A SFC model for Italy

(First draft: please do not quote)

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Abstract

This working paper aims at developing a medium-scale stock-flow consistent dynamic model for the Italian economy. On the theoretical side, it builds upon the pioneering work by Godley and Lavoie (2006)[2]. Sectoral balances of the Italian economy are explicitly modelled and their evolution over non-ergodic time under different scenarios is analysed. The model also draws upon the applied work by Burgess et al. (2016)[1]. Eurostat annual and quarterly data (from 1995 to 2016) are used to estimate most of model parameters (e.g. consumption function parameters, housing investment parameters, loan and deposit interest rates, etc.). Other parameters are either borrowed from the available literature or taken from a range of realistic values (e.g. depreciation rate of capital, weights on past errors in agents' expectations, etc.). The model is then used to explain recent developments in the Italian economy and to provide a medium-term analysis of alternative policy options.

Keywords: Sectoral Balances, Flow of Funds, Macro Modelling, Italian Economy

JEL Classification: E21, E22, E25, E37

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1 Introduction

This working paper aims at developing a medium-scale stock-flow consistent dynamic model for the Italian economy. A theory-informed but data-driven method is used. On the theoretical side, the model is inspired by the pioneering work by Godley and Lavoie (2006)[2].[1] Sectoral balances of the Italian economy are explicitly modelled and their evolution over non-ergodic time under different scenarios is analysed. This paper also draws upon the applied work by Burgess et al. (2016)[1]. For the model is developed building upon available (Eurostat) macroeconomic data rather than microeconomic first principles. In particular, no dynamic optimisation problem faced by an individual representative agent is considered in this work. It is recognised that today's financially-sophisticated economies would be better regarded as a complex (monetary) system, whose emerging behaviour is non-linear and path-dependent. As a result, either a heterogeneous agent-based micro-founded approach or a macro (monetary) accounting approach seem to be the most appropriate analytical tools. The second method is chosen here.

Figure 1: Italy's sectoral financial balances (annual, 1995-2016)

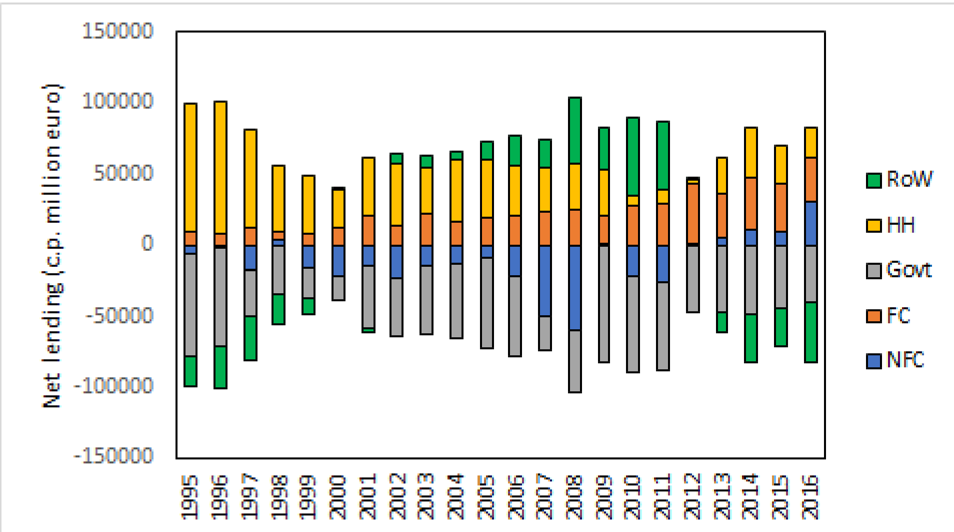


Figure 1 shows that the Italian sectoral financial balances have gone through three different phases since the mid-1990s. A reduction in external surpluses (green bars) and household net saving (yellow bars) along with a reduction in government deficit (gray bars) during the 1990s. An increase in non-financial corporations (NFCs) deficit (blue bars) along with an increasing external deficit (meaning a surplus recorded by the rest of the world) up until 2011. Finally, Italy has been running again external surpluses (coupled with a stable government deficit and an increasing surplus of NFCs and other domestic sectors) since the outbreak of the so-called "European Sovereign Debt Crisis".

The aim of the paper is to develop a macroeconomic model accounting

[1] See Nikiforos and Zezza (2017)[4] for a recent survey.

for the dynamics above, while creating and comparing different hypothetical (future) scenarios for main macroeconomic variables. For this purpose, the rest of the work is organised as follows. Section 2 presents the theoretical model, equation by equation. Section 3 provides a detailed description of the method used to re-classify and aggregate Eurostat data, construct sectoral balance-sheets, estimate model parameters, and forecast trends in relevant time series. Section 4 presents the preliminary findings and discusses possible future developments.

2 The theoretical model

As mentioned, the model is built upon Eurostat data. Accordingly, five macro-sectors are considered: 1. households (marked by the subscript H); 2. non-financial corporations (or firms, F); 3. the government (G); 4. financial corporations (including banks and other financial institutions, B); 5. the rest of the world (or foreign sector, RoW). The role of the central bank, meaning the European Central Bank (ECB hereafter), is considered as well. The main assumptions and features of the model are listed below.

a) The model aims at fitting Eurostat classifications, while assuring full stock-flow consistency.

b) The economy is demand-led both in the short- and long-run. Total production determines the employment level.

c) Monetary variables are all expressed at current prices (euro).

d) Total gross output is assumed to be produced by non-financial firms only, on behalf of other sectors.[2]

e) Distribution and hence sectoral GDPs are determined by institutional, political, social and historical factors. This factors are embodied in coefficients named “beta” (β_j, where the subscript j denotes the sector).

f) Each sector is marked by either a portfolio investment function or a financial investment rule.

g) Net stocks of financial assets and liabilities, rather than gross stocks, are usually taken into consideration. This is a limitation that must be addressed in a more advanced version of this work.

h) Since there is no information about “who pays who”, some simplifying hypotheses about sectoral portfolio compositions are used, based on observation of available data.

i) In practice, all dividends are paid by non-financial firms and received by households, while almost all securities are issued by the government. Interests are paid by government and non-financial firms to banks, households and the rest of the world.

[2] As a result, there is only one production function to be defined. Incidentally, this is coherent with the Marxist view that value is created in the (manufacturing) production sphere and “distributed” to other sectors through the price setting mechanism (i.e. via market forces and institutional factors).

l) Banks and other financial institutions are regarded as an integrated and consolidated sector. This is not a major simplification for the Italian system, as the financial sector is dominated by a few banks.

m) Some model "parameters" include trend components to improve the fit of past data. In addition, some dummy variables are used to address structural breaks (see Section 2.7).

2.1 *Households*

As is known, Italian households were marked by an exceptional saving rate up until the early 1990s. However, a plurality of economic, institutional and political factors (including reforms of the labour market, the change in the pension system, the coming into force of the Maastricth Treaty, the launch of the Euro, two major financial crises, and the beginning of the "austerity" era) have affected remarkably the financial situation of household sector ever since. Italian households still exhibit a high saving rate compared to other industrialised or developed countries, but the gap has been narrowing down over time. This has gone along with symmetrical changes in other sectoral financial balances.

In formal terms, household disposable income is made up of household gross domestic product (meaning gross output *minus* intermediate consumption) *plus* wages *minus* taxes (on income, wealth, import and production) *plus* net interest entries *plus* transfers (including subsidies and benefits) *plus* annuities (including dividends and other property incomes):

$$YD = GDP_H + WB - \tau_H + INT_H + T_H + ANN_H \tag{1}$$

Notice that the household sector is here defined in broad terms, as it includes non-profit institutions serving households (NPISH). This is the reason the disposable income equation includes a (sectoral) gross domestic product component. The latter is assumed to be produced materially by non-financial firms on behalf of NPISH. In principle, household disposable income could be calculated net of GDP_H. This would be like assuming that households can meet a certain share of their consumption needs. In that case, household gross domestic product should be deducted by consumption to calculate household net lending (in equation 13).

Household annuities are defined as the summation of dividends and other property incomes:

$$ANN_H = DIV_H + PROP_H \tag{2}$$

As mentioned, household gross domestic product is taken as a share of total product:

$$GDP_H = \beta_H \cdot GDP \tag{3}$$

Similarly, net wages are defined as a share of total GDP:

$$WB = \omega_T \cdot GDP \tag{4}$$

The household (net) income share to GDP is therefore:

$$\omega_L = \frac{INT_H + ANN_H + WB \cdot (1 - \omega_S)}{GDP} \tag{5}$$

where ω_S is the share of wages paid by NPISH to total wages.

Taxes paid by households are defined as a share of (past) wages:

$$\tau_H = \theta_H \cdot WB_{-1} \tag{6}$$

The net interest received by households equals interest revenues net of interest payments:

$$INT_H = INT_H^{RECV} - INT_H^{PAID} \tag{7}$$

The total interest received by households is the summation of interests earned on bank deposits, incomes from bonds (according to the average return rate, r_{BA}) and other positive interests (captured by a residual component):

$$INT_H^{RECV} = r_{D,-1} \cdot D_{H,-1} + r_{BA,-1} \cdot B_{H,-1} + INT_{H,RES,-1}^{RECV} \tag{8}$$

The total interest paid by households is the summation of interest payments on mortgages and other payments on loans (captured by a residual component):

$$INT_H^{PAID} = r_{M,-1} \cdot MORT_{H,-1} + INT_{H,RES,-1}^{PAID} \tag{9}$$

Transfers received by households are defined as a share of (past) households wages:

$$T_H = \alpha_{H,T} \cdot WB_{-1} \tag{10}$$

Similarly, other property income received by households is:

$$PROP_H = \alpha_{H,P} \cdot WB_{-1} \tag{11}$$

Household consumption is defined by the Haig-Simons function:

$$C_H = c_1 \cdot E(YD) + c_2 \cdot NW_{H,-1} \tag{12}$$

where YD is household disposable income and NW_H is their net wealth, while c_1 and c_2 are the propensities to consume out of income and wealth, respectively.

