The general equilibrium effects of a productivity increase on the economy and gender in South Africa

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Abstract

This study utilises a computable general equilibrium model to examine the effects of economy-wide (SIM 1) and partial (SIM 2) productivity increases on the economy, gender employment, wages, income and welfare in South Africa. SIM 1 results in 'output' led employment demand and increased earnings for all skill types of men and women. Skilled men benefit more than others in most sectors. Under SIM 2, productivity has a negative employment impact in the selected sectors, on all skills mostly in labour-intensive sectors. In general, productivity improves households' welfare due to reduced commodity prices and improved earnings. If productivity rises only in men-intensive sectors, men's wages rise while raising productivity in only women-intensive sectors affect women negatively.

Keywords: CGE, FDI, South Africa, Gender, Productivity.

JEL D24; F11; F14; F21; J16

1 Introduction

The South African democratic government that came to power in 1994 presided over Africa's largest and most industrialised economy, but one that suffered from gross inequities (Gini index 59.3) and a lack of international competitiveness. In 1995, 23.8 per cent of the population was living on less than US$2 a day (World Bank, 2005). The new government adopted a wide range of policies to remove inequality and improve competitiveness. Raising productivity and ultimately, economic growth was viewed as a necessary step to achieving substantial and sustained reductions in poverty. Pro-growth reforms assume that growth in a small or middle income open economy like South Africa is dependent on increasing efficiency and productivity, which depend on a range of factors, including improved human capital and education, infrastructural investment, trade reform and the existence of contestable markets. Since 2000, significant positive changes have taken place in the economy. For example, Arora and Bhundia (2003) attribute the revival in growth in South Africa since 1994 to total factor productivity (TFP) growth and not to growth in factor inputs. Edward and Golab (2003) report increased exports in South Africa to have emanated from rise in relative productivity.

Despite productivity and moderate growth in output, there has been falling employment, resulting in the phenomenon known as "jobless growth". There have also been differences of effects between men and women. South Africa's annual narrow unemployment rate is 22.6 per cent for men and 31.7 per cent for women (Labour Force Survey, 2005). Indeed, the poverty rate among female headed households is 60 per cent compared with 31 per cent for male-headed households. Evidence has shown that macroeconomic policies can affect men and women work differently, depending on the nature of the work performed, and because women face difficulties accessing loans, they own different resources/assets, they acquire different education, different technologies, etc., (see Gladwin, 1991; Fontana & Wood, 2000 and Fofana et al., 2007). In addition, women in

particular spend most of their time attending to household chores, all of which are barriers to them having equal access to the labour market as men.

One of the challenges of the government is to strive to achieve the millennium development goals (MDGs), with one of them being "promoting gender equality and empowering women". It therefore becomes important to assess the impact of various policies on the employment of men and women separately. In this paper, the focus is on understanding the relationship between gender and productivity so that policy makers are better able to identify areas where productivity may advance broader domestic goals, and whether these polices might actually undermine other public policy priorities.

The question that needs to be addressed then is what is the likely effect of productivity growth on employment and wages of men and women of various skills in South Africa, given the significant differences in the gender composition of employment across sectors? There are many possible effects of the policies that have been implemented so far, but it is impossible to isolate these effects without a sharp tool such as the one proposed for use in this paper. This paper utilises a computable general equilibrium (CGE) model, which is a tool that captures, in a general equilibrium framework, all direct and indirect effects of macroeconomic shocks on employment, wages and welfare.

This paper contributes to the literature on the effects of productivity on macroeconomics, gender employment, wages, and welfare. Most of the literature to date on productivity and gender is in partial analysis models (Braustein, 2003). Previous work in South Africa by Punt et al. (2003) on productivity effects in a general equilibrium framework does not distinguish labour by gender and only concentrates on the agricultural sector. Thus, this study fills a very important gap by analysing the effects of productivity on men and women separately for all sectors of the economy. The paper analyses the general equilibrium impact on gender by focusing on two types of simulations: economy-wide increases in productivity, and productivity increases targeted at selected sectors. Sensitivity analysis using varying elasticities of substitution by gender are conducted to ascertain the outcome of gender rigidities in sectors. The study starts by looking at the determinants of productivity and briefly discusses education and employment of men and women in South Africa. Section 2 provides the study methodology. Section 3 presents the experiments and results of the first simulation (economy-wide), and section 4 provides results of the selected sectors' simulations. Section 5 gives household welfare conditions, while section 6 gives a brief discussion on sensitivity analysis. And, section 7 concludes.

1.1 Determinants of total factor productivity (TFP)

Sources of productivity include capital good imports, licensing agreements, international trade, investment in machinery etc**.** (Klein, Aaron, & Hadjimichael, 2000:3-4). Between 1994 and 2001 Arora and Bhundia (2003) accredit TFP in South Africa to: trade in real Gross Domestic Product (GDP) (46.6 per cent); equipment and machinery (50.4 per cent); private sector (72.1 per cent), and private sector investment in equipment and machinery (73.1 per cent). Arezki, Ahmed and Funke (2003) found trade openness and private sector participation to have accounted for 90 per cent of TFP growth during the 1990s in South Africa.

Research and development (R&D) induces productivity but has not played a major role in South Africa and Thailand (Arora & Bhundia, 2003:9 and Diao et al., 2005). Braunstein (2000) and Edwards and Golub (2003:29) associate quality education with enhanced labour-force productivity. Söderbom and Teal (2003) used a panel data analysis on 93 countries between 1970-2000 to find if trade and higher levels of human capital promote productivity growth. Their results showed a doubling of the level of openness resulting in a 0.8 per cent increase in technical progress. They also found a significant impact of the level of human capital on the level of income but found no effect on productivity emanating from the level of human capital.

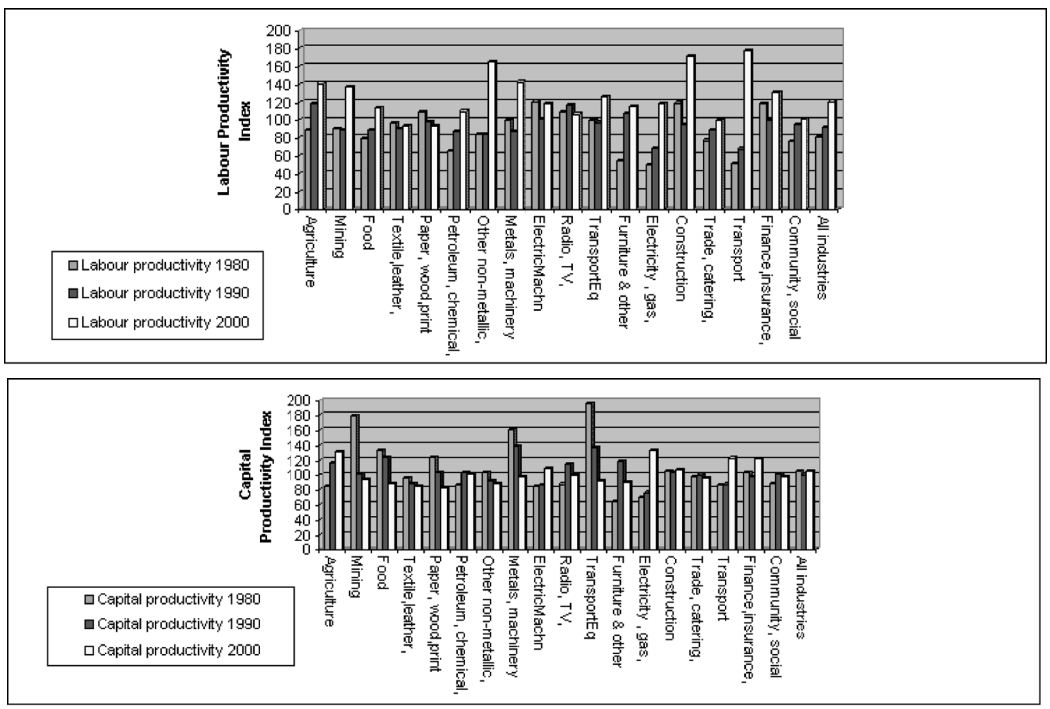
Foreign Direct Investment (FDI) is a comprehensive source of productivity because it

