

Pierros, Christos

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Empirical stock–flow consistent models: evolution, current state and prospects

Christos Pierros*

Researcher, Labour Institute of the General Confederation of Greek Workers (INE GSEE), Athens, Greece

The paper explores the evolution of empirical stock–flow consistent (SFC) models, emphasising their structure, scope and number of financial and physical assets. Three types of models can be identified. The New Cambridge type is characterised by the aggregation of households, firms and banks into one aggregate private sector. The Godley–Lavoie type, termed after the impact of their collective work, treats the main institutional sectors separately. The third type, despite being largely heterogeneous, is marked by higher complexity. The paper argues that the structure of the models should vary according to the research question at hand, as higher complexity is ensued by augmented discrepancies between in-sample projections and actual data, especially in the financial domain. Despite this trade-off, several aspects of the models need to be improved, even at the expense of having more complicated structures. The paper provides some indications towards the direction that these improvements ought to take.

Keywords: *empirical stock–flow consistent, stock–flow consistent modelling, empirical macrostructural models*

JEL codes: *E10, E12, E17*

1 INTRODUCTION

Despite that the first empirical stock–flow consistent (SFC) model was developed in the late 1970s, SFC models gradually rose to prominence only very recently for reasons already discussed in the literature (Caverzasi/Godin 2015; Nikiforos/Zezza 2018; Zezza/Zezza 2019). The structure and the behavioural framework of these models have evolved from simple to much more complex according to the research questions they are trying to address, the dynamics they are trying to capture and the specificities of the economy under consideration. Contrary to other types of models, in which the actual values are plugged into generic structures,¹ the task of applying an SFC model in an actual economy is much more demanding.

Since their initial development in the late 1970s, three classes of SFC models can be identified. The New Cambridge (NC) approach follows firmly the methodology developed primarily in the Cambridge Economic Policy Group (CEPG) in the late 1970s and

* Email: c.pierros@inegsee.gr. A shorter and quite different version of this paper appears in Byrialsen, M., Valdecantos, S., and Raza, H. (eds.), *Empirical Macroeconomic Models: An Applied Approach*, London, UK: Routledge.

1. In example, according to Cherrier et al. (2023), the systematisation and formalisation of Dynamic Stochastic General Equilibrium (DSGE) models is such that their tractability and portability is ensured nowadays with minimum effort.

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early 1980s. The second type is largely influenced by the seminal work of Godley/Lavoie (2006) (henceforth GL), and it has a larger structure as compared to the first type and is able to assess rigorously a larger set of policies. Models that belong to the third type have a highly complex structure as they aim to capture more complicated transmission channels and mechanisms that underline the function of actual economies. For this reason, they are termed High Complexity (HC) models.

The paper provides a systematic review of the empirical SFC models, based on their structure. The models taken under consideration capture the majority of an economy's features, and their behavioural framework is either estimated econometrically or calibrated according to actual data. The discussion takes into account 28 empirical SFC models, the vast majority of which are estimated econometrically, while two are of reduced form. It is important to note that there is a growing number of models that are estimated–calibrated for multi-country regions instead of single countries (for example Jacques et al. 2023). In order to make the review more comprehensive, the focus is laid on models that are applied to single countries.² The paper argues that, on the one hand, the risk of poor performance is greater, with the more complex being its structure. Simply put, there is a trade-off between complexity and the goodness of fit. On the other hand, some specific aspects are overly simplified and need to be further developed. The actual choice of the level of complexity should depend on the nature of the research question, data availability and the features of the economy at hand.

The remainder of the paper is organised as follows. Section 2 discusses some particular features of empirical SFC models, while Section 3 is dedicated to the description of each of the three types of SFC models. Section 4 highlights some issues that ought to be addressed in the future, and Section 5 concludes.