Notice that *adaptive expectations* are assumed, meaning that $E(x) = x_{-1} + \upsilon \cdot (E(x_{-1}) - x_{-1})$. Accordingly, expected income is:

$$E(YD) = YD_{-1} + \upsilon \cdot \Big(E(YD_{-1}) - YD_{-1}\Big)$$

Net wealth is the summation of dwellings, currency & deposits, shares & equity, securities and other financial assets, *minus* the stock of mortgage debt:

$$NW_H = HOUSE_H + D_H + V_H + B_H + OFIN_H - MORT_H$$

Alternatively, it can be expressed in dynamic terms, its change over time being defined by saving out of disposable income:

$$NW_H = NW_{H,-1} + YD_H - CONS_H - INV_H + FUNDS_H \tag{13}$$

where INV_H is (housing) investment undertaken by household and $FUNDS_H$ is a composite variable defined below.

Household financial assets holdings are:

$$NFW_H = NW_H - HOUSE_H + MORT_H \tag{14}$$

Household non-financial assets holdings, meaning dwellings, equal past period housing stock (net of depreciation rate) plus new housing investment:

$$HOUSE_H = (1 - \delta_H^1) \cdot HOUSE_{H,-1} + \delta_H^2 \cdot INV_H \tag{15}$$

where δ_H^1 is the depreciation rate of capital and δ_H^2 can be regarded as the share of household investment actually devoted to housing.

Portfolio allocation by households is modelled based on Brainard and Tobin (1968)[3], Godley and Lavoie (2006)[2] and Burgess et al. (2016)[1]. For the sake of simplicity, we assume that all shares are marked by the same average return rate. Total net equity (stock) held by households is:

$$\begin{aligned} V_H = {} & \lambda_{1,0}^H \cdot E(NFW_H) + \lambda_{1,1}^H \cdot E(NFW_H) \cdot r_V + \lambda_{1,2}^H \cdot E(YD_H) + \\ & + \lambda_{1,3}^H \cdot E(NFW_H) \cdot r_{BA} \end{aligned}$$

where both $\lambda_{1,0}^H$ and $\lambda_{1,1}^H$ define the proportion of net financial wealth households wish to hold in form of equity & shares, $\lambda_{1,2}^H$ is the proportion of net financial wealth held in form of cash and deposits, and $\lambda_{1,3}^H$ is the proportion of net financial wealth held in form of securities (notably, Treasury bonds & bills and NFC securities). Notice that r_V is the (average) return rate on equity and shares, and r_{BA} is the (average) return rate on securities. The latter is defined by equation (77), whereas the former can be calculated as a function of the market price of shares:

$$r_V = v_1 \cdot r_{V,-1} + v_2 \cdot \frac{\Delta p_V}{p_{V,-1}} \tag{16}$$

The return rate on Italian equity and shares grows as their market price grows.

As a result, the ratio of household shares and equity holdings to net financial wealth is:

$$\frac{V_H}{E(NFW_H)} = \lambda_{1,0}^H + \lambda_{1,1}^H \cdot r_V + \lambda_{1,2}^H \cdot \frac{E(YD_H)}{E(NFW_H)} + \lambda_{1,3}^H \cdot r_{BA} \tag{17}$$

Notice that shares are not issued by NFCs only. A small percentage of equity and shares held by Italian investors is issued by domestic financial and/or foreign institutions. NFC equity held by households can be defined as a share of household equity portfolio:

$$V_{F,H} = \chi_F \cdot V_H \tag{18}$$

Similarly, financial institutions equity held by households is:

$$V_{B,H} = \chi_B \cdot V_H \tag{19}$$

where χ_F and χ_B are "moving parameters" defining the ratio of NFC equity to total equity and the ratio of financial sector's equity to total equity, respectively - see Section 2.7.

Rest of the world equity held by households can be now defined as a residual:

$$V_{RoW,H} = (1 - \chi_F - \chi_B) \cdot V_H \tag{20}$$

Notice that the total stock of equity and shares in the economy is:

$$V_T = V_F + V_B + V_{RoW} \tag{21}$$

So, the amount of total dividends received by households is:

$$DIV_H = DIV_{F,H} + DIV_{B,H} + DIV_{RoW,H} \tag{22}$$

Turning to securities, the ratio of household holdings to net financial wealth is:

$$\frac{B_H}{E(NFW_H)} = \lambda_{2,0}^H + \lambda_{2,1}^H \cdot r_V + \lambda_{2,2}^H \cdot \frac{E(YD_H)}{E(NFW_H)} + \lambda_{2,3}^H \cdot r_{BA} \tag{23}$$

where $\lambda_{2,j}^H$ parameters have the usual meaning.

The Italian market of securities is dominated by government issues. However, a small percentage of securities held by Italian investors is issued by NFCs. For the sake of simplicity, it is assumed that each sector holds the same share of NFC securities to total securities. In addition, all securities are assumed to carry the same average return rate.[3]

Accordingly, NFC securities held by households can be defined as:

$$B_{F,H} = q_F \cdot B_H \tag{24}$$

where q_F is the average percentage of NFC securities to total securities over the considered period.

[3] These simplifying hypotheses are due to data limitations and should be relaxed in future works. Notice, however, that cross-sector portfolio compositions may well be uneven, because each sector can choose the desired amount for each "type" of financial assets (shares, securities, deposits, etc).

So, government bonds & bills held by households can be calculated as a residual:

$$B_{G,H} = (1 - q_F) \cdot B_H \tag{25}$$

Clearly, the total stock of securities in the economy is the summation of government bonds & bills and NFC securities:

$$B_{TOT} = B_G + G_F$$

Bank deposits and cash held by households are:

$$\frac{D_H}{E(NFW_H)} = \lambda^H_{3,0} + \lambda^H_{3,1} \cdot r_V + \lambda^H_{3,2} \cdot \frac{E(YD_H)}{E(NFW_H)} + \lambda^H_{3,3} \cdot r_{BA} \tag{26}$$

where $\lambda^H_{3,j}$ parameters have the usual meaning.

Other financial assets held by households are defined in residual terms as either:

$$OFIN_H = NFW_H - V_H - B_H - D_H$$

or:

$$\frac{OFIN_H}{E(NFW_H)} = \lambda^H_{4,0} + \lambda^H_{4,1} \cdot r_V + \lambda^H_{4,2} \cdot \frac{E(YD_H)}{E(NFW_H)} + \lambda^H_{4,3} \cdot r_{BA} \tag{27}$$

where: $\lambda^H_{4,0} = 1 - (\lambda^H_{1,0} + \lambda^H_{2,0} + \lambda^H_{3,0})$ and $\lambda^H_{4,j} = -(\lambda^H_{1,j} + \lambda^H_{2,j} + \lambda^H_{3,j})$, for $j = 1, 2, 3$.

New mortgages to households are modelled as a function of household disposable income, the stock of dwellings, and housing investment:

$$MORT_H = MORT_{H,-1} + \phi_1 \cdot YD_{-1} + \phi_2 \cdot HOUSE_{H,-1} + \phi_3 \cdot INV_{H,-1} \tag{28}$$

Investment undertaken by households is defined as a function of several variables, including past housing investment, household mortgages, dwellings stock, household disposable income, and the property income growth rate:

$$\begin{aligned} INV_H = {} & \vartheta_1 \cdot INV_{H,-1} + \vartheta_2 \cdot MORT_{H,-1} + \vartheta_3 \cdot HOUSE_{H,-1} + \\ & + \vartheta_4 \cdot YD_{H,-1} + \vartheta_5 \cdot r_{H,-1} \end{aligned} \tag{29}$$

The property income growth rate is:

$$r_H = \frac{\Delta PROP_H}{PROP_{H,-1}} \tag{30}$$

Finally, net borrowing by households can be defined as their own consumption and investment (including adjustment in funds) in excess of disposable income. *Net lending by households* is therefore:

$$NL_H = YD + FUNDS - CONS_H - INV_H \tag{31}$$

where "funds" is a heterogeneous entry including adjustment in pension funds, capital transfers and non-produced non-financial products (see figures 2 to

4). For the sake of simplicity, it is regarded as a linear function of (lagged) disposable income:

$$FUNDS_H = \alpha_{H,FU} \cdot YD_{H,-1} \tag{32}$$

Notice that sectoral net lending values are the key variables of the model. For they allow reproducing cross-sector financial balances displayed in Figure 1.

2.2 *Non-financial corporations*

While facing a long-standing crisis since the mid-1990s or even earlier - a period marked by an apparent stagnation in labour productivity and the loss of Italy's central position in the global international chain - Italy is still the second biggest manufacturing economy in the European Union. Around a quarter of Italian GDP is still attributed to (manufacturing) industry.

From an accounting viewpoint, Italy's overall GDP can be defined as gross output, Y, *minus* intermediate consumption, $CONS_{INT}$, *plus* taxes on products net of subsidies, τ_P^{NET} (see Figure 2, based on Eurostat data), that is:

$$GDP = Y - CONS_{INT} + \tau_P^{NET} \tag{33}$$

As mentioned, it is assumed that non-financial corporations (NFCs) produce all output on the behalf of other sectors. However, the amount of GDP associated with NFCs is just a share of total GDP:

$$GDP_F = \beta_F \cdot GDP \tag{34}$$

where β_F is a parameter depending on several institutional factors.

