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Educational Policy, Growth and Labor Market in South Africa: A Dynamic Computable General Equilibrium Analysis

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1- Introduction

Education is one of the major concerns in many countries, notably in developing countries. Indeed, improving access to education is the second aim of the Millennium Development Goals which were adopted by the United Nations in 2000. A more educated society is more productive, and is also able to better take care of itself. As many studies have shown, such as Glewwe (2002), a high educational level improves economic growth. Beyond social conceptions that exist in particular environments that may lead to removing a child from school, economic incentives exist that may encourage parents to keep their children in school. For many parents, it is the expected future income that children will receive that is an important factor in the decision to keep them in school. The more educated that a child is, the more likely it is that his or her income will be higher.

Compared to other African countries, South Africa has a high enrolment rate and has significant infrastructure. Nevertheless, there still exist strong inequalities between household groups in terms of access to education, as a result of South Africa's past policies. Indeed, during the segregationist regime, schools were racially organised, with excellent conditions made available to the country's "White" households and deplorable conditions for the country's other households, notably for the "African" communities. According to Case and Yogo (1999), financial decisions concerning former black schools were made by a "White" government that was at best, indifferent to the educational needs of the "African" schools.

With the end of the apartheid legacy in 1994, the government committed itself to providing equitable conditions for all students in South Africa. However, many obstacles exist today: differences in the qualifications of teachers; differences in area of residence; former "White" schools are very popular and thus increase tuition fees in order to control the influx of new students.

The government therefore introduced a system of subsidies in order to help the most deprived students pay the school fees in these former "White" schools, which tend to be located in city centres. These bursaries cover the steep tuition prices as well as part of the transportation costs of getting to school. Yet, the urban geography of the majority of South Africa's cities, notably Johannesburg, reveals that the bursary system is often inefficient. Indeed, most of the desired schools tend to be in upper-class neighbourhoods (Sandton or Bryanston, in the case

of Johannesburg), and these neighbourhoods tend to be geographically far from the homes of "African" students (Soweto or Alexandra). As the transportation systems are not reliable and underdeveloped, students must travel approximately three hours a day in order to attend these schools, which in practical terms makes attendance unrealistic. To counter this problem, the most logical solution would ultimately be to build quality schools in the underprivileged neighbourhoods.

Aware of this new form of discrimination, the government is trying to implement an educational policy for all schools throughout the country, notably in those located in the townships.

In our study, we propose to analyse the impact of a pro-educational policy on different households as well as the impact on the labour market, in a dynamic framework. More precisely, we will develop a sequential dynamic CGE model capable of measuring the impact of an increase in expenditure in public education on the performance of the educational system, as well as on its consequences in the labour market in the short term and over a 20 year horizon.

2-Model:

Our model is inspired by the pedagogical model EXTER developed by Decaluwé et al. Our equations blocs are quite standards and defined in annexes.

The model includes 28 production sectors, 24 are tradable and 4 non tradable. These 4 are government's one (education primary, education secondary, higher education, public services without education). Each of these sectors use labor and capital as production factors. Figure 1 represents the structure of production. We suppose that capital and skilled labor are complementary : given technology, it's not possible to make facilities work without skilled people. In other words, it won't be possible for the firm to use capital without skilled labor as we suppose that substitution elasticity is equal to 0.1.

Figure 1 : Structure of production and labor market
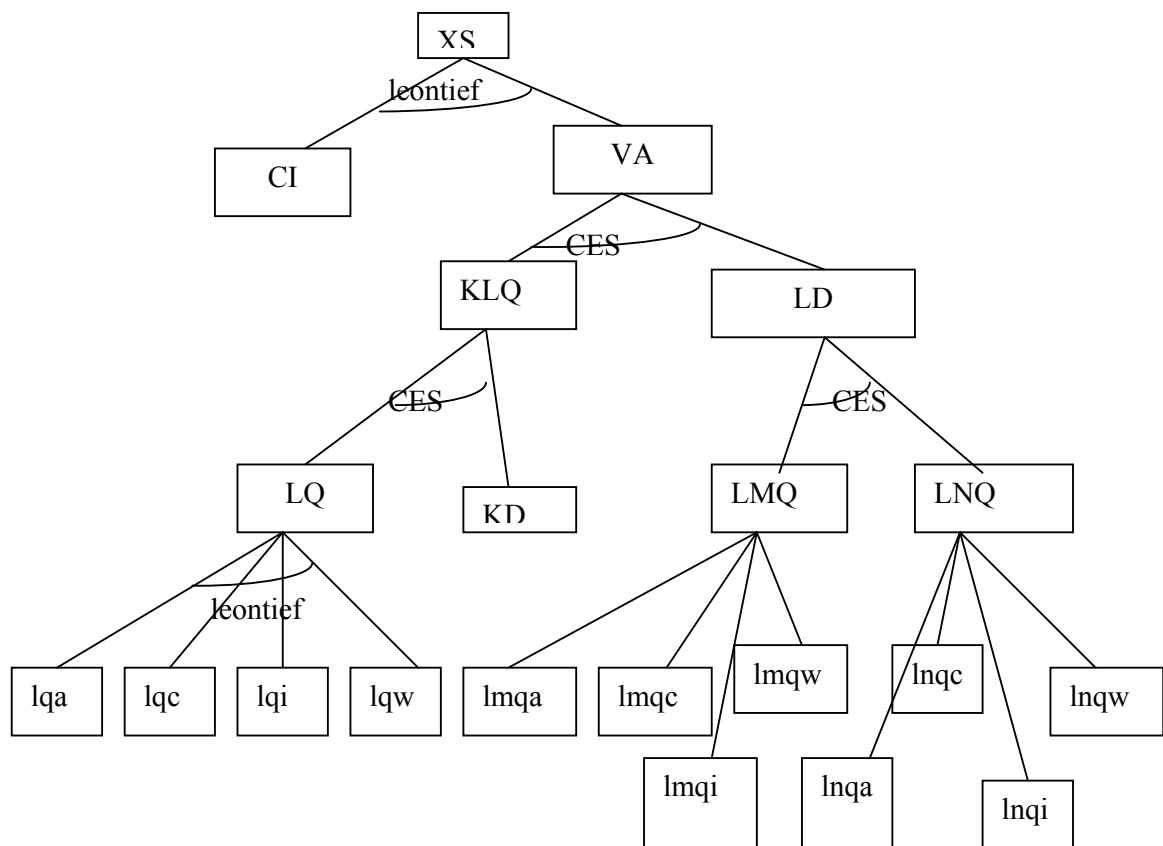
With

XS_i	Production of I sector
VA_i	Value added for I sector
CI_i	Intermediate consumption for I branch
KLQ:	Skilled Labor-Capital aggregate
KD_i	Capital demand for I sector
LD_i	Aggregated demand for I sector
LQ_i	Qualified labor demand for I sector
LMQ_i	Semi Qualified labor demand for I sector
LNQ_i	Unqualified labor demand for I sector
LQC_i	Coloured qualified labor demand for I sector
LQA_i	African qualified labor demand for I sector
LQI_i	Indian qualified labor demand for I sector I
LQW_i	White qualified labor demand for I sector
$LMQA_i$	African semi qualified labor demand for I sector
$LMQC_i$	Coloured semi qualified labor demand for I sector

LMQI_i	Indian semi qualified labor demand for I sector
LMQW_i	White semi qualified labor demand for I sector
LNQA_i	African unqualified labor demand for I sector
LNQC_i	Coloured unqualified labor demand for I sector
LNQI_i	Indian unqualified labor demand for I sector
LNQW_i	White unqualified labor demand for I sector

To take into account South African labor market specificities, we've disaggregated labor into 12 different labor types, by group population (African, Coloured, Indian and White) and qualification (Skilled, middle skilled, unskilled). In each labor market, we've unemployment. We have 4 types of agents: households (4 representative households, classified by group population), Firms, Government, and the rest of world.

Each tradable product can be sold on local market or can be exported. In the same way, households can choose between goods produced locally or imported goods[3].

We are interested in analysing student behaviours and educative impact on the labour market. To modelise student's behaviours, we use a logistic function, used by Bourguignon and al (2006). Students are classified into three educational sectors (primary, secondary and tertiary). Each year, the student can graduate (*dip*), drop out (*aban*) or replicate (*red*). When a student is graduated, he can go on studying (*contdip*) or enter on labour market (*quitdip*).

$$attitude_{LOG,ED,H,T} = att_{\log,ed,h} + \frac{\alpha^{ed}_{\log,ed,h}}{1 + EXP\left(\beta^{ed}_{\log,ed,h} * attitude\mathrm{int}_{\log,ed,h,t} - attitudeo_{\log,ed,h}\right)}$$

With *:*

attitude_{LOG,ED,H,T} : Behavior LOG[4] of student H in the cycle ED[5] at year T.

att_{\log,ed,h} : Maximal share for behavior LOG in ED cycle for student H

$\alpha^{ed}_{\log,ed,h}$, $\beta^{ed}_{\log,ed,h}$: Constants in logistic function

*attitude*int_{\log,ed,h,t} : Value of the intermediate variable of behaviour LOG for ED cycle at year T

attitudeo_{\log,ed,h} : Behaviour LOG for students H at ED cycle for base year.

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[3] See in annexes the equations blocks
[4] LOG behavior represents behaviors given by the logistic function, that is to say shares of repeat, graduate and graduate that continue their studies.
[5] ED cycle makes reference at primary, secondary and tertiary cycles.

This function will allow us to specify from endogenous way behaviors of graduated (*dip*), repeaters (*red*) and graduated that continue (*contdip*) for each student given its population group, in each education level for each year.

In the previous expression, only *attitude*int$_{log,ed,h,t}$ is endogenous. This variable is an intermediate one ; It explains the relation between the behavior variable and its components. For example, in making decisions, a student is influenced by three variables:

(a) the quality of school, which is a variable directly linked to government spending. Indeed, if government decides to increase the number of teachers in the primary cycle, we could expect that the quality would improve because of a drop in the pupil/teacher ratio. If the quality of school increases, the student would have more incentive to continue.

(b) the wage differential between semi-skilled and unskilled workers. If the mean semi-skilled wage is higher than the unskilled one, the student would be induced to study more since s/he will expect to earn a higher income.

(c) the differential wage between semi-skilled and skilled labour. It would also be more interesting to continue if the mean skilled wage is higher than the semi-skilled one.