2 MAIN FEATURES

The term stock–flow consistency has steered a debate on which models ultimately fall within this category. Nikiforos/ Zezza (2018) and Zezza/Zezza (2019) indicate a set of stock–flow consistency principles that characterise the SFC models, which, however, are not meant to define them accurately. Dos Santos (2006) and Ehnts (2019) argue that a major characteristic of the SFC models is that the behavioural framework is not only rooted on but also constrained by a solid accounting structure, as the latter reduces the degrees of freedom in the construction of the behavioural framework (Taylor 2004 cited in Lavoie 2022: 294). Going a step further would require a specific focus on what Zezza/Zezza (2019) mention as the stock-to-flow feedback principle.

SFC models can be identified through an evolutionary view on the nature of the balance sheet, which, in essence, is the cumulative outcome of decisions taken in the past. It registers in quantitative terms the historical route or the evolutionary path of the individual, sector or the economy under examination and constrains the potential future outcomes. This comes about through the integration of balance sheet items in the behavioural equations. The dynamic multiplier is a typical example of this, as the introduction of the lagged net wealth effect on consumption³ reflects in a consistent manner the lasting impact of the accumulated past decisions on the current and future outcomes.

2. An exception is made for the global model of Cripps/Izurieta (2014) as it is estimated econometrically.

3. See Godley/Lavoie (2006: ch.3).

This might not be a unique characteristic of the SFC models, but it helps in distinguishing them from the vast majority of other types of models, such as the DSGE models in which the balance sheet is stripped off from its evolutionary aspects and merely adjusts gradually to some predetermined equilibrium values.⁴ On the contrary, in SFC models the balance sheet constitutes one of the main reasons for the presence of path dependency. The trajectory that is governed by the accumulation of assets and liabilities is, practically, a sequence of short-run outcomes that dictate future flows (e Silva/Santos 2011; Zezza/Zezza 2019). The rest defining features of the SFC models, whether theoretical or empirical, are rooted mainly in the Post-Keynesian tradition.

2.1 Structure and scope

Canelli et al. (2021) divide the empirical SFC models into two groups, the theory-driven and the data-driven. In this paper, I take a different route and divide models according to the complexity of their structure, the number of institutional sectors and the amount of financial and physical assets. This further allows dividing empirical SFC models into three types, namely, the NC type, which aggregates households, firms and banks in one sector; the Godley and Lavoie type, which treats separately the standard institutional sectors; and the HC type, which is characterised by great heterogeneity.

It is logically coherent to argue that more complex structures are usually theory-driven, though this need not always be the case. For instance, the model for the Netherlands (Meijers/Muysken 2022) has a complex financial structure as the Dutch economy is heavily financialised, while the model for Colombia (Godin et al. 2023) has a large set of financial assets due to the importance of borrowing in foreign currency. In both cases, the complexity is imposed by the actual circumstances and not by the theory.

Nonetheless, higher complexity bears a cost in terms of the model fitting actual data. Not many cases reviewed in this paper provide in-sample projections. From the available data, it occurs that, in their vast majority, models fit quite well data of the real side of the economy but miss the financial side. This could be attributed to a number of reasons: (a) the use of different data sets that are not entirely consistent with national accounts data; (b) difficulties in modelling capital gains, which are of higher frequency, more stochastic and volatile; (c) higher sensitivity of more complex models to parameter changes; (d) closures and assumptions on residuals that are usually associated with the behaviour of the financial sector; and (e) behavioural frameworks, such as Tobinesque rules and accommodative banks, which are not suitable for the economy at hand.

Table 1 presents some main characteristics of the three types of empirical SFC models. The majority of them has a highly complex structure, and from the median year of publication, it seems that HC models are more recent and preferable. The average number of sectors and financial and physical capital assets ensure the validity of the division applied in this paper. On average, the number of assets is doubled between the NC and GL models. The same is the difference between the GL and HC models. Regarding the sectors, on average NC models utilise a minimum set, the GL models make use of the five standard

4. For instance, in the former DSGE model of the European Commission (Ratto et al. 2009), any discussion about money holdings is ruled out by assumption as portfolio choices adjust to the interest rate rule. In both versions of the DSGE model of the ECB (Gomes et al. 2012, Bokan et al. 2018), the balance sheet of non-liquidity constrained households is also consisted of state-contingent securities, which absorb the discrepancies from agents' optimal decisions on other asset holdings and have no further impact on their spending behaviour, or their portfolio choice. The stock-to-flow feedback effect is muted.

