PART VII

FINANCIAL INTEGRATION AND POLICY ISSUES

24. The integration of the financial system in macroeconometric models for policy simulation

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1 INTRODUCTION

Macroeconometric models used by institutions for policy simulation are typically the result of large multi-year efforts; changing them is costly and it is therefore not surprising that significant advances to them after a deep reassessment are often made in the aftermath of economic and financial crises. The stagflation of the 1970s put the Cowles Commission approach into question and the rationalization of its failure was provided by the Lucas Critique (Lucas, 1976) that paved the way to structural models with a clear identification of deep parameters and a coherent way to formalize expectations, starting an evolution that has led to dynamic stochastic general equilibrium (DSGE) modelling.

Financial factors and firms balance sheet do not initially matter in these models. As clearly discussed by Morley (2016), the rationale for this choice is in the Modigliani and Miller (1958) theorem: if the value of firms is independent of their sources of finance, then firms' investment decisions are affected by macroeconomic conditions but not by developments in financial markets. The strength of the assumptions of the Modigliani-Miller theorem is questioned empirically, in the case of firms, by the presence of financial market imperfections that give raise to an external finance premium, a wedge between the cost of external finance (through debt or equity) and that of internal finance. This is at the root of the financial accelerator mechanism, modelled by Bernanke and Gertler (1989) and Kiyotaki and Moore (1997). In these models a rise in interest rates deteriorates the balance sheet of firms, as it raises the cost of servicing the debt and thereby its burden; moreover, the reduction in demand lowers the value of the firm and of asset prices, inducing a drop in the value of the firm's collateral. A negative shock that increases the external finance premium discourages firms from investing and spending and this pushes down economic activity even further. These and other financial frictions were included in DSGE macroeconomic models for policy simulation available well before the 2007 financial crisis (see e.g. Bernanke et al. 1999). However, these models focused on credit constraints on non-financial borrowers and credit transactions were seen as market-based without a proper role for financial intermediaries.

The failure of these models to account for the real effects of financial crises of 2008, driven by subprime lending, as well the financial crisis of 2010–11 in the euro area, driven by government debt, has led to a modification in the structure of macrofinancial models

with the inclusion of financial intermediaries and the explicit characterization of their relevance in the transmission mechanism of policy and non-policy shocks.[1]

In conveying some very interesting reflections on macroeconomic modelling after the financial crisis, Blanchard (2018) remarks the presence of widespread acknowledgement of the poor performance of DSGE models, paired with little agreement on what alternative future paradigm should be pursued. He lends support to the view that current DSGE models must be improved rather than discarded to propose an eclectic approach to modelling that considers different types of models for different purposes. The specific classification he provides features foundational models, DSGE models, policy macroeconometric models, toy models and forecasting models. In this survey we concentrate on the interaction between policy and DSGE macrofinancial models.

We take the twin crises of 2008 and 2010–11 as a watershed to divide our presentation in two parts. Section 2 provides first a brief historical account of how the financial and banking system has been included in macroeconomic models before the financial crises to then consider the advances made in DSGE and policy models after the crises. In doing so, we also consider the stock-flow consistent (SFC) approach in macrofinancial econometric modelling. In Section 3, the discussion is centred on the capability of SFC models to address the criticisms of DSGE models. To inform this discussion, our assessment relies on the recent modelling work at the Italian Treasury on the specification, estimation and simulation of ITFIN, an SFC econometric model for the Italian economy (Barbieri Hermitte et al. 2023).

2 FINANCIAL AND BANKING SYSTEM IN POLICY MODELS: A BRIEF HISTORY

2.1 From the 1970s to the financial crises

The first generation of policy models featuring a monetary and financial system include the large-scale macroeconometric models which were built in the spirit of the Cowles Commission. This approach came under severe criticism in the 1970s as a consequence of their failure to predict stagflation, a phenomenon that widely characterized those years (see e.g. Galí and Gertler (2007)). The validity of these large-scale macroeconometric models has been seriously put into question by influential macroeconomists, such as Lucas (1976) and Sargent (1981), on the ground that, without an optimization-based approach that leads to structural equations, the estimated parameters are not invariant to changes in the structure of the economy and/or in the policy regime. Parallel to the "Lucas critique," Sims (1980) pointed to the lack of identification assumptions in the relationships among macroeconomic variables of these models, so that the stability of the parameter estimates across policy regimes is far from granted.

In response to these critiques a class of macroeconomic models that has gained a large consensus in the profession is that of New Keynesian, DSGE models. These models

[1] This choice simply reflects the increasing importance of the financial sector, without entering into the evaluation of the role that finance plays in the economy and without addressing the issue of whether its size and pervasiveness are justified (see Mazzuccato 2018).

feature a structural macroeconomic framework with explicit theoretical foundations, which allows them to address both the Lucas and the Sims critique to traditional models.

