ITFIN: a Stock-Flow Consistent Model for the Italian Economy*

Riccardo Barbieri Hermitte[1], Alberto Cagnazzo[1], Carlo A. Favero[2], Francesco Felici[1], Valeria Macauda[3], Francesco Nucci[4], and Cristian Tegami[3]

[1] *Ministry of the Economy and Finance (MEF)*

[2] *Bocconi University and MEF*

[3] *Sogei s.p.a.*

[4] *Sapienza University and MEF*

Abstract

Italy is characterized by a large sectoral imbalance (the government debt) that generates a pervasive country-risk premium and affects financial markets and the real economy. ITFIN is a quarterly econometric model for the Italian economy developed at Italy's Department of Treasury that adopts a stock-flow consistent framework to describe the sectoral and macroeconomic dynamics. The model focuses on the determination of sovereign risk premium in the government debt market, its impact on the financial and banking system, and its transmission to the real economy. The financial position of each institutional sector is derived through a stock-flow consistent approach. Prices and returns for financial instruments are derived by modeling their supply and demand, along with a characterization of how financial stocks impinge on agents' decisions and the pattern of real variables. This paper illustrates the model and describes its properties by simulating the economy's response under two counterfactual scenarios on monetary policy and different shocks to fiscal policy.

JEL codes: E60, C54.

Keywords: Stock-Flow consistent econometric modelling, Italian economy.

*This project has been launched and developed at Italy's Department of Treasury of MEF. We thank the editor, Angus Chu, two anonymous referees, Ottavio Ricchi, Matthieu Darracq Pariès, Riccardo De Bonis and participants at a seminar at the Treasury for insightful comments and suggestions. We are also grateful to Luca Gagliardone for excellent research assistance. In the late stage of the project, Cagnazzo and Felici left the Department of Treasury and their current affiliation is, respectively, the Ministry of Economic Development and the Ministry of Tourism. The views expressed in the paper are those of the authors and do not involve the institutions of affiliation.

1 Introduction

Italy is characterized by a large sectoral imbalance (the government debt) that generates a pervasive country-risk premium and affects financial markets and the real economy. ITFIN is a quarterly, stock-flow consistent econometric model for the Italian economy developed at Italy's Department of Treasury. The model focuses on the determination of sovereign risk premium in the government debt market, its impact on the financial and banking system, and its transmission to the real economy. Figure 1 shows the importance of the negative correlation between sovereign risk, as measured by the spread between interest rates on Italian and German government 10-year bonds, and GDP growth.

INSERT FIGURE 1

In ITFIN model we document a large and significant impact of sovereign risk on the economy, mostly determined via channels that involve the banking and the financial sector. In particular, while most of the theoretical literature has focused on the role of productivity and GDP growth in explaining sovereign interest rates and debt accumulation, we show that the opposite feedback, from sovereign risk to output growth, is of great relevance. The structure and the properties of the ITFIN model are indeed consistent with the fact that, while the 2008 crisis in Italy has originated mostly from contagion effects due to sharp contraction of foreign demand and the drop of foreign stock prices, during the subsequent 2011 crisis, the rise in market interest rates and the losses generated by non-performing loans have clearly originated from domestic political instability. Therefore, we model an endogenous mechanism with feedbacks between the sovereign spread and the weakening of the banks balance sheets, in the spirit of the "diabolic loop" analyzed in Brunnermeier et al. (2016).

In particular, ITFIN features a dynamic structure in which the evolution over time of the financial assets and liabilities of the different sectors of the economy is carefully modelled and it originates from financial flows associated to agents' decisions on saving and portfolio composition. The modelling strategy imposes consistency between financial stocks and flows in each sector of the economy. Moreover, the financial positions in terms of the assets and liabilities of the various institutional sectors impinge on economic decisions that agents take and thereby on the pattern of the real economy. The breakdown of the model in institutional sectors broadly reflects the one of the National Financial Accounts (Flow of funds) data. In addition, the model is characterized by a detailed breakdown of financial instruments issued and held by each sector. ITFIN is a highly data-driven model, as the relationships between variables in the behavioural equations, although derived from economic theory, feature a dynamic, data-driven structure.

ITFIN exploits the full potential of two different data sources, namely the Flow of funds (i.e. National Financial Accounts) and the National Accounts. The two databases provide a complementary picture of the overall economy, in that the former includes a detailed description of financial asset and liability holdings across several sectors and, therefore, of imbalances between sectors, whereas the latter focuses on income flows and revenues that both financial and real assets generate. We follow the literature on stock-flow consistency (see e.g. Godley and Lavoie (2007) and Zezza and Zezza (2019)) and make sure that the evolution over time of the value of stocks in each sector of the model is precisely matched by the generation of corresponding flows. In particular, ensuring the stock-flow consistency has entailed a significant effort to map changes in the financial stocks with both revaluations at market prices and agents' saving and portfolio decisions.

The economy is made of six different sectors: Government (G), Banks (B), Insurance companies, pension and mutual funds (P), Households (H), Non-financial firms (F), and the Rest of the World (R). In addition to these six sectors, we also keep track of the balance sheet of the national Central Bank (CB). The national Central Bank implements unconventional monetary policy on behalf of the ECB by executing sovereign debt purchases on the secondary market as well as long term refinancing operations (e.g. LTRO and TLTRO). It also operates through the standard banks refinancing channel. The European Central Bank implements conventional monetary policy by setting monetary policy rates.

The ITFIN model employs a large number of different asset types to reproduce a realistic portfolio allocation of the agents and it assigns a relevant role to money, credit and finance in shaping the pattern of variables in the economy. This modelling strategy serves a twofold purpose.

Firstly, we keep track of the interconnectedness of the sectors up to the limitations of the data. For example, each sector in the model (except Government and the Rest of the World) holds cash in deposits; when households decide to hold additional liquidity in their bank accounts as precautionary saving in response to a shock, the banking system registers an increase in liabilities that in turn affects other sources of financing and asset allocation. Decisions by other sectors have also an impact on bank financing, through sector-specific effects that are tested as significant in the model. This type of connections is recorded for each asset up to a modelling simplification. In the example, we did not explicitly model government deposits because the corresponding stock does not exhibit significant variation over time and can be easily represented as a multiplicative constant of total worth held by the sector. We followed similar simplification choices to decide whether a specific asset or liability enters the sector's stylized balance sheet or not.

Secondly, by tracking in the model the structure of the Flow of funds database, not only do we exploit its informative potential, but we also track the effects of omissions. In fact, the size of discrepancies between net financial positions of each sector in the model and in the data is an indicator of the effect of omitted variables. Therefore, we have an immediate check of the reliability of the simplifying modelling choices based on well-established accounting principles and practices.

In the rest of the document, we describe the features of ITFIN with a focus on the model structure, its main equations and identities. We also illustrate the properties of the model via monetary and fiscal policy simulations. More specifically, in Section (2.1) we provide some background and highlight the main features of our methodology, while Section (2.2) is focussed on the interplay between stocks and flows in the model. In Section (3) we illustrate the structure of ITFIN and analyze each sector, characterizing the main modelling features and how stock-flow consistency is ensured.[1] Finally, in Section (4) the properties of the model are illustrated via a number of simulation exercises. In particular, we first derive a baseline scenario where the pattern for the exogenous international variables is that of consensus forecast and fiscal policy variables are set to a pattern consistent with the legislation in place and the scenarios considered in the most recent official public finance documents available when the simulation was conducted. We therefore engineer a number of alternative scenarios. We first consider counterfactual scenarios on ECB's asset purchase programmes, in which we consider two different hypotheses on QE tapering. We seek to characterize how different the macroeconomic outcome would be in case the Eurosystem's program of purchasing sovereign bonds were less extensive than what has been actually envisaged. Then, we consider three different expansionary shocks to fiscal policy: they refer to public investment, government consumption and the tax rates on household income. For all these shocks, we evaluate the dynamic response of economic and financial variables with respect to the baseline scenario. Finally, Section (5) concludes.

[1]The equations of the model have a specification that typically characterize short- and long-run relationships between the variables within an Equilibrium Correction Mechanism (ECM).

2 Methodology

2.1 Background and distinctive features

Our objective is to specify a model where financial flows and gross positions of financial assets and liabilities are explicitly considered so that the evolution of economic and financial balances and their response to shocks can be suitably analyzed. In ITFIN, credit and financial conditions affect agents decisions on real economic variables and asset allocation and, in turn, there are feedbacks in the model from the state of the economy to credit creation and financial asset positions. ITFIN features these characteristics as it belongs to the class of stock-flow consistent (SFC) models. SFC models were pioneered in independent work by Tobin and Godley (see Godley and Lavoie (2007).[2] Despite being used for decades, first by Godley at UK Treasury and CEPG, then by his associates at the Levy Economics Institute (Zezza (2009)), and later also by Goldman Sachs (Hatzius (2003)) for macroeconomic policy analysis, SFC models have increased their popularity only starting from the financial crisis of 2007-08. This was due to several factors. First, the publication of "Monetary Economics" by Godley and Lavoie (2007), who presented the theoretical foundations of SFC modelling; second, the recognition (see Bezemer (2010), among others) that SFC models were better equipped to analyze (and predict) financial crises (see Godley (1999); Godley et al. (2007)) with respect to standard state-of-art neoclassical and New-Keynesian models, where money and banks only played a secondary role – if present; third, and more recently, the publication in 2016 of the first "institutional" SFC model from the Bank of England (Burgess et al. (2016)), which greatly helped to spread the SFC approach outside post-Keynesian circles. Since then, the SFC approach has indeed been used to cover a broad variety of theoretical issues (see Nikiforos and Zezza (2017) for a recent survey). Zezza and Zezza (2020) provide the first attempt to specify a purely data-driven Godley-Levy-type model to the Italian economy.[3]

Our model building strategy is based on three founding pillars: (i) the model is stock-flow consistent, in that every flow comes from somewhere and goes somewhere within the model and sectors' financial balances (the difference between their income and outlays) contribute coherently to the formation of stock (balance-sheet) variables. Therefore, the model is aimed at describing the profound interconnections between sectors. This approach fully exploits the accounting principle used in the data (Flow of Funds), that traces domestic and international

[2]Early works by Tobin and Godley include Tobin (1969), Brainard and Tobin (1968) and Godley and Cripps (1983).

[3]Other contributions that develop SFC models for a country's economy include Byrialsen and Raza (2022), Canelli et al. (2021), and Michelena and Guaita (2017).

financial flows across institutional sectors, so that both the net financial assets and the net lending are equal to zero if they are aggregated (through summation) across all sectors in the economy. (ii) The model employs a realistic description of the economy, shapes a central role for nominal variables, including money and financial assets, and involves a large number of agents. Such a detailed picture is made possible only by the tractable numerical solution of the model, that employs both structural econometrics and time-series analysis. That is, behavioural rules replace optimal decisions, adaptive expectations replace rational expectations, and general equilibrium allocations arise from equating demand and supply of all relevant variables. (iii) The modelling strategy merges a data-driven approach to a theoretically grounded structure. Equation specification choices mostly trace back to structural results obtained in the DSGE literature, but are brought to the data for estimation and empirical validation. The most important consequence is that there is no claim in this class of models of policy invariance à la Lucas, because behavioural rules do not build from primitive assumptions but are "ad hoc" decided, letting the data speak within the boundaries of state-of-art theoretical knowledge. The discussion on whether this approach leads to improvements to the DSGE methodology is beyond our scope (see Favero and Hendry (1992)), but we highlight the complementarity between the two approaches, which allows us to benefit from both a robust microfounded derivation of optimal behaviours and a practically reliable model suited to provide coherent forecasts for all the sectors of the economy.

This strategy introduces a relevant difference between our approach and the standard SFC modelling approach. In the standard SFC literature all demand for assets should depend on their relative rate of return with respect to all other assets in the portfolio. In our approach, the demand for each asset depends on the risk adjusted returns, which are obtained by considering a risk premium on the top of the risk free asset. In the case of government bonds, for example, the demand depends on the (exogenous) risk-free German yield and on the (endogenous) risk premium which is captured by the BTP-BUND spread. Under no arbitrage, risk adjusted returns are equalized for all assets; however, our ECM specification allows for deviations from no-arbitrage in the short-run.

The model contributes to the empirical literature on the estimation of the supply side of government debt, as in Vayanos and Vila (1999), Reinhart and Sack (2000), Jovanovic and Rousseau (2001), Krishnamurthy and Vissing-Jorgensen (2011), and Greenwood and Vayanos (2014). On the demand for government debt, our work is related to Krishnamurthy and Vissing-Jorgensen (2012). Differently from those papers, our contribution considers the case of Italy, in which government bonds are not risk-free, to link simultaneously demand and supply. Our specification of the demand functions by the different sectors is both empirically motivated, in that it is driven by the observation of the importance of non-linearities in the relation between the excess return of Italian bonds on the risk-free asset (i.e. the German Bund), and the quantity of debt demanded by each sector, and theoretically motivated, in that we seek to study the possible existence of multiple equilibria in price determination, testing the recent literature on sovereign debt models as in Lorenzoni and Werning (2013), which builds from the seminal work of Cole and Kehoe (2000). Multiple equilibria in the government bond market have been widely discussed since the contribution of Calvo (1988), who pointed out that, in a model of rational investors, expectations of future default can generate multiple solutions to the price of a bond. Typically, a low-rate equilibrium emerges when the market considers the probability of default as low, while a high rate equilibrium emerges when the market considers the probability of default as high. These models have been used to understand the behaviour of government bonds yields during the Euro-area sovereign crisis (Corsetti et al. (2014), De Grauwe and Ji (2012)).

To investigate these theories, our demand for Italian government bonds by each sector features a dynamic that allows the long-term (cointegrating) specification to depend non-linearly on the spread between yields to maturity of 10-year Italian and German bonds. Non-linearities are modelled with the "Hermite polynomial" used in term-structure literature to capture the slope and the curvature of the yield curve (see, for example, Nelson and Siegel (1987), Diebold and Li (2006), and Gürkaynak et al. (2007)). These terms allow for a smooth and non-linear hump-shaped relation between the spread and the amount of bonds demanded, with the location, the form of the hump and its convexity driven by estimated parameters.

We model the supply side of the Italian bond market with several distinctive features. First, the supply of bonds depends on the evolution of public finance through a standard debt accumulation equation. In the model, we have two alternative options: we can either treat the public expenditure aggregates as exogenous or we can activate a reaction function of fiscal authority, which tightens policy in case of divergence from an orderly path of the primary deficit-to-GDP ratio. Second, we introduce a behavioural rule for the public debt manager, assuming that he/she plans ex-ante to finance the entire deficit with long-term debt and then uses bills to cover the gap between planned and actual debt generated by unexpected variation in the price of bonds. Our determination of the short-run equilibrium allows the model to closely fit the observed fluctuations in bills and bonds and matches the observations that, in the Euro area period, long-term debt is the main driver of the Italian debt dynamics, while short-term debt is rather stable over time. This evidence is remarkably different from the one reported and discussed in Missale and Blanchard (1994), who observe a strong inverse relation between the level of the debt and its maturity at high level of debt.

Interestingly, Missale and Blanchard (1994) justify the observed relationship in the data with the idea that the government may need to decrease the maturity of the debt as debt increases to maintain the credibility of its anti-inflationary stance. This argument, however, cannot clearly be applied to the Euro area, where anti-inflationary stance is in the mandate of an independent European monetary authority. Moreover, the hypothesis of a strategic behaviour of the debt manager, who uses bills to cover the amount of unexpected debt due to price movements, is consistent with a long-term strategy of lenghtening the duration of public debt: the trend in debt is financed with long-term bonds while cyclical fluctuations around the trend are financed with short-term bills.

2.2 Stocks and flows in the model

For each sector, we outline in the model a balance sheet and a profit and loss account that, albeit streamlined, tend to track the corresponding configuration of, respectively, the Financial Accounts (Flow-of-funds data), maintained by the Bank of Italy, and the Institutional sector accounts (within National Accounts), released by the Italian statistical institute (Istat). The Financial Accounts have detailed balance sheets for 13 sectors and the financial system is disaggregated in seven sectors: Central bank, monetary financial institutions, other financial intermediaries, financial auxiliaries, mutual funds, insurance companies, and pension funds. By contrast, the Institutional sector accounts do not have any breakdown within the financial sector. Against this backdrop, our modelling choice was to single out three different sectors within the financial system: a) the one consolidating monetary financial institutions, other financial intermediaries and financial auxiliaries (we call it Banks); b) the one comprising Insurance companies, mutual and pension funds and c) the Central Bank.[4]

Tables (1)-(3) illustrate how the net worth and the net lending of each sector arise in the model. In particular, Table (1) focuses on financial and non-financial assets and, as for the former, it indicates the financial instruments issued and held by each institutional sector as envisaged in the model (*who holds what*). The table also highlights the types of non-financial assets in the economy that are considered in ITFIN. Tables (2) and (3) focus on flows related to, respectively, non-financial and financial transactions that involve each sector. Non-financial flows refer to purchases of consumption and investment goods by different sectors, foreign trade, wage payments, taxes and government transfers.[5]

[4]The lack of national accounts data on real transactions for these three sectors has posed additional challenges in the construction of the database and, admittedly, the disaggregation within the financial sector may introduce further discrepancies between model outcomes and published data. On the other hand, however, banks play a special role in the transmission mechanisms of shocks, notably those related to sovereign risk, and in this regard having this sectoral heterogeneity is a relevant feature.

[5]Zezza and Zezza (2019) provide an insightful discussion on how to build applied SFC models à la Godley

For each of these items, the table records both sides of the underlying transactions, both for the sector that receives a payment (with a plus sign) and for the sector that makes that payment (with a minus sign). The flows associated to financial transactions are reported in Table (3) and they comprise, among others, interest payments for a considerable number of assets, dividends on stocks, pension payments. Similarly to flows in Table (2), for each type of financial flows, the table records the underlying operations from the side of the sector that makes a payment and from the side of those that receives it.

As mentioned earlier, in addition to financial assets, we also consider real assets such as physical capital for production, whose accumulation is driven by investment decisions, housing wealth, that enters the household net wealth, and inventories, whose stock is fed by changes in inventories that ensure equality between GDP and the demand components: private and public consumption, investment (net of imports), foreign demand for domestic products (exports). Admittedly, as real capital is split between firm's capital stock, housing and inventories, there are no public infrastructures, meaning that in the current version of the model government investment does not feed on any stock.

The relevant flows related to non-financial transactions are private and public consumption, investment in capital and housing, exports and imports, wages and subsidies. Moreover, flows in the model explicitly include a variety of different taxes, direct and indirect transfers to households (including pensions), and social security contributions as well as payments to private pension schemes. Flows in the model also originate from financial transactions as each stock in the balance sheet generates positive income flows for a sector if it is an asset and negative income flows if it is a liability. In ITFIN the primary source of data for the flow variables are the Institutional sector accounts released by Istat. We also consider the information on financial flows drawn the Flow-of-funds data (Financial Accounts); specifically, we employ this information for computing the appreciation rate over time of the equity issued by firms and banks. For reasons elucidated convincingly in Zezza and Zezza (2020), Appendix I, there are substantial discrepancies in the net lending of institutional sectors between the two sources of data: the non-financial accounts of institutional sectors and the financial accounts.

starting from data on both financial and non-financial accounts.

Table 1: Total economy - Balance Sheet

	Firms	Banks	Insurance Comp. Pension Funds	Government	Households	Rest of the World	National Central Bank
	F	B	P	G	H	R	CB
Non-financial assets							
Capital	$+K$						
Housing wealth					$+H$		
Inventories	$+Inv$						
Financial assets							
Deposits	$+D_B^F$	$-D_B$	$+D_B^P$		$+D_B^H$		
Reserves		$+R$					$-R$
Interbank		$-IB$				$+IB$	
Eurosystem debits						$+TG$	$-TG$
Refinancing operations		$-RO$					$+RO$
Bank bonds		$-B_B$	$+B_B^P$		$+B_B^H$	$+B_B^R$	
Government bonds		$+B_G^B$	$+B_G^P$	$-B_G$	$+B_G^H$	$+B_G^R$	$+B_G^{CB}$
Government bills		$+b_G^B$	$+b_G^P$	$-b_G$	$+b_G^H$	$+b_G^R$	
Rest of the World bonds		$+B_R^B$	$+B_R^P$			$-B_R$	
Mortgages		$+M_H^B$			$-M_H^B$		
Loans	$-L_F^B$	$+L^B$			$-L_H^B$		
Firm equity	$-E_F$	$+E_F^B$			$+E_F^H$		
Bank equity		$-E_B^R$				$+E_B^R$	
Rest of the World equity	$+E_R^F$		$+E_R^P$			$-E_R$	
Private pensions			$-PF_P^H$		$+PF_P^H$		
Rest of the World mutual funds		$+MF_R^B$			$+MF_R^H$	$-MF_R$	
Domestic mutual funds			$-MF_P^H$		$+MF_P^H$		
Net wealth	NW^F	NW^B	NW^P	NW^G	NW^H	NW^R	NW^{CB}

The table reports a matrix with the stylized balance sheet of the economy as envisaged in the ITFIN model.

Table 2: Total economy - Flows associated to non-financial transactions

	Firms	Banks	Insurance Comp. Pension Funds	Government	Households	Rest of the World	National Central Bank
	F	B	P	G	H	R	CB
Non-financial transactions							
Consumption	$+C$				$-C$		
Investment in housing	$+I^H$			$+I^H * (\tau^{vat})$	$-I^H * (1+\tau^{vat})$		
Firm investment	$-I^F + I^F$						
Government investment	$+I^G$			$-I^{G(1)}$			
Government consumption	$+C^G$			$-C^{G(1)}$			
Exports	$+EX$					$-EX$	
Imports	$-IM^P$			$-IM^G$		$+IM$	
Δ Inventories	$+\Delta Inv$						
Wages	$-W^m$-W^s			$-W^{g(2)}$	$+W$		
Direct taxes	$-T_F^{D,G}$			$+T^{D,G}$	$-T_H^{D,G}$		
Indirect taxes				$+C * (\tau^{vat})$	$-C * (\tau^{vat})$		
Taxes on production	$-T_F^{P,G}$			$+T_F^{P,G}$			
Transfers	$+TR_G^F$			$-TR_G$	$+TR_G^H$		
Financial transactions							
	...	...	...	...	...	...	...
Net lending	NL^F	NL^B	NL^P	NL^G	NL^H	NL^R	NL^{CB}

The table reports a matrix of flows that refer to non-financial transactions in the economy as envisaged in the ITFIN model. τ^{vat} is the Value-added tax (VAT) rate, with Government paying VAT on its purchases and receiving VAT revenues from private consumption and investment.

Table 3: Total economy - Flows associated to financial transactions

	Firms F	Banks B	Insurance Comp. Pension Funds P	Government G	Households H	Rest of the World R	National Central Bank CB
Non-financial transactions							
	...	...	...	...	...	...	...
Financial transactions							
Deposits	$+i_D D_B^F$	$-i_D D_B$	$+i_D D_B^P$		$+i_D D_B^H$		
Reserves		$+i_R R$					$-i_R R$
Interbank		$-r^{B,3m} IB$				$+r^{B,3m} IB$	
Refinancing operations		$-i_{RO} RO$					$+i_{RO} RO$
Bank bonds		$-i_B B_B$	$+i_B B_B^P$		$+i_B B_B^H$	$+i_B B_B^R$	
Government bonds		$+i^{G,10Y} B_G^B$	$+i^{G,10Y} B_G^P$	$-i^{G,10Y} B_G$	$+i^{G,10Y} B_G^H$	$+i^{G,10Y} B_G^R$	$+i^{G,10Y} B_G^{CB}$
Government bills		$+i^{G,12m} b_G^B$	$+i^{G,12m} b_G^P$	$-i^{G,12m} b_G$	$+i^{G,12m} b_G^H$	$+i^{G,12m} b_G^R$	
Rest of the World bonds		$+i^R B_R^B$	$+i^R B_R^P$			$-i^R B_R$	
Mortgages		$+i_M M_H^B$			$-i_M M_H^B$		
Loans	$-i_L^F L_F^B$	$+i_L L^B$			$-i_L^H L_H^B$		
Firm equity	$-Div_F$	$+Div_F^B$			$+Div_F^H$		
Bank equity		$-Div_B^R$				$+Div_B^R$	
Rest of the World equity	$+Div_R^F$		$+Div_R^P$			$-Div_R$	
Private pension contributions			$+Co_P$		$-Co_P$		
Private pension annuities			$-An_P$		$+An_P$		
Public pension contributions				$+Co_G$	$-Co_G$		
Public pension annuities				$-An_G$	$+An_G$		
Rest of the World mutual funds		$+i_R^{MF} MF_R^B$			$+i_R^{MF} MF_R^H$	$-i_R^{MF} MF_R$	
Domestic mutual funds			$-i_P^{MF} MF_P^H$		$+i_P^{MF} MF_P^H$		
Net lending	NL^F	NL^B	NL^P	NL^G	NL^H	NL^R	NL^{CB}

The table reports a matrix of flows that refer to payments related to financial transactions in the economy as envisaged in the ITFIN model.

Before illustrating how the stock-flow consistency is achieved in each sector of the model, let us characterize first, in general terms, the interplay in ITFIN between financial stocks and flows. The standard accumulation equation for net financial assets of sector i, $NFA_t^{i,M}$, is the following (Eq. 1):

$$NFA_t^{i,M} = NFA_{t-1}^{i,M} + SFA_t^{i,M} + NL_t^{i,M}, \quad (1)$$

where $SFA_t^{i,M}$ is the stock-flow adjustment term for sector i and $NL_t^{i,M}$ is the sector *i-th*'s net lending; the superscript M denotes that the variable is the one as constructed in the ITFIN model. The above expression can be re-written by considering each individual $j-th$ asset, $Asset_{j,t}^i$, and liability, $Liability_{j,t}^i$, that it is held by sector i and it is explicitly modelled:

$$NFA_t^{i,M} = \sum_{j=1}^{N} Asset_{j,t-1}^i (1 + rr_{j,t}) - \sum_{k=1}^{N} Liability_{k,t-1}^i (1 + rr_{k,t}) + NL_t^{i,M}, \quad (2)$$

where $rr_{j,t}$ and $rr_{k,t}$ are the revaluation rates between period $t-1$ and t of each asset and liability that is held by sector i and is included in ITFIN. In Eq. (2) the stock-flow adjustment term, $SFA_t^{i,M}$, is characterized as follows:

$$SFA_t^{i,M} = \sum_{j=1}^{N} Asset_{j,t-1}^i rr_{j,t} - \sum_{k=1}^{N} Liability_{k,t-1}^i rr_{k,t}, \quad (3)$$

and it is determined by the following relationship:

$$SFA_t^{i,M} = \Delta NFA_t^{i,M} - NL_t^{i,M}. \quad (4)$$

2.2.1 A bridge between National Accounts and the Model

Without providing the degree of detail of subsequent sections, we have just introduced how the stock-flow consistency for each sector is obtained within the ITFIN model. Let us now show how, in the same spirit, stock-flow consistency is achieved within National accounts, that is by considering all actual items of the financial and institutional National accounts. Moreover, we also characterize how to bridge the framework of the ITFIN model with that of the National accounts.