For the sake of simplicity, total intermediate consumption can be defined as a share of total output:

$$CONS_{INT} = c_{INT} \cdot Y \tag{35}$$

The share of total intermediate consumption to total output is defined as a function of the past share and the lagged output:

$$c_{INT} = o^1 \cdot c_{INT,-1} + o^2 \cdot Y_{-1} \tag{36}$$

Total stock of fixed capital (at current prices) is:

$$K = (1 - \delta_K) \cdot K_{-1} + INV \cdot (1 - \xi_{INV}) \tag{37}$$

where δ_K is a parameter accounting for capital depreciation and ξ_{INV} can be regarded as the percentage of overall investment that goes to waste (or is not productive). While both parameters are estimated, the latter is treated as a constant, whereas the former is taken as a "moving parameter" (see Section 2.7).

Total capital grows at an endogenous rate, g_K, so total investment is:

$$INV = K_{-1} \cdot g_K \tag{38}$$

The growth rate is defined as a function of capital utilisation rate (proxied by the GDP to capital ratio), the risk premium on loans (meaning the cost of financing exceeding the risk-free interest rate) and the profit rate:[4]

$$g_K = \gamma_Y + \gamma_U \cdot \frac{GDP_{-1}}{K_{-1}} - \gamma_R \cdot (r_{L,F,-1} - r_{Z,-1}) + \gamma_\Pi \cdot \frac{\Pi_{F,-1}}{K_{-1}} \tag{39}$$

where Π_F is the NFC profit net of taxes.

Narrowly-defined NFC investment is a share of total investment:

$$INV_F = \delta_F \cdot INV \tag{40}$$

where δ_F is the ratio of NFC investment to total investment.

Data show that deposits held by non-financial corporations grow quicker than the GDP, so that:

$$D_F = (1 + \eta_F) \cdot D_{F,-1} \cdot \frac{GDP}{GDP_{-1}} \tag{41}$$

where η_F is an estimated parameter accounting for the different growth of bank deposits.

Aggregate demand is defined as the summation of household consumption, government spending (consumption), investment, intermediate consumption and export, *minus* import and (net) taxes:

$$\begin{aligned} Y_{AD} = {} & CONS_H + CONS_G + INV + CONS_{INT} + \\ & + EXP - IMP - \tau_T^{NET} \end{aligned} \tag{42}$$

where τ_T^{NET} stands for total taxes on products net of subsidies (see Figure 2).

Looking at non-Neoclassical literature, gross output can be defined either through a Leontief function (e.g. $Y = Min(N/a_1, K/a_2)$, where K is a non-labour input taken as a proxy for capital and a_1 and a_2 are technical coefficients) or as a linear function of employment. For the sake of simplicity, the second option is chosen here.[5] More precisely, gross output is defined as the annual product per employee times the number of employees:

$$Y = PROD \cdot N$$

[4] However, equation 39 was replaced by a purely estimated g_K when the model was used to fit past data - see (B.43) in Section 2.7.

[5] This is a key difference with respect to Burgess et al. (2016)[1], who use a standard Cobb-Douglas production function instead.

However, equation above does not define output but the employment level, as the former is assumed to adjust *smoothly* to aggregate demand:

$$Y = Y_{AD} \tag{43}$$

and hence:

$$N = \frac{Y}{PROD} \tag{44}$$

The rate of growth of productivity is an endogenous, depending on growth rates of autonomous demand components (notably, investment, export and government consumption):[6]

$$\begin{aligned} g_{PROD} = g_1 + g_2 \cdot d\big(log(INV_F)\big) + g_3 \cdot d\big(log(EXP)\big) + \\ + g_4 \cdot d\big(log(CONS_G)\big) \end{aligned} \tag{45}$$

So, current labour productivity is:

$$PROD = PROD_{-1} \cdot (1 + g_{PROD}) \tag{46}$$

Following Burgess et al. (2016)[1], import depends on output and the exchange rate:

$$IMP = IMP_{-1} \cdot exp\Bigg(\mu_1 + \mu_2 \cdot ln\Big(\frac{Y_{-1}}{Y_{-2}}\Big) + \mu_3 \cdot (NER_{-1} - NER_{-2})\Bigg) \tag{47}$$

where NER is the nominal exchange rate (see Section 2.6) and $exp(x)$ is an exponential function of x, that is, e^x.

Profits of non-financial corporations (net of taxes) are defined as a residual: total *GDP minus* other sectors' *GDP* (that is, NFC *GDP*) *minus* wages paid by NFCs (net of other sectors' wages) *minus* taxes *plus* subsidies *plus* net interest payments *plus* adjustment in funds *plus* other property incomes. In formulas:

$$\begin{aligned} \Pi_F = GDP_F - (WB - WB_{OTHER}) - \tau_F + T_F + \\ + INT_F + FUNDS_F + PROP_F \end{aligned} \tag{48}$$

Since ω_L is the labour income share of GDP, the non-labour share is:

$$\zeta = 1 - \omega_L \tag{49}$$

NFCs earn interests on their own bank deposits and government bond holdings and face (negative) interest payments on bank loans and issued securities. A residual component is accounted for as well, so that the net interest income earned by NFCs is defined as:

$$\begin{aligned} INT_F = r_{D,-1} \cdot D_{F,-1} - r_{L,F} \cdot L_{F,-1} - r_{BA} \cdot (B_{F,-1} - B_{G,F,-1}) + \\ + INT_F^{RES} \end{aligned} \tag{50}$$

[6] A dummy variable was added to equation 45 when the model was used to fit past data. This allows addressing the structural break in productivity that took place in the third quarter of 2007.

The value above is expected to be negative as interest payments made by NFCs normally outstrip interest earnings.[7] Households, domestic financial institutions and foreign investors are the recipients of NFC interest payments. More precisely, net interests that households receive from NFCs are:[8]

$$INT_{F,H} = INT_H \cdot i_F \tag{51}$$

where i_F is the share of interests paid by NFCs to total interest payments (which include interests paid by the government on Treasury bonds & bills). In other words, it is assumed that each sector receives the same proportion of interest payments from NFCs.

Similarly, net interest payments that financial institutions receive from NFCs are:

$$INT_{F,B} = INT_B \cdot i_F \tag{52}$$

Net interest payments that foreign investors receive from NFCs are:

$$INT_{F,RoW} = INT_{RoW} \cdot i_F \tag{53}$$

For the sake of simplicity, wages paid by other sectors rather than NFCs are defined as a share of total wages:

$$WB_{OTHER} = \omega_O \cdot WB \tag{54}$$

Retained profits are:

$$\Pi_{FU} = s_F \cdot \Pi_F \tag{55}$$

where s_F is the average retention rate of NFCs, defining their own self-funding capacity.

Accordingly, NFC distributed profits (dividends) are:

$$DIV_F = (1 - s_F) \cdot \Pi_F \tag{56}$$

Taxes paid by NFCs are a fixed percentage of *pre-tax* profits:

$$\tau_F = \theta_F \cdot \Big(GDP_F - (WB - WB_{OTHER}) - INT_F - FUNDS_F - PROP_F \Big) \tag{57}$$

For the sake of simplicity, subsidies and transfers to/from NFC are determined as a percentage of NFC profits:

$$T_F = \alpha_{F,T} \cdot \Pi_F \tag{58}$$

Similarly, the adjustment in NFC funds is:

$$FUNDS_F = \alpha_{F,FU} \cdot \Pi_F \tag{59}$$

[7] However, data show that the value of net interest has turned positive in the last few years.

[8] Notice that $INT_{F,H}$ does not mirror household holdings of NFC securities. This is likely to be due to the fact that we are considering net flows and stocks (rather than gross flows and stocks) and average return rates (rather than security-specific return rates).

Other (net) property income paid by NFCs is:

$$PROP_F = \alpha_{F,O} \cdot \Pi_F \tag{60}$$

Data show that Italian government, financial institutions and households are all (net) holders of equity and shares issued by Italian NFCs. As a result, dividends paid by NFCs to the government should be defined as:

$$DIV_{F,G} = e_G \cdot DIV_F \cdot \frac{V_{F,G}}{V_F} \tag{61}$$

where e_G is the share of dividends which are "actually" received by the government.[9]

Similarly, dividends paid by NFCs to financial institutions should be calculated as:

$$DIV_{F,B} = e_B \cdot DIV_F \cdot \frac{V_{F,B}}{V_F} \tag{62}$$

where e_B is the share of dividends which are actually received by (or paid to) the financial sector.

We can now define dividends paid by NFCs to households as a residual:

$$DIV_{F,H} = DIV_F - DIV_{F,G} - DIV_{F,B} \tag{63}$$

Equations (61) and (62) show that, in principle, dividends should be distributed to households, government and financial institutions based on their own equity holdings. However, data show that (net) dividends received by government and financial institutions are negligible. This is likely to be due to the differences in equity & shares' portfolios across sectors. So, we assume that $e_G = e_B = 0$ and hence $DIV_{F,H} = DIV_F$ hereafter. In other words, Italian households are the only recipient of NFC distributed profits.

The total stock of NFC equity & shares is

$$V_F = V_{F,H} + V_{F,G} + V_{F,B} \tag{64}$$

In line with current literature, it is assumed that firms can issue new equity to fund a small percentage of their investment plans (Burgess et al. 2016[1]). The real volume of equity is:

$$V_F^R = V_{F,-1}^R + \psi \cdot \frac{INV_{F,-1}}{p_{V,-1}} \tag{65}$$

where p_V is the unit market price of NFC equity. This is an average price, which can be simply defined as:

$$p_V = \frac{V_F}{V_F^R} \tag{66}$$

[9] This point is discussed below.

Italy is usually regarded as a traditional or "bank based" system. For Italian NFCs rely mainly on bank loans to fund their own production and investment plans. By contrast, financial markets usually do not occupy center stage.

In line with SFC literature, new bank loans obtained by firms are determined as a residual:

$$\begin{aligned} L_F &= L_{F,-1} + INV_F - \Pi_{FU} - NPL - p_V \cdot \Delta V_F + \Delta D_F \\ &= L_{F,-1} - NL_F - NPL - p_V \cdot \Delta V_F + \Delta D_F \end{aligned} \tag{67}$$

Equation above shows that the change in bank loans obtained by NFCs equals their own investment plans *minus* retained profits *minus* loans write-offs *minus* share issues *plus* the change in their own bank deposits.