New Keynesian DSGE models have become the most popular quantitative framework for policy analysis and are widely used in institutions, such as central banks, finance ministries and international organizations. From a methodological point of view, the approach of New Keynesian DSGE models is that of quantitative macroeconomics, which was pioneered by the Real Business Cycle (RBC) theory. According to this approach, the artificial economy is characterized through the first-order conditions originating from agents' optimization problems under uncertainty. Once this system of equations, that are made of intertemporal and intratemporal optimal conditions, is log-linearized and structural parameters calibrated (or estimated), the dynamic model is solved through simulation methods. The properties of the model are assessed through a comparison of empirical and model-based moments of, respectively, the actual and the artificial, model-based variables, as well as through the dynamic responses of variables to stochastic shocks. Importantly, observed variables need in general to be de-trended before comparison with artificial variables. While sharing the same methodology, RBC and New Keynesian DSGE models profoundly differ in their assumptions on the structure of the economy (e.g. price stickiness vs. price flexibility; perfect vs. imperfect competition) and their predictions (e.g. non-neutrality vs. neutrality of money). Typically, the emphasis of RBC models on monetary and financial factors has been limited and the effects of a monetary policy shift on real output predicted to be zero throughout the whole simulation horizon. Against this backdrop, it is not surprising that the micro-founded, theory-driven models in the suite of models of policy institutions are of the New Keynesian type, rather than the RBC type.

Since the early versions of these models were launched, a variety of nominal and real frictions, shocks and transmission mechanisms have been progressively added to the structure of the baseline framework (see e.g. Smets and Wouters 2007 and Christiano et al. 2005). Against this backdrop, there have been important attempts to focus on financial factors well before the financial crisis. Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), among others, do model the interaction between the financial sector and the real economy but they put emphasis in their work on the credit constraints faced by non-financial borrowers. They model financial market frictions by introducing an agency problem between borrowers and lenders. The agency problem induces the presence of an external finance premium, which adds to the cost of credit for the borrower. The size of this premium increases if the borrower balance sheets deteriorates and this induces a "financial accelerator" mechanism so that, during an economic downturn, often associated with a fall in asset prices, the balance sheets deteriorate and the external finance premium goes up. This acts to depress spending in producer durables and employment, thus amplifying the economic downturn (see Gertler and Kiyotaki 2010). As Bernanke et al. (1999) put it, if the mechanism of "financial accelerator" is active in the model, then deteriorating credit market conditions are not simply the reflection of a declining economy but are in themselves an important factor that magnifies the severity of a downturn.

According to Brzoza-Brzezina et al. (2013), the literature on financial frictions developed before the crisis is mostly based on two alternative approaches. One is that initiated by Bernanke and Gertler (1989), according to which financial frictions arise because

monitoring a loan applicant is costly (costly state verification) and this drives a wedge between the rate of the loan and the risk-free rate. Their model relates the external finance premium to firms' net worth and as the latter declines the cost of external finance increases and firms reduce their investment. If net worth is procyclical, then the effects of economic shocks are amplified by the financial accelerator. The other approach originates from the work of Kiyotaki and Moore (1997), and expanded by Iacoviello (2005), introducing financial frictions via collateral constraints on borrowing. Agents differ in their rate of time preference and this sort them into lenders and borrowers. The financial sector intermediates between these groups and frictions exist because lenders cannot force borrowers to repay their loans and, thus, borrowers are required to provide collateral. In their model, Kiyotaki and Moore (1997) relate the external finance premium to the value of durable assets used both as inputs for production and as collateral to secure loans. Because the prices of these durable assets are procyclical, their model also generates a financial accelerator (see Morley 2016). In this case, the presence of financial frictions impinges on the volumes of loans by restraining them. Conversely, in Bernanke and Gertler (1989) the presence of financial frictions affects the economy through the prices of the loans, rather than the quantity of debt. Many of the insights of these two models are incorporated by Bernanke et al. (1999) into a New Keynesian DSGE model of the business cycle.

In spite of the valuable attempts to model financial factors, at the outbreak of the financial crisis most of the DSGE models used at the time exhibited a serious limitation: the absence of a proper role to financial intermediaries. This was evident from the inability of those models to deal with the effects of financial shocks on the economy and to capture the prominent role of banks and the financial system in the propagation of shocks. Although the mechanisms envisaged in theoretical models available before the crisis were operating on the financial side of the economy, they only dealt with a fragment of the problem, namely the demand for credit. This contrasts with the fact that a key feature of the financial crisis was the inability of financial intermediaries to supply credit to the economy. In the models available before the crisis, credit transactions are market-based and do not involve financial intermediaries (see Beck et al. 2014). In the next section we illustrate the post-crisis effort in DSGE modelling with the advances made for characterizing the role of financial factors in business fluctuations.

Parallel to the developments of DSGE models, reliance on large-scale macroeconometric models in policy institutions have continued to be widespread. This reflects profound innovation in macroeconometric modelling compared to the first generations of models in the tradition of the Cowles Commission. It is true that this new class of macroeconometric models are not developed within an agents' intertemporal optimization framework with rational expectations and this leads to some shortcomings compared to carefully micro-founded theoretical models, where the parameters describing tastes and technology are readily identified. On the other hand, however, the parsimoniously parameterized theory-dependent models, like the DSGE models, have some limitations with respect to more data-driven, dynamic, large-scale macroeconometric models. Indeed, Spanos (1990) introduces the distinction between structural and statistical identification in econometric modelling, asserting that structural identification refers to the uniqueness of the structural parameters, as defined by the re-parameterization of the reduced form of the model, while statistical identification, on the contrary, deals with the selection of a data-congruent model as a reduced form. Consolo et al. (2009) reiterate the importance of both statistical

and structural identification for DSGE. The difference between statistical and structural identification is well illustrated in a thoughtful reflection on DSGE models after the subprime loans crisis provided by Linde (2018). His comparison of the performance forecast from the Smets and Wouters (2007) DSGE model with a Bayesian VAR (BVAR) conditional on the state of the economy in 2008:Q3 shows that the structural model and the reduced-form VAR produce very similar forecasts and that both models cannot predict the crisis and its transmission mechanisms. The strong similarity between the forecasts from the two different models witnesses that the DSGE does not impose invalid restrictions on the BVAR statistical model. However, statistical identification is not achieved in that the BVAR model is not a congruent statistical representation of the data during the financial crisis.