Let us show first the accumulation equation for Net financial assets of the sector i that includes *all* assets and liabilities as in the Financial accounts, $NFA_t^{i,NA}$. As shown before, Eq. (1) is referred to the model (M); the counterpart of it for the official Financial, National accounts as a whole (NA) is the following:

$$NFA_t^{i,NA} = NFA_{t-1}^{i,NA} + NL_t^{i,NA} + SFA_t^{i,NA}. \quad (5)$$

By comparing Eqs. (1) and (5), one should note that three sources of discrepancy exist between the two equations. First, the wedge ($RES_t^{i,NFA}$) between $NFA_t^{i,NA}$ and $NFA_t^{i,M}$, that is

$$RES_t^{i,NFA} = NFA_t^{i,NA} - NFA_t^{i,M}. \quad (6)$$

The above discrepancy, of course, reflects the fact that, in each sector, not all assets and liabilities are modelled. Second, the wedge between $SFA_t^{i,NA}$ and $SFA_t^{i,M}$, which refers to the stock-flow adjustment term associated with the other assets and liabilities ($OAOL$) not included in the ITFIN model ($SFA_t^{i,OAOL}$):

$$SFA_t^{i,OAOL} = SFA_t^{i,NA} - SFA_t^{i,M}. \quad (7)$$

Finally, a wedge arises between the aggregate net lending of sector i employed in the model and that of National accounts. In particular, some financial and/or non-financial transactions are not modelled in ITFIN and this introduces the following additional residual term ($RES_t^{i,NL}$):

$$RES_t^{i,NL} = NL_t^{i,NA} - NL_t^{i,M}. \quad (8)$$

By construction, the three terms in Eqs. (6) through (8) are not modelled. However, for each sector in the model, we assign in simulations proper values to each of them by relying on simple hypotheses. By doing so, we can bridge model accounting and national accounting and ensure stock-flow consistency at the level of both the model and the National accounts.

In Figure (2) we document the pattern of model-based financial positions (as measured by net financial assets) and net lending of each sector and compare them with the corresponding actual counterpart. The source of the existing divergence in the sample between model-based net financial assets, $NFA_t^{i,M}$, and actual $NFA_t^{i,NA}$ (drawn from the financial accounts) has been elucidated earlier in this section, as several financial assets issued by a sector and held by another sector are not considered in ITFIN. This may reflect a need for simplicity or, even more so, a lack of information in financial accounts to pin down precisely "who holds what and how much", which has required the adoption of some hypothesis.[6] Inspection of

[6]For example, financial accounts data provide information on the market value of the stock of equity issued by the bank sector but *not* on the corresponding amount of it held by each other sector. To tackle this issue, banks equity has been modelled under the hypothesis that it is held by one sector only.

Figure (2) indicates that, while in some sectors the divergence in model-based and actual net financial assets, NFA, is sizeable, in general, however, it is rather stable (although with some exceptions). Thus, in model simulation, we adjust the simulated values of $NFA_t^{i,M}$ with an exogenous, constant correction coefficient, calculated as the average ratio in the sample of actual to model-based NFA. The fact that, in the sample, this ratio is rather stable is reassuring, as the simulated $NFAs$, once adjusted with the constant correction coefficient, are expected to be comparable with the (yet to be) observed empirical counterpart.

Overall, the extent of matching is acceptable when, in Figure (2), we compare for each sector the evolution over time of model-based net lending with that of actual net lending (i.e. balances from National Accounts).[7] As mentioned before, the non-financial accounts of institutional sector are not disaggregated between banks, on one side, and Insurance companies, pension and mutual funds, on the other, and therefore the pattern of actual net lending for each of these sectors is not available from official data. For completeness, we also show for each sector the pattern of net aggregate flows, rather than stocks, as drawn from the Financial Accounts ("Flows from Flow of Funds"; we actually show in the figures a 4-quarter moving average of these data). The degree of matching between these actual series and model-based net lending varies from sector to sector but, not surprisingly and as discussed in the previous section, it is, in general, rather poor (see Zezza and Zezza (2020)). This is especially true in the case of the banking sector and the Insurance companies, pension and mutual funds sector, for which official data from non-financial accounts are not available.

INSERT FIGURE 2

3 The Model

3.1 Government

A distinctive feature of our modelling of the government sector is the way in which the demand for and the supply of government bonds are identified in ITFIN and how their interaction determines the equilibrium bond price and quantity, both in the short and in the long run.

In our simplified set-up the government holds no financial assets and its total debt is composed of bills, with a maturity of twelve months or lower, and bonds. Data strongly suggest that Italian public debt has been gradually, but steadily, converted almost entirely

[7]For a comparison between actual and model-based net lending, see e.g. Burgess et al. (2016), who describe the SFC model of the Bank of England.

into long-term bonds, far before the low-interest rate era, while the amount of short-term debt outstanding has been fluctuating around a constant over the last two decades (since the early 2000s). Therefore, we assume that the debt manager plans, in each period, to finance the entire public deficit by issuing bonds, and then uses Treasury bills to cover discrepancies between planned and actual borrowing requirement. These discrepancies originate from unexpected movements in bond prices. Before auctions take place, the sovereign debt manager forms expectations on the equilibrium price and fixes consequently the amount of bonds to be issued. Bills are then issued as a buffer in order to cover the extra financing needs caused by short-term deviations of actual bond prices from expected ones. In the model, the equilibrium bond price is determined by equating the supply of bonds, as it arises from the per-period financing needs of the fiscal authority, to the demand for them (evaluated at market prices), which is linked to saving and portfolio decisions of a variety of lenders.

When simulating the model we consider two alternative specifications for the stance of fiscal policy. Under the first mode, the fiscal authority follows a behavioural rule estimated from data, where primary deficit-to-GDP ratio reacts to the economic growth rate and the interest expenditure-to-GDP ratio. In practice, the level of public expenditure is set endogenously so as to ensure that the primary deficit-to-GDP ratio responds to output growth and the cost of servicing public debt. This fiscal reaction function can be deactivated in the model and, under the alternative mode, each component of public expenditure is set exogenously in every period.

In order to fully exploit agents' heterogeneity in our dataset (the Italian Flow of Funds and National accounts), we divide lenders into five large groups: a) Households, b) Banks, c) Insurance companies, pension and mutual funds, d) Rest of the World and e) the Central Bank (whose demand is treated as exogenous in ITFIN). Data suggest that these groups of agents react to interest rates and macroeconomic conditions in different ways, thus suggesting a separate modelling of the demand for Italian government bonds from each sector. The demand for sovereign bonds from the various sector is in general a highly non-linear function of the expected equilibrium interest rate: the same quantity may therefore be associated to multiple equilibrium interest rates. In other words, our specification of the long-run demand for government debt allows for a backward-bending demand curve, whose intersection with the - almost linear - long-run supply curve may not be unique. An interesting shape emerges empirically, in which the demand curve is rather flat for values of the spread below 150 basis points to steepen up remarkably for values of the spread above that threshold. Given this shape of the demand function, the cost of fiscal irresponsibility becomes rapidly much larger for high values of the spread.

3.1.1 National accounting and model accounting

The ITFIN model characterizes the financial decisions of Government. Albeit rich, the degree of detail in the model does not coincide with the level of disaggregation in the official Financial Accounts (Flow of funds data).

A stylized financial balance sheet for the Government sector that mimics the Financial Accounts (Flow of funds) maintained by the Bank of Italy is presented in Table (4).

Table 4: Government - stylized financial balance sheet

Asset	Liabilities
Government assets (A^G)	Government bonds (B_G)
	Government bills (b_G)
	Other Liabilities (OL_G)

Conversely, the assets and liabilities explicitly listed in Table (5) are those considered in the ITFIN model.

Table 5: Government - stylized financial balance in the Model sheet

Asset	Liabilities
	Government bonds (B_G)
	Government bills (b_G)

There are no financial assets, while, liabilities are Government bonds B_G and Government bills, b_G. As mentioned earlier, Government bonds are held by a) households (H), b) banks (B), c) insurance companies, pension and mutual funds (P), d) the Rest of the World (R) and e) the Central Bank (CB):

$$B_{G,t} = B^H_{G,t} + B^P_{G,t} + B^B_{G,t} + B^R_{G,t} + B^{CB}_{G,t}. \tag{9}$$

In the balance sheet of the government, our modelling choice generates one residual term, namely the difference between other liabilities, OL_G, and Government assets, A^G. Such residual drives a wedge between Model Accounting (M) and National Accounting (NA) as the following expressions expound:

$$NFA_t^{G,M} = -\left(B_{G,t} + b_{G,t}\right), \tag{10}$$

$$\begin{aligned} NFA_t^{G,NA} &= A_t^G - \left(B_{G,t} + b_{G,t}\right) - OL_{G,t}, \\ NFA_t^{G,NA} &= NFA_t^{G,M} + A_t^G - OL_{G,t}. \end{aligned} \tag{11}$$

3.1.2 Model Closures

Following Taylor (2021), model closures are designed to warrant Stock-Flow consistency. The government dynamic budget constraint in the model is:

$$B_{G,t} + b_{G,t} = B_{G,t-1} + b_{G,t-1} + Def_t - SFA_t^{G,M}, \tag{12}$$

where $B_{G,t}$ and $b_{G,t}$ are, respectively, the stock of government bonds and bills (at market prices) outstanding in period t, Def_t is public deficit in period t and $SFA_t^{G,M}$ is the model-based stock-flow adjustment term for the government, which is characterized as follows in light of Eqs. (1), (10) and (12):

$$SFA_t^{G,M} = \Delta NFA_t^{G,M} - NL_t^{G,M}; \tag{13}$$

$NL_t^{G,M}$ is government net lending and amounts to $-Def_t$. Model closure in the government sector is ensured by the behaviour of the debt manager, who initially plans to finance the entire deficit with long-term debt (bonds) only:

$$B_{G,t}^s = \frac{B_{G,t-1}}{E\left(P_{G,t}\right)} + \frac{Def_t}{E\left(P_{G,t}\right)}, \tag{14}$$

where $B_{G,t}^s$ is the supply of government bonds in period t and $E(P_{G,t})$ is the expectation of the market price of government bonds for period t. The debt manager has adaptive expectations for the price of long-term debt, that obey the following mechanism:

$$E\Big(P_{G,t}\Big) = P_{G,t-1} + \kappa \left[E\Big(P_{G,t-1}\Big) - P_{G,t-1}\right], \tag{15}$$

where κ is a parameter. The equilibrium price of sovereign bonds is determined in the market by equating demand for bonds at market prices, $B_{G,t}$, and supply of them evaluated at market prices, $B_{G,t}^s P_{G,t}$:

$$P_{G,t} = \frac{B_{G,t}}{B_{G,t}^s}. \tag{16}$$

The yield to maturity for government bonds is characterized through the following equation (Eq. 17):

$$\log(1 + r_t^{G,10Y}) = \beta_0 - \beta_1 \log\left(P_{G,t}\right) + u_t, \tag{17}$$

where the coefficient on $\log\left(P_{G,t}\right)$ can be interpreted as the inverse of duration and the intercept term controls for measurement errors. The stock-flow consistency in the model is guaranteed by the change in the stock of government bills, $\Delta b_{G,t}$. In particular, as Eq. (18) states, the period change of the short-term debt is set to be equal to the difference between two elements: a) the gap between expected and actual sovereign bond price multiplied by the supply of government bonds and b) the stock-adjustment term, $SFA_t^{G,M}$:

$$\Delta b_{G,t} = \Big(E\left(P_{G,t}\right) - P_{G,t}\Big) B^s_{G,t} - SFA_t^{G,M}. \tag{18}$$

This implies that an unexpected increase of the yield to maturity of long-term debt is financed by issuing short-term debt, i.e. government bills. To verify that this guarantees stock-flow consistency, let us combine Eqs. (14) and (18) so as to obtain

$$\begin{aligned} \Delta b_{G,t} &= E\left(P_{G,t}\right) B^s_{G,t} - B_{G,t}, \\ \Delta b_{G,t} &= B_{G,t-1} + Def_t - B_{G,t} - SFA_t^{G,M}, \end{aligned} \tag{19}$$

where the second expression precisely matches Eq. (12). In model simulations, the variable $SFA_t^{G,M}$ is projected according to the following equation:

$$SFA_t^{G,M} = \beta_0 + \beta_1[\log(E(P_{G,t})) - \log(P_{G,t})] + u_t, \tag{20}$$

This is a specificity of the government sector as, in all other sectors (except the central bank), the stock-flow adjustment term, $SFA_t^{i,M}$, is, in simulation, treated as exogenous and projected using the mean value computed over the sample.

3.1.3 Main modelling features

The market for Italian government bonds is characterized in ITFIN by pinning down the equilibrium in the long-term segment of the debt market, which is obtained by equating demand for and supply of government bonds.

The distinctive feature of our modelling approach is the capability of explicitly characterizing the non-linear relationship clearly present in the data between the debt held by each domestic sector and the Rest of the World and the spread of BTP and BUND rates of return. Importantly, this characteristic has the potential of generating multiple equilibria in the market for Italian long-term government bonds.

The demand for long-term government bonds originates from several sectors in the economy: Banks (B), Households (H), Insurance companies, Pension and Mutual funds (P), the Rest of the World (R) and the Central Bank (CB):

$$B_{G,t} = B_{G,t}^{H} + B_{G,t}^{P} + B_{G,t}^{B} + B_{G,t}^{R} + B_{G,t}^{CB}. \tag{21}$$

With the exception of the demand from the Central Bank, which is treated as exogenous, (and that from the Insurance, Pension and Mutual Funds) the demand equation for Italian sovereign bonds from each other sector *i-th* listed in Eq. (21) has a common, benchmark specification which can be characterized as follows (Eq. (22)):

$$\begin{aligned} \Delta_4 \log\left(B_{G,t}^{i}\right) &= \beta_{0,i} - \beta_{1,i} \log\left(B_{G,t-4}^{i}\right) + \beta_{2,i} DS_{i,t} + \\ &+\beta_{3,i}\left(\frac{1-\frac{\exp\left(-E\left(r_{t-1}^{G,10Y}-r_{t-1}^{Ger,10Y}\right)\right)}{\tau_1}}{\frac{E\left(r_{t-1}^{G,10Y}-r_{t-1}^{Ger,10Y}\right)}{\tau_1}} - \frac{\exp\left(-E\left(r_{t-1}^{G,10Y}-r_{t-1}^{Ger,10Y}\right)\right)}{\tau_1}\right) + \\ &+\beta_{4,i}\left(\frac{1-\frac{\exp\left(-E\left(r_{t-1}^{G,10Y}-r_{t-1}^{Ger,10Y}\right)\right)}{\tau_2}}{\frac{E\left(r_{t-1}^{G,10Y}-r_{t-1}^{Ger,10Y}\right)}{\tau_2}}\right) + u_{i,t}. \end{aligned} \tag{22}$$

The dependent variable is the (4-quarter log change in the) Government bonds held by sector *i-th* (for some sectors it is the log change in the ratio between the sector's government bond holdings and its total assets). As discussed earlier, the most relevant factor in shaping the evolution of demand for government bonds is the expectation on the sovereign spread, $r_t^{G,10Y} - r_t^{Ger,10Y}$, defined as the difference in the yields on the Italian and the German 10-year government bonds and, henceforth, denoted as s_t.[8] In ITFIN we establish and empirically test that the relationship between the demand for sovereign bonds and the spread is non-linear.[9] In particular, in Eq. (22) above, we rely on the "Hermite polynomial" largely used in the literature on the term structure of interest rate to model the slope and the curvature of the yield curve (see e.g. Nelson and Siegel (1987), Diebold and Li (2006), and Gürkaynak

[8] Agents form adaptive expectations on the spread on the basis of the mechanism presented in Eq. (15)

[9] A critic might argue that, by including the sovereign spread, rather than sovereign yields, as a proxy for the price of sovereign securities, the estimated effect would fail to capture the possible impact on the dependent variable of those components of Government bond yields that are unrelated to sovereign risk, such as, for example, the term premium. We clarify, however, that the sovereign spread is included in this and other equations for its informative content on the extent of sovereign risk and it is precisely the effect of it that we try to single out.

et al. (2007)). The Hermite polynomial allows to model non-linear relationships with a relatively limited number of parameters and, in particular, in the equation above, it reads as follows (Eq. (23)):

$$\mathbf{H}(s_t;\tau) = \left(\frac{1-\exp(-E(s_t)/\tau)}{E(s_t)/\tau} - \exp\left(-\frac{E(s_t)}{\tau}\right)\right), \tag{23}$$

where τ is a parameter. As for the variable, $DS_{i,t}$, also inserted in Eq. (22), it is an exogenous, sector-specific demand-shifter that, arguably, may also reflect fluctuations in market risk appetite.

The dynamics of the supply of long-term debt is determined by the stock of existing debt and by government deficit. Total government deficit, Def_t, is driven by primary deficit, D_t, and interest payments, Int_t:

$$Def_t = D_t + Int_t, \tag{24}$$

where Int_t is the total cost for servicing debt in period t and it is obtained as $Int_t = i_{A,t}G^{debt}_{t-1}$, where $i_{A,t}$ is the average interest rate on debt and G^{debt}_t is the value of nominal debt outstanding (at face value). The latter has the same dynamics of the supply of long-term bonds plus a statistical factor, D^{stat}_t, and its evolution over time is therefore the following: $\Delta G^{debt}_t = Def_t + D^{stat}_t$.

In the model, the average interest rate on public debt, $i_{A,t}$, is projected as follows:

$$\Delta i_{A,t} = \beta_0 - \beta_1\left[i_{A,t-1} - \beta_2\left(\frac{r^{G,10Y}_{t-1} + .. + r^{G,10Y}_{t-40}}{40}\right) - \beta_3 r^{G,12m}_{t-1}\right] + u_t, \tag{25}$$

where $r^{G,10Y}_t$ is the yield to maturity on long-term government bonds and $r^{G,12m}_t$ is the yield to maturity on short-term government bills. The equation for the yield on short-term debt reads as follows:

$$\Delta r^{G,12m}_t = \beta_0 - \beta_1\left(r^{G,12m}_{t-1} - \beta_2 r^{B,3m}_{t-1}\right) + \beta_3\Delta r^{B,3m}_t + \beta_4\Delta\left(r^{G,10Y}_t - r^{Ger,10Y}_t\right) + u_t, \tag{26}$$

where $r^{B,3m}_t$ represents the 3-month Euribor rate and $r^{Ger,10Y}_t$ is the yield to maturity on German long-term sovereign bonds.

The primary deficit is defined by three components: government expenditure, G_t, government revenues, T_t and the profit from holdings financial assets that the Bank of Italy pays off to the fiscal authority, $Retr_t^{CB}$; it reads as follows:[10]

$$D_t = G_t - T_t - Retr_t^{CB}; \tag{27}$$

tax revenues are disaggregated in a number of items, each of which is a linear function of the macroeconomic variables representing the corresponding tax bases. Taxation is therefore endogenous and the breakdown of tax revenue sources is the following:

$$T_t = T_{H,t}^{D,G} + T_{F,t}^{D,G} + T_t^{I,G} + T_{F,t}^{P,G} + Co_{G,t}, \tag{28}$$

where $T_{H,t}^{D,G}$ and $T_{F,t}^{D,G}$ are direct taxes for, respectively, households and firms, $T_t^{I,G}$ are indirect taxes, $T_{F,t}^{P,G}$ are taxes on production and $Co_{G,t}$ are social security contributions.[11] The profits of the Central Bank that are paid off to the Treasury, $Retr_t^{CB}$, are modelled through an error correction mechanism which is described in the Central Bank section (see Eq. (116)).

As discussed earlier, in the simulations performed with the model the value of public expenditure is set in two alternative modes. In the first mode, public expenditure is endogenous and determined by a fiscal reaction function defined on primary deficit as a ratio to GDP, $d_t = \frac{D_t}{GDP_t}$, and characterized as follows (Eq. (29)):

$$\Delta d_t = \beta_0 - \beta_1 \Big(d_{t-1} + \beta_2 g_{t-1}^r + \beta_3 i_{A,t} g_{t-1}^{debt} \Big) + u_t. \tag{29}$$

In the above equation, the change in the primary deficit-to-GDP ratio is modelled as an ECM, in which the short-term dynamics are driven by the gap between the actual and the equilibrium primary deficit-to-GDP ratio.

The equilibrium primary deficit-to-GDP ratio is the target primary deficit-to-GDP ratio in the policy maker reaction function. This is determined by the rate of GDP growth, g_{t-1}^r, and by the interest expenditure-to-GDP ratio, $i_{A,t} g_{t-1}^{debt}$, where $g_t^{debt} = \frac{G_t^{debt}}{GDP_t}$,$i_{A,t} = \frac{Int_t}{G_t^{debt}}$. In this set-up, expenditure endogenously adjusts according to the fiscal rule. In the alternative mode public expenditure, G_t, and each component of it, are exogenous variables. In ITFIN, the breakdown of public expenditure is the following:

[10] To be more precise, the official aggregate used for $Retr_t^{CB}$ in Eq. (27) also includes dividends paid to the government for its state-owned equity investments. Although financial assets held by the government are not modelled in ITFIN, we do not net out these dividends from $Retr_t^{CB}$ due to lack of proper granular information.

[11] The VAT rate (τ^{vat}) in the model is applied to private consumption (C), Government consumption (C^G), Government investments (I^G) and investment in housing (I^H). Moreover, Government pays and receives indirect taxes on public production (W^g).

$$G_t = C_t^G + W_t^g + I_t^G + An_{G,t} + TR_{G,t}^H + TR_{G,t}^F, \quad (30)$$

where C_t^G are Government net purchases, W_t^g are wage payments for public employees, I_t^G are public investment, $An_{G,t}$ are public pensions while $TR_{G,t}^H$ and $TR_{G,t}^F$ are transfers to, respectively, households and firms.

3.2 Banks

In this section we illustrate how the banking industry is modelled in ITFIN and describe the interaction between banks and agents in the other sectors. Banks obtain funds from the rest of the economy, lend resources to households, firms and the government and hold shares of firms and mutual funds. In addition to their traditional role of financial intermediary, we emphasize the role of banks as a bridge between decisions of monetary and fiscal authorities, on the one hand, and those of households and firms, on the other. In this respect, we seek to characterize the channels through which sovereign risk and the conduct of monetary policy affect the banking sector and how the response by banks affects the rest of economy. We believe that singling out these transmission mechanisms is important for understanding relevant dynamics observed in the Italian economy over the last decades. In ITFIN, the model's structure of the banking sector is built around three central elements, which are used as sources of identification for both banks supply of credit and banks demand for funds.

The first element is the so called "diabolic loop", as introduced in Brunnermeier et al. (2016) (see also Farhi and Tirole (2017)). As banks hold sovereign securities, changes in their yields affect the market value of these securities and the bank capital held by the shareholders. We will see that, despite the fact that a large share of government debt is typically held in banks portfolios until maturity, the supply of funds to the economy is heavily influenced by the value of capital, which, in turn, is affected by the evolution of market prices of assets. When interest rates on government bonds rise (and prices fall) this affects the cost of funding for banks, which also tends to rise. This occurs because, for some sources of bank finance, such as, for example, bonds issued by banks, the interest rate on these instruments is positively related to the interest rate on sovereign bonds. In turn, a higher cost of funding passes through to interest rates that banks set on their loans to households and firms. Moreover, higher government yields deteriorate banks' capital ratio and this induces a tightening of credit conditions, increasing interest rates on their loans.[12]

[12]It is important to note that, in the simulations with the model, movements of the endogenous sovereign spread fully determine those of the Italian government yields, as in ITFIN the yield on the German Bund is

The intuition behind this mechanism is straightforward: a rise of interest rates on loans may, on the one hand, increase short-term profits, covering up some of the capital losses, and, on the other, by reducing the amount of loans demanded, it downsizes the bank exposure to risky assets, lowering the gap with the risk-adjusted regulatory capital. As described in Brunnermeier et al. (2016), a tightening in credit conditions negatively affects the economy, generating a reduction in tax revenues and a subsequent increase in government's liabilities which might further harshen the loop. As we illustrate below, we first provide descriptive evidence, mainly based on graphs, of the co-movement between the sovereign spread and interest rates on loans charged to firms and households. We then specify a model structure consistent with this evidence and illustrate how the shocks' transmission channels operate in ITFIN consistently with causal links between sovereign risk and credit conditions.

The second element is a sequential structure in the way banks rely on different sources of financing. The latter are characterized through a sort of pecking order which is used as a source of identification of the banks demand for alternative types of funds. In particular, deposits are the main source for financing banks traditional investment activities (loans and mortgages). The equilibrium level of deposits is mostly exogenous to the banking sector, as it is primarily driven by the state of the economy and money demand on the part of households. However, banks set autonomously the interest rate on this source of financing, in turn affecting the demand for deposits. The latter, of course, similar to the supply of loans and mortgages, change over time in response to evolving economic conditions, monetary policy decisions and adjustments in banks capital. These fluctuations in deposits and investment assets generate a time-varying financing gap that banks fill with other sources of funds. These are the issuance of bonds as well as access to refinancing operations of the Central Bank, including both regular and longer-term, non-standard refinancing, such as MROs, LTROs, and TLTROs. Once banks exhaust these sources of financing, they can raise funds through the foreign interbank debt market.

The third key element is unconventional monetary policy in the form of quantitative easing (the asset purchases programmes of the ECB). The latter acts as a shifter of the demand for government bonds affecting the interest rates on sovereign bonds and, thereby, the supply of funds from the banking sector to the economy through the mechanisms described earlier in this section. Of course, credit supply has an impact on the volume of economic activity.

In the next section we analyse in more detail the interplay between sovereign risk and banks decisions with a focus on the Italian economy.

treated as an exogenous variable. The latter is projected throughout the simulation sample using institutional forecasts.

3.2.1 The Italian diabolic loop

We document a strong feedback between sovereign risk and economic activity in Italy despite an extensive action of the monetary authority. As Figure (3) shows, in the year 2009 the average financing cost borne by Italian banks has declined in the aftermath of the first wave of longer-term refinancing operations and non-standard monetary policy interventions and, parallel to this, net interest rates on loans dropped and bank profits rose. Subsequently, however, the Italian sovereign crises started to materialize, exerting a significant impact on banks financing costs, whose average rate increased by roughly two percentage points, and on lending rates, which also rose. This pattern is detected until the end of 2012 and, parallel to this, a drop in banks profits has been observed since 2010, which, however, is characterized by a strong persistence as it lasts even after the end of the sovereign crisis.

INSERT FIGURE 3

Likewise, Figure (4) highlights the relationship between sovereign spread, equity of banks, approximated by their market capitalization, and (net) interest rates on loans. Of course, causality cannot be established through graphical evidence and we acknowledge that the direction of causality may have run from the sovereign to banks in some countries (e.g. Italy) and the opposite way in others (e.g. Ireland and Spain). On the other hand, no matter what the trigger was, several countries have exhibited a self-reinforcing negative spiral involving sovereign strain, fragility of the banking sector and economic downturns (see Angelini et al. (2014)). Using ITFIN, we shed light on the mechanisms underlying this spiral as it took place in the Italian economy, where the sovereign spread rose during the debt crisis, financial markets anticipated banks' losses on the large stock of government debt held in their portfolios and thus the value of banks equity fell. Together with other channels at work in the model, these losses have induced banks to raise interest rates on their loans with negative impact on growth.