packages and incorporates various techniques (Klein et al., 2000:3-4). Blalock and Gertler (2005) found FDI to have raised average productivity in foreign and domestic firms in Indonesia. Urata and Kawai (2000) compared the level of TFP at 266 Japanese parent firms and 744 affiliates in textiles, chemicals, machinery and electrical machinery and found high intrafirm transfer through FDI. In Taiwan, results of a regression on the firm-level data of 8 846 firms by Chuang and Lin (1999) found a 1 per cent increase in an industry's FDI ratio yielding a 1.4 per cent to 1.88 per cent increase in a domestic firm's productivity. Barrel and Pain (1997) used time series data and found a 1 per cent rise in FDI to enhance labour efficiency by 0.27 per cent in West Germany, and by 0.26 per cent in the UK. Biggs, Shah and Srivastava (1995) found FDI to have enhanced productivity on manufacturing firms in Ghana, Kenya and Zimbabwe in the early 1990s. There is hence overwhelming evidence that FDI leads to or enhances productivity. Since South Africa has experienced relatively substantial inflow of FDI (South African Reserve Bank Quarterly Bulletins 2000–2006), the contribution of this study is to ascertain the impact of the implied increased productivity on gender labour, households welfare and the South African economy.

1.2 Sectoral productivity

Figure 1 shows capital and labour productivity trends for the years 1980, 1990 and 2000. Capital and labour productivity grew positively at an average annual rate of 1.3 per cent and 3.47 per cent, respectively, during the period 1980–2000. Higher capital productivity is found in the mining, machinery and transportation sectors, although the rate for 1980 exceeded that for 1990 and 2000. Unlike capital, labour productivity was lower in 1980 compared with subsequent years of 1990 and 2000. Higher labour productivity is in the sectors of agriculture, metals, metal products, machinery, transport equipment, construction and transportation services. South Africa's productivity rise follows increase in foreign capital utilisation by local firms (Edwards, 2001).

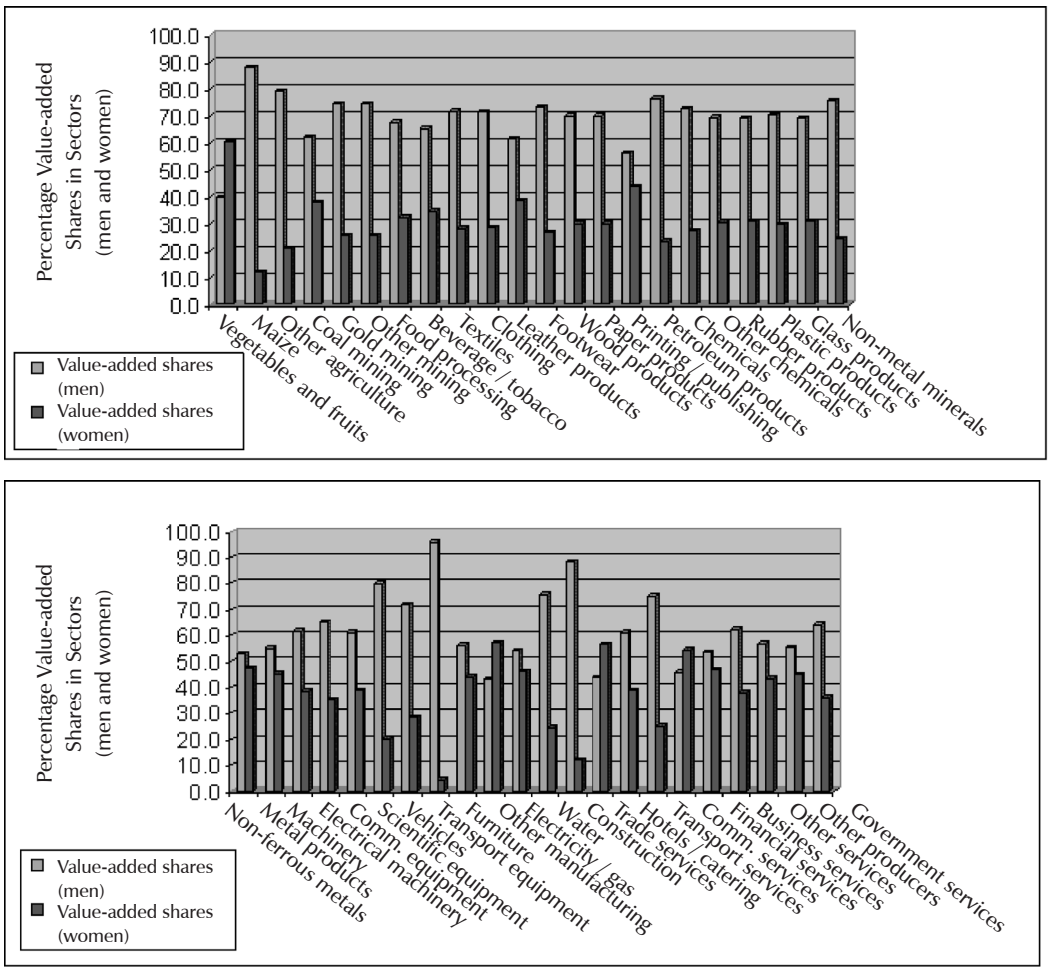
Figure 1
Factor productivity in South African sectors



Source: UNDP Human Development Report (2003)

Figure 2 shows the value-added shares between men and women in various sectors. This can be taken as an indicator of productivity whereas productivity was measured in value terms where various factors' value added was composed together and set per unit of labour that is disaggregated by gender. The results show lower productivity shares for women when compared with men in many sectors. Women's productivity, however, exceeds that of men in the service sectors of trade and communication and in the other-manufacturing sector. Men's productivity exceeds that of women even in some women-intensive sectors of textiles and apparel. This emanates from the 'vertical hierarchy' framework in these sectors where men concentrate at the top high-paying positions while women concentrate in low-paying positions.

Figure 2
Men and women value-added shares in various sectors



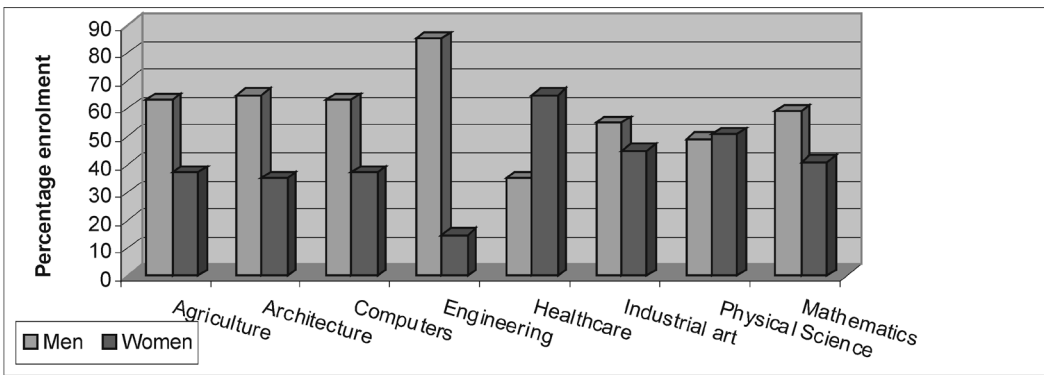
Source: own calculation from 2000 gendered SAM

1.3 Education and employment of men and women in South Africa

According to the World Bank (2006), women are participating at levels comparable to men in the education system. However, figure 3 shows women lagging behind men in educational areas such as engineering, mathematics, architecture and environmental design, areas closely associated with skills and sectors where productivity tends to create long-term and high-salaried employment. On the other hand, women exceed

men in areas of health, and social studies. Involvement in modern science and technology is crucial at a time when productivity-based sectors are major forces in the growth and development of the international economy.

