.83]**	[0.04]	[0.95]	[1.27]	[2.26]*
eduyear2	0.004	0.01	0.001	0.006	0.011	0.007	0.005	0.006	0.007
	[3.59]**	[8.96]**	[0.24]	[3.81]**	[12.97]**	[3.14]**	[4.23]**	[9.01]**	[8.10]**
expyear	0.033	0.065	0.009	0.032	0.038	0.051	0.038	0.031	0.034
	[6.06]**	[8.72]**	[0.31]	[4.06]**	[7.45]**	[3.15]**	[5.50]**	[8.13]**	[6.11]**
expyear2	0	-0.001	0	0	0	-0.001	0	0	-0.001
	[5.30]**	[7.74]**	[0.00]	[2.33]*	[4.76]**	[2.13]*	[4.06]**	[5.04]**	[4.55]**
headd	0.056	0.112	0.216	0.051	0.058	0.189	0.149	0.117	0.218
	[1.49]	[1.83]	[0.88]	[0.97]	[1.77]	[1.60]	[3.44]**	[4.60]**	[6.31]**
urban	0.408	0.362	0.658	0.31	0.295	0.395	0.273	0.303	0.309
	[8.35]**	[9.82]**	[4.53]**	[5.92]**	[8.80]**	[2.43]*	[6.47]**	[10.86]**	[8.17]**
union	0.569	0.556	-0.033	0.408	0.272	-0.108	0.624	0.404	0.056
	[11.83]**	[15.51]**	[0.22]	[8.59]**	[9.85]**	[1.18]	[15.32]**	[17.82]**	[1.89]
married	0.033	0.094	-0.077	0.089	0.193	0.018	0.038	0.253	0.173
	[1.00]	[2.16]*	[0.35]	[1.78]	[6.32]**	[0.18]	[0.93]	[10.70]**	[5.27]**
Constant	7.792	7.674	8.368	8.039	8.229	8.41	7.943	8.031	9.174
	[97.87]**	[62.41]**	[13.84]**	[60.69]**	[98.18]**	[22.51]**	[71.85]**	[115.94]**	[62.64]**
Sample Size	1665	1713	123	804	2412	368	1588	4544	2649
R-squared	0.26	0.42	0.41	0.29	0.31	0.37	0.28	0.32	0.24

Notes: Absolute value of t statistics in bracket. Significance level * significant at 5%; ** significant at 1%

Source: Authors' calculations. See Essama *et al*. (2007).

The informal wage equation *(iw)* is analogous to the formal wage equation:

$$\log iw_i = x_i \beta_{iw} + u_{iiw} \tag{3}$$

Similarly, the specification of self-employment earnings (π) is expressed as:

$$\log \pi_i = x_i \beta_{\pi} + u_{i\pi} \tag{4}$$

Table A3 contains the results of the OLS estimation of both informal wage and self-employed income equations.

Similar patterns are observed relative to the case of wage employment. For instance, in the primary sector, heads of households earn 35 percent more from self-employment than non-heads of household. This is much higher than the 20 percent premium they earn as wage employees in the same sector. Similarly, self-employment pays more (15 to 30 percent) in the urban area than in the rural area. However, this premium is lower than the one estimated for formal wage employment. Finally, we observe that self-employment pays much more for highly

skilled individuals than for the other skill categories. Similarly, for people engaged in the formal sector of the economy.