Sovereign tensions impinge on the banking sector through several channels in addition to that associated with losses on government securities on the assets side of banks' balance sheets. For example, sovereign strains may deteriorate banks' funding conditions because government bonds are typically used as collateral and thus a drop in their price, in addition to credit risk, may affect the availability and cost of bank funding. Moreover, a deterioration in sovereign ratings often induces mechanical downgrades of domestic financial institutions, thus reducing the value of their liabilities (see, among others, Bofondi et al. (2018) and Battistini et al. (2014)). In general, the connection between sovereign spread and banks' equity may reflect a variety of factors and not just the direct relation between spread, yields and prices of government bonds in banks' portfolio. For example, an increase in sovereign spreads generates adverse effects on the whole economy that, in turn, affect banks' profits and the market value of bank equity.[13]

INSERT FIGURE 4

Finally, a visual inspection of Figure (4) suggests that, no matter which type of shock hits the economy, periods of financial tensions have similar implications for the correlation between growth and sovereign spread. In particular, during the Great Recession in 2008 financial instability in the US and EU markets drove down the value of banks equity, with direct spillovers on the real economy through the rise of interest rates on loans. In turn, the slower growth performance negatively impacted on government revenues and induced a rise of public debt and sovereign interest rates. Conversely, the driver of the sovereign crisis in 2011 was a sudden and dramatic shift in expectations about debt sustainability, which was put into questions following sovereign market tensions in Southern Europe. A similar pattern has been recorded in the first half of 2018, after incautious announcements on the future stance of fiscal policy by members of the coalition winning the election. Financial market tensions boosted the sovereign spread, thereby affecting banks equity and economic activity.

Against this backdrop, it is important to note that the pattern of public finance indicators is not uniform across the different episodes of financial market tensions. In particular, as Figure (5) shows, in 2009, when the financial shock hit the banking system, government debt and the sovereign spread increased due to higher deficits, as automatic counter-cyclical expenditure and unemployment benefits rose substantially in association with higher unemployment and lower levels of activity. By contrast, tensions in 2011 in the sovereign market had a negative effect on GDP but were not accompanied by an increase in primary deficits and public debt that, in principle, might rationalize a rising pattern of the spread as the one which has been observed up to 2012.

INSERT FIGURE 5

[13]Using credit risk premia from CDS contracts, Angelini et al. (2014) provide some evidence on the link between the creditworthiness of sovereign issuers and that of their domestic banks. The correlation between CDS premia for the sovereign and the banks is not found to be stronger than that between sovereigns and domestic non-financial corporations. Moreover, with the exception of Italy, there is little evidence that the sovereign-banks correlation in credit risk premia increases with banks' exposure to the domestic sovereigns.

The previous considerations hinge on a narrative analysis of economic and financial developments. In order to identify the complex relationship between sovereign risk, banks decisions and output performance, we need to build enough structure in the model in order to properly characterize each transmission channel.

3.2.2 National accounting and model accounting

A stylized financial balance sheet for the banking sector that fully encompasses the Flow of funds data compiled by the Bank of Italy is presented in Table (6).

Table 6: Banks - stylized financial balance sheet

Asset	Liabilities
Loans (L^B)	Deposits (D_B)
Mortgages (M^B)	Interbank debt (IB)
Bonds held by Banks (B^B)	Bank bonds (B_B)
Government bonds (B_G^B)	ECB loans (including LTRO and TLTRO) (RO)
Government bills (b_G^B)	Bank equity (Capital) (E_B)
Reserves at the ECB (R)	Other Liabilities (OL_B)
Mutual funds held by Banks (MF^B)	
Equity held by Banks (E^B)	
Other Assets (OA^B)	

By contrast, the stylized financial balance sheet of the banking sector that is considered in the ITFIN model is presented in Table (7), which reports the assets and liabilities explicitly envisaged in the model.

In the model, the patterns of change over time of the financial stock variables are matched by revaluations at market prices and intra-period flows from saving and portfolio decisions in all sectors of the economy.

In ITFIN, the net worth of the banking sector, NW_t^B, is calculated as the sum of the following financial assets held by the sector to finance specific sectors net of the following liabilities issued by the sector and corresponding to financial instruments held by specific sectors (Eq. (31)):

Table 7: Banks - stylized financial balance sheet in the Model

Asset	Liabilities
Loans to Households (L_H^B)	Households deposits (D_B^H)
Loans to Firms (L_F^B)	Firms deposits (D_B^F)
of which: Non performing loans (NPL)	ICPMF deposits (D_B^P)
Mortgages to Households (M_H^B)	Bank bonds held by Households (B_B^H)
Bonds issued by the RoW (B_R^B)	Bank bonds held by ICPMF (B_B^P)
Government bonds (B_G^B)	Bank bonds held by the RoW (B_B^R)
Government bills (b_G^B)	ECB loans (including LTRO and TLTRO) (RO)
Reserves at the ECB (R)	Interbank debt with the RoW (IB)
Mutual funds issued by the RoW (MF_R^B)	Banks equity held by the RoW (E_B^R)
Equity issued by Firms (E_F^B)	

$$NW_t^B = L_{H,t}^B + L_{F,t}^B + M_{H,t}^B + B_{R,t}^B + B_{G,t}^B + b_{G,t}^B + R_t + MF_{R,t}^B + E_{F,t}^B - D_{B,t}^H - D_{B,t}^F - D_{B,t}^P - B_{B,t}^H - B_{B,t}^P - B_{B,t}^R - RO_t - IB_t - E_{B,t}^R. \quad (31)$$

Because physical capital and, in general, real assets of the banking sector are not modelled in ITFIN, the sector's net worth in the model, NW_t^B, coincides with the net financial assets of the banking sector (B) considered in the ITFIN model (M), which we define as $NFA_t^{B,M}$. Thus, the latter is of course characterized as in Eq. (31).

The financial assets held by the banks that are explicitly considered in ITFIN are therefore the following: loans to households at time t, $L_{H,t}^B$, loans to firms, $L_{F,t}^B$, mortgages to households, $M_{H,t}^B$, bonds issued by foreign entities (Rest of the World), $B_{R,t}^B$, domestic government bonds and bills held by banks, respectively, $B_{G,t}^B$ and $b_{G,t}^B$, reserves held in banks accounts at the Central Bank, R_t, mutual funds issued by foreign management companies, $MF_{R,t}^B$, equity issued by domestic, non-financial firms, $E_{F,t}^B$. Conversely, the liabilities of the banking sector considered in ITFIN are the following: deposits held by households, $D_{B,t}^H$, deposits held by firms, $D_{B,t}^F$, deposits held by Insurance companies, pension and mutual funds (ICPMF), $D_{B,t}^P$, bank bonds held by households, $B_{B,t}^H$, bank bonds held by ICPMF, $B_{B,t}^P$, bank bonds held by the Rest of the World, $B_{B,t}^R$, funds borrowed by the Central Bank (including MROs, LTROs and TLTROs), RO_t, interbank debt with the Rest of the World,

IB_t, and equity (capital) issued by banks and held by the Rest of the World, $E^R_{B,t}$.

Conversely, let $NFA^{B,NA}_t$ denote net financial assets of the banking sector (B) drawn from the Flow of Funds, that is the National (Financial) accounts. Differently from the corresponding aggregate of the model, that is $NFA^{B,M}_t$, it includes all existing assets held by banks and issued by other sectors and all existing liabilities issued by banks and corresponding to instruments held by other sectors. $NFA^{B,NA}_t$ can therefore be expressed as follows:

$$NFA^{B,NA}_t = NFA^{B,M}_t + [(L^B_t - L^B_{H,t} - L^B_{F,t}) + (M^B_t - M^B_{H,t}) + (MF^B_t - MF^B_{R,t}) + (B^B_t - B^B_{R,t}) + \\ + (E^B_t - E^B_{F,t}) - (D_{B,t} - D^H_{B,t} - D^F_{B,t} - D^P_{B,t}) - (B_{B,t} - B^H_{B,t} - B^P_{B,t} - B^R_{B,t}) - (E_{B,t} - E^R_{B,t})] + \\ + OA^B_t - OL_{B,t}. \tag{32}$$

In the right-hand side of Eq. (32), the terms in square brackets reflect the circumstance that, for specific financial instruments, the ITFIN model does not consider the entire amount of banks holdings. For example, the model takes into account loans to households and to firms but not those to agents in other sectors. On the other hand, there are also instruments that, albeit present in the Flow of funds data, are not considered in ITFIN: these are the other assets and other liabilities, respectively, OA^B_t and $OL_{B,t}$, included in the right-hand side of Eq. (32).

3.2.3 Model Closures

Each item of bank assets and liabilities included in Eq. (31), and therefore in $NFA^{B,M}_t$, is modelled in ITFIN. In general, this is done through a behavioural equation that characterizes the agents decision on the amount of the specific financial instrument to hold every period. Stock-flow consistency is ensured by the dynamics of the amount of interbank debt with the Rest of the World, IB_t, (Eq. 33):[14]

[14] Aggregate interbank debt is absent in financial accounts data. In the database of the model we calculate it as the total amount of deposits held by the Rest of the world at Italian banks, net of the liabilities of the central bank to the Eurosystem within Target2 settlement system. The sources of these two variables are, respectively, the Financial accounts and the Central bank balance sheets.

$$\Delta IB_t = \Delta L^B_{H,t} + \Delta L^B_{F,t} + \Delta M^B_{H,t} + \Delta B^B_{R,t} + \Delta B^B_{G,t} + \Delta b^B_{G,t} + \Delta R_t + \Delta MF^B_{R,t} + \Delta E^B_{F,t}$$
$$-\Delta D^H_{B,t} - \Delta D^F_{B,t} - \Delta D^P_{B,t} - \Delta B^H_{B,t} - \Delta B^P_{B,t} - \Delta B^R_{B,t} - \Delta RO_t - \Delta E^R_{B,t}$$
$$+NL^{B,M}_t + SFA^{B,M}_t, \quad (33)$$

where $NL^{B,M}_t$ is the net lending of the banking sector as characterized in ITFIN.

3.2.4 Main modelling features

Profits of the Italian banks are modelled as follows (Eq. (34)):

$$\Pi^B_t = i_{M,t} M^B_{H,t-1} + i^H_{L,t} L^B_{H,t-1} + i^F_{L,t}(L^B_{F,t-1} - NPL_{t-1}) + i^R_t B^B_{R,t-1} + i^{G,10Y}_t B^B_{G,t-1} + i^{G,12m}_t b^B_{G,t-1} +$$
$$+ i_{R,t} R_{t-1} + i^{MF}_{R,t} MF^B_{R,t-1} + Div^B_{F,t} - i_{D,t}(D^H_{B,t-1} + D^F_{B,t-1} + D^P_{B,t-1}) +$$
$$- i_{B,t}(B^H_{B,t-1} + B^F_{B,t-1} + B^P_{B,t-1}) - i_{RO,t} RO_{t-1} - r^{B,3m}_t IB_{t-1}. \quad (34)$$

Each positive and negative item of financial income included in the above expression is considered explicitly in the banks Net Lending ($NL^{B,M}$). In particular, each of these items of financial income is modelled in ITFIN as the product between the value of the specific asset or liability in period $t-1$ and the corresponding interest rate between $t-1$ and t that is dated, conventionally in t.

The net lending, $NL^{B,M}_t$ in Eq. (33) is the amount of banks profits, net of dividends, that is channeled to the accumulation of a variety of financial assets and liabilities (Eq. (35)):

$$NL^{B,M}_t = \Pi^B_t - Div^R_{B,t}. \quad (35)$$

For each financial stock the ITFIN model features a behavioural equation both on the asset and liability side. Any financial instrument has both a demand and a supply side and, in general, both of these dimensions are considered in the model together with the price or the return of the security.

As for loans and mortgages, three different equations characterize the demand for loans to households, loans to firms and mortgages. The details of these three demand equations are illustrated in the households section (see Eq. (76) and Eq. (77)) and in the firms section (see Eq. (94)).

With regard to credit supply conditions, these are characterized through three different equations referring to the interest rates on, respectively, loans to households, loans to firms and mortgages. It is important to emphasize that in the ITFIN model we explicitly distinguish between interest rates on the stock of financial instruments outstanding in the market, i_t, and interest rates on the flow of financial instruments issued in the period, r_t. We characterize the latter with behavioural equations that incorporate relations between the interest rate on the *flow* of a given instrument and other economic and financial variables. Conversely, we model the pattern of interests rates on the *stock* of a financial instrument by using simple statistical equations linking interest rates on the stock of an instrument to past values of interest rates on flows of that instrument. We focus first on the interest rates on new loans to households, $r^H_{L,t}$, (see Eq. (36)). The equation reads as follows:

$$\Delta_4(r^H_{L,t} - r^{B,3m}_t) = \beta_0 - \beta_1\Big[(r^H_{L,t-4} - r^{B,3m}_{t-4}) - \beta_2(r_{fin,t-4} - r^{B,3m}_{t-4}) - \beta_3 \log\Big(\frac{RWA_{t-4}}{E^R_{B,t-4}}\Big) + \\ - \beta_4 \log(VA^m_{t-4})\Big] + \beta_5 \Delta_4(r^H_{L,t-1} - r^{B,3m}_{t-1}) + u_t. \quad (36)$$

The dependent variable is the (4-period change in the) spread between the interest rate on bank lending to households and the Euribor rate, $r^H_{L,t} - r^{B,3m}_t$, and the equation is characterized by a long-run relation between this interest rate margin and each of the following explanatory variables: a) the banks' cost of funding, measured as the difference between a weighted average of interest rates on banks liabilities and the Euribor rate, $r_{fin,t} - r^{B,3m}_t$; b) the log ratio between risk-weighted assets, RWA_t, and the market value of banks capital, $E^R_{B,t}$[15]; c) the value added of the market sector of the economy, VA^m_{t-4}. The equation also includes the lagged dependent variable.

The banks cost of funding has a positive impact on the margin between the interest rate on bank lending and the Euribor rate and the estimated coefficient reflects both the extent of the pass-through of the cost of funding into the interest rates set on loans and also the extent to which banks are able to absorb in their mark-ups changes in their marginal costs. Moreover, the size of risk-weighted assets, RWA_t, has a positive effect on the interest rates on bank loans while the market value of banks capital has a negative effect on them. The estimation results suggest that an increase in non-performing loans, $NPLs$, is associated with a rise in the interest rates on loans. The value of risk-weighted assets is the weighted sum of bank's assets and in the model it is characterized through the following expression

[15] In ITFIN, it is assumed that the equity issued by banks is entirely held by the Rest of the World (R).

(Eq. (37)):

$$RWA_t = \nu_1 M_H^{B,t} + \nu_2(L_{H,t}^B + L_{F,t}^B - NPL_t) + \nu_3(NPL_t - NPL_t^{Prov}) + \nu_4(B_{G,t}^B + b_{G,t}^B) + \nu_5 E_{F,t}^B + \nu_6 MF_{R,t}^B + \nu_7 B_{R,t}^B, \quad (37)$$

where the coefficients, ν_i, are calibrated on the basis of the institutional framework on bank capital requirements and prudential supervision. The above expression explicitly consider the stock of non-performing loans, $NPLs$, and that of bank loan loss provisions, NPL_t^{Prov}. In particular, bank loans are considered net of $NPLs$, with a weight of ν_2, while $NPLs$ are considered net of bank loan loss provisions, NPL_t^{Prov}, with a weight of ν_3, a larger value than that for the coefficient ν_2.

The stock of non-performing loans, presented in the firms section (see Eq. (95)), is modelled through a behavioural equation, in which a long run relationship is estimated between the stock of NPL_t and each of these variables: a) the stock of loans to firms (with a positive sign), b) the level of firm profits, $\Pi_{F,t}$ (with a negative effect) c) the interest rate margin given by the spread between the interest rate on loans to firms and the Euribor rate (with a positive sign) .

It is important to emphasize that the $NPLs$ variable is a stock and its evolution over time is therefore affected by net flows of exposures that become non performing and by bank write-offs of non-performing debt. While positive net flows of non-performing exposures tend to increase the stock of $NPLs$, the amount of write-offs, on the contrary, tend to reduce the stock of NPL. As for bank loan loss provisions, NPL_t^{Prov}, a simple equation is included in ITFIN, where the value of them is positively associated with the value of $NPLs$.

Against this backdrop, it becomes clear why higher values of both risk-weighted assets, RWA, and non-performing loans, NPL, induce banks to set higher interest rate margins on their loans. Indeed, banks are forced to increase their profit margins to put up with the higher fragility induced by increasing values of $NPLs$ and risk-weighted assets, RWA. On this regard, we note that, as Eqs. (34) and (35) clearly indicate, the value of bank non-performing debt, NPL, contributes to reduce the level of bank profits and that of net lending.

A similar structure characterizes the equation for the interest rates on new loans to non financial firms, $r_{L,t}^F$ (see Eq. (38)):

$$\Delta_4(r^F_{L,t} - r^{B,3m}_t) = \beta_0 - \beta_1\Big[(r^F_{L,t-4} - r^{B,3m}_{t-4}) - \beta_2 \log\left(\frac{RWA_{t-4}}{E^R_{B,t-4}}\right) - \beta_3(r_{fin,t-4} - r^{B,3m}_{t-4})\Big] + \beta_4\Delta_4(r^F_{L,t-1} - r^{B,3m}_{t-1}) + u_t. \quad (38)$$

The dependent variable is the (4-period change in the) spread between the interest rate on bank lending to non-financial firms and the Euribor, $r^F_{L,t} - r^{B,3m}_t$, and there is a long-run relation between the dependent variable (in level), the log of the ratio between risk-weighted assets and the market value of banks capital and the banks' cost of funding relative to the Euribor rate, $r_{fin,t} - r^{B,3m}_t$. The equation includes the lagged dependent variable as regressor.

As for the equation for the interest rates on the flows of new mortgages, $r_{M,t}$, the dependent variable is the (4-period change in the) spread between the interest rate on bank mortgages and the Euribor, $r_{M,t} - r^{B,3m}_t$, (see Eq. (39)). The equation features a long-term relation between the interest rates on flows of mortgages (net of the Euribor rate) and the log ratio of risk-weighted assets and banks capital at market prices. Moreover, changes in the interest rates on mortgages are linked in the short-run to changes in the cost of funds for banks and in the market value of the housing stock.[16]

$$\Delta_4(r_{M,t} - r^{B,3m}_t) = \beta_0 - \beta_1\left[(r_{M,t-4} - r^{B,3m}_{t-4}) - \beta_2 \log\left(\frac{RWA_{t-4}}{E^R_{B,t-4}}\right)\right] + \beta_3\Delta_4 r_{fin,t-4} + {} - \beta_4\Delta_4 \log(P^H_t H_t) + u_t. \quad (39)$$

The banks demand for bonds issued by the Rest of the World, $B^B_{R,t}$, is characterized by an equation featuring a long-run negative relation with the sovereign spread, on the one side, and the amount of risk-weighted assets, on the other. Conversely, a positive association is detected between the value of bonds issued by the Rest of the World and held by banks and the value of those bonds held by the ICPMF sector, $B^P_{R,t}$.[17] The equation reads as follows (Eq. 40):

[16] Some recent papers include the sovereign spread as regressor in their equations for banks' lending rates (see, among others, Albertazzi et al. (2014), Neri (2013) and Zoli (2013)). We do not insert this variable in Eqs. (36), (38) and (39) because the effects of the spread on lending rates are already allowed for, therein, through the impact of the spread on the RWA-to-bank capital ratio and on the banks' funding relative cost.

[17] The sovereign spread may, in some sense, be seen as part of the relative return for banks of holding foreign bonds. The stock of foreign bonds held by ICPMF is inserted in the equation as portfolio decisions by banks and ICPMF are likely to exhibit commonalities.

$$\Delta \log(B^B_{R,t}) = \beta_0 - \beta_1 \log(B^B_{R,t-1}) - \beta_2 s_{t-1} - \beta_3 RWA_{t-1} + \beta_4 \log(B^P_{R,t-1}) + u_t. \tag{40}$$

The ITFIN model considers the banks demand for mutual funds issued by the Rest of the World, MF^B_R. The corresponding equation (see Eq. (41)) features a long-run positive relation between the value of mutual funds shares issued by the Rest of the World and held by banks on the one side and the average rate of return on these mutual funds (net of the Euribor) on the other, $r^{MF}_{R,t-4} - r^{B,3m}_{t-4}$. A positive relation is also established with the value of banks equity at market prices, E^R_B, and, as for this variable, we recall that in ITFIN only banks equity held by the Rest of the World are considered. The equation is the following (Eq. (41)):

$$\Delta_4 \log(MF^B_{R,t}) = \beta_0 - \beta_1 \left[\log(MF^B_{R,t-4}) + \beta_2(r^{MF}_{R,t-4} - r^{B,3m}_{t-4}) - \beta_3 \log(E^R_{B,t-4})\right] + u_t. \tag{41}$$

Among banks assets we consider in the model the banks demand for equity issued by firms, $E^B_{F,t}$. In ITFIN the equation for this variable is specified as follows (Eq. (42)):

$$\Delta_4 \log(E^B_{F,t}) = \beta_0 - \beta_1 \left[\log(E^B_{F,t-4}) - \beta_2 \log(P_{E_{F,t-4}}) + \beta_3 \log\left(Div_{F,t-1}\right) - \beta_4 \log(L^B_{F,t-4})\right] + \\ + \beta_5 \Delta_4 \log(P_{E_{F,t}}) + u_t. \tag{42}$$

The equation includes a long-run relationship between (the log of) firms equity held by banks and the following variables: a) the (log of the) market prices of firms equity, b) the (log of) dividends paid by firms, c) the (log of) loans to the firms sector. The equation also features a relationship with changes over time in the market prices of firms equity. As for the latter, we characterize its dynamics through an equation that is illustrated in the firms section.

Concerning the banks demand for deposits held at their accounts at the Central Bank, R_t, we model these banks assets through a long-run relationship between these reserves and the share of government bonds held by the Central Bank over the total of government bonds outstanding in the market. The equation is modelled as follows (Eq. (42)):

$$\Delta log(R_t) = \beta_0 - \beta_1 \left[log(R_{t-1}) - \beta_2 log\left(\frac{B^{CB}_{G,t-1}}{B_{G,t-1}}\right)\right] + u_t. \tag{43}$$

Let us now focus on the banks demand for domestic sovereign bonds. A crucial aspect pertaining to the banking sector is the mechanism through which a drop in the market value of the sovereign debt associated to an increase in the interest rate on sovereign bonds can generate substantial effects on the real economy through the reduction in the supply of funds by the banking sector. This mechanism involves a feedback effect that deteriorates the government's financial position by an increase in the probability of a bail-out and by a reduction in the tax revenues. As discussed earlier, in ITFIN we model such loop for the Italian economy and find substantial evidence of its empirical relevance, as a rise in the sovereign spread is shown to significantly affect the economy through a weaker banking sector. The banks demand for long-term government bonds is modelled through an equation that includes a non-linear component (through a Hermite polynomial) in the relationship between banks demand for government bonds and their rate of return, measured in relative terms using the sovereign spread with the German bund (see Eq. (22)).[18]

Above a given threshold level, a rise in the interest rate on sovereign bonds and then in the spread induces a reduction in the amount of bonds demanded for by banks. Moreover, an estimated equation for the interest rate on bonds issued by domestic banks establishes that a rise in the sovereign spread induces an increase in the interest rates on banks bonds. The latter, in turn, is included in the measure of the cost of funding for banks and therefore a rise in the cost of funding is detected after a sovereign spread increase. That cost of funding for banks positively affects the levels of interest rates that banks set on loans to households and firms as well as on mortgages (see Eq. (36), Eq. (38) and Eq. (39)). This deterioration in the cost conditions that banks apply on their credit transactions negatively impinges on the access to finance of households and firms and thereby on the real economy.

The equation for the interest rates on the flow of bonds issued by banks has the following specification (Eq. (44)):

$$\log\left(1+r_{B,t}\right)=\beta_0+\beta_1\left[\frac{B_{G,t}}{b_{G,t}}\log(1+r_t^{G,10Y})+\left(1-\frac{B_{G,t}}{b_{G,t}}\right)\log\left(1+r_t^{G,12m}\right)\right]+u_t. \quad (44)$$

The pattern of interest rate on newly issued bank bonds, $r_{B,t}$, is modelled through a average of the yield to maturity on government bonds and government bills, weighted on the share of long-term government securities to total government securities. Thus, as anticipated earlier, a rise in the sovereign spread induces a rise in the interest rates that banks set in the bonds they issue and, therefore, in their cost of funding. The supply equation of the bonds

[18] The detailed anatomy of this equation is illustrated in the government section.

issued by banks (i.e. $B^H_{B,t} + B^R_{B,t} + B^P_{B,t}$ or equivalently, $B_{B,t}$).[19]

$$\Delta \log (B_{B,t}) = \beta_0 - \beta_1 [\log (B_{B,t-1}) - \beta_2 \log (GAP_{t-1})] - \beta_3 \Delta \log (1 + s_t) + u_t. \tag{45}$$

In the equation above (Eq. (45)) the funding gap, GAP_{t-1}, of the banking sector is defined as the excess of the log of loans and mortgages over the log of deposits. Importantly, the extent of the funding gap has a positive effects on the supply of banks bonds, both in the short and long run and the long-run relation in the equation is one-to-one. The inclusion of the spread in Eq. (45) is aimed at capturing the direct transmission of tensions from the sovereign bond markets to the cost conditions for banks in issuing bonds (see also Eq. 44). We have opted to include the spread rather than the relative costs of bonds issuance vs central bank refinancing because, as argued convincingly by Goyal et al. (2013), changes in the monetary policy rate had little impact on bank funding costs, as the latter were mainly driven by domestic sovereign yields after the sovereign bond crisis. The corresponding demands, respectively by households, $B^H_{B,t}$, and by Rest of the World, $B^R_{B,t}$, mainly rely on a long-run relationship between the size of the corresponding share over the total outstanding value of these bonds and the corresponding yield to maturity.

Banks primarily finance their activities through deposits. The long-term trend of the overall banks balance sheet reflects that of deposits. Among the latter, the largest and most volatile component is held by the households, and therefore the households demand for deposits is the only component of the overall demand that is explicitly modelled in ITFIN through a behavioural equation in the households section (see Eq. 74).

The amount of deposits is out of the direct control of the banking sector and, thus, as for the supply of banks deposits, we assume that it fully adjusts to demand. Financial intermediaries, however, can influence the pattern of deposits through the interest rates on them offered to the lenders. The interest rates on the flow of new deposits set by banks, $r_{D,t}$, are modelled through Eq. (46) and they are determined by the monetary policy rate (approximated by the Euribor rate) as well as the sovereign spread. By inducing a rise in deposit rates, tensions in the sovereign debt market impinge on the banks cost of funding also through this additional channel and this affects the cost of access to bank credit.