Figure 3
Gender skills enrolment in various fields in South Africa



Source: Department of Education (DOE), HEMIS database 2000

While education is a necessary condition for acquiring the skills and knowledge to participate in the economy, it is not a guarantee for equal employment. Women have higher rates of unemployment compared to men who achieve the same level of schooling (LFS, 2000-06). This partially reflects women foregoing employment to tend to household needs and the inherent discrimination towards women at the workplace (Leresche, 1993 and Çagatay, Elson & Grown, 1995). Following Fontana and Wood (2000), we capture these rigidities in the labour market by modelling a low elasticity of substitution between men and women in the work place.

2
Methodology of the study

2.1 Model specification and data

This study uses a structural-neoclassical model, based on the general equilibrium model developed by Dervis, de Melo and Robinson (1982), which was extended into an International Food Policy Research Institute (IFPRI) standard CGE model (Lofgren, Harris & Robinson 2001). The present paper introduces gender to the labour categories in the IFPRI model. The following sections discuss the additions to this model and data in terms of the gender aspects of the model used for this study.

2.2 Selected equations for the model

Below we mostly discuss the equations that are related to household consumption and to the gender specification in the labour market. The rest of the model is described in Lofgren, Harris and Robinson (2001) and Thurlow and Van Seventer (2002). In equation 1 households, h, maximise a Stone-Geary utility function, U_h, subject to their linear budget constraint, $QH_{c,h}$, yielding the linear expenditure system (*LES*). The model has one representative consumer per household type, rendering identical preferences for all consumers in a given category. Where c represents commodities consumed by households, $\gamma_{c,h}$: minimum subsistence for the households and $\beta_{c,h}$: marginal budget share for the households.

$$U_h = \prod \left(QH_{c,h} - \gamma_{c,h}\right)^{\beta_{c,h}} \quad (1)$$

Equation 2 denotes measures of welfare changes depicted by the equivalent variation (EV). Positive EV_h shows improved welfare and vice versa. Where U^1 represents utility after simulation, U^0: baseline utility: h: household, p^0: original consumer prices, and E is expenditure.

$$EV_h = E\left(U_h^1, P_C^0\right) - E\left(U_h^0, P_C^0\right) \quad (2)$$

The production function is a nested multi-level production function. The functions are CES

in nature but allow for Leontief functions as special cases. The model used here comprises capital and six types of labour identified by skills and by gender.

$$QL_{i_s} = A_i \left[\alpha_i QL_{mn_s}^{-\rho_i} + (1-\alpha_i) * QL_{fm_s}^{-\rho_i} \right]^{-(1/\rho_i)} \quad (3)$$

Equation 3 shows how at the bottom level of the CES production process, men and women of the same skills (s) combine to form a composite skills labour (QL_{i_s}). Where ρ_i is a substitution parameter, QL_{mn_s}: men skill type labour, QL_{fm_s}: women skill labour, and A_i: production technology. The same elasticity of substitution is used in all sectors.

$$QL_{fm_s} = \left[\left(\frac{W_{mn}}{W_{fm}} \right) \left(\frac{\alpha_i}{1-\alpha_i} \right) \right]^{\sigma_i} * QL_{mn_s} \quad (4)$$

Equation 4 illustrates how Cost minimisation behaviour by firms generates the relative demand functions for men and women labour. The equation shows relative demand for men and women labour to rely on a share parameter $\left(\frac{\alpha_i}{1-\alpha_i} \right)$, the relative wage rate $\left(\frac{W_{mn}}{W_{fm}} \right)$, and the sectoral elasticity of substitution σ_i, where W_{mn} and W_{fm} refer to wages for men and wages for women respectively.

$$QV_i = A_i \left[\gamma_i K_i^{\rho_i} \bar{r}_i + (1-\gamma_i) \left(\varpi_1 QL_{i_1} + \varpi_2 QL_{i_2} + \varpi_3 QL_{i_3} \right)^{-\rho_i} \right]^{-(1/\rho_i)} \quad (5)$$

Equation 5 shows the aggregation of composite labour (QL_{i_s}) and capital (K) by a CES production function forming the sectoral value added, QV_i. Where A_i is a technological production function shift parameter, γ_i: production function share parameter, QL_{i_s}: sectoral labour inputs, s: skills category of labour (i.e., s = 1: unskilled, 2: semi-skilled, 3: skilled); K_i:sectoral capital stock, $\sigma_i = \frac{1}{(1+\rho_i)}$:elasticity of substitution between the primary inputs (capital and labour), and $w_s = \frac{W_s}{W_i}$: calibrated weighted share for skill labour categories. The value-added from equation 5 above, combines with intermediates (domestic and imports) in fixed proportions to produce gross output.

$$W_s = \frac{W_{fm_s} \sum_i QL_{fm_s,i} + W_{mn_s} \sum_i QL_{mn_s,i}}{\sum_i QL_i} \quad (6)$$

Equation 6 shows sectoral average wage rates, W_s that differs depending on the skill type of men and women labour. Women wage and men wage are determined through demand and supply of their type of labour respectively.

$$W_{s_i} = \left[\sum_g ww_{g,s,i} * \left(1 + tfac_{g,s,i}\right) 1 - \theta_{g,i} * \Phi_{g,i} \theta_{g,i} \right] \quad (7)$$

Note that the labour according to gender is combined following a CES function as in equation 7 where W_{s_i} is the wage for composite labour by skills, $ww_{g,s,i}$: the wages for each worker skill types respectively, $tfac_{g,s,i}$: the labour tax rate, $\phi_{g,i}$: the distribution parameter, and $\theta_{g,i}$: the elasticity of substitution between men and women, Also, s: labour categories by skills (skilled, semi-skilled and unskilled), g: labour categories by gender (men and women) and i refers to sectors.

$$QLS_{fm} = \sum_i QLD_{fm,i} \quad (8)$$

$$QLS_{mn} = \sum_i QLD_{mn,i} \quad (9)$$

Each market clears when the sum of the sectoral labour demand equates labour supply by gender as shown in equations 8 and 9.

2.3 Model-closure rules

South Africa is assumed to be a price taker on international markets, hence all prices of imports and exports are fixed in foreign currency units and the balance of trade (BOT) is fixed at its Social Accounting Matrix (SAM) base. The exchange rate is an equilibrating mechanism for the BOT. The model assumes a saving-driven investment economy that allows the investment rate to adjust in order to maintain a fixed level of total savings. According to Sadoulet and De Janvry (1995:143), the Saving Investment (S-I) balance plays a minor role, for example, in a static model, like the current one. Variations of the investment levels following changes in savings have few consequences, as they affect only the level of demand. The government account balance is achieved with constant direct tax rates on domestic non-governmental institutions, which maintain government

income, while government savings are free to adjust. The level of government expenditure is indexed to consumer prices in order to maintain government expenditure in real terms.

