BANK ĊENTRALI TA' MALTA
EUROSISTEMA
CENTRAL BANK OF MALTA

A Fiscal Block for the Bank's Structural Macro-Econometric Model of the Maltese Economy

Article published in the Quarterly Review 2014:3, pp. 60-67

BOX 5: A FISCAL BLOCK FOR THE BANK'S STRUCTURAL MACRO-ECONOMETRIC MODEL OF THE MALTESE ECONOMY[1]

In 2013 the Bank published a new structural macro-econometric model of the Maltese economy, which has since been put to many uses.[2] Economic modelling, however, is a continuous process. Besides being reviewed regularly to ensure that it remains a faithful representation of how the underlying economy functions, a model can be developed further to capture more links within the economy and thus contain a higher degree of richness. In this light, the Bank's core model has been extended to include a detailed fiscal block. Previously, the government sector was modelled in a simplified manner. Many fiscal variables were not modelled or were assumed to be exogenous; hence, this sector was little influenced by developments in the rest of the economy. The inclusion of an endogenous fiscal block has allowed for a more realistic modelling of the government sector, which now bears stronger ties with other sectors of the economy.

The fiscal block was built with three key uses in mind. First, it enhances the ability to conduct simulations and thus assess the impact of various shocks on the domestic economy on two fronts. On the one hand, the block realistically captures how fiscal variables respond to macroeconomic shocks. For example, it can show how government debt reacts to an increase in interest rates. On the other hand, it opens channels that allow for a range of fiscal shocks, making it possible, for instance, to study the economic impact of lower income tax rates. Second, the fiscal block can complement the Bank's current fiscal forecasting framework, particularly with regard to medium to long-term forecasts. The final motivation for the development of the fiscal block is to deepen our understanding of how the domestic economy functions.

Fiscal blocks in traditional structural macro-econometric models

In many traditional structural models like the Bank's core model, the government sector is broken down into a number of revenue and expenditure categories. The level of disaggregation varies across models. For example, in their overview of the main structural macro-econometric models used within the Eurosystem, Fagan and Morgan report that the degree of disaggregation ranges from a model which consists of three revenue and five expenditure components, to one containing 26 revenue and 22 expenditure categories. On average, the models studied have nine revenue and eight expenditure components.[3]

In these models, fiscal variables are often modelled by multiplying an exogenous effective revenue or expenditure rate by a suitable macroeconomic base – a macroeconomic variable to which the fiscal variable is closely tied. The effective rate is the ratio of the

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[2] The model is documented in Grech, O., Micallef, B., Rapa, N., Grech, A. G. and Gatt, W., "A Structural Macro-Econometric Model of the Maltese Economy", *Working Paper* No. 02/2013, Central Bank of Malta.

[3] See Fagan, G. and Morgan, J., "An Overview of the Structural Econometric Models of Euro-Area Central Banks", in Fagan, G. and Morgan, J. (eds.), *Econometric Models of the Euro-Area Central Banks*, Edward Elgar, 2005, pp. 1-49.

fiscal variable to the chosen base. Since the macroeconomic base is generally determined endogenously, the same applies to the fiscal variable. For example, if VAT receipts are modelled using this approach, an exogenous effective VAT rate is multiplied by a suitable base, such as nominal consumption, with the effective rate being the ratio of VAT receipts to the base.[4,5] If nominal consumption is determined within the model, as is usually the case in such models, the response of VAT receipts will also be endogenous.

In the instances when this is not a suitable modelling strategy, the fiscal variable is generally kept exogenous or is modelled as maintaining its share of some broader fiscal or macroeconomic aggregate. Behavioural equations are rarely used, except in the case of social benefits. The number of revenue and expenditure categories kept exogenous also varies across models. However, in many cases most fiscal variables are endogenised.