[19] We recall that the banks bonds considered in the model are those held by households (H), firms (F) and ICPMF (P).

$$\Delta \log(1+r_{D,t}) = \beta_0 - \beta_1 \left[\log(1+r_{D,t-1}) - \beta_2 \log(1+r_{t-1}^{B,3m}) - \beta_3 s_{t-1}\right] + \beta_4 \Delta \log(1+r_t^{B,3m}) + u_t. \tag{46}$$

There is another important source of financing for banks, namely their access to funds of the Central Bank through the various types of refinancing operations in favour of its counterparts, RO_t. Importantly, to model the degree of banks reliance on this instrument, we use again the funding gap as an explanatory variable. In particular, our estimation results support the view that the size of the banks funding gap has a one-to-one positive effect on the value of banks refinancing operations with the Central Bank. The equation, in particular, reads as follows (Eq. (47)):

$$\Delta \log(RO_t) = \beta_0 - \beta_1 \left[log(RO_{t-1}) - \beta_2 \log(GAP_{t-1})\right] + \beta_3 \Delta_4 r_{fin,t} + u_t. \tag{47}$$

The sequential structure of financing of the banking sector gives rise to a sort of "pecking order" in banks financing. First, the primary source of banks financing is deposits. Second, as elucidated earlier, we focus on the funding gap, namely the excess of loans and mortgages (illiquid assets) over deposits, and the size of this gap positively affects the degree of banks reliance on two other sources of financing: banks bonds and refinancing operations with the Central Bank. Third, the amount of interbank funds that banks borrow from the Rest of the World is determined as a residual, as we have shown earlier in illustrating (Eq. (33)).

Of course, there is another source of financing for banks, which is equity. In ITFIN we consider equity issued by banks and held by the Rest of the World and the demand for banks equity, $E_{B,t}^R$, is modelled through an equation (Eq. (48)) linking such demand to the amount of dividends that banks pay to the Rest of the World, $Div_{B,t}^R$ and to the market prices of banks equity, $P_{E_B,t}$.

$$\Delta_4 \log(E_{B,t}^R) = \beta_0 - \beta_1 \log(E_{B,t-4}^R) + \beta_2 \log(Div_{B,t-4}^R) + \beta_3 \log(P_{E_B,t-4}) + \beta_4 \Delta_4 \log(P_{E_B,t-1}) + u_t. \tag{48}$$

The model also comprises an equation for the market prices of banks equity, $P_{E_B,t}$, and one for the amount of dividends banks pay to the Rest of the World, $Div_{B,t}^R$. As for the former (see Eq. (49)), the market prices of banks equity is negatively affected in the long run by the size of risk-weighted assets, RWA_t and by the stock of Government bonds in the banks' balance sheet (rescaled over the relative price), $\frac{B_{G,t-4}^B}{P_{G,t-4}}$. In the short run, changes in the US stock market index, $SP500_t$, have a positive effects on the market prices of banks equity while changes in the sovereign spread exert a negative effect.

$$\Delta_4 \log(P_{E_B,t}) = \beta_0 - \beta_1 \left[\log(P_{E_B,t-4}) + \beta_2 \log(RWA_{t-4}) + \beta_3 \log\left(\frac{B^B_{G,t-4}}{P_{G,t-4}}\right)\right] + \beta_4 \Delta_4 \log(SP500_{t-1}) + \\ -\beta_5 \Delta_4 s_{t-1} + u_t. \quad (49)$$

The equation for dividends (see Eq. (50)) includes a long-run relation, that is positive in both cases, between the amount of dividends that banks pay to the Rest of the World, $Div^R_{B,t}$, and, respectively, a) the value added of the economy, VA_t, and b) the ratio between the market value of banks capital, $E^R_{B,t}$, and risk-weighted assets, RWA_t. In the short run, also the spread between the banks interest rates on loans (calculated as a weighted average of the interest rates set on loans to households and firms) and the Euribor, $(r_{L,t-4} - r^{B,3m}_{t-4})$, is considered in the equation:

$$\Delta_4 \log(Div^R_{B,t}) = \beta_0 - \beta_1 \left[\log(Div^R_{B,t-4}) - \beta_2 \log(VA_{t-4}) - \beta_3 \log\left(\frac{E^R_{B,t-4}}{RWA_{t-4}}\right)\right] + \beta_4 (r_{L,t-4} - r^{B,3m}_{t-4}) + \\ +\beta_5 \Delta_4 \log(VA_{t-1}) + u_t. \quad (50)$$

3.3 Insurance Companies, Pension and Mutual Funds (ICPMF)

3.3.1 National accounting and model accounting

A stylized financial balance sheet for the ICPMF sector that fully replicates the Flow of funds data, is presented in Table (8). According to Financial Accounts, ICPMF holds deposits, bonds, equity and other assets, while among liabilities, domestic asset managers issue pension funds, mutual funds and other liabilities.

The balance sheet of the sector, considered in the ITFIN model, is presented in Table (9).

In ITFIN, ICPMF holds the following assets: bank deposits, $D^P_{B,t}$, bank bonds, $B^P_{B,t}$, bonds issued by the Rest of the World, $B^P_{R,t}$, Government bonds, $B^P_{G,t}$, Government bills, $b^P_{G,t}$ and equity issued by the Rest of the World, $E^P_{R,t}$. As for the liabilities, we consider domestic mutual and pension funds, both held by households, $MF^H_{P,t}$, $PF^H_{P,t}$. Therefore, the ICPMF net wealth, NW^P_t, is obtained as the sum of the financial assets held by the sector

Table 8: ICPMF - stylized financial balance sheet

Asset	Liabilities
Deposits (D_B^P)	Domestic mutual funds (MF_P)
Bonds (B^P)	Pension funds (PF_P^H)
Government bonds (B_G^P)	Other Liabilities (OL_P)
Government bills (b_G^P)	
Equity holdings (E^P)	
Other Assets (OA^P)	

Table 9: ICPMF - stylized financial balance in the Model sheet

Asset	Liabilities
Deposits (D_B^P)	Domestic mutual funds held by Households (MF_P^H)
Bank Bonds (B_B^P)	Pension funds held by Households (PF_P^H)
Bonds issued by the RoW (B_R^P)	
Government bonds (B_G^P)	
Government bills (b_G^P)	
Equity issued by the RoW (E_R^P)	

net of its liabilities (Eq. (51)):

$$NW_t^P = D_{B,t}^P + B_{B,t}^P + B_{R,t}^P + B_{G,t}^P + b_{G,t}^P + E_{R,t}^P - MF_{P,t}^H - PF_{P,t}^H. \quad (51)$$

As ITFIN does not consider real assets of ICPMF, the net wealth, NW_t^P, as defined in Eq. (51), coincides with the net financial assets of the ICPMF sector (P) considered in the model (M) and defined as $NFA_t^{P,M}$.

Conversely, let us denote with $NFA_t^{P,NA}$ the net financial assets of the ICPMF sector (P) as drawn from the Flow of funds (i.e. National (Financial) accounts, NA). This aggregate includes all existing assets held by the ICPMF sector and issued by other sectors and all existing liabilities issued by ICPMF and corresponding to financial instruments held by other sectors. $NFA_t^{P,NA}$ can therefore be expressed as follows:

$$NFA_t^{P,NA} = NFA_t^{P,M} + [(B_t^P - B_{B,t}^P - B_{R,t}^P) + (E_t^P - E_{R,t}^P) - (MF_{P,t} - MF_{P,t}^H)] + OA_t^P - OL_{P,t}. \tag{52}$$

The terms in square brackets of Eq. (52), reflect the fact that, for specific financial instruments, ITFIN does not consider the entire holding of ICPMF. Moreover, there are financial instruments that are in the Flow of funds data but are not taken into account in ITFIN: we gather them together in two groups, that of the other assets, OA_t^P, and that of the other liabilities, $OL_{P,t}$, and we include them in Eq. (52).

3.3.2 Model Closures

Each item of assets and liabilities of the ICPMF sector included in Eq. (51), and therefore in $NFA_t^{P,M}$, is characterized in ITFIN with a behavioural equation modelling the agents decision on holding a specific financial instrument. In particular, on the assets side, there is a behavioural equation for the ICPMF sector's demand for deposits, $D_{B,t}^P$, an equation for domestic government bonds, $B_{G,t}^P$, one for domestic government bills, $b_{G,t}^P$, an equation for the sector ICPMF's demand for equity issued by the Rest of the World (R), $E_{R,t}^P$. On the ICPMF sector's liabilities side, there is a households demand equation for domestic mutual funds shares, $MF_{P,t}^H$, and an equation for pension funds holdings, $PF_{P,t}^H$.

Stock-flow consistency is achieved by restricting the dynamics of the amount of bonds issued by the Rest of the World and held by the ICPMF sector, $D_{B,t}^P$, as follows:

$$\Delta B_{R,t}^P = \Delta MF_{P,t}^H + \Delta PF_{P,t}^H - \Delta B_{B,t}^P - \Delta D_{B,t}^P - \Delta B_{G,t}^P - \Delta b_{G,t}^P - \Delta E_{R,t}^P + NL_t^{P,M} + SFA_t^{P,M}, \tag{53}$$

where $NL_t^{P,M}$ is the net lending of the sector.

3.3.3 Main modelling features

The amount of annuity payouts and insurance payments ($An_{P,t}$) is modelled as follows, taking as dependent variable the 4-period logarithmic change in the ratio of $An_{P,t}$ to the households private pension net wealth ($PF_{P,t}^H$) (Eq. (54)):

$$\Delta_4 \log\left(An_{P,t}\right) = \beta_0 - \beta_1 \left[\log\left(An_{P,t-4}\right) + \beta_2 \log(PF^H_{P,t-4}) - \beta_3 \log\left(An_{G,t-4}\right)\right] + \beta_4 \Delta_4 \log(GDP_t) + \\ + \beta_5 \Delta_4 \log(An_{P,t-1}) + u_t. \tag{54}$$

In the above equation annuity payouts are related in the long run with the (log) amount of private pensions, $PF^H_{P,t}$, and by the annuity payout on the public scheme, $An_{G,t}$. In the short run, private annuities depend on the 4-period change in the GDP. Contributions to the private pension schemes, $Co_{P,t}$, are paid by the households and are calculated as the product between wages, W_t, and a contribution rate, $r^{Co_P}_t$, which is measured as the implicit, average rate of contribution (Eq. (55)):

$$Co_{P,t} = r^{Co_P}_t W_t. \tag{55}$$

Importantly, the contributions to the private pension schemes, $Co_{P,t}$, do not enter the definition of the ICPMF sector's net lending, $NL^{P,M}_t$, as it is conversely the case for contributions to the public pension system, which concur to calculate the net lending of the Government sector. Contributions to private pension funds directly feed individual accounts in accordance with the functioning of a fully-funded system.

The evolution of private pension funds is modelled as follows (Eq. (56)):

$$\Delta\left(PF^H_{P,t}\right) = Co_{P,t} + LP_t C_t. \tag{56}$$

According to Eq. (56), the dynamic of private pensions is driven by the value of private contribution, $Co_{P,t}$, plus the life insurance premium, LP_t, measured as a percentage of households consumption, C_t.
Concerning the demand for shares of domestic mutual funds, Eq. (57)) features a short-run relationship between the log change in shares of domestic mutual funds, $MF^H_{P,t}$, and the sovereign spread. Moreover, a long-run relationship is found between (the log of) $MF^H_{P,t}$ and the following variables: the spread between the return on domestic mutual funds and the 3-month Euribor rate, $(r^{MF}_{P,t} - r^{G,12m}_t)$ and the (log of the) stock of pension funds, $PF^H_{P,t}$.

$$\Delta_4 log\left(MF^H_{P,t}\right) = \beta_0 - \beta_1 \left[log\left(MF_{P,t-4}\right) - \beta_2 \left(r^{MF}_{P,t-4} - r^{G,12m}_{t-4}\right) + \beta_3 log\left(PF_{P,t-4}\right)\right] + \\ - \beta_4 \Delta_4(s_t) + \beta_5 \Delta log(P_{E_B,t}) + u_t. \tag{57}$$

As for the assets in the ICPMF portfolio, the demand for deposits by ICPMF depends by the stock of pension funds and it is modelled as follows (Eq. (58)):

$$\Delta_4 \log\left(D^P_{B,t}\right) = \beta_0 - \beta_1 \left[\log\left(D^P_{B,t-1}\right) - \beta_2 \log\left(PF^H_{P,t-1}\right)\right] - \beta_3 \Delta_4 \log(D_{B,t-1}) + \beta_4 \Delta_4 \log(D_{B,t-4}) + u_t. \tag{58}$$

The demand by the sector for Italian sovereign bonds is modelled by Eq. (59):

$$\Delta_4 log\left(B^P_{G,t}\right) = \beta_0 - \beta_1 log\left(B^P_{G,t-4}\right) + \beta_2 log\left(B^B_{G,t-4}\right) + \beta_3(\pi_{t-4}) + u_t. \tag{59}$$

The dependent variable is the 4-quarter logarithmic change in Government bonds held by the ICPMF sector, $B^P_{G,t}$. The empirical specification of the above equation features a relationship between the amount of Government bonds held by ICPMF, the inflation rate, π_t, and the value of Government bonds, $B^B_{G,t}$.

The demand by the sector for Italian sovereign bills is modelled by a behavioral equation. The equation includes a long run relation between the the share of Treasury bills held by the ICPMF sector over the market value of their total amount outstanding in the market, the corresponding yield to maturity and the spread between the interest rate on bank deposit and that on 3-month Euribor.

Eq. (60) characterizes the evolution of the demand of the ICPMF sector for equity issued by the Rest of the world, $E^P_{R,t}$.

$$\Delta_4 \log\left(\frac{E^P_{R,t}}{TA^P_t}\right) = \beta_0 - \beta_1 \left[\log\left(\frac{E^P_{R,t-4}}{TA^P_{t-4}}\right) - \beta_2 log\left(SP500_{t-4}\right) - \beta_3 log(\mathcal{E}_{t-4})\right] + \\ + \beta_4 \Delta_4 \log\left(GDP_{t-1}\right) + u_t. \tag{60}$$

The dependent variable is the 4-period logarithmic change between the ratio of the demand for foreign equity to the total of asset of the ICPMF sector, TA^P_t. The demand equation for foreign equity is characterized by a long-run relationship between the dependent variable, the US stock market index, $SP500_t$, and the nominal effective exchange rate, $\mathcal{E}_t$. Both an expansion of the US stock market and an appreciation of the domestic currency induce a statistically significant increase in the amount of foreign equity demanded by the ICPMF sector.

We assume that the Net Lending of the ICPMF sector ($NL^{P,M}_t$) coincides with the sector's profits (Π^P_t) (Eq.(61)):

$$NL_t^{P,M} = \Pi_t^P. \tag{61}$$

In the ITFIN model, profits (and net lending) of the ICPMF sector are characterized as follows (Eq. (62)):

$$\begin{aligned}\Pi_t^P = &\left[i_{D,t}D_{B,t-1}^P + i_t^{G,10Y}B_{G,t-1}^P + i_t^{G,12m}b_{G,t-1}^P + i_t^R B_{R,t-1}^P + i_{B,t}B_{B,t-1}^P + Div_{R,t}^P\right] + \\ &-\left(\frac{MF_{P,t-1}^H}{(PF_{P,t-1}^H + MF_{P,t-1}^H)}\right)\left[i_{D,t}D_{B,t-1}^P + i_t^{G,10Y}B_{G,t-1}^P + i_t^{G,12m}b_{G,t-1}^P + i_t^R B_{R,t-1}^P + i_{B,t}B_{B,t-1}^P + Div_{R,t}^P\right] + \\ &- An_{P,t}. \end{aligned} \tag{62}$$

Positive components of the above expression refer to the interest payments received by the ICPMF sector for holding financial instruments issued by other sectors and to the dividends. In particular, inflows for interest payments pertain to the following assets held by the ICPMF sector, each featuring a corresponding interest rates: bank deposits ($i_{D,t}D_{B,t-1}^P$), Government bonds ($i_t^{G,10Y}B_{G,t-1}^P$), Government bills ($i_t^{G,12m}b_{G,t-1}^P$), bonds issued by banks ($i_{B,t}B_{B,t-1}^P$) and bonds issued by the Rest of the World ($i_{R,t}B_{R,t-1}^P$). As for dividends ($Div_{R,t}^P$), they are associated with the amount of equity issued by the Rest of the World. Of course, the sector profits do not include capital incomes associated with the assets of mutual funds, which are managed on the behalf of households investing in domestic mutual funds. A negative components is the annuity payouts made by pension funds together with payments and reimbursements made by insurance companies to their clients ($An_{P,t}$).

3.4 Households

3.4.1 National accounting and model accounting

Let us characterize first a stylized financial balance sheet for the households sector as drawn from the Financial Accounts (Flow of Funds) data released by the Bank of Italy. As Table (10) shows, the financial assets held by the households sector include the following: bank deposits, bonds, bills, equity, domestic and foreign mutual funds, pension funds and other assets. As for the liabilities, the households sector relies on mortgages and loans, both granted by banks, plus other liabilities.

It is often the case that, also for this sector, for a specific type of financial asset held by households and listed in Table (10), the model considers only the amount of that households asset that is issued by some (not all) of the sectors issuing that financial instrument. Table

Table 10: Households - stylized financial balance sheet

Asset	Liabilities
Deposits held by Households (D_B^H)	Mortgages (M_H^B)
Bonds held by Households (B^H)	Loans (L_H^B)
Bills held by Households (b^H)	Other Liabilities (OL_H)
Equity held by Households (E^H)	
Domestic mutual funds held by Households (MF_P^H)	
Foreign mutual funds held by Households (MF_R^H)	
Pension funds (PF_P^H)	
Other Assets (OA^H)	

(11) takes this into account and characterizes in detail the stylized financial balance sheet of the households as considered in the ITFIN model:

Table 11: Households - stylized financial balance in the Model sheet

Asset	Liabilities
Deposits held by Households (D_B^H)	Mortgages (M_H^B)
Bank bonds held by Households (B_B^H)	Loans (L_H^B)
Government bonds held by Households (B_G^H)	
Government bills held by Households (b_G^H)	
Firms equity held by Households (E_F^H)	
Domestic mutual funds held by Households (MF_P^H)	
Foreign mutual funds held by Households (MF_R^H)	
Pension funds (PF_P^H)	

The evolution over time of the market value of the assets and liabilities held by the households sector is determined by the pattern of their market prices as well as from the saving and portfolio decisions taken in all sectors.

In ITFIN, the net wealth (NW_t^H) of the households sector, calculated as financial and real assets net of its liabilities, is defined as follows (Eq. (63):

$$NW_t^H = \overbrace{D_{B,t}^H + B_{B,t}^H + B_{G,t}^H + b_{G,t}^H + E_{F,t}^H + MF_{P,t}^H + MF_{R,t}^H + PF_{P,t}^H - M_{H,t}^B - L_{H,t}^B}^{financial} + \overbrace{P_t^H H_t}^{nonfinancial}, \quad (63)$$

where the financial assets held by the households listed above are those explicitly considered in ITFIN: bank deposits, $D_{B,t}^H$, bank bonds, $B_{B,t}^H$, long- and short-term government bonds, respectively $B_{G,t}^H$ and $b_{G,t}^H$, equity of domestic non-financial firms, $E_{F,t}^H$, shares of mutual funds, respectively, domestic, $MF_{P,t}^H$, and foreign, $MF_{R,t}^H$, and households pension wealth, $PF_{P,t}^H$. The liabilities considered are mortgages, $M_{H,t}^B$, and loans, $L_{H,t}^B$, all granted by banks. The net wealth of households also comprises the market value of the housing stock they held, which is obtained as the product of house prices, P_t^H, and the housing stock, H_t.

Let $NFA_t^{H,M}$ denotes net financial assets of the households sector (H) considered in the model (M). It coincides with the above expression except for the value of the housing stock (real assets) and is therefore defined as:

$$NFA_t^{H,M} = D_{B,t}^H + B_{B,t}^H + B_{G,t}^H + b_{G,t}^H + E_{F,t}^H + MF_{P,t}^H + MF_{R,t}^H + PF_{P,t} - M_{H,t}^B - L_{H,t}^B. \quad (64)$$

Conversely, $NFA_t^{H,NA}$ denotes net financial assets of the households sector (H) drawn from the Flow of Funds and its relationship with $NFA_t^{H,M}$ can be expressed as follows:

$$NFA_t^{H,NA} = NFA_t^{H,M} + \left[(E_t^H - E_{F,t}^H) + (B_t^H - B_{B,t}^H - B_{G,t}^H) + (b_t^H - b_{G,t}^H)\right] + OA_t^H - OL_{H,t}. \quad (65)$$

3.4.2 Model Closures

For each asset and liability included in Eq. (64) we employ a behavioural equation to model the household decision on the per-period holding amount. The asset whose dynamics guarantees stock-flow consistency within the model is the firms equity held by households, $E_{F,t}^H$. Its dynamics is determined as follows:

$$\Delta(E_{F,t}^H) = \Delta\left(M_{H,t}^B + L_{H,t}^B\right) - \Delta\left(D_{B,t}^H + B_{B,t}^H + B_{G,t}^H + b_{G,t}^H + MF_{P,t}^H + MF_{R,t}^H + PF_{P,t}^H\right) + \\ + NL_t^{H,M} + SFA_t^{H,M}, \quad (66)$$

where $NL_t^{H,M}$ is the net lending of the households sector as characterized in the model.

It is the amount of saving channeled to the accumulation of a variety of financial assets and liabilities. In the case of households, the net lending reflects choices on non-financial variables such as, for example, consumption expenditure and housing investment, as well as on financial variables such as, for example, the items of capital income arising from different types of financial assets held and interest payments originating from different types of liabilities.

3.4.3 Main modelling features

Let us begin by characterizing the households expenditure on consumption goods. The econometric specification of the equation for households consumption is described by an error correction representation where the dependent variables is the first differenced (log of) consumption expenditure, net of payments for VAT. The explanatory variable in the short run is the rate of variation (over a 4-quarter period) of disposable income net of payments for VAT ($YD_t^{H,M} - \tau_t^{vat}C_t$), while in the long-run, an equilibrium relationship is estimated between the 4-quarter lagged values of (the log of) consumption, net wealth ($NW_t^H + P_t^H H_t$), disposable income net of payments for VAT and the interest rate on bank deposits, ($r_{D,t}$).

$$\Delta_4 log\left(\frac{C_t}{1+\tau_t^{vat}}\right) = \beta_0 - \beta_1\Big[log\left(\frac{C_{t-4}}{1+\tau_{t-4}^{vat}}\right) - \Big(\beta_2 log(NW_{t-4}^H + P_{t-4}^H H_{t-4}) + (1-\beta_2) \\ \big(log(YD_{t-4} - \tau_{t-4}^{vat}C_{t-4})\big)\Big) - \beta_3(r_{D,t-4})\Big] + \beta_4\Delta_4 log\left(YD_t - \tau_t^{vat}C_t\right) + u_t. \quad (67)$$

In order to gauge how the net lending of the household sector, $NL_t^{H,M}$, arises, let us begin with the expression below (Eq. (68)) describing how disposable income is characterized in ITFIN:

$$YD_t^{H,M} = \overbrace{YP_t^H - T_{H,t}^{D,G} - Co_{P,t} - Co_{G,t} + An_{G,t} + An_{P,t} + TR_{G,t}^H}^{nonfinancial} + \overbrace{i_{D,t}D_{B,t-1}^H - i_{M,t}M_{t-1} +}^{financial} \\ \underbrace{-i_{L,t}^H L_{B,t-1}^H + i_t^G B_{G,t-1}^H + i_t^{G,12m} b_{G,t-1}^H + i_{B,t}B_{B,t-1}^H + i_{P,t}^{MF} MF_{P,t-1}^H + i_{R,t}^{MF} MF_{R,t-1}^H + Div_{F,t}^H}_{financial}. \quad (68)$$

It is composed of households gross income (YP_t^H) net of taxes paid by the sector ($T_{H,t}^{D,G}$) minus the contributions paid for both social security public schemes and private pension plans ($Co_{G,t}$ and $Co_{P,t}$) plus pension benefits received by public institutions ($An_{G,t}$) and by private pension funds ($An_{P,t}$). Other social security transfers to households are also added ($TR^H_{G,t}$). Different sources of capital incomes are considered in the disposable income aggregate and each of them is modelled in ITFIN as the product between the value of the specific asset held by households in period $t-1$ and the corresponding interest rate in period t. The specific financial assets held by the households that we consider in ITFIN are the following: deposit holdings, with the period capital income being modelled as $i_{D,t}\ D_{t-1}$; long-term government bonds, with the period capital income being equal to $i^{G,10Y}_t B^H_{G,t-1}$, short-term government bills, with the period capital income being equal to $i^{G,12m}_t b^H_{G,t-1}$, bonds issued by banks, with their period capital income equal to $i_{B,t} B^H_{B,t-1}$, domestic and foreign mutual funds, with the corresponding period capital incomes for households calculated by taking into accounts each specific asset holding of the mutual funds and its corresponding rate of return. $i^{MF}_{P,t} MF^H_{P,t-1}$ and $i^{MF}_{R,t} MF^H_{R,t-1}$ refer to households capital incomes from domestic and foreign mutual funds and finally, disposable income also include dividends paid on stocks (equity) issued by the non-financial firms held by the households, $Div^H_{F,t}$. The expression for disposable income also includes expenditure for interest payments on households debt: as for mortgages, they are modelled as the value of mortgages times the corresponding interest rate, $i_{M,t} M^B_{H,t-1}$, while, as for the other loans, they are modelled as the value of other bank loans to households times the corresponding interest rate, with an expenditure in period t of $i^H_{L,t} L^B_{H,t-1}$.[20]

Gross households income, YP^H_t, is the sum of labour income for employees in both the market and public sector, W_t, and other gross mixed income, W^m_t, that corresponds to the income obtained from the households use of their own production facilities (income from self-employment).[21] Direct taxes, $T^{D,G}_{H,t}$ are calculated as the product between gross income and the corresponding tax rate, while private pension contributions, $Co_{P,t}$, and social contributions, $Co_{G,t}$, have labour income, W_t, as tax base (Eqs. (55), (69) and (70)):

$$T^{D,G}_{H,t} = r^{D,G}_{H,t} YP^H_t, \tag{69}$$

$$Co_{G,t} = r^{Co_G}_t W_t. \tag{70}$$

Public pension transfers evolve with the (4-quarter period) inflation rate (defined on the GDP deflator) and the population over working age, $N_{over65,t}$ (Eq. (71)):

[20] $i^H_{L,t}$ and $i^H_{M,t}$ refer to average interest rates paid on the existing stock, while $r^H_{L,t}$ and $r^H_{M,t}$ represent the interest rates on new issuances. An equivalent notation applies to other assets, where relevant.

