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**A small macroeconomic model  
for Malawi**

Documents

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## **1. Introduction**

In meetings between representatives of the Malawian government and Statistics Norway in May 2004, we agreed upon developing a small and aggregated model of the Malawian economy as a first step in efforts to construct a disaggregated model based on new national accounts data for Malawi expected to become available sometime during 2006. A model project consists of many components of which one is knowledge of the software used for programming and solving the model. In order to gain some experience with the TROLL software, we agreed to start with a small model as a testing ground for later work. Also there may be delays in creating a database for a large-scale model so the project would benefit from proceeding along several independent tracks to avoid being potentially held up by delays in other parts of the overall project. A third reason is that many of the issues in econometrics and economic theory that one encounters in modelling are more or less the same irrespective of the level of aggregation. So there is a general learning potential for modelling, even by starting off by developing an aggregated model.

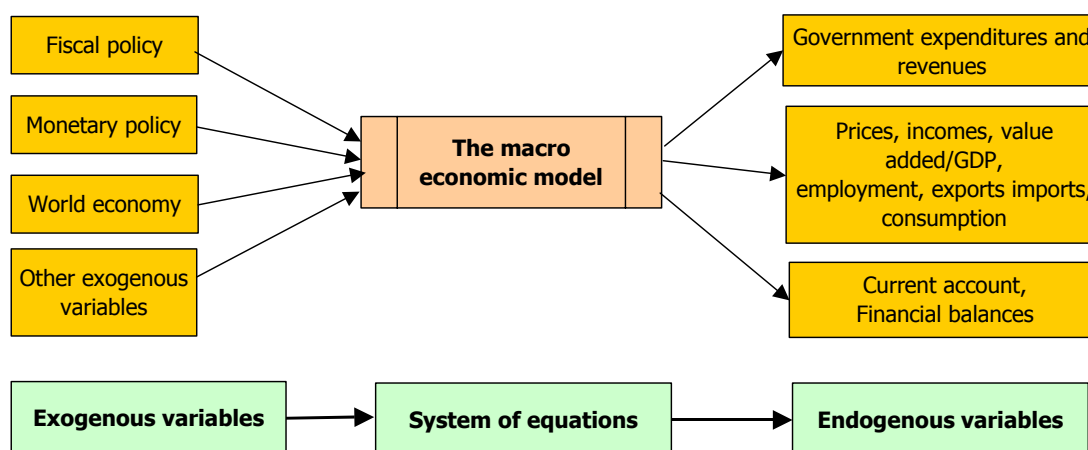
Ending up with a small model of some hundred equations is rather on the big side, and perhaps not the best starting point. A much smaller model would serve the purpose as a training ground for learning the TROLL software. However, as applied economists we like to have some feeling of relevance when modelling. Thus the model easily becomes larger than originally contemplated even though issues relating fiscal policy and its impact on monetary conditions as well as interest rates etc. are not modelled in a satisfactory way in the present small model. On the other hand and referring back to what was said earlier, the present model of the real side of the economy (but clearly not the monetary side) is perhaps not far from how one will model various sectors later on. Hopefully many of the adding up equations and identities will be useful for a disaggregated model as well.

In this document we first present the main features of model, before the various blocks of the model is more thoroughly described in Chapter 3. In Chapter 4 we present the main variables in the baseline scenario for the period 2005-2011. In Chapter 5 we study the models tracking performance by means of a historical simulation. In Chapter 6 we have used the model to simulate a fiscal shift. In Appendix 1 there is a list of all the variables in the model, and some data issues are discussed in Appendix 2. In Appendix 3 all the equations in the model is presented, and in Appendix 4 we present detailed information from estimating the econometric equations.

## **2. Main features of the model**

The structure of the small macroeconomic model can be illustrated schematically as in Figure 1. The model user will have to make assumptions with respect to a number of fiscal policy variables such as government employment and purchases, the average government wage rate, direct and indirect tax rates incl. import duties. Among the monetary variables the model user will have to fix interest rates and some financial assets such as government net lending abroad. Some variables are determined outside the Malawian economy such as demand for Malawian export produce, world market prices, foreign grants etc. Finally some other variables such as the Malawian labour force will have to be fixed. Also private investments are an exogenous variable in this model but should clearly be made endogenous at a later stage. Given these assumptions, the model will calculate a number of national account variables such as value added, price indices for value added as well as for final demand components. Financial balances in addition to the government budget balance will be determined along with some very aggregated monetary variables, like money supply and total domestic lending.

**Figure 1 Schematic outline of the model**



The model works like a simple Keynesian model if taken very literally. This means that a change in demand such as government purchases will increase incomes, employment and private consumption and thereby also GDP in the private sector. Tax revenues will increase as a consequence but not sufficient to eliminate the expenditure increase so that the government budget balance will deteriorate and increase government domestic lending. Increased demand will increase imports and increase the current account deficit. This will be financed by an increase in private net lending abroad because government lending is exogenous. If the model user does not think this is feasible he/she may have to reduce the foreign exchange reserves in order to finance the increased deficit on the current account.

If world demand for Malawian exports increases for a given terms of trade, exports will increase and so will GDP. Increased incomes will again increase employment and household incomes and thereby private consumption. Tax revenues will now increase while expenditures remain unchanged so the government budget balance improves. Thus net domestic lending is reduced. Export revenues will increase but so will imports because of higher domestic demand, but the current account will also improve. This may either reduce private lending or be counteracted by increasing foreign exchange reserves. A worsening term of trade, say as a result of higher import prices, will worsen the current account and increase prices also on domestic components of demand, reduce real household incomes and private consumption. Lower real incomes will on the one hand reduce some direct tax revenues but may increase some indirect taxes due to the increase in nominal values (but again this may be counteracted due to lower volumes of consumption and imports).

Our choice of how the model is closed, that is how we have chosen which variables are exogenous and which are endogenous (and is solved by the equations of the model), can easily be changed if the model user thinks another closure or solution is more realistic. We have simply made a very traditional choice in order to have a working model. If one chooses to have a fixed value of the government budget balance due to say financing restrictions or targets on domestic borrowing, parts of government spending can be made endogenous in order meet that target. Similarly, if one chooses to impose a current account target, the exchange rate or volume of imports will have to be determined so that this is achieved. If imports are to be controlled, some components of domestic demand must be adjusted for this to take place. This can be achieved through spending limits or tax rate hikes.

The macro model has more than one hundred equations but most of these equations are not part of a simultaneous system. In fact the largest block constitute of 29 simultaneous equations. This should be considered the core of the model.

Here we explain the structure of the model in some detail to give an overview of the structure. First of all the model is solved recursively through time. This means that for a given set of exogenous variables that the model user will have to determine before the computer can solve anything, the set of endogenous variables is solved for each year chronologically. Given these input data for exogenous variables, the model first (for each year) solves an equation for the wage rate in the private sector (WP). This rate is simply proportional to the exogenous wage rate in the government sector (WG). Then government consumption in constant prices (CG) is determined given exogenous input values for government employment (LWP) and purchases of goods and services (MG). Total investments are determined as the sum of various fixed investments as well as stockbuilding. Value added in the government sector (YG) is assumed to be proportional to the input of labour in the government sector. Based on the solution of the variables in these four equations, the software then solves the largest simultaneous block of 28 variables. This block contains most of the main macroeconomic variables such as demand components, employment, and price indices. Given values for these macro variables a number of other variables such as government revenues and expenditures are determined. Then government saving, lending and interest payments are determined in a small block consisting of four equations. Later a similar small block containing the current account and non-factor services and private foreign borrowing and interest payments are determined. Finally, the macroeconomic variables are used to determine the industry structure in a "top down" system of recursive equations. If one should chose another way of closing the model, the block structure will change, so the structure above pertains to this special version of the model. We illustrate numerically the workings of the model in Chapter 6 by carrying out a simple multiplier study.

### 3. Detailed specification of sub-models

#### 3.1. Introduction

In what follows, we have tried to separate the presentation into equation for the various model blocks. The financial programming part is clearly the most undeveloped of these in the present model. For some equations we suggest alternatives that would result in additional equations. These equations are not implemented in the first model version.

#### 3.2. Government sector

We assume the government has no assets abroad. Further, government owned enterprises are assumed to be part of the business sector implying that the government sector is considered mainly as a functional unit rather than an institutional sector. Government revenue (GREV) is disaggregated into tax revenue (TREV) and other non-tax revenue (ONTR)

**Eq. 1**  $GREV = TREV + ONTR$

Total government revenue (GRTOT) includes further transfers to the government from abroad or foreign grants (TRFG)

**Eq. 2**  $GRTOT = GREV + TRFG$

Gross tax revenue is decomposed into direct taxes (TD), indirect taxes (TIT), and miscellaneous taxes (TOT) comprised of miscellaneous duties, export levy, other taxes, tax refunds, and collection of arrears

**Eq. 3**  $TREV = TD + TIT + TOT$

Then total direct tax revenue (TD) is the sum of taxes from households (TDH) and from companies (TDB)

**Eq. 4**  $TD = TDH + TDB$

Indirect taxes (TIT) is modelled as the sum of import duties (TITID) and an aggregate of value added tax and excise duty (TIVATED)

**Eq. 5**  $TIT = TITID + TIVATED$

while import duties is linked to the value of import by a rate

**Eq. 6**  $TITID = TIDRATE * VI$

Value added tax is determined by a rate to the value of private consumption ( $PCPO * CPO$ )

**Eq. 7**  $TIVATED = TIVATRATE * PCPO * CPO$

Total government expenditure (GEXP) is divided into government consumption and gross investment (VCG and VJG respectively), transfers to households (TRGH), government interest payment (INTG), and other government expenditures (OEG).

**Eq. 8**  $GEXP = VCG + VJG + TRGH + INTG + OEG$

It is relevant to try to specify equations determining each of these variables as functions of relevant explanatory variables. We split the government interest payments into domestic and foreign public debt (INTGF and INTGD respectively)

**Eq. 9**  $INTG = INTGF + INTGD$

We now define government gross savings (GSAV) as

**Eq. 10**  $GSAV = GRTOT + VJG - GEXP$

where  $GEXP - VJG$  is current government expenditures. Notice that it is the value of investment and consumption that enter into the budget equations.

Government consumption can be divided into labour costs, capital costs and material costs. Wage costs per employee are denoted as  $WG$  and the number of employees as  $LWG$ . Call the volume of material costs for consumption purposes  $MG$  and the corresponding price index  $PMG$ . Capital costs are often set equal to depreciation costs ( $DG$ ) multiplied by the price index for government gross investment ( $PJG$ ) but are not included in the Malawian national accounts at the present. Thus

**Eq. 11**  $VCG = WG * LWG + PMG * MG + RVCG$

$RVCG$  is a residual term. If the government finances its expenditures partly by using fees, these fees should be subtracted in Eq. 11. At this stage we define material purchases net of fees.

Government consumption in fixed prices ( $CG$ ) is given by

**Eq. 12**  $CG = WG.0 * LWG + MG + RCG$

Here  $WG.0$  is the wage rate in the base year of the model (when all price indices are unity) and is equal to 0.01259.  $RCG$  is a residual that makes the equation fit the national accounts data outside the base year.

Value added produced by the government is determined from the income or supply side and equals labour costs (and in principle also capital costs). The latter consist usually only of depreciation costs (in spite of the fact that cost benefit analysis would often require a positive rate of return on capital). Define the capital stock in the government sector as  $KG$  and suppose that there is a constant rate of depreciation  $DELTA_G$ . We then define the usual capital accumulations formulae as

**Eq. 13**  $KG = JG + KG(-1) - DG$

and the depreciation ( $DG$ ) is determined by

**Eq. 14**  $DG = DELTA_G * KG(-1)$

The volume of government value added ( $YG$ ) is determined by

**Eq. 15**  $YG = LWG * RYG$

$RYG$  is an exogenous calibration variable used to secure that the equation fits the national accounts data. In current prices government value added is determined by

**Eq. 16**  $VYG = WG * LWG * RVYG$

$RVYG$  is a calibration variable. Gross investment in the government sector in current prices is

**Eq. 17**  $VJG = PJG * JG$

In order to determine fiscal policy sustainability it is useful to make the financing and costs of fiscal deficits endogenous. Let government gross domestic debt (LGD), government gross foreign debt (LGF) and government financial assets (LDG) have corresponding and possibly different interest rates (IR<sub>xx</sub>). Then interest payments (INT<sub>xx</sub>) can be determined respectively by

**Eq. 18**  $INTGD = IRGD * (LGD + LGD(-1)) / 2$

**Eq. 19**  $INTGF = IRGF * (LGF + LGF(-1)) / 2$

The government budget and financing constraint can be written as

**Eq. 20**  $GSAV = VJG + (LDG - LDG(-1)) - (LGD - LGD(-1)) - (LGF - LGF(-1))$

This equation states that gross savings plus domestic and foreign borrowing equals the accumulation of physical assets (VJG) or financial assets by lending to domestic residents (again assuming that the government does not accumulate foreign assets). If one considers foreign borrowing as somehow restricted (meaning that LGF is exogenous), this equation can be regarded as determining the government's net domestic borrowing. Whether to include variables in gross terms as we have done, or in net terms, is not very important at this stage, but it is probably easier to obtain reasonable figures for the interest rates used in Eq. 18 and Eq. 19 if we specify the variables in gross terms. If we consider government lending to domestic residents (LDG) as a policy variable, it is perhaps most relevant to treat LGD as endogenous and determined by Eq. 20, while GSAV is determined by Eq. 10. LGD could also be disaggregated further into lending from the central bank and domestic banks as well as the issuing of bonds bought by the private sector (incl. the domestic financial sector). In the present version of the model, LGD is endogenous.

As already mentioned, tax revenues should be described by the model as well. Direct taxes can be decomposed into taxation of household income and companies' profits. Indirect taxes could be disaggregated into import duties (levied on either import volume or value, or both) and sales taxes (VAT, sales tax, or on certain goods such as petrol, alcohol, tobacco, cars or other goods that governments typically tax heavily).

At present we assume that net indirect taxes consist only of a sales tax per volume unit of private sector value added (YP) so that the purchasing price (PYP) is

**Eq. 21**  $PYP = (1 + TP) * PYPF / (1 + TP.0) * RPYP$

PYPF is the value added price at factor costs and TP is the net indirect tax rate, while RPYP is a calibration variable (that equals one in the base year). In the base year both price indices are one by definition so we must divide by the value of the tax factor in the base year (TP.0), which is equal to 0.1406.

Note that import duties have been included in the TP-factor for simplicity. We treat the import price (in Kwacha) as an exogenous variable in the present model but this clearly depends both on foreign prices, the exchange rate as well as import duties.

Let us define household taxable income as YH. Assume that the business sector taxation (TDB) is exogenous and that the average direct tax rate on household gross income is TH. We simply postulate

**Eq. 22**  $TDH = TH * YH$

An alternative to simply using an average tax rate in Eq. 22 is to use a linear formulation in order to separate between marginal and average tax effects.

Disregarding Eq. 21, this model block consist of 21 equations that determines 21 variables: GREV, GRTOT, TREV, TD, TIT, TITID, TIVATED, GEXP, INTG, GSAV, VCG, CG, KG, DG, YG, VYG, VJG, INTGD, INTGF, LGD and TDH.

The exogenous variables pertaining to the government sector are: ONTR, TRFG, TRGH, OEG, LWG, MG, JG, LGF, LDG, TDB, TH, TD and interest rates. In addition, a number of price indices and other variables enter this block. They will be made endogenous in other model blocks presented below.

### 3.3. Household sector

The specification of the household sector will to some extent depend on the detailing level in the income accounts of the national accounts. At present the national accounts do not contain income account by institutional sectors, thus we must define household income using the available relevant data. Of importance in this section is the separation of the private sector into a smallholder sector that almost completely produce for own consumption, and the rest of the private sector which we may call the formal, or monetary, part of the private economy.

Let us now consider how to model household consumption. In general a typical macro econometric consumption function would include an income term, a wealth term and a real interest term. Due to weak data we exclude the wealth-term, and the real interest term was not found to have significant impact in describing consumption<sup>1</sup>. As the income term we use disposable income in the household sector adjusted for inflation.