Table A3: OLS Estimates of the Informal and Self Employees Income Equation

	Informal Employees			Self Employees		
Variables	**Agriculture Sector**	**Industry Sector**	**Service Sector**	**Agriculture Sector**	**Industry Sector**	**Service Sector**
gender	0.095	0.347	0.254	0.146	0.605	0.45
	[1.34]	[3.88]**	[8.43]**	[3.52]**	[7.40]**	[10.81]**
eduyear	-0.01	0.041	-0.045	-0.059	0.027	-0.024
	[0.49]	[1.44]	[4.73]**	[4.12]**	[1.02]	[1.79]
eduyear2	0.007	0.002	0.011	0.011	0.004	0.007
	[4.00]**	[1.08]	[14.53]**	[10.44]**	[2.60]**	[8.66]**
expyear	0.029	0.023	0.043	0.042	0.049	0.078
	[3.01]**	[1.86]	[9.33]**	[8.62]**	[4.06]**	[13.74]**
expyear2	0	0	-0.001	0	-0.001	-0.001
	[3.12]**	[1.39]	[7.68]**	[3.83]**	[3.35]**	[12.52]**
headd	0.153	0.11	0.121	0.352	0.065	0.182
	[2.05]*	[1.47]	[4.36]**	[7.00]**	[0.74]	[4.20]**
urban	0.311	0.397	0.177	0.131	0.158	0.27
	[3.68]**	[5.84]**	[6.55]**	[1.91]	[1.96]*	[6.78]**
married	0.124	0.184	0.055	.	.	.
	[1.99]*	[2.59]**	[1.99]*	.	.	.
skillH	.	.	.	0.361	0.811	0.556
	.	.	.	[1.85]	[5.92]**	[10.42]**
formallab	.	.	.	1.451	0.798	0.703
	.	.	.	[17.45]**	[7.05]**	[13.58]**
Constant	7.665	7.594	7.331	6.926	7.215	6.982
	[52.30]**	[37.71]**	[98.81]**	[83.49]**	[34.98]**	[72.40]**
Sample Size	758	693	3860	2544	776	3217
R-squared	0.21	0.22	0.28	0.44	0.42	0.42

Notes: Absolute value of t statistics in brackets
Significance level * significant at 5%; ** significant at 1%

Source: Authors' calculations. See Essama *et al.* (2007).

Aggregation. Given individuals earnings, household income is aggregated according to the following formula.

$$y_h = \sum_{i \in h} w_i L_{iw} + \sum_{ieh} i w_i L_{iiw} + \sum_{i \in h} \pi_i L_{i\pi} + y_{0h} \qquad (5)$$

The first two components add all earnings (wage and self-employment) across individuals and activities, while the last element is an exogenous unearned income such as transfers and capital

income[23]. The relative share of the other income varies significantly across income deciles. On average, 9 percent of the household income is derived from other sources of income which is non-wage income for labourers and non-self-employed income for self-employed people. The ratio of other income to the total income varies between 12 percent in the lowest decile to 9 percent in the richest decile in the income distribution. Real income is obtained by deflating total income by a household specific consumer price index $\mathbf{CPI_h}$. This is a weighted sum of prices of various commodities purchased by the household weighted by the budget shares that vary across households.

Linking the Micro-Simulation Component to the CGE Model. To be able to assess the *endowment*, *price* and *occupational* effects of an oil price shock in a way that fully account for heterogeneity at both individual- and household-levels requires appropriate channels of communication between the CGE model and the micro-simulation components. This communication between the CGE model and the micro-simulation model works as follows. The CGE model translates the impact of the shocks and policies through changes in relative prices of commodities and factors, and through levels of employment. The micro-simulation model takes these changes as exogenous and translates them into changes in household behaviour which underpins changes in earnings, occupational status and welfare.

To obtain meaningful results from the simulation framework, one must ensure that outcomes from the micro-simulation model are consistent with the aggregate results from the CGE model both before and after the shock. This implies that the links between the two models must respect a set of consistency constraints, which require that the observed occupational choices predicted by the micro-simulation model match the employment shares in the CGE model. Similarly, simulated earnings at the micro level must match macro predictions.[24] A key consideration here stems from the fact that occupational choice depends on the random utility function which is a *latent variable*. For example, a policy change might cause unemployed or inactive individuals to become employed in one of the segments of the labour market. Implementation of the consistency constraints, therefore, requires information on both the observable and non-observable components of the occupational and earning models. The observable components of these models are calculated on the basis of estimated parameters and data on observable characteristics. For those showing zero earnings, counterfactual earnings are computed on the basis their observable characteristics, estimates of the relevant coefficients, and residuals drawn from a normal distribution with the same standard deviation as the distribution of residuals for those individuals with nonzero earnings.

In practice, differences underlying the micro and macro data (sampling weights, coverage, imputed values, etc.) make it very difficult to fully enforce the consistency constraints

[23] All Other Income: Income derived from the sale of vehicles, fixed property, other property, rents collected, payments received from boarders and other members of the household, lump sums resulting from employment before retirement, gratuities and other lump sum payments received from pension, provident and other insurance or from private persons, life insurance and inheritances received, claims, grants, total withdrawals from savings, remittances, and other sources of income.