[21] In the case of unincorporated enterprises, which are part of the households sectors, labour income includes, in addition to compensations of employees, an element corresponding to the remuneration for work activities carried out by the owner or members of his family which cannot be distinguished from his profits as entrepreneur.

$$\Delta_4 log\left(An_{G,t}\right) = \beta_0 - \beta_1 log(An_{G,t-1}) + \beta_2 log(N_{over65,t})[1 + \Delta_4 log(P_{GDP,t})] + u_t, \quad (71)$$

while other transfers to households are set as a function of nominal GDP as well as public pension transfers (Eq. (72)):

$$\Delta_4 log\left(TR^H_{G,t}\right) = \beta_0 - \beta_1\left[log(TR^H_{G,t-4}) - \beta_2 log\left(An_{G,t-4}\right)\right] - \beta_3 \Delta_4 log(GDP_t) + u_t. \quad (72)$$

In turn, the net lending (or savings), $NL^{H,M}_t$, of the household sector is given by its disposable income net of both consumption and investment in housing (Eq. (73)):

$$NL^{H,M}_t = YD^{H,M}_t - C_t - I^H_t. \quad (73)$$

A large number of behavioural equations are estimated in ITFIN to characterize households demand for the financial assets they hold. Also the households decisions on the amount of debt (loans and mortgage) is modelled through estimating equations.

As for the households demand for bank deposit, the dependent variable is the log change of the deposits held by households, $\log(D^H_{B,t})$ and, in modeling the pattern of bank deposits, we simply consider the lagged dependent variable and the saving rate of the households sector, sr_t, (see Eq. (74)):

$$\Delta\log(D^H_{B,t}) = \beta_0 - \beta_1\Delta\log(D^H_{B,t-1}) + \beta_2\log\left(1 + sr_{t-1}\right) + u_t. \quad (74)$$

Other behavioural equations are estimated for the households demand for, respectively, a) bonds issued by banks; b) long-term government securities, modelled in line with the general specification of Eq. (22) presented in the Government sector; c) mutual fund shares issued by domestic mutual fund management companies; d) foreign mutual fund shares; e) domestic pension funds.[22]

As for the shares of mutual funds issued by foreign asset managers and held by the households sector, $MF^H_{R,t}$, we consider a simple specification with a long-run relationship between (the log of) $\frac{MF^H_{R,t}}{TA^H_t}$ and the spread between the return on foreign mutual funds and the 3-month Euribor rate, $(r^{MF}_{R,t} - r^{B,3m}_t)$. TA^H_t is the market value of total assets held by

[22]The specification of most of these equations and the others in the model is described in detail in the paper. The estimation results and diagnostic tests for all stochastic equations in ITFIN can be found in an on-line appendix accompanying the working paper version, which is available upon request and accessible at the website of Italy's Department of Treasury.

the households sector in period t. The equation of the households demand for these financial instruments reads as follows (Eq. (75)):

$$\Delta_4 log\left(\frac{MF^H_{R,t}}{TA^H_t}\right) = \beta_0 - \beta_1\left[log\left(\frac{MF^H_{R,t-4}}{TA^H_{t-4}}\right) + \beta_2\left(r^{MF}_{R,t-4} - r^{B,3m}_{t-4}\right)\right] - \beta_3\Delta_4 log(\mathcal{E}_{t-1}) + u_t. \tag{75}$$

As for the liabilities, the model features a households demand equation for bank loans and one for bank mortgages.

The households demand for bank loans, L^H_B is characterized as follows (Eq. (76)):

$$\Delta log(L^B_{H,t}) = \beta_0 - \beta_1\left[log(L^B_{H,t-1}) - \beta_2 log(NW^H_{t-1} + P^H_{t-1}H_{t-1})\right] - \beta_3\left(r^H_{L,t} - r^{B,3m}_t\right) + u_t, \tag{76}$$

where an empirical relationship is uncovered between the stock of loans, the sector net wealth and the spread between the interest rate on loans to households, $r^H_{L,t}$ and the 3-month Euribor, $r^{B,3m}_t$. The equation of the households demand for mortgages is characterized by a long-run positive relationship between the stock of mortgages, $M^B_{H,t}$ and an indicator of the volume of housing sales in period t multiplied by a house price index, $S^H_t P^H_t$ and a negative relationship between $M^B_{H,t}$ and the interest rate on the new mortgages, $r_{M,t}$ (see Eq. (77)).

$$\Delta log(M^B_{H,t}) = \beta_0 - \beta_1\left[log(M^B_{H,t-1}) - \beta_2 log(S^H_{t-1}P^H_{t-1}) + \beta_3 log(1 + r_{M,t})\right] + u_t. \tag{77}$$

3.4.4 The housing market

Let us begin the characterization of the housing market in the ITFIN model with a simple equation linking the (log of the) volume of housing sales in period t, S^H_t, to its one-period lag and the log change in the house price index. The other two explanatory variables are a) the log change of the ratio between total households net wealth and the value of the housing stock and b) the time change in the interest rate on bank loans to households. The equation reads as follows (Eq. (78)):

$$log(S^H_t) = \beta_0 + \beta_1\Delta log(P^H_t) - \beta_2 log(S^H_{t-1}) + \beta_3\Delta\log\left(\frac{NW^H_{t-1} + P^H_{t-1}H_{t-1}}{P^H_{t-1}H_{t-1}}\right) - \beta_4\Delta\log(1 + r^H_{L,t}) + u_t. \tag{78}$$

The volume of the housing stock, H_t, is assumed to evolve over time obeying the following accumulation equation (Eq. (79)):

$$H_t = (1-\delta^H)H_{t-1} + \frac{I_t^H}{P_t^H}, \tag{79}$$

where I_t^H is the value of investment in housing in period t and it is expressed in volume by deflating it with the house price index. In ITFIN the evolution over time of the value of investment in housing, I_t^H, is characterized through the following equation (Eq. (80)):

$$\Delta_4 log(I_t^H) = \beta_0 - \beta_1 \left[log(I_{t-4}^H) - \beta_2 log(P_{t-4}^H S_{t-4}^H) - \beta_3 log(M_{H,t-4}^B)\right] + \beta_4 \Delta_4 log(P_t^H S_t^H) + \\ - \beta_5 \Delta_4 (r_{M,t-1}) + u_t. \tag{80}$$

The equation features a short-run positive relationship between the log 4-quarter change of I_t^H and each of the following two variables: a) the (log 4-quarter change in the) volume of housing sales times the price index and b) the (4-quarter change in the) interest rate on mortgages paid by households. As for the long-run relationship, the value of investment in housing is positively linked to both the volume of housing sales times the house price index and to the stock of mortgages held by the households sector. Importantly, in the above equation, a real variable such as investment in housing, is influenced, among other things, by financial variables in the form of both interest rates and credit aggregates. Finally, we characterize the behaviour of house price through the following equation (Eq. (81)):

$$\Delta_4 log\left(\frac{P_t^H}{1+\tau_t^{vat}}\right) = \beta_0 - \beta_1 \left[log\left(\frac{P_{t-1}^H}{1+\tau_{t-1}^{vat}}\right) + \beta_2 \left(r_{M,t-1} - r_{t-1}^{B,3m}\right)\right] + \beta_3 \Delta log(I_{t-1}^H) + u_t, \tag{81}$$

where a short-run link is envisaged between the 4-quarter log change of the house price index and that of investment in housing. Conversely, in the long run the house price index is anchored (with a negative sign) to the interest rate on mortgages net of the 3-month Euribor. According to the above equation and similar to Eq. (80), financial variables, and interest rates in particular, impinge on the pattern of the house price index; at the same time, the latter is affected by business cycle conditions proxied by the change over time of investment in housing.

3.5 Firms

3.5.1 National accounting and model accounting

A stylized financial balance sheet for the (non-financial) firms sector that mimics the National Financial Accounts data is presented in Table (12).

Table 12: Firms - stylized financial balance sheet

Asset	Liabilities
Deposits (D_B^F)	Loans (L_F^B)
Equity held by Firms (E^F)	Bonds issued by Firms (B_F)
Bonds held by Firms (B^F)	Equity issued by Firms (E_F)
Other Assets (OA^F)	Other Liabilities (OL_F)

The assets and liabilities listed in Table (12) are the main stocks considered in the National Financial Accounts. The table also features other firms financial assets (OA^F) and liabilities (OL_F) which have a smaller weight in the sector portfolio, such as, for example, bills or mutual funds. Conversely, the assets and liabilities listed in Table (13) below are those explicitly considered in the ITFIN model. More specifically, as for the financial assets of non-financial firms, they are deposits, $D_{B,t}^F$, and equity issued by the Rest of the World, $E_{R,t}^F$. As for the liabilities of firms sector, they include bank loans, $L_{F,t}^B$, allowing for the distinction between performing and non-performing loans, NPL_t, and equity issued by the sector and held by households, $E_{F,t}^H$, and banks, $E_{F,t}^B$.

Thus, for the firms sector the stylized financial balance sheet in the model is the following (Table 13):

Table 13: Firms - stylized financial balance in the Model sheet

Asset	Liabilities
Deposits (D_B^F)	Loans (L_F^B)
RoW equity held by Firms (E_R^F)	*among which:* Non-performing loans (NPL)
	Equity issued by Firms held by Households (E_F^H)
	Equity issued by Firms held by Banks (E_F^B)

The pattern of the assets and liabilities held by the firms sector is determined by the evolution of their market prices and the saving and portfolio decisions taken in all sectors of the economy. The net worth of the firms sector, NW_t^F, is calculated as financial and non-financial assets held by the sector net of their liabilities (Eq. (82)):

$$NW_t^F = \overbrace{D_{B,t}^F + E_{R,t}^F - L_{F,t}^B - E_{F,t}^H - E_{F,t}^B}^{financial} + \overbrace{K_t + Inv_t}^{nonfinancial}. \tag{82}$$

As mentioned before, in the ITFIN model the financial assets held by firms are bank deposits, $D_{B,t}^F$ and international equity, $E_{R,t}^F$, while the firms sector liabilities include bank loans, $L_{F,t}^B$, and equity issued by the sector and held by households and banks, $E_{F,t}^H$ and $E_{F,t}^B$. Firms non-financial assets are the stock of fixed capital, K_t, and the stock of inventories, Inv_t. Admittedly, in the current version of the model, while we do track period changes in inventories, we do not consider how they build up over time to form the stock of inventories, Inv_t.

Let $NFA_t^{F,M}$ denote net financial assets of the firms sector (F) considered in the model (M). It is defined as follows:

$$NFA_t^{F,M} = D_{B,t}^F + E_{R,t}^F - L_{F,t}^B - E_{F,t}^H - E_{F,t}^B. \tag{83}$$

Conversely, $NFA_t^{F,NA}$ denotes net financial assets of the firms sector (F) drawn from the Flow of Funds, i.e. National (Financial) accounts. It can be expressed as:

$$NFA_t^{F,NA} = NFA_t^{F,M} + [(E_t^F - E_{R,t}^F) - (E_{F,t} - E_{F,t}^H - E_{F,t}^B)] + OA_t^F - OL_{F,t}. \tag{84}$$

3.5.2 Model Closures

For each asset and liability included in Eq. (83) we employ, in general, a behavioural equation to model the firms decision on the amount of it to hold every period. In particular, there is a behavioural equation for firms equity issued by the Rest of the World and one for bank loans (net of non-performing loans, NPL), with a specific equation for NPLs also. On the liability side, there is an equation for the value of equity that the firms sector issue. Bank deposits, $D_{B,t}^F$, are the most liquid asset held by firms and money demand functions are typically seen as unstable due to financial innovation. In light if this, deposits have been selected as the residual asset for this sector and their dynamics is obtained as follows:

$$\Delta D_{B,t}^F = \Delta E_{F,t}^H + \Delta E_{F,t}^B + \Delta L_{F,t}^B - \Delta E_{R,t}^F + NL_t^{F,M} + SFA_t^{F,M}, \tag{85}$$

where $NL_t^{F,M}$ is the net lending of the firms sector as characterized in the ITFIN model. It is the amount of firms saving channelled to the accumulation of a variety of financial assets and liabilities. The net lending of firms reflect net profits of the firms sector, obtained by subtracting the wage bill from value added and by adding interest payments for deposits and subtracting those for bank loans (net of NPLs); moreover, direct taxes and indirect taxes on production are subtracted, while production subsidies to firms are added.

3.5.3 Main modelling features

Let us start with the fundamental accounting relationship characterizing Gross Domestic Product (GDP_t), as the sum of private and public consumption (respectively C_t and $C^{G,t}$), investments in capital (I_t^F) and housing (I_t^H), public investment (I_t^G), the trade balance calculated as exports (EX_t) net of imports (IM_t), and change in inventories (ΔInv_t). The identity is characterized as follows (Eq.(86)):

$$GDP_t = C_t + C_t^G + I_t^F + I_t^H + I_t^G + EX_t - IM_t + \Delta Inv_t. \tag{86}$$

It is important to emphasize that in the ITFIN model, production activities are undertaken by the firms sector only. Therefore, firms output is measured as the value added of the market sector in the economy and it is computed as GDP minus taxation on value added (net of transfers), T_t^{VA}, and the value added of the public sector, VA_t^G.

$$VA_t^m = GDP_t - (T_t^{VA} + VA_t^G). \tag{87}$$

The amount of resources, Y_t, is obtained by summing GDP and imports, IM_t (see Eq. (88)):

$$Y_t = GDP_t + IM_t. \tag{88}$$

With the exception of public consumption and public investment, each component of GDP in Eq. (86), including firms investment in fixed capital and change in inventories, is modelled using behavioural equations. The long-run dynamics of investments, I_t^F, is modelled by setting them as a function of profits gross of government transfers, $\Pi_{t-1}^F + TR_{G,t-1}^F$, and government investments, I_{t-1}^G. The specification also features the log change in value added, as a proxy for the level of activity, $\Delta\log(VA_t^m)$, and in the stock value of loans net of NPL, $(\Delta\log(L_{F,t-1}^B - NPL_{t-1}))$:

$$\Delta\log(I_t^F) = \beta_0 - \beta_1\left[\log(I_{t-1}^F) - \beta_2\log(I_{t-1}^G) - \beta_3\log(\Pi_{t-1}^F + TR_{G,t-1}^F)\right] + \beta_4\Delta\log(VA_t^m) + \\ + \beta_5\Delta\log\left(L_{F,t-1}^B - NPL_{t-1}\right) + u_t. \quad (89)$$

The firms capital stock, K_t, evolves through a standard accumulation equation (Eq. (90)):

$$K_t = (1-\delta^K)K_{t-1} + I_t^F, \quad (90)$$

where δ^K is the depreciation rate.

Net profits of the firms sector, Π_t^F, are defined in (Eq. (91)) and are obtained by subtracting the wage bill, $(W_t^m + W_t^s)$, from value added, VA_t^m, by adding interest payments for deposits, $i_{D,t}D_{B,t-1}^F$, and dividends distributed for the international equity, $Div_{R,t}^F$, and by subtracting interest payments for bank loans (net of NPLs), $i_{L,t}^F(L_{F,t-1}^B - NPL_{t-1})$; moreover, direct taxes, $T_{F,t}^{D,G}$, and indirect taxes on production, $T_{F,t}^{P,G}$, are subtracted, while investment subsidies to firms, $TR_{G,t}^F$, are added.[23]

$$\Pi_t^F = VA_t^m - (W_t^m + W_t^s) - i_{L,t}^F(L_{F,t-1}^B - NPL_{t-1}) + i_{D,t}D_{B,t-1}^F - T_{F,t}^{D,G} - T_{F,t}^{P,G} + TR_{G,t}^F + Div_{R,t}^F. \quad (91)$$

Direct taxes paid by firms, $T_{F,t}^{D,G}$, are calculated as the product between the tax rate, $r_{F,t}^{D,G}$, and the corresponding tax base that includes the value added of the sector net of wage bills and where net interest payments are added (Eq. (92)):

$$T_{F,t}^{D,G} = r_{F,t}^{D,G}\Big[VA_t^m - W_t^m - W_t^s - i_{L,t}^F(L_{F,t-1}^B - NPL_{t-1}) + i_{D,t}D_{B,t-1}^F\Big]. \quad (92)$$

Indirect taxes on production, $T_{F,t}^{P,G}$, are computed as the product of the tax base (value added) and the corresponding tax rate, $r_{F,t}^{P,G}$, transfers, $TR_{G,t}^F$, are set as function of nominal GDP, while, as for dividends distributed by firms, their pattern is characterized by a behavioural equation.

Firms hold equity issued by the Rest of the World, E_R^F. In ITFIN, the firms' demand for this security it is modelled through the following equation:

$$\Delta\log(E_{R,t}^F) = \beta_0 - \beta_1\log(E_{R,t-1}^F) + \beta_2\log(VA_{t-1}^m) + \beta_3\Delta\log(E_{R,t-1}^F) + u_t, \quad (93)$$

[23] W_t^m and W_t^s represent wage payments for, respectively, workers in the market sector and self-employees.

where Eq. (93) shows a significant relation between the equity held by firms, its past values and the value added of the market sector.

Let us now focus on the characterization of the firms demand for bank loans. The estimated equation is the following:

$$\Delta_4 \log(L^B_{F,t}) = \beta_0 - \beta_1 \Big[\log(L^B_{F,t-4}) + \beta_2(r_{L,t-4} - r^{B,3m}_{t-4}) - \beta_3 \log(E_{F,t-4}) + \\ + \beta_4 \log(\Pi^F_{t-4}) - \beta_5 \log\left(\frac{I^F_{t-4}}{VA^m_{t-4}}\right) \Big] + \beta_6 \Delta_4 \log(VA^m_t) + u_t. \quad (94)$$

The above demand equation features a long-run relationship between the (log) level of the loans to firms and the following variables: a) the interest rate on these loans (net of the Euribor); b) the equity issued by firms (and held by households and banks); c) the level of firms profits; d) the ratio of firms investments to value added. In the short run part of the equation, changes in firms value added enters as an explanatory variable. As for the firms loans we explicitly consider in ITFIN the pattern of NPLs and this aggregate is modelled through Eq. (95) whose specification reads as follows:[24]

$$\Delta_4 \log(NPL_t) = \beta_0 - \beta_1 \Big[\log(NPL_{t-4}) - \beta_2 \log(L^B_{F,t-4}) + \beta_3 \log(\Pi^F_{t-4}) - \beta_4 (r_{L,t-1} - r^{B,3m}_{t-1}) \Big] + u_t. \quad (95)$$

In the long run, the stock of NPL_t depends positively on bank loans to firms, negatively on firms profits and positively on movements in the interest rate on bank loans net of the interbank rate.

We recall that firms finance activities also through their own equity that, in ITFIN, are demanded by households and banks. The equation for firms equity has the following empirical specification with firms equity price as the dependent variable (Eq. (96)):

$$\Delta_4 \log(P_{E_F,t}) = \beta_0 - \beta_1 \Big[\log(P_{E_F,t-4}) - \beta_2 \log(P_{E_B,t-4}) - \beta_3 \log(\Pi^F_{t-4}) - \beta_4 \log(K_{t-4}) \Big] + \\ + \beta_5 \Delta_4 \log(E_{F,t-1}) + \beta_6 \Delta_4 \log(P_{E_B,t}) + u_t. \quad (96)$$

[24] The variable NPL_t used in the ITFIN model refers to bad debts only, which represent the most relevant sub-component of total NPLs.

In the above equation, a long run relationship is postulated and estimated between the (log of the) market prices of equity issued by firms, $P_{E_F,t}$, and the following variables: a) the (log of the) market prices of equity issued by banks, $P_{E_B,t}$, b) the (log of) aggregate firms profits, $\Pi_t^{F,M}$, and c) the (log of the) capital stock, K_t. A short run relationship is also included between changes in the dependent variable and changes of both the value of equity issued by firms and outstanding in the market, $E_{F,t}$, and of the (log of the) market prices of equity issued by banks, $P_{E_B,t}$.

As for dividends distributed by firms, their pattern is characterized in (Eq. (97)).

$$\Delta_4 \log\left(\frac{Div_{F,t}}{\Pi_t^F}\right) = \beta_0 - \beta_1\left[\log\left(\frac{Div_{F,t-4}}{\Pi_{t-4}^F}\right) + \beta_2 \log\left(GDP_{t-4}\right)\right] + \beta_3 \Delta_4 \log\left(\frac{Div_{F,t-1}}{\Pi_{t-1}^F}\right), \tag{97}$$

where the dependent variable is the four-period log change of the dividends-to-profits ratio, $\left(\frac{Div_t^F}{\Pi_t^F}\right)$. The empirical equation for dividends features a long run relationship between dividends distributed by firms $\left(\frac{Div_{t-4}^F}{\Pi_{t-4}^F}\right)$ and past realization of $\log(GDP_{t-4})$. The effect of the latter variable on firms dividends is statistically significant supporting the intuition that the dividends distribution (normalized by firms' profits) are function of the national economic scenario.

Finally, the net lending of the firms sector, $NL_t^{F,M}$, obeys to the following identity (Eq. (98)):

$$NL_t^{F,M} = \Pi_t^F - Div_t^F - I_t^F - \Delta Inv_t + TR_{G,t}^F, \tag{98}$$

where, $NL_t^{F,M}$, is set equal to profits net of dividends, investments and change in inventories plus investment subsidies.

3.5.4 The labour market

In the labour market, we explicitly distinguish in ITFIN between three different sources of labour income for households: a) the total amount of wages for employees in the market sector, W_t^m; b) the total amount of wages for employees in the public administration, W_t^g; and c) the total amount of income for self-employment, W_t^s. The sum of these components generates the total amount of wages in the model:

$$W_t = W_t^m + W_t^g + W_t^s. \tag{99}$$

In the labour market, the labour wedge is defined as the following ratio (Eq. (100)):

$$\tau_t^W = \frac{T_{H,t}^{D,G} + T_t^{I,G} + T_t^{VA}\left(\frac{W_t}{(W_t + An_{G,t})}\right)}{W_t}, \tag{100}$$

where $T_{H,t}^{D,G}$ represents direct taxes for households, $T_t^{I,G}$ are indirect taxes, T_t^{VA} is the taxation on value added, net of transfers and $An_{G,t}$ is the sum of public pension annuities. For each of the three components of wages, we specify a behavioural equation and a distinctive feature that characterizes each of them is the inclusion of the unemployment rate, u_t, as explanatory variable of the evolution of labour income. In particular, consistently with the predictions of standard economic models we uncover a negative effect of the unemployment rate on the level of labour income. For a given level of both the wage rate and the labour force, a reduction in employment mechanically drives up the unemployment rate and drives down labour income. Moreover, there a number of ways to rationalize the negative effect by focusing on the effect of the unemployment rate on the wage rate (rather than labour income as a whole). For example, the higher unemployment rate reduces the bargaining power of the workers with a subsequent negative effect on the individual wage. The labour income of employees in the market sector is modelled as follows (Eq. (101)):

$$\Delta_4 \log\left(\frac{W_t^m}{(1+\tau_{m,t}^W)}\right) = \beta_0 - \beta_1\left[\log\left(\frac{W_{t-4}^m}{(1+\tau_{m,t-4}^W)}\right) + \beta_2 log(1+u_{t-4})\right] + \\ - \beta_3\Delta_4 log(1+u_t) + \beta_4\Delta_4\log\left(VA_{t-2}^m\right) + e_t, \tag{101}$$

where the relationship between labour income (over the relative tax wedge) and the unemployment rate holds in the the long run. Furthermore we consider the short-run effect produced by unemployment and by the value added of the market sector, (VA_{t-2}^m). The labour income of employees in the public sector, W_t^g, is an exogenous variable if public expenditure is treated as exogenous in the model; conversely, under the alternative mode of setting public expenditure consistent with a fiscal reaction function, the variable W_t^g, endogenously moves in line with labor income in the market sector.

The pattern over time of labour compensation of the self-employees, W_t^s, obeys the following equation (Eq. 102):

$$\Delta_4 log(W_t^s) = \beta_0 - \beta_1\left[log(W_{t-4}^s) - \beta_2 log(GDP_{t-4})\right] - \beta_3\Delta_4 log(1+u_t) + e_t. \tag{102}$$

A key feature of ITFIN is the way we characterize the unemployment rate. In particular, for the latter variable we specify the following equation, where, in addition to the standard channel linking the unemployment rate to the level of economic activity, GDP_t, we allow for an important role of financial variables in explaining the pattern of the unemployment rate, (Eq. (103)):

$$\Delta_4 log(1+u_t) = \beta_0 - \beta_1 \left[log(u_{t-4}) + \beta_2 log(P_{E_{F,t-4}}) - \beta_3 s_{t-4} - \beta_4 \tau^W_{t-4}\right] + \beta_5 \Delta_4 log(1+u_{t-1}) + \\ - \beta_6 \Delta_4 log(Y_{t-1}) + e_t. \quad (103)$$

The equation features a long-run relationship between the unemployment rate on the one side and both the stock price index, $P_{E_{F,t}}$ and the sovereign spread on the other. In particular, we rely on a stream of literature that emphasizes the nexus between the unemployment rate and the evolution of the stock market index and other asset prices. Before focusing on these contributions, we compare in Figure (6) the observed pattern of the unemployment rate with that of the stock market index (left figure) and that of the sovereign spread (right figure).

INSERT FIGURE 6

Visual inspection of both figures indicates a considerable matching between each pair of series. In particular, the actual data point to a strong negative association between the stock market index and the unemployment rate. This relationship has been confirmed in some contributions to the literature that have uncovered a statistically significant relationship between the two variables (See, e.g., Phelps (1999), Phelps and Zoega (2001), Zoega (2012), Farmer (2011, 2013) and Fritsche and Pierdzioch (2017)). This empirical finding is consistent with the predictions of equilibrium unemployment theories that explain variations in the equilibrium unemployment rate through changes in performance indicators of the economy such as for example the productivity growth (see Zoega (2012) for a structuralist, Phelps-type of interpretation). Figure 6 also points to a positive association between the unemployment rate and the (lagged) level of the sovereign spread. Our empirical findings, presented by Eq. (103), confirm that the stock market index has a statistically significant negative effect on the unemployment rate while the corresponding effect of the sovereign spread is positive and also statistically significant. Perhaps surprisingly, the long-run relationship between asset prices and the unemployment rate is often neglected in theoretical and empirical work trying to rationalize the unemployment patterns. In the ITFIN model, we do emphasize this transmission channel consistently with our general objectives of bridging together the real and financial side of the economy as well as ensuring stock-flow coherence.

3.6 Rest of the World

3.6.1 National accounting and model accounting

A stylized financial balance sheet for the Rest of the World (RoW) that reproduces the information of the Financial Accounts data (i.e. Flow of Funds) is presented in Table (14).