Loans write-offs are a share of total loans to NFCs:

$$NPL = \xi_F \cdot \xi_B \cdot L_{F,-1} \tag{68}$$

where ξ_B is the percentage of non-performing bank loans (NPBL), while ξ_F is the share of NPBLs which give rise to NFC loans write-offs.

It is now possible to determined the *net lending by NFCs*, which is:

$$NL_F = \Pi_{FU} - INV_F \tag{69}$$

As mentioned, this is the key sectoral magnitude of this model, as it defines its financial balance/relationship with the rest of the economy.

There are still some NFC variables to be defined, before turning to other sectors. The net disposable income of NFCs is:

$$YD_F = \Pi_{FU} - FUNDS_F \tag{70}$$

NFC net wealth (or worth) is:

$$NW_F = NW_{F,-1} + YD_F - INV_F + FUNDS_F \tag{71}$$

NFC net financial assets holdings (including deposits) are:

$$NFW_F = -NW_F - K \cdot \nu_{K,F} + L_F + V_F + B_F - B_{G,F} \tag{72}$$

Notice that $\nu_{K,F}$ (i.e. the percentage of total capital owned by the NFC sector) may well be different from δ_F (i.e. the ratio of NFC investment to total investment). The latter refers to the investment undertaken in the last two decades or so, while the former refers to the stock of capital overall accumulated over time.

Other financial assets of NFCs (and net security holdings up until 2003) are:

$$OFIN_F = -NFW_F - D_F \tag{73}$$

The (net) demand for Italian NFC securities arises from domestic financial institutions, households and foreign investors:[10]

$$B_F = B_{F,B} + B_{F,H} + B_{F,RoW} \tag{74}$$

Finally, the net amount of government bonds held by NFCs (up until 2003) is:

$$B_{G,F} = B_G \cdot q_{G,F} \tag{75}$$

where $q_{G,F}$ is an empirically-estimated parameter, defining the ratio of NFC securities to government securities.

2.3 *The government*

As is well known, Italy is marked by one of the biggest government debt to GDP ratios among developed countries. The absolute value of government debt is also remarkable. This makes the Italian government securities' market one of the biggest (and most liquid) in the world. Total nominal demand for Italian government securities is defined as the summation of sectoral demands:

$$B_G = B_{G,H} + B_{G,RoW} + B_{G,B} + B_{G,F} \tag{76}$$

Focusing on 10-year Treasury bonds (named BTP), yields are defined by adding a mark-up to the risk-free interest rate (i.e. the German 10-year government bond rate):

$$r_B = r_Z \cdot (1 + m)$$

Similarly, the average return rate on Italian government securities - including Treasury bills (BOT), zero-coupon certificates (CTZ), floating rate notes (CCT) and bonds with other maturities - can be calculated as:

$$r_{BA} = r_Z \cdot (1 + m_A) \tag{77}$$

where the mark-up is defined as:

$$m_A \equiv \frac{SPREAD_A}{r_Z} \tag{78}$$

and the average spread between Italian and German bonds is determined as a linear function of the market price of Italian bonds:

$$SPREAD_A = s_A^1 + s_A^2 \cdot p_B \tag{79}$$

While Italy's government debt to GDP ratio is one of the highest in the EU, the government deficit to GDP ratio has been one of the lowest since the early 1990s. In fact, Italy has been marked by primary surpluses ever since (except for 2009).

Notice that both Eurostat and the ECB liken the concept of "surplus" ("deficit") with that of "net lending" ("net borrowing"). The latter is defined as

[10] Notice that the Italian NFC sector has become a net issuer of securities since 2003.

"the last balancing item of the non-financial accounts - namely the balancing item of the capital account".[11] In formal terms, *net lending by the government* arises from revenues net of spending and interest payments:

$$NL_G = GOV_{REV} - GOV_{SP} - INT_G \tag{80}$$

Interest payments, in turn, depend on the average return rate on government securities and the amount of outstanding debt (in form of securities):

$$INT_G = r_{BA} \cdot B_{G,-1} \tag{81}$$

Government total spending is given by the summation of government consumption, investment, wage payments, total transfers (including subsidies and benefits) and adjustment in funds:

$$GOV_{SP} = CONS_G + INV_G + WB_G + T_{TOT} + FUNDS_G \tag{82}$$

Government total revenue is given by the summation of government GDP (i.e. the *cost* of goods and services produced by the government), total taxes, property incomes and dividends:

$$GOV_{REV} = GDP_G + \tau_{TOT} + PROP_G + DIV_G \tag{83}$$

For the sake of simplicity, government consumption is defined as a share of total GDP *plus* a discretionary or stochastic component:

$$CONS_G = \alpha_G^C \cdot GDP + \epsilon_G \tag{84}$$

Similarly, government investment is defined as a share of total GDP:

$$INV_G = \alpha_G^I \cdot GDP \tag{85}$$

and government wages are:

$$WB_G = \omega_G \cdot GDP \tag{86}$$

The total amount of equity and shares held by the government is defined by parameter α_G^V:

$$V_G = \alpha_G^V \cdot GDP \tag{87}$$

More in detail, the value of net NFC equity and shares held by the government is assumed to be:

$$V_{F,G} = x_F \cdot V_G \tag{88}$$

where x_F is the percentage of NFC equity and shares to total equity and shares.

Similarly, the value of financial sector equity and shares held by the government (up until 2007) is:

$$V_{B,G} = x_B \cdot V_G \tag{89}$$

[11] See Eurostat Glossary at: http://ec.europa.eu/eurostat/statistics-explained/

where x_B is the percentage of financial sector's equity and shares to total equity and shares.

The value of foreign sector equity and shares held by the government is defined as a residual:

$$V_{RoW,G} = (1 - x_F - x_B) \cdot V_G \tag{90}$$

The total tax revenue is the summation of taxes paid by domestic private and foreign sectors:

$$\tau_{TOT} = \tau_H + \tau_F + \tau_B + \tau_{RoW} \tag{91}$$

The amount of total transfers is the summation of transfers paid by government to domestic private and foreign sectors:

$$T_{TOT} = T_H + T_F + T_B + T_{RoW} \tag{92}$$

Government GDP is evaluated in terms of costs of production. For the sake of simplicity, it is defined here as a share of total GDP:

$$GDP_G = \beta_G \cdot GDP \tag{93}$$

Net dividends paid to government are the summation of dividends from NFCs, financial institutions and foreign issuers:

$$DIV_G = DIV_{F,G} + DIV_{B,G} + DIV_{RoW,G} \tag{94}$$

Government property income is simply defined as a share of total GDP:

$$PROP_G = \alpha_G^P \cdot GDP \tag{95}$$

Similarly, the adjustment in funds for the government is defined as:

$$FUNDS_G = -\alpha_G^{FU} \cdot GDP \tag{96}$$

Using adaptive expectations, the change in the real supply of government bonds (BTP) is determined by both government borrowing needs and newly issued Treasury bills (BOT):[12]

$$B_G^R = B_{G,-1}^R - \frac{-NL_G}{p_{B,-1}} + \frac{BOT_{-1}}{p_{B,-1}} \tag{97}$$

where p_B is the (average) unit price of Italian Treasury bonds and BOT is the quantity of Treasury bills issued by the government in current period.

So, the market price of Italian government bonds is:

$$p_B = \frac{B_G}{B_G^R} \tag{98}$$

[12] For the sake of simplicity, government securities other than Treasury bonds and bills are neglected.

The nominal supply of Treasury bills is:

$$BOT = p_{B,-1} \cdot \Delta B_G^R - \left(B_G - B_{G,-1} \cdot \frac{p_B}{p_{B,-1}} \right) \tag{99}$$

In other words, the Italian government issues bills to deal with temporary cash imbalances.

Total taxes on products (net of subsidies) are defined as a percentage, θ_{TOT}, of gross output:

$$\tau_{TOT}^{NET} = \theta_{TOT} \cdot Y \tag{100}$$

Interests paid by government to financial institutions are defined as total interest payments received by financial institutions *minus* interests paid by non-financial firms:

$$INT_{G,B} = INT_B - INT_{F,B} \tag{101}$$

Similarly, interests paid by government to households are defined as a residual:

$$INT_{G,H} = INT_H - INT_{F,H} \tag{102}$$

and the same goes for interests paid by government to foreign investors, which amount to:

$$INT_{G,RoW} = INT_{RoW} - INT_{F,RoW} \tag{103}$$

Notice that, looking at available data, interest payments to each sector do not mirror sectoral bond holdings. As mentioned, this is likely to be due to the fact that net values (rather than gross values) and average return rates (rather than asset-specific rates) are used.

For the sake of simplicity, the net stock of loans obtained (or granted) by the government is defined as a percentage of government net wealth:

$$L_G = NW_G \cdot \eta_L^G \tag{104}$$

Similarly, the net stock of deposits and cash held by the government is:

$$D_G = NW_G \cdot \eta_D^G \tag{105}$$

Finally, Italian government net wealth is roughly equal to:

$$NW^G = NL_G - B_G \tag{106}$$

Notice that equation (106) is just an approximation and should be refined in future versions of this work.