While theory-intensive models, like the DSGE models, pursue structural identification, the models in the so-called LSE (London School of Economics) tradition pay a greater attention to statistical identification. In general, this new generation of large-scale macroeconometric models are extensively focused on pursuing adequacy of the statistical model implicit in the estimated structure. To ensure this, a rich dynamic structure characterizes the specification of each equation and proper tests are conducted to verify that residuals do not exhibit autocorrelation, heteroscedasticity and deviation from normality. These models are characterized by modelling stochastic trends and introducing dynamic specifications for the equations, involving long-run equilibrium relations among the variables in (log) level with an error correction mechanism that allows to correct for deviations from the equilibrium. To account for short-run patterns, the equations also feature a rich lag structure for the (log) differences in the dependent variable and the regressors. These type of policy models, such as the FRB/US model, where the specification is more loosely driven by theory and a more important role is assigned to the data in equations specification, are labelled by Wren-Lewis (2018) as Structural Econometric Models (SEM).

The accurate tracking of sectoral balance sheets and their interaction is not a typical feature of SEM, while it is of central importance in SFC models. SFC models were pioneered in independent work by Tobin and Godley (see Godley and Lavoie 2007).[2] The chief concept behind this approach is very clearly expressed by Brainard and Tobin (1968), who state explicitly that, in modelling the interdependencies between the real economy and financial markets, a failure to take into account some elementary interrelationships, such as those enforced by balance sheet identities, can result in serious errors of econometric-based policy evaluation. In the specification of the model, the SFC approach explicitly includes the intertemporal budget constraint for each sector, modelling all of its assets and liabilities except one. This residual asset (or liability) is derived in model closure through an identity that reflects the relationship between stocks and flows and is disciplined by the intertemporal budget constraint. Despite being used for decades, first by Godley at the UK Treasury, then by his associates at the Levy Economics Institute (Zezza 2009), and later also by Goldman Sachs for macroeconomic policy analysis (Hatzius 2003), the popularity of SFC models has increased extensively after the financial crisis of 2007–08.

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

2.2 Modelling after the financial crisis

The Great Financial Crisis induced a significant rethink of the way to model the interactions between the financial sector and the real economy. After the outbreak of it, a new literature on financial factors in business cycles has emerged building on previous work discussed in the previous section. In their illuminating survey, Brunnermeier et al. (2012) point out that the different financial frictions might interact to lead to non-linearities and amplification mechanisms not only in the transmission but also in the generation of shocks. Following the points made in the surveys, Brunnermeier and Sannikov (2014) study the equilibrium dynamics of an economy with financial frictions. In this context highly non-linear amplification effects are present and a persistent endogenous risk, driven by assets illiquidity, emerges even for low levels of exogenous risk due to conventional shocks.

Gertler and Kiyotaki (2010) convincingly argue that there are two aspects of the crisis that have not been captured in earlier, pre-crisis, modelling work on financial factors in business fluctuations. The first one is the disruption of financial intermediation (see Brunnermeier 2009 and Bernanke 2009): most of pre-crisis models with financial frictions emphasized credit market constraints on non-financial borrowers and treated financial intermediaries as a veil. Second, to counter the crisis, the policy institutions have relied on various unconventional policy measures that range from asset purchases (sovereign and non-sovereign bonds as well as injection of equity into banks) to direct lending to non-financial borrowers in credit markets. With regard to the first aspect, Gertler and Kiyotaki (2010) and Woodford (2010) point to the importance of modelling the presence of frictions within financial markets (i.e. within financial intermediation) rather than between "non-financial" borrowers and lenders operating in frictionless financial markets (see Morley 2016). Thus, while traditional models put emphasis on credit constraints of non-financial borrowers, post-crisis models focus more on credit constraints imposed on financial intermediaries. Credit transactions, rather than being market-based, largely involve the presence of banks and the latter face capital requirements and have balance sheets that may well deteriorate. The models developed after the financial crisis seek to incorporate these elements on the ground that the transmission mechanisms of monetary policy mostly depend on the conditions of the banking system (see Beck et al. 2014).

Against this backdrop, Gertler and Kiyotaki (2010) focus on the disruption of financial intermediation as a key feature of the crisis episodes. To incorporate this in their model, they assume that there is an agency problem that may limit the ability of banks to obtain funds from depositors. When the conditions of the intermediary's balance sheet constrain its ability to source funds from deposits, a wedge between lending and deposit rates arise and, during a crisis, this spread largely increases, pushing up the cost of credit for firms.

Another feature of the financial crisis was the disruption of the interbank market, with banks having difficulties to receive funds not only from deposits but also from other banks in the interbank markets. To reproduce this, Gertler and Kiyotaki (2010) introduce "liquidity" shocks hitting banks in an idiosyncratic way, so that some of them are in surplus and other in deficits of funds. This allows for an interbank market of funds but, because of the agency problem, an intermediary may be unable to obtain funds from other banks (disruptions of the interbank market) and in this case non-financial firms can

borrow only from a smaller group of financial intermediaries, with adverse consequences for economic activity.

As argued by Beyer et al. (2017), modern modelling of the monetary policy stance requires a structured design of the monetary transmission mechanism, that includes the role of financial intermediaries as well as private and government balance sheets. By doing so, the transmission channels of unconventional monetary policy and central bank asset purchase programmes are envisaged and their effects on asset prices and the economy can be analysed.