The consumption function applies only to “monetary consumption”, i.e. households that are not smallholders, and their consumption is called CPO.

$$\text{Eq. 23 } \text{LOG}(\text{CPO}/\text{CPO}(-1)) = 0.0536 + 0.9848 * \text{LOG}(\text{YHDR}/\text{YHDR}(-1)) \\ - 0.2869 * \text{LOG}(\text{CPO}(-1)/\text{YHDR}(-1)) - 0.6002 * \text{DUM94} + \text{RCPO}$$

The economic interpretation of this specification is that consumption will rise in the short run if real disposable income is increasing, and if the gap between the level of the consumption and real disposable income is negative (i.e. positive saving), and this is adjusted by increasing the consumption level to its long term level. The fact that the coefficient in the long term (the error correction term of  $\text{LOG}(\text{CPO}(-1)/\text{YHDR}(-1))$ ) is one, reflects that consumption follow the income level in the long run.

We now focus on smallholder consumption. Let us denote this CPS and the corresponding price index PCPS. Smallholder consumption is, as already mentioned, assumed equal to smallholder production. This sector consists of self-employed so the value of production and consumption is all operating surplus. In view of the fact that the production is not marketed, but consumed by the households themselves, the operating surplus is not taxed.

We further make the perhaps drastic assumption that output of the smallholder sector is proportional to the total number of self-employed in the economy. Actually there are many self-employed people that are not smallholders but we have no information on how to separate the number of self-employed smallholders and those that are part of the market economy. Note that the total labour force is exogenous also in this model.

In a previous version of the model an increase in the number of wage earners either in government or the private economy would reduce the number of self-employed (i.e. they were really regarded as hidden unemployment). In this model version the self-employed will reduce the smallholder production when employed in the market economy. Thus increased employment in the market economy, will partly “crowd out” (or “in” depending on your point of view) employment of the smallholder sector.

The consumption function of smallholder household is not estimated, but rather postulated as

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<sup>1</sup> Musila (2002) pp. 299 estimated a consumption function where wealth and real interest rate were tested as arguments but the equation did not perform satisfactorily.

**Eq. 24**  $CPS = LS * RCPS$

The idea behind this function is that smallholders consume all they produce (as is the case also with the rest of the households in the long term, but not necessarily in the short term). I.e. they have no savings or borrowing. Since smallholder consumption follows smallholder production we can model the consumption level directly as a production function. The overall dominating input factor in the smallholder sector is labour (LS), and we simplify by assuming that only labour is used in their production. The term RCPS is a residual.

To implement the assumption that smallholders consume all they produce (YFAGS) we specify

**Eq. 25**  $YFAGS = CPS$

This equation is needed in the breakdown of total GDP into sectors using historical weights.

We include an equation summing monetary consumption and smallholders consumption (CPO and CPS), which is equal to total private consumption

**Eq. 26**  $CP = CPO + CPS$

PCP is the price index for private consumption defined as

**Eq. 27**  $PCP = VCP / CP$

We further assume that consumer prices for the smallholders (PCPS) follow consumer prices for total private consumption. The price indices are in fact not very different, in spite of the fact that PCP covers much more than what one would expect enters into the consumption basket of smallholders. We have therefore assumed that PCPS is equal to PCP, but include an error term (RPCPS) in order to reproduce the history of PCPS exactly.

**Eq. 28**  $PCPS = PCP * RPCPS$

We also need private consumption in current value (VCP), defined as

**Eq. 29**  $VCP = PCPO * CPO + PCPS * CPS$

This disaggregation of the private sector is in accordance with the Malawian national accounts, where smallholder production and consumption are specified as separate items in fixed and current prices. The two are almost the same but the smallholder sector has a marginal sale (of maize) to Admarc. In 2000 this sale amounted to little over 3 % of total smallholder production and is ignored here for simplicity.

Household disposable income (YHD) is defined as gross income minus direct taxes

**Eq. 30**  $YHD = YH - TDH$

To get real disposable income we divide by the price deflator

**Eq. 31**  $YHDR = YHD / PCPO$

Household gross income (YH) is simply the sum of wages and salaries (WH), Part of operating surplus that accrues to households (OSH), and transfers (pensions) from the government (TRGH)

**Eq. 32**  $YH = WH + OSH + TRGH$

Note that we in the tax equation (Eq. 22) have used YH also as taxable income. This could be discussed. Income such as government transfers (TRGH) may be wholly or partly untaxed. There may be a different tax structure for wage and salary income (WH) compared to capital and property income or income for self-employment (part of OSH). This can be handled by specifying separate tax equations for different (groups of) income components. For now, this very simple specification has been chosen.

The terms entering Eq. 32 should be linked to other model variables. We start with wage income. We have earlier specified government wages and employment cf. Eq. 11. By defining similar variables for private sector wage rate (WP) and employment (LWP) we have

**Eq. 33**  $WH = WG * LWG + WP * LWP$

As we can see from Eq. 33 we assume that all wage costs are income for household. This is reasonable only if there are no taxes on labour paid by business i.e., no employment taxes for financing pension funds or similar incomes (or that such schemes are paid for by the employees themselves).

The part of operating surplus, which is income for self-employed etc., is simply a share (OSHRATE) of total operating surplus (OS). The last-mentioned will be define later, so for the moment we have

**Eq. 34**  $OSH = OSHRATE * OS - PCPS * CPS + ROSH$

Note that we have deducted the value of smallholder consumption from the operating surplus (of other households). ROSH is a residual term (set to zero at the moment) that could simply be considered as an exogenous income component for households.

Household saving (HSAV) is defined as disposable income minus private consumption (VCP)

**Eq. 35**  $HSAV = YHD - VCP$

Savings are equal to accumulation of net financial and physical assets. At the moment we have no data for this and HSAV is simply a "dead end" in the model.

The household block consists of 12 equations that determine YH, YHD, WH, OSH, CP, VCP, HSAV, YHDR, CPO, CPS, PCP and PCPS.

The exogenous variable that relate to the household sector is OSHRATE. The block also includes variables that need to be determined elsewhere in the model such as price indices and possibly wage rates.

### 3.4. The external sector

The trade balance is defined as the value of exports minus the value of imports (VX-VI). The volume of total exports (X) times the price index of exports (in domestic currency) yields the value of exports VX

**Eq. 36**  $VX = PX * X$

Similarly for imports

**Eq. 37**  $VI = PI * I$

where PI, the price of import, is exogenous in the model. The price of exports depends on price of imports (reflecting cost of input factors and world market prices) and the price on domestic value added (reflecting wages and other domestic cost drivers). In the long run export prices follow the price on domestic value added. In the short run we will see increasing export prices as the import and/or value added prices increases.

**Eq. 38**  $LOG(PX/PX(-1)) = -0.0714 + 0.2309 * LOG(PI/PI(-1)) + 0.7814 * LOG(PYP/PYP(-1)) - 0.3026 * LOG(PX(-1)/PYP(-1)) + 0.3353 * DUM9498 + RPX$

The current account (CA) includes also factor payments and transfers. We specify

**Eq. 39**  $CA = VX - VI + NTRFP + NFS$

NTRFP is net transfers to the private sector and NFS is net factor services. NTRFP should possibly be included in the household income definition if the transfers mainly go to households. We have not done that at this stage but this issue should be considered. NFS is determined by

**Eq. 40**  $NSF = -INTGF - INTPF + INTFER + RNFS$

Net factor services include interest payments on foreign debt and other factor services captured by the residual RNFS. Interest income on the foreign exchange reserves (FER) is given by

**Eq. 41**  $INTFER = IRFER * (FER + FER(-1)) / 2$

IRFER is the average interest rate. Interest payment on foreign government debt and private debt are captured by INTGF and INTPF respectively. Eq. 19 determine INTGF, while INTPF is determined by

**Eq. 42**  $INTPF = IRPF*(LPF + LPF(-1))/2$

Note that liabilities of the private sector to foreign financial institutions are denominated in local currency in Eq. 42. If we value them in foreign currency we must introduce a number of exchange rates since the import weighted exchange rate used earlier may not be relevant for calculating the value of foreign loans in domestic currency.

Finally, the current account and the capital account are related through

**Eq. 43**  $CA+TRFG = FER-FER(-1)-(LPF-LPF(-1))-(LGF-LGF(-1))+ERROM$

This equation says that a current account surplus (deficit) can be used to increase (decrease) foreign exchange reserves, or to reduce (increase) private or public foreign debt given a level of foreign transfers (grants) to the government (TRFG) that also is included in Eq. 2. ERROM is a residual called errors and omission in the balance of payments.

We have suggested an export equation of the so-called Armington type where exports depend on relative prices between domestic export prices (PX) and world market prices, as well as an indicator of markets size or market growth (YUSWORLD). An alternative would be to introduce a so-called transformation function (the CET-form is one example) where total output is made a function of output to the domestic market and export markets and that profit maximizing behaviour determines how output is distributed between these two markets depending only on the price on the domestic market relative to that on the export market. This would make exports more supply determined than the Armington-approach does, although this will depend on other aspects of modelling as well.

The estimated Armington function is

**Eq. 44**  $DEL(\LOG(X))=-28.73+0.29*DEL(\LOG(PI/PX)) + 0.85*\LOG(YUSWORLD(-1) / X(-1))$

$+ 0.41*\LOG(YUSWORLD(-2)/X(-2))+ 0.17*\LOG(PI(-2)/PX(-2))+RX$

and says that exports increases in the short term if imports gets relatively more expensive than exports, i.e. Malawian goods are increasing their market share on the world market. In the long term, exports will grow at the same speed as the world market size, for given relative prices. If Malawian exports become relatively cheaper than other countries exports, exports from Malawi will grow faster than the world market, and gain market share. Musila (2002) found that estimated income elasticities for some export equations had negative sign, indicating that some of Malawi's export products are inferior.

For imports it is common to introduce an import function of some form. The simplest is

$I = ISHARE*Y$

making total imports a share of GDP in constant prices. An alternative would be to make imports a constant share of total demand for goods (DEM)

**Eq. 45**  $DEM = CPO + MG + JG + JP + X + JS$

where private gross investment in fixed capital (JP) and changes in stocks (JS) are introduced. We now specify

**Eq. 46**  $I = ISHARE*DEM$

A sophistication of this would be to introduce different weights to the demand components in Eq. 46 based on differences in import-intensities. One could also make the ISHARE-variable endogenous by letting it depend on relative prices between imported and domestic goods and services. We leave this for discussion and assume for the time being that ISHARE is exogenous and use Eq. 45 and Eq. 46 to determine the total volume of imports.

### 3.5. The business sector

We now turn to modelling of private sector value added. This sector comprises not only standard businesses with profit maximization as the objective, but also publicly owned companies that operates as

independent institutional units. The borderline between the latter companies and the government sector can be difficult to draw. We suggest that we specify a constant return to scale productions function for the private non-smallholders sector, relating the volume of private value added in factor prices (YPFO) to employment (LWP) and the private sector capital stock at the beginning of the year (KP(-1))

$$YPF = TFP * LWP^\alpha * KP(-1)^{1-\alpha}$$

where the parameter  $\alpha$  is the income share of labour, and TFP is total factor productivity. We use a gestation lag of one year for the capital stock. This implies that it is the stock at the beginning of the year that is actively used in production so that current year net investment only affects demand not supply. For short and medium term analyses, it is often the case that one specifies an inverted production function that determines labour demand. We suggest doing so for the time being.

The inverted labour demand function derived from the production function includes non-smallholder value added in factor prices (YPFO).

By inverting the production function and assuming a labour share of 0.5,<sup>2</sup> we have

$$\text{Eq. 47 } \text{DEL}(\text{LOG}(\text{LWP})) = 2.06 + 0.43 * \text{DEL}(\text{LOG}(\text{YPFO})) - 0.46 * (\text{LOG}(\text{LWP}(-1)) - 2 * \text{log}(\text{YPFO}(-1)) + \text{log}(\text{KP}(-2))) - 0.01 * \text{TREND} + \text{RLWP}$$

RLWP is an error term or a calibration variable. In the data appendix we discuss the calculation of total factor productivity and the capital stock.

We can interpret Eq. 47 as indicating the desired level of employment. This is reflected in the long run solution (defined as when all changes in variables are zero) build into Eq. 47. I.e. in the long run, labour demand follows output, adjusted for a constant growth in the capital stock and total factor productivity.

In the short run, due to hiring and firing costs etc., actual labour demand will typically differ from the desired level. This is reflected in the lag behaviour in Eq. 47, which says that adjustment of employed labour lags somewhat on output. The long run term implies that the adjustment of labour demand will continue until the employment again is consistent with its long run level. The trend variable is, as the equation now is estimated, both a part of the long run solution and a part of the short-term dynamics. This makes the interpretation a bit challenging. It is, however, most convenient to use this set up in the specification of the model.

Since we have assumed that smallholder consumption equals production the sum of value added in the private non-smallholder sector (YPFO) and CPS is equal to the total private sector value added at factor costs

$$\text{Eq. 48 } YPF = YPFO + CPS$$

The capital stock accumulates according to the standard formulae

$$\text{Eq. 49 } KP = JP - DP + KP(-1)$$

Depreciation (DP) is again assumed to be geometric

$$\text{Eq. 50 } DP = \text{DELTAP} * KP(-1)$$

We should discuss how to model gross investment in the private (non-housing) sector. A simple way would be to introduce a flexible accelerator type of equation relating changes in the capital stock (and thereby investment via Eq. 49) to changes in output or value added. Another issue is the introduction of relative factor prices and possibly introducing a role for credit policy in the investment equation. We leave that for discussion. A simple solution at this stage would be the following. Let

$$KP = \text{DELTA} * YPFO$$

---

<sup>2</sup> The labour share was determined by estimating the production function as a static equation.

where DELTA is the capital output ratio. Given the production function this ratio is not exogenous or a parameter but rather a variable. Let us ignore that for now. In equilibrium  $JP = DELTAP * KP$  so that gross investment is just enough to replace depreciation. Thus one alternative is to postulate

$$JP = DELTAP * DELTA * YPFO.$$

In this case the capital stock will evolve according to

$$KP = DELTAP * DELTA * (YPF - YPF(-1)) + DELTAP^2 * DELTA * YPF(-1)$$

Here an increase in YPF will increase JP immediately but very moderately (typically 0.2) and the capital stock will increase very slowly to its new equilibrium level.

Another alternative is the following. By insert the equation between KP and YPF above into Eq. 49 and solve for JP, we have

$$JP = \sigma * YPF - (1 - \delta_p) * \sigma * YPF(-1) = \sigma * (YPF - YPF(-1)) + \delta_p * \sigma * YPF(-1)$$

Here investment depends on two terms; the first makes investment jumps as output changes while the second tells what the new equilibrium level of investment will be. There is instantaneous adjustment of the capital stock from its previous level. This is unrealistic due to costs of adjusting the capital stock. Normally the capital output ratio is in the range of 2-3. The above equation says that if output increases by say 1 bill. Kwacha, investment will increase at least twice as much the same year to reach the desired capital stock by the end of that year. Next year investment will return to its long run level which is much lower as DELTAP is typically less than 0.1.

These are two quite different alternatives. Intermediary cases can be found by reducing or increasing the coefficient in front of the change in output to a desired level, one can in an ad hoc way take adjustment costs into account. The third alternative at this stage is to let JP be exogenous (that is why we have not given any number to the equations above). Alternative solutions can be discussed and tested as part of the model as a whole.

The next issue is the modelling of prices. The deflator of private sector value added at factor costs (PYPF) is a central price index.

We define gross operating surplus (OS) by

$$\text{Eq. 51 } OS = PYPF * YPF - WP * LWP$$

Assume further that firms maximize this operating surplus and that markets are characterized by imperfect competition. Then prices are set as a mark-up over marginal costs. Marginal costs in our case could be interpreted as short-run marginal costs and will in the case of the production function we have postulated, be proportional to labour unit costs (LUC)

$$\text{Eq. 52 } LUC = WP * LWP / YPFO$$

The mark-up will be a function of all variables entering the demand function for goods such as income and relative prices (in our aggregated case PYPF/PI). Thus in general we can postulate:<sup>3</sup>

$$PYPF = f(LUC, PI, DEM)$$

Given the data available, the following empirical version of the general function is estimated:

---

<sup>3</sup> If the functional form is log-linear we need to determine two coefficients (as the sum of the coefficients for LUC and PI sum to unity) in order to determine the model. An assumption in an earlier version of the model was:  $PYPF = MARKUP * LUC$ . Notice that this solution cannot be distinguished from the simple first order condition for profit maximization under price-taking behavior (in which case the mark-up is equal to the inverse of  $\alpha$ ). In the current version of the model, also relative prices (represented by import prices) are taken into account.

$$\text{Eq. 53 } \text{LOG}(PYPF/PYPF(-1)) = 0.10 + 0.71*\text{LOG}(PYPF(-1)/PYPF(-2)) + 0.48*\text{LOG}(PI/PI(-1)) + \\ 0.24*\text{LOG}(LUC/LUC(-1)) - 0.36*\text{LOG}(PYPF(-1)/PI(-1)) + \\ 0.15*\text{LOG}(LUC(-1)/PI(-1)) + RPYPF$$

In the short run, changes in PYPF are given by changes in labour unit costs and changes in import prices. The inclusion of change in PYPF with one lag on the right hand side reflects some persistence in these prices. In the long run, PYPF is positively affected by import prices, reflecting partly that some inputs are imported and partly that domestic products to some extent compete with internationally produced products. Secondly, PYPF is positively affected by labour unit costs, mirroring that producers must cover increased wage costs by increasing their prices on produced goods.