In practice, governments are restricted by the inter-temporal government budget constraint. This implies that, for debt to be sustainable, the initial government debt and the interest accumulated over time have to eventually be repaid through sufficiently large primary balances.[6] For this reason, many macro-econometric models include a fiscal rule that is activated in long-run simulations to ensure some degree of fiscal solvency. This is achieved by adjusting a fiscal variable – in many cases some form of direct taxation – to reach a target which is generally specified in terms of the government balance or debt ratio.[7,8]

An overview of the fiscal block for the Bank's macro-econometric model

In constructing the fiscal block, the standard approach in the literature was followed. The revenue side consists of 16 categories and there are 11 components on the expenditure side, which make the fiscal block one of medium scale. Most of these fiscal variables are modelled through the "effective rate times base" approach, with suitable bases chosen by relying on both theory and empirics. In other words, the macroeconomic bases that were ultimately selected bear a strong relationship to the fiscal variable being modelled not only from a theoretical standpoint, but also from a statistical one borne out in the data. The fiscal block is now captured through 66 equations, of which 22 are identities.

Charts 1 and 2 below provide a schematic representation of the revenue and expenditure sides, respectively. They display the fiscal block's structure, links within the fiscal block itself, and links which the block shares with the rest of the model. Variables enclosed in blue are endogenous, while those in red are exogenous. Identities are enclosed in black. Arrows indicate the direction of influence which, in some cases, runs in both directions.

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4 In the absence of additional information, the effective rate is generally based on trends in the actual data.

5 Mathematically:

$$VAT\ receipts = effective\ VAT\ rate * nominal\ consumption$$, i.e.

$$VAT\ receipts = \frac{VAT\ receipts}{nominal\ consumption} * nominal\ consumption$$.

6 For further details on fiscal sustainability, see Farrugia, J. and Grech, O., "Assessing the Sustainability of Maltese Government Debt", *Working Paper* No. 04/2013, Central Bank of Malta, and references therein.

7 See Mitchell, P., Sault, J. and Wallis, K., "Fiscal Policy Rules in Macroeconomic Models: Principles and Practice", *Economic Modelling*, 17(2), 2000, pp. 171-193, for a comparison of fiscal rules.

8 For examples and descriptions of fiscal blocks within traditional structural macro-econometric models, see Fagan, G. and Morgan, J. (eds.), *Econometric Models of the Euro-Area Central Banks*, Edward Elgar, 2005 and Bank of England, *Economic Models at the Bank of England*, London: Bank of England, 2000.