In a recent reassessment of macroeconomic models for monetary policy analysis from a finance perspective, Dou et al. (2020) highlight the relevance of several transmission channels: the interest rate, the inflation expectations, the balance sheet and the bank lending channel. If prices are sticky, then a cut in nominal short-term interest rates leads to lower real interest rates (interest rate channel). However, a shift in the policy rates directly affects interest rates in the money market but consumption and investment depend upon lending rates set by banks in medium- to long-term contracts. These rates are affected by inflation expectations. Thus, if monetary policy has a more expansionary stance, then, at given nominal interest rates, this result in higher expected inflation and, in turn, in lower real rates and higher private expenditure. The higher demand induced by higher expected inflation pushes the marginal costs up with upward pressures on prices that reinforce the effect on inflation (inflation expectations channel). The balance sheet channel is linked with the external finance premium. Finally, the bank lending channel means that a more expansionary monetary policy leads to an increase in the amount of loanable funds available to banks and thereby in the stock of credit to firms and households.

These contributions highlight the importance of having a framework that includes all frictions in the models for policy simulations. In fact, tracking firms' balance sheets is important to pin down the balance sheet channel, tracking financial intermediaries' balance sheets is crucial for the identification of the bank lending channel, tracking households' balance sheets and the different components of households wealth avoids misspecification in modelling residential investment and consumption and, moreover, tracking government imbalances is fundamental to emphasize the role of government debt and its burden on balance sheets of the different sectors in determining the transmission mechanism of policy and non-policy shocks.

The extensions to models made In "ecen' years are especially focused on assigning a prominent role to financial intermediaries. Gerali et al. (2010) incorporate a monopolistically competitive banking sector into a DSGE model of the euro area with financial frictions and show that banks magnify the transmission of shocks. Banks supply credit using deposits or bank capital to fund their activities and are subject to an exogenous leverage ratio. Thus, bank capital is crucial in determining credit supply because, if a shock deteriorates the bank's financial position, then the bank reduces its credit supply and this amplifies the effects of the shock. They show that shocks originating in the banking sector explain most of the 2008 GDP drop in the euro area.

Christiano et al. (2010) include a banking sector and financial markets in a standard DSGE model and show that financial factors are major determinants of business fluctuations, being both triggers and channels of propagations of the 2007–08 financial crisis. In their setup, these financial factors are characterized through the following elements:

asymmetric information and agency problems in financial contracts, liquidity constraints that banks face in their funding and shocks that change the perception of market risk and hit financial intermediaries. Darracq Paries et al. (2011) develop a model for the euro area where some firms and households are financially constrained and where a bank capital channel and regulatory constraints are explicitly envisaged. Angeloni and Faia (2013) build a DSGE macro framework that incorporates a financial sector in which banks are subject to runs. Bank capital regulation is present in the model and the transmission of monetary policy is analysed focusing on situations in which banks are fragile and risky. Bocola (2016) proposes a model where banks hold sovereign debt, so that a collapse in government bond prices due to concerns about a possible future sovereign default puts a strain on the funding of banks and induces them to cut their leverage as a precautionary measure.

As Beyer et al. (2017) emphasize, a large stream of literature in the aftermath of the financial crisis has analysed the effects of expansionary policy when nominal policy rates are at, or close to, their zero lower bound. Christiano et al. (2011) and Eggertsson (2011), among others, have shown that the economy's response to expansionary policy impulses can be very different depending on whether nominal interest rates are expected to be positive or not. Thus, the incorporation of a lower bound on nominal interest rates allows to control for the inability of monetary policy, in some circumstances, to provide adequate stimulus to the economy using the policy rate.

Confronted with the zero lower bound on policy rates, most central banks have adopted unconventional measures, such as direct central bank lending and asset purchase programmes. An important contribution on unconventional monetary policy and its effects on economic activity is that of Gertler and Karadi (2011). They propose a DSGE model where financial intermediaries face endogenously determined balance sheet constraints due to an agency problem between intermediaries and depositors. Thus, the ability of banks to receive deposits and grant loans to the private sector depends on their net worth and a negative shock that deteriorates the intermediary capital impinges on lending and borrowing in a way that increases credit costs. To insert unconventional monetary policy into the model, Gertler and Karadi (2011) allow the central banks to act as a financial intermediary but without facing constraints on its leverage ratio because no agency problem arises between the central bank and its creditors. Thus, in a period of disruption of financial markets, the central bank can intervene to support credit flows increasing its balance sheet in response to the crisis. Curdia and Woodford (2011) extend a basic New Keynesian model to consider financial intermediation and explicitly incorporate the central bank's balance sheet. The imperfection in the financial sector manifests itself with a wedge between borrowing and lending rates. Their findings indicate that if private financial markets are sufficiently impaired, then there can be a beneficial role for central bank credit policy or asset purchases.

Furthermore, the interaction between labour market frictions and financial market frictions have also been investigated, either on the firm side (Monacelli et al. 2011), or on the household side (Gorn and Trigari 2021). In a parallel development, the heterogeneous agent research agenda has abandoned the complete markets paradigm and the absence of constraints in lending by incorporating liquidity constraints and uninsurable idiosyncratic income risk in Heterogenous Agents Neo Keynesians (HANK) models (see, for example, Kaplan et al. 2018).