The business sector model block so far consists of 6 equations that determine LWP, KP, DP, OS, LUC, and PYPF. The main exogenous variables are gross investment JP and the wage rate WP. In addition total factor productivity (TFP) as estimated partly by the trend term in the labour demand equation is important. In practice shifts in TFP must be entered into simulations using the error term RLWP. YP and YPF are determined from the demand side by the national accounts identities to be presented below.

The deflator for private consumption is modelled as determined by prices on domestically and foreign produced goods, reflecting that both type of goods are included in the consumption basket:<sup>4</sup>

$$\text{Eq. 54 } \text{LOG}(PCPO/PCPO(-1)) = 0.05 + 0.29*\text{LOG}(PI/PI(-1)) + 0.61*\text{LOG}(PYP/PYP(-1)) - \\ 0.53*\text{LOG}(PCP(-1)/PI(-1)) + 0.24*\text{LOG}(PYP(-1)/PI(-1)) + RPCPO$$

The formulation is analogous to the equation for PYPF.

As mentioned earlier, we have included a breakdown of GDP into production sectors in the model. This breakdown is in accordance with that of the national accounts. Apart from Eq. 25, where we stated that smallholder consumption is equal to their production, we have distributed GDP to the various sectors using historical weights. This has been done for GDP at factor costs and in current value.

### 3.6. National accounts identities and adding up

In constant and current prices supply of goods and services (value added plus imports) is equal to the use or demand for goods and services. So

$$\text{Eq. 55 } Y + I = C + J + X + JS$$

where stock building (JS) are assumed to be exogenous.

Total GDP at constant prices (Y) is given by adding up the private (YP) and government (YG) value added components

$$\text{Eq. 56 } Y = YG + YP$$

Correspondingly for consumption (C), where government and private consumption is denoted CG and CP respectively

$$\text{Eq. 57 } C = CG + CP$$

Total consumption in current value (VC) is the sum of government and private consumption in current prices, and are denoted VCG and VCP respectively

---

<sup>4</sup> A theoretical formulation of the deflator for private consumption (PCP) is:

$$**** PCP = PYP^\gamma * PI^{1-\gamma} * RPCP$$

where  $1 \geq \gamma \geq 0$ . In an earlier model version, the weight on PYP was 0.75. RPCP is a calibration variable that is equal to one in the base year when both PYP and PI are one. Using a price such as \*\*\*\* also for other price indices allows for some final demand price indices to be more dependent on imported inputs (or import competition in final goods markets). Notice that the formulation in equation \*\*\*\* also covers the special case where world market prices determine the final good price - a case that could be relevant for the export price (PX).

**Eq. 58**  $VC = VCP + VCG$

Total investments (J) is the sum of investment in the private and the government sector

**Eq. 59**  $J = JG + JP$

Total value added in current prices (VY) is the sum value added of in private and government sectors (VYP and VYG respectively)

**Eq. 60**  $VY = VYG + VYP$

where VYG is defined by Eq. 16 (no PYG is specified but could be so simply by defining  $PYG = VYG/YG$ ).

For total GDP in current prices we have

**Eq. 61**  $PY*Y + VI = VCG + VCP + VJ + PJS*JS - VX$

This implies that in order for Eq. 61 to hold with equality, the price index for total GDP (PY) will be residually determined. Now, private value added in current prices is defined as

**Eq. 62**  $VYP = PYP*VYP$

Private sector value added at factor costs (YPF) are defines as

**Eq. 63**  $YPF = YP/(1+TP.0)$

where TP.0 is the value of the tax factor in the base year and equal to 0.1406. Total gross investment in fixed capital in current prices is given by

**Eq. 64**  $VJ = PJG*JG + PJP*JP$

For the private investment price we have estimated the following relationship

**Eq. 65**  $LOG(PJP/PJP(-1)) = 0.11+0.8*LOG(PI/PI(-1)) - 0.56*LOG(PJP(-1)/PI(-1)) - 0.19*DUM9403+RPJP$

There was no significant effect from prices on domestically produced goods, which is plausible if most capital goods are imported. The deflator for gross investment in fixed capital in government sector is identical to PJP so we simply have

**Eq. 66**  $PJG = PJP$

The deflator for government purchase of goods and services is determined as

**Eq. 67**  $PMG = PYP*RPMG$

Where RPMG is a residual. The deflator for the price deflator for stock building is simply

**Eq. 68**  $PJS = PYP*RPJS$

The equation  $PJS = PYP$  fits data well up to 1986 but then there is a big jump in PJS that is captured by the residual RPJS.

We also added a few other equations that could be useful when judging results from model runs. Total capital stock (K)

**Eq. 69**  $K = KG + KP$

Total employment or labour force (LABFORCE) is exogenous so this equation determines the number

**Eq. 70**  $LABFORCE = LWG + LWP + LS$

of self employed (LS).

We have not discussed how wages (WG and WP) are determined. They are now treated as exogenous variables but linked in order to have only one of them exogenous. We have postulated

**Eq. 71**  $WP = WPRATE * WG$

### **3.7. Financial programming**

Until now we have specified a model where a number of important financial variables are exogenous. Most importantly this relates to the exchange rate and various interest rates. These variables are undoubtedly related and may be described by a money market interest rate. This will still leave the question on how to determine this money market rate unanswered. The differences between short and long term interest rates on assets are also issues to be considered. For now we propose a minimum framework that could be extended later.

Money supply (M) broadly defined consists of domestic credit and foreign exchange reserves (FER) introduced earlier. We have

**Eq. 72**  $M = LD + FER$

Domestic credit can be disaggregated into a number of variables some of which have already been introduced earlier. Government gross domestic debt (LGD) minus domestic assets (LDG) is part of LD as well as household assets and loans. These variables could therefore be linked but as long as we have not specified the total credit market, we may simply disaggregate into private and government. So

**Eq. 73**  $LD = LGD - LDG + LPD$

LPD is net private domestic debt and LGD-LDG is net government debt.

Foreign debt can also be disaggregated into private and government debt. These variables were introduced earlier. The government budget balance is also relevant at this stage.

The logic of the model presented so far is as follows. As long as net foreign lending is the sum of two exogenous components, the balance of payment restriction will determine changes in net foreign reserves. This value enters the money supply equation. We let most of the credit terms entering Eq. 73 exogenous, thus money supply is determined by Eq. 72. We may then proceed by introducing a money demand function or at least an equation showing how the velocity of money changes

**Eq. 74**  $VM = VY/M$

If one wants to move beyond this simple framework by assuming a money demand function including interest rate(s) in order to determine a money market interest rate(s), this can be discussed. The relevance of such a model will of course depend on how stable one thinks a money demand function is for an economy like Malawi. We have no information or knowledge about this issue, so we leave it for discussion. Note also that we have assumed that the exchange rate is exogenous. This is probably not realistic, but we suggest that we do not try to address this issue at this stage. Prices (and consequently inflation) are determined in the model as a function of monetary variables (foreign prices and exchange rate) and domestic cost and demand variables that again are influenced by these variables.

## 4. The baseline scenario

Because this is a technical documentation rather than an economic analysis we will not elaborate on the assumptions and outcome from the model. However, in this chapter we will give a brief description of the main assumptions and results in the baseline scenario, which is the basis for the chapter on model performance (Chapter 5 below) and the chapter on policy shifts (Chapter 6 below).

**Table 1 Baseline scenario: Main macroeconomic figures**

	2004	2005	2006	2007	2008	2009	2010	2011
<i>Per cent growth</i>								
Total consumption	4.3	2.5	5.8	1.4	2	2	2.2	2.6
- Private consumption	5.5	2.7	6.4	1.3	2	2	2.3	2.8
- - Smallholders	3.9	-11	31.4	1.5	1.5	1.4	1.5	1.5
- - Others	6.1	8	-1.5	1.2	2.3	2.3	2.7	3.4
- Government consumption	-3.2	1.7	1.7	1.7	1.7	1.7	1.7	1.2
Total investments	-6.9	5	9	3	3	2.9	3	2.9
- Government investments	-6.9	5	8.9	3	3	3	3	2.9
- Private investments	-6.9	5	9	3	3	3	2.9	3
- Stock building	4.6	0	0	0	0	0	0	0
Exports	7.9	8.9	0.6	3.9	5.3	3.3	2.2	2.8
Imports	4.2	7.4	0	2	3	2.5	2.5	3
GDP	3.9	1.8	7.8	1.8	2.4	2.1	2.1	2.5
GDP at factor costs	5.1	1.3	7.7	1.8	2.4	2.1	2.1	2.5
- Value added in government	2.3	1	1	1	0.9	1	0.9	0.9
- Private sector total	5.4	1.4	8.4	1.9	2.5	2.2	2.2	2.6
- - Private sector monetary	6.1	7.9	-1.5	2.1	3.1	2.7	2.6	3.2

We have, to some extent, tried to implement the knowledge of the economic conditions prevailing for the Malawian economy as of October 2005. Most important in this matter is the drop in Smallholders consumption in 2005 due to the conditions in the agricultural sector (see Table 1). Constituting almost 30 per cent of total GDP this will affect the total output accordingly. For 2006 however, there is better prospects for the agricultural sector.

When it comes to the government sector (see) revenues as share of current GDP are fairly constant at about 21 per cent. Total expenditures are declining from a 38 per cent share of GDP in 2005 to 28 per cent in 2011. This is mainly due to reduced government domestic debt, easing the burden of debt, but also by assumptions for the government wage bill. We have assumed the government wage rate to be roughly constant in real terms, and a one per cent growth path of government employment. We have further assumed a 2 per cent annual increase in government purchases of goods and services.

**Table 2 Baseline scenario: Central government operations**

	2004	2005	2006	2007	2008	2009	2010	2011
<i>In millions of Malawi Kwacha</i>								
Tot. Rev incl. Grants	65015	75826	82647	91595	102141	114138	128078	148001
- Revenue	45222	54054	58698	65250	73163	82261	93014	105924
- - Tax revenue	40089	48407	52486	58418	65647	73994	83920	95920
- - Non-tax revenue	5133	5646	6211	6832	7515	8267	9093	10003
- Grants	19792	21772	23949	26344	28978	31876	35064	42076
Total expenditure	78306	86388	88302	92887	102877	114127	126841	140524
- Wages and salaries	14067	15912	18000	19998	22218	24684	27424	30468
- Interest payments	21889	21756	14726	10578	10848	11069	11210	10999
- Other current expenditures	9778	10756	11832	13015	14316	15748	17323	19055
- Purchases of goods and services	15663	17773	19873	22118	24647	27664	31288	35173
- Pensions and transfers	1798	2014	2255	2526	2829	3169	3549	3975
- Government fixed investments	15108	18174	21612	24650	28017	31790	36044	40851
Overall balance	-13290	-10561	-5654	-1292	-735	10	1237	7476
Government saving	1818	7612	15958	23357	27281	31801	37281	48327

From Table 3 we see that a considerable reduction in the GDP deflator brings it well below the double-digit inflation in 2006 – 2008, after that it increases somewhat to reach about 10 per cent annual growth. Consumer prices also drops considerably from 2005 to 2006, but thereafter is quite stable at around 10 per cent. This is mainly due to the growth assumption for import prices and roughly constant real wages.

**Table 3 Baseline scenario: Prices and costs**

	2004	2005	2006	2007	2008	2009	2010	2011
<i>Per cent growth</i>								
GDP Deflator	15.9	14.1	8.7	8.5	8.8	9.6	10.5	10.8
Consumer prices	11.3	14.7	10.2	9.6	9.7	10.1	10.6	10.7
Import prices	12	8.9	6	9.9	10	9.9	9.9	9.9
Export prices	22.7	1.6	2.6	5.2	6.4	7.9	9.2	10
Wage rate private sector	14.1	11.9	12	9.9	9.9	10	10	9.9
Labour unit cost private sector	10.1	12.3	23	12.8	11.8	12.5	12.1	11.4

From Table 4 we can see that the Current Accounts are quite stable at about 20 per cent of current GDP (about 12 per cent when including grants).

**Table 4 Baseline scenario: Balance of payments**

	2004	2005	2006	2007	2008	2009	2010	2011
<i>In per cent of nominal GDP</i>								
Exports	27	26.4	23	22.7	22.7	22.5	22.2	22.1
Imports	43.8	45.3	40.6	40.9	41.4	41.6	41.4	41.2
Current account balance	-18.2	-19.9	-18.6	-19.5	-20	-20.4	-20.6	-20.6
Government transfers	9.6	9.4	8.7	8.6	8.4	8.3	8	8.5

## 5. Model performance

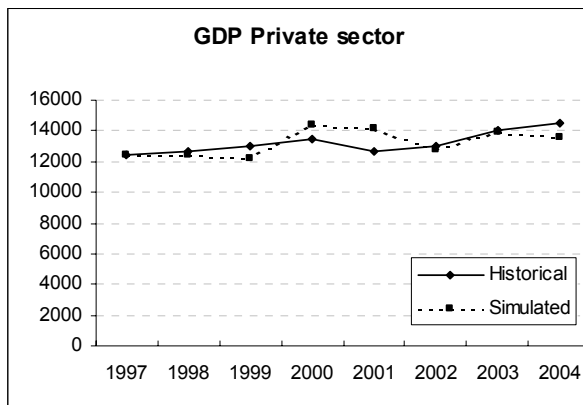
A model's performance is often judged on the basis of its capability to produce accurate forecasts for the endogenous variables in the model, when they are compared against the actual outcome. However, the results of such a test do not only depend on the model, but also of the estimates given as exogenous input to the model. Also time is needed to collect observed variables to check the outcome. An alternative way to test the model itself is to see how well the simulation tracks the historical data when actual values for the exogenous variables are input to the model. By this way errors will not be due to incorrect assumptions for the exogenous variables as these are known for the period considered, i.e. it is solely the model properties that are tested.

A historical test should preferably be done as a "post-sample" test, i.e. for a historic period after the period used for estimating the model's equations. However, since we have incorporated all available historical information in estimating the coefficients of the equations, the test of the model is done as an "in-sample" test, i.e. simulation outcome is compared against the historical data within the estimation period.

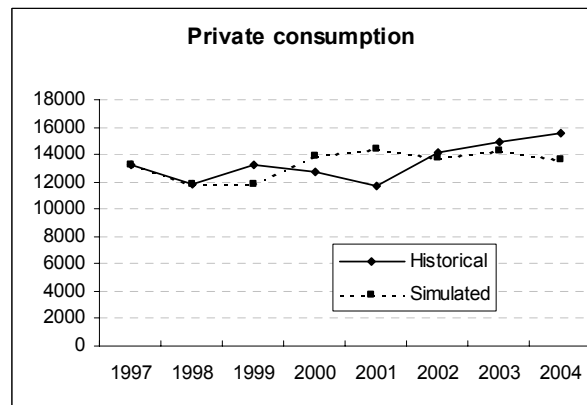
The use of an "in-sample" test rather than a "post-sample" test means that we assist the model in tracking the outcome for the endogenous variables by eliminating possibilities for structural breaks in econometric equations. On the other side, the model is simulated dynamically, which means that actual numbers for endogenous variables are used only for lagged variables in the years before the simulation period starts. For years within the simulation period only simulated values are used. In this way, accumulation of simulation errors can take place and the simulation is therefore a test of the ability of the model to keep on track. This test is also consistent with the actual forecasting situation, where endogenous variables are (for the most) known up to the year when the simulation starts.

In this test of the model, the residuals in the 7 econometric equations in the model were fixed at zero, and the model was simulated for the period from 1998 to 2004. The results from the simulation are presented in Figure 2 to Figure 7.