Chart 1

SCHEMATIC REPRESENTATION OF THE REVENUE SIDE

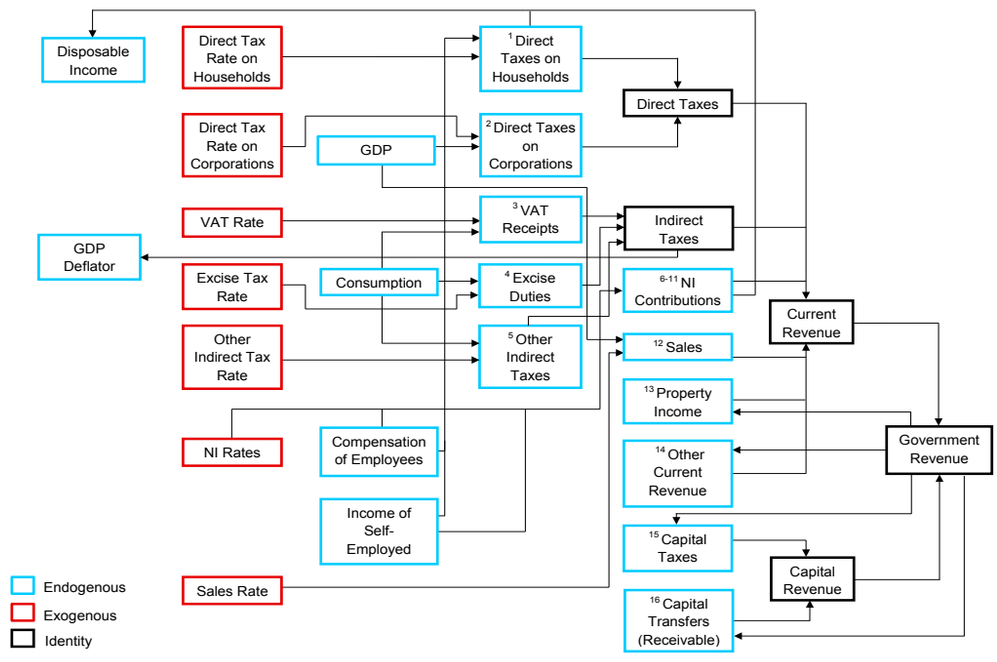
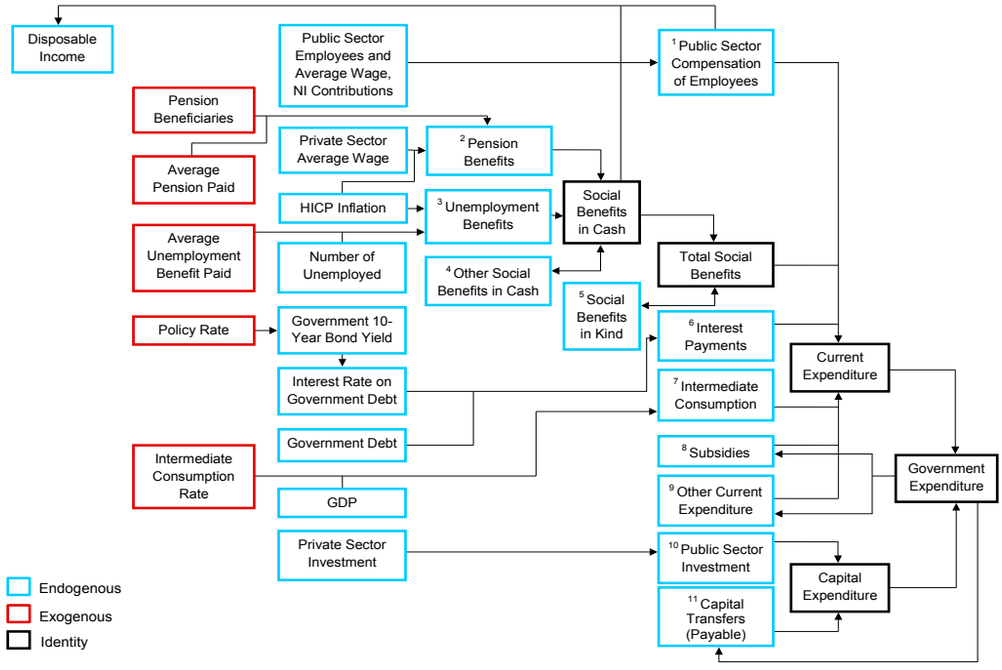


Chart 2

SCHEMATIC REPRESENTATION OF THE EXPENDITURE SIDE



The charts also display the number of revenue and expenditure categories at the highest level of disaggregation.[9]

The charts show that, at the highest level of disaggregation, there are 16 components on the revenue side and 11 categories on the expenditure side, as outlined previously. The first revenue component, for example, is direct taxes on households.[10] This variable is modelled using the "effective rate times base" approach, with compensation of employees plus income of the self-employed serving as the base, since direct taxes on households are largely levied on these sources of income, while the data support this prior belief that the fiscal variable and the base are strongly correlated. In all, 13 variables are modelled using the "effective rate times base" approach.[11]

In cases when this approach was not deemed to be suitable, a different modelling strategy was employed. Certain fiscal variables were assumed to maintain their share in a broader fiscal or macroeconomic aggregate, or were constructed via decomposition. For instance, a substantial portion of government property income consists of profits earned by the Central Bank of Malta. These profits are not closely tied to some macroeconomic variable and hence the "effective rate times base" approach would not be appropriate. Instead, this variable is assumed to maintain its share in government revenue. There are ten variables in total that are modelled using this strategy.[12] In addition, four variables are constructed through decomposition.[13] Public sector compensation of employees, for example, is calculated by multiplying the number of government employees by the average wage in the public sector, and adding employers' national insurance contributions paid by the Government along with imputed national insurance contributions.