Table 1 Empirical stock–flow consistent models by type and main characteristics

Type	Number of models	Median year of publication	Average financial assets	Average capital assets	Average sectors
NC	7	1999	4	1	3
GL	8	2019	6	2	5
HC	13	2022	11	4	6

Note: NC, New Cambridge; GL, Godley and Lavoie; HC, High Complexity.

Table 2 Empirical stock–flow consistent models by type and scope

Type	IM	MTP	FMF	FID	FIN	GT
NC	5	3	1	1
GL	3	1	7
HC	3	...	6	1	2	5

Note: IM, external or sector imbalances; MTP, medium-term projections; FMF, fiscal, monetary or financial operations; FID, functional income distribution; FIN, financialisation; GT, green transition.

institutional sectors, while models that are more complicated integrate slightly more sectors, either in the production or in the financial domain.

Table 2 presents the scope(s) of each type of model as reported by the respective author(s). The scope of the model usually defines its structure. For instance, medium-term projections are carried out through NC models, while financialisation and green transition dynamics necessitate the examination of more complex dynamics and transmission mechanisms. Therefore, HC models are more suitable for this task. The GL models have a comparatively more generic structure and fit data well; thus, these models are multi-purposed.

2.2 Empirical form and estimation

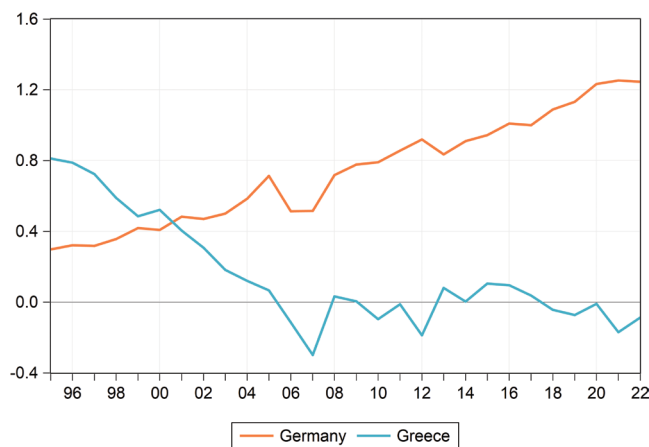
In the majority of the empirical SFC models, the behavioural equations are estimated econometrically. The most typical empirical form is the error correction, as it is fully compatible with the underlying mechanism of SFC models, according to which stock–flow norms do not deviate for a long time away from their long-term values and the steady-state growth.⁵ For instance, in the Levy model for Greece (Papadimitriou et al. 2013) the private expenditure, which is a typical feature of the NC approach, is estimated econometrically and depends on its long-term relation with the disposable income of the private sector, its lagged accumulated financial wealth, household credit and capital gains, as well as on the respective error correction terms. The formulation is very similar in estimated-calibrated HC models. For example, in the continuous-time model for Colombia (Godin et al. 2023), households first decide on a target level of consumption, based on their disposable income, wealth and new credit. The target is equivalent to the long-term relation in the NC model. Then households adjust their current consumption to the targeted one, which is also equivalent to the error correction term in the NC model.