Developments in theoretical models do not have found a major impact in SEM policy models. In fact, as documented by Hendry and Muellbauer (2018), the Bank of England abandoned this modelling approach before the crisis and did not restore it afterwards. On the other hand, the European Central Bank has adopted a new policy model after 2010 and a blueprint for a new semi-structural model of the FRB-US type is described in Angelini et al. (2019). The model introduces generalized adjustment costs as the relevant source of attrition for the optimizing behaviour of economic agents and it is aimed at providing a credible narrative for observed economic developments by keeping a balance between theoretical consistency and empirical fit. The model is made of three blocks: a demand block, a supply block and a financial block. The demand block models the behaviour of households, firms, government and foreign sector. The supply block models the factors of production, capital and labour. The financial block models wealth, monetary policy and a number of interest rates by putting an endogenous modelled risk spread component on top of a risk-free term structure driven by the expectations theory. Stock and flows of wealth are detailed only for the household sector. Balance sheets of other sectors are not tracked and the potential non-linearities and amplifications emerging in the transmission due to interactions between the balance sheets of different sectors are excluded by the adopted specification strategy.

Another class of policy models is that of SFC models, whose popularity has greatly increased after the financial crisis of 2007–08 and the publication of "Monetary Economics" by Godley and Lavoie (2007), who presented the theoretical foundations of SFC modelling. Being centred on sectoral balance sheets, these models are by their nature better equipped to analyse (and predict) financial crises (see Godley 1999; Godley et al. 2007) with respect to standard neoclassical and New Keynesian models, where money and banks only played a secondary role – if present (see Bezemer 2010, among others). The publication in 2016 of the first "institutional" SFC model from the Bank of England (Burgess et al. 2016) 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 survey). In their assessment of macroeconomic models at the Bank of England after the crisis, Hendry and Muellbauer (2018) point to the integration of the real side of the economy and the financial flows and balance sheets with stock-flow consistency that has been proposed in the non-DSGE model of Burgess et al. (2016). Their model is seen as "a useful prelude to greater future integration between the real and the financial sides of a policy model with richer behavioural relationships."

3 DO SFC MODELS ADDRESS THE CRITICISMS OF DSGE MODELLING?

Our assessment of the ability of the SFC approach in modelling financial intermediation is based on the discussion provided by Stiglitz (2018) on the main underlying reasons for failure of DSGE models. In particular, Stiglitz points out that macro models should provide insights on the deep downturns that have happened to modern economies and on the effectiveness of the policy measures to counter them. In his view the DSGE approach failed to do so for a number of reasons: (i) the choice of concentrating on detrended data

and inappropriate model validation; (ii) incorrect modelling of consumption and investment decisions; (iii) assumptions of rational expectations and common knowledge; (iv) the use of the representative agent model or too simple extension of it; (v) the underlying theory of financial markets and money; (vi) excessive aggregation; and (vii) the nature of shocks, the sources of perturbation to the economy and the theory of how the economy adjusts to shocks.

As, according to Stiglitz (2018), all these reasons played a role in explaining the failure, we use them to evaluate the stock-flow consistent approach after the introduction of the main features of ITFIN, an SFC model for the Italian economy developed at Italy's Department of Treasury.

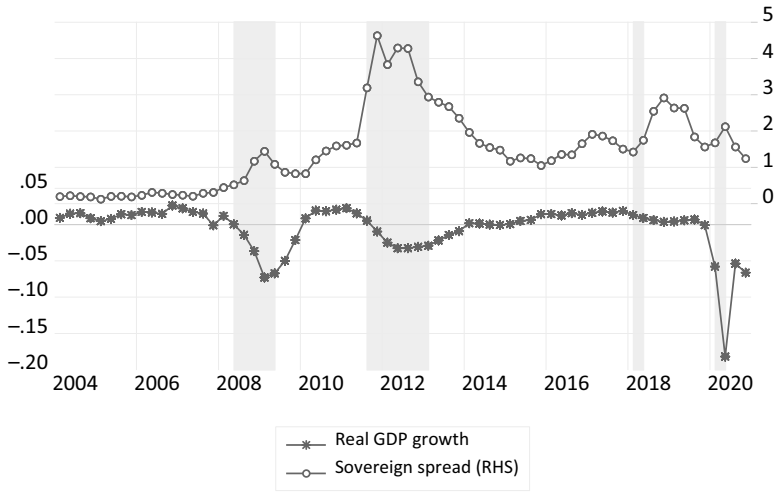
3.1 SFC modelling: an application to the Italian economy

The Italian economy is characterized by a government debt to GDP ratio that fluctuated in 2022 around 150%. This large sectoral imbalance generates a pervasive country-risk premium and affects financial markets and the real economy. The country-risk premium drives an external finance risk premium that impacts firms' balance sheets, affects firms' investment decisions and generates a financial accelerator effect. The important weight of government securities in banks assets causes a deterioration of the banks' balance sheets in the presence of sovereign debt crises that, in turn, reduces the supply of loans by banks. The recessionary impact of the ensuing bank credit restrictions amplifies the debt crisis, in the spirit of the "diabolic loop" analysed in Brunnermeier et al. (2016). Figure 24.1 illustrates the significant negative correlation between sovereign risk, as measured by the spread between interest rates on Italian and German government 10-year bonds, and GDP growth.

To explicitly address these characteristics of the Italian Economy, Italy's Department of Treasury has developed ITFIN, a quarterly, SFC econometric model (see Barbieri Hermitte et al. 2023). The theoretical and empirical literature has mainly focused on the role of productivity and GDP growth in explaining fluctuations in the cost of sovereign debt and its accumulation. The model also explicitly allows for the opposite feedback, from sovereign risk to output growth, and finds it is of great empirical relevance. The structure and the properties of the model can accommodate both the 2008 crisis, driven from contagion effects due to sharp contraction of foreign demand and the drop of foreign stock prices, and the subsequent 2011 crisis, where the rise in market yields and the losses generated by nonperforming loans have clearly originated from domestic political instability.