At the highest level of disaggregation, the most significant revenue categories are VAT, and direct taxes on households and on corporations, which together account for around half of total revenue. Compensation of employees, pension benefits and intermediate consumption are the largest expenditure components, with a combined weight in total spending of nearly two-thirds.[14]

From the components of government revenue and government expenditure, fiscal aggregates are produced through identities. For example, on the revenue side, direct taxes on households and on corporations are added to generate direct taxes, while, on the expenditure side, social benefits in cash consist of the sum of pension benefits, unemployment benefits and other social benefits in cash.

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9 In this context, a component at the highest level of disaggregation is not one that cannot be subdivided further, but rather one which is not decomposed to a greater degree in the model.

10 See ECB, *Government Finance Statistics Guide*, Frankfurt: ECB, August 2014, for definitions of fiscal variables.

11 Arguably, the only contentious base is that for direct taxes on corporations. From a theoretical point of view, this variable should move in line with gross operating surplus. However, this is not supported empirically, largely as a result of noise in the data. Consequently, nominal GDP was chosen as the base since the data suggest that this variable bears a stronger link with direct taxes on corporations and the choice can also be justified on theoretical grounds.

12 These variables are: property income, other current revenue, capital taxes, capital transfers on the revenue side, other social benefits in cash, social benefits in kind, subsidies, other current expenditure, public sector investment and capital transfers on the expenditure side.

13 Namely, public sector compensation of employees, pension benefits, unemployment benefits and interest payments.

14 These figures are the average shares over the 2000-2013 period.

To better understand the mechanics of the fiscal block, suppose that, on the revenue side, the direct tax rate on households is reduced. This lowers direct taxes on households, leading to a drop in the intake of direct taxes but also influencing the rest of the model through an increase in disposable income, which largely affects private consumption. The fall in direct taxes gives rise to lower current revenue, in turn causing a decrease in total revenue. Turning to the expenditure side, an increase in the policy rate, for example, raises the government ten-year bond yield. This results in a rise in the interest rate on government debt which, in turn, brings about higher interest payments. The change in the latter raises current expenditure and thus total expenditure.

Besides government revenue and expenditure, and their main components, model users are likely to be interested in other key fiscal variables, such as government consumption, the government balance, the government primary balance and government debt. These variables can easily be computed since they are composed almost entirely of variables that emerge from the revenue side and the expenditure side, and will therefore be determined endogenously.[15,16] For example, government consumption is equal to the sum of compensation of employees, intermediate consumption, social benefits in kind and consumption of fixed capital, less sales. Since, except for consumption of fixed capital, these components are determined within the model, government consumption will also be endogenous.

The fiscal block also includes a fiscal rule that is activated in long-run simulations to ensure some level of fiscal solvency, as explained previously. It aims at a debt ratio with a target value of 60.0%, which is reached by adjusting the direct tax rate on households.[17]

A word on the data

The main source of the quarterly fiscal data used in the fiscal block is the Quarterly Accounts of General Government. This source, however, does not provide a quarterly disaggregation of all components of direct taxes, indirect taxes, social security contributions and social benefits in cash found in the fiscal block. Annual data for such variables were taken from statistical releases on tax revenue and the classification of functions of general government, and converted to a quarterly frequency based on patterns observed in government cash data. Moreover, in the case of components of government consumption – namely, compensation of employees, intermediate consumption, social benefits in kind, consumption of fixed capital and sales – data from both the Quarterly Accounts of General Government and

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[15] Government consumption = public sector compensation of employees + public sector intermediate consumption + social benefits in kind + public sector consumption of fixed capital – public sector sales.
Government balance = government revenue – government expenditure.
Government primary balance = government revenue – government expenditure + interest payments on government debt.
Government $debt_t$ = government $debt_{t-1}$ – government $balance_t$ + deficit-debt $adjustment_t$.