Table 14: RoW - stylized financial balance sheet

Asset	Liabilities
Equity held by RoW (E^R)	RoW bonds (B_R)
Bonds held by RoW (B^R)	RoW mutual funds (MF_R)
Bills held by RoW (b^R)	RoW equity (E_R)
Interbank market net assets (IB)	Other Liabilities (OL_R)
Eurosystem Target 2 balance (TG)	
Other Assets (OA^R)	

As for the assets, Table (14) reports equity, E^R, bonds, B^R, bills, b^R, interbank market positions, IB, and the Eurosystem debits (i.e. Target 2 balances), TG. Liabilities of the RoW sector include bonds, B_R, mutual funds, MF_R, and equity issued by the RoW, E_R. Table (14) also features other financial assets (OA^R) and liabilities (OL_R) held by the sector. Conversely, the stylized financial balance sheet considered in the ITFIN model for the Rest of the World is the following (Table 15):

Table 15: RoW - stylized financial balance in the Model sheet

Asset	Liabilities
Equity issued by Banks (E_B^R)	RoW equity held by Firms (E_R^F)
Bonds issued by Banks (B_B^R)	RoW equity held by ICPMF (E_R^P)
Government bonds (B_G^R)	RoW bonds held by Banks (B_R^B)
Government bills (b_G^R)	RoW bonds held by ICPMF(B_R^P)
Interbank market net assets (IB)	RoW mutual funds held by Households (MF_R^H)
Eurosystem Target 2 balance (TG)	RoW mutual funds held by Banks (MF_R^B)

As for financial assets, these are bank equity, E_B^R, bank bonds, B_B^R, Government bonds, B_G^R, Government bills, b_G^R, interbank market net assets, IB, and the Eurosystem Target 2 balance, TG.[25] The RoW liabilities include RoW equity, E_R^F, and, E_R^P, held, respectively, by firms and ICPMF, RoW bonds, B_R^B, and, B_R^P, held, respectively, by banks and ICPMF and RoW mutual funds, MF_R^H and MF_R^B, held, respectively, by households and banks.[26] The net wealth of the RoW sector, NW_t^R, is computed as financial assets held by the sector net of its liabilities (Eq. (104)):

$$NW_t^R = E_{B,t}^R + B_{B,t}^R + B_{G,t}^R + b_{G,t}^R + IB_t + TG_t - B_{R,t}^B - B_{R,t}^P - E_{R,t}^F - E_{R,t}^P - MF_{R,t}^H - MF_{R,t}^B. \quad (104)$$

Let $NFA_t^{R,M}$ refer to net financial assets of the RoW sector (R) considered in the model (M). Conversely, $NFA_t^{R,NA}$ denotes net financial assets of the RoW sector (R) as drawn from the Financial Accounts. The latter can be expressed as:

$$NFA_t^{R,NA} = NFA_t^{R,M} + [(E_t^R - E_{B,t}^R) + (B_t^R - B_{B,t}^R - B_{G,t}^R - b_{G,t}^R) - (E_{R,t} - E_{R,t}^F - E_{R,t}^P) - (B_{R,t} - B_{R,t}^B - B_{R,t}^P) \\ - (MF_{R,t} - MF_{R,t}^H - MF_{R,t}^B)] + OA_t^R - OL_{R,t}. \quad (105)$$

3.6.2 Model Closures

For each asset and liability included in Eq. (105) we employ a behavioural equation to model the corresponding decision of the Rest of the World on the amount of it to hold every period. Conversely, the amount of Eurosystem debts, TG_t, is modelled as follows:

$$\Delta(TG_t) = \Delta(B_{R,t}^B) + \Delta(B_{R,t}^P) + \Delta(E_{R,t}^F) + \Delta(E_{R,t}^P) + \Delta(MF_{R,t}^H) + \Delta(MF_{R,t}^B) - \Delta(E_{B,t}^R) - \Delta(B_{B,t}^R) + \\ - \Delta(B_{G,t}^R) - \Delta(b_{G,t}^R) - \Delta(IB_t) + NL_t^{R,M} + SFA_t^{R,M}. \quad (106)$$

[25] By assuming that the Rest of the world holds the equity issued by Italian bank we include incoming FDI in the model, although, admittedly, we do not distinguish between foreign direct investments and portfolio equity investments.

[26] In line with what envisaged for the other sectors, the pattern of assets and liabilities held by the Rest of the world sector is determined by the evolution of their market prices and the saving and portfolio decisions taken in all sectors of the economy.

3.6.3 Main modelling features

In ITFIN, the trade balance of the Italian economy is a key transmission channel that contributes to the propagation of shocks to financial and non-financial variables. In particular, it affects the firms sector in terms of output of the market sector (the value added, VA_t^m) and, on the other hand, the trade balance constitutes a component of the Net Lending of the RoW. As for imports, IM_t, their long-run pattern is modelled through a relationship between imports, exports, EX_t, and domestic demand, Dem_t.[27] In the short run, imports are determined by exports themselves and by an index of production prices of foreign manufacturing products expressed in euro, PPI_t^R (Eq. (107)):

$$\Delta \log(IM_t) = \beta_0 - \beta_1 \left[\log(IM_{t-1}) - \beta_2 \log(EX_{t-1}) - \beta_3 \log(Dem_{t-1})\right] + \\ + \beta_4 \Delta \log(PPI_t^R) + \beta_5 \Delta \log(EX_t) + \beta_6 \Delta \log(Dem_t) + u_t. \quad (107)$$

As for exports of goods and services, these are estimated as follows (Eq. (108)):

$$\Delta \log(EX_t) = \beta_0 - \beta_1 \left[\log(EX_{t-1}) - \beta_2 \log(WD_{t-1} \cdot PPI_{t-1}^{R,fc}) + \beta_3 \log(\mathcal{E}_{t-1})\right] + \\ + \beta_4 \Delta \log(WD_{t-1} \cdot PPI_{t-1}^{R,fc}) - \beta_5 \Delta \log(\mathcal{E}_t) + u_t. \quad (108)$$

In the long run (the lagged log-levels of) exports are modelled as a function of (log of) the nominal effective exchange rate, $\mathcal{E}_t$, and of World demand, WD_t, expressed in nominal terms by multiplying it with an index of production prices of foreign manufacturing products expressed in foreign currency, $PPI_t^{R,fc}$.[28] These two variables further affect exports in the short run. Not surprisingly, an increase in the nominal exchange rate, which represents here an appreciation of the euro, has a negative impact on exports. In ITFIN, the nominal effective exchange rate in the sector is modelled as follows (Eq.(109)):

$$\Delta_4 log(\mathcal{E}_t) = \beta_0 - \beta_1 \left[log(\mathcal{E}_{t-4}) - \beta_2 \log\left(1 + \frac{NL_{t-4}^R}{TA_{t-4}^R}\right)\right] + \beta_3 \Delta_4 log(\mathcal{E}_{t-1}) - \beta_4 i_{t-4}^R + u_t. \quad (109)$$

We assume that the Net Lending of the RoW sector (NL_t^R) is equal to the sector profits

[27] The latter is defined, in line with Eq. (86), as follows: $Dem_t = C_t + C_t^G + I_t^F + I_t^H + I_t^G + \Delta Inv_t$.

[28] In computing the World demand, WD_t, the weights reflect the incidence of imports of Italian products across different destination countries.

(Π_t^R) minus dividends paid on equity issued by the Rest of the World ($Div_{R,t}$) and interest paid by foreign mutual funds ($i_{R,t}^{MF} MF_R$) (Eq.(110)):

$$NL_t^{R,M} = \Pi_t^R - Div_{R,t} - i_{R,t}^{MF} MF_{R,t-1}. \tag{110}$$

In turn, profits of the RoW are characterized as follows (Eq.(111)):

$$\Pi_t^R = (IM_t - EX_t) + i_t^{G,10Y} B_{G,t-1}^R + i_t^{G,12m} b_{G,t-1}^R + i_{B,t} B_{B,t-1}^R + r_t^{B,3m} IB_{t-1} + Div_{B,t}^R - i_t^R B_{R,t-1}^P. \tag{111}$$

The first component of the profit function is the negative of the Italian trade balance. Positive components of the above expression refer to interest payments received by the RoW for holding a variety of credit instruments issued by agents that are resident in Italy and to dividends on stocks issued by companies based in Italy. Specifically, interest payments pertain to the following assets held by the RoW sector, each featuring a corresponding interest rates: Italian Government bonds ($i_t^{G,10Y} B_{G,t-1}^R$) and Government bills ($i_t^{G,12m} b_{G,t-1}^R$) and bonds issued by banks based in Italy ($i_{B,t} B_{B,t-1}^R$). Moreover, we include interest payments arising from the interbank market ($r_t^{B,3m} IB_{t-1}$), since RoW includes, of course, the foreign banking sector. As for dividends ($Div_{B,t}^R$), they are associated with the amount of stocks held by the Rest of the World. The negative components of profits include interest flows paid on bonds outstanding that have been issued by the sector ($i_t^R B_{R,t-1}^P$). Let us now consider interest payments made by foreign mutual fund management companies in favor of sectors investing in foreign mutual funds ($i_{R,t}^{MF} MF_{R,t-1}$). In our model, the flow of interests paid by the RoW on its mutual funds ($MF_{R,t-1}$) is channeled to the sectors holding them, namely households and banks. These interest payments are set on the basis of positive flows of interests on other assets, weighted through the share of mutual funds issued by the sector over the total liabilities of the sector $\left(\frac{MF_{R,t-1}}{TL_{R,t-1}}\right)$.

3.7 Central Bank

3.7.1 National accounting and model accounting

A stylized financial balance sheet for the Central Bank which would fully reproduce the information of the Flow of Funds data is presented in Table (16).

In the model, Central Bank assets are government bonds, B_G^{CB}, and bank refinancing, RO, while liabilities include the reserves of the banking sectors, R. Moreover, we include the claims and liabilities of Italian central banks vis-à-vis the ECB that arise from cross-border

Table 16: Central Bank - stylized financial balance sheet

Asset	Liabilities
Gold	Banknotes
Assets in foreign currency	Liabilities in foreign currency
Bank refinancing (RO)	Liabilities with Banks (R)
Bonds generated by QE (B_G^{CB})	Eurosystem Target 2 balance (TG)
Bank portfolio	Other Liabilities (OL_{CB})
Eurosystem credits	Capital and reserves
Other Assets (OA^{CB})	

payment flows executed through TARGET2. The total TARGET claims netted against total TARGET liabilities are the TARGET2 balances, TG. Positive values represent a net claim of the Italian central bank on the ECB and negative values a net liability. The Central Bank does not retain profits arising from interest payments on refinancing operations and government bond holdings, as these profits are paid off to the fiscal authority and contribute to the reduction of government deficit.

Table 17: Central Bank - stylized financial balance in the Model sheet

Asset	Liabilities
Bank refinancing (RO)	Reserves of the banking sectors (R)
Government bonds held by Central Bank (B_G^{CB})	Eurosystem Target 2 balance (TG)

Conventional monetary policy, treated as exogenous, is conducted by the ECB which sets the policy rate. Unconventional monetary policy is instead conducted by the Bank of Italy by buying bonds through the asset purchase programmes and through longer-term bank refinancing operations. The amount of these transactions is exogenously determined in the model. The change in Target 2, TG, is driven by the balance of payments and the net holding of foreign assets. Net financial assets of the Central Bank (CB) are, therefore, defined as follows in the model:

$$NFA_t^{CB} = \left(RO_t + B_{G,t}^{CB}\right) - \left(TG_t + R_t\right), \tag{112}$$

We characterize the net lending of the CB through the following expression:

$$NL_t^{CB,M} = i_{RO,t} RO_{t-1} + i_t^{G,10Y} B_{G,t-1}^{CB} - i_{R,t} R_{t-1} - Retr_t^{CB}, \tag{113}$$

where we take into account that the income from interest-bearing assets held by the Central bank (against the banknotes in circulation and deposit liabilities to banks) is transferred to the government.[29] The income of the CB transferred to the government is modelled with the following specification:

$$\Delta \log Retr_t^{CB} = \beta_0 - \beta_1 \Big(\log Retr_{t-1}^{CB} - \log i_{t-1}^{G,10Y} B_{G,t-2}^{CB} \Big) + u_t, \tag{114}$$

where a long-run relationship is established between the profits of the Central Banks and the value of revenues for holding government bonds, obtained as the product between the value of government securities held by the Central Banks, $B_{G,t}^{CB}$, and the interest rate on the stock of public debt, $i_t^{G,10Y}$. As we have

$$NFA_t^{CB} = NFA_{t-1}^{CB} + NL_t^{CB} + SFA_t^{CB}, \tag{115}$$

the stock-flow consistency for the Central Bank is achieved in model simulation by treating SFA_t^{CB} as endogenous and setting it as:

$$SFA_t^{CB} = \Delta NFA_t^{CB} - NL_t^{CB}. \tag{116}$$

4 Model properties in monetary and fiscal policy simulations

This section is devoted to the evaluation of the ITFIN model as a whole by constructing alternative scenarios in which counterfactual hypotheses are adopted along specific dimensions and shocks are imparted to selected exogenous variable.

[29] Whilst income of the Central bank is transferred to the government, we do not force $NL_t^{CB,M}$ to be zero for two reasons: first, data on $NL_t^{CB,M}$ from institutional accounts are not available and those from financial accounts indicate that it is different from zero. Second, as elucidated in section 3.1.3, due to lack of granular data, the variable we use for $Retr_t^{CB}$, not only refers to income of the Central bank transferred to the government but also to dividends paid to the government originating from state-owned equity investments.

4.1 A baseline scenario

In order to validate the model, we need to assess whether its properties are sensible. We do so in this section through an impulse response analysis for a variety of different shocks. Preliminary to this, we have conducted a baseline simulation of a reference scenario. The latter has been simulated for eleven years (44 quarters) following the estimation period, which was 2000:q1-2019:q4. To be more precise, in order to exploit all information from actual data which was available to us up to 2021:q2, we have forced the simulation outcomes for each variable in the model to exactly match their corresponding pattern of actual available data. This applies to the period 2020:q1 - 2021:q2 while, starting from the subsequent quarter (i.e. since 2021:q3), the simulation was truly out-of-sample up to the end of 2030. The pattern of exogenous variables has been imputed as follows. As for the international exogenous variables, such as world demand, exchange rates, oil price, US stock index and the Euro-area monetary policy rates (conventional monetary policy), we have used consensus forecasts available when the simulation was conducted (late 2021). The latter were broadly consistent with those utilized for drafting the most recent official economic and financial document available at that time (NADEF, "Update to the Economy and Finance Document", Ministry of the Economy and Finance, October 2021). As for the exogenous fiscal variables, such as implicit tax rates for different government revenue sources and various aggregates of government expenditure, we have assigned values to them that were consistent with unchanged legislation in place and thus with figures used in the most recent public finance official document available in late 2021 (NADEF 2021, cited earlier).

To check whether the baseline simulation outcomes with ITFIN are reasonable, in Figure (7) we compare the simulated pattern of GDP annual growth rate with that of the latest official macroeconomic framework under unchanged legislation available in late 2021 when the simulation was conducted (reported in NADEF 2021). The forecasting horizon of NADEF 2021 spans four years, 2021 - 2024 and the figure shows that ITFIN simulation outcomes seem to be rather sensible in that horizon, as the model-based pattern of GDP growth is broadly consistent with that envisaged in the Government official economic document.

INSERT FIGURE 7

4.2 Quantitative easing and counterfactual scenarios on ECB's Asset Purchase Programmes

Various dimensions of unconventional monetary policy are explicitly considered in ITFIN and the large scale asset purchase programmes of the Central Bank (quantitative easing) play a crucial role in it, especially as to what pertains purchases of sovereign bonds. As we have seen before, in ITFIN the demand for Italian sovereign bonds originates from a number of sectors in the economy, including the Central Bank. The demand for these bonds is endogenous for all sectors apart from one and it is characterized through a specific stochastic equation for each of them. The sole exception is the Central Bank, whose demand for government bonds is assumed to be exogenous. To set unconventional monetary policy in the baseline scenario, we have used information on the stock of bonds that is estimated to be held by the Italian Central Bank throughout the simulation horizon. To do this, we have combined official communication of ECB decisions on the size of the assets purchases programmes with some hypothesis on the pace of these asset purchases and on the extent to which they are oriented towards Italian sovereign bonds. This led us to estimate a stock of Italian sovereign bonds held by the Italian Central Bank amounting to about 450 billions euro at the end of 2019 and rising gradually until March 2022, when the stock held by the Central Bank is expected to reach the value of 800 billions and to remain unchanged since then.

Against the background of our baseline simulation, we have considered two counterfactual scenarios in which net purchases of Italian bonds by the Central Bank are assumed to evolve differently compared to the actual pattern envisaged in the baseline scenario. We have constructed a first counterfactual scenario, in which the net purchases of Italian government bonds follow the pattern which was envisaged before the outbreak of COVID-19. In this scenario, it is therefore assumed that the substantial Pandemic Emergency Purchase Programme (PEPP) was not launched by the ECB, while, on the contrary, it actually was (on March 18th 2020). Under this scenario, positive net purchases are made throughout both 2020 and 2021 but with a stop since 2022:q1, so that the stock of Italian sovereign bonds held by the Central Bank reaches the value of 520 billions euro in 2021:q4 and stays unchanged since then. Hence, in this scenario the stock of bonds held by the Central Bank increases at a lower rate in the years 2020 and 2021 compared to the baseline scenario and reaches a level that, since 2022:q1, is 280 billions lower in every quarter.

We have also considered a second counterfactual scenario on the stance of quantitative easing by the monetary authority. This scenario implies a downward shift in the demand for governments bonds by the Central Bank that is even stronger than that envisaged in the first scenario. In particular, the counterfactual hypothesis features a pattern of net asset sales of government bonds since 2021:q1. The pace of these net sales is such that the stock of 450 billions euro held by the central bank at the end of 2019 gradually declines, reaching slightly more than 150 billions at the end of 2029.

In Figure (8) we show the pattern over time (from 2020 to 2030) of the stock of Italian government bonds held by the Bank of Italy under the three scenarios: the baseline scenario, the first counterfactual scenario, where the PEPP programme is excluded so that the stop in net asset purchases would occur at the end of 2021, and a more critical counterfactual scenario with positive net asset sales since the beginning of 2021.

INSERT FIGURE 8

We now examine how the simulation outcomes differ across the three scenarios, that is the baseline and the two counterfactual scenarios. The simulation horizon spans several years up to 2030. Let us focus first on the spread between interest rates on Italian and German sovereign 10-year bonds as well as on the deficit-to-GDP and debt-to-GDP ratios (see Figure 9). To gauge the implications for the economy of these counterfactual scenarios on the quantitative easing, we emphasize first how the latter imply a downward shift of different size in the demand for government bonds (with respect to the baseline scenario) and this induces a rise in the sovereign spread. The model predicts that, with these downward shifts in bonds demand, at the end of 2021 the endogenous sovereign spread would increase, with respect to the baseline scenario, by about 120 basis points (bp) in the first counterfactual scenario and by slightly more than 130 bp in the second. At the end of 2022, the spread would be higher by about 130 and 160 bp in the first and second scenario, respectively. As for the subsequent years, in the first scenario the spread would remain above the corresponding baseline value by a slightly increasing amount that almost reaches 130 bp at the end of 2030. In the second scenario, the spread increases by more and equals about 360 bp at the end of the simulation horizon without reaching a plateau level. The multi-panel Figure (9) also documents how the counterfactual scenarios on the stance of quantitative easing affect the indicators of public finance. Both deficit-to-GDP ratio and debt-to-GDP ratio exhibit a worsening with respect to the baseline scenario. As for the former, the divergence with respect to the baseline scenario manifests itself at the end of 2020 and increases over the years. This holds true for both counterfactual scenarios, although the second one systematically features a higher value of the deficit-to-GDP ratio which, at the end of the horizon, is about 3.1 percentage points larger than that of the baseline scenario. In the first scenario the divergence with the baseline scenario increases over time and reaches about 1.4 percentage points at the end of the horizon. Similar findings emerge for the debt-to-GDP ratio, whose patterns exhibit an increasing divergence between those of the counterfactual scenarios and that of the baseline scenario.

In Figure (10) we document how the pattern of the main macroeconomic aggregates diverges from that of the baseline scenario under each of the two counterfactual scenarios on the pace of asset purchase programmes of the Central Bank. A contractionary impact on output and the rest of the economy is detected in both counterfactual scenarios, although the effects are stronger in the second one. In the top-left panel, we see how GDP declines in both scenarios with respect to the baseline.[30] In the first counterfactual scenario, GDP is lower in the medium run by about 0.6 percentage points and by 0.3 at the end of the horizon. The impact on GDP takes several periods to materialize in a visible fashion because, in the initial quarters, the gap between the stock of government bonds held by the central bank in the baseline and in the counterfactual scenario is not particularly large and, on the other hand, agents' decisions in the model do not anticipate future expected developments. In the second scenario, GDP is lower by an increasing amount, that reaches 0.9 percentage points at the end of the horizon. Not surprisingly, the impact on GDP displays no tendency to fade out as, in this scenario, net sales of government bonds continue to be executed by the central bank at the end of the simulation horizon. As for the unemployment rate, it does increase in both counterfactual scenarios relatively to the baseline as it is documented in the bottom-right panel. In the first scenario, it would reach, in 2024, a level which is about 0.8 percentage points higher than that in the baseline, with this divergence remaining roughly invariant since then. On the contrary, in the second scenario, the unemployment rate increases by more and its deviation from the unemployment rate in the baseline scenario becomes larger and larger. In the other two panels we see how private consumption and total investment decline with respect to the baseline scenario when the counterfactual scenarios on the pace of QE are envisaged. Let us quickly review the transmission mechanisms at work in the model that lie behind the patterns documented in Figure (10). An important channel through which the rise of the spread transmits its effects to economic activity deals with a decline of employment and, thereby, of total labor compensations, which drives down private consumption. We recall that this mechanism originates from the negative, structural relationship in ITFIN between asset prices and the unemployment rate which draws on the analyses by Farmer (2011, 2013), Phelps (1999) and Phelps and Zoega (2001). Moreover, a relevant bank channel operates in the model in the aftermath of a downward shift in sovereign bonds. In particular, as the spread on interest rates rise, the market value of Italian bonds goes down and so does bank equity. The capital position of banks deteriorates and this contributes to an increase in the cost of bank financing. This induces banks to raise interest rates on loans, with contractionary effects on credit and investment (Brunnermeier et al. (2016)). Moreover, if NPLs were to rise, this would amplify the worsening of banks'

[30] It is important to emphasize that the model does not feature equations for prices and the latter, including the GDP deflator, are treated as exogenous variables. Thus, the response of GDP to any shock is the same in the model for nominal and real GDP. This holds true also for the other macroeconomic aggregates (consumption, investment, etc).

capital position further. To inspect the mechanisms in more detail, we report in Figure (11) the patterns of several interest rates that are relevant for the banking sector and compare their pattern in the baseline scenario with that in one of the two counterfactual scenarios (the second one, more extreme than the first). The figures show that, no matter which financial instrument we consider, whether it be a bank asset or liability, interest rates are at a higher level compared to the baseline scenario. Given the importance in ITFIN of assets and liabilities held by each institutional sector, we also document, for both the banking and the household sector, the pattern over time of some of their most relevant assets and liabilities (see, respectively, Figures 12 and 13). Among the notable features from the two figures, we point to the higher amount, with respect to the base scenario, of government bonds held by banks and households under the counterfactual hypothesis of quantitative easing tapering. Parallel to this, bank loans and mortgages in general, including those to households, decline relatively to the reference scenario. The market value of bank equity also goes down compared to the baseline scenario. Finally, we document in Figure 14 the reduction of bank loans to firms and, interestingly enough, the invariance in the stock of NPLs with respect to the baseline scenario. We now examineother properties of the model by focusing on the macroeconomic response to various types of fiscal policy shocks. Differently from the alternative scenarios on quantitative easing that we have examined thus far, shifts in government purchases and public investment directly impinge on aggregate demands and, thereby, on output.

INSERT FIGURE 9

INSERT FIGURE 10

INSERT FIGURE 11

INSERT FIGURE 12

INSERT FIGURE 13

INSERT FIGURE 14

4.3 The macroeconomic response to fiscal policy shocks of different type

In this section, we focus on a number of fiscal policy impulses of different sources and analyze the macroeconomic dynamic response to each of them as predicted by ITFIN model. The policy shifts we consider are the following: 1) an increase of government purchases; 2) an increase of public investments, and 3) a reduction of the tax rate on household income. In all cases, the expansionary shocks are permanent and, in order to ensure comparability of the responses across types of shock, their size is uniform. In particular, the yearly permanent shock to both government consumption and public investments amounts to one per cent of the value of nominal GDP of 2020. In the third scenario, that of a tax cut, we engineer a reduction of the implicit tax rate on household income so as to generate an ex-ante drop of tax revenues equal, every year, to one per cent of the value of nominal GDP in 2020. Importantly, these expansionary interventions are not accompanied by a parallel increase of taxes or reduction in public expenditure, so that their funding implies an ex-ante equal increase of public deficit. Table (18) reports the impact on GDP with respect to the baseline scenario of each of the three expansionary fiscal policy impulses and the figures are thus time-varying fiscal multipliers. Perhaps not surprisingly, public investments exhibit the highest values of fiscal multipliers: the effect at impact is 0.9 and it increases up to 1.4 in the third year. Since then it gradually declines, reaching 0.8 in the last year. The impact of public consumption is also substantial, albeit below unity in all periods. As for the tax rate cut, the effect of it is weak in the first year (0.3) but it becomes larger in the subsequent years, reaching the value of 0.5 in the third year.

Table 18: Dynamic fiscal multipliers by type of shock

	year									
	1	2	3	4	5	6	7	8	9	10
Government consumption	0.7	0.8	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.4
Public investment	0.9	1.2	1.4	1.3	1.2	1.1	1.0	0.9	0.9	0.8
Tax rate on household income	0.3	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3

The table reports the response of GDP to each fiscal shock. Figures are percentage deviations from the baseline scenario.

In Multi-panel Figure (15) we report the dynamic impact of each policy shock on the sovereign spread as well as on the two main indicators of public finance, that is the deficit-to-GDP and the debt-to-GDP ratio.

In all scenarios, the spread systematically increases with respect to the reference scenario but to a limited extent. After the first three years, the increase of the spread compared to the baseline is small and ranges between about 3 and 8 basis points depending on the type of the shock. At the end of the horizon sample, the spread is higher than in the baseline scenario by about 30 to 40 basis points. The effect on the spread is,in general, lower in the case of an increase of public investments than for the other two shocks because the stronger is the expansionary effect on output of the fiscal shock, the smaller is the increase of the spread.

Compared to the baseline scenario, there is, of course, a worsening in the pattern of the deficit-to-GDP ratio, whose increase, however, is lower in absolute value than the ex-ante increase (equal to one percentage point). Moreover, differences across shocks in the impact on deficit-to GDP ratio do not seem to be remarkable. As for the debt-to-GDP ratio, in the initial years of the simulation sample, the shock to public investment and government consumption seem to reduce, rather than increase, the debt-to-GDP ratio with respect to the baseline. In the case of a shift in government consumption shift, however, since 2023 the ratio has become higher than the corresponding baseline level and the deviation has risen over time. The same holds true for public investment also but since 2025.