Capital is modelled as fully employed and sectorally mobile while capital's rental rate adjusts in order to maintain the employment level in the economy. Skilled labour is mobile and fully employed while its economy-wide wage adjusts to ensure that the sum of skilled labour demands from all sectors equals the quantity supplied. The unskilled and semi-skilled men and women labour is mobile across sectors but unemployed, their wages are fixed in nominal terms at the base level while their unlimited supply adjusts in order to equate to the sum of their demand.

All prices in the model are expressed relative to the consumer price index (CPI), the *numéraire*. The choice of CPI enables general equilibrium analysis to proceed without considering the effects of inflation on the optimal use of resources.

2.4 The data

The main dataset for the CGE model is the 2000 South Africa SAM, which was originally developed without gender considerations (Thurlow & Van Seventer, 2002). The present study disaggregated labour according to gender and skills. The Income Expenditure Survey (IES) (2000), and Labour Force Survey (LFS) (2000-2003) and October Household Survey (OHS) (1999) provided data that supplied proportions of men and women in different sectors. This enabled the mapping of men and women value added to their respective households. The study disaggregates factors of production between men and women workers and determines factor earnings distinguished by gender. The household survey provided information related to wages and returns to capital produced by each sector at the 3-digit level of the national industrial code for registered sectors. This value required to be disaggregated by gender and differentiated by skills. This involved performing the one to one correspondence between value added and the men and women workers. In order to necessitate this, we utilised the labour force survey data that provides the total number of workers in the sector. This also required to be disaggregated between men and women and between various skills of workers. The share of each type of labour in a particular sector was generated and linked to the labour earnings shares derived from the IES and household survey. The household survey contains the national industrial code identification of each household member, and information regarding the members' work. The information about the 'working status' of each eligible household member above the age 15 was recorded in order to identify workers per sector. It should be noted that capital was not disaggregated by gender due to lack of appropriate information from the data of the surveys. Thus, the factors of production distinguished by gender and skills were broken up into the following categories for each of the sectors using both household survey and labour force survey data: women skilled, men skilled, women semi-skilled, men semi-skilled, women unskilled, men unskilled. The data then was transferred to the SAM accordingly and the adjustments were made in order to make sure that the SAM balances. We used the RAS methodology to balance the SAM after transferring the data.

By dividing factors of production separately into men and women workers, this study helps to establish separate wages, employment and earnings of men and women workers. The assumption of the study is that the value added generated in a sector gets distributed to women and men workers according to their proportions delivered from sample survey data according to average earning rates. The average earnings rate is weighted by shares of different types of labour (i.e. women and men workers and their wage rates so that it reveals the differential earning rate of the different types of labour). The flow of value added is mapped from sectors to different types of factors of production and the flow of factor earnings are mapped to different types of factor owners within their respective households, which determines the factor incomes of these households.

The gendered model assumes that women and men workers are imperfect substitutes. According to Sadoulet and De Janvry (1995),

the range of substitutability is represented by 0.3 for low substitutability, 0.8 for medium low, 1.2 for medium high and 3.0 for very high substitutability. Following Fontana and Wood (2000), we introduce a fairly low elasticity of substitution between women and men workers as a way of capturing the gender rigidities found in South Africa. There is no empirical study of gender substitution elasticities in South Africa. The rate of 0.50 used in this study follows that used in Zambia by Fontana (2001) as per similarities in rigidity of gender substitution between the South African and the Zambian economies. As with previous studies (Fontana & Wood, 2000 and Fontana, 2001), the study uses the same elasticity of substitution for all sectors due to lack of available data on these parameters. The main results are thus reported under this assumption. Hence the aggregate production function is affected. In this case total factor productivity will have equal proportionate impact on skilled and unskilled labour. We assume this to be reasonable in the short to medium run before much adjustment is done in the production functions of industries. However, elasticities of substitution are activity-specific, and substitution between men and women work may be greater in some sectors than others. As such, the assumption of uniform elasticities would have some bias on the results. For this reason, as part of sensitivity analysis, the study uses very low substitution elasticities for sectors where there is a priori reason to expect gender bias in demand. An elasticitiy of 0.1 was used in coal, gold, other mining, construction, transportation and machinery as part of sensitivity analysis. The model is written and solved in General Algebraic Modelling System (GAMS) and gives short to medium-term equilibrium results due to its comparative static nature. The model further uses elasticities such as output, export, imports, etc., based on estimated elasticities used for South Africa in Thurlow and Seventer (2002) and Case (2000).

3
The model policy simulations

TFP is modelled as an exogenous source of technological changes by a 1 per cent increase in the technological parameter of a production function (see equation 5). The 1 per cent productivity increase is justifiable, given the modest inflow of FDI in South Africa and following Arora and Bundia (2003) that TFP growth was from 0.2 per cent in 1980-1993 to 3.4 per cent from 1994-2001. Further, Fallon and Pereira de Silva (1994) assert that TFP growth in manufacturing in developing countries has been low, at 0.5 per cent per year, over the past 20 years, well below the levels achieved in high-performing economies. The empirical observations by Chuang and Lin (1999) support the use of 1 per cent as well.

Three simulations are run in this paper, two main simulations, plus a third, which performs a sensitivity analysis function. The first simulation (SIM 1) involves a 1 per cent economy-wide (all sectors) rise of total factor productivity (TFP). The second simulation, (SIM 2), involves a 1 per cent productivity rise in selected sectors of textiles, apparel, leather, chemicals, other chemicals, metal products, and vehicles. These seven sectors were selected because they have attracted considerable FDI in South Africa, hence the increase in productivity (South African Reserve Bank Quarterly Bulletins (2000–06)). The aim of this policy is to assess the effects of the last few years' increased productivity as induced by FDI. The third simulation, (SIM 3), is a sensitivity analysis. This involves a 1 per cent productivity rise in women-intensive sectors (beverages and tobacco, apparel, textiles, footwear, electrical machinery, machinery, communication equipment, and scientific equipment) and men-intensive sectors (coal, gold, other mining, construction, transportation and machinery). In addition, SIM 3 involves varying elasticity of substitutions between men and women (0.1, 0.5 and 1.5) thus observing the impact of gender rigidities or lack of them in sectors. The aim of SIM 3 is thus to see whether there would be a difference to women employment if there was to be policy to deliberately target women or men-intensive sectors only and to see the outcome related to gender rigidities in sectors. The interest in the women intensive sectors is because women are likely to be vulnerable to employment loss after technical progress. We want to see if the

potential positive employment gains in other sectors would be favourable to women.

3.1 Simulation results of economy-wide factor productivity rise (SIM 1)

3.1.1 Macroeconomic results

Following the productivity shock, output increases and domestic prices drop in all sectors, reflecting increased efficiency and lower costs per unit of output. This leads to an increase in real Gross Domestic Product (GDP) by nearly 1.2 per cent. Given constant real government expenditure, GDP boosts government revenue (1.4 per cent) that raises government savings (0.8 per cent). The higher level of real GDP allows consumers to enjoy a higher level of consumption. As a result, South Africa increases imports (1.4 per cent) compared with the baseline. Increased imports create a demand for foreign currency and thus raise the Rand price of foreign currency, which causes a depreciation of the currency. The depreciation raises exports (1.3 per cent) that helps to finance imports. Indirect taxes and the government's total revenues all increase with the productivity rise, by 1.6 per cent and 2.0 per cent respectively.