**Figure 2 Historical and simulated values: GDP private sector**



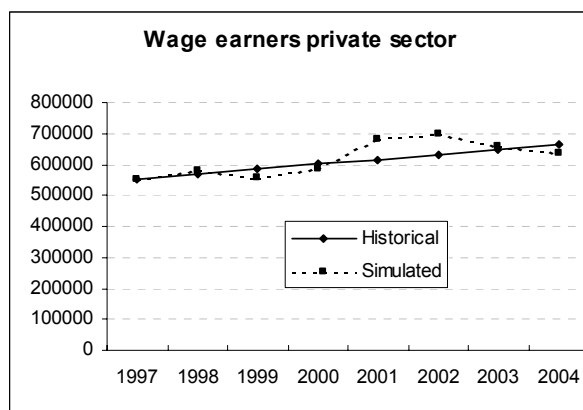
**Figure 3 Historical and simulated values: Private consumption**



For GDP in the private sector (c.f. Figure 2) the model is not on track in the period 1999 – 2001, the simulation error in 2001 being more than 11 per cent. From Figure 3 we realise that private consumption looks like a contributor to this pattern of being on the low side in 1999, and then overshoot the actual values in 2000 and 2001. In fact, going into more details, private consumption for non-smallholders is 14.8 percent below its historical value in 1999, and then in 2000-1 becoming 12.8 and 34.8 per cent above its historical values respectively.

Based on these results in general, we can conclude that more work is needed for us to be satisfied. This applies to both looking into the econometrics, but also ensuring a consistent database.

**Figure 4 Historical and simulated values: Wage earners private sector**



**Figure 5 Historical and simulated values: GDP deflator factor costs private sector**

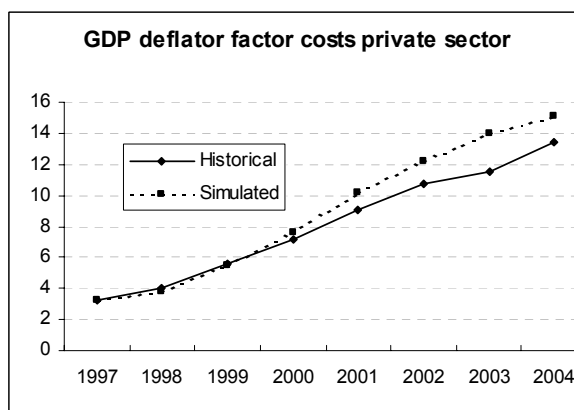
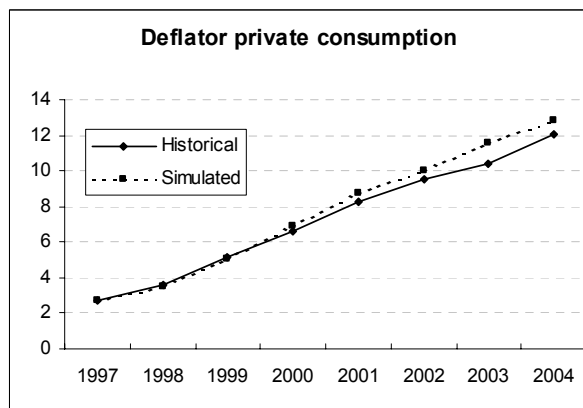


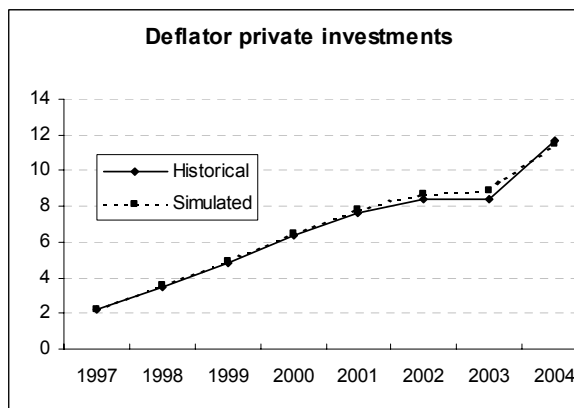
Figure 4 shows the results for the number of wage earners in the private sector. We had problems obtaining data for the number of employees, but apart from 2001-2 the results are satisfactory.

Figure 5 - Figure 7 shows some price deflators. The GDP deflator at factor costs (c.f. Figure 5) drifts away from its historical value. This systematic miscalculation arise as there is some inaccuracy in the equation itself producing large residuals, and the problems of tracking history are strengthened by the simultaneity in the model. This equation is sensitive to the labour unit costs. The overestimation of the employment (c.f. Figure 4) results in too high labour unit costs, which in turn feed into the factor price equation.

**Figure 6 Historical and simulated values: Deflator private consumption**



**Figure 7 Historical and simulated values: Deflator private investments**



The simulation inaccuracy in the GDP deflator at factor cost is directly linked to the private sector GDP deflator at market prices. This in turn, determines the deflator for private consumption, shown in Figure 6, resulting in the same pattern of overestimation.

The deflator for private investments (see Figure 7) is not affected by the GDP factor price and labour unit costs, but is a function of the import price, which is exogenous to the model.

## 6. Multiplier analyses

In this section we shall illustrate how the model behaves quantitatively when subjected to two shifts. We have created a baseline simulation extending from 2004 (the final year of the historical database at present) to 2011. This baseline is quite smooth in terms of economic development (see chapter 4 above). In our simulations we first study the effects of a fiscal shift, where we have implemented a permanent increase in government purchases of goods and services (MG) by 10 per cent from 2005 to 2011. In the second simulation we increase the price of imports by 10 per cent from 2005 to 2011.

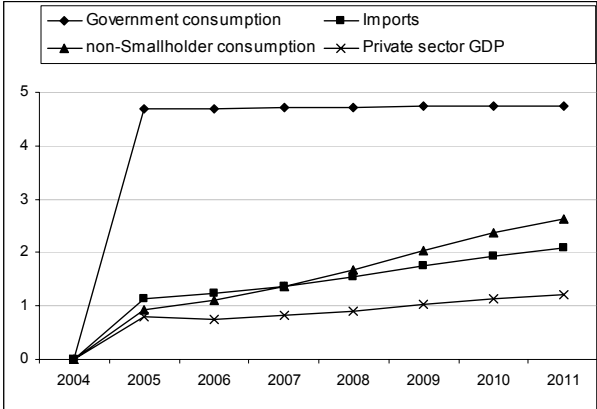
### 6.1. Increase in government spending

The increase in MG will feed directly into government consumption, increasing it by almost 4.8 per cent (see Figure 8). The increased demand is met by higher domestic production and imports. There will be an immediate increase in the demand component (DEM), which increases imports by about 2 per cent in the long run. Private sector GDP increases by 0.8 per cent the first year and to 1.2 per cent after 7 years. This increase in GDP brings along a rise in operating surplus and wage income (see Figure 9) that lead to higher disposable income and non-smallholders consumption.

The increase in demand and private sector GDP cause an increase in the number of wage earners in the private sector. Since the labour force and government employment are exogenous, the number of self-employed is falling, i.e. surplus of labour from (mainly) agriculture is employed in the formal sector.

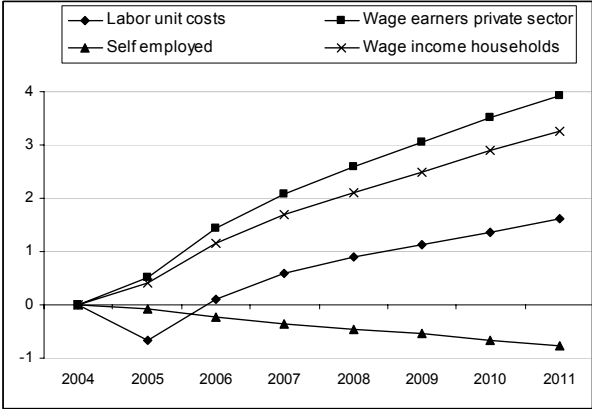
**Figure 8 GDP, consumption, imports.**

Per cent deviation from baseline scenario



**Figure 9 Employment and labour costs.**

Per cent deviation from baseline scenario



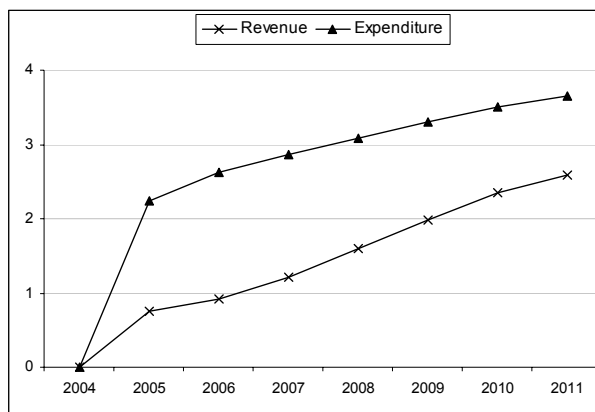
The increase in government consumption will lead to higher government expenditures (see Figure 10), increasing 2.2 per cent the first year. Also revenues increase due to income from direct taxes and taxes on international trade. In Figure 11 we see that government savings as share of current GDP drops 0.68 percentage points (from 3.3 to 2.6), then stabilising at this difference. The government budget deficit is financed solely from domestic borrowing, resulting in increased government interest payments.

Increasing private foreign debt finances the current accounts deficit, as government lending abroad is exogenous.

We also see that the trade balance and the current accounts are shifted downwards about 0.4 percentage points.

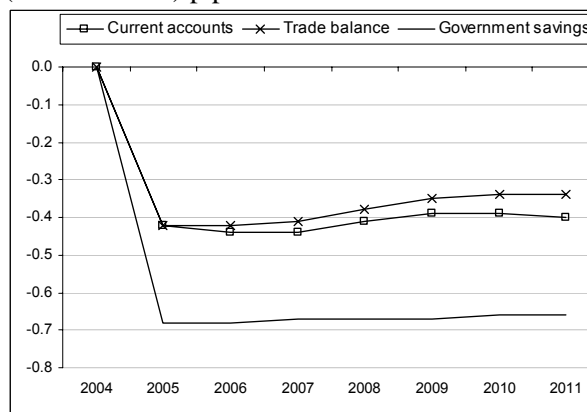
**Figure 10 Government revenues and expenditures.**

Per cent deviation from baseline scenario



**Figure 11 Current accounts and government savings**

(share of GDP) p.p. deviation from baseline scenario

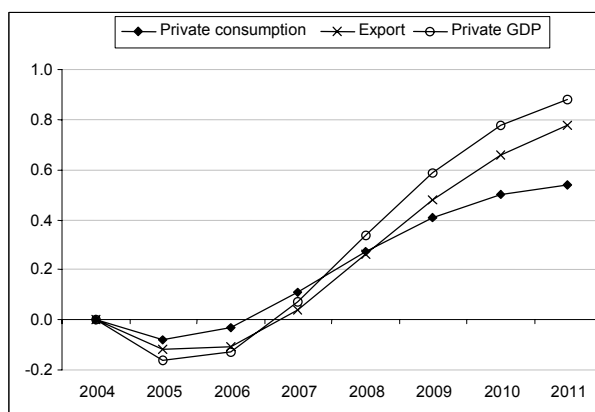


In Figure 12 we show the effects on some of the price deflators in the model. The principal driving forces of the price deflators are import prices and labour costs. Import price is exogenous in the model and the baseline assumptions are presented in Table 3. The J-shaped development occurs because the labour costs declines the first year (see Figure 9) due to non-smallholder GDP (YPFO) increasing more than the wage costs. Private sector wage rate being virtually exogenous the adjustment in labour cost comes entirely from increased employment. In the long run however, labour costs follows the number of employees and the non-smallholders value added.

Also the deflator for GDP at factor costs (PYPF) is important to the nominal picture. This deflator depends on import price and labour unit costs (weights of about 2/3 and 1/3 respectively in the long run).

**Figure 12 Price deflators**

Per cent deviation from baseline scenario





## 6.2. Increase in import price

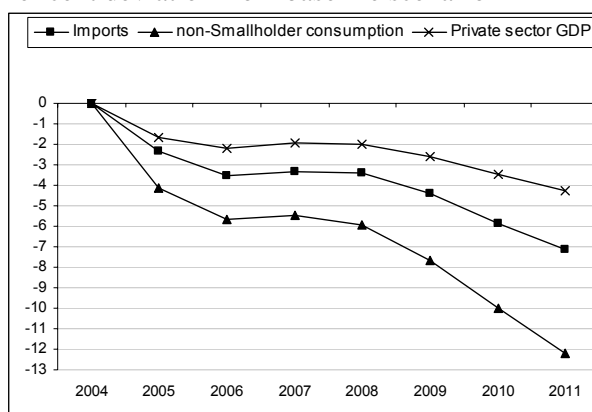
An increase in import price will reduce non-smallholders consumption by more than 4 per cent the first year, ending up at a more than 12 per cent reduction in 2011 (c.f. Figure 14). Both the short term and long term effects are mainly due to reduced real disposable income in the household sector. Real disposable income decreases because the consumer price increases following the increase in the price of imported goods. The consumption function has been designed so that private consumption follows real disposable income in the long run.

Import volume is assumed a share of domestic demand, in which non-smallholders consumption constitutes more than 60 per cent. It is the reduction in consumption that leads to the reduced volume of imports by 7 per cent in the long run. Although the isolated effect from lower imports on GDP is positive, this lowers the GDP in the private sector by more than 4 per cent in the long run.

In the private sector the amount of labor is linked to output through a Cobb-Douglas production function. From Figure 15 we can see that the number of wage earners goes down by 11 per cent relative to the baseline scenario in the long run. This number is outweighed by an increase in the number of self-employed, which in turn leads to an increase in smallholder's consumption. In 2005 and 2006 the decline in the number of employees in the private sector is stronger than that in value added, so labor unit costs increases temporarily. After that however, reduction in employment is greater than that of value added (the wage rate is unchanged) and the labor unit costs decreases. The wage income to the households drops with the employment in the private sector.

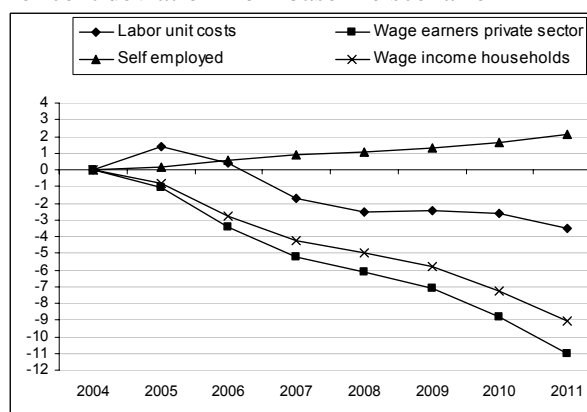
**Figure 14 GDP, consumption, imports.**

Per cent deviation from baseline scenario



**Figure 15 Employment and labour costs.**

Per cent deviation from baseline scenario



In Figure 16 we see that there is an increase in nominal tax revenues the first 5 years. Thereafter tax revenues are lower than in the baseline scenario. The government revenues are affected by the increase in import prices and taxes on international trade (import duties), value added tax and direct taxes on households. Import duties are based on the value of imports, which increases in the whole period, though somewhat less in the long run. The value of import increases by 7.4 per cent the first year, thereafter gradually declining to 2.2 per cent in 2011. It is only when the volume of imports has declined enough to offset the effects from the import duties that total tax revenues goes down.

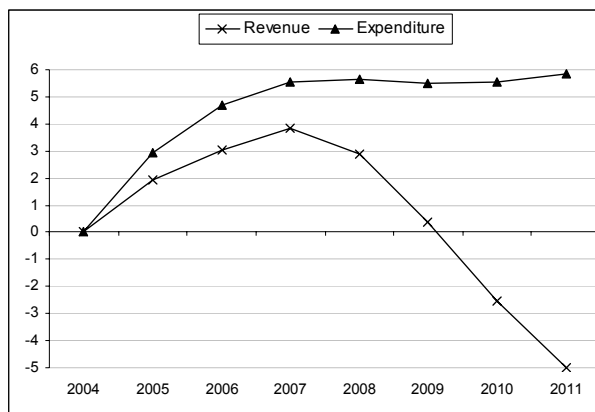
The value added tax is based on the value of consumption. As is evident from Figure 14 and Figure 18 the volume is decreasing while the price increases. The value of consumption, the "tax base", increases until 2008 (including), thereafter declining.