INSERT FIGURE 15

For all the three fiscal impulses, the response of GDP with respect to the baseline scenario is hump-shaped, although output seems to revert back to baseline rather gradually (see Figure 16). The response of GDP to shocks to public investment and government purchases is rather similar in the first year but the former becomes more expansionary since then. Shocks to government consumption and public investment are less expansionary for private consumption and more so for business investments. Focusing on private consumption, perhaps not surprisingly, the most expansionary shift is the cut of tax rates on household incomes for its positive direct effect on disposable income. The consumption response to the other two types of fiscal expansions is less strong and is even slightly negative in the final years of the simulation in the case of shock to government purchases. As for the response of total investment with respect to the baseline, the particularly strong response of total investments in the case of a shock to public investments comprise both the shock itself to public investments, which are, of course, part of total investment, and the positive response of private investment. The response of total investment to a cut in tax rates on household income is slightly positive in the first three years but it becomes negative thereafter. To understand these patterns, let us also focus on the response of unemployment. As Figure

(16) documents, following a tax cut on household income, the unemployment rate is systematically below the corresponding level of the baseline scenario. In the aftermath of the other two shocks (public investment and government consumption), the unemployment rate slightly declines with respect to the baseline scenario in the early stages of the simulation horizon and, in the medium run, the effect is positive although particularly small in size. Indeed, the rise of the spread following the expansionary fiscal shocks tends to increase unemployment with respect to the baseline. However, for the cut in tax rates on household income, the effect on unemployment of the higher spread is more than compensated by an opposite one: the cut in tax rates on household income drives down the tax wedge on labor and, thereby, the unemployment rate. On the other hand, the effects on investment expenditure of a cut in tax rates on household income are rather limited because the subsequent increase of overall labor compensations (wage bills) with respect to the baseline negatively impinge on firms' profits.

5 Conclusions

We have documented in the paper how sovereign risk tensions arise endogenously in our stock-flow consistent model through shifts in the demand for government bonds by one or more sectors and/or through shifts in their supply induced by changes in the stance of budgetary policy. In the model we have devised mechanisms that generate nonlinearity in the way investors'decision to hold governments bonds is taken. In particular, for relatively low levels of interest rates on sovereign bonds, a rise in those rates induces investors to demand a higher amount of these assets. However, through proper estimation methodologies, we have uncovered in the data the presence of a bend in the, otherwise standard, downward sloping curve of demand for government bonds by several sectors. Thus, we find that - above a certain threshold of interest rates - a rise of them induces investors to reduce, rather than increase, the amount of demand for these bonds.

Against this backdrop, the overall credit and financial side of the economy is modelled in great details and it provides several important channels through which financial and non-financial shocks propagate to the economy. Importantly, this allows us to characterize, among other things, the interplay between sovereign risk, banks'capital position and availability of credit in the economy. As we elucidate in the paper, the framework envisaged in ITFIN is well suited to analyse on quantitative grounds issues that are extremely relevant for policy makers. We emphasize here only a few of the numerous issues which have been addressed in the paper: a) assessing the effects on sovereign risk of the QE policy enacted by the central bank; b) evaluating the implications for banks' balance sheets of tensions in the sovereign bond market; c) investigating the determinants of NPLs' pattern as well as their effect on banks' credit decisions; d) establishing how departures from fiscal discipline on the part of the government may trigger a rise of the sovereign spread.

In ITFIN, all these aspects can be analyzed in a framework where the accumulation of assets and liabilities by each sector of the economy is modelled in detail and originates from both price revaluations and financial flows associated to decisions on saving and portfolio allocation. As elucidated in detail, our modelling strategy in ITFIN imposes consistency in every sector of the economy between stocks and flows.

As for the properties of the model, among other things, we have shown in the paper how QE tapering may lead to contractionary effects in the economy with respect to a reference scenario that features ECB's asset purchases in line with actual decisions of the Governing council. In doing so, we have inspected the numerous transmission mechanisms associated with these counterfactual scenarios that explain the different macroeconomic patterns as compared to the base scenario. Moreover, we have appraised the macroeconomic response to fiscal policy, showing that it depends substantially on the type of impulse imparted (public investment, government purchases, tax rates on household income).

References

Albertazzi, U., T. Ropele, G. Sene, and F. M. Signoretti (2014): "The impact of the sovereign debt crisis on the activity of Italian banks," *Journal of Banking & Finance*, 46, 387–402.

Angelini, P., G. Grande, and F. Panetta (2014): "The negative feedback loop between banks and sovereigns," *Bank of Italy Occasional Paper*.

Battistini, N., M. Pagano, and S. Simonelli (2014): "Systemic risk, sovereign yields and bank exposures in the euro crisis," *Economic Policy*, 29, 203–251.

Bezemer, D. J. (2010): "Understanding financial crisis through accounting models," *Accounting, organizations and society*, 35, 676–688.

Bofondi, M., L. Carpinelli, and E. Sette (2018): "Credit supply during a sovereign debt crisis," *Journal of the European Economic Association*, 16, 696–729.

Brainard, W. C. and J. Tobin (1968): "Pitfalls in financial model building," *The American Economic Review*, 58, 99–122.

Brunnermeier, M. K., L. Garicano, P. Lane, M. Pagano, R. Reis, T. Santos, D. Thesmar, S. V. Nieuwerburgh, and D. Vayanos (2016): "The Sovereign-Bank Diabolic Loop and ESBies," *American Economic Review: Papers and Proceedings*, 106, 508–512.

Burgess, S., O. Burrows, A. Godin, S. Kinsella, and S. Millard (2016): "A dynamic model of financial balances for the United Kingdom," Tech. rep., Bank of England Staff Working Paper No. 614, September.

Byrialsen, M. R. and H. Raza (2022): "Household debt and macroeconomic stability: An empirical stock-flow consistent model for the Danish economy," *Metroeconomica*, 73, 144–197.

Calvo, G. A. (1988): "Servicing the public debt: The role of expectations," *The American Economic Review*, 647–661.

Canelli, R., G. Fontana, R. Realfonzo, and M. V. Passarella (2021): "Are EU policies effective to tackle the Covid-19 crisis? The case of Italy," *Review of Political Economy*, 33, 432–461.

Cole, H. L. and T. J. Kehoe (2000): "Self-fulfilling debt crises," *The Review of Economic Studies*, 67, 91–116.

Corsetti, G., K. Kuester, A. Meier, and G. J. Müller (2014): "Sovereign risk and belief-driven fluctuations in the euro area," *Journal of Monetary Economics*, 61, 53–73.

De Grauwe, P. and Y. Ji (2012): "Mispricing of sovereign risk and multiple equilibria in the Eurozone," Tech. rep., CEPS working paper 361.

Diebold, F. X. and C. Li (2006): "Forecasting the term structure of government bond yields," *Journal of econometrics*, 130, 337–364.

Farhi, E. and J. Tirole (2017): "Deadly embrace: Sovereign and financial balance sheets doom loops," *The Review of Economic Studies*, 85, 1781–1823.

Farmer, R. (2011): "Animal Spirits, Financial Crises and Persistent Unemployment," Tech. rep., NBER Working Paper 17137.

——— (2013): "The Stock Market crash really did cause the great recession," Tech. rep., NBER Working Paper 19391.

Favero, C. and F. D. Hendry (1992): "Testing the Lucas critique: A review," *Econometric Reviews*, 11, 265–306.

Fritsche, U. and C. Pierdzioch (2017): "Animal spirits, the stock market, and the unemployment rate: Some evidence for German data," *Economics Bullettin*, 37, 204–213.

Godley, W. (1999): "Seven unsustainable processes," *Special report.*

Godley, W. and F. T. Cripps (1983): *Macroeconomics*, Oxford University Press,UK.

Godley, W. and M. Lavoie (2007): *Monetary economics*, Palgrave Macmillan,UK.

Godley, W., D. B. Papadimitriou, G. Hannsgen, and G. Zezza (2007): "The US Economy Is There a Way Out of the Woods?" *Available at SSRN 1055521.*

Goyal, R., P. K. Brooks, M. Pradhan, T. Tressel, G. Dell'Ariccia, and C. Pazarbasioglu (2013): *A banking union for the euro area*, International Monetary Fund.

Greenwood, R. and D. Vayanos (2014): "Bond supply and excess bond returns," *The Review of Financial Studies*, 27, 663–713.

Gürkaynak, R. S., B. Sack, and J. H. Wright (2007): "The US Treasury yield curve: 1961 to the present," *Journal of monetary Economics*, 54, 2291–2304.

Hatzius, J. (2003): *The private sector deficit meets the GSFCI: a financial balances model of the US economy*, Goldman, Sachs & Company.

Jovanovic, B. and P. L. Rousseau (2001): "Liquidity effects in the bond market," Tech. rep., National Bureau of Economic Research.

Krishnamurthy, A. and A. Vissing-Jorgensen (2011): "The effects of quantitative easing on interest rates: channels and implications for policy," Tech. rep., National Bureau of Economic Research.

——— (2012): "The aggregate demand for treasury debt," *Journal of Political Economy*, 120, 233–267.

Lorenzoni, G. and I. Werning (2013): "Slow moving debt crises," Tech. rep., National Bureau of Economic Research.

Michelena, G. and N. Guaita (2017): "Modelo de stock-flujo consistente para el análisis macroeconómico (sfarg)," *URL: https://doi. org/10.13140/rg*, 2.

Missale, A. and O. J. Blanchard (1994): "The debt burden and debt maturity," *The American Economic Review*, 84, 309–319.

Nelson, C. R. and A. F. Siegel (1987): "Parsimonious modelling of yield curves," *Journal of Business*, 60, 473–489.

Neri, S. (2013): "The impact of the sovereign debt crisis on bank lending rates in the euro area," *Bank of Italy occasional paper*.

Nikiforos, M. and G. Zezza (2017): "Stock-Flow Consistent macroeconomic models: a survey," *Journal of Economic Surveys*, 31, 1204–1239.

Phelps, E. S. (1999): "Behind this Structural Boom: the Role of Asset Valuations," *American Economic Review Papers and Procedings*, 89, 63–68.

Phelps, E. S. and G. Zoega (2001): "Stocks and Jobs: The Valuation of Firms and Business Assets as a Factor in Structural Slumps and Booms," *Economic Policy*, 32, 85–114.

Reinhart, V. and B. Sack (2000): "The economic consequences of disappearing government debt," *Brookings Papers on Economic Activity*, 2000, 163–209.

Taylor, L. (2021): *Reconstructing Macroeconomics*, Cambridge, MA and London, England: Harvard University Press.

Tobin, J. (1969): "A general equilibrium approach to monetary theory," *Journal of money, credit and banking*, 1, 15–29.

Vayanos, D. and J.-L. Vila (1999): "Equilibrium interest rate and liquidity premium with transaction costs," *Economic theory*, 13, 509–539.

Zezza, F. and G. Zezza (2020): "A stock-flow consistent quarterly model of the Italian economy," *Levy Economics Institute, Working Papers Series.*

Zezza, G. (2009): "Fiscal policy and the economics of financial balances," *European Journal of Economics and Economic Policies: Intervention*, 6, 289–310.

Zezza, G. and F. Zezza (2019): "On the design of empirical stock–flow consistent models," *European Journal of Economics and Economic Policies: Intervention*, 16, 134–158.

Zoega, G. (2012): "Employment and asset prices," *Applied Economics*, 44, 3343–3355.

Zoli, M. E. (2013): *Italian sovereign spreads: their determinants and pass-through to bank funding costs and lending conditions*, International Monetary Fund.

Figures

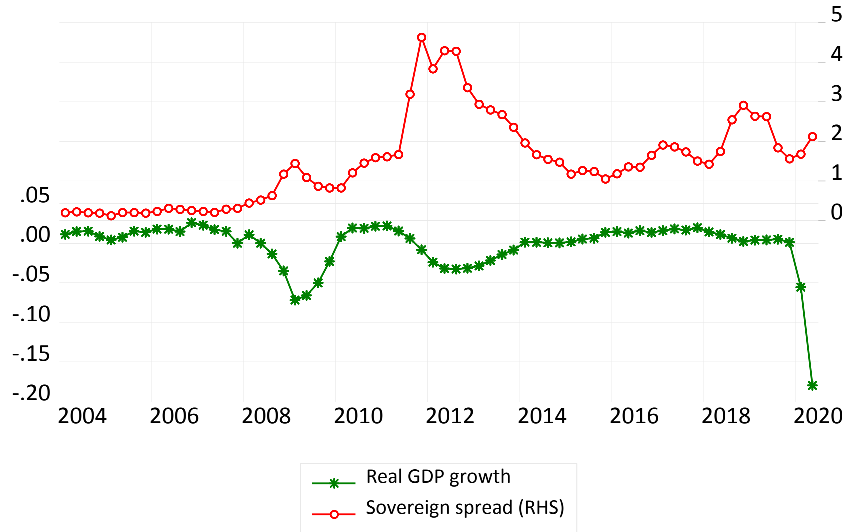

Figure 1: Real Italian GDP growth (left) and Sovereign spread (right) between the 10-year Italian and German bonds

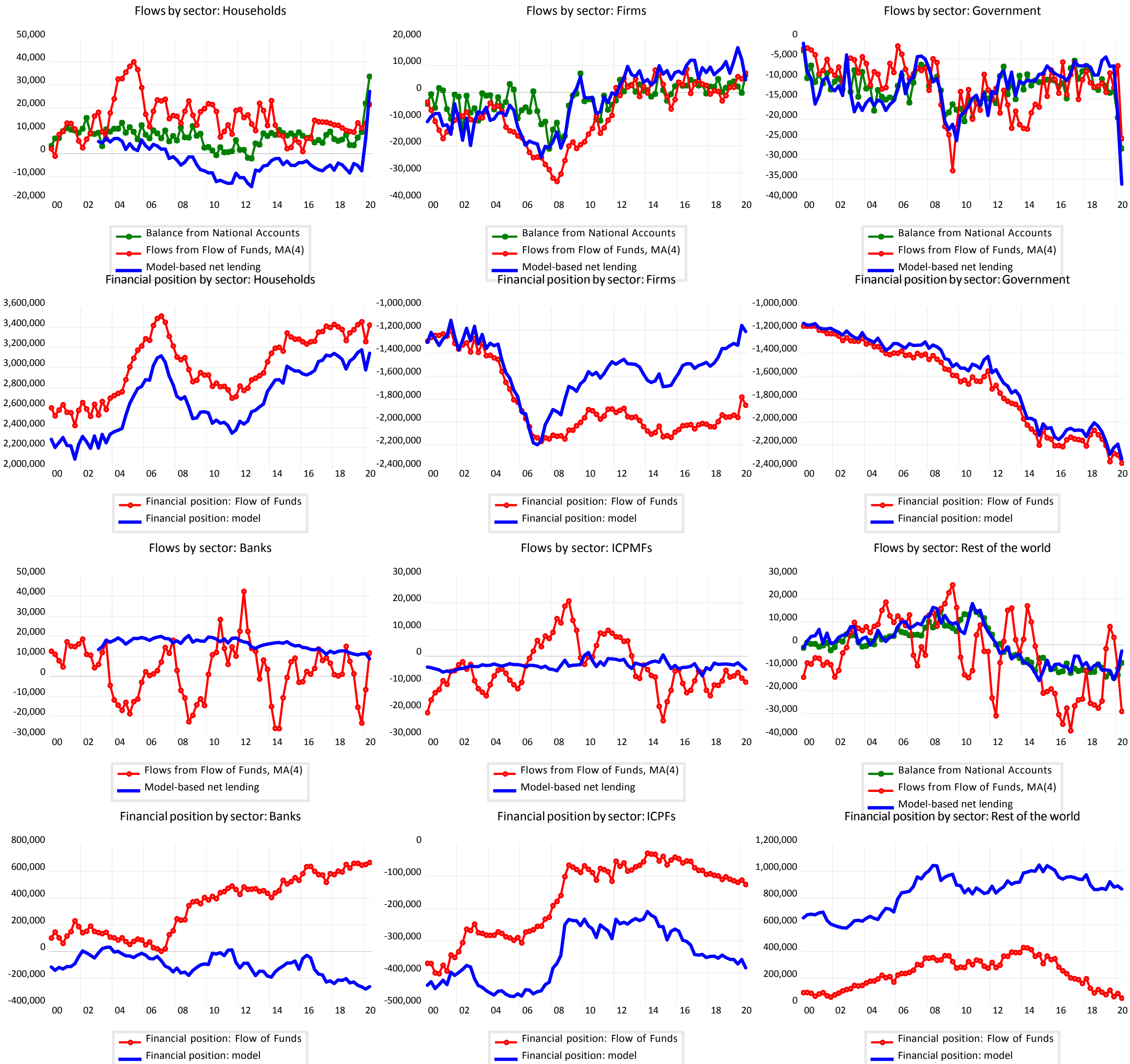

Figure 2: Financial positions and balances by sector in the National Accounts (balance), National Financial Accounts Flow of Funds, (flows), and in the ITFIN model (net lending)

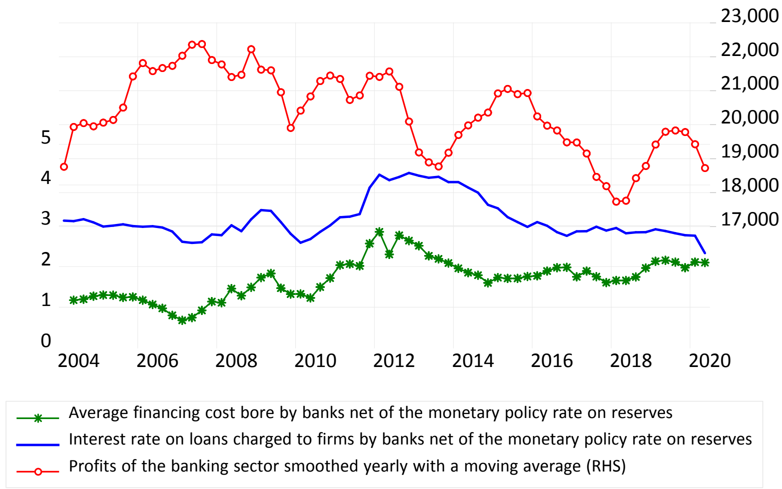

Figure 3: Average financing cost borne by banks interest rates charged to firms

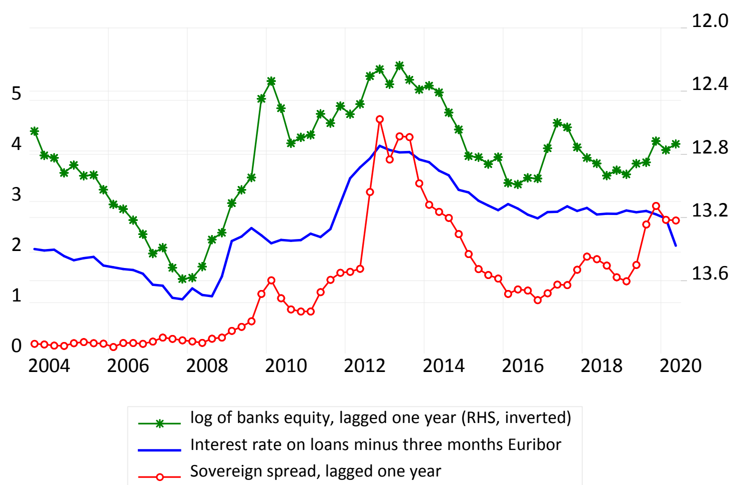

Figure 4: Log of banks equity at market prices and interest rates differentials

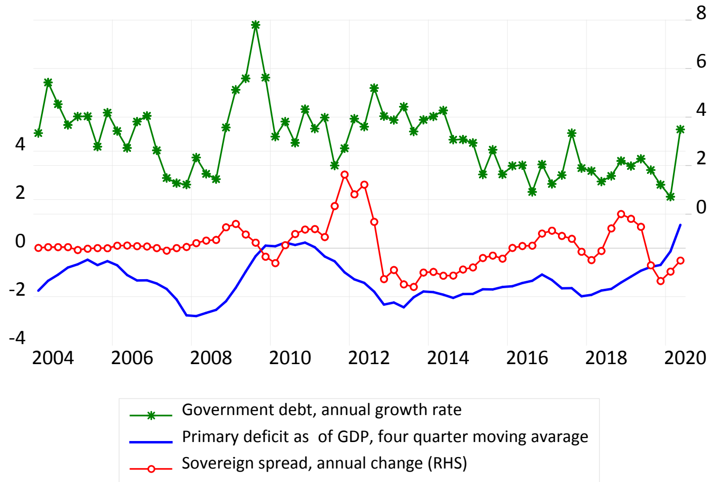

Figure 5: Growth rate of debt and quarterly deficit

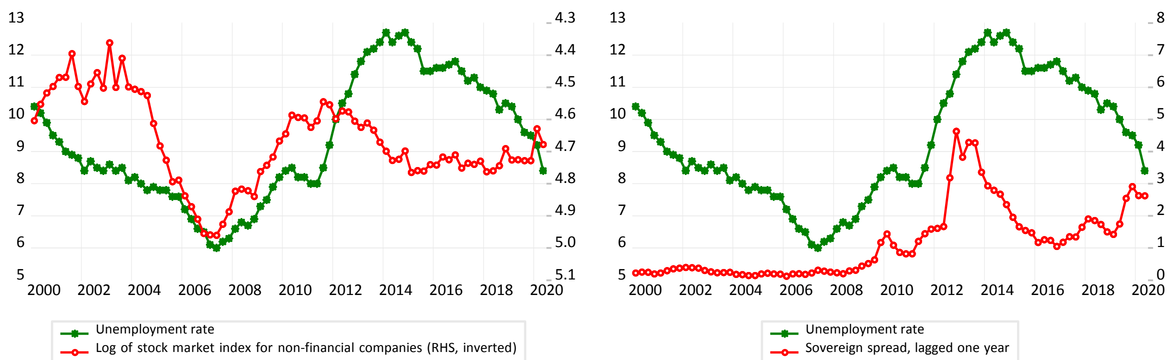

Figure 6: Unemployment rate and financial variables

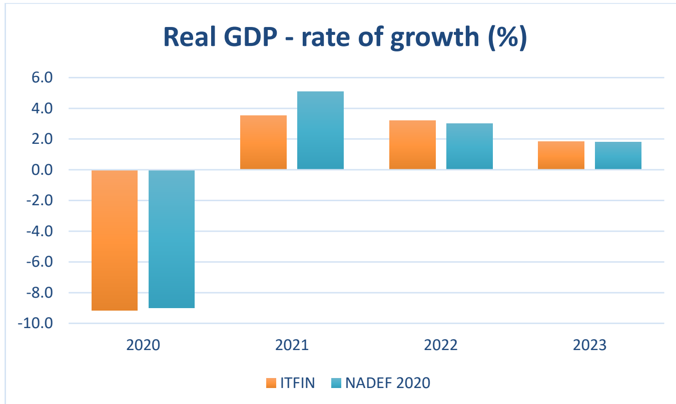

Figure 7: Baseline macroeconomic scenario vs. Official forecasts: Real GDP growth

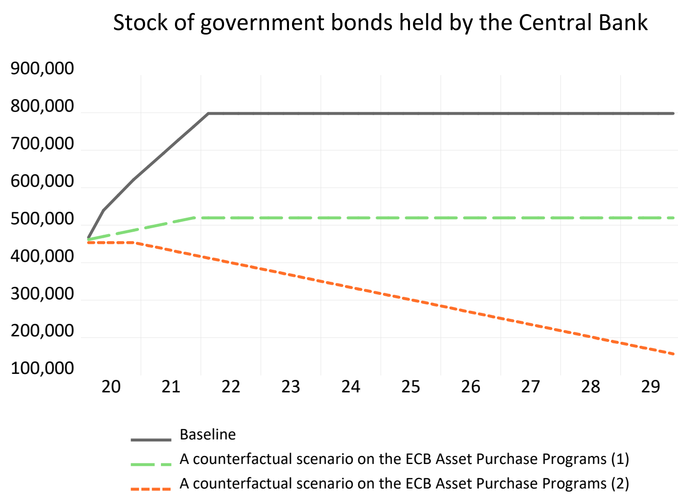

Figure 8: Stock of Italian government bonds held by the Bank of Italy under three scenarios: the baseline scenario, the first counterfactual scenario, where the PEPP programme is excluded so that the stop in net asset purchases would occur at the end of 2022, and a more critical counterfactual scenario with positive net asset sales since the beginning of 2021

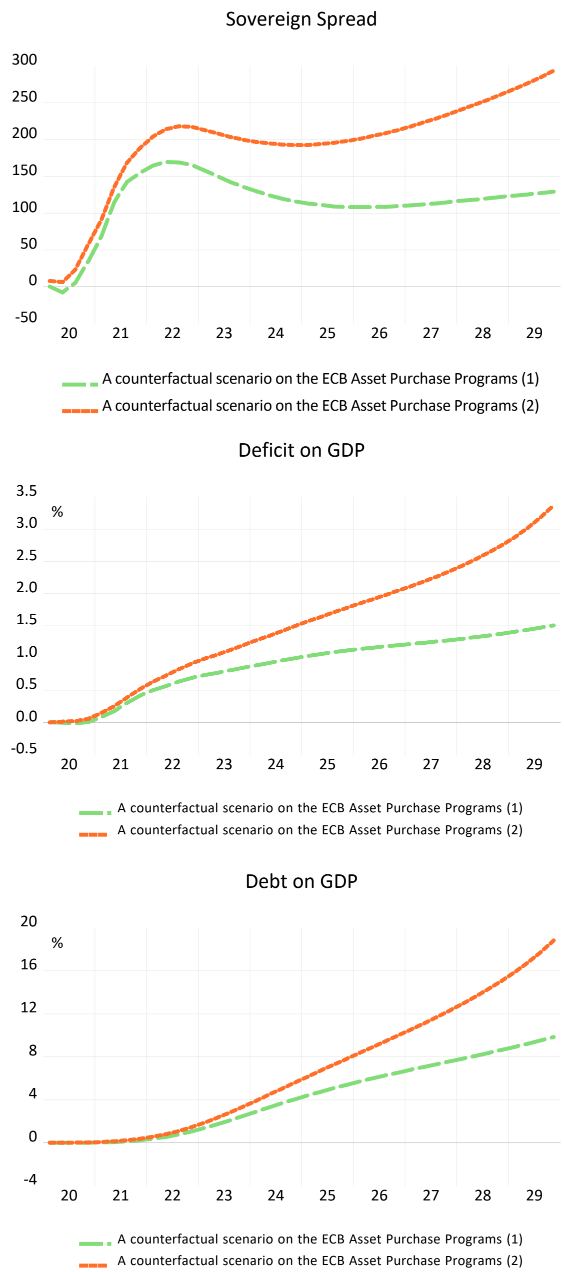

Figure 9: Spread between interest rates on Italian and German sovereign 10-year bonds, deficit-to-GDP and debt-to-GDP ratios in two counterfactual scenarios: Deviation from the baseline scenario