Knowing how the student behaviour is influenced, one can analyse the impact of an increase in public spending in education on the education system and also on the labour market many years later.

Thus, through this variable, a change in education quality for instance, will have consequences on the evolution of the shares of students in the education system, and that will modify the share of students that graduate and repeat.. This intermediate variable is specified as follow :

$$attitude\text{int}_{LOG,ED,H,T}=attitude_{LOG,ED,H,T}*\left(EDUQUAL_{ED,T}\right)^{\varphi ed1}*\left(\frac{\frac{wmoy2_T}{wmoy1_T}}{\frac{wmoy2o}{wmoy1o}}\right)^{\varphi ed2}*\left(\frac{\frac{wmoy3_t}{wmoy2_t}}{\frac{wmoy3o}{wmoy2o}}\right)^{\varphi ed3}$$

with :

$EDUQUAL_{ED,T}$: education quality in ED cycle for T period

wmoy1 : mean wage rate of unskilled

wmoy2 : mean wage rate of middle skilled

wmoy3 : mean wage rate of skilled

φ1 : elasticity of education behavior regard to education quality

φ2 : elasticity of education behavior compared to wage incentive between unskilled and middle skilled workers.

φ3 : elasticity of education behavior compared to wage incentives between skilled and middle skilled workers

We apply that educational quality is linked to government resources such as:

$$EDUQUAL_{ED,T} = \frac{\dfrac{\sum_{ed} XS_{ed,t}}{\sum_{ed} XSO_{ed}}}{\dfrac{\sum_{H} ENR_{H,ED,T}}{ENRO_{H,ED}}}$$

With :

$XS_{ed,t}$: production of ED sector at T period

XSO_{ED} : production of ED sector at the base year

$ENR_{H,ED,T}$: volume of students of each population group by cycle at T period

$ENRO_{H,ED}$: volume of students of each population group by cycle at the base year

For the two other components of the intermediate variable, each of them represent the future opportunities of earnings that a better education level would give them. To evaluate the mean wages, we computed balanced means by skilled levels:

$$wmoy1_T = \left(wnqa_t * \sum_i LNQA_{i,t} + wnqc_t * \sum_i LNQC_{i,t} + wnqi_t * \sum_i LNQI_{i,t} + wnqw_t * \sum_i LNQW_{i,t} \right) / \sum_i LNQ_{i,t}$$

$$wmoy2_T = \left(wmqa_t * \sum_i LMQA_{i,t} + wmqc_t * \sum_i LMQC_{i,t} + wmqi_t * \sum_i LMQI_{i,t} + wmqw_t * \sum_i LMQW_{i,t} \right) / \sum_i LMQ_{i,t}$$

$$wmoy3_T = \left(wqa_t * \sum_i LQA_{i,t} + wqc_t * \sum_i LQC_{i,t} + wqi_t * \sum_i LQI_{i,t} + wqw_t * \sum_i LQW_{i,t} \right) / \sum_i LQ_{i,t}$$

We specify other education behavior from residual way. We apply that every year, a student can graduate, drop out or repeat, so the sum of these three shares is equal to one. Logistic

function gives the shares of students that repeat and graduate, so we can easily find the share of drop out for each population group, for each education level at each time:

$$attitude"aban"_{ED,H,T}=1-attitude"dip"_{Ed,H,T}-attitude"red"_{ED,H,T}$$

On the same way, we suppose that graduate students have two possibilities : they can go on studying at the next education level, or they can enter the labor market. So, the sum of these two shares is also equal to one. Logistic function gives us the share of student that graduate and continue, so we can find the share of students that graduate and enter the labor market. Thus :

$$attitude"quitdip"_{ED,H,T}=1-attitude"contdip"_{ED,H,T}$$

We can evaluate the graduation rate for each year by cycle :

$$attitude"dipdc"_{ED,H,T}=attitude"dip"_{ED,H,T}/années_{ed}$$

with :

$attitude"dip",ED,H,T$: share of students H that are graduated in each cycle at T period
$années_{ed}$: number of years that lasts a cycle

We have specified endowments in different labor categories for households. We gave the Bourguignon et al. specification.

$$parqual_{H,T}=\frac{LSQ_{H,T}}{\sum_{H}LSQ_{H,T}+LSMQ_{H,T}+LSNQ_{H,T}}$$

$$parmoyqual_{H,T}=\frac{LSMQ_{H,T}}{\sum_{H}LSQ_{H,T}+LSMQ_{H,T}+LSNQ_{H,T}}$$

$$parnonqual_{H,T}=\frac{LSNQ_{H,T}}{\sum_{H}LSQ_{H,T}+LSMQ_{H,T}+LSNQ_{H,T}}$$

With :

$parqual_{H,T}$: share of skilled labor endowment for H households at period T.

$parmoyqual_{H,T}$: share of middle skilled labor endowment for H households at period T

$parnonqual_{H,T}$: share of unskilled labor endowment for H households at period T

$LSQ_{H,T}$:Skilled labor endowment for household H at T period.

$LSMQ_{H,T}$: Middle skilled labor endowment for household H at T

$LSNQ_{H,T}$: unskilled labor endowment for household H at T

We apply that every year, a student can graduate, drop out or repeat. If he drops out, he enters the labour market at the next lower level. If the student graduates, he can go on at school at the next level or enter the labour market.

Thus, qualified labour supply at (T+1) is determined by the qualified at the previous period, and the volume of students that had graduated the tertiary level and decides to enter the labor market[6] such as :

$$LSQA_{T+1}=parqual_{"african",T}*\left(LSQA_{T}+LSMQA_{T}+LSNQA_{T}\right)+$$
$$ENR_{"african","tertiaire",T}*attitude_{"dip","tertiaire","african",T}*entree_{"tertiaire"}$$

With

$LSQA_{T+1}$: *African* qualified labor supply at T+1 period

$ENR_{"african","tertiaire",T}$: volume of *African* students enrolled in tertiary level

$attitude_{"dip","tertiaire","african"T}$: share of *African* graduated in tertiary level

$entree_{"tertiaire"}$: parameter giving the share of graduated student that entered the labor market.

$LSQA_{T}$: *African* qualified labor supply at T period

$LSMQA_{T}$: *African* middle qualified labor supply at T period

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[6] We do exactly the same for the other population group

$LSNQA_T$: *African* unqualified labor supply at T period

The middle qualified labour supply is determined by the volume of middle qualified present the year before, the volume of students that have graduated secondary level and decides to enter the labour market, more those who were in tertiary level and had decided to drop out.

$$LSMQA_{T+1} = parmoyqual_{"african",T} * (LSQA_T + LSMQA_T + LSNQA_T)$$
$$+ \ ENR_{"african","secondaire"T} * attitude_{"dip","secondaire","african",T} * entree_{"secondaire"}$$
$$+ ENR_{"african","tertiaire",T} * attitude_{"aban","tertiaire","african",T} * entree_{"tertiaire"}$$

With :

$LSMQA_{T+1}$: *African* middle qualified labor supply at T+1 period

$ENR_{"african","secondaire"T} * attitude_{"dip","secondaire","african",T} * entree_{"secondaire"}$: volume of *African* students graduated of secondary level that enter the labor market.

$ENR_{"african","tertiaire",T} * attitude_{"aban","tertiaire","african",T} * entree_{"tertiaire"}$: volume of *African* students that dropped out in tertiary and enter the labor market at the next lower level

We had the same specification for unskilled labor supply at T+1 : it is composed of students that have graduated primary school and students of secondary level that have dropped out.

$$LSNQA_{T+1} = parnonqual_{"african",T} * (LSQA_T + LSMQA_T + LSNQA_T)$$
$$+ \ ENR_{"african","secondaire"T} * attitude_{"aban","secondaire","african",T} * entree_{"secondaire"}$$
$$+ ENR_{"african"," primaire",T} * attitude_{"dip"," primaire","african",T} * entree_{" primaire"}$$

So, we can analyse the impact of an increase in public spending in education on the educational system and also on labour market many years later. We will analyse two situations:

    -there is no fiscal policy to finance this policy

    -a fiscal policy is carried out.

3-Data and Closure:

We use the Social Account Matrix 2001, used by Decaluwé et al (2004) and we took the values of theirs parameters in production functions, in consumption function and for income elasticity.

In each labour market, we have unemployment and we've found data on the Labour Force Survey 2001. We've supposed that unemployed with a level inferior of primary school is considered as unskilled, an unemployed that has reached secondary is middle skilled, and unemployed that had at least MATRIC was skilled.

To modelise unemployment, we choose the Shapiro-Stiglitz specification, and for the incentive constraint, we've taken Annabi's data (2003) which matched with Kingdon et Knight's study[7] (2000).

In 2001, according to UNDP, the share of public spending given for education was 18.5%. Within the educational sector, this budget is divided by 47.8% to primary sector, 31.3% to secondary sector, and 14.6% for higher school.

To calibrate the educational data, we've used the Census 2001 and many studies on this topic.

Van der Berg (2005) determined that drop out rate in higher school was 55% for *African* and *Coloured*, and that this rate was at least twice higher than White or Indian's one.

We've applied that Colored and African students have the same behavior at school and Indian and White students have also the same.

We've found in the Census 2001 the repeating rate by cycle and population group, and we've compared it to Castro Leal and Van der Berg studies.

We did not have the true values, so we tried to give an order of magnitude acceptable and logical with the labor market and the educational system in 2001.

This table gives us the student behaviors at the base year.

Table 1. Students behaviors at the base year

Behavior by cycle	African	Coloured	Indian	White
Primary graduate (dip)	0.77	0.77	0.77	0.77
Secondary graduate	0.65	0.65	0.65	0.65
Higher school graduate	0.25	0.25	0.5	0.5

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[7] They certificated that a wage curve was existing in South Africa, that is to say that wages vary in inverse sense of unemployment (See Banchflower and Oswald, 1995)

Primary drop out (aban)	0.12	0.12	0.12	0.12
Drop out secondary	0.22	0.22	0.2	0.2
Drop out higher school	0.55	0.55	0.2	0.2
Repeat primary(red)	0.11	0.11	0.11	0.11
Repeat secondary	0.13	0.13	0.15	0.15
Repeat higher school	0.2	0.2	0.3	0.3
Leave diploma primary (quitdip)	0.25	0.25	0.25	0.25
Leave diploma secondary	0.3	0.3	0.3	0.3
Leave diploma higher school	1	1	1	1
Continue diploma primary (contdip)	0.75	0.75	0.75	0.75
Continue diploma secondary	0.7	0.7	0.7	0.7
Continue diploma higher school	0	0	0	0
Graduation rate in primary(dipdc)	0.11	0.11	0.11	0.11
Graduation rate in secondary	0.13	0.13	0.13	0.13
Graduation rate in tertiary	0.0625	0.0625	0.125	0.125

In each cycle, for each population group, a student can graduate (dip), repeat (red) or drop out (aban), such that the sum of these three shares is equal to one. For instance, at the base year, in the primary cycle, 77% of pupils graduate, whereas 12% drop out and 11% repeat. In the same way, when a student graduates, s/he can go on (contdip) or leave (quitdip), making the sum of these two shares equal to one. Here, we suppose that after the primary cycle, 75% of pupils continue to the next level, and 25% choose to leave to enter the labour market.