3.1.2 Sectoral output and employment changes due to factor productivity rise

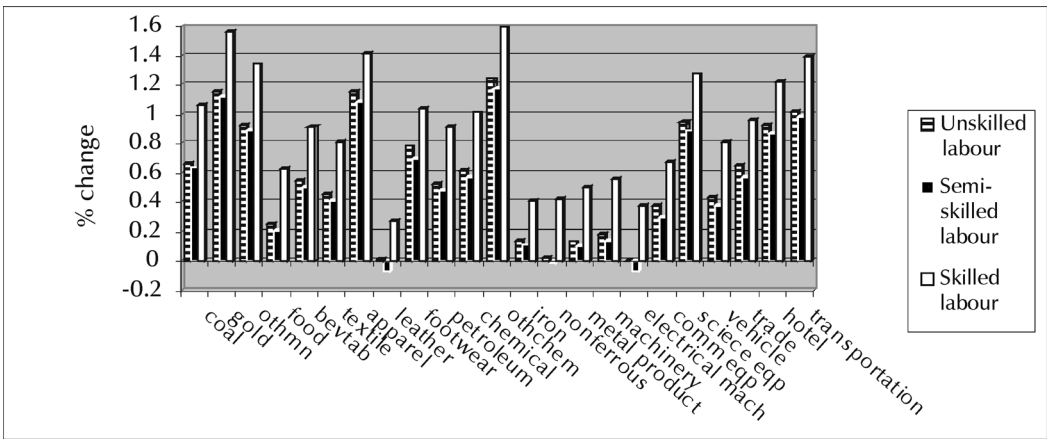
Economy-wide productivity is expansionary as seen in a significant increase of more than one per cent in domestic output in all sectors except in construction (0.2 per cent) and government (0.1 per cent). These two sector products are not required as intermediates in other sectors. The major sectoral winners are gold (1.9 per cent), rubber (1.6 per cent), apparel (1.9 per cent), other mining (1.6 per cent), transportation (1.6 per cent), other industry (2.0 per cent), transport equipment (2.2 per cent) and scientific equipment (2.2 per cent) that increase by more than a percentage point. Imports rise mostly in the sectors with high import shares in the base year level such as labour-intensive sectors (textiles 2.2 per cent, leather 2.0 per cent, food 1.9 per cent, apparel 1.7 per cent, scientific equipment 1.5 per cent) and capital-intensive (chemical 1.5 per cent; vehicles 1.4 per cent) and communication equipment (0.7 per cent).

The sectors that benefit the most from increased exports are apparel (2.3 per cent), scientific equipment (2.0 per cent), communication equipment (2.0 per cent), metal products (1.9 per cent), electrical machinery (1.9 per cent), machinery (1.7 per cent), and vehicles (1.3 per cent). The presence of intra-industry trade in the economy allows sectors such as apparel and scientific equipment to have both export-orientation and import-competing characteristics. We expect the expanding sectors to demand more factors of production.

Results of economy-wide productivity rise show output having a significant positive impact on employment. The expanding economy coupled with rising exports raises the demand for factors of production. Figure 4 shows a general rise of sectoral employment by skill type with skilled labour benefiting more than other skill types in all sectors. The results support observations that find productivity to raise the demand for skilled labour relative to unskilled and skilled labour in South Africa (Edwards 2001, Pretorius 2002:17). The greatest increase of unskilled employment occurs in mining (gold, coal, other mining), other chemicals, apparel, footwear and scientific equipment because these sectors increased output and exports as well and are relatively unskilled labour intensive. Slight employment increases occur in metal products, machinery, iron and steel, non-ferrous, communication equipment, and food because these sectors are highly capital-intensive. Unskilled labour holds steady in leather with a slight rise of less than 0.10 per cent. Sectoral demand for semi-skilled labour is similar to that of unskilled labour except in leather and electrical machinery where its demand falls reflecting their relative unimportance in these sectors.

Figure 4

Percentage change labour demand: economy-wide productivity rise



3.1.3 Gender employment changes due to economy-wide factor productivity rise

An economy-wide productivity rise is expansionary and hence increases employment demand for men and women. In the short run, the expansion of firms has a trigger effect on retaining and increasing employment of unskilled women. However, the current static model cannot predict the sustainability of increased women jobs. The outcome of the productivity increase for semi-skilled men and semi-skilled women shows slight differences between gender, although the trend favours semi-skilled women relative to semi-skilled men. Significant differences occur in women-intensive sectors of food, apparel and communication equipment.

Increased productivity raises the economy-wide demand for skilled men more than for skilled women (see Figure 5). This is seen in the increase in the wage rates of skilled workers. This happens in both traditional and non-traditional women-intensive sectors, for example, in apparel (skilled women 1.3; skilled men 1.6), footwear (skilled women 0.9; skilled men 1.2), textiles (skilled women 0.6; skilled men 0.9), and leather (skilled women 0.2; skilled men 0.4), respectively. This indicates a bias against skilled women in women-intensive sectors. The apparel sector, with a generally higher concentration of women (72 per cent) at the base level, experiences a higher increase for skilled men relative to skilled women. Gender economists term such occurrence as the 'defeminisation' through technology in both higher and in less value-added manufacturers (Elson, 2000).

Figure 5

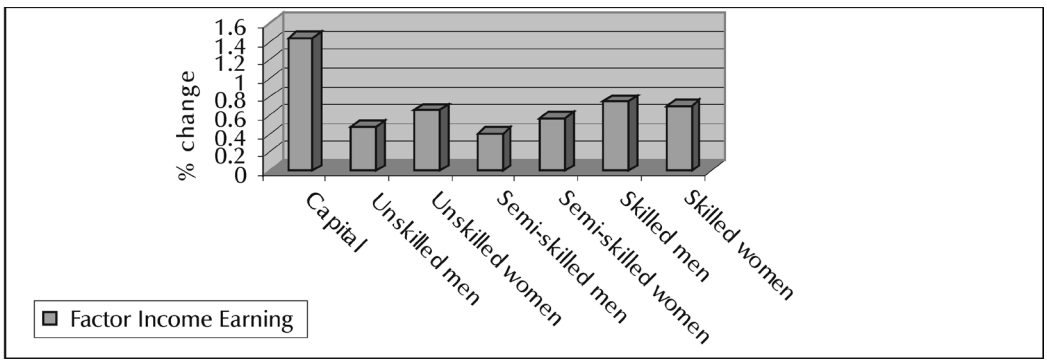
Percentage change employment by skill and gender: economy-wide productivity rise

3.1.4 Change in wages and factor earnings due to factor productivity rise

Capital's earnings rise (1.2 per cent) higher than other factors of production based on its higher productivity. Under the assumption of flexible supply of unskilled and semi-skilled labour (elastic supply), the increased demand for such skills types raises their supply, and while their nominal wages remain fixed at the base year level, their real wages change. Economy-wide rise of employment of men and women leads to an increase of their income earnings (see Figure 6). The income earnings of unskilled and semi-skilled women are slightly greater than that of unskilled and semi-skilled men because of higher increased demand for women's labour as compared to that of men of the same skill. On the other hand, for skilled workers, hiring is higher for skilled men than skilled women leading to slightly greater earnings for skilled men compared to skilled women workers.

Figure 6

Percentage change factor income: economy-wide productivity rise



4 Results of factor productivity rise in selected sectors (SIM 2)

South Africa's productivity, which generally is concentrated in selected sectors, has been growing at the rate of 3.2 per cent per year, but this has not led to job creation (South Africa Department of Labour, 2006). This finding is consistent with other studies on employment, that find productivity to have been a major factor associated with reduced levels of employment in South Africa (Jenkins & Thomas, 2002; Edwards, 2001). This section aims to analyse the economy-wide effects of a productivity rise in a few sectors.

4.1 Macroeconomic results: Factor productivity rise in selected sectors

Except for lower magnitudes, macroeconomic results for SIM 2 are similar to those for SIM 1. With SIM 2 as for SIM 1, increased factor earnings and increased consumption due to reduced commodity prices raise household welfare albeit slightly, especially for low-income households.