5. For a detailed discussion, see Zezza (2013).

In this constellation, a negative shock is ensued by a gradual adjustment towards the target or the long-term value, with the speed of adjustment depending also on the magnitude of the balance sheet effect, for example, the presence of path-dependency. This does not imply that the long-term coefficients act necessarily as attractors in an equilibrium sense, but rather as long-term tendencies, which, however, could be subject to structural changes at any point in time. Figure 1 presents two examples of opposite cases, namely the wealth-to-income ratios of Germany and Greece for the period between 1995 and 2022. In the case of Germany, the ratio is fairly stable around its trend, implying that the error correction term could justify any gradual adjustment to the long-term structure. In the case of Greece, the presence of a structural break is clearly evident in 2007. The trend before the break has been negative, while after 2007 the stock–flow norm fluctuates around zero, not in a homoscedastic manner.

SFC models do not impose equilibrium conditions, and for this reason, they are able to trace imbalances and unsustainable conditions. In order to do so, there is a requirement for a constant re-evaluation of stability conditions. The researcher ought to carefully balance between the stability of the model, for example, respond to Lucas' critique through cointegrating relations, and the stability of the economy under examination, for example, avoid ergodicity that might be imposed by the cointegrating relations, which in the real world are always subject to change.

A final note in the estimation of empirical models relates to whether the introduction of shocks, in order to carry out policy assessments, ought to take place in isolation of other dynamics. The common practice in all models discussed below is to introduce shocks after the estimation of a baseline scenario. In this case, the possibility that unobserved dynamics affect the policy outcome is particularly high. In order to address this issue, one would first have to estimate a potential steady state and then introduce the shock. Nonetheless, for the estimation of the steady state the researcher would either have to arbitrarily impose



Note: Net financial wealth excludes the assets and liabilities of the central bank.

Source: Own elaboration of Eurostat data.

Figure 1 Net financial wealth to disposable income ratio of the private sector in Germany and Greece (1995–2022)

long-term conditions to the current state of the economy or impose other *ad hoc* rules. In addition, a shock in the current state of the economy might be biased due to the presence of unobserved dynamics, but the policy outcomes are fairly consistent with the conditions that prevail at the specific point in time, in which the shock has been introduced. Simply put, a shock at time t yields a biased outcome, due to the presence of unobserved dynamics. However, assuming the implementation of the policy at time t in a real economy its overall performance would depend also on the unobserved dynamics. The actual choice on whether to assume a steady state or not depends on whether the researcher aims to highlight the properties of the economy or its performance at a specific time period.

3 EMPIRICAL SFC MODELS

The presentation of the three types of models pays particular attention on how the structure of each type of model is closely connected with its scope, as stated by the authors. Due to space limitation issues, the discussion is restricted to the description of groups of models and not on a model-to-model basis, although, in some instances, it is less convenient to do so. Additionally, the section examines the nexus between complexity and the goodness of fit, conditionally to the availability of in-sample projections that allow such a discussion. A few remarks are in place. First, the performance of each model in the in-sample projections largely depends on whether the simulation is dynamic or static. In the former case, the model makes use of the first-period data and provides projections based on the estimated coefficients and the exogenous values. In the static simulation, the model makes use of the previous period's data. In the dynamic simulation, residuals are accumulating and the overall performance is expected to be poorer as compared to the static simulation. Unfortunately, in the vast majority of the papers, the authors do not provide any relevant information. Second, *ad hoc* rules are employed in order to assess the goodness of fit. High performance occurs when projections follow the same trend with actual data and their discrepancy is trivial. Medium performance is characterised by either a discrepancy between the projected and actual data that does not exceed 2 per cent of GDP or the projections' trends follow a different path from the actuals. The model performs poorly if both trends are different from those of actual data and the discrepancy is large. Finally, the following section briefly presents some notable closures applied in each model.