It should be noted that when a student graduates from tertiary level, he is obliged to leave, making this share equal to one. The graduation rate, (dipdc), gives us the graduation rate by year in the cycle. For instance, the primary cycle lasts 7 years. So, the mean graduation rate, or graduation rate by year, is the graduation rate for the cycle (dip) divided by the number of years in the corresponding cycle. To analyse the effects of an increase of public spending on the education sectors and many years later in the labour market, the paper developed a recursive dynamic CGE model solved within a 20-year horizons. Equilibrium in each market is reached trough relative price variations. The exchange rate is fixed. We assume that South Africa is a small country and so world prices are exogenous as well as the initial demand for exports. Labour supplies are exogenous in the first period and becomes endogenous with the performance and choices made by students. Capital stocks are exogenous in the first period, whereafter sectoral endowments in capital become endogenous with the introduction of an investment function and a capital accumulation equation.

Variables presented in bloc 11 (in annexes) are exogenous at the first period and then grow with the population growth rate.

For the second scenario, we keep the same hypothesis than in the first scenario except that government spending is fixed and equal at its BAU value. Fiscal policy is financed by direct taxes paid by households.

4-Results of the educational policy

The paper studies the impact of a permanent increase in public expenditure of 10% in the secondary and 20% in the tertiary education sectors. Knowing that the level of public spending in higher education is relatively low, the paper tests for a 20% increase in tertiary education. The big increase in both sectors is for the first year. Then, we suppose that government spending increases in each education sectors by about 2% per annum, which is the population rate, such as public spending per pupil remains constant over the period. In addition, given that South Africa suffers from a skill shortage, the paper also wants to see what would be the impact on the supply of skilled labour of such a significant increase. Note that these increases are modelled to benefit all population groups.

1st scenario: Education policy without fiscal policy

Short run (2001)

1. Educational system

As budgets are higher in the secondary and tertiary sectors, quality education in each of these sectors is increasing. In addition, there is a decrease in the drop out and repeat rates in these two cycles (Table 2). Nonetheless, primary schools are not affected by these changes. Knowing that student behaviour is determined by wage incentives, also note that the differential wage between unskilled and semi-skilled, and between the semi-skilled and skilled, increases. It means that students are motivated to keep studying.

We can see that the education policy has a positive impact on student behaviour. As expected, there is no change in household endowment. Indeed, since it takes time to become qualified, the effects of education can only be seen in long run.

Table 2. Variation of the educational behavior (en %)

Behavior by cycle	African	Coloured	Indian	White
Primary graduate (dip)	0	0	0	0
Secondary graduate	2	2	2	2
Higher school graduate	12.4	12.4	6.4	6.4
Primary drop out (aban)	0	0	0	0
Drop out secondary	-5.45	-5.45	-6	-6
Drop out higher school	-4.91	-4.91	-12.5	-12.5
Repeat primary(red)	0	0	0	0
Repeat secondary	-0.77	0.77	-0.67	-0.67
Repeat higher school	-1.5	-1.5	-2.33	-2.33
Leave diploma primary (quitdip)	0	0	0	0
Leave diploma secondary	-3.67	-3.67	-3.67	-3.67
Leave diploma higher school	0	0	0	0
Continue diploma primary (contdip)	0	0	0	0
Continue diploma secondary	1.57	1.57	1.57	1.57
Continue diploma higher school	0	0	0	0
Graduation rate in primary(dipdc)	0	0	0	0
Graduation rate in secondary	2.3	2.3	2.3	2.3
Graduation rate in higher school	12	12	6.4	6.4

2. Wage rates, employment and production

The paper seeks to understand the interactions between the education system and the rest of the economy. To produce more, the education sector needs more labour force, and notably semi-skilled workers, as teachers for instance. So there is an increase in semi-skilled work demand and also an increase of the intermediate consumptions for these two sectors. As there is an increase in labour demand, the unemployment rate decreases, and the decrease, as shown in Table 3 concerns all works categories. For African skilled workers, the unemployment rate decreases of 0.68%. Moreover, these increases in the labour demand put pressure on the labour market and an increase of wage rate. Table 3 also shows the increase in wage rate for each labour category. For unskilled Coloured workers, their wage rate increases by 0.27%.

Table 3. Variation of unemployment rates and wages by qualification and group population (en %)

Employment classes	Variation of unemployment rate (en %)	% of wage rate
Unemployment of African qualified	-0.2	0.13
Unemployment of Coloured qualified	-0.14	0.13
Unemployment of Indian qualified	-0.12	0.1

Unemployment of White qualified	-0.1	0.1
Unemployment of African middle qualified	-0.35	0.14
Unemployment of Coloured middle qualified	-0.49	0.29
Unemployment of Indian middle qualified	-0.39	0.25
Unemployment of White middle qualified	-0.53	0.42
Unemployment of unskilled African	-0.34	0.17
Unemployment of unskilled Coloured	-0.46	0.28
Unemployment of unskilled Indian	-0.32	0.2
Unemployment of unskiled White	-0.35	0.26

However, in some sectors, the increase of wage rates leads up to reduce workforce. Indeed, the increase of factors prices reduces the incentives to produce for some sectors, and in these sectors, workforce is going to decrease. (table 5). On the overall of economy, labor demand increases about 0.09%.

Tableau 4. Variation of total labor demand and production by sector (en %)

Sectors	Total Labor Demand	Production
Agriculture (AGRI)	0,07	0,03
Coal industries (COAL)	-0,45	-0,14
Gold Industries (GOLD)	-0,76	-0,46
Others mining (OTHMIN)	-0,75	-0,24
Food Industries(FOOD)	0,28	0,11
Textile Industries(TEXT)	0,04	0,03
Footwear industries (FOOTWEAR)	0,21	0,1
Petroleum(PETROL)	-0,08	-0,02
Other non metallic mineral products (OTHNON)	0,18	0,07
Basic Iron/Steel(STEEL)	-0,21	-0,1
Electrical machinery(ELEC)	0,02	0,01
Radio (RADIO)	0,15	0,09
Transport equipment (TRANSEQ)	0,07	0,04
Other manufacturing(OTHMAN)	0	0
Electricity(ELECT)	0,15	0,04
Water(WAT)	0,91	0,13
Construction (CONSTR)	0,34	0,22
Trade (TRADE)	0,05	0,04
Hotels-Restaurants (HOT)	0,14	0,06
Transports services (TRANSSER)	0	0
Communications (COM)	0,24	0,13
Financial Intermediation	0,25	0,08

(FININT)		
Real Estate (REALE)	0,59	0,1
Business Activities (BUSAC)	0,28	0,21
General Government (SERN)	-0,33	-0,19
Primary education (PRIMAIRE)	-0,33	-0,19
Secondary education (SECONDAIRE)	12,41	7,38
Tertiary education (TERTIAIRE)	25,44	14,76

3. Incomes and expenditures of agents

Due to the rise of their salary, households income increases for each population group, likewise their savings and consumption expenditures. We can also see that the welfare is increasing.

Table 5. Impacts on households (en %)

	African	Coloured	Indian	White
Income Variation	0,40	0,47	0,42	0,38
Disponible income variation	0,4	0,68	0,44	0,38
Savings Variation	0,4	0,68	0,44	0,38

Firms receive mainly earnings from productive capital. We know that we have an increase of labour demand , so capital is relatively scarce, so its income is going to increase. The return of capital increases about 1.16%. So, income firms increases (+0.51%) and their savings too (+1.04%).

Concerning government, we know on the one hand that his expenditures increase strongly.
On the other hand, the receipts on households and firms increase (because they're a part of their income). In the same way, receipts on production increase. Government income increase (+0.44%). Nevertheless, this increase is not long enough to improve government savings. Indeed, government' savings decreases of 3.3%. This result was expected, because that government decided to rise its expenditures in education. What we have to find is that in long run, government will get his money back.

South African exports decrease in all sectors. In the meantime, local prices are increasing (because of the increase of factors cost for firms and on the exceed of demand from households), so households prefer buying imported goods that become less expensive. As a

result, the current account balance is being financed by an increase of foreign savings.(29.9%)[8].

Agents Savings' increase, except the government one, such as total savings increase (+0.88%).

In short term, the increase in public expenditures in education leads to an improvement on the quality of education, and to an increase of labour demand and a decrease in unemployment. Households demands for good increase, so local prices increase, and households prefer buying imported goods.
The impacts on educational system can't be thought in short run, there is no change in households endowments.

In long run (2020)

1. Impact on education :

The paper compares two simulations: one with shocks to the education policy, and another without the shocks. Education quality increases in secondary and tertiary education, respectively 9.87% and 19.83%. For primary school, quality decreases about 0.09%. As in the short run, education quality is a variable directly determined by government expenditure, so we expect the quality to increase in the secondary and tertiary level. For the primary level, quality decreases. We suppose that spending by capita is constant for the period in this level, wages in this sector are increasing, so real per capita spending in this level are decreasing, and its quality decreases. As shown in Table 7, students behaviour changes due to improvements in education quality in secondary and tertiary., with the drop-out and repetition rate falling in the secondary and tertiary sectors. The skilled endowment for households grows because of the pro-education policy.

Table 6. Variation in % of households endowments in labor

	African	Coloured	Indian	White
Endowment in skilled labor	+3.89	+3.86	+1.94	+1.86
Endowment in middle skilled labor	-0.65	-1.24	-1.04	-1.99
Endowment in unskilled labor	-0.46	-0.24	-0.53	-0.52

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[8] Foreign Savings was very low, that 's why the percentage seem to be very high

During the 20-year period and as a result of this policy, endowments in skilled labour increases, especially for African and Coloured. This represents the first major difference with the short-run.