2.4 *Banks and other financial institutions*

Italy's financial sector is dominated by a few large banks (notably *Unicredit* and *Intesa Sanpaolo*). Consequently, commercial banks and non-bank financial institutions can be included in the same sector without loss of realism. As usual, the GDP to be attributed to financial institutions as a whole is defined as a percentage, β_B, of total GDP:

$$GDP_B = \beta_B \cdot GDP \tag{107}$$

Profits made by financial institutions are calculated as the summation of financial sector's GDP, net dividends, net interest payments and adjustment in funds, *minus* wages paid and taxes net of transfers:

$$\begin{aligned}\Pi_B = {} & GDP_B - WB_B - \tau_B + T_B + DIV_B + \\ & + PROP_B + INT_B + FUNDS_B\end{aligned} \tag{108}$$

It is possible to derive the *net lending of financial institutions* by subtracting both received dividends and investment spending from (retained) profits:

$$NL_B = PI_B - DIV_B - INV_B \tag{109}$$

For the sake of simplicity, the wage bill paid by financial institutions is also defined as a share of total GDP:

$$WB_B = \omega_B \cdot GDP \tag{110}$$

Total taxes on financial sector profits are:

$$\tau_B = \theta_B \cdot \Pi_B \tag{111}$$

Similarly, the value of total transfers received by financial institutions is determined as a percentage of profits:

$$T_B = \alpha_B^T \cdot \Pi_B \tag{112}$$

Other property incomes received by financial institutions are:

$$PROP_B = \alpha_B^P \cdot \Pi_B \tag{113}$$

The adjustment in funds for the financial sector is:

$$FUNDS_B = \alpha_B^{FU} \cdot \Pi_B \tag{114}$$

Financial sector net earning from lending is defined as net interest paid by households *plus* net interest paid by NFCs *plus* a residual:

$$INT_B = \left(INT_H^{PAID} + (-INT_F)\right) + INT_B^{RES} \tag{115}$$

where the residual component, INT_B^{RES}, is estimated empirically to account for other interest entries and improve data fitting.

The investment undertaken by financial institutions is assumed to depend on past investment, a trend component, the risk-free interest rate, the return rate on equity, the (expected) profit rate, and the (change in) average market price of shares:

$$INV_B = \gamma_B^0 + \gamma_B^1 \cdot INV_{B,-1} + \gamma_B^2 \cdot t + \gamma_B^3 \cdot r_Z + \\ + \gamma_B^4 \cdot r_{V,-1} + \frac{\gamma_B^5 \cdot \Pi_B}{K \cdot \nu_{K,B}} + \gamma_B^6 \cdot \Delta p_V \tag{116}$$

Financial sector net wealth is:

$$NW_B = NW_{B,-1} + \Pi_{BU} - INV_B \tag{117}$$

Financial institutions retain a percentage, s_B, of total profit:

$$\Pi_{BU} = \Pi_B \cdot s_B \tag{118}$$

The *net* stock of bank loans is the summation of mortgages to households and loans granted to NFCs and the government:

$$L_B = MORT_H + L_F + L_G \tag{119}$$

Similarly, the *net* stock of bank deposits is:

$$D_B = D_H + D_F + D_G \tag{120}$$

Notice that the *total* stock of loans is higher than L_B, as it must account for the foreign sector:

$$L_{TOT} = L_B + L_{RoW} \tag{121}$$

Accordingly, the change in the *total* stock of deposits in current period equals the change in total loans:

$$D_{TOT} = D_{TOT,-1} + \Delta L_{TOT} \tag{122}$$

Turning to financial assets held by the financial institutions, the overall amount is:

$$NFW_B = NW_B - K \cdot \nu_{K,B} \tag{123}$$

where $\nu_{K,B}$ is the percentage of fixed capital owned by financial institutions and hence $K \cdot \nu_{K,B}$ is the stock of capital invested in the financial sector.

Apart from loans, Italian banks and financial institutions' financial assets are made up of securities, equity & shares and other undefined assets.[13]

The ratio of financial institutions' equity & shares holdings to net financial wealth is:

$$\frac{V_B}{E(NFW_B)} = \lambda_{1,0}^B + \lambda_{1,1}^B \cdot r_V + \lambda_{1,2}^B \cdot r_{BA} \tag{124}$$

[13] Financial assets' holdings by sector are shown by Table 3 (securities) and Table 4 (equities & shares) in the *Appendix*.

The ratio of financial institutions' securities holdings to net financial wealth is:

$$\frac{B_B}{E(NFW_B)} = \lambda^B_{2,0} + \lambda^B_{2,1} \cdot r_V + \lambda^B_{2,2} \cdot r_{BA} \tag{125}$$

where $\lambda^B_{2,j}$ coefficients are defined in the usual way.

Goverment bonds held by financial institutions are defined as a residual:

$$B_{G,B} = (1 - q_F) \cdot B_B \tag{126}$$

where q_F is the ratio of NFC securities to total securities, which is assumed to mirror the actual financial institutions' security portfolio composition.

NFC securities held by financial institutions are:

$$B_{F,B} = q_F \cdot B_B \tag{127}$$

Net dividends paid by financial corporations to households are negligible, so:

$$DIV_{B,H} = e_B \cdot DIV_B \cdot \frac{V_{B,H}}{V_B} \approx 0 \tag{128}$$

Similarly, net dividends paid by financial corporations to the government are:

$$DIV_{B,G} = e_B \cdot DIV_B \cdot \frac{V_{B,G}}{V_B} \approx 0 \tag{129}$$

In other words, it is implicitly assumed that $e_B = 0$, so that financial corporations pay no dividends to other sectors:

$$DIV_B = DIV_{B,H} + DIV_{B,G} = 0 \tag{130}$$

Net NFC equity and shares held by financial corporations are:

$$V_{F,B} = x_F \cdot V_B \tag{131}$$

where x_F is the ratio of NFC equity to total equity.

Recalling net wealth definition (NW_B), other financial assets held by the financial institutions can be determined as a residual:

$$OFIN_B = INV_B - NW_B + V_B + L_B - D_B \tag{132}$$

Finally, commercial banks set the interest rate on loans to NFCs by adding a mark-up over the ECB target rate:

$$r_{L,F} = r_{ECB} + r_{ADD} \tag{133}$$

where r_{ADD} is the risk premium paid by NFCs (see Section 2.6).

2.5 *The rest of the world*

For the sake of accounting consistency, the GDP attributed to the rest of the world (displayed by the last column in Figure 2) is defined as a residual:

$$GDP_{RoW} = GDP - (GDP_H + GDP_F + GDP_G + GDP_B) \tag{134}$$

Similarly, *net lending by the rest of the world* must match domestic net borrowing:

$$NL_{RoW} = -(NL_H + NL_F + NL_G + NL_B) \tag{135}$$

The latter is nothing but the negative of the current account for the Italian economy.

Loans granted to or obtained from the rest of the world depend on many factors, including past loans, the ECB target interest rate, the GDP attributed to the rest of the world, the (nominal) exchange rate, the total trade volume, and the Italian trade balance:

$$\begin{aligned} L_{RoW} = \Phi_L^1 \cdot L_{RoW,-1} + \Phi_L^2 \cdot r_{ECB} + \Phi_L^3 \cdot GDP_{RoW} + \\ + \Phi_L^4 \cdot NER + \Phi_L^5 \cdot (IMP + EXP) + \Phi_L^6 \cdot (IMP - EXP) \end{aligned} \tag{136}$$

Similarly, deposits held by the rest of the world can be defined as:

$$\begin{aligned} D_{RoW} = \Phi_D^1 \cdot L_{RoW,-1} + \Phi_D^2 \cdot GDP_{RoW} + \Phi_D^3 \cdot (IMP + EXP) + \\ + \Phi_D^4 \cdot (IMP - EXP) + \Phi_D^5 \cdot r_{BA} + \Phi_D^6 \cdot GDP \end{aligned} \tag{137}$$

Export is assumed to be driven by (changes in) output, exchange rate, wages and employment:

$$\begin{aligned} EXP = EXP_{-1} \cdot exp\Bigg(\mu_1^X + \mu_2^X \cdot ln\Big(\frac{Y_{-1}}{Y_{-2}}\Big) + \mu_3^X \cdot (NER_{-1} - NER_{-2}) + \\ + \mu_4^X \cdot ln\Big(\frac{WB_{-1}}{WB_{-2}}\Big) + \mu_5^X \cdot ln\Big(\frac{N_{-1}}{N_{-2}}\Big)\Bigg) \end{aligned} \tag{138}$$

Net dividends paid by the rest of the world to Italian households are:

$$DIV_{RoW,H} = e_{RoW} \cdot DIV_{RoW} \cdot \frac{V_{RoW,H}}{V_{RoW}} \tag{139}$$

where e_{RoW} is the share of dividends (distributed by foreign institutions) actually received by households.

Similarly, net dividends paid by the rest of the world to the Italian government are:

$$DIV_{RoW,G} = e_{RoW} \cdot DIV_{RoW} \cdot \frac{V_{RoW,G}}{V_{RoW}} \tag{140}$$

Net dividends paid by the rest of the world to Italian financial institutions are:

$$DIV_{RoW,B} = e_{RoW} \cdot DIV_{RoW} \cdot \frac{V_{RoW,B}}{V_{RoW}} \tag{141}$$

The rest of the world equity held by Italian financial institutions is:

$$V_{RoW,B} = x_B \cdot V_{RoW} \tag{142}$$

where x_B is the ratio of financial institutions' equity to total equity.

By contrast, Italian government bonds held by the rest of the world are:

$$B_{G,RoW} = (1 - q_F) \cdot B_{RoW} \tag{143}$$

where q_F is the ratio of NFC securities to total securities.

Italian NFC securities held by the rest of the world are:

$$B_{F,RoW} = q_F \cdot B_{RoW} \tag{144}$$

Total (net) securities held by the rest of the world depend on return rates on bonds and other financial assets, and the exchange rate:

$$B_{RoW} = b^1 \cdot r_Z + b^2 \cdot r_{ECB} + b^3 \cdot r_{BA} + b^4 \cdot NER + b^5 \cdot r_V \tag{145}$$

Total (net) equity issued by the rest of the world is defined as a residual:

$$V_{RoW} = V_H + V_G - (V_F + V_B) \tag{146}$$

Data show that net dividends paid by the rest of the world to Italian investors are negligible:

$$DIV_{RoW} = DIV_F - DIV_H - DIV_G - DIV_B \approx 0 \tag{147}$$

The net interest earned by the rest of the world is also defined as a residual:

$$INT_{RoW} = INT_H + INT_B - (INT_F + INT_G) \tag{148}$$

Transfers to the rest of the world are simply defined as a share of Italy's GDP:

$$T_{RoW} = \alpha^T_{RoW} \cdot GDP \tag{149}$$

Similarly, taxes paid by the rest of the world are:

$$\tau_{RoW} = \theta_{RoW} \cdot GDP \tag{150}$$

To sum up, rest of the world's variables are defined in a residual way, except for those mirroring portfolio decisions. The rationale is to assure the accounting consistency of the model.