The government income from direct taxes on households follow the same pattern as the value added tax. It first increases before it gradually becomes less than in the baseline scenario. The reduction in the employment (c.f. Figure 15) and the increase in nominal GDP (over the period 2005-10) leads to an

increase in the operating surplus. This in turn, leads to an increase in the gross income in the household sector, which is the tax base for direct taxes on the households.

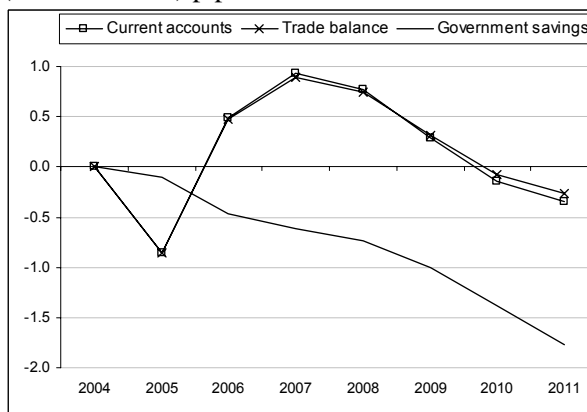
**Figure 16 Government revenues and expenditures.**

Per cent deviation from baseline scenario



**Figure 17 Current account and government savings.**

(Share of GDP) p.p. deviation from baseline scenario

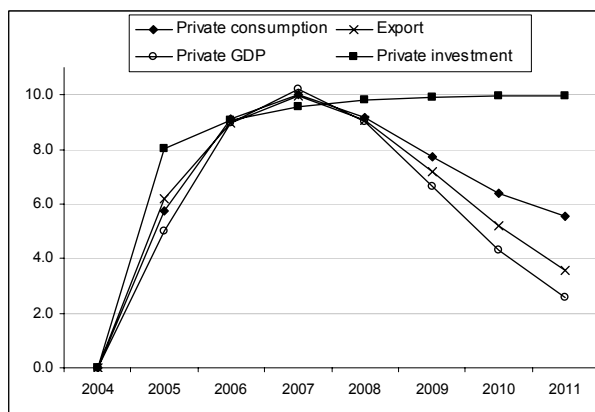


The government depends upon imports both for consumption and investments, so the increase in import price will affect their spending. The increase in government expenditures comes from increases in investments and consumption, and is financed by increasing the domestic debt, leading to increased interest payment on the government domestic debt. The increase in expenditures is solely due to increases in prices on investments and consumption, leaving the quantities unchanged.

In Figure 18 we see the effects on some of the price indices. Note that the price deflator for private investment is closely related to the (shift in) import price, because of the high import share of investment goods. The other price indices are influenced by the domestic prices, which in turn is linked to the costs of domestic production (labour unit costs).

**Figure 18 Price deflators.**

Per cent deviation from baseline scenario



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## Appendix 1. List of variables

Type N = endogenous, X = exogenous

Symbol	Type	Explanation
C	N	Total consumption
CA	N	Current account
CG	N	Government consumption
CP	N	Private consumption
CPO	N	Private consumption non smallholders
CPS	N	Private consumption smallholders
DELTAG	X	Depreciation rate government capital
DELTA P	X	Depreciation rate private sector capital
DEM	N	Demand facing private producers and importers
DG	N	Depreciation government capital
DP	N	Depreciation private sector capital
DUM94	X	Dummy = 1 in 1994, otherwise = 0
DUM9403	X	Dummy = 1 in 1994 and 2003, otherwise = 0
DUM9498	X	Dummy = 1 in 1994 and 1998, otherwise = 0
ERROM	X	Errors and omissions (in capital balance)
FER	X	Foreign exchange reserves
GEXP	N	Government expenditures (current accounts)
GREV	N	Total government revenue
GRTOT	N	Total government revenue including grants
GSAV	N	Government saving
HSAV	N	Household saving
I	N	Total imports of goods and services
INTFER	N	Interest payment on foreign exchange reserves
INTG	N	Interest payment on government debt (domestic and foreign)
INTGD	N	Interest payment on government domestic debt
INTGF	N	Interest payment on government debt to foreigners
INTPF	N	Interest payment on private debt to foreigners
IRFER	X	Interest rate earned on foreign exchange reserves
IRGD	X	Interest rate on government domestic debt
IRGF	X	Interest rate on government foreign debt
IRPF	X	Interest rate on private debt to foreigners
ISHARE	X	Share of imports in total demand
J	N	Total gross investment in fixed capital
JG	X	Gross investment government sector
JP	X	Gross investment private sector
JS	X	Stock building
K	N	Total stock of fixed capital
KG	N	Stock of fixed capital government sector
KP	N	Stock of fixed capital private sector
LABFORCE	X	Total labour force
LD	N	Total domestic credit
LDG	X	Domestic debt to the government
LGD	N	Domestic government debt
LGF	X	Government foreign debt
LPD	X	Private domestic debt
LPF	N	Private foreign debt

LS	N	Number of self employed
LUC	N	Labour unit costs
LWG	X	Number of wage earners government sector
LWP	N	Number of wage earners private sector
M	N	Money stock
MG	X	Government purchase of goods and services (1994-prices)
NFS	N	Net financial services
NTRFP	X	Net transfers to private from abroad
OEG	X	Other expenditures government
ONTR	X	Other non-tax revenue
OS	N	Operating surplus
OSH	N	Operating surplus accruing to households
OSHRATE	X	Share of operating surplus accruing to households
PCP	N	Deflator private consumption
PCPO	N	Deflator private consumption smallholder
PCPS	N	Deflator private consumption other
PI	X	Import deflator
PJG	N	Deflator government investment in fixed capital
PJP	N	Deflator private investment in fixed capital
PJS	N	Deflator stockbuilding
PMG	N	Deflator government purchases of goods and services
PX	N	Export deflator
PY	N	GDP-deflator
PYFAG	N	Deflator GDP agricultural sector in factor prices
PYFAGL	N	Deflator GDP agricultural large scale sector in factor prices
PYFAGS	N	Deflator GDP agricultural small scale sector in factor prices
PYFCO	N	Deflator GDP construction sector in factor prices
PYFDI	N	Deflator GDP distribution sector in factor prices
PYFEW	N	Deflator GDP electricity and water sector in factor prices
PYFFP	N	Deflator GDP financial and professional sector in factor prices
PYFMA	N	Deflator GDP manufacturing sector in factor prices
PYFMQ	N	Deflator GDP mining and quarrying sector in factor prices
PYFOD	N	Deflator GDP ownership of dwelling sector in factor prices
PYFPS	N	Deflator GDP priv. and social com. services sector in factor prices
PYFSE	N	Deflator GDP services sector in factor prices
PYFTC	N	Deflator GDP transport and communication sector in factor prices
PYFUC	N	Deflator GDP agricultural sector in factor prices
PYP	N	Deflator GDP private sector in market prices
PYPF	N	Deflator GDP private sector in factor prices
RCG	X	Residual government consumption
RCPO	X	Residual consumption non smallholders sector
RCPS	X	Residual consumption smallholders sector
RLWP	X	Residual labour demand
RNFS	X	Residual net factor services
ROSH	X	Residual operating surplus to households
RPCPO	X	Residual deflator non smallholders sector
RPCPS	X	Residual deflator smallholders sector
RPJP	X	Residual deflator for private investment
RPJS	X	Residual deflator for stockbuilding
RPMG	X	Residual deflator for government purchases of goods
RPX	X	Residual deflator for exports

RPYP	X	Residual deflator for GDP
RPYPF	X	Residual deflator for GDP private sector in market price
RVCG	X	Residual government consumption in current value
RVYG	X	Residual government sector GDP in current value
RX	X	Residual exports in constant prices
RYG	X	Residual government sector GDP in constant prices
RYPF	X	Residual GDP in private sector at factor cost
TD	N	Total direct taxes
TDB	X	Direct taxes on companies
TDH	N	Direct taxes on households
TH	X	Tax rate on household gross income
TIDRATE	X	Tax rate between import value and import duties
TIT	N	Indirect taxes
TITID	N	Import duties
TIVATED	N	Value added tax (surtax) and excise duty
TIVATRATE	X	Rate between TIVATED and private sector monetary consumption
TOT	X	Taxes (sum of misc. duties, export levy, other taxes, tax refunds, collections of arrears)
TP	X	Indirect tax rate
TREND	X	Trend variable 1 in 1979, 2 in 1980, ...
TREV	N	Gross tax revenue
TRFG	X	Transfers (grants) to the government from abroad
TRGH	X	Transfers (pensions) from the government to households
VC	N	Total final consumption in current prices
VCG	N	Value of government consumption
VCP	N	Value of private consumption
VI	N	Value of total imports
VJ	N	Value of total gross investment in fixed capital
VJG	N	Value of gross investment in government
VM	N	Velocity of money
VX	N	Value of total exports
VY	N	Value of GDP
VYAG	N	GDP agricultural sector in current value
VYAGL	N	GDP agricultural large scale sector in current value
VYAGLRATE	X	Rate of GDP agriculture large scale sector of total GDP private sector in current value in current value
VYAGS	N	GDP agricultural small scale sector in current value
VYAGSRATE	X	Rate of GDP agricultural small scale sector of total GDP private sector in current value
VYCO	N	GDP construction sector in current value
VYCORATE	X	Rate of GDP construction sector of total GDP private sector in current value
VYDI	N	GDP distribution sector in current value
VYDIRATE	X	Rate of GDP distribution sector of total GDP private sector in current value
VYEW	N	GDP electricity and water sector in current value
VYEWRATE	X	Rate of GDP electricity and water sector of total GDP private sector in current value
VYFP	N	GDP financial and professional sector in current value
VYFPRATE	X	Rate of GDP financial and professional sector of total GDP private sector in current value
VYG	N	Value of GDP government sector
VYMA	N	GDP manufacturing sector in current value
VYMARATE	X	Rate of GDP manufacturing sector of total GDP private sector in current value

VYMQ	N	GDP mining and quarrying sector in current value
VYMQRATE	X	Rate of GDP mining and quarrying sector of total GDP private sector in current value
VYOD	N	GDP ownership of dwelling sector of total GDP private sector in current value
VYODRATE	X	Rate of GDP ownership of dwelling sector of total GDP private sector in current value
VYP	N	Value of private sector GDP
VYPS	N	GDP private and social community services sector in current value
VYPSRATE	X	Rate of GDP private and social community services sector of total GDP private sector in current value
VYSE	N	GDP services sector in current value
VYTC	N	GDP transport and communication sector in current value
VYTCRATE	X	Rate of GDP transport and communication sector of total GDP private sector in current value
VYUC	N	GDP unallocable finance charges sector in current value
WG	X	Wage rate government sector employees
WH	N	Total wage income for households
WP	N	Wage rate private sector employees
X	N	Volume of total exports
Y	N	GDP in constant 1994-prices
YF	N	GDP at 1994 factor cost
YFAG	N	GDP agricultural scale sector at constant 1994 factor cost
YFAGL	N	GDP agricultural large scale sector at constant 1994 factor cost
YFAGLRATE	X	Rate of GDP agricultural large scale sector of total GDP private sector at constant 1994 factor cost
YFAGS	N	GDP agricultural small scale sector at constant 1994 factor cost
YFAGSRATE	X	Rate of GDP agricultural small scale sector of total GDP private sector at constant 1994 factor cost
YFCO	N	GDP construction sector at constant 1994 factor cost
YFCORATE	X	Rate of GDP construction sector of total GDP private sector at constant 1994 factor cost
YFDI	N	GDP distribution sector at constant 1994 factor cost
YFDIRATE	X	Rate of GDP distribution sector of total GDP private sector at constant 1994 factor cost
YFEW	N	GDP electricity and water sector at constant 1994 factor cost
YFEWRATE	X	Rate of GDP electricity and water sector of total GDP private sector at constant 1994 factor cost
YFFP	N	GDP financial and professional sector at constant 1994 factor cost
YFFPRATE	X	Rate of GDP financial and professional sector of total GDP private sector at constant 1994 factor cost
YFMA	N	GDP manufacturing sector at constant 1994 factor cost
YFMARATE	X	Rate of GDP manufacturing sector of total GDP private sector at constant 1994 factor cost
YFMQ	N	GDP mining and quarrying sector at constant 1994 factor cost
YFMQRATE	X	Rate of GDP mining and quarrying sector of total GDP private sector at constant 1994 factor cost
YFOD	N	GDP ownership of dwelling sector at constant 1994 factor cost
YFODRATE	X	Rate of GDP ownership of dwelling sector of total GDP private sector at constant 1994 factor cost
YFPS	N	GDP private and social community services sector at constant 1994 factor cost
YFPSRATE	X	Rate of GDP private and social community services sector of total GDP private sector at constant 1994 factor cost
YFSE	N	GDP services sector at constant 1994 factor cost
YFTC	N	GDP transport and communication sector at constant 1994 factor cost
YFTCRATE	X	Rate of GDP transport and communication sector of total GDP private sector at constant 1994 factor cost
YFUC	N	GDP unallocable finance charges sector at constant 1994 factor cost

YG	N	GDP in government sector in 1994-prices
YH	N	Gross income household sector
YHD	N	Disposable income household sector
YHDR	N	Real disposable income household sector
YP	N	GDP in fixed 1994-market prices, private sector
YPF	N	GDP in fixed 1994-factor prices, private sector
YPFO	N	GDP in fixed 1994-factor prices, private sector non smallholder sector
YUSWORLD	X	GDP World

## **Appendix 2. Some data issues**

Most of the data used in the model are taken directly from the national accounts of Malawi. As in the current Malawian National Accounts the base year in the model is 1994 implying that values in fixed and current prices are equal in that year. Thus all price indices are equal to unity in 1994. Malawian data for some important variables do not exist and have to be estimated for each year. In what follows we will describe how this was done.

### **Appendix 2.1. Capital stocks**

The national accounts do not include capital stock estimates. We have used the standard perpetual inventory method. First we have looked at the series for gross investment in fixed capital by sector (private and government). For the private sector gross investment (JP) is a stationary variable although it fluctuates a lot. We thus estimated the average investment over the entire period 1979 to 2002 and divided it by an assumed depreciation rate (set to 0.1) in order to get an estimate of the initial capital stock  $KP(0)$  where year 0 is the end of 1978. Then assuming the equations included in the model, a series of capital stock data can easily be estimated.

For the government sector we have used the same method. In this case, however, the investment series are not necessarily stationary (a formal test has not been carried out). There is a high investment level in the early years dropping to about half the level in the early 1980s before increasing back to initial levels during the later 1990s. Thus it is far from obvious how to choose a representative and "stationary" level. We have simply chosen the average investment level again using data for the period 1979 to 2002. Then calculated the initial capital stock as explained above using the same depreciation rate as for the private sector. Then the formulas in the model handle the rest. Note however, that the data for depreciation and capital stock in the government sector is not really used for anything in the model as it now stands as capital costs is not included in the construction of government consumption and value added. Also since we are mainly interested in the period starting in the mid 1990s and onwards, the importance of our guesstimate of the initial capital stock diminishes quite quickly when the assumed depreciation rate is as high as 0.1. Thus the capital stock in the latter part of our historical period is not very sensitive to our initial estimate.

### **Appendix 2.2. Employment**

We have data for employment of wage earners (employees) from 1979 to 1995, but not for more recent years. The data for employees in the government sector (LWG) are extended assuming virtually no change in government employment from 1995 to 2003. We have the wage sum (wages and salaries in government sector) from the national accounts. Thus given  $WG*LWG$  and our estimate for LWG, we calculate WG.

To determine private sector employment of wage earners a more elaborate procedure has been used. Using the postulated Cobb-Douglas production function and using first order conditions for profit maximization, we know that the share of wages in factor income is equal to the parameter  $\alpha$  in the production function. We use data for the period where data do exist, to estimate  $\alpha$ . Using this estimate for years after 1995 together with data for factor income in current prices, we can calculate the sum of wages and salaries in the private sector ( $WP*LWP$ ). We then assumed a constant ratio between government and private wage rates per employee in order to get an estimate of WP. Then LWP can be calculated. This procedure gave unreasonably large fluctuations in LWP, so the initial estimate was somewhat smoothed (using a centred moving average) to produce the final estimate of LWP. Given this smoothing procedure, the initial estimate of  $WP*LWP$  is changed due to changes in LWP so that the factor share has a cyclical development as opposed to the constant level chosen initially using the production function parameter.