2. Impact on production :

A double effect exists here. On one hand, there is an increase in skilled demand due to the increase in the production of both education sectors, corresponding to the increase of public expenditure. On the other hand, the education reform has produced more skilled workers, resulting in an excess supply of skilled workers.

The supply effect is greater than the demand effect and leads to a higher unemployment rate among skilled workers. Also note that the labour demand for unskilled and semi-skilled labourers increases (while their unemployment rates decreases) For these labour categories, we do not have the supply effect as we have for skilled workers as these categories have become relatively more scarce. Therefore, wage rates for unskilled and semi-skilled workers increase whereas wage rates for skilled categories workers decreases. The increase in the unemployment rates of skilled people represents the second difference with the short run.

In terms of productive sectors, the same effect exists as in short run, that is to say that some sectors are firing people and decreasing their production whereas others are increasing. Sectors which hire people are the same as in short run. Producers can sell to the local market or export part of their production. In local price, all prices are increasing, such that producers are induced to sell on the local market.

3. Impact on agents :

Given the above, one would expect household income to grow due to the increase in the semi-skilled and unskilled wage rates. As in the short run, saving, taxes and consumption expenditure are increasing.

Table 7. Variation of income and saving of households (in %)

	African	*Coloured*	*Indian*	*White*
Income:	0,17	0,19	0,17	0,14

Disponible income	0,17	0,28	0,18	0,15
Savings	0,17	0,27	0,18	0,15

As in short run, firm's income and savings increase.(+0.51% et 1.04%)

Public expenditures increase of 10% in secondary and 20% in higher school at the first period and then increase about 2% each year, such as spending by capita are constant).
Government receipts increase. Direct taxes on households and firms increase and in the same way, indirect taxes also increase. Government income increase about 0.6%. Anyway, this increase is not sufficient to cover government spending. Government savings decrease about 2.8%.

Imports are increasing due to local prices which are higher and exports are decreasing because producers prefer selling in local market. Foreign saving increase about 1.4%.

Total investment increase in value (+0.65%)

Conclusion of the first scenario:
This first scenario analyses the impact of an increase in public expenditures on education in South Africa. In the short term, there is a very positive effect on employment because of the strong increase in the labour demand of the education sectors. There is also a positive impact on student behaviour, with the shares of drop outs falling, particularly for Africans and Coloureds in tertiary education. This policy also provides beneficial impacts during the long term, notably on the education sectors, and through the improvement of the skilled labour endowment of households.

However, over the 20-year horizon the education policy results in an increase of the unemployment rate of skilled workers. Moreover, the policy is expensive for some sectors, causing them to hire less people and reduce their production. On balance, though, production and employment and thus, household income grow, so that household demand for goods and services increases. Local prices increase as a result of this increase in demand, and so households shift towards buying imports.

A further negative effect is that the South African economy becomes increasingly more dependant on the rest of world. In addition, government saving decreases. One would

have hoped that the policy could generate enough qualified people who could find a job and pay taxes. However, this does not happen and it would be interesting to see what would happen if the government decides to impose a tax (or something else) to finance this policy, which could also affect households contributions.

An education policy is essential to correct inequalities and to produce more skilled people, which are two major problems in South Africa. Getting skilled would also allow to earn more, and would have effects on health in the country. Nevertheless, this policy must be supported by appropriate fiscal policy to finance a part of the education policy, because without an appropriate fiscal policy, it would be financially unsustainable, that is what we analyse in the second scenario.

2nd scenario: Education policy joined to a fiscal policy

Here, we want to analyse the same policy but government does not want to resort to borrowing. Indeed, as we have seen in the previous scenario, the rest of the world finances our deficit. We know that it is not sustainable. Thus, we suppose here that government savings is fixed and equal to the BAU[9] value, and the policy is financed by a fiscal policy.

We introduce a tax on household direct tax, able to generate enough savings to finance this policy. In other words, if current account balance decreases, it won't be because of this policy. We can compare the effects of paying the policy now (tax on households) or paying later (borrowing on the rest of world).

Short run (2001)

1. Educational system

We do not expect any changes on the educational system, we will still have an improvement of education quality in secondary and tertiary levels after an increase of government expenditure in these two sectors.

We have the same results as in the previous scenario in terms of behaviour shares.

2. Wage rates, employment and production

What are the consequences of the increase of the public spending on the labor market?

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[9] Business As Usual

As in the previous scenario, labor demand increases in educational sectors (secondary and tertiary).

Here we have a significant difference between the two scenario: indeed, we can see with the fiscal policy that labor demand only increases from the educational sectors. These sectors lead the labor demand.

Unemployment rates decrease, and wages increase, but it's only driven from the secondary and tertiary sectors.

Table 8 : Impact on unemployment and wages

Employment classes	Variation of unemployment rate (en %)	% of wage rate
Unemployment of African qualified	-0,18	0,12
Unemployment of Coloured qualified	-0,11	0,10
Unemployment of Indian qualified	-0,07	0,06
Unemployment of White qualified	-0,06	0,06
Unemployment of African middle qualified	-0,26	0,11
Unemployment of Coloured middle qualified	-0,25	0,15
Unemployment of Indian middle qualified	-0,10	0,06
Unemployment of White middle qualified	-0,37	0,29
Unemployment of unskilled African	-0,11	0,06
Unemployment of unskilled Coloured	-0,21	0,13
Unemployment of unskilled Indian	-0,02	0,01
Unemployment of unskiled White	-0,03	0,02

3-Impacts on households

What are the consequences on households?

We expect household income to increase because of the increasing of wages and the decreasing of unemployment.

We know that this policy is financed by households, paid by direct taxes. So, we expect direct taxes to increase and available income to decrease. In the same way, consumption expenditures are decreasing.

Table 9 : Impact on households :

	African	Coloured	Indian	White
YH	0,20	0,25	0,22	0,21
SH	-0,30	-0,17	-0,37	-0,41
TDH	3,60	3,64	3,62	3,60

Here we have a very big difference between the two scenario. In the previous one, households consumption was increasing, due to the increase of available income. Here, direct taxes increase to finance the policy, such as households have to reduce their consumption.

4-Impacts on production

What is the impact on demand?

On the one hand, we know that households demand is decreasing. On the other hand, production factors prices are increasing for firms: indeed, wages are going up, and capital rate also (in short run, capital is fixed. Labor demand is increasing so capital is relatively scarce, such as is price increases.)

Firms will expect to sell less and would reduce their production, and fire people because their cost is relatively high.

Table 10 : Impact on production

Sectors	XS
Agriculture (AGRI)	-0,24
Coal industries (COAL)	-0,08
Gold Industries (GOLD)	-0,12
Others mining (OTHMIN)	-0,07
Food Industries(FOOD)	-0,27
Textile Industries(TEXT)	-0,20
Footwear industries (FOOTWEAR)	-0,27
Petroleum(PETROL)	-0,09
Other non metallic mineral products (OTHNON)	-0,03
Basic Iron/Steel(STEEL)	-0,07
Electrical machinery(ELEC)	-0,05
Radio (RADIO)	-0,03
Transport equipment (TRANSEQ)	-0,04
Other manufacturing(OTHMAN)	-0,08
Electricity(ELECT)	-0,14
Water(WAT)	-0,04
Construction (CONSTR)	-0,02
Trade (TRADE)	-0,14
Hotels-Restaurants (HOT)	-0,13

Transports services (TRANSSER)	-0,19
Communications (COM)	-0,12
Financial Intermediation (FININT)	-0,16
Real Estate (REALE)	-0,14
Business Activities (BUSAC)	0,07
General Government (SERN)	-0,07
Primary education (PRIMAIRE)	-0,07
Secondary education (SECONDAIRE)	7,51
Tertiary education (TERTIAIRE)	14,89

In front of the decrease of demand on the local market, local prices decrease such as producers prefer selling their production abroad. Indeed, we suppose that producers can sell their production on the local market or abroad. Prices in each of these markets influence them. As prices in local market are decreasing in most of the sectors, producers prefer selling their production abroad whereas in local market. Thus, exports raise.

In the same time, as local prices are decreasing, households prefer buying their products on this market, because imported goods are becoming relatively more expensive.

In that way, current account balance is decreasing by 0.71%. In other words, South Africa is beginning less dependant to the rest of world.

On the other agents, what do we have?

Firms receive mainly capital remuneration for their income, so, firm's income is stepping up (+0.05%) and its savings is also increasing (+0.11%).

For government, its income is increasing (+1.06%) due to the increasing of households direct taxes, and firms taxes. Its expenditure is increasing but its savings is kept constant.

Total investment is increasing (+0.13%).

Long run (2020)

Concerning the education system, we find the same results in this scenario than in the previous one: behaviours are improving, drop out go down, and graduation rates increase. Moreover, household's endowments raise.

On the labour market, we observe the same results: the education reform creates too many qualified students, so there is unemployment on skilled market.

In the other labor markets, unemployment rates decrease for each population group.

Table 11 : Impact on unemployment and wage rates

Employment classes	Variation of unemployment rate (en %)	% of wage rate
Unemployment of African qualified	2,93	-1,92
Unemployment of Coloured qualified	3,16	-2,64
Unemployment of Indian qualified	1,32	-0,98
Unemployment of White qualified	1,67	-1,12
Unemployment of African middle qualified	-0,12	0,05
Unemployment of Coloured middle qualified	-0,78	0,46
Unemployment of Indian middle qualified	-0,24	0,15
Unemployment of White middle qualified	-1,61	1,25
Unemployment of unskilled African	-0,24	0,11
Unemployment of unskilled Coloured	-0,05	0,01
Unemployment of unskilled Indian	-0,07	0,07
Unemployment of unskiled White	-0,08	0,02

What are the consequences on households?

We know that unemployment increases for skilled workers, that means that qualified wage rate are decreasing. The variation of the income will represent the structure of the households. Indeed, Indian and White households are more endowed of skilled labor. As this kind of work is decreasing, we expect that their income would increase less than African or Coloured income.

The variation is very low for each household but income decreases for each population group. Moreover, the South African government decides to make households pay directly the policy, we suppose that direct taxes are increasing such as available income is decreasing for each households. As a matter of fact, households savings and consumption is also decreasing.

Table 12 : Impacts on households

	African	Coloured	Indian	White
YH	-0,08	-0,09	-0,11	-0,12
YDH	-0,75	-0,90	-0,96	-1,00
TDH	0,02	0,02	0,02	0,02

With the decrease of their income, households will reduce their consumption, so we will have ceteris paribus, a demand decrease.