[24] Bourguignon, Robilliard and Robinson (2002) explain that benchmark consistency could be achieved by ensuring that the calibration of the CGE is compatible with the consistency constraints.

described above. We therefore adopt several steps to achieve the consistency. First, because of the importance of the labour market structure in South Africa, we ensure that the occupational choices in the micro simulation have the same classification as the labour categories in the CGE model and capture the appropriate taxonomy, structural and unemployment issues in South Africa. Second, the base years for the SAM (2003) and the survey data (2000) in our study of South Africa are different. In order to retain the more recent numbers in the macro accounts as well as the familiar poverty and inequality measurements of the micro data, we employ percent changes to communicate changes in employment, wages, and prices from the CGE to the micro simulation.[25]

As noted by Bourguignon, Robilliard and Robinson (2002), reconciliation in the post-shock micro simulation means adjusting the intercepts (or constant terms) of the wage and occupational functions to ensure that changes predicted by the income generation model are consistent with those predicted by the CGE model.

[25] Savard (2006) discusses a way to achieve consistency in a case when the SAM of the CGE model and the survey data of the micro simulation have the same base year.

Table A4: Description of Variables used in the Analysis

Variable name	Description
Demographic variables, individual-level data	
gender	Dummy variable:1 male, 0 female
age	Years of age
nchild09	Number of children aged 0–9 in household
nchild01	Number of children aged 0–1 in household
headd	Dummy variable: 1 household head, 0 otherwise
married	Dummy variable: 1 married couple, 0 otherwise
urban	Dummy variable: 1 urban, 0 rural
prov	Regional province variable
hhsize	Household size
Education and experience, individual-level data	
eduyear	Number of years spent in school. Highest education completed.
eduyear2	Number of years spent in school-squared
expyear	Experience measured as (=age-eduyear-5)
expyear2	Experience-squared measured as (=age-eduyear-5)*squared
eduyearhd	Years of schooling of head of the household
skillH	Professional, semiprofessionals, technical occupations, managerial, executive administrative occupations, and certain transport occupations, such as pilot navigator
skillM	Clerical occupations, sales occupations, transport, delivery and communications occupations, service occupations, farmer, farm manager, artisan, apprentice and related occupations, production foreman, production supervisor
SkillL	Elementary occupations and domestic workers
Income from employment and occupational categories, individual level data	
fwage	Yearly wage income in rand, formal workers
fwagelog	Log of yearly wage income, formal workers
Iwage	Yearly wage income in rand, informal workers
iwagelog	Log of yearly wage income, informal workers
selfincr	Yearly total self-employed income in rand
seinclog	Log of yearly self-employed income
fambusiness	Dummy variable: 1 someone in the household owns family business, 0 otherwise
occhoice1	Dummy variables: 0 unemployed and inactive;1self-employed, agriculture; 2 informal wage employee; 3 formal wage employee
occhoice2	Dummy variables:1 Inactive and unemployed; 2 formal sector workers, low-skilled in agriculture; 3 formal sector workers, semi-skilled in agriculture; 4 formal sector workers, high-skilled in agriculture; 5 formal sector workers, low-skilled in industry; 6 formal sector workers, semi-skilled in industry; 7 formal sector workers, high-skilled in industry; 8 formal sector workers, low-skilled in services; 9 formal sector workers, semi-skilled in services; 10 formal sector workers, high-skilled in services; 11 informal sector workers, agriculture; 12 informal sector workers, industry; 13 informal sector workers, services; 14 self-employed, agriculture; 15 self-employed, industry; and 16 self-employed, services

Economic sectors

Primary sector	Includes agriculture, forestry, and fishing, mining and quarrying
Secondary sector	Includes manufacturing, electricity, other utilities, and construction
Tertiary sector	Includes trade, transport, financial, and business services; and social, personal, and community services
Formallab	Dummy variable for formal labour: based on question asked in LFS 2000.
informallab	Dummy variable for informal labour: based on question asked in LFS 2000.

Household aggregate expenditures and income variables, household level– data from income and expenditure survey 2000

Household expenditures and consumer price index for 17 household expenditure categories	
	Food, Non-alcoholic beverages, alcoholic beverages, cigarettes, cigars, and tobacco, clothing and footwear
	Housing, fuel and power, furniture and equipment, household operations, health, transport
	Communication, recreation and entertainment, education, miscellaneous personal care,
	Other miscellaneous goods and services
Household aggregate income	Includes formal wage income, informal wage income, and self-employed income from labour force survey, and other income from income and expenditure survey.

Sources: LFS, 2000; IES, 2000.