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 explicitly modelled and it originates from financial flows associated to agents' decisions determining the supply and demand of financial assets. A model closure, based on taking a single item of each sector balance sheet as residual, imposes consistency between financial stocks and flows in each sector of the economy.

Moreover, the financial positions of the various institutional sectors affect the agents' economic decisions and 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



Note: Periods of recession are shaded in grey.

Source: Authors' own elaborations on ISTAT (GDP) and Refinitiv (10-year BUND and BTP) data.

Figure 24.1 Real Italian GDP growth and sovereign spread between the 10-year Italian and German bonds

issued and held by each sector. ITFIN is a highly data-driven model, where the specification of the behavioural equations, although broadly consistent with theory, is designed to generate residuals that pass diagnostic tests. Modelling stock and flows implies simultaneous modelling of (stochastic) trends and cycles. Data are not detrended and cointegration is exploited to pin down long-run relations among variables driven by common stochastic trends. Deviations from long-run equilibria are then allowed in the dynamic specifications but error correction modelling ensures convergence to long-run equilibria.

The SFC model is based on 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 assets and liabilities across sectors, whereas the latter focuses on income flows and revenues that both financial and real assets generate. Following the literature on stock-flow consistency (see e.g. Godley and Lavoie 2007 and Zezza and Zezza 2019) the evolution over time of the value of stocks in each sector in the model is determined by its intertemporal budget constraint. The economy consists of seven different sectors: Government (G), Banks (B), Insurance companies, pension and mutual funds (P), Households (H), Non-financial firms (F), the national Central Bank (CB) and the Rest of the World (R). The national central bank does not implement conventional monetary policy as policy rates are set by the European Central Bank (ECB) and taken as exogenous in the model, instead it 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 model assigns a central role to money, credit and finance in determining the pattern of financial and real variables in the economy and considers demand and supply of a large number of financial instruments, that are simultaneously assets for some sectors and liabilities for others. In doing so the model keeps track of the interconnectedness of the sectors up to modelling simplification. In fact, not all assets and liabilities are modelled but only those that exhibit significant variation over time in the balance sheets of the various sectors.

However, model tracking of the structure of the flow of funds database allows to evaluate promptly the effects of omissions and simplifications. In fact, the size of discrepancies between the evolution over time of net financial positions of each sector in the model and in the data is an indicator of the effect of omitted variables.

The modelling strategy is not based on the estimation of first-order conditions derived through intertemporal optimization and the specification of behavioural equations, which is loosely driven by theory, is carefully tested to ensure its coherence with the data. As a consequence, the estimated parameters cannot be identified as policy invariant parameters describing taste and technology.

An illustration of the application of this flexible approach comes from the modelling of the demand for financial assets. In the standard SFC literature all demand for assets should depend on their relative rate of return with respect to all other assets in each sector portfolios. This choice leads to multicollinearity problems due to the correlation in returns. Indeed, under the no arbitrage hypothesis risk, adjusted returns are equalized and therefore co-movements in risk premia naturally generate collinearity between returns. A potential solution to this problem is to make the demand for each asset depend on its own 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. Importantly, an Equilibrium Correction Mechanism (ECM) strategy can be adopted to allow for temporary deviations from no arbitrage in the short run that disappear in the long-run equilibrium. This approach could be further extended to include the latest results available in the asset pricing literature and adopt a factor-driven specification which makes the demand for each asset a function of common characteristics, as proposed by Koijen and Yogo (2019).

3.2 SFC model and the Stiglitz critique of DSGE

In this section we shall review the structural elements of SFC models through the lens of the list of arguments provided by Stiglitz (2018) to support his view on the failure of DSGE models.

3.2.1 Trends, cycles and model evaluation

The first dimension of the criticism to DSGE models is related to model evaluation. As DSGE models concentrate on the explanation of economic cycles, they are not confronted with actual data but with detrended data. Detrending is not consistent with the fact that relevant macroeconomic phenomena, such as the output effects of financial crises are nonstationary and occur at lower frequencies. In the SFC approach both trends and cycles are explicitly modelled because stocks are, by their nature, affected by trends even when flows are mean reverting. The explicit modelling of trends can be used for

model evaluation within a cointegration framework that identifies common trends among different variables. No pre-filtering of data is needed when evaluating SFC models. In addition to this, since SFC models track model-based financial positions that differ from the corresponding actual financial positions also for the constraints imposed by data and the need for simplicity in the model, the discrepancy between these positions is an immediate, within sample check for assessing the validity of the model and its limitations.