What about production?

Production costs increases, so firms will reduce their production, expecting less opening. Besides, households consumption is decreasing because of the increase of direct taxes such as production is decreasing in many sectors.

Table 13 : Impact on production

Sectors	Production
Agriculture (AGRI)	-0,68
Coal industries (COAL)	-0,14
Gold Industries (GOLD)	-0,15
Others mining (OTHMIN)	-0,05
Food Industries(FOOD)	-0,77
Textile Industries(TEXT)	-0,46
Footwear industries (FOOTWEAR)	-0,69
Petroleum(PETROL)	-0,20
Other non metallic mineral products (OTHNON)	-0,01
Basic Iron/Steel(STEEL)	-0,03
Electrical machinery(ELEC)	0,01
Radio (RADIO)	0,09
Transport equipment (TRANSEQ)	0,01
Other manufacturing(OTHMAN)	-0,18
Electricity(ELECT)	-0,39
Water(WAT)	-0,24
Construction (CONSTR)	0,06
Trade (TRADE)	-0,32
Hotels-Restaurants (HOT)	-0,42
Transports services (TRANSSER)	-0,44
Communications (COM)	-0,31
Financial Intermediation (FININT)	-0,47
Real Estate (REALE)	-0,65
Business Activities (BUSAC)	0,08
General Government (SERN)	0,13
Primary education (PRIMAIRE)	0,13
Secondary education (SECONDAIRE)	10,10
Tertiary education (TERTIAIRE)	20,07

Thus, production is decreasing in most of the sectors, except one in which non tradable sectors are intensive.

Producers that sell their products on local market and exports will prefer export their production, because local price is decreasing.

In that way, exports are increasing.

On the other side, consumers will prefer buying local products because they are relatively less expensive than imported products.

We will expect that current account balance would increase.

What about government?

Its revenues increase thanks to direct taxes paid by households, this taxes allow the financing of the policy (government spending are increasing).

The impact on investment is positive:+0.47%

Total investment is increasing

5-Conclusion:

In this paper, we wanted to evaluate the impact of education policy financed of two different ways: the first one represents a borrowing on the rest of world, in other words an increase of foreign debt. The second way is financed by households, they pay directly for this policy.

The education policy consists in an increase of public spending in secondary and tertiary education sectors.

On the education sector, results are quite good, households are becoming more skilled and the improvement of the education sector produces more qualified African and Coloured, that is a big problem in the country.

Nevertheless, whatever the way of financing this policy, in long run, we have unemployment for qualified people. The simulation of the model suggests that the South African economy does not increase enough to create enough qualified jobs. This result could also be explained by the importance of the increase in public spending. Indeed, the South African government could decide to increase each year the spending for education, reaching an increase of 10% over 10 years. The results would probably be different.

ANNEXES

Table 14. Unemployment rate by population group and qualification

Unemployment rate	Base 2001
Skilled *African*	0.1390
Skilled *Coloured*	0.0190
Skilled *Indian*	0.0530
Skilled *White*	0.0060
Middle Skilled *African*	0.4160
Middle Skilled *Coloured*	0.1910
Middle Skilled *Indian*	0.1650
Middle Skilled *White*	0.0770
Unskilled *African*	0.2850
Unskilled *Coloured*	0.2040
Unskilled *Indian*	0.1380
Unskilled *White*	0.1100

Source :Census 2001

BLOC 1 Production (equations 1 to 21)

(1) $XS_{i,t} = VA_{i,t}/v_i$

(2) $CI_{i,t} = io_i * XS_{i,t}$

(3) $DI_{tr,j,t} = aij_{tr,j} * CI_{j,t}$

(4) $DIT_{tr,t} = \sum_{j} DI_{tr,j,t}$

(5) $VA_{i,t} = A_i^{kl} * \alpha_i^{kl} * LD_{i,t}^{-\varsigma_i^{kl}} + (1-\alpha_i^{kl}) * KLQ_{i,t}^{-\varsigma_i^{kl}})^{-1/\varsigma_i^{kl}}$

(6) $LD_{i,t} = (\alpha_i^{kl}/1-\alpha_i^{kl})^{\sigma_i^{kl}} * (pag_{i,t}/w_{i,t})^{\sigma_i^{kl}} * KLQ_{i,t}$

(7) $LD_{i,t} = A_i^{l} * \alpha_i^{l} * LMQ_{i,t}^{-\varsigma_i^{l}} + (1-\alpha_i^{l}) * LNQ_{i,t}^{-\varsigma_i^{l}})^{-1/\varsigma_i^{l}}$

(8) $LMQ_{i,t} = (\alpha_i^{l}/1-\alpha_i^{l})^{\sigma_i^{l}} * (wnq_{i,t}/wmq_{i,t})^{\sigma_i^{l}} * LNQ_{i,t}$

(9) $KLQ_{i,t} = A_i^{ag} * \alpha_i^{ag} * LQ_{i,t}^{-\varsigma_i^{ag}} + (1-\alpha_i^{ag}) * KD_{i,t}^{-\varsigma_i^{ag}})^{-1/\varsigma_i^{ag}}$

(10) $LQ_{i,t} = (\alpha_i^{ag}/1-\alpha_i^{ag})^{\sigma_i^{ag}} * (r_{i,t}/wq_{i,t})^{\sigma_i^{ag}} * KD_{i,t}$

(11) $LQA_{i,t} = qa_i * LQ_{i,t}/wqa_t$

(12) $LQC_{i,t} = qc_i * LQ_{i,t}/wqc_t$

(13) $LQI_{i,t} = qi_i * LQ_{i,t}/wqi_t$

(14) $LQW_{i,t} = qw_i * LQ_{i,t}/wqw_t$

(15) $LMQA_{i,t} = mqa_i * LMQ_{i,t}/wmqa_t$

(16) $LMQC_{i,t} = mqc_i * LMQ_{i,t}/wmqc_t$

(17) $LMQI_{i,t} = mqi_i * LMQ_{i,t}/wmqi_t$

(18) $LMQW_{i,t} = mqw_i * LMQ_{i,t}/wmqw_t$

(19) $LNQA_{i,t} = nqa_i * LNQ_{i,t}/wnqa_t$

(20) $LNQC_{i,t} = nqc_i * LNQ_{i,t}/wnqc_t$

(21) $LNQI_{i,t} = nqi_i * LNQ_{i,t}/wnqi_t$

(22) $LNQW_{i,t} = nqw_i * LNQ_{i,t}/wnqw_t$

BLOC 2. Income and savings of households and firms(equations 23 to 27)

(23) $YH_{h,t} = \lambda_h^{wq} * \sum_i LQ_{i,t} + \lambda_h^{wmq} * \sum_i LMQ_{i,t} + \lambda_h^{wnq} * \sum_i LNQ_{i,t} + \sum_H TRH_{H,HJ,T} + DIV_H$
$+ TRW_{H,T} + TGH_{H,T}$

(24) $YDH_{H,T} = YH_{H,T} - TDH_{H,T} - TWR_{H,T} - \sum_{HJ} TRH_{H,HJ,T}$

(25) $SH_{H,T} = \rho_H * YDH_{H,T}$

(26) $YF_T = (1-\lambda) * \sum_i r_{i,t} * KD_{i,t} + TGF_t + TRWF_t$

(27) $SF_T = YF_T - \sum_H DIV_{H,T} - TDF_T - DIV\_row_t$

BLOC 3. Government's income and spendings in EDUSA (equations 28 to 34)

(28) $YG_t = \sum_H TDH_{H,T} + \sum_{tr} TI_{tr,t} + \sum_{im} TIM_{im,t} + TDF_t + TRWG_t + \lambda * \sum_i r_{i,t} * KD_{i,t}$

(29) $SG_t = YG_t - G_t - \sum_H TGH_{H,T} - TGF_t - TGR_t$

(30) $TDF_t = tyf * YF_t$

(31) $TDH_{H,T} = tyh_h * YH_{H,T}$

(32) $TI_{im,t} = tx_{im} * PL_{im,t} * D_{im,t} + tx_{im} * e_t * PWM_{im} * M_{im,t} * (1 + tm_{im})$

(33) $TI_{nim,t} = tx_{nim} * PL_{nim,t} * D_{nim,t}$

(34) $TIM_{im,t} = tm_{im} * e_t * PWM_{im} * M_{im}$

BLOC 4 : Foreign trade (equations 35 to 42)

$(35)\quad XS_{x,t}=B_x^e*\left(\beta_x^e*EX_{x,t}^{\kappa_x^e}+(1-\beta_x^e)*D_{x,t}^{\kappa_x^e}\right)^{1/\kappa_x^e}$

$(36)\quad XS_{nx,t}=D_{nx,t}$

$(37)\quad EX_{x,t}=\left[(PE_{x,t}/PL_{x,t})^{\tau_x^e}+((1-\beta_x^e)/\beta_x^e)^{\tau_x^e}\right]*D_{x,t}$

$(38)\quad Q_{im,t}=A_{im}^m*\left(\alpha_{im}^m*M_{im,t}^{-\upsilon_{im}^m}+(1-\alpha_{im}^m)*D_{im,t}^{-\upsilon_{im}^m}\right)^{-1/\upsilon_{im}^m}$

$(39)\quad Q_{nim,t}=D_{nim,t}$

$(40)\quad M_{im,t}=\left((\alpha_{im}^m/(1-\alpha_{im}^m))^{\sigma_{im}^m}*(PD_{im,t}/PM_{im,t})^{\sigma_{im}^m}\right)*D_{im,t}$

$(41)\quad CAB_t=e_t*\sum_{im}PWM_{im,t}*M_{im,t}+TGR_t+\sum_H TWR_{H,T}+DIV\_row_t-e_t*\sum_x PFOB_{x,t}*EX_{x,t}$
$\qquad\qquad -\sum_H TRW_{H,T}-TRWF_t-TRWG_t$

$(42)\quad EXD_{x,t}=EXER_{x,t}*\left(PWE_{x,t}/PFOB_{x,t}\right)^{\sigma_x^e}$

BLOC 5. Local and final demand (equations 43 to 47)

$(43)\quad FBCF_{tr,t}=\mu_{tr}*ITSV_t/PC_{tr,t}$

$(44)\quad ITSV_t=IT_t-\sum_{tr}PC_{tr,t}*STK_{tr,t}$

$(45)\quad C_{tr,h,t}=\left(C\_MIN_{tr,h,t}*PC_{tr,t}+\chi_{tr,h}*\left(CTH_{H,T}-\sum_{trj}C\_MIN_{trj,h,t}*PC_{trj,t}\right)\right)/PC_{tr,t}$