4.1.1 Employment changes due to factor productivity rise in selected sectors

The direct effect of productivity increase in selected sectors is the reduction of employment in these sectors, albeit by slightly less than a percentage point (see Figure 7). Efficiency gains enable sectors to switch their production process by reducing employment demand of all skill types. Skilled labour in labour-intensive sectors is mostly affected because of its substantial higher wages, which raises its marginal productivity, for example, decline in the scientific equipment (total labour falls by 0.8 per cent, unskilled 0.7 per cent, semi-skilled 0.7 per cent and skilled by 0.9 per cent). This outcome differs from that of SIM 1 where employment rises significantly in all sectors. The fall in employment is effected by increased efficiency enabling profit-

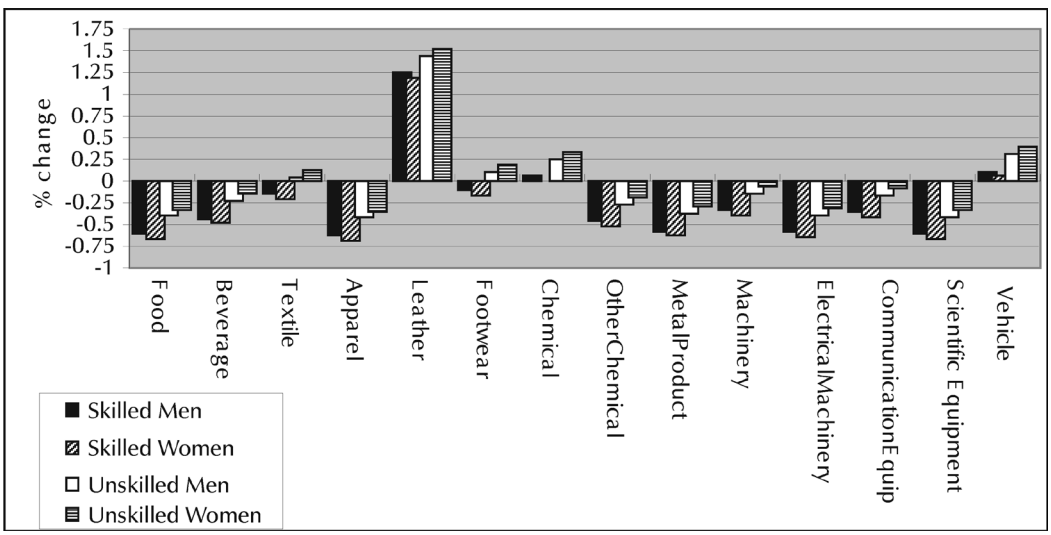
maximising producers to expand by employing fewer resources, particularly labour due to its rising marginal productivity. Despite falling employment demand, all productivity raised sectors increase their output.

Sectors with initially low productivity, for example, the woman-intensive sector of apparel, see the worst of employment contraction. Sectors such as non-ferrous, metal products, transport equipment, other industries, and furniture, which have strong linkages with policy-affected sectors, respond by slightly reducing their demand for employment as they are forced to become efficient in order to stay in business.

Labour, which is released from the efficient sectors, relocates mostly to service sectors of trade (unskilled 0.7 per cent, semi-skilled 0.6 per cent, skilled 0.5 per cent), communication (unskilled 0.4 per cent, semi-skilled 0.4 per cent, skilled 0.2 per cent) and water (unskilled 0.5 per cent, semi-skilled, 0.6 per cent) (see Figure 8). Other service sectors such as communication, finance and business sectors, also see a slight rise of such labour. In this study, there is an influx of women into the trade sector. Other non-CGE studies have equated such influx with the easy entry into such sectors due to low skills requirements.

Despite employment downturns in sectors where a productivity rise began, the relocation of labour from such efficient sectors to other sectors due to economy-wide improvement has economy-wide positive employment effects. A similar outcome has been observed in South Africa. For example, using a CGE model to study the effects of productivity rise on agriculture, Punt et al. (2003) found a productivity rise in agriculture to reduce employment sectorally but to increase it economy-wide due to an expanding economy. Thus, this outcome shows efficiency gains in a few sectors having economy-wide positive employment effects. This result is captured by CGE rather than partial equilibrium models as CGE model results show sectoral inter-linkages.

Figure 7
Percentage change employment due to selected productivity rise



4.1.2 Gender employment changes due to factor productivity rise in selected sectors

Table 1 shows, for the shocked sectors, a decline of all skill types for men and women employment due to productivity rise in selected sectors. Unskilled men labour drops more, relative to unskilled women labour, because of their higher marginal productivity when compared with unskilled women who receive lower real wages. However, compared to skilled men, skilled

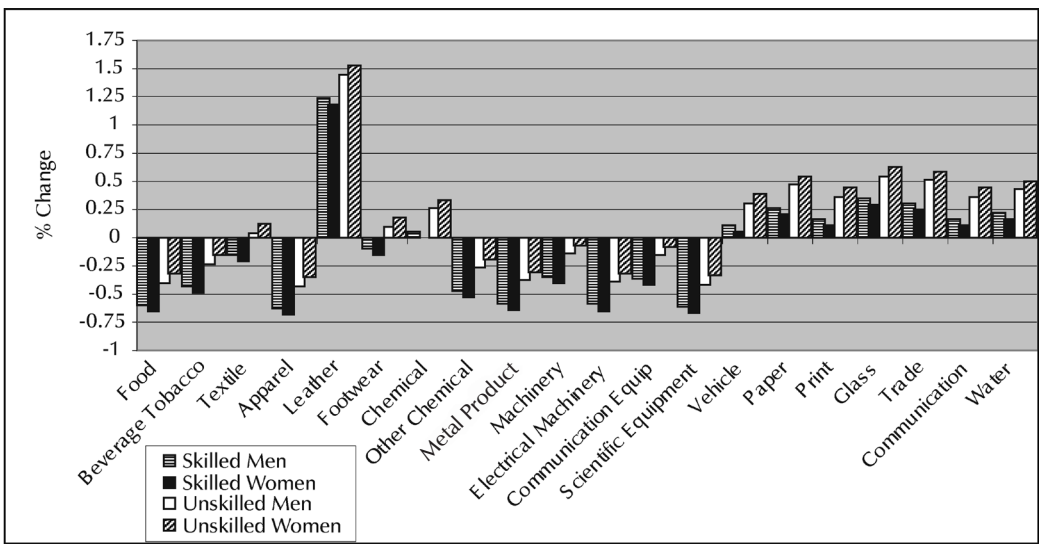
women employment declines more in all sectors that reduce employment necessitating rising wages for men in order to retain them.

The full employment assumption associated with skilled labour enables displaced men and women to obtain employment in other sectors (i.e. trade, communication, etc.) that were not directly affected by productivity rise. As seen in Figure 8, skilled men employment exceeds that of skilled women in those sectors. Sectors such as other mining, leather, paper, print and petroleum witness a fall of women labour while men labour demand rises. In sectors where employment rises, which are leather and vehicles, the rate of increase for skilled men exceeds that of skilled women. These two sectors increase men and women employment particularly because of their increased demand by other expanding sectors, for example, leather in vehicles (car seats), and vehicles in transportation services.

The negative employment effects associated with skilled women when compared to skilled men supports the observation that productivity is associated with competitive skills, which are mostly possessed by men. This limits the benefits of productivity in terms of job creation, particularly for skilled women labour that mostly possess skills that are different from those of men in most sectors (Figure 3). However, in reality, there is no guarantee that all retrenched employees, particularly that for unskilled labour, will be absorbed in other sectors. Bezuidenhout (2006) found most retrenched workers in the textile sector to have difficulties finding new employment in other sectors, because of non-transferable skills. They found, however, retrenched men being able to obtain employment faster than retrenched women.