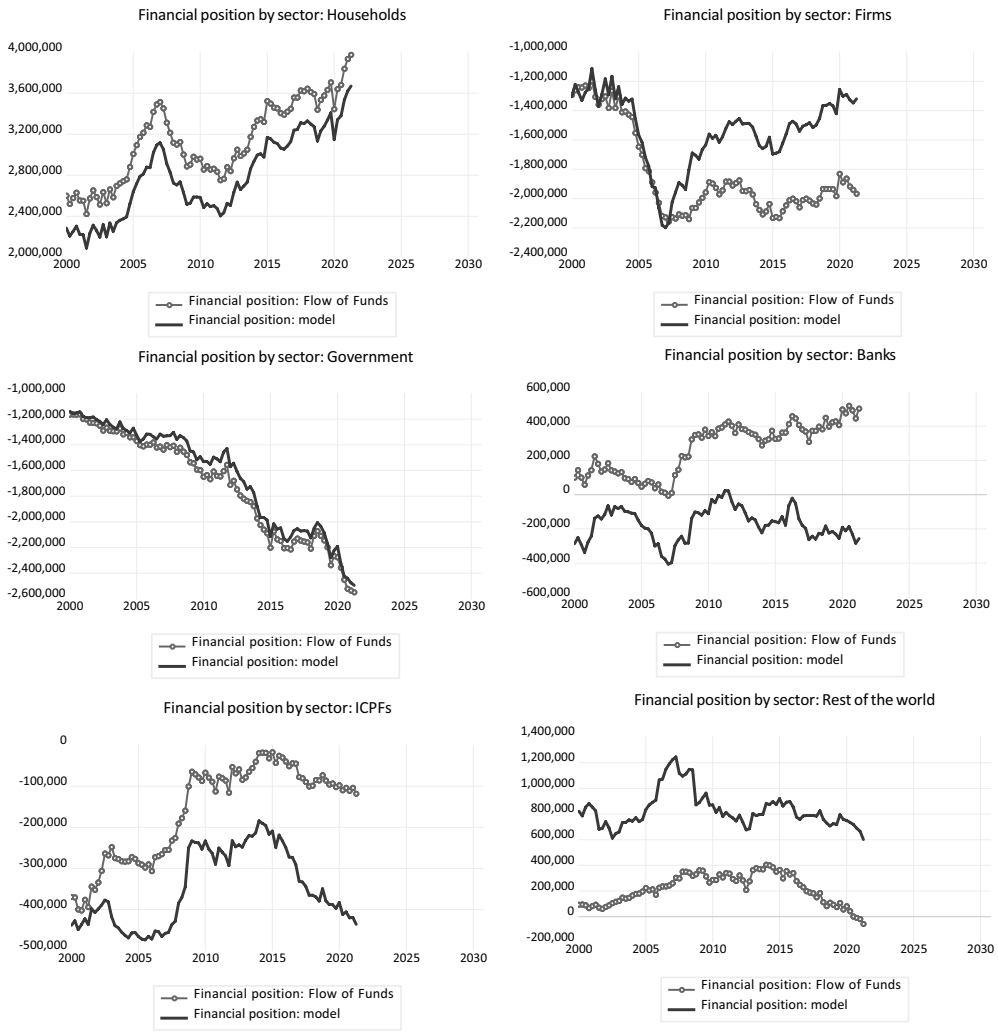
Figure 24.2 illustrates the point by documenting the pattern of model-based financial positions (as measured by net financial assets) and their actual counterpart taken from the financial accounts where all assets and liabilities are considered. The source of the existing divergence in the sample between model-based net financial assets, NFA^{i,M_t}, and actual NFA^{i,NA_t} is a measure of the impact of the simplification strategies adopted in the model. This may also reflect a lack of information in financial accounts to pin down precisely "who holds what and how much," which has required the adoption of some hypotheses. Inspection of Figure 24.2 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, with some exceptions. Constant discrepancies might be successfully dealt with add-factors in out of sample simulations, which make model-based observations directly comparable with their observed empirical counterparts. Time-varying discrepancies, on the contrary, would make transparent the weaknesses of the model (see Barbieri Hermitte et al. 2023).

3.2.2 Modelling of consumption and investment decisions

Stiglitz points out that modelling consumption and investments decisions via the optimizing behaviour of representative agents that do not face liquidity constraints does not capture important mechanisms related to the sectoral balance sheets that are crucial in determining the transmission mechanism of shocks during a financial crisis. Against this backdrop, on the contrary, in SFC frameworks consumption and investment decisions are modelled by attributing a crucial role to the balance sheet of households, firms and financial intermediaries. This naturally leads to a model that features not only a financial accelerator mechanism, linking the external finance premia to the fluctuations in firms' balance sheets, but also a further channel of transmission that relates the supply of loans to the quality of banks' balance sheet and highlights the importance of regulatory capital. Temporary, but persistent, deviations from the frictionless equilibrium are also allowed for by the adoption of an error correction strategy to model the dynamics of households, firms and financial intermediaries.

3.2.3 Rational expectations and common knowledge

SFC models do not adopt the hypothesis of rational expectations and the assumption of common knowledge. The way in which the equilibrium is determine in the market for loans and mortgages is consistent with asymmetric information, which is therefore a relevant feature in the model. SFC models are typically solved using a backward-looking, adaptive expectations hypothesis. This assumption considerably simplifies the simulations of the model at the cost of being rather extreme. In principle, a flexible specification for expectations formation, such as the diagnostic expectations hypothesis (see Bordalo et al. 2022 for an illustration), might be seen as a promising route. Under this mechanism expectations eventually converge to rational expectations but deviations from rationality are allowed for, as expectations temporarily overweight future outcomes that become more



Source: Authors' own elaborations on the ITFIN model database.

Figure 24.2 Financial positions by sector in National Financial Accounts (Flow of Funds) and in the ITFIN model

likely in light of incoming data. The persistence of deviations from rationality is controlled for by a given parameter.

3.2.4 Representative agent

In SFC models the economy is characterized as being made of a number of sectors. The aggregate demand for and supply of assets result from aggregating the demand and supply of each sector but aggregate behaviour does not result from the aggregation of

individual agents' decisions. Model closure is achieved by leaving to a residual component in each sector's balance sheet the role of guaranteeing that the intertemporal budget constraint is satisfied.