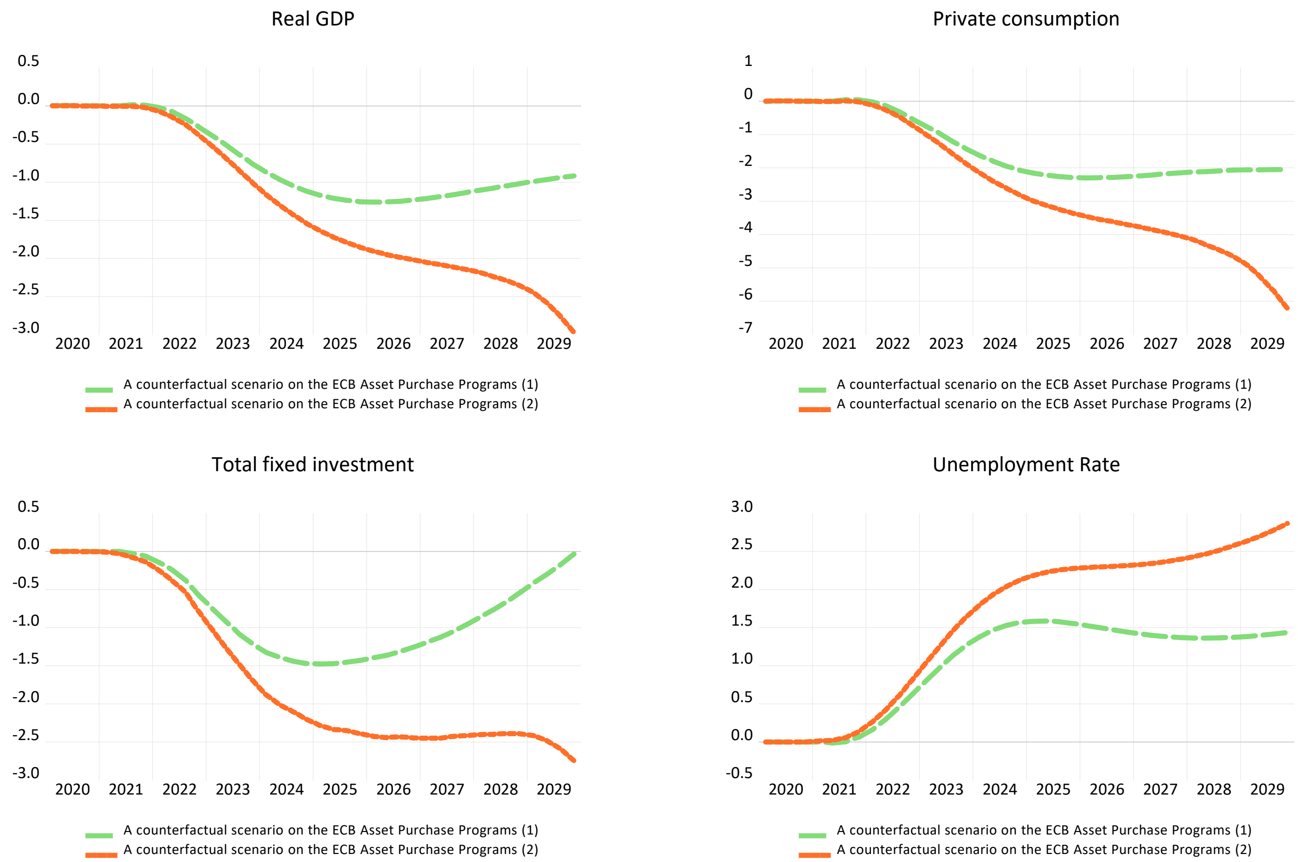

Figure 10: Transmission channels in the two counterfactual scenarios: Macroeconomic aggregates (Percentage points of deviation from the baseline scenario)

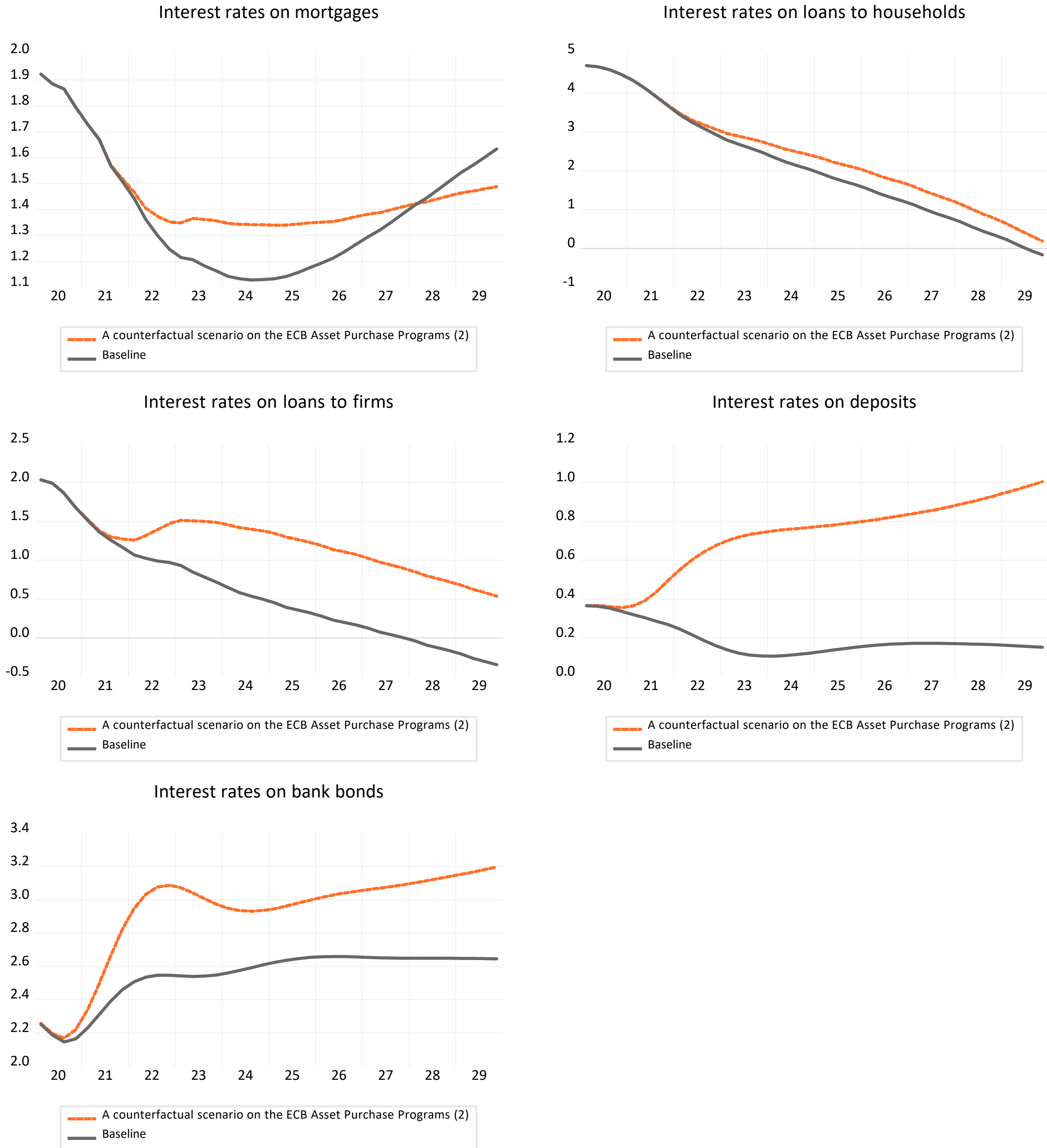

Figure 11: Transmission channels in the two counterfactual scenarios: Relevant Interest Rates for the Banking Sector

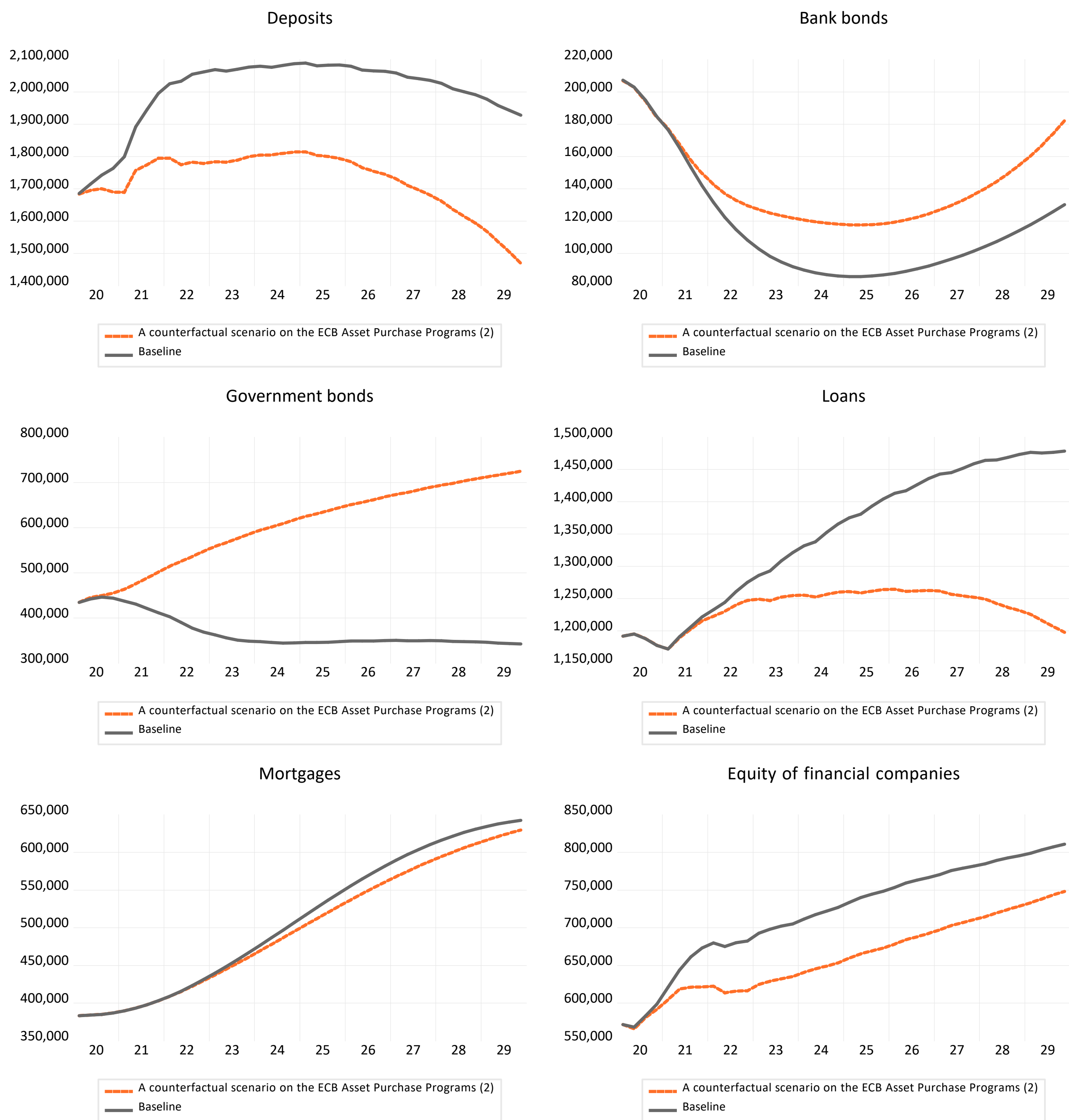

Figure 12: Transmission channels in the two counterfactual scenarios: Assets and Liabilities of the Banking Sector

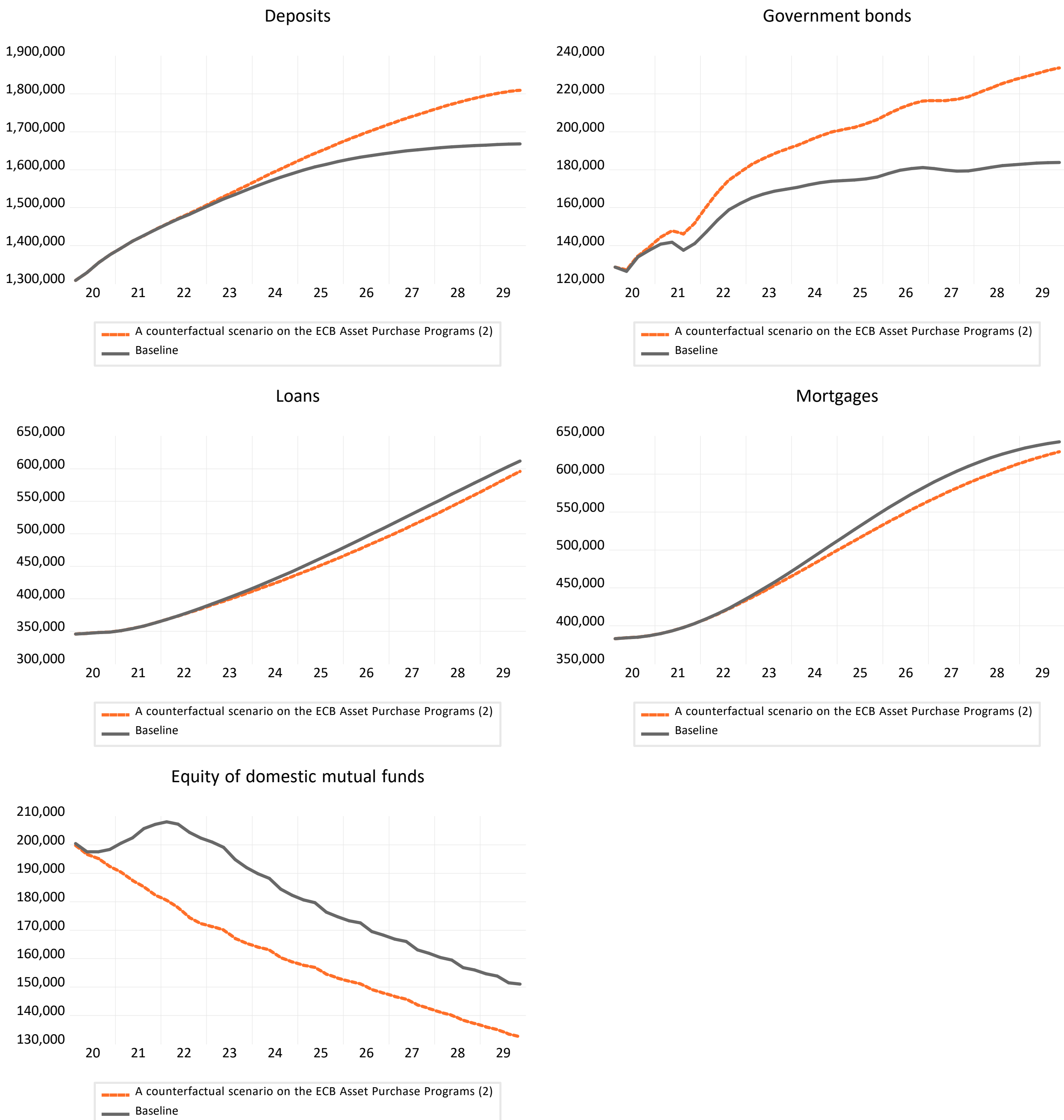

Figure 13: Transmission channels in the two counterfactual scenarios: Assets and Liabilities for the Household Sector

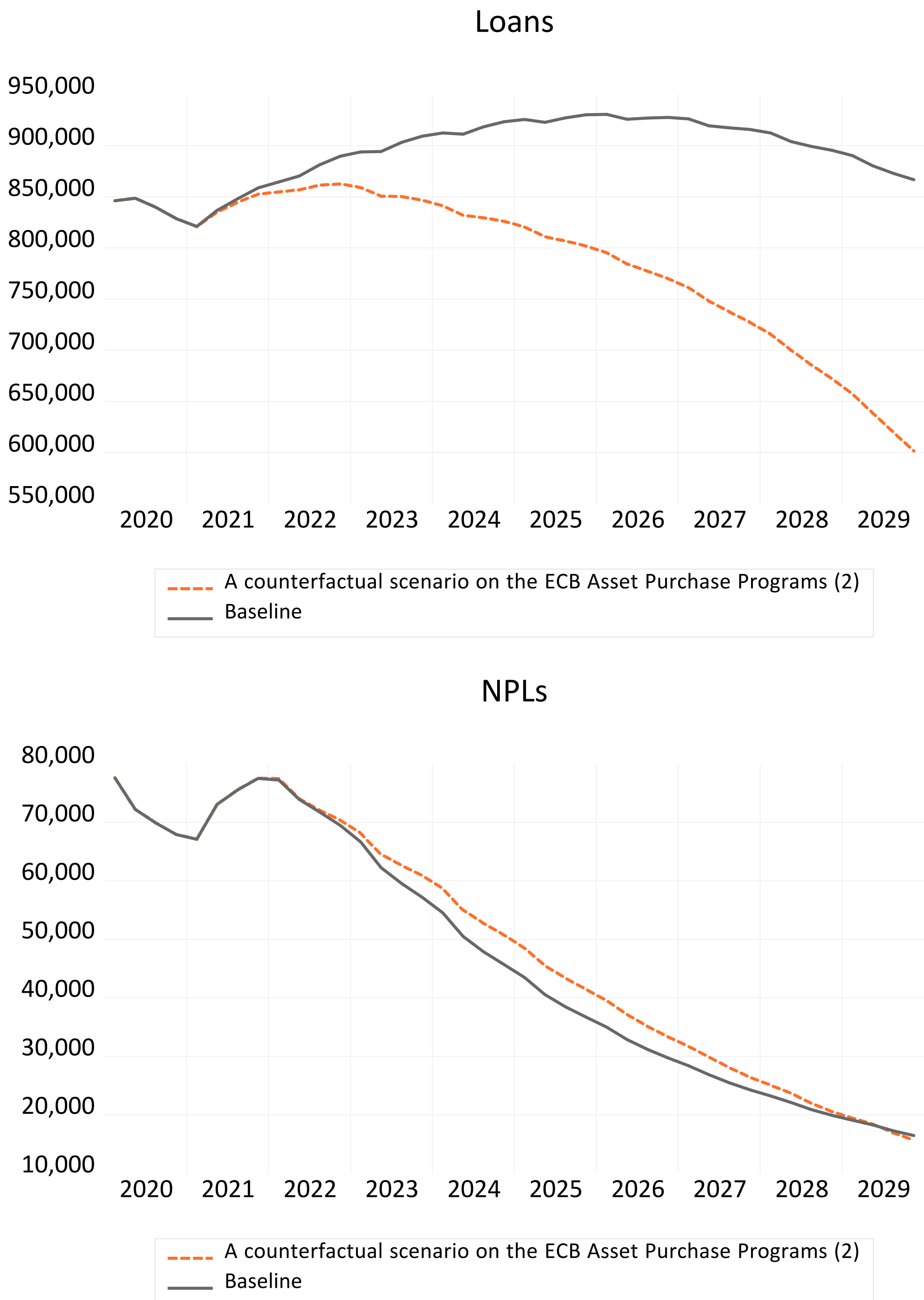

Figure 14: Transmission channels in the two counterfactual scenarios: Firms' Loans and NPLs

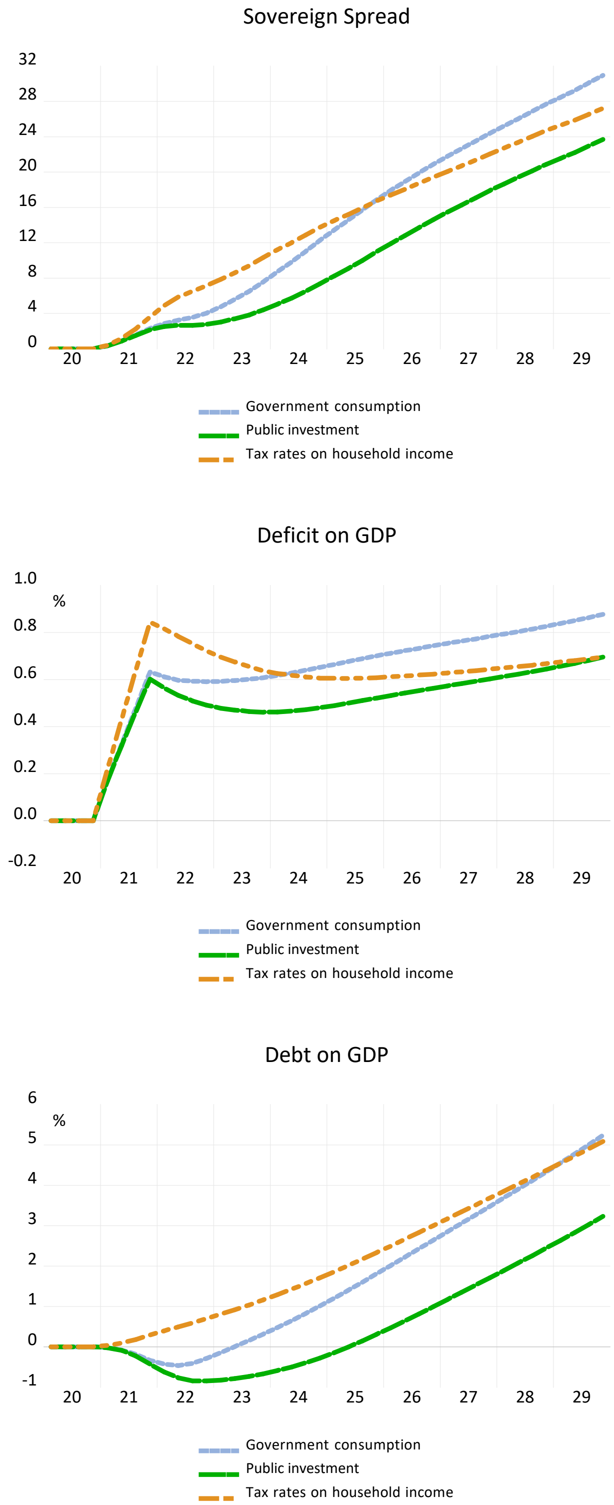

Figure 15: Dynamic impact of each policy shock on the sovereign spread, deficit-to-GDP ratio and debt-to-GDP ratio: deviation from the baseline scenario

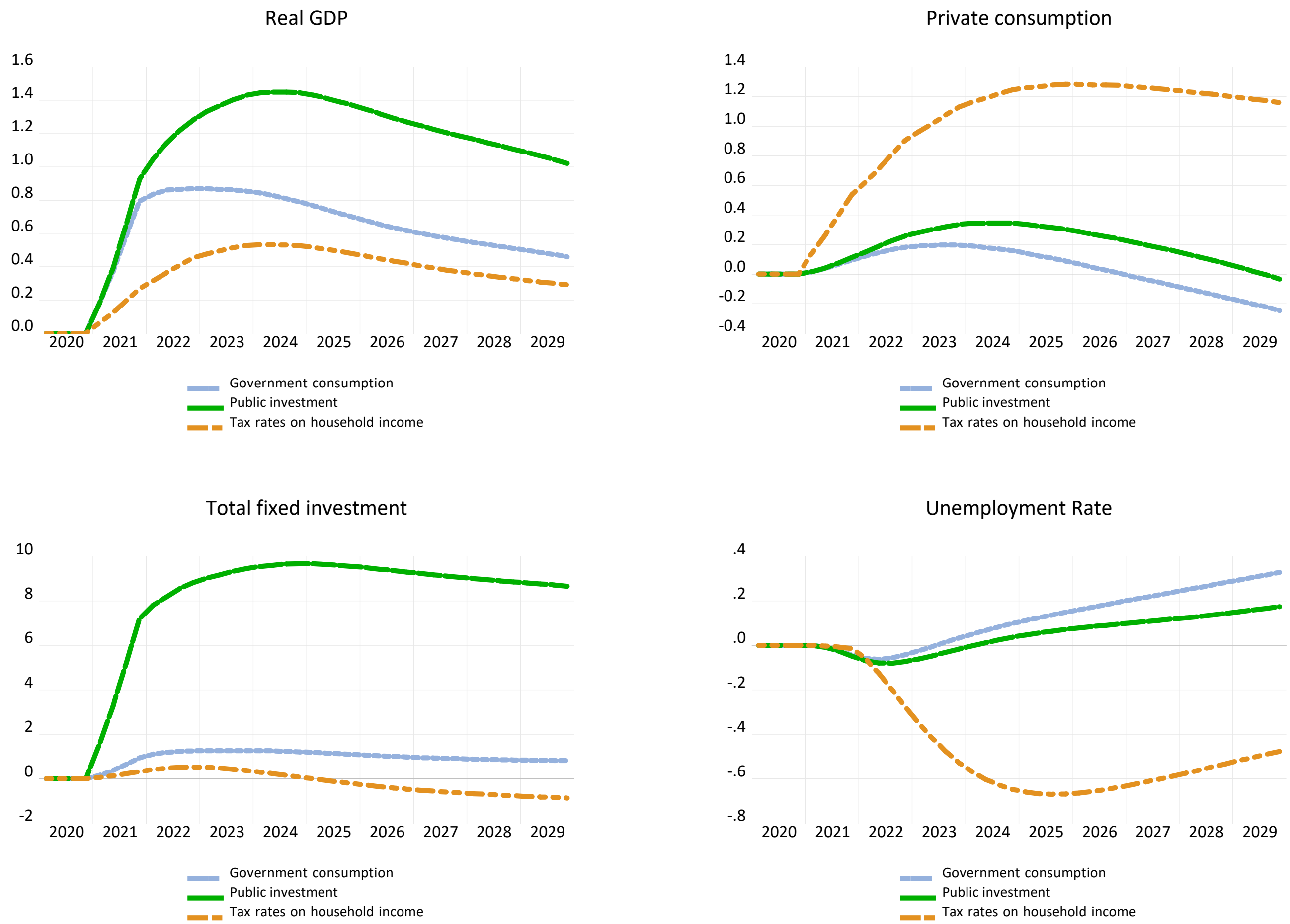

Figure 16: Impulse response of macroeconomic variables to each shock: percentage points of deviation from the baseline scenario

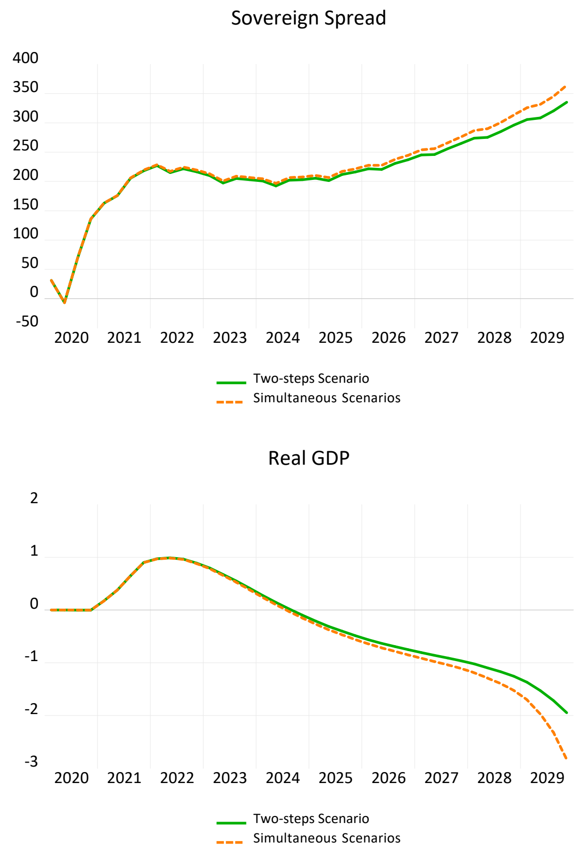

Figure 17: Detecting nonlinearities in the Macro Response to Shocks: Percentage deviation of GDP with respect to the baseline scenario in the two scenarios