$(46)\quad CTH_{H,T}=YDH_{h,t}-SH_{h,t}$

$(47)\quad G_t=P_{ntr,t}*XS_{ntr,t}$

BLOC 6. Prices (equations 48 to 62)

(48) $pag_{i,t}=\left(PV_{i,t}*VA_{i,t}-LD_{i,t}*w_{i,t}\right)/KLQ_{i,t}$

(49) $w_{i,t}=\left(wmq_{i,t}*LMQ_{i,t}+wnq_{i,t}*LNQ_{i,t}\right)/LD_{i,t}$

(50) $wq_{i,t}=\left(wqa_t*LQ_{i,t}*qa_i+wqc_t*qc_i*LQ_{i,t}+wqi_t*LQ_{i,t}*qi_i+wqw_t*qc_i*LQ_{i,t}\right)/LQ_{i,t}$

(51) $wmq_{i,t}=(wmqa_t*LMQ_{i,t}*mqa_i+wmqc_t*mqc_i*LMQ_{i,t}+$
$\qquad wmqi_t*LMQ_{i,t}*mqi_i+wmqw_t*mqc_i*LMQ_{i,t})/LMQ_{i,t}$

(52) $wnq_{i,t}=(wnqa_t*LNQ_{i,t}*nqa_i+wnqc_t*nqc_i*LNQ_{i,t}+$
$\qquad wnqi_t*nqi_i*LNQ_{i,t}+wnqw_t*nqw_i*LNQ_{i,t})/LNQ_{i,t}$

(53) $PV_{i,t}=\left(P_{i,t}*XS_{i,t}-\displaystyle\sum_{tr}PC_{tr,t}*DI_{tr,i,t}\right)/VA_{i,t}$

(54) $n_{i,t}=\left(pag_{i,t}*KLQ_{i,t}-wq_{i,t}*LQ_{i,t}\right)/KD_{i,t}$

(55) $PD_{tr,t}=PL_{tr,t}*(1+tx_{tr})$

(56) $PM_{im,t}=\left(1+tx_{im}\right)*(1+tm_{im})*e_t*PWM_{im,t}$

(57) $PE_{x,t}=e_t*PFOB_{x,t}$

(58) $PC_{im,t}=\left(PD_{im,t}*D_{im,t}+PM_{im,t}*M_{im,t}\right)/Q_{im,t}$

(59) $PC_{nim,t}=PD_{nim,t}$

(60) $P_{x,t}=\left(PL_{x,t}*D_{x,t}+PE_{x,t}*EX_{x,t}\right)/XS_{x,t}$

(61) $P_{nx,t}=PL_{nx,t}$

(62) $PINDEX_t=\displaystyle\sum_{i}PV_{i,t}*\delta_i$

BLOC 7. Incentives constraints (equations 63 to 74)

(63) $wqa_t=ee1+\left(ee1/qq\right)*(bb/unqa_t+rr)$

(64) $wqc_t=ee2+\left(ee2/qq\right)*(bb/unqc_t+rr)$

(65) $wqi_t=ee3+\left(ee3/qq\right)*(bb/unqi_t+rr)$

(66) $wqw_t=ee4+\left(ee4/qq\right)*(bb/unqw_t+rr)$

(67) $wmqa_t=ee5+\left(ee5/qq\right)*(bb/unmqa_t+rr)$

(68) $wmqc_t=ee6+\left(ee6/qq\right)*(bb/unmqc_t+rr)$

(69) $wmqi_t=ee7+\left(ee7/qq\right)*(bb/unmqi_t+rr)$

(70) $wmqw_t=ee8+\left(ee8/qq\right)*(bb/unmqw_t+rr)$

(71) $wnqa_t=ee9+\left(ee9/qq\right)*(bb/unnqa_t+rr)$

(72) $wnqc_t=ee10+\left(ee10/qq\right)*(bb/unnqc_t+rr)$

(73) $wnqi_t=ee11+\left(ee11/qq\right)*(bb/unnqi_t+rr)$

(74) $wnqw_t=ee12+\left(ee12/qq\right)*(bb/unnqw_t+rr)$

BLOC 8. Equilibrium (equations 75 to 90)

$$(75)\quad Q_{good,t}=\sum_H C_{good,H,t}+DIT_{good,t}+FBCF_{good,t}+STK_{good,t}$$

$$(76)\quad LSQA_t=\sum_i LQA_{i,t}+unqa_t*LSQA_t$$

$$(77)\quad LSQC_t=\sum_i LQC_{i,t}+unqc_t*LSQC_t$$

$$(78)\quad LSQI_t=\sum_i LQI_{i,t}+unqi_t*LSQI_t$$

$$(79)\quad LSQW_t=\sum_i LQW_{i,t}+unqw_t*LSQW_t$$

$$(80)\quad LSMQA_t=\sum_i LMQA_{i,t}+unmqa_t*LSMQA_t$$

$$(81)\quad LSMQC_t=\sum_i LMQC_{i,t}+unmqc_t*LSMQC_t$$

$$(82)\quad LSMQI_t=\sum_i LMQI_{i,t}+unmqi_t*LSMQI_t$$

$$(83)\quad LSMQW_t=\sum_i LMQW_{i,t}+unmqw_t*LSMQW_t$$

$$(84)\quad LSNQA_t=\sum_i LNQA_{i,t}+unnqa_t*LSNQA_t$$

$$(85)\quad LSNQC_t=\sum_i LNQC_{i,t}+unnqc_t*LSNQC_t$$

$$(86)\quad LSNQI_t=\sum_i LNQI_{i,t}+unnqi_t*LSNQI_t$$

$$(87)\quad LSNQW_t=\sum_i LNQW_{i,t}+unnqw_t*LSNQW_t$$

$$(88)\quad IT_t=\sum_h SH_{h,t}+SF_t+SG_t+CAB_t$$

$$(89)\quad EXD_{x,t}=EX_{x,t}$$

$$(90)\quad LEON_t=Q_{BUSAC,T}-\sum_H C_{BUSAC,H,T}-DIT_{BUSAC,T}-FBCF_{BUSAC,T}-STK_{BUSAC,T}$$

BLOC 9. Welfare (equation 91)

$$(91)\ EV_{h,t}=\prod_{tr}(PCO_{tr}/PC_{tr,t})^{\chi_{tr,h}}*\left(CTH_{h,t}-\sum_{trj}C\_MIN_{trj,h,t}*PC_{trj,t}\right)$$
$$-\left(CTHO_H-\sum_{trj}C\_MINO_{trj,h,t}*PCO_{trj}\right)$$

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BLOC 10. Dynamic equations (equations 92 to 96)

(92) $KD_{i,t+1}=KD_{i,t}*(1-delt)+IND_{i,t}$

(93) $IND_{i,t}/KD_{i,t}=\left(g1_i*(n_{i,t}/U_t)^2\right)+\left(g2_i*(n_{i,t}/U_t)\right)$

(94) $U_t=PK_t*(ir+delt)$

(95) $PK_t=\sum_{tr}PC_{tr,t}*\mu_{tr}$

(96) $IT_t=PK_t*\sum_{i}IND_i$ namique. Il exprime une certaine mise

BLOC 11. Exogenous variables increasing with population growth rate

(97) $TGH_{H,T+1}=TGH_{H,T}*(1+n)$

(98) $TGR_{T+1}=TGR_{T}*(1+n)$

(99) $TGF_{T+1}=TGF_{t}*(1+n)$

(100) $TRW_{H,T+1}=TRW_{H,T}*(1+n)$

(101) $TRWF_{t+1}=TRWF_{t}*(1+n)$

(102) $TRWG_{t+1}=TRWG_{t}*(1+n)$

(103) $TWR_{h,t+1}=TWR_{h,t}*(1+n)$

(104) $TRH_{H,HJ,T+1}=TRH_{H,HJ,T}*(1+n)$

(105) $DIV_{H,T+1}=DIV_{H,T}*(1+n)$

(106) $DIV\_row_{t+1}=DIV\_row_{t}*(1+n)$

(107) $C\_MIN_{tr,h,t+1}=C\_MIN_{tr,h,t}*(1+n)$

(108) $G_{t+1}=G_{t}*(1+n)$

(109) $STK_{t+1}=STK_{t}*(1+n)$

BLOC 12 : Education equations (equations 110 to 134)

(110) $attitude_{LOG,ED,H,T}=att_{\log,ed,h}+\dfrac{\alpha_{\log,ed,h}^{ed}}{1+EXP\left(\beta_{\log,ed,h}^{ed}*attitude\mathrm{int}_{\log,ed,h,t}-attitudeo_{\log,ed,h}\right)}$

(111) $attitude\mathrm{int}_{LOG,ED,H,T}=attitude_{LOG,ED,H,T}*\left(EDUQUAL_{ED,T}\right)^{\rho ed1}$

$$* \left(\frac{\frac{wmoy2_T}{wmoy1_T}}{\frac{wmoy2o}{wmoy1o}} \right)^{\varphi ed2} * \left(\frac{\frac{wmoy3_t}{wmoy2_t}}{\frac{wmoy3o}{wmoy2o}} \right)^{\varphi ed3}$$

$$(112)\ EDUQUAL_{ED,T} = \frac{\sum_{ed} XS_{ed,t}}{\sum_{ed} XSO_{ed}} \bigg/ \frac{\sum_{H} ENR_{H,ED,T}}{ENRO_{H,ED}}$$

$$(113)\ wmoy1_T = \left(wnqa_t * \sum_i LNQA_{i,t} + wnqc_t * \sum_i LNQC_{i,t} + wnqi_t * \sum_i LNQI_{i,t} + wnqw_t * \sum_i LNQW_{i,t} \right)$$
$$\bigg/ \sum_i LNQ_{i,t}$$

$$(114)\ wmoy2_T = \left(wmqa_t * \sum_i LMQA_{i,t} + wmqc_t * \sum_i LMQC_{i,t} + wmqi_t * \sum_i LMQI_{i,t} + wmqw_t * \sum_i LMQW_{i,t} \right)$$
$$\bigg/ \sum_i LMQ_{i,t}$$