3.2.5 Theory of financial markets and money

Equilibria in the financial markets are determined through the interaction between aggregate demand and supply of different assets that in turn are constructed considering the contribution of each sector in determining the pattern of the relevant aggregate. Risk premia are endogenously determined and non-linearities are allowed for, so that multiple equilibria are possible.

To illustrate the approach, let us consider the market for Italian government debt in ITFIN (see Barbieri Hermitte et al. 2023). In the model government holds no financial assets and its total debt is composed of bills, with a maturity of 12 months or lower, and bonds. The equilibrium in the bond market is determined by matching supply and demand for government bonds. New issuances are determined by the debt manager given the total deficit determined as the sum of the primary deficit, pinned down by a fiscal reaction function, and the total cost of financing the debt, pinned down by the debt maturity and the term structure of sovereign yields. 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 are determined by unexpected movements in bond prices. Before auctions take place, the sovereign debt manager forms expectations on the equilibrium price and fixes accordingly 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. This mechanism ensures that the intertemporal government budget constraint holds in each period and enforces the stock-flow consistency.

The demand for government bonds (evaluated at market prices) depends on the saving and portfolio decisions of five large groups of lenders: (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). The demand for sovereign bonds from the various sector is in general a non-linear function of the risk adjusted returns in which the risk premium is measured by the spread between the yield to maturity of the Italian bonds and the yield to maturity of the German Bonds, which is taken as the risk-free asset in the euro area. 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. This feature of the specification allows the model to generate a high volatility of the BTP-BUND spread consistent with patterns observed in the data and with the presence of multiple equilibria in price determination.[3]

[3] See the literature on sovereign debt models as in Lorenzoni and Werning (2013), which builds on the seminal work of Cole and Kehoe (2000) and Calvo (1988). Multiple equilibria models have been used to understand the behaviour of government bond yields during the Euro-area sovereign crisis (Corsetti et al. 2014; De Grauwe and Ji 2012).

As all the sectors' balance sheets are tracked in the model, the demand for and the supply of all the components of money is modelled. The neutrality of money, even in the long run, is not a feature of SFC models. In fact, as stock-flow consistency is naturally imposed on nominal variables, modelling inflation and its long-run and short-run dynamics is not traditionally a focus of this approach. As clearly stated in Godley and Lavoie (2007), SFC models provide a framework that describes the values that variables ought to take at given production costs and prices; therefore, they deal with observed nominal variables. Price setting is considered only as an add-on to the framework and it usually based on a unit-cost pricing approach. This feature makes the model appropriate in an environment where financial crisis happens while inflation closely fluctuates around the central bank target but the basic approach has limitations in modelling persistent fluctuations in inflation.

3.2.6 Shocks and adjustments to shocks

The SFC approach naturally attributes a role to sectoral balance sheets not only in determining the adjustment to shocks and characterizing their transmission mechanisms, but also in potentially creating endogenous shocks related to sectoral imbalances. (Stochastic) trends and cycles of relevant variables are modelled in error correction specifications where deviations of variables from their long-run trends are temporary, with a speed of adjustment that is estimated from the data. Adjustment to shocks takes time and persistence in variables like unemployment is tracked in the artificial series generated in simulation.

4 CONCLUSIONS

The failure of predicting and modelling the financial crises led to important modifications in the mainstream DSGE modelling approach in the direction of attributing a prominent role to financial intermediation. SFC modelling might provide a complement to the mainstream approach in line with the argument made by Blanchard (2018) in favour of improving, rather than discarding, the foundations of DSGE models within a heterogeneous eclectic approach to modelling.

SFC models, based on tracking the balance sheets of all sectors of the economy, provide a natural framework to build econometric models for policy simulations in line with the developments in the macro-finance literature on the role of financial intermediaries in the shocks' transmission mechanisms. There are several areas of potential development for these models. The first one is modelling inflation. To guarantee stock-flow consistency, nominal demand for and supply of all financial instruments are specified; in this context a strong Keynesian flavour is often introduced by setting inflation at the central bank target without modelling its fluctuations. This is acceptable only in a world without inflation fluctuations. Extensions to model inflation within the SFC approach should be a priority in the agenda. The second potential area for important developments is modelling the expectations formation mechanism. The commonly adopted hypothesis of adaptive expectations facilitates model simulation but gives an excessive backward-looking flavour to the approach. This could be substituted by a more flexible specification for the expectations such as the diagnostic expectations hypothesis. The third area is the consideration

of more recent developments from the asset pricing literature in modelling supply and demand for assets. The traditional approach of expressing the demand for each asset as a function of all asset prices runs inevitably in difficulties in estimating elasticities characterized by strong co-movements in all asset prices. No arbitrage restrictions, possibly allowing for short-run deviations from market efficiency, could help towards more parsimonious specifications with better empirical performances. Finally, SFC models have the important advantage of being capable of modelling trends and cycles in the data. A more explicit identification of the main drivers of the economy in the long run, with the possibility of linking trends in financial markets with structural development in productivity and the demographic structure of the economy, would constitute a natural extension of the currently most adopted theoretical set-ups. Other important issues that might be explicitly addressed in future work include the role of public loan guarantee programmes as well as government guarantees in the form of deposit insurance schemes or the promise of a bank bailout in case of failure.

DISCLAIMER

The views expressed in the chapter are those of the authors and do not involve the institutions of affiliation.

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