## Appendix 3. The model

ENDOGENOUS: C CA CG CP CPO CPS DEM DG DP GEXP GREV GRTOT GSAV HSAV I INTFER INTG INTGD  
 INTGF INTPF J K KG KP LD LGD LPF LS LUC LWP M NFS OS OSH PCP PCPO PCPS PJG PJP PJS PMG  
 PX PY PYFAG PYFAGL PYFAGS PYFCO PYFDI PYFEW PYFFP PYFMA PYFMQ PYFOD PYFPS PYFSE PYFTC  
 PYFUC PYP PYPF TD TDH TIT TITID TIVATED TREV VC VCG VCP VI VJ VJG VM VX VY VYAG VYAGL  
 VYAGS VYCO VYDI VYEW VYFP VYG VYMA VYMQ VYOD VYP VYPS VYSE VYTC VYUC WH WP X Y YF YFAG  
 YFAGL YFAGS YFCO YFDI YFEW YFFP YFMA YFMQ YFOD YFPS YFSE YFTC YFUC YG YH YHD YHDR YP  
 YPF YPFO

EXOGENOUS: DELTAG DELTAP DUM94 DUM9403 DUM9498 ERROM FER IRFER IRGD IRGF IRPF ISHARE  
 JG JP JS LABFORCE LDG LGF LPD LWG MG NTRFP OEG ONTR OSHRATE PI RCG RCPO RCPS RLWP RNFS  
 ROSH RPCPO RPCPS RPJP RPJS RPMG RPX RPYP RPYPF RVCG RVYG RX RYG RYPF TDB TH TIDRATE  
 TIVATRATE TOT TP TREND TRFG TRGH VYAGLRATE VYAGSRATE VYCORATE VYDIRATE VYEWRATE  
 VYFPRATE VYMARATE VYMQRATE VYODRATE VYPSRATE VYTCRATE WG WPRATE YFAGLRATE YFCORATE  
 YFDIRATE YFEWRATE YFFPRATE YFMARATE YFMQRATE YFODRATE YFPSRATE YFTCRATE YUSWORLD

1: GREV = TREV+ONTR  
 2: GRTOT = GREV+TRFG  
 3: TREV = TD+TIT+TOT  
 4: TD = TDH+TDB  
 5: TIT = TITID+TIVATED  
 6: TITID = TIDRATE\*VI  
 7: TIVATED = TIVATRATE\*PCPO\*CPO  
 8: GEXP = VCG+VJG+TRGH+INTG+OEG  
 9: INTG = INTGF+INTGD  
 10: GSAV = GRTOT+VJG-GEXP  
 11: VCG = WG\*LWG+PMG\*MG+RVCG  
 12: CG = 0.01259\*LWG+MG+RCG  
 13: KG = JG+KG(-1)-DG  
 14: DG = DELTAG\*KG(-1)  
 15: YG = LWG\*RYG  
 16: VYG = WG\*LWG\*RVYG  
 17: VJG = PJG\*JG  
 18: INTGD = IRGD\*(LGD+LGD(-1))/2  
 19: INTGF = IRGF\*(LGF+LGF(-1))/2  
 20: GSAV = VJG+LDG-LDG(-1)-(LGD-LGD(-1))-(LGF-LGF(-1))  
 21: PYP = (1+TP)\*PYPF/(1+0.1406)\*RPYP  
 22: TDH = TH\*YH  
 23: YHD = YH-TDH  
 24: YHDR = YHD/PCPO  
 25: YH = WH+OSH+TRGH  
 26: WH = WG\*LWG+WP\*LWP  
 27: OSH = OSHRATE\*OS-PCPS\*CPS+ROSH  
 28: HSAV = YHD-VCP  
 29:  $\text{LOG}(CPO/CPO(-1)) = 0.0536 + 0.9848 * \text{LOG}(YHDR/YHDR(-1)) - 0.2869 * \text{LOG}(CPO(-1)/YHDR(-1)) - 0.6002 * \text{DUM94} + \text{RCPO}$   
 30: CPS = LS\*RCPS  
 31: CP = CPO+CPS  
 32: VCP = PCPO\*CPO+PCPS\*CPS  
 33: PCP = VCP/CP  
 34:  $\text{LOG}(PX/PX(-1)) = -0.071442 + 0.2309 * \text{LOG}(PI/PI(-1)) + 0.781455 * \text{LOG}(PYP/PYP(-1)) - 0.302608 * \text{LOG}(PX(-1)/PYP(-1)) + 0.335347 * \text{DUM9498} + \text{RPX}$   
 35: VX = PX\*X  
 36: VI = PI\*I  
 37: CA = VX-VI+NTRFP+NFS  
 38: NFS = -INTGF-INTPF+INTFER+RNFS  
 39: INTFER = IRFER\*(FER+FER(-1))/2  
 40: INTPF = IRPF\*(LPF+LPF(-1))/2  
 41: CA+TRFG = FER-FER(-1)-(LPF-LPF(-1))-(LGF-LGF(-1))+ERROM  
 42: DEM = CPO+MG+JG+JP+X+JS  
 43: I = ISHARE\*DEM  
 44:  $\text{DEL}(1:\text{LOG}(X)) = -28.734 + 0.290941 * \text{DEL}(1:\text{LOG}(PI/PX)) + 0.854594 * \text{LOG}(YUSWORLD(-1)/X(-1)) + 0.412703 * \text{LOG}(YUSWORLD(-2)/X(-2)) + 0.170321 * \text{LOG}(PI(-2)/PX(-2)) + \text{RX}$

45: DEL(1:LOG(LWP)) = 2.0578+0.4321\*DEL(1: LOG(YPFO))-0.4586\*(LOG(LWP(-1))  
-2\*LOG(YPFO(-1))+LOG(KP(-2)))-0.0101\*TREND+RLWP  
46: KP = JP-DP+KP(-1)  
47: DP = DELTAP\*KP(-1)  
48: OS = PYPF\*YPF-WP\*LWP  
49: YPF = YPFO+YFAGS  
50: LUC = WP\*LWP/YPFO  
51: LOG(PYPF/PYPF(-1)) = 0.104321+0.708408\*LOG(PYPF(-1)/PYPF(-2))+  
0.475095\*LOG(PI/PI(-1))+0.235742\*LOG(LUC/LUC(-1))  
-0.364528\*LOG(PYPF(-1)/PI(-1))+0.146252\*LOG(LUC(-1)/PI(-1))+RPYPF  
52: LOG(PCPO/PCPO(-1)) = 0.052753+0.286583\*LOG(PI/PI(-1))+0.613581\*LOG(PYP/PYP(-1))  
-0.531505\*LOG(PCPO(-1)/PI(-1))+0.236691\*LOG(PYP(-1)/PI(-1))+RPCPO  
53: LOG(PJP/PJP(-1)) = 0.102279+0.810991\*LOG(PI/PI(-1))-0.5266\*LOG(PJP(-1)/PI(-1))  
-0.193706\*DUM9403+RPJP  
54: PJG = PJP  
55: PMG = PYP\*RPMG  
56: PJS = PYP\*RPJS  
57: PCPS = PCP\*RPCPS  
58: Y+I = C+J+JS+X  
59: Y = YG+YP  
60: C = CG+CP  
61: J = JG+JP  
62: PY\*Y+VI = VCG+VCP+VJ+PJS\*JS+VX  
63: VY = VYG+VYP  
64: VYP = PYP\*YP  
65: YPF = YP/(1+0.1406)+RYPF  
66: VC = VCP+VCG  
67: VJ = PJG\*JG+PJP\*JP  
68: K = KG+KP  
69: LABFORCE = LWG+LWP+LS  
70: WP = WPRATE\*WG  
71: M = LD+FER  
72: LD = LGD-LDG+LPD  
73: VM = VY/M  
74: YFAGS = CPS  
75: YFAGL = YFAGLRATE\*YPF  
76: YFMQ = YFMQRATE\*YPF  
77: YFMA = YFMARATE\*YPF  
78: YFEW = YFEWRATE\*YPF  
79: YFCO = YFCORATE\*YPF  
80: YFOD = YFODRATE\*YPF  
81: YFDI = YFDIRATE\*YPF  
82: YFTC = YFTCRATE\*YPF  
83: YFFP = YFFPRATE\*YPF  
84: YFPS = YFPSRATE\*YPF  
85: YFUC = YPF-YFAGS-YFAGL-YFMQ-YFMA-YFEW-YFCO-YFOD-YFDI-YFTC-YFFP-YFPS  
86: YFAG = YFAGS+YFAGL  
87: YFSE = YFDI+YFTC+YFFP+YFPS+YG+YFUC  
88: YF = YFAG+YFMQ+YFMA+YFEW+YFCO+YFOD+YFSE  
89: VYAGS = VYAGSRATE\*VYP  
90: VYAGL = VYAGLRATE\*VYP  
91: VYMQ = VYMQRATE\*VYP  
92: VYMA = VYMARATE\*VYP  
93: VYEW = VYEWRATE\*VYP  
94: VYCO = VYCORATE\*VYP  
95: VYOD = VYODRATE\*VYP  
96: VYDI = VYDIRATE\*VYP  
97: VYTC = VYTCRATE\*VYP  
98: VYFP = VYFPRATE\*VYP  
99: VYPS = VYPSRATE\*VYP  
100: VYUC = VYP-VYAGS-VYAGL-VYMQ-VYMA-VYEW-VYCO-VYOD-VYDI-VYTC-VYFP-VYPS  
101: VYAG = VYAGS+VYAGL  
102: VYSE = VYDI+VYTC+VYFP+VYPS+VYG+VYUC  
103: PYFAGS = VYAGS/YFAGS  
104: PYFAGL = VYAGL/YFAGL  
105: PYFMQ = VYMQ/YFMQ  
106: PYFMA = VYMA/YFMA

107: PYFEW = VYEW/YFEW  
108: PYFCO = VYCO/YFCO  
109: PYFOD = VYOD/YFOD  
110: PYFDI = VYDI/YFDI  
111: PYFTC = VYTC/YFTC  
112: PYFFP = VYFP/YFFP  
113: PYFPS = VYPS/YFPS  
114: PYFUC = VYUC/YFUC  
115: PYFAG = VYAG/YFAG  
116: PYFSE = VYSE/YFSE

## Appendix 4. Estimation results

### Appendix 4.1. Introduction

The selection of equations for estimation is based on a desirability to cover main parts of the private sector economic behaviour and the availability of data. One obvious candidate is the equation describing private consumption, due to its large contribution to GDP. The equation for volume of exports is also estimated using a so-called Armington function. A labour demand function has been estimated using an inverted Cobb-Douglas production function. In addition we have estimated four price equations; export price, consumer price, factor price and the price of private investments.

Our estimation methods have been Ordinary Least Squares (OLS). Some effort has been put into the dynamic specification of the equations. Together with the simultaneous modelling approach for the model as a whole, this should gain the macroeconomic modelling efforts considerably. Building a model concentrating for the most on analysing short to medium terms effects of policy shocks and forecasts, a good description of the dynamic process is needed. Having said that, the dynamic specification of the model requires more effort by the model users to obtain a sound knowledge of the workings of the model than in the case of static equations.

The general econometric approach is often named “general to specific”, because we start with a fairly general model including all relevant variables according to economic theory. The econometric specification at this stage should be quite flexible.

During the estimation process variables whose coefficients are not considered significant is removed and restrictions are tested and imposed in order to obtain a specification without too many coefficients to estimate. All equations in this section are specified as log-linear, giving the advantage that the elasticities are easily calculated from estimated results. The dynamic specification is the so-called error-correction model in which both the long run properties and short run dynamics can be specified explicitly. When simulating these equations, the error-correction mechanism will force the endogenous variables towards the long run (steady state) solution. In the true economy there will always be short-term shocks pushing the economy outside this steady-state path. The error correction formulation opens up for this shocks and in the same time ensures that the economy is drawn back towards the (more structural) long run solution. One particular advantage with this specification is that it is easy to impose and test theoretical assumptions, and the structural economic theory build into the equation can be read out of the so called error correction term.

For a simple two variable model, the log-linear specification can be written as follows:

$$\text{A5 1} \quad \log(y) - \log(y_{-1}) = a + b \cdot \log(y_{-1}) + c \cdot \log(x_{-1}) + \underline{d \cdot (\log(x) - \log(x_{-1}))} + \underline{e \cdot (\log(y_{-1}) - \log(y_{-2}))} + u$$

where  $y$  is the endogenous variable,  $x$  is the exogenous variable,  $u$  is the error term and  $a$ ,  $b$ ,  $c$ ,  $d$  and  $e$  are coefficients. The **highlighted** part of the equation is the long run solution, while the underlined part is the short run dynamics. The estimate of  $b$  should always be negative and the long run elasticity is given by  $-c/b$ . If the estimate of  $c$  is negative, the elasticity is accordingly positive and vice versa. If estimates  $c$  and  $d$  are equal, the (long run) elasticity is equal to 1 and the restriction  $b = c$  can be imposed explicitly in the equation and tested as in the following regression (where difference terms are omitted for simplicity):

$$\text{A5 2} \quad \log(y) - \log(y_{-1}) = a + b \cdot (\log(y_{-1}) + \log(x_{-1})) + f \cdot \log(y_{-1}) + u$$

If  $f$  is significant, the restriction  $b = c$  is accepted.

For a three variable model the restriction will be imposed somewhat differently. For ease of exposition, we omit difference and error terms. The model without restrictions is:

$$\text{A5 3} \quad \log(y) - \log(y_{-1}) = a + b \cdot \log(y_{-1}) + c \cdot \log(x_{-1}) + d \cdot \log(z_{-1})$$

The following specification impose the restriction that the sum of the long run elasticities are unity, the elasticity of y with respect to x being c/c+d, and the elasticity with respect to z is equal to d/c+d:

$$\text{A5 4} \quad \log(y) - \log(y_{-1}) = a + c \cdot (\log(y_{-1}) - \log(x_{-1})) + d \cdot (\log(y_{-1}) - \log(z_{-1}))$$

Tests of restrictions and the procedure leading from the general to the preferred equation are not presented here, but explanation of the chosen specification are attached to each equation. The final version of each equation is presented, based on estimation of the implemented equation in TROLL. The most important output from TROLL estimation is as follows:

**Table 5 Statistics from estimation in TROLL**

<i>Output statistics</i>	<i>Explanation</i>	<i>Output statistics</i>	<i>Explanation</i>
NOB	Number of observations	NOVAR	Number of variables
NOCOEF	Number of coefficients	RANGE	Estimation period
RSQ	R <sup>2</sup>	SER	Standard error of regression
DW	Durbin-Watson statistic	ESTIMATE	Estimated values
STER	Standard deviation	TSTAT	T-statistic

## Appendix 4.2. Private consumption

A typical consumption function would include an income term, a wealth term and a real interest term. Due to weak data we exclude the wealth-term. Due to estimation results we have also discarded the real interest variable from the equation. As the income term we use disposable income in households, adjusted for inflation. The consumption function applies only to households that are not smallholders, and their consumption is called CPO. The equation in the model is

$$\text{LOG (CPO/CPO (-1))} = 0.0536 + 0.9848 \cdot \text{LOG (YHDR/YHDR (-1))} - 0.2869 \cdot \text{LOG (CPO (-1) / YHDR (-1))} - 0.6002 \cdot \text{DUM94} + \text{RCPO}$$

Symbols in the equation

CPO	Private consumption non-smallholders
YHDR	Real disposable income household sector
DUM94	Dummy = 1 in 1994, otherwise = 0
RCPO	Residual term consumption non-smallholders sector

In the short term consumption will rise if the real disposable income is increasing, this is the term  $0.9848 \cdot \text{LOG (YHDR/YHDR(-1))}$ .

If the gap between the level of consumption and real disposable income is negative (i.e. positive saving), that is, if  $\text{LOG (CPO(-1)/YHDR(-1))}$  is negative, this is adjusted by increasing the consumption level to its long run level.