2.6 *The central bank*

Since Italy is a member of the Euro Area, the target interest rate is set autonomously by the ECB:

$$r_{ECB} = \bar{r}_{ECB} \tag{151}$$

The exchange rate is taken as an exogenous from Eurostat database, and it is defined as the effective nominal exchange rate with 42 trading partners:

$$NER = N\bar{E}R \tag{152}$$

The risk-free interest rate is the return rate on 10-year German bonds, which is also an exogenous variable for Italy:

$$r_Z = \bar{r}_Z \tag{153}$$

Finally, the mark-up NFCs are charged by banks is defined as:

$$r_{ADD} = \rho_1 \cdot r_{ECB,-1} + \rho_2 \cdot r_{LF,-1} + \rho_3 \cdot d\Big(log(GDP)\Big) + \rho_4 \cdot \frac{L_{F,-1}}{V_{F,-1}} \tag{154}$$

In other words, the risk-premium over the target interest rate is determined by the level of the ECB rate, the past interest rate on loans to NFCs, the GDP growth rate, and the NFC leverage ratio.[14]

The model is now complete, meaning that all transaction flows displayed by Figure 4 and all related assets & liabilities' stocks have been defined. Next sub-section shows how parameters are defined to improve the models' fitting power.

2.7 *Moving parameters and exogenous variables*

The main target of the model is not to fit past data, but to help create alternate qualitative scenarios for macroeconomic variables (to be compared with the *status quo*). However, one could guess whether the model can be calibrated to reproduce historical time series. As the period considered is rather extended and marked by structural breaks, parameters and exogenous variables are treated like variables when the model is used to fit past data. In other words, parameters are allowed to change over time following a deterministic trend. The latter is defined, in turn, by meta-parameters, b_j (with $j = 1, 2, 3, ..., 125$). In addition, six dummy variables, labelled d_j (with $j = 1, 2, 3, ..., 6$), are used to address structural breaks.

Starting from household GDP share to total GDP, it is defined as:

$$\beta_H = b_1 + b_2 \cdot t \tag{B.1}$$

The wage share to GDP is:

$$\omega_T = b_3 \cdot \omega_{T,-1} + b_4 \cdot t + b_5 \cdot t^2 \tag{B.2}$$

The household tax rate is:

$$\theta_H = b_6 + b_7 \cdot t \tag{B.3}$$

[14] Notice that equation (154) was replaced by a purely estimated r_Z when the model was used to fit past data - see (B.39) in Section 2.7.

Other (residual) interest received by households is:

$$INT^{RECV}_{H,RES} = b_8 + b_9 \cdot t \tag{B.4}$$

The estimated interest rate on mortgages is:

$$r_M = b_{10} + b_{11} \cdot t \tag{B.5}$$

Other (residual) interest paid by households is:

$$INT^{PAID}_{H,RES} = b_{12} + b_{13} \cdot t + b_{14} \cdot t^2 \tag{B.6}$$

The household transfers to (lagged) wage ratio is:

$$\alpha_{H,T} = b_{15} + b_{16} \cdot t \tag{B.7}$$

The household property income to (lagged) wage ratio is:

$$\alpha_{H,P} = b_{17} + b_{18} \cdot t \tag{B.8}$$

The percentage of NFC equity to total equity is:

$$\chi_F = b_{19} + b_{20} \cdot t + b_{21} \cdot t^2 \tag{B.9}$$

Similarly, the percentage of financial institutions equity to total equity is:

$$\chi_B = b_{22} + b_{23} \cdot t + b_{24} \cdot t^2 \tag{B.10}$$

The percentage of NFC securities to total securities is:

$$q_F = b_{25} + b_{26} \cdot t + b_{27} \cdot t^2 \tag{B.11}$$

NFC GDP share to total GDP is:

$$\beta_F = b_{28} \cdot \beta_{F,-1} + b_{29} \cdot t + b_{30} \cdot t^2 \tag{B.12}$$

The capital depreciation rate is:

$$\delta_K = b_{31} + b_{32} \cdot t + b_{33} \cdot t^2 + d_1 \tag{B.13}$$

NFC investment to total investment ratio is assumed to depend also on gross output level:

$$\delta_F = b_{34} + b_{35} \cdot \delta_{F,-1} + b_{36} \cdot Y_{-1} + b_{37} \cdot t \tag{B.14}$$

The residual interest earned by NFCs is:

$$INT^{RES}_F = b_{38} + b_{39} \cdot t + b_{40} \cdot t^2 \tag{B.15}$$

The share of interests paid by/to NFCs to total interest payments is:

$$i_F = b_{41} \cdot i_{F,-1} + b_{42} \cdot t + b_{43} \cdot t^2 \tag{B.16}$$

The ratio of other wages to total wages is:

$$\omega_O = b_{44} + b_{45} \cdot t \tag{B.17}$$

The rate of retention of profit after taxes is:

$$s_F = b_{46} + b_{47} \cdot t \tag{B.18}$$

The tax rate on NFC profits is:

$$\theta_F = b_{48} + b_{49} \cdot t \tag{B.19}$$

The NFC transfers to profit ratio is:

$$\alpha_{F,T} = b_{50} + b_{51} \cdot t \tag{B.20}$$

The NFC funds to profit ratio is:

$$\alpha_{F,FU} = b_{52} + b_{53} \cdot t \tag{B.21}$$

The percentage of bank loans write-offs is:

$$\xi_B = b_{54} \cdot d_2 + b_{55} \cdot t + b_{56} \cdot t^2 \tag{B.22}$$

The government consumption to GDP ratio is:

$$\alpha_G^C = b_{57} \cdot \alpha_{G,-1}^C + b_{58} \cdot d_3 + b_{59} \cdot t + d_3 \cdot b_{60} \cdot t \tag{B.23}$$

The government investment to GDP ratio is:

$$\alpha_G^I = b_{61} \cdot \alpha_{G,-1}^I + b_{62} \cdot d_4 + b_{63} \cdot t \tag{B.24}$$

The government wages to GDP ratio is:

$$\omega_G = b_{64} \cdot \omega_{G,-1} + b_{65} \cdot d_5 \cdot \omega_{G,-1} \tag{B.25}$$

The government total equity to GDP ratio is:

$$\alpha_G^V = b_{66} + b_{67} \cdot t + b_{68} \cdot t^2 \tag{B.26}$$

The ratio of government adjustment in funds to GDP is:

$$\alpha_G^{FU} = b_{69} \cdot \alpha_{G,-1}^{FU} + b_{70} \cdot t \tag{B.27}$$

The ratio of government (other) property income to total GDP is:

$$\alpha_G^P = b_{71} + b_{72} \cdot \alpha_{G,-1}^P + b_{73} \cdot t + b_{74} \cdot t^2 \tag{B.28}$$

The ratio of net loans to net wealth for the government sector is:

$$\eta_L^G = b_{75} + b_{76} \cdot t + b_{77} \cdot t^2 \tag{B.29}$$

The ratio of net deposits to net wealth for the government sector is:

$$\eta_D^G = b_{78} + b_{79} \cdot t + b_{80} \cdot t^2 \tag{B.30}$$

Financial institutions' GDP to total GDP is:

$$\beta_B = b_{81} + b_{82} \cdot t + b_{83} \cdot t^2 \tag{B.31}$$

The ratio of financial institutions wages to total GDP is:

$$\omega_B = b_{84} + b_{85} \cdot t + b_{86} \cdot t^2 \tag{B.32}$$

The ratio of total taxes paid by financial institutions to total GDP is:

$$\theta_B = b_{87} + b_{88} \cdot t + b_{89} \cdot t^2 \tag{B.33}$$

The ratio of total transfers received by financial institutions to total GDP is:

$$\alpha_B^T = b_{90} + b_{91} \cdot t + b_{92} \cdot t^2 \tag{B.34}$$

The ratio of financial institutions adjustment in funds to total GDP is:

$$\alpha_B^{FU} = b_{93} + b_{94} \cdot t + b_{95} \cdot t^2 \tag{B.35}$$

The ratio of other property income received by financial institutions to total GDP is:

$$\alpha_B^P = b_{96} + b_{97} \cdot t + b_{98} \cdot t^2 \tag{B.36}$$

Residual interests earned by financial institutions are:

$$INT_B^{RES} = b_{99} + b_{100} \cdot t + b_{101} \cdot t^2 \tag{B.37}$$

The rate of retention of profit in the financial sector is:

$$s_B = b_{102} + b_{103} \cdot t + b_{104} \cdot t^2 \tag{B.38}$$

The empirically-estimated mark-up over the target interest rate steered by the ECB is:

$$r_{ADD} = b_{105} \cdot r_{ADD,-1} + b_{106} \cdot t + b_{107} \cdot t^2 + b_{108} \cdot t^3 + b_{109} \cdot t^4 \tag{B.39}$$

The ratio of RoW transfers to total GDP is:

$$\alpha_{RoW}^T = b_{110} + b_{111} \cdot t + b_{112} \cdot t^2 \tag{B.40}$$

The ratio of RoW taxes to total GDP is:

$$\theta_{RoW} = b_{113} + b_{114} \cdot t + b_{115} \cdot t^2 \tag{B.41}$$

The total tax rate on products (net of subsidies) is:

$$\theta_{TOT} = b_{116} + b_{117} \cdot \theta_{TOT,-1} + b_{118} \cdot t + b_{119} \cdot t^2 \tag{B.42}$$

The empirically-estimated growth rate of capital is:

$$g_K = b_1 20 + b_{121} \cdot g_{K,-1} + b_{122} \cdot d_6 + b_{123} \cdot t + b_{124} \cdot t^2 + b_{125} \cdot d_6 \cdot t \tag{B.43}$$

As mentioned, the latter replaces equation (39) when the model is used to fit past data.