3.1 Mark I: New Cambridge

The main feature of the NC approach is the aggregation of households, non-financial and financial corporations in one sector. In most cases, this is reflected in an aggregate private expenditure function, which treats consumption and investment as one single variable. The latter typically depends on the aggregate private sector disposable income, net financial wealth and other financial variables.⁶ Given this formulation, one could obtain stable medium-term stock–flow relations, which translate to a stable net financial wealth–disposable income ratio.⁷ This approach was initiated in the CEPG during the 1970s and has

6. For further details on the explanatory variables, see for example Cripps et al. (1976).

7. For a discussion on the necessity of this formation on behavioural grounds, see Fetherston/Godley (1978).

Table 3 *Empirical NC models*

Authors	Country	Scope	Fit		Notable closure
			Real	Financial	
Cripps/Godley (1976)	UK	IM/MTP	N/A	N/A	Private sector financial wealth
Davis (1987a,b)	UK	FMF	N/A	N/A	Private sector financial wealth
Godley/Zezza (1992)	Denmark	FMF	Good	N/A	Private sector wealth
Godley (1999)	USA	IM/MTP	N/A	N/A	Private sector financial wealth
Papadimitriou et al. (2013)	Greece	IM/MTP	N/A	Adequate/Good	Private sector net external debt
Pierros (2021)	Greece	FID	Good	N/A	Private sector net external debt
Valdecantos (2022)	Argentina	IM	Good	N/A	Private sector money holdings

been criticized in both the Keynesian (Bispham 1975) and the Monetarist and Neoclassical (Blinder 1978) domains.⁸

Table 3 summarises the empirical SFC models of the NC type. In the majority of the models, the self-reported scope is to trace imbalances, based on the evolution of the sector financial balances. In addition, most models are used for medium-term projections. Concerning the latter case, the light structure in conjunction with the comparatively small number of behavioural equations implies that the degrees of freedom are not restricted significantly and that the model is expected to be less sensitive to parameter changes.

Models with such a standardised form include the model for the UK (Cripps/Godley 1976), the model for the US (Godley 1999) and the two models for Greece (Papadimitriou et al. 2013; Pierros 2021), even though the one model for Greece (Pierros 2021) transforms the private expenditure function in order to account for the impact of functional income distribution on economic performance. The rest models are variations of the NC approach as they have separate consumption and investment functions, but in the balance sheet of the model, the private domestic entities are treated as one sector. The slightly different structure of these variations is also evident in their scope, which is either more generic or more suitable to examine specific instability issues, such as the volatility of the exchange rate in the case of Argentina (Valdecantos 2022).

Not many models provide in-sample projections. Both the models for Greece and the one for Argentina have a very good fit in terms of national account data. Regarding financial data, the one model for Greece (Pierros 2021) does not provide in-sample projections, while the other (Papadimitriou et al. 2013) has a very good fit when estimating financial variables at historic costs but not a great one concerning market costs. According to the authors, this is in large due to the combined use of different data sets. The model for Argentina provides in-sample projections for savings as a proxy for the replication of

8. For a detailed exposition of the debate regarding the private expenditure function, see Maloney (2012) and Mata (2012).

financial data. The fit is excellent but it does not replicate actual financial variables, in a strict sense.

Finally, in almost all cases the main closure of the model is related to the wealth of the private sector. This follows from the very simple balance sheet that the majority of the NC models utilise. In this respect, the private sector wealth absorbs all the discrepancies. There are minor variations in this set-up. Wealth can be either financial or total as in the case of Godley/Zezza (1992) and further, it could be total net financial wealth or vis-à-vis the external sector. A notable extension is the case of the model for Argentina, which has a richer structure in terms of the balance sheet. In this particular case, money holdings clear the portfolio allocation of the private sector.

3.2 Mark II: Godley and Lavoie

The publication of the book by Godley/Lavoie (2006), which currently serves as the major textbook on theoretical SFC models, has exposed analytically how the stock–flow relations affect the behaviour of each of the five standard institutional sectors and their interaction. This gave rise to a new generation of empirical SFC models, aiming to capture dynamics emanating from richer structures as compared to the first generation. In terms of the demand components, consumption and investments are now determined separately, but in advance so are the balance sheet and the financial balance of households and firms. However, structures that are more detailed are equally more demanding in terms of data. Thereby, data availability constraints become more binding and the difficulty of constructing from whom-to-who matrices becomes much higher.