Figure 8

Percent change unskilled and skilled gender: productivity rise selected sectors



4.2 Wages and factor earnings changes due to factor productivity rise

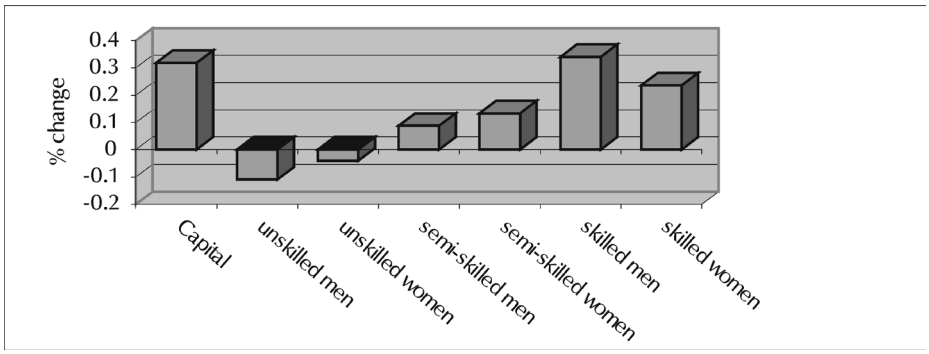
Figure 9 shows changes of capital rent and wages for men and women that occurred due to a selected sector productivity rise. Wages of unskilled and semi-skilled workers are fixed at their base level while capital's rent and skilled wages vary in order to balance the employment requirements. In this instance, wages for skilled men and women increase.

All factors, except unskilled women and men, see an increase in their earnings. Among labour skills, skilled men benefit the most. Semi-skilled women earnings increase more, relative to earnings of semi-skilled men because of their economy-wide increased demand. The earnings for skilled men and women labour increase with

the earning of skilled men increasing more than that of the skilled women due to their higher initial wages. Several studies find higher wages to be associated with FDI, which is a major source of productivity (Braunstein, 2000). However, economy-wide earnings of unskilled women and men decline, with those of men declining more than those of unskilled men following their employment loss in the efficient sectors, which outweighs the rate at which they are absorbed in other sectors, which are mostly low paying sectors.

Figure 9

Percentage change earnings: Productivity rise selected sectors



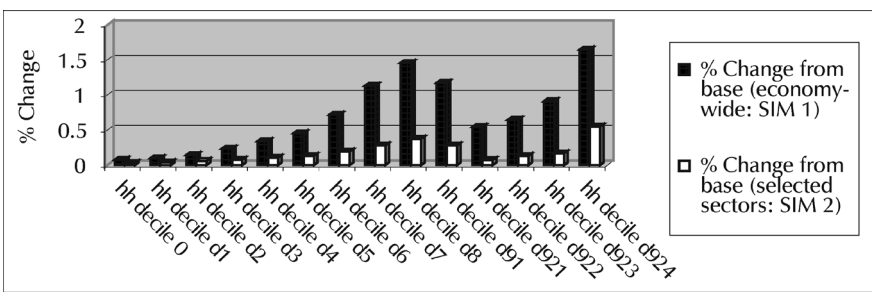
5
Equivalent variation: factor productivity rise (SIM 1 and SIM 2)

In this study, the household welfare is measured by the equivalent variation (EV) measure. Figure 10 shows the improvements of welfare for all the households with higher magnitudes for SIM 1 when compared with those for SIM 2. In general, nominal incomes fall for all household categories as a result of productivity rise that induced fall in prices. However, with both simulations, the shift in relative income across the household deciles favours high-income households. These households derive most of their income from increased capital earnings and from increased earnings of skilled labour.

The improvement in regular wages coupled with falling commodity prices due to rising cheap imports, induced by the efficiency rise, make commodities affordable especially for low-income households, who respond by increasing consumption. Low-income households spend a large share of their expenditure on consumables (textile, footwear, etc.) whose price has fallen. Due to concentration of men workers relative to women workers in higher-income households, a productivity rise that benefits high-income households tends to favour those men over women. Women, particularly unskilled women, are concentrated in low-income households and, as such, their welfare improves less when compared with that of skilled men and women in high-income households.

Figure 10

Percentage change equivalent variation (SIM 1 and SIM 2)



6 Sensitivity analysis (SIM 3)

6.1 Varying elasticity of substitution between men and women by sectors

The effect of the productivity increase may be susceptible to changes in certain parameters that have been used in the study. As such, this study tests the sensitivity of results by running sensitivity analyses. These include changes in elasticity of substitution (ES) by gender in the production function. In the model, the ES among men and women in the production function of all products is the same, at the value of 0.50. However, in the real world, it may-be that in some sectors the substitution among men and women could be more imperfect. These include sectors such as the construction, transportation, machinery and mining sectors that only comprise a small proportion of women labour relative to men. The study thus runs a sensitivity analysis using different values of ES among men and women in the production function. Although there is no estimation of this elasticity, it is assumed that sectors that, at the base level, have a high intensity in the use of either men or women labour (over 75 per cent) represent an imperfect substitution among labour by gender. The elasticity was set at 0.1 in these sectors while the rest of the sectors maintain the elasticity value of 0.50.

The simulation is run for productivity rises within all sectors with ES at low levels (0.1) in men-intensive sectors. The direction of results are similar as when elasticity was set at 0.5 level. There is an increase in employment demand for all types of skills for men and women. Unskilled women labour rises more than other types of skills. However, loss of employment occurs in the sectors of other mining and construction for all types of skills, particularly skilled men and women. Overall, the magnitudes of the changes are not very different from the case of the same elasticity of 0.5. However, wages favours men labour.

When productivity rises in only women-intensive sectors, the results show a mixture of rises and falls in employment demand in various sectors. The general employment demand increases in the sectors of textiles, leather, scientific equipment and other industries. The rise in employment favours all skill types of women, which rise more compared to the skill types of men. The magnitude of employment favours unskilled women, which exceed those of both semi-skilled and skilled men and women. For example, in the footwear sector, while unskilled men labour rises by 0.6 per cent, unskilled women rise by 0.8 per cent, and semi-skilled women and men rise by 0.54 per cent and 0.51 per cent respectively, almost the same pattern as with SIM 2, where the elasticity was uniform at 0.5. The sensitivity results compare well with the case of uniform elasticity. The sectors of beverage and tobacco, apparel, rubber, plastics, communication equipment, and trade decline and follow the same pattern and magnitudes as depicted with the results of SIM 2.

The results show that in general women intensive sectors, particularly the largest women employer, apparel (72 per cent), are negatively affected by rise in productivity where most sectors shed jobs. However, women benefit by securing jobs in other expanding sectors, such as leather, footwear, scientific equipment and other industries.

6.2 Varying levels of substitution elasticities

The comparative sensitivity analysis was carried out using uniform values of elasticity of substitution (ES) at 1.5, 0.5 and 0.1. The results show that with high ES, sectors find it slightly easier to respond to productivity increases than when the ES is low. It is consistently true that as the ES rises, the magnitudes of change get bigger. However, the directions of change in variables are still the same with the 1.5 and 0.1 elasticities of substitution as with the original 0.5 ES. The sectors that expand based on the three levels of ES of 1.5, 0.5 and 0.1 are respectively gold (2.7 per cent, 2.5 per cent, 0.7 per cent), leather (1.9 per cent, 1.8 per cent, 1.6 per cent), and footwear (1.4 per cent, 1.3 per cent, 0.6 per cent). While these sectors benefit at all levels of ES, including low ES (0.1), the mainly women-intensive sectors only benefit with the elasticity

of substitution at 1.5 and 0.5 levels. These are finance, paper, rubber, business, hotel, water, other products, printing food, textile, other industry, trade and glass.