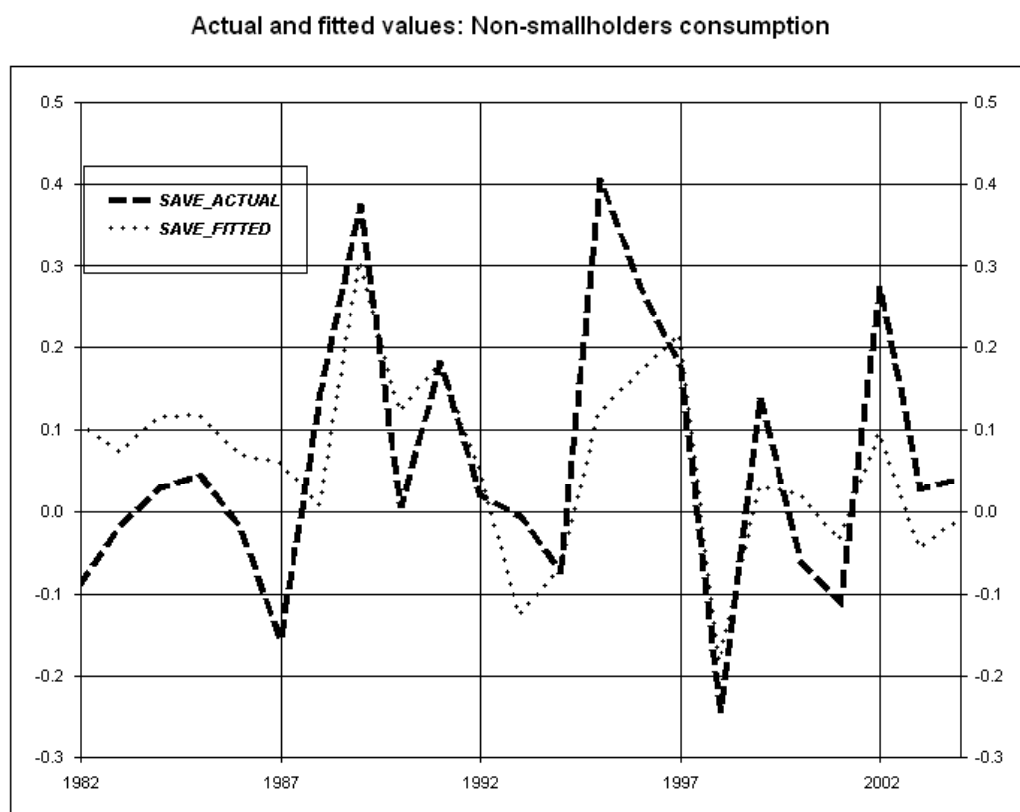
The fact that the coefficient in the long term is one reflects that consumption in the long run follows the income level. To isolate the long run solution we eliminate all lags and replace all delta terms with zeros. Then we get:

$$0 = -0.2869 \cdot \text{LOG (CPO/YHDR)} - 0.6002 \cdot \text{DUM94}, \text{ or (removing the dummy)}$$

$$0.2869 \cdot \text{LOG (CPO)} = 0.2869 \cdot \text{LOG (YHDR)}, \text{ or (dividing and taking anti-log)}$$

**CPO = YHDR**, which is the long run solution.

Figure 19 Actual and fitted values: Non-smallholders consumption



ORDINARY LEAST SQUARES

LHS VARIABLE: LOG(CPO/CPO(-1))

NOB = 23 NOVAR = 4 NCOEF = 4  
RANGE: 1982A to 2004A

RSQ =	0.45038	CRSQ =	0.363598
F(3/19) =	5.189786	PROB>F =	0.008683
SER =	0.131651	SSR =	0.329306
DW(0) =	1.597949	COND =	2.798646
MAX:HAT =	1	RSTUDENT =	NA
DFFITS =	NA		

COEF	ESTIMATE	STER	TSTAT	PROB> T
LOG(YHDR/YHDR(-1))	0.984823	0.268847	3.663136	0.001653
LOG(CPO(-1)/YHDR(-1))	-0.286946	0.149176	-1.923542	0.069527
DUM94	-0.600209	0.193611	-3.100076	0.005894
CONST	0.053583	0.028319	1.892128	0.073814

### Appendix 4.3. Price of export

The price of exports depends on price of imports, reflecting cost of input factors and world market prices, and the price on domestic value added, reflecting wages and other domestic cost drivers. The export estimated price equation is:

$$\text{LOG(PX/PX(-1))} = -0.0714 + 0.2309 \cdot \text{LOG(PI/PI(-1))} + 0.7814 \cdot \text{LOG(PYP/PYP(-1))} - 0.3026 \cdot \text{LOG(PX(-1)/PYP(-1))} + 0.3353 \cdot \text{DUM94} + \text{RPX}$$

Symbols in the equation

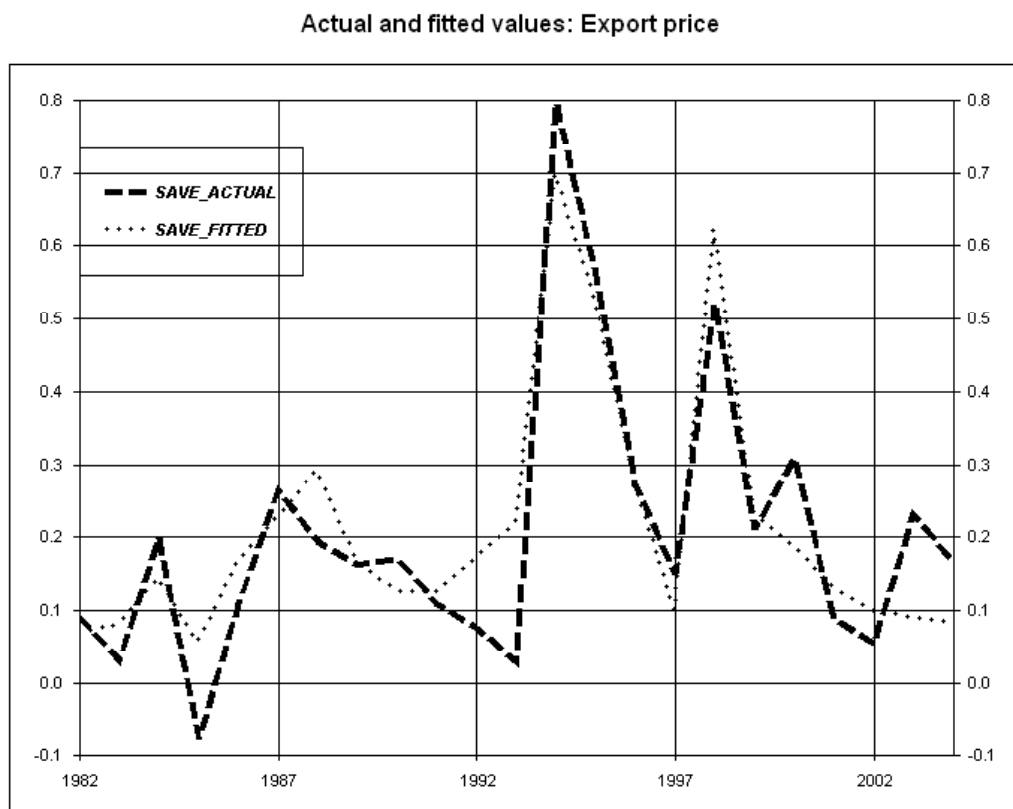
- PX            Export deflator
- PI            Import deflator
- PYP          Deflator GDP in the private sector in market prices
- DUM9498     Dummy = 1 in 1994 and 1998, otherwise = 0
- RPX          Residual term deflator for exports

From the long run version of this equation, given as

$$0 = -0.302608 * \text{LOG}(PX/PYP) + 0.335347 * \text{DUM9498}$$

we realise that in the long run export prices follow the price on domestic value added. In the short run export prices will increase as the import and/or value added prices increases.

**Figure 20 Actual and fitted values: Export price**



ORDINARY LEAST SQUARES

LHS VARIABLE: LOG(PX/PX(-1))

NOB = 24    NOVAR = 5    NCOEF = 5

RANGE: 1981A to 2004A

RSQ =	0.79274	CRSQ =	0.749106
F(4/19) =	18.168057	PROB>F =	0
SER =	0.095838	SSR =	0.174513
DW(0) =	1.913695	COND =	7.176143
MAX:HAT =	0.68038	RSTUDENT =	-2.27693
DFFITs =	2.668272		

COEF	ESTIMATE	STER	TSTAT	PROB> T
LOG(PI/PI(-1))	0.226913	0.167065	1.358232	0.190301
LOG(PYP/PYP(-1))	0.785573	0.203952	3.851759	0.001075

LOG (PX (-1) / PYP (-1))	-0.297663	0.161375	-1.844541	0.080753
DUM9498	0.337171	0.08596	3.92242	0.000915
CONST	-0.070908	0.06036	-1.174751	0.254608

#### Appendix 4.4. Volume of exports

We have estimated an export equation of the so-called Armington type (exports depend on relative prices between domestic export prices and world market prices, as well as an indicator of markets size or market growth. The estimated function is

$$\text{DEL}(\text{LOG}(X)) = -28.734 + 0.2909 \cdot \text{DEL}(1: \text{LOG}(\text{PI}/\text{PX})) + 0.8545 \cdot \text{LOG}(\text{YUSWORLD}(-1)/X(-1)) \\ + 0.4127 \cdot \text{LOG}(\text{YUSWORLD}(-2)/X(-2)) + 0.1703 \cdot \text{LOG}(\text{PI}(-2)/\text{PX}(-2)) + \text{RX}$$

Symbols in the equation

X	Volume of total exports
YUSWORLD	GDP World
PI	Import deflator
PX	Export deflator

In the short run, exports increase if imports get relatively more expensive than exports, i.e. if PI increases more than PX, which means Malawian goods are increasing their market share on the world market.

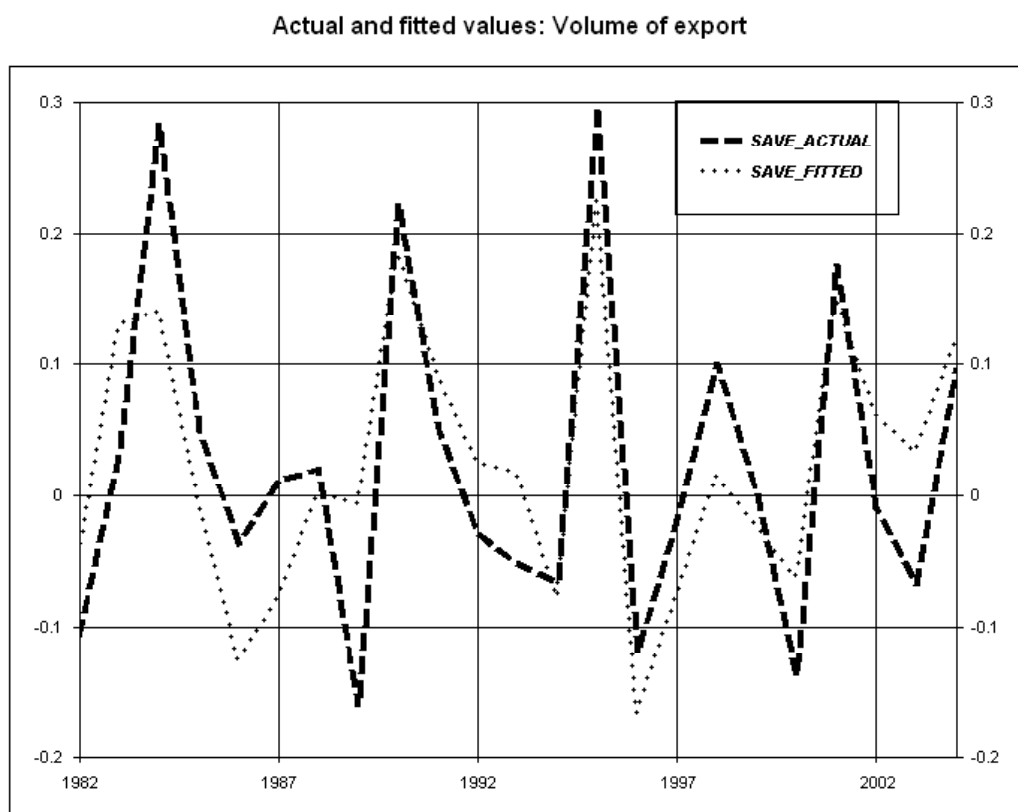
In the long run, exports will grow at the same speed as the world market size, for given relative prices. If Malawian exports become relatively cheaper than other countries exports, exports from Malawi will grow faster than the world market, and gain market share. This is clear from studying the long run part of the equation, given as

$$0 = 0.854594 \cdot \text{LOG}(\text{YUSWORLD}/X) + 0.412703 \cdot \text{LOG}(\text{YUSWORLD}/X) + 0.170321 \cdot \text{LOG}(\text{PI}/\text{PX})$$

or,

$$\text{LOG}(X) = \text{LOG}(\text{YUSWORLD}) + (0.1703/1.2672) \cdot [\text{LOG}(\text{PI}) - \text{LOG}(\text{PX})]$$

Figure 21 Actual and fitted values: Volume of exports



ORDINARY LEAST SQUARES

LHS VARIABLE: DEL(1: LOG(X))

NOB = 24 NOVAR = 5 NCOEF = 5

RANGE: 1981A to 2004A

RSQ =	0.673979	CRSQ =	0.605343
F(4/19) =	9.819625	PROB>F =	0.000176
SER =	0.082183	SSR =	0.128327
DW(0) =	1.5545	COND =	712.45195
MAX:HAT =	0.608422	RSTUDENT =	-2.136748
DFFITS =	0.797582		

COEF	ESTIMATE	STER	TSTAT	PROB> T
DEL(1: LOG(PI/PX))	0.289729	0.112437	2.576804	0.018476
LOG(YUSWORLD(-1)/X(-1))	0.85468	0.1642	5.205109	5.03739239e-005
LOG(YUSWORLD(-2)/X(-2))	0.411276	0.178479	2.304343	0.03266
LOG(PI(-2)/PX(-2))	0.170506	0.067115	2.540513	0.019956
CONST	-28.703678	5.401225	-5.31429	3.95803661e-005

## Appendix 4.5. Private sector employment

We have modeled private sector employment by the following equation:

$$\text{DEL}(1: \text{LOG}(\text{LWP})) = 2.0578 + 0.4321 * \text{DEL}(1: \text{LOG}(\text{YPFO})) - 0.4586 * (\text{LOG}(\text{LWP}(-1)) - 2 * \text{LOG}(\text{YPFO}(-1))) + \text{LOG}(\text{KP}(-2)) - 0.0101 * \text{TREND} + \text{RLWP}$$

Symbols in the equation

LWP                      Number of wage earners in the private sector

YPFO GDP in fixed 1994-factor prices, private sector non-smallholder sector  
 KP Stock of fixed capital in the private sector  
 TREND Trend variable 1 in 1979, 2 in 1980, etc.  
 RLWP Residual term number of wage earners in the private sector

It is an inverted production function, and the change in labour employed is determined by the change in value added, the level of employment relative to value added and capital, and a trend variable.