$$(115)\ wmoy3_T = \left(wqa_t * \sum_i LQA_{i,t} + wqc_t * \sum_i LQC_{i,t} + wqi_t * \sum_i LQI_{i,t} + wqw_t * \sum_i LQW_{i,t} \right) \bigg/ \sum_i LQ_{i,t}$$

$$(116)\ attitude"aban",ED,H,T = 1 - attitude"dip",Ed,H,T - attitude"red",ED,H,T$$

$$(117)\ attitude"quitdip",ED,H,T = 1 - attitude"contdip",ED,H,T$$

$$(118)\ attitude"dipdc",ED,H,T = attitude"dip",ED,H,T / années_{ed}$$

$$(119)\ parqual_{H,T} = \frac{LSQ_{H,T}}{\sum_H LSQ_{H,T} + LSMQ_{H,T} + LSNQ_{H,T}}$$

$$(120)\ parmoyqual_{H,T} = \frac{LSMQ_{H,T}}{\sum_H LSQ_{H,T} + LSMQ_{H,T} + LSNQ_{H,T}}$$

$$(121)\ parnonqual_{H,T} = \frac{LSNQ_{H,T}}{\sum_{H} LSQ_{H,T} + LSMQ_{H,T} + LSNQ_{H,T}}$$

$$(122)\ LSQA_{T+1} = parqual_{"african",T} * \left(LSQA_T + LSMQA_T + LSNQA_T \right) +$$
$$ENR_{"african","tertiaire",T} * attitude_{"dip","tertiaire","african",T} * entree_{"tertiaire"}$$

$$(123)\ LSQC_{T+1} = parqual_{"coloured",T} * \left(LSQC_T + LSMQC_T + LSNQC_T \right) +$$
$$ENR_{"coloured","tertiaire",T} * attitude_{"dip","tertiaire",T} * entree_{"tertiaire"}$$

$$(124)\ LSQI_{T+1} = parqual_{"indian",T} * \left(LSQI_T + LSMQI_T + LSNQI_T \right) +$$
$$ENR_{"indian","tertiaire",T} * attitude_{"dip","tertiaire","indian",T} * entree_{"tertiaire"}$$

$$(125)\ LSQW_{T+1} = parqual_{"white",T} * \left(LSQW_T + LSMQW_T + LSNQW_T \right) +$$
$$ENR_{"white","tertiaire",T} * attitude_{"dip","tertiaire","white",T} * entree_{"tertiaire"}$$

$$(126)\ LSMQA_{T+1} = parmoyqual_{"african",T} * \left(LSQA_T + LSMQA_T + LSNQA_T \right)$$
$$+\ ENR_{"african","secondaire"T} * attitude_{"dip","secondaire","african",T} * entree_{"secondaire"}$$
$$+ ENR_{"african","tertiaire",T} * attitude_{"aban","tertiaire","african",T} * entree_{"tertiaire"}$$

$$(127)\ LSMQC_{T+1} = parmoyqual_{"coloured",T} * \left(LSQC_T + LSMQC_T + LSNQC_T \right)$$
$$+\ ENR_{"coloured","secondaire"T} * attitude_{"dip","secondaire","coloured",T} * entree_{"secondaire"}$$
$$+ ENR_{"coloured","tertiaire",T} * attitude_{"aban","tertiaire","coloured",T} * entree_{"tertiaire"}$$

$$(128)\ LSMQI_{T+1} = parmoyqual_{"indian",T} * \left(LSQI_T + LSMQI_T + LSNQI_T \right)$$
$$+\ ENR_{"indian","secondaire"T} * attitude_{"dip","secondaire","indian",T} * entree_{"secondaire"}$$
$$+ ENR_{"indian","tertiaire",T} * attitude_{"aban","tertiaire","indian",T} * entree_{"tertiaire"}$$

$$(129)\ LSMQW_{T+1} = parmoyqual_{"white",T} * \left(LSQW_T + LSMQW_T + LSNQW_T \right)$$
$$+\ ENR_{"white","secondaire"T} * attitude_{"dip","secondaire","white",T} * entree_{"secondaire"}$$
$$+ ENR_{"white","tertiaire",T} * attitude_{"aban","tertiaire","white",T} * entree_{"tertiaire"}$$

$$(130)\ LSNQA_{T+1} = parnonqual_{"african",T} * \left(LSQA_T + LSMQA_T + LSNQA_T \right)$$
$$+\ ENR_{"african","secondaire"T} * attitude_{"aban","secondaire","african",T} * entree_{"secondaire"}$$
$$+ ENR_{"african","primaire",T} * attitude_{"dip","primaire","african",T} * entree_{"primaire"}$$

$$(131)\ LSNQC_{T+1} = parnonqual_{\text{"coloured"},T} * (LSQC_T + LSMQC_T + LSNQC_T)$$

$$+\ ENR_{\text{"coloured"},\text{"secondaire"}T} * attitude_{\text{"aban"},\text{"secondaire"},\text{"coloured"},T} * entree_{\text{"secondaire"}}$$

$$+ ENR_{\text{"coloured"},\text{"primaire"},T} * attitude_{\text{"aban"},\text{"primaire"},\text{"coloured"},T} * entree_{\text{"primaire"}}$$

$$(132)\ LSNQI_{T+1} = parnonqual_{\text{"indian"},T} * (LSQI_T + LSMQI_T + LSNQI_T)$$

$$+\ ENR_{\text{"indian"},\text{"secondaire"}T} * attitude_{\text{"aban"},\text{"secondaire"},\text{"indian"},T} * entree_{\text{"secondaire"}}$$

$$+ ENR_{\text{"indian"},\text{"primaire"},T} * attitude_{\text{"dip"},\text{"primaire"},\text{"indian"},T} * entree_{\text{"primaire"}}$$

$$(133)\ LSNQW_{T+1} = parnonqual_{\text{"white"},T} * (LSQW_T + LSMQW_T + LSNQW_T)$$

$$+\ ENR_{\text{"white"},\text{"secondaire"}T} * attitude_{\text{"aban"},\text{"secondaire"},\text{"white"},T} * entree_{\text{"secondaire"}}$$

$$+ ENR_{\text{"white"},\text{"primaire"},T} * attitude_{\text{"dip"},\text{"primaire"},\text{"white"},T} * entree_{\text{"primaire"}}$$

$$(134)\ ENR_{H,ED,T+1} = ENR_{H,ED,T} * (1+n)$$

Bibliography

BOURGUIGNON, F, LOFGREN, H et C. DIAZ-BONILLA (2006) « MAMS : An Economywide Model for Analysis of MDG Country Strategies », Technical Documentation, DECPG, World Bank

CASTRO-LEAL, F (1999) « Poverty and inequality in the distribution of public education spending in South Africa », WP n°19330, World Bank

CENSUS 2001 : Primary tables South Africa Census'96 and 2001 compared. Statistics South Africa, Report n°03-02-04,Pretoria, 2004

DECALUWE, B., A. MARTENS et L. SAVARD (2001) <u>La politique économique du développement et les modèles d'équilibre général calculable</u>, Les Presses de l'Université Montréal, Canada

FOFANA, I., B. DECALUWE, J. COCKBURN, M. CHITIGA et R. MABUGU (2005) « A Gender Aware Macroeconomic Model for Evaluating Impacts of Policies on Poverty Reduction in Africa : The Case of South Africa », WP, Université Laval

GLEWWE, P. (2002) « Schools and skills in developping countries : Education Policies and socioeconomics outcomes », Journal of Economic Literature, 40(2), pp.436-448

SCHOOLS REGISTER OF NEEDS SURVEY (2005), Department of Education, South Africa

SELOD, H. et Y.ZENOU (2003) « Private versus Public schools in post apartheid South Africa cities : theory and policy implications. », Journal of Development Economics, vol.71, pp.351-394

SHAPIRO, C et J.E. STIGLITZ (1984) « Equilibrium Unemployment as a Worker Discipline Device », American Economic Review, vol 74, pp. 433-444

VAN DER BERG, S., R.BURGER, M.LOU et D.YOU (2005) « Trends in poverty and inequality since the political transition », Stellenbosch Economic Working Paper, n°1, Univertsity of Stellenbosch, South Africa

Variables, parameters and sets

Endogenous variables :

Prices :

w_i	Composite wage rate
wq_i	Mean skilled sectorial wage rate
wmq_i	Mean semi skilled sectorial wage rate
wnq_i	Mean unskilled sectorial wage rate
$wnqa$	Wage rate for unskilled African worker
$wnqc$	Wage rate for unskilled Coloured worker
$wnqi$	Wage rate for unskilled Indian worker
$wnqw$	Wage rate for unskilled White worker
$wmqa$	Wage rate for semi skilled African worker
$wmqc$	Wage rate for semi skilled Coloured worker
$wmqi$	Wage rate for semi skilled Indian worker
$wmqw$	Wage rate for semi skilled White worker
wqa	Wage rate for skilled African worker
wqc	Wage rate for skilled Coloured worker
wqi	Wage rate for skilled Indian worker
wqw	Wage rate for skilled White worker
r_i	Rate of return in I sector
P_i	Producer price in sector I
PV_i	Value added price of I sector I
PD_i	Domestic price of good TR
PL_i	Domestic price without taxes of good TR
PC_{TR}	Composite price of good TR
PM_{IM}	Imported price of good IM
PE_X	Exported price of good X
$PINDEX$	Index price
$PFOB_X$	FOB price
$pag_{i,t}$	Aggregate KLQ price

*Production

XS_i	Production of I sector
VA_i	Value added for I sector
$DI_{TR,J}$	Intermediate demand from TR branch in I product
CI_i	Intermediate consumption for I branch

*Factors

KD_i	Capital demand for I sector
LD_i	Labour demand for I sector

KLQ_i	Aggregate skilled labor and capital
LQ_i	Qualified labour demand for I sector
LMQ_i	Semi Qualified labour demand for I sector
LNQ_i	Unqualified labour demand for I sector
LQC_i	Coloured qualified labour demand for I sector
LQA_i	African qualified labour demand for I sector
LQI_i	Indian qualified labour demand for I sector I
LQW_i	White qualified labour demand for I sector
$LMQA_i$	African semi qualified labour demand for I sector
$LMQC_i$	Coloured semi qualified labour demand for I sector
$LMQI_i$	Indian semi qualified labour demand for I sector
$LMQW_i$	White semi qualified labour demand for I sector
$LNQA_i$	African unqualified labour demand for I sector
$LNQC_i$	Coloured unqualified labour demand for I sector
$LNQI_i$	Indian unqualified labour demand for I sector
$LNQW_i$	White unqualified labour demand for I sector