Almost all models, presented in Table 4, have a rather more generic macroeconomic structure and thus they are able to assess a large variety of fiscal, monetary and financial operations. The only two models that examine very specific research questions are the model for Moldova (Le Heron/Yol 2019) and the model for Iceland (Raza et al. 2019). Both are in the reduced form. They are clearly theory-driven, in the sense that first the structure is developed in isolation to the actual economy and then the model is calibrated according to actual data.

Additionally to their structure, almost all models of the GL type are also heavily influenced by the behavioural framework of Godley/Lavoie (2006). This is evident in the Tobinesque portfolio allocation of wealth, the behaviour of the banking sector, which holds an accommodative stance, as well as in the central bank operations, which clear the bond market. In the Icelandic model, this role is held by the foreign sector. A notable exception is made in the case of the model for Italy (Passarella 2019) and the model for Campania (Canelli et al. 2021), which, so far, is the only empirical SFC model at sub-national level. Both models make use of the ‘Other financial assets’ item of the financial accounts as the variable that absorbs all discrepancies in the portfolio allocation of each institutional sector. This resembles the role that state-contingent securities hold in the DSGE models. However, a detrimental difference is the presence of the stock-to-flow feedback mechanism in the two SFC models that is the balance sheet effect in the behavioural equations. Note that in the case of the UK model (Gudgin et al. 2015), there is a lack of information regarding the closures of the model.

As in the case of the NC models, there is limited provision of in-sample projections. The models for the UK and Campania (Canelli et al. 2021) have an excellent fit regarding the real side of the economy, while the model for Moldova misses the actual values in some specific variables and for a limited period. In broad terms, it projects consistently real data. Concerning the financial side, only the Italian models provide in-sample projections. The model of Passarella (2019) replicates the net lending/borrowing positions of all

Table 4 Empirical GL models

Authors	Country	Scope	Fit		Notable closure
			Real	Financial	
Kinsella/Tiou-Tagba Aliti (2012)	Ireland	IM/FMF	N/A	N/A	Wealth of the external sector
Gudgin et al. (2015)	UK	FMF/MTP	Good	N/A	N/A
Le Heron/Yol (2019)	Moldova	IM	Adequate/Good	N/A	Central bank refunds
Passarella (2019)	Italy	FMF	N/A	Adequate/Good	‘Other financial assets’
Raza et al. (2019)	Iceland	IM	N/A	N/A	RoW demand for domestic bills
Canelli et al. (2021)	Campania (IT)	FMF	Good	Adequate/Good	‘Other financial assets’
Michelenia (2021)	Argentina	FMF	N/A	N/A	Central bank bond holdings
Nguyen et al. (2023)	Vietnam	FMF	N/A	N/A	Central bank bond holdings

institutional sectors quite well but misses the actual values for small periods. The model for Campania has an excellent fit of both real and financial variables, though it slightly misses the actual values vis-à-vis the external sector. Nevertheless, despite the minor discrepancies the overall fit of the models is very efficient and satisfying. These discrepancies are rather expected and, up to a level, unavoidable. As it will be pointed out later, the larger the discrepancy, the higher the complexity of the model.

All in all, GL empirical SFC models have a generic structure in terms of institutional sectors and are the most versatile in carrying out both *ex ante* and *ex post* policy assessments. This is also evident in the scope of the models as reported by their authors. The closures in the Italian models make efficient use of variables that are usually considered exogenous and of little interest, if any at all. An advantage is that the GL type provides insights into the financial domain of the economy and can highlight macro-financial transmission mechanisms as compared to the NC approach.