[16] The only two variables that are needed to calculate these other key fiscal variables but do not emerge from the revenue side or from the expenditure side are consumption of fixed capital and the deficit-debt adjustment. In this context, consumption of fixed capital refers to depreciation of public sector capital, while the deficit-debt adjustment, commonly referred to as the stock-flow adjustment, captures those transactions or factors that influence the outstanding debt but are not reflected in the primary balance. For further details on the deficit-debt adjustment, see Farrugia, J. and Grech, O., "Assessing the Sustainability of Maltese Government Debt", *Working Paper* No. 04/2013, Central Bank of Malta. In the model, both consumption of fixed capital and the deficit-debt adjustment are given an exogenous path.

[17] For further details on the modelling of the fiscal block, see Grech, O. and Micallef, B., "A Structural Macro-Econometric Model of the Maltese Economy", Central Bank of Malta, 2014.

the National Accounts were used.[18] Throughout, annual and quarterly data were taken from 2013 and 2013Q4 vintages, respectively. All the data sources are published by the National Statistics Office.

Simulation results

To illustrate the properties of the Bank's model augmented with the fiscal block, the results of two medium-term simulations are reported.[19] The first simulation is a government consumption shock – hence a shock on the expenditure side – defined as a permanent increase in real intermediate consumption that leads to an *ex-ante* change in the share of real government consumption in real GDP by 1 percentage point. The results are summarised in Table 1.

The rise in government consumption results in an immediate increase in GDP. This leads to higher employment and wages, and hence disposable income, which, in turn, raises private consumption. Moreover, the increase in GDP also stimulates investment. These developments bring about a further rise in GDP, offset to some degree by higher imports.

Table 1
THE MACROECONOMIC IMPACT OF A GOVERNMENT CONSUMPTION SHOCK

Percentage changes from baseline levels unless otherwise specified

	Year 1	Year 2	Year 3
Economic Activity			
Real GDP	0.77	0.83	0.64
Private consumption	0.12	0.82	0.46
Government consumption	5.23	5.34	5.07
Gross fixed capital formation	0.57	1.11	1.06
Exports	-0.05	-0.28	-0.51
Imports	0.41	0.61	0.28
Prices			
GDP deflator	0.16	0.60	0.87
Labour Market			
Unemployment rate[1]	0.00	-0.11	-0.11
Fiscal Developments			
Total receipts	0.45	1.15	1.18
Total expenditures	2.63	3.01	3.15
Balance[2]	-0.98	-0.84	-0.88
Gross debt[2]	0.29	0.75	1.52

[1] Absolute changes from baseline in percentage points.

[2] Absolute changes from baseline as a percent of GDP.

Source: Author's calculations.

[18] For each of these five variables, the model contains two series: one with the Quarterly Accounts of General Government as its source, and another taken from the National Accounts. Data from the former source are required because they correspond to key fiscal statistics, such as the government balance and government debt, while data from the latter source are needed to generate a series of government consumption that is consistent with GDP data.

[19] Following common practice, the fiscal rule was switched off in both simulations.

This raises the output gap which, in turn, leads to an increase in prices, as shown by the GDP deflator. Higher prices give rise to a loss in competitiveness and thus to a decline in exports. Still, the net effect on GDP is positive, which translates into lower unemployment.

On the fiscal side, as a result of the increase in government consumption, government expenditure rises. Due to higher macroeconomic bases, government revenue also rises, but the net effect is for the government balance ratio to fall – which implies a deterioration of the deficit ratio – and consequently the government debt ratio increases.[20]

The second simulation is a shock on the revenue side, in particular a shock to direct taxes, defined as a permanent increase in direct taxes that leads to an *ex-ante* change in the ratio of government revenue to GDP by 1 percentage point. The shock is distributed proportionately between direct taxes on households, on corporations and social security contributions. The key results are shown in Table 2.