*Demand

$C_{TR,H}$	Consumption of good TR by household H
CT_H	Total consumption spending for household H
G	Public consumption in value
DIT_{TR}	Total intermediate consumption for TR good
IT	Total investment in value
D_{TR}	Local demand on TR good
Q_{TR}	Absorption of good TR
$FBCF_{tr}$	Gross Fixed Capital Formation of good TR
STK_{tr}	Stocks variation
$ITSV$	Investment without stocks variations

*Trade

EX_X	Exports demand
M_{IM}	Import demand
EXD_X	Foreign demand for good X(volume)

*Incomes and savings

**Households

YH_H	Gross Income for household H
YDH_H	Disponible income for household H
SH_H	Household saving
TDH_H	Direct taxes paid by household H

**Firms

YF	Firms' income
SF	Firms' saving
TDF	Direct taxes paid by firms

**Government

YG	Government's income
SG	Government's saving

**Rest of world (ROW)

CAB	Foreign saving (current account balance)

*Unemployment rates

unqa	Unemployment rate for African skilled worker
unqc	Unemployment rate for Coloured skilled worker
unqi	Unemployment rate for Indian skilled worker
unqw	Unemployment rate for White skilled worker
unmqa	Unemployment rate for African semi skilled worker
unmq	Unemployment rate for Coloured semi skilled worker
unmqi	Unemployment rate for Indian semi skilled worker
unmqw	Unemployment rate for White semi skilled worker
unnqa	Unemployment rate for African unskilled worker
unnqc	Unemployment rate for Coloured unskilled worker
unnqi	Unemployment rate for Indian unskilled worker
unnqw	Unemployment rate for White unskilled worker

*Taxes

TI_{TR}	Indirect taxes on products TR
TIM_{IM}	Imports duties on products IM

*Dynamic

PK	Capital index price
U	Use capital cost
IND_i	Investment demand by destination for I sector

<u>Exogenous variables</u>

PWM_{IM}	World price of importations
PWE_X	World price of exportations
TRW_H	Transfer from ROW to household
TRWF	Transfer from ROW to firms
TRWG	Transfer from ROW to government

TGH_H	Transfers from government to household
TGF	Transfers from government to firms
TGR	Transfers from government to ROW
$EXER_X$	Initial value for exports foreign demand
TWR_H	Transfers from household to ROW
DIV_H	Dividends paid to household
DIV_row	Dividends paid to ROW
$TRH_{H,HJ}$	Transfers between household
$LSQA$	Skilled African labor supply
$LSQC$	Skilled Coloured labor supply
$LSQI$	Skilled Indian labor supply
$LSQW$	Skilled White labor supply
$LSMQA$	Semi skilled African labor supply
$LSMQC$	Semi skilled Coloured labor supply
$LSMQI$	Semi skilled Indian labor supply
$LSMQW$	Semi skilled White labor supply
$LSNQA$	Unskilled African labor supply
$LSNQC$	Unskilled Coloured labor supply
$LSNQI$	Unskilled Indian labor supply
$LSNQW$	Unskilled White labor supply
e	Exchange rate
$C\_MIN_{TR,H}$	Minimal consumption of good TR by household H

*Education

$attitude_{cpt,ed,h}$	Student behaviour in each cycle (ED)for each group population(H)
$attitude\mathrm{int}_{LOG,ED,H}$	Intermediate variable in student behaviour
$EDUQUAL_{ED}$	Quality of each education cycle
$wmoy1$	Mean unskilled wage rate
$wmoy2$	Mean semi skilled wage rate
$wmoy3$	Mean skilled wage rate
$ENR_{H,ED}$	Students by population group by cycle (volume)
$parqual_H$	Share of skilled people in household H
$parmoyqual_H$	Share of semi skilled people in household H
$parnonqual_H$	Share of unskilled people in household H

Parameters :

*education

$\varphi1$	Elasticity of education behaviour regards to education quality
$\varphi2$	Elasticity of education behaviour regards to differential wage between unskilled and semi skilled.
$\varphi3$	Elasticity of education behaviour regards to differential wage between semi skilled and skilled

| *années*$_{ed}$ | Number of year in each cycle ED |
| *entree*$_{ed}$ | Share of graduate student that enter labour market |

*dynamic

Ir	Interest real rate
*g*1$_i$	Parameter 1 in investment function demand
g2$_i$	Parameter 2 in investment function demand
n	Population growth rate
delt	Capital depreciation rate
temp$_i$	Parameter auxiliary
RES	parameter rescaling

*parameters for unemployment

ee1	Effort disutility for skilled African household
ee2	Effort disutility for skilled Coloured household
ee3	Effort disutility for skilled Indian household
ee4	Effort disutility for skilled White household
ee5	Effort disutility for semi skilled African household
ee6	Effort disutility for semi skilled Coloured household
ee7	Effort disutility for semi skilled Indian household
ee8	Effort disutility for semi skilled White household
ee9	Effort disutility for skilled African household
ee10	Effort disutility for skilled Coloured household
ee11	Effort disutility for skilled Indian household
ee12	Effort disutility for skilled White household
bb	Probability to be fired
qq	Probability to detect a lazy worker
rr	Discount rate

*production function

**parameters in CES between capital et travail

A_i^{kl}	Scale coefficient
α_i^{kl}	Share parameter
σ_i^{kl}	Substitution elasticity
τ_i^{kl}	Parameter of substitution

**parameters in Leontief function
io$_i$	Coefficient (intermediate consumptions)
v$_i$	Value added coefficient
aij$_{tr,j}$	Coefficient Input Output

**Composite labor function (Cobb Douglas)

A_i^c	Scale parameter between LQ,LMQ and LNQ
α_i^c	Share of skilled work
β_i^c	Share of semi skilled work

**skilled work function Leontief)

qa_i	Share of skilled African in sector I
qc_i	Share of skilled Coloured in sector I
qi_i	Share of skilled Indian in sector I
qw_i	Share of skilled White in sector I

**semi skilled work function   (Leontief)

mqa_i	Share of semi skilled African in sector I
mqc_i	Share of semi skilled Coloured in sector I
mqi_i	Share of semi skilled Indian in sector I
mqw_i	Share of semi skilled White in sector I

**Unskilled work function

nqa_i	Share of unskilled African in sector I
nqc_i	Share of unskilled Coloured in sector I
nqi_i	Share of unskilled Indian in sector I
nqw_i	Share of unskilled White in sector I

*taxes rates

tx_{tr}	Indirect tax rate for good TR
tyh_H	Direct tax rate paid by household
tyf	Direct tax rate paid by firms
tm_{IM}	Import duties rate

*Parameters in income and saving functions

ρ_H	Saving propensity for household
λ_{wq}^h	Share of skilled labour income received by households
λ_{wmq}^h	Share of semi skilled labour income received by households
λ_{wnq}^h	Share of unskilled labour income received by households

*Parameters in household consumption demand (LES)

χ_{tr}^H	Marginal propensity to consume good TR by household H

$yelas_{tr,h}$	Income elasticity of good TR
V_MIN_H	Minimal consumption in value
$FRISCH_H$	Frisch parameter

*Parameters in imports (CES)

A_{IM}^m	Scale parameter
τ_{IM}^m	Substitution parameter (CES function)
α_{IM}^m	Share parameter (CES function)
σ_{IM}^m	Substitution elasticity

*Parameters in exports function (CET)

B_X^E	Scale parameter
κ_X^E	Transformation parameter
β_X^E	Share parameter
τ_X^E	Transformation elasticity
σ_X^E	Exports elasticity demand

*Other parameters

λ	Share of capital income received by government
λ_f	Share of capital income received by firms
δ_i	Share of branch I in total value added
μ_{tr}	Share of good TR in value in total investment

Sets :

I,J: All sectors
$\in I${*AGRI,COAL,GOLD,OTHMIN,FOOD,TEXT,FOOTW,PETROL,OTHNON,STEEL,ELEC, RADIO,TRANSEQ,OTHMAN,ELECT,WAT,CONSTR,TRADE,HOT,TRANSSER,COM,FININT ,REALE,BUSAC,SERN,PRIMAIRE,SECONDAIRE,TERTIAIRE*}

TR: Tradable sectors
$\in I${*AGRI,COAL,GOLD,OTHMIN,FOOD,TEXT,FOOTW,PETROL,OTHNON,STEEL,ELEC, RADIO,TRANSEQ,OTHMAN,ELECT,WAT,CONSTR,TRADE,HOT,TRANSSER,COM,FININT ,REALE,BUSAC*}

NTR: Non tradable sectors
$\in I${*SERN, PRIMAIRE,SECONDAIRE,TERTIAIRE* }

ED: *Education sectors*
$\in NTR${*PRIMAIRE,SECONDAIRE,TERTIAIRE*}

NED: *Non education sector into non tradable*
$\in$ NTR{*SERN*}

X: Exports sectors
    $\in$
      TR{AGRI,COAL,GOLD,OTHMIN,FOOD,TEXT,FOOTW,PETROL,OTHNON,STEEL, ELEC,RADIO,TRANSEQ,OTHMAN,ELECT,CONSTR,TRADE,HOT,TRANSSER,COM,FI NINT,REALE,BUSAC}

NX : Non export sector
$\in$ *TR{WAT}*

IM : Import sector
$\in$ *TR{AGRI,COAL,OTHMIN,FOOD,TEXT,FOOTW,PETROL,OTHNON,STEEL,ELEC,RADI O,TRANSEQ,OTHMAN, WAT,CONSTR,TRADE,HOT,TRANSSER,COM,FININT,REALE,BUSAC}*

NIM : Non import sector
$\in$ *TR{GOLD, ELECT}*

GOOD :For Walras verification law
$\in$ *TR{AGRI,COAL,GOLD,OTHMIN,FOOD,TEXT,FOOTW,PETROL,OTHNON,STEEL,ELE C,RADIO,TRANSEQ,OTHMAN,ELECT,WAT,CONSTR,TRADE,HOT,TRANSSER,COM,FINI NT,REALE}*

H : Households
H={African,coloured,indian,white}

CPT : Behaviour of students
CPT={aban, red, dip, quitdip, contdip, dipdc, dipsc}

LOG : Behaviours determined by the logistic function
$\in$ *CPT{red, dip, contdip}*

RES : Behaviours determined by residual way
I $\in$ *CPT{aban,quitdip}*

T : Time
={1,2…20}