3 Method: balance-sheets, data and calibration

The dataset covers relevant variables for the Italian economy (financial assets and liabilities, non-financial assets, non-financial transactions, and annual accounts by sector) from 1990 to 2016 on a quarterly basis at the sectoral level. Before estimating/calibrating model parameters, the transaction flow matrix (TFM hereafter) must be matched to Italy's national accounts provided by Eurostat. The full TFM for Italy in 2015 is shown by Figure 2.

Figure 2: The full transaction-flow matrix (Italy, 2015, annual, current prices, million euro)

Italy 2015		Non-Financial Corporation S11	Financial Corporations S12	Government S13	Households S14_S15	Rest of World S2	Total economy (row total) S1
Gross Output	P1	2095694	130440	306245	580440	0	3112819
Intermediate Consumption	P2	-1360170	-54429	-90092	-129658	0	-1634349
Taxes on Product	D21	0	0	189354	0	2251	191605
Subsidies on Products	D31	0	0	-24469	0	-167	-24636
Memo: GDP		735524	76011	381038	450782	2084	1645439
Consumption	P3	0	0	-311639	-1001014		-1312653
Exports	P6	0	0	0	0	-493934	-493934
Imports	P7	0	0	0	0	446042	446042
Investment	P5 (G)	-149558	-4429	-36959	-93949		-284895
Total Production		585966	71582	32440	-644181	-45808	-1
Wages	D1	-411085	-32356	-161998	609723	-4284	0
Taxes on Production and Imports	D2***	-26528	-5735	240236	-18620	-189354	-1
Subsidies on Production	D3	4347	4	-28481	3929	20201	0
Dividends	D42	-109941	-1633	4271	114625	-7322	0
Interests payments	D41	-5209	18574	-65237	30759	21113	0
Other property income	D4G*	-11995	-17221	3924	23481	1812	1
Taxes on Income and Wealth	D5	-27869	-6022	241582	-206485	-1206	0
Social Benefits (net of social contributions)	D6**	1273	2461	-113732	112607	-2609	0
Other Current Transfers	D7	-5061	-1075	-6476	-6232	18844	0
Adjustments in Pension Funds	D8	-1272	-2461	0	3733	0	0
Capital Transfers	D9	18031	8294	-25421	2889	-3792	1
Total Transfers		-575309	-37170	88668	670409	-146597	1
Sum Production and Transfers		10657	34412	121108	26228	-192405	0
Acquisition less consumption of non produced, non financial products	NP	-1535	-18	-420	789	1184	0
Tax les subsidies on product	-D21+D31	0	0	-164885	0	164885	0
Computed Net Lending Position		9122	34394	-44197	27017	-26336	0
Net Lending Position	B9	9120	34396	-44197	27017	-26336	0
Total by sector (column total)		2	-2	0	0	0	0

Looking at the figure above, two issues are apparent. First, lines 6 to 9 of the full TFM do not sum up to zero. In other words, there is no information about "who pays who", meaning about cross-sector transactions. Second, the number of entries is very high and should be reduced to avoid an excessive number of variables and equations. To address these issues, the full TFM is narrowed down in two steps.[15] First, it is assumed that everything is produced by non-financial corporations upon request of other sectors. Strong though it may seem, this assumption allows meeting the stock-flow conditions for production entries in a simple way, so that each row total amounts to zero. Figure 3 shows the reduced TFM, where the SFC *quadruple-entry principle* is met. Second, the TFM is further simplified by merging together some entries (rows), as shown by Figure 4. This is the accounting structure the theoretical model was built upon.

As mentioned, Eurostat quarterly data (from the first quarter of 1996 to the last quarter of 2016) are used to estimate most of model parameters (e.g. consumption function parameters, housing investment parameters, loan and

[15] See Antoine Godin's website (https://github.com/antoinegodin) for a detailed introduction to empirical SFC models.

Figure 3: The reduced or simplified transaction-flow matrix (Italy, 2015, annual, current prices, million euro)

Italy 2015		Non-Financial Corporation S11	(capital)	Financial Corporations S12	Government S13	Households S14_S15	Rest of World S2	Total economy (row total) S1
Gross Output	P1	2095694		130440	306245	580440	0	3112819
Intermediate Consumption	P2	-1360170		-54429	-90092	-129658	0	-1634349
Taxes on Product	D21	0		0	189354	0	2251	191605
Subsidies on Products	D31	0		0	-24469	0	-167	-24636
Memo: GDP per sector		735524		76011	381038	450782	2084	1645440
Memo: total GDP		1645440						
GDP Redistribution		-909915	= -Σ	76011	381038	450782	2084	0
Consumption	P3	1312653		0	-311639	-1001014	0	0
Exports	P6	493934		0	0	0	-493934	0
Imports	P7	-446042		0	0	0	446042	0
Investment	P5 (G)	284895	-149558	-4429	-36959	-93949	0	0
Wages	D1	-411085		-32356	-161998	609723	-4284	0
Taxes on Production and Imports	D2	-26528		-5735	240236	-18620	-189354	0
Subsidies on Production	D3	4347		4	-28481	3929	20201	0
Dividends	D42	-109941		-1633	4271	114625	-7322	0
Interests payments	D41	-5209		18574	-65237	30759	21113	0
Other property income	D4G	-11995		-17221	3924	23481	1812	0
Taxes on Income and Wealth	D5	-27869		-6022	241582	-206485	-1206	0
Social Benefits (net of social contributions)	D6	1273		2461	-113732	112607	-2609	0
Other Current Transfers	D7	-5061		-1075	-6476	-6232	18844	0
Adjustments in Pension Funds	D8	-1272		-2461	0	3733	0	0
Capital Transfers	D9	18031		8294	-25421	2889	-3792	0
Acquisition less consumption of non produced, non financial products	NP	-1535		-18	-420	789	1184	0
Tax les subsidies on product	-D21+D31	0		0	-164885	0	164885	0
Computed Net Lending Position		9123		34394	-44197	27017	-26336	0
Net Lending Position	B9	9120		34396	-44197	27017	-26336	0
Total by sector (column total)		0		0	0	0	0	0

deposit interest rates, etc.). When quarterly data are unavailable, annual data are used. Annual series are turned into quarterly series using a "linear-match last" method. Other parameters are either borrowed from the available literature or chosen from a range of realistic values (e.g. weights on past errors in agents' expectations, the depreciation rate of capital, etc.). All non-empirically estimated or fine-tuned parameters are summed up in Table 1. Notice that equations are first estimated one at a time and then using a "seemingly unrelated regression" (SUR) method. A selection of SUR-estimated parameter values can be found in Table 2.[16]

Notice also that all data are downloaded by *R* files and grouped together in a single accounting sheet. The latter is then used by an *EViews* program which: *a)* estimates model parameters; *b)* calibrates the model using estimated and fine-tuned parameter values; *c)* compares actual data with "forecasted" values; and *d)* create alternate scenarios for relevant variables to be compared with baseline values. The main advantage of the model is that it allows accounting explicitly for the impact of stocks on flows and *vice versa*, highlighting the role of financial institutions, assets and cross-sector relationships/balances. Programs' structure is sketched in Figure 7, while main findings are presented in the next section.

[16] The complete EViews program, including all estimations of parameter values, can be provided upon request.

Figure 4: The super-simplified transaction-flow matrix (Italy, 2015, annual, current prices, million euro)

Italy 2015		Non-Financial Corporation S11	(capital)	Financial Corporations S12	Government S13	Households S14_S15	Rest of World S2	Total economy (row total) S1
Gross Output	P1	2095694		130440	306245	580440	0	3112819
Intermediate Consumption	P2	-1360170		-54429	-90092	-129658	0	-1634349
Taxes on Product	D21	0		0	189354	0	2251	191605
Subsidies on Products	D31	0		0	-24469	0	-167	-24636
Memo: GDP		735524		76011	381038	450782	2084	1739563
Memo: GDP		1645440						
GDP Redistribution		-909915	= -Σ	76011	381038	450782	2084	0
Consumption	P3	1312653		0	-311639	-1001014	0	0
Exports	P6	493934		0	0	0	-493934	0
Imports	P7	-446042		0	0	0	446042	0
Investment	P5 (G)	284895	-149558	-4429	-36959	-93949	0	0
Wages	D1	-411085		-32356	-161998	609723	-4284	0
Total Taxes	D2+D5-D21	-54397		-11757	292464	-225105	-1206	0
Dividends	D42	-109941		-1633	4271	114625	-7322	0
Interests payments	D41	-5209		18574	-65237	30759	21113	0
Other property income	D4G	-11995		-17221	3924	23481	1812	0
Transfers (subsidies, benefits, etc.)	D3+D6+D7-D31	559		1390	-124220	110304	11967	0
(Change in) funds	D8+D9+NP	15224		5815	-25841	7411	-2608	0
Computed Net Lending Position		9123		34394	-44197	27017	-26336	0
Net Lending Position	B9	9120		34396	-44197	27017	-26336	0
Total by sector (row total)		0		0	0	0	0	0

Legenda:

	Constructed time series by merging existing ones
	Constructed time series by forcing a counterpart (hypothesis: non-financial firms produce everything)
	Constructed time series by taking existing data from production account
-100	Payment
100	Revenue