The rise in direct taxes results in lower disposable income which, in turn, gives rise to a decline in private consumption and thus GDP. As a result of the decrease in GDP,

Table 2
THE MACROECONOMIC IMPACT OF A DIRECT TAXES SHOCK
Percentage changes from baseline levels unless otherwise specified

	Year 1	Year 2	Year 3
Economic Activity			
Real GDP	-0.07	-0.31	-0.39
Private consumption	-0.81	-1.22	-1.33
Government consumption	0.42	0.04	-0.03
Gross fixed capital formation	-0.01	-0.41	-0.70
Exports	-0.02	-0.14	-0.15
Imports	-0.40	-0.63	-0.69
Prices			
GDP deflator	0.08	0.26	0.23
Labour Market			
Unemployment rate[1]	0.01	0.03	0.03
Fiscal Developments			
Total receipts	2.34	2.09	1.96
Total expenditures	0.18	-0.01	-0.16
Balance[2]	0.95	0.91	0.92
Gross debt[2]	-0.96	-1.82	-2.54

[1] Absolute changes from baseline in percentage points.
[2] Absolute changes from baseline as a percent of GDP.
Source: Author's calculations.

[20] The simulations display one of the key benefits of integrating a fiscal block within a broader macro-econometric model, namely that it allows for a simultaneous response between fiscal developments and the wider economy. In other words, changes in fiscal variables influence the macro-economy while developments in the latter affect the fiscal side of the economy. This interaction allows model users to gauge more accurately how the underlying economy functions.

investment also falls, causing a further drop in GDP. Lower GDP also brings about a reduction in private sector employment and wages, which is mirrored in a decline in the corresponding public sector variables. This drop in public sector employment and wages is outweighed by the increase in social security contributions paid by the Government as an employer implied by the shock to direct taxes, leading to a net rise in public sector compensation of employees. In the first two years of the simulation horizon, government consumption increases, largely because the rise in compensation of employees in the public sector is stronger than the reduction in intermediate consumption. This drop reflects the decrease in the macroeconomic base, namely GDP. In the outer year, however, the fall in intermediate consumption outweighs the rise in compensation of employees and therefore government consumption declines, albeit marginally. Higher social security contributions exert upward pressure on unit labour costs and thus prices. Elevated prices cause a loss in competitiveness, which gives rise to a fall in exports. Overall, GDP decreases, which leads to a rise in unemployment.

Turning to fiscal developments, government revenue increases as a result of higher direct taxes. Initially, government expenditure rises slightly but it falls in the second and third year of the simulation horizon, mostly because higher public sector compensation of employees is gradually outweighed by the decline in interest payments resulting from lower government debt. The net effect translates into an increase in the government balance – implying an improvement in the deficit ratio – which causes the government debt ratio to fall.

Concluding remarks

This article presents a recent development with regard to the Bank's macro-econometric model of the Maltese economy, namely the incorporation of a relatively detailed fiscal block. Simulation results illustrate the properties of the augmented model and suggest that the mechanics of the model are plausible from both a theoretical and empirical standpoint. The core model enhanced with the fiscal block is a valuable tool in the Bank's toolkit, particularly in view of recent developments in the fiscal arena, both internationally and domestically, such as increased attention given to public finances in the light of the recent European sovereign debt crisis and the creation of an independent fiscal council, respectively.

Once again, however, this does not represent the final stage in the model's development. The fiscal block itself can be extended by, for example, modelling pension benefits and interest payments in greater detail. The model has also been developed further to include a richer financial block, enhanced macro-financial linkages and a price block that is more responsive to domestic economic activity. In addition, it has been re-estimated using more recent data. These latter refinements are presented in a paper on the Bank's website, which also contains further details on the fiscal block outlined above.[21] Other developments are envisaged, including re-estimating the model using ESA 2010 data and an enhanced integration of the supply side, particularly with regard to the labour market. Moreover, the model is evaluated on a regular basis to ensure that it remains a faithful representation of how the Maltese economy functions.

[21] See Grech, O. and Micallef, B., "A Structural Macro-Econometric Model of the Maltese Economy", Central Bank of Malta, 2014.