After we impose strict rigidities (ES 0.1), few sectors benefit when compared with the lower rigidities cases. Indeed sectors' output decline in plastic (-0.3 per cent), rubber (-0.2 per cent), communication equipment (-0.01 per cent), and scientific equipment (-0.1 per cent). However, except for capital rent, wages move up higher with low ES compared with higher ES. This means that with rigidities, sectors are compelled to retain and pay higher wages, due to lack of substitutability of gender.

6.3 Employment demand

With both low and higher elasticity of substitution, unskilled and semi-skilled women employment demand exceeds that of unskilled and semi-skilled men. However, the magnitude for the latter is rather small relative to other types of skill. With skilled type of labour, the rate of employment demand of the skilled men exceeds that of skilled women. The gender rigidities have possibility of changing the mixture of women and men workers in sectors in response to changes in their relative wages. Increased ES reduces the fall in women labour demand, which stems from the rise in productivity.

7 Conclusion

This paper has analysed impacts of productivity increase on the South African economy and gender by means of a CGE model. The results have shown that factor productivity rise results in gains from a more efficient usage of resources, which increases GDP, and improves the government budgetary position. In addition, productivity generates direct welfare benefits to households by lowering domestic commodity prices, and by increased earnings for factors, especially for skilled men and skilled women.

An economy-wide productivity increase creates jobs for all skill types of men and women, through an economy-wide rise in output. However, productivity benefits skilled men more than any other type. On the other hand, unskilled and semi-skilled women labour benefit more from economy-wide productivity rise than unskilled and semi-skilled men because when women find themselves out of work, they are forced to accept a lower wage to be hired elsewhere. This improves their earnings, particularly with partial productivity rise.

Unlike economy-wide productivity rise, a direct effect of a partial productivity rise is efficiency gain, resulting in job losses in productivity-raised sectors and in sectors in which they have strong linkages. Unskilled women labour falls less than unskilled men while skilled women labour falls more than that of skilled men. Displaced workers, skilled, semi-skilled and unskilled men and women switch to export-oriented, labour-intensive and capital-intensive sectors which have expanded resulting in economy-wide job creation. This model assumes no relocation costs, however in reality, relocation will be required to find alternative employment, increasing the time required and other costs to find new work. Adjustment costs may be severe and long-lasting for the poorest members of households, particularly unskilled women, due to low levels of education and skills, and limited savings that could be used to finance relocation or retraining. In general, unskilled men and women earnings fall, while skilled labour, particularly skilled men's earnings, rise.

The indirect effect of job creation through intersectoral linkages is overlooked in many partial equilibrium studies, which conclude that productivity leads to job losses. While partial productivity directly reduces levels of employment in the affected sectors, it also creates employment in other sectors via reduced factor costs. This type of analysis explains the importance of looking at both direct and indirect economy-wide effects.

The change of substitution of men for women suggests that greater flexibility, meaning high elasticity of substitution, would dampen the negative impact of a sharp decline in women's market employment due to shocks such as increase in productivity. This shows that if the work place did not discriminate against some forms of labour, at the same skill level, there

would be less harmful effects on women and hence improved production.

From a gender perspective, the increase in productivity creates challenges for women seeking employment, and it has the potential of promoting gender inequality in South Africa by keeping women in low paying positions. Economy-wide productivity raises the employment demand and earnings of unskilled women from their baseline level. However, productivity within selected sectors sheds employment, mostly in women intensive sectors. Although retrenched men and women relocate to other sectors, earnings of unskilled women drop because their job losses are outweighed by their job gains mostly in low-paying positions. This has an implication on the welfare improvement of low-income households, which derive most of their income from unskilled women labour. It appears that as jobs and wages improve in quality, women tend to be excluded from them. Investing in the appropriate skill development of women in areas of science, engineering and information technology etc., associated with productivity, could enhance women's potential to benefit from a productivity-enhanced economy. However, such initiatives should focus on the economic, socio-cultural, and political constraints that perpetuate gender inequalities.

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Appendix 1

Table 1
Trade, productivity levels and factor shares in sectors

	Productivity level (2000)	Export shares	Import shares	Capital share in sectors	Men share in sectors	Women share in sectors
Maize	2.1	1.8	0.4	85.3	13.4	1.3
Wheat	2.4	0.2	0.2	92	7.3	0.7
Fruit Vegetables	2.7	0.9	1	63	24.8	12.2
Poultry	1.7	0.2	0.3	37.5	45.8	16.7
Dairy Livestock	1.7	0.2	0.3	76.4	21.6	2
Other Agriculture	1.8	0.3	0.2	57.2	20.6	22.2
Coal mining	2.4	3.4	0.2	54.4	44.4	1.2
Gold mining	1.8	10.1	0	29.3	68.9	1.9
Other mining	2.2	19.9	10	66.1	32.3	1.6
Food processing	2.7	2.6	2.6	44	44.2	11.7
Beverage / tobacco	2.3	1.6	1	71.1	23.9	5
Textiles	1.6	0.9	1.4	21.4	57.4	21.3
Apparel	0.9	0.9	1.2	13.2	35.9	50.8
Leather	1.8	0.4	0.3	46.6	16.3	37.1
Footwear	1.6	0.1	0.8	49.2	12.1	38.8
Wood product	1.6	0.8	0.5	30.5	59.5	10
Paper product	3.4	2.4	1.2	55	26.7	18.3
Printing	3.5	0.4	1	24	51.2	24.8
Petroleum	2.3	3.5	1.2	85.6	13.5	1
Chemicals	2.5	3.8	4.6	61.9	34.3	3.9
Other chemicals	3	1.9	5.1	33.5	48.1	18.3
Rubber product	3	0.5	0.8	29.7	39.1	31.1
Plastic product	3.7	0.3	0.9	10.2	46.7	43.1
Glass product	2.3	0.2	0.3	29	69.9	1.2
Non-metal	2.8	0.4	1	65.3	25.6	9.1
Iron & steel	3	7.2	1	51.1	39.3	9.6
Non-ferrous	3.1	3.5	1.7	81.5	17.6	0.9
Metal product	3.4	1.1	1.7	33.4	62.1	4.5

	Productivity level (2000)	Export shares	Import shares	Capital share in sectors	Men share in sectors	Women share in sectors
Machinery	3.8	4.6	13.1	19.3	66	14.7
Electrical machinery	3	1	2.5	47.7	37.5	14.8
Comm. equipment	2.4	0.7	5.5	27.2	37	35.8
Scientific equipment	2.6	0.4	2.7	28.6	40.3	31.1
Vehicles	3.4	5	12.2	44.3	44	11.7
Transport equipment	3	1.1	3.2	7.6	90.3	2.1
Furniture	2.4	1.1	0.4	28.3	63.3	8.4
Other manufacture	1.9	1.5	1.4	46.9	29.3	23.8
Electricity / gas	1.7	0.5	0.1	65.2	29.5	5.4
Water	1.7	0	0	67.2	29.1	3.7
Construction	3.7	0.1	0.3	40.1	54.5	5.5
Trade services	3.2	0.2	0.2	45.5	33.5	21
Hotels services	2.3	2.6	1.9	76.8	13.1	10.3
Transport service	2.2	5.3	8.8	55.5	39.3	5.2
Comm. service	2.6	1.1	1.6	60.2	23.9	15.7
Financial service	1.9	3	1.9	60.8	24.8	14.4
Business service	2	1	1.7	69	18	12.9
Other services	1.8	0.3	0.4	49.3	17.3	33.5
Other produce	2.2	0.9	1.3	15.6	49.7	34.6
Government	3	0	0	33.7	47.8	18.6

Source: 2000 South African-gendered SAM