In the short run labour demand is only affected by changes in output. In the long run we have the following relationship:

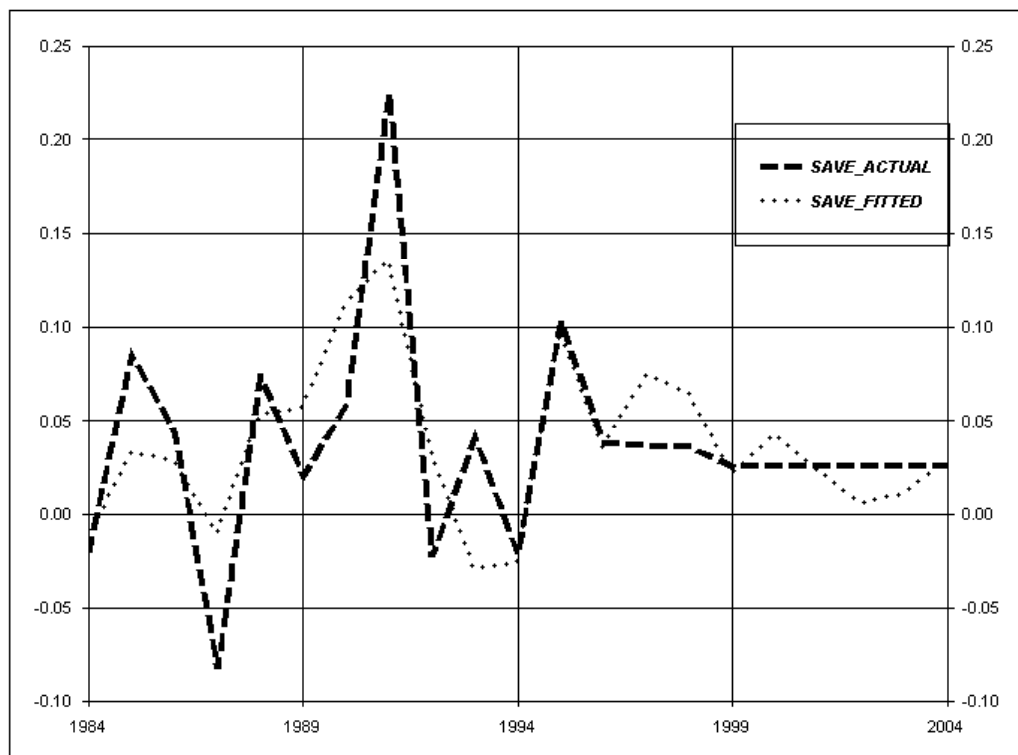
$$0 = -0.4586 * (\text{LOG}(\text{LWP}) - 2 * \text{LOG}(\text{YPFO}) + \text{LOG}(\text{KP})) - 0.0101 * \text{TREND}$$

where the specification of the long run solution  $\text{LOG}(\text{LWP}) = 2 * \text{LOG}(\text{YPFO}) + \text{LOG}(\text{KP})$ , implies that we have imposed constant returns to scale and the labour and capital share is set to 0.5. This assumption is roughly in line with tests and results from the estimation process. Note that the trend variable is the same as an inverted total factor productivity-factor. The error correction mechanism of the equation can be written as

$$\text{YPFO} = e^{0.11 \text{TREND}} * \text{LWP}^{0.5} * \text{KP}^{0.5}$$

**Figure 22 Actual and fitted values: Number of wage earners, private sector**

Actual and fitted values: Number of wage earners, private sector



ORDINARY LEAST SQUARES

LHS VARIABLE: DEL(1: LOG(LWP))

NOB = 23 NOVAR = 4 NCOEF = 4  
 RANGE: 1982A to 2004A

RSQ = 0.460683 CRSQ = 0.375527  
 F(3/19) = 5.409911 PROB>F = 0.007322

SER =	0.052963	SSR =	0.053296
DW(0) =	2.680604	COND =	130.089647
MAX:HAT =	0.482737	RSTUDENT =	3.213222
DFFITS =	1.344543		

COEF	ESTIMATE	STER	TSTAT	PROB> T
DEL(1: LOG(YPFO))	0.468785	0.217879	2.151584	0.044504
LOG(LWP(-1))	-0.49184	0.132586	-3.709585	0.001487
-2*LOG(YPFO(-1))				
+LOG(KP(-2))				
TREND	-0.011944	0.003353	-3.562346	0.002079
CONST	2.225925	0.587017	3.791929	0.001232

## Appendix 4.6. Factor price

The equation for value added at factor prices is estimated as:

$$\begin{aligned} \text{LOG(PYPF/PYPF(-1))} = & 0.104321 + 0.708408 * \text{LOG(PYPF(-1)/PYPF(-2))} + \\ & 0.475095 * \text{LOG(PI/PI(-1))} + 0.235742 * \text{LOG(LUC/LUC(-1))} \\ & - 0.364528 * \text{LOG(PYPF(-1)/PI(-1))} + 0.146252 * \text{LOG(LUC(-1)/PI(-1))} + \text{RPYPF} \end{aligned}$$

Symbols in the equation

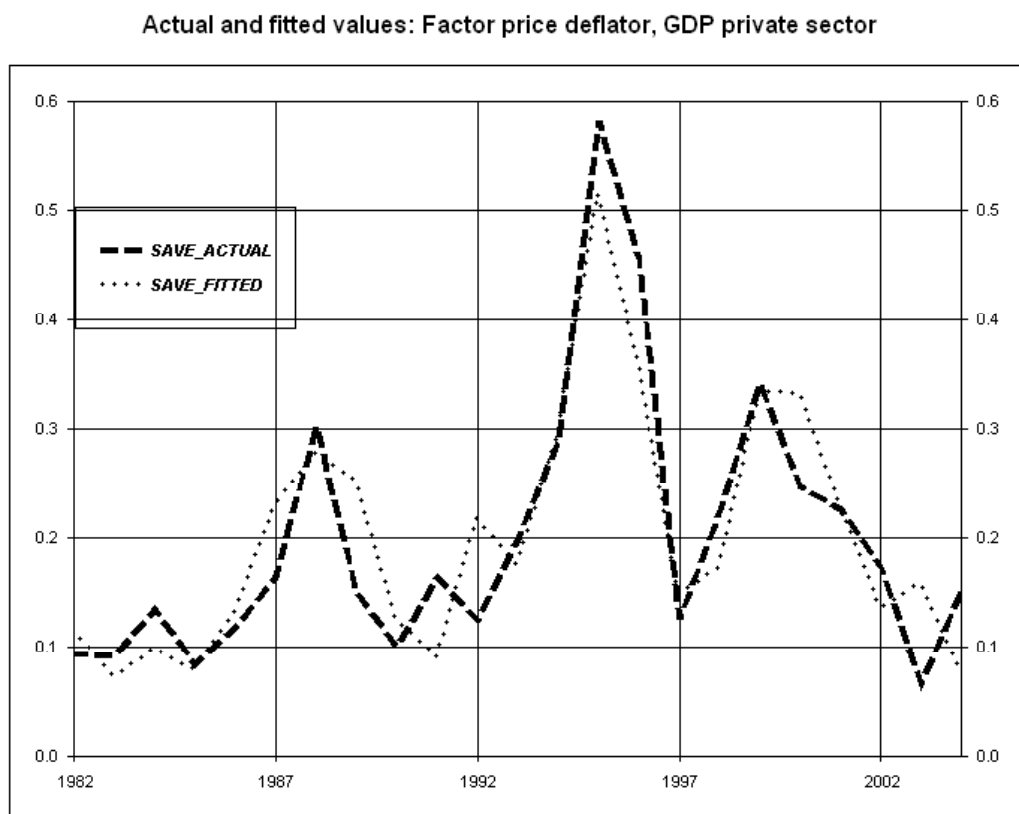
PYPF            Deflator GDP in the private sector in factor prices  
PI                Import deflator  
LUC              Labour unit costs  
RPYPF           Residual term deflator for GDP in the private sector at factor cost

In the short run, changes in PYPF are given by changes in labour unit costs and changes in import prices. The inclusion of change in PYPF with one lag on the right hand side reflects some persistence in these prices.

In the long run, PYPF is positively affected by import prices, reflecting partly that some inputs are imported and partly that domestic products to some extent compete with internationally produced products. Secondly, PYPF is positively affected by labour unit costs, mirroring that producers must cover increased wage costs by increasing their prices on produced goods. In the long run we have

$$\text{LOG(PYPF)} = 0.598790 * \text{LOG(PI)} + 0.401209 * \text{LOG(LUC)}$$

Figure 23 Actual and fitted values: Factor price deflator, GDP private sector



ORDINARY LEAST SQUARES

LHS VARIABLE: LOG(PYPF/PYPF(-1))

NOB = 23 NOVAR = 6 NCOEF = 6

RANGE: 1982A to 2004A

RSQ =	0.791617	CRSQ =	0.730328
F(5/17) =	12.916105	PROB>F =	0
SER =	0.065226	SSR =	0.072326
DW(0) =	2.435739	COND =	15.802914
MAX:HAT =	0.825065	RSTUDENT =	2.249119
DFFITTS =	2.381552		

COEF	ESTIMATE	STER	TSTAT	PROB> T
LOG(PYPF(-1)/PYPF(-2))	0.703712	0.119244	5.901457	1.74119835e-005
LOG(PI/PI(-1))	0.495126	0.103012	4.806474	0.000165
LOG(LUC/LUC(-1))	0.183297	0.085492	2.144021	0.046783
LOG(PYPF(-1)/PI(-1))	-0.368342	0.097561	-3.775496	0.001509
LOG(LUC(-1)/PI(-1))	0.112088	0.065132	1.720935	0.10341
CONST	0.073053	0.075288	0.97032	0.345491

### Appendix 4.7. Consumer price

The deflator for private, non-smallholders consumption is estimated as a function of prices on domestically and foreign produced goods, reflecting that both type of goods are included in the consumption basket. The equation is:

$$\text{LOG(PCPO/PCPO(-1))} = 0.052753 + 0.286583 * \text{LOG(PI/PI(-1))} + 0.613581 * \text{LOG(PYP/PYP(-1))} - 0.531505 * \text{LOG(PCPO(-1)/PI(-1))} + 0.236691 * \text{LOG(PYP(-1)/PI(-1))} + \text{RPCPO}$$

Symbols in the equation

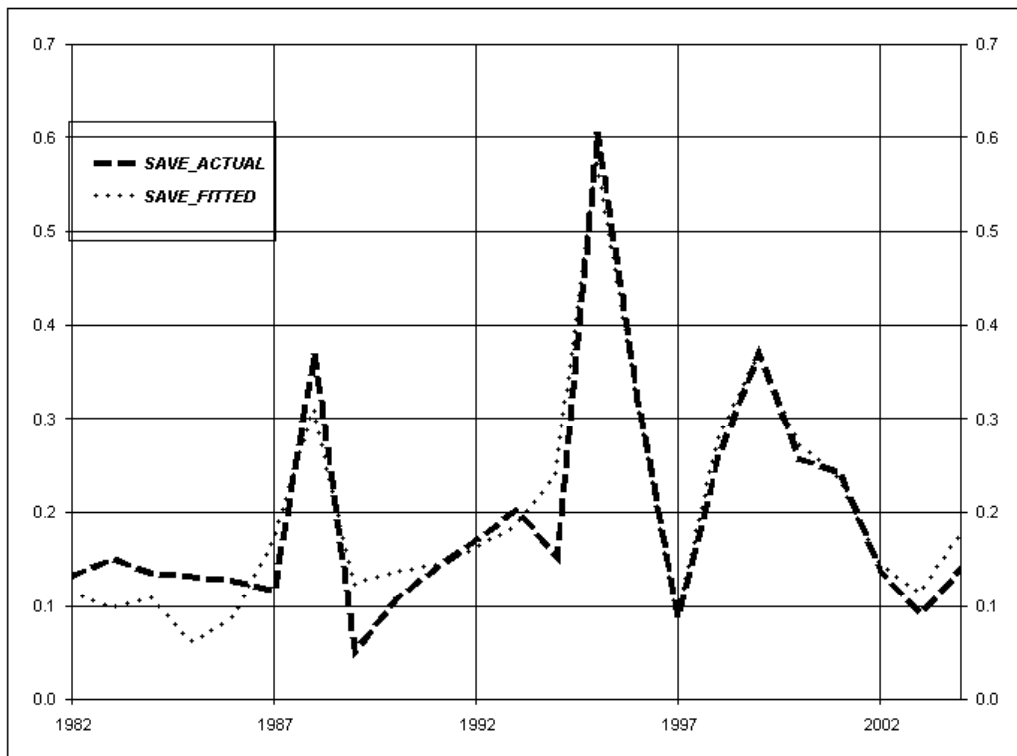
- PCPO Deflator for private consumption non-smallholders
- PI Import deflator
- LUC Labour unit costs
- PYPF Deflator GDP in the private sector in factor prices
- RPCPO Residual term deflator for private consumption non-smallholders

As we can see, both changes in import prices and domestic producer prices affect the consumer prices in the short run. For the long run we have this relationship:

$$\text{LOG}(\text{PCPO}) = 0.554677 * \text{LOG}(\text{PI}) + 0.445322 * \text{LOG}(\text{PYP})$$

**Figure 24 Actual and fitted values: Deflator non-smallholders consumption**

Actual and fitted values: Deflator non-smallholders consumption



ORDINARY LEAST SQUARES

LHS VARIABLE: LOG(PCPO/PCPO(-1))

NOB = 24 NOVAR = 5 NCOEF = 5

RANGE: 1981A to 2004A

RSQ =	0.900776	CRSQ =	0.879886
F(4/19) =	43.121346	PROB>F =	0
SER =	0.042421	SSR =	0.034191
DW(0) =	2.189001	COND =	11.716857
MAX:HAT =	0.615518	RSTUDENT =	-2.485658
DFFITTS =	1.216059		

COEF	ESTIMATE	STER	TSTAT	PROB> T
LOG(PI/PI(-1))	0.255079	0.076255	3.345055	0.003402
LOG(PYP/PYP(-1))	0.591791	0.113722	5.203837	5.05159404e-005
LOG(PCPO(-1)/PI(-1))	-0.622668	0.224768	-2.770271	0.012187
LOG(PYP(-1)/PI(-1))	0.306107	0.121496	2.51947	0.020865
CONST	0.074874	0.032205	2.324909	0.03131

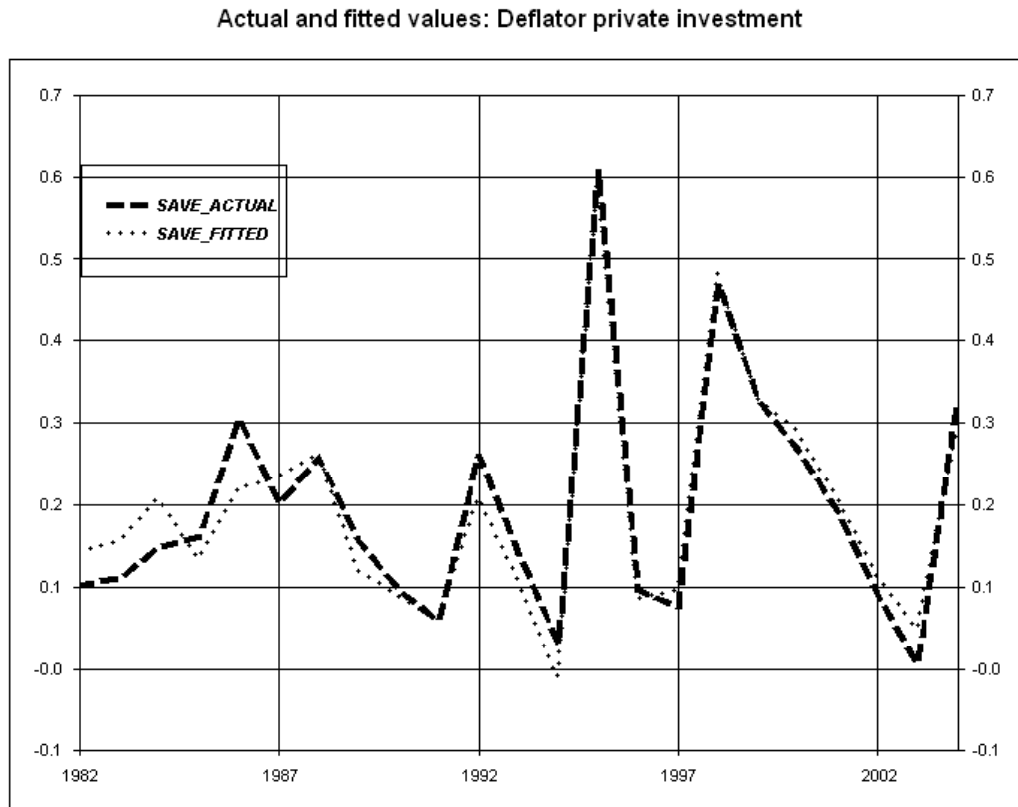
## Appendix 4.8. Price of investments

For the investment prices we have the following estimated relationship:

$$\text{LOG}(PJP/PJP(-1)) = 0.107607 + 0.800961 * \text{LOG}(PI/PI(-1)) - 0.5563 * \text{LOG}(PJP(-1)/PI(-1)) - 0.191998 * \text{DUM9403} + \text{RPJP}$$

There was no significant effect from prices on domestically produced goods, which is plausible if most capital goods are imported.

Figure 25 Actual and fitted values: Deflator private investment



ORDINARY LEAST SQUARES

LHS VARIABLE: LOG(PJP/PJP(-1))

NOB = 25 NOVAR = 4 NCOEF = 4

RANGE: 1980A to 2004A

RSQ =	0.931511	CRSQ =	0.921727
F(3/21) =	95.206104	PROB>F =	0
SER =	0.03937	SSR =	0.03255
DW(0) =	1.464798	COND =	3.461825
MAX:HAT =	0.512993	RSTUDENT =	2.527708
DFFITS =	-1.578176		

COEF	ESTIMATE	STER	TSTAT	PROB> T
LOG(PI/PI(-1))	0.800961	0.051951	15.417535	0
LOG(PJP(-1)/PI(-1))	-0.55636	0.099674	-5.581809	1.53740126e-005
DUM9403	-0.191998	0.029873	-6.427132	2.25969887e-006
CONST	0.107607	0.013835	7.777737	0