Table 1: Fine-tuned parameters

Equation number	Description	Parameter values
8	Weight on past errors in expectations	$\upsilon = 0.000$ [0.100]
37	Capital depreciation rate (initial value)	$\delta_k = 0.013$
41	Extra growth of NFC deposits compared with NFC GDP	$\eta_F \approx 0.0079$ $\eta_F \approx 0.0079$
68	% of NPBL turning into NFC loans write-offs	$\xi_F = 0.15$
61	Share of accounting dividends received by the government	$e_G = 0$ $e_G = 0$
62	Share of accounting dividends received by financial institutions	$e_B = 0$
139	Share of accounting dividends received by the rest of the world	$e_{RoW} = 0$
65	% of investment funded by new shares	$\psi = 0.010$
8	Interest rate on bank deposits	$r_D = 0.000$
9	Interest rate on mortgages and other loans to households	$r_M = 0.0935$

Table 2: Main estimated parameters (OLS method, 1996-2015)

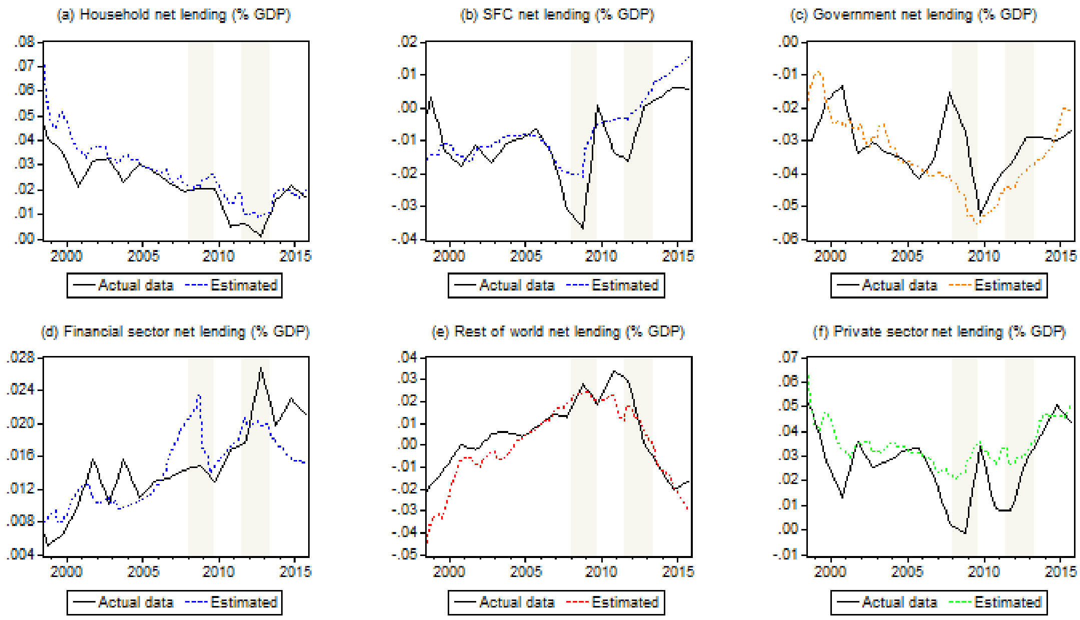
Equation number	Dependent variable	Parameter values
8	Household consumption	$c_1 = 0.677, c_2 = 0.046$
11	Change in mortgages	$\phi_1 = -114130.680, \phi_2 = 0.332,$ $\phi_3 = 0.365, \phi_4 = -0.104$
12	Housing investment	$\vartheta_1 = 1.425, \vartheta_2 = 0.015$

4 Preliminary findings

The model can be now used to: first, check the adherence or fit of estimated series to past data; second, forecast future developments in main endogenous variables, particularly sectoral financial balances; third, create alternate scenarios to be compared with the *status quo*.

a) Fitting past data. Figure 5 shows financial balances (net lending) for each Italian macro-sector. The period considered is from the first quarter of 1998 to the fourth quarter of 2015.

Figure 5: Sectoral financial balances in Italy over 1998q1-2015q4

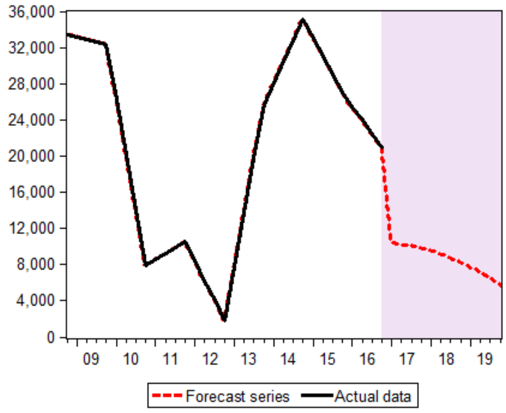


Black lines show sectoral net lending ratios (to GDP) recorded by Eurostat, while dotted coloured lines show the series estimated by the model. The fit is good for all macro-sectors (although not perfect, due to data limitations and theoretical constraints/restrictions), particularly for the household one. Shaded areas show the US financial crisis of 2007-2008 and the European Sovereign Debt Crisis, respectively.

b) Forecasting future trends. The model can be used to provide (qualitative) forecasts for future trends in time series. In principle, two methods can be followed: *i*) average values in the last few quarters can be used to re-estimate model parameters; *ii*) model's forecast values can be "normalised" to fit last available actual data. The former (call it "static" forecast) reduces the impact of forecasting errors, but neglects most historical information; the latter (call it "dynamic" forecast) uses all the available information in the data sample, but can be subject to a higher forecasting error.

Figure 6 shows forecast values for net lending by Italian households (red dotted line) in the next three years or so. Method (*ii*) is used. Although the estimate is still a preliminary one, it shows that a downward trend in household financial balance is expected to persist in the next few quarters.

Figure 6: Household net lending (c.p. million euro)



c) Simulating alternate scenarios. The model can now be used to simulate the reaction of endogenous variables to shocks to key parameters. The new scenario is then compared with the baseline or *status quo*, meaning the last period in which data are available (the first quarter of 2017 in the example above).[17] Since Italy is asked by European institutions to reduce its debt to GDP ratio in the next few years, the impact (on household financial balance) of a change in government spending is considered.

Figure 7: Household net lending: reaction to shocks to government spending

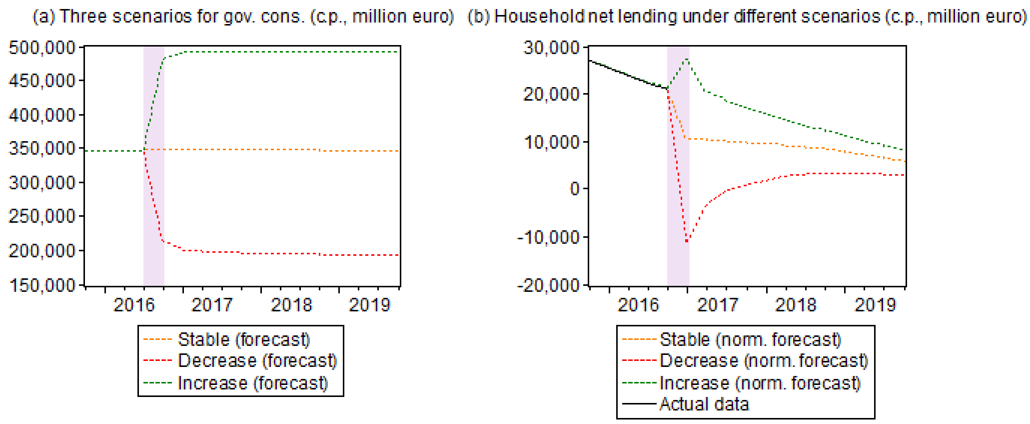


Figure 7 contrasts household net lending under three alternative scenarios about government consumption: the baseline scenario, where government con-

[17] This is an advantage compared with purely-theoretical SFC models, where steady state values must be calculated (either analytically or through numerical simulations) before testing model's reactions to shocks.

sumption is assumed to keep following its historical trend (orange line); an "austerity" scenario, marked by a sharp fall in government consumption (-10% of GDP, red line); a "profligacy" scenario, characterised by a sharp increase in government consumption (+10% of GDP, green line). Chart (a) displays the three forecast series, while chart (b) shows the impact on net lending by Italian households. As one would expect, a fall in government consumption goes along with a worsening of household financial balance (compared to the baseline) and *vice versa*.

References

[1] Burgess, S., Burrows, O., Godin, A., Kinsella, S. and Millard, S., 2016. A dynamic model of financial balances for the United Kingdom, *Bank of England Working Papers*, No. 614.

[2] Godley, W. and Lavoie, M., 2006. *Monetary economics: an integrated approach to credit, money, income, production and wealth.* Springer.

[3] Brainard, W.C. and Tobin, J., 1968. Pitfalls in financial model building. *The American Economic Review*, 58, pp.99-122.

[4] Nikiforos, M. and Zezza, G., 2017. Stock-flow Consistent Macroeconomic Models: A Survey. *Levy Economics Institute Publications*, Working Paper No. 891, May 2017.

A Appendix: Additional tables and figures

Table 3: "Who holds what": cross-sector (net) securities holdings

Holder	*Issuer* NFCs	FCs	Gov.	House.	R.o.W.
NFCs			$[B_{g,f}]$		
FCs	$B_{f,b}$		$B_{g,b}$		
Gov.					
House.	$B_{f,h}$		$B_{g,h}$		
R.o.W.	$B_{f,row}$		$B_{g,row}$		

Table 4: "Who holds what": cross-sector (net) equity holdings

Holder	*Issuer* NFCs	FCs	Gov.	House.	R.o.W.
NFCs					
FCs	$V_{f,b}$				$V_{row,b}$
Gov.	$V_{f,g}$	$[V_{b,g}]$			$V_{row,g}$
House.	$V_{f,h}$	$[V_{b,h}]$			$V_{row,h}$
R.o.W.					

Figure 8: Programs structure