3.3 Mark III: High Complexity

The structures in this type of model are largely heterogeneous and critically depend on the research question. Additionally, a higher complexity is accompanied by more pressing data requirements, as values for several important variables are either not publicly available or not even observed, for example, they are immeasurable. In these cases, *ad hoc* values/rules and calibrating rule the roost. This does not necessarily imply that models of the HC type are always theory-driven. In some cases, higher complexity is unavoidable for practical reasons. The HC models are summarised in Table 5.

Table 5 Empirical HC models

Authors	Country	Scope	Fit		Notable closure
			Real	Financial	
Cripps/Izurieta (2014)	Global	FMF/IM	N/A	N/A	N/A
Burgess <i>et al.</i> (2016)	UK	IM	N/A	Poor	Household pension wealth
Miess/Schmelzer (2016)	Austria	FMF	N/A	N/A	N/A
Jackson/Victor (2020)	Canada	GT	N/A	N/A	Loan provision/Equity issuance
Valdecantos (2021)	Argentina	FMF/GT	N/A	N/A	Financial sector bond holdings
Mazier/Reyes (2022)	France	FIN	Adequate	Adequate	Accommodative banking sector
Meijers/Muysken (2022)	Netherlands	FIN	Good	Poor	Central bank reserves
Zezza/Zezza (2022)	Italy	FMF	Good	Poor	'Other financial assets'
Godin <i>et al.</i> (2023)	Colombia	IM/GT	N/A	N/A	Households' equity holdings
Hermitte <i>et al.</i> (2023)	Italy	FMF	Good	Very poor	Households' equity holdings
Espagne <i>et al.</i> (2023)	Vietnam	GT	N/A	N/A	Financial sector bond holdings
Yilmaz <i>et al.</i> (2023)	Tunisia	GT	N/A	N/A	Financial sector bond holdings
Byrialsen <i>et al.</i> (2024)	Denmark	IM/FMF/FID	N/A	N/A	Accommodative banking sector

It is interesting to note that in several cases the closures vary according to the structure of the models. For instance, the UK model of Burgess *et al.* (2016) is mostly dedicated in modelling explicitly the housing market and the heavy involvement of insurance companies and pension funds (ICPF) in the financial side of the economy. A notable closure of the model is the pension wealth of households. The model for Colombia (Godin *et al.* 2023) and one of the models for Italy (Hermitte *et al.* 2023) utilise a large number of financial assets. The financial operations of the institutional sectors are highly complex; thus, one of the behavioural functions is downgraded in order to clear the respective market. In both cases, this role is held by households' demand for equities. Note, however, that in the case of the Colombian model, the complex structure captures the liquidity requirements of the domestic sector for foreign reserves and loans, in order to examine how the green transition process will affect them. On the contrary, the Italian model applies a highly complex structure without a specific research intension. This does not imply that all closures are complicated. On the contrary, in several cases, the banking sector has an accommodative stance, clearing the financial markets, mainly the bonds market or providing credit on demand. In other cases, it is the central bank that clears the bonds market.

Concerning the scope of the models, in many cases, it appears under the generic label fiscal, monetary or financial operations. This is similar to the GL type discussed above, though the models in this case are more apt to assess policies that are more specific. For instance, the model of Cripps/Izurieta (2014) is applied to ten different groups of countries, covering almost the entire globe. It provides detailed insights on issues related to policy design with a varying degree of policy coordination. The Austrian model (Miess/Schmelzer 2016) exploits in full the available data provided by the Eurostat in order to build a detailed financial sector. The models for Italy (Zezza/Zezza 2022) and Denmark (Byrialsen et al. 2024) have a rather generic structure but use an extensive number of physical assets, along with financial ones. The rest models serve specific purposes and so their structure follows firmly. The models for France (Mazier/Reyes 2022) and the Netherlands (Meijers/Muysken 2022) examine several aspects of financialisation in the respective countries and for this reason, they either utilise a large set of financial assets or have an extended financial sector. On the contrary, the models assessing green transition dynamics have a more detailed non-financial corporate sector.

Finally, the fit concerning the real side of the economy is in general high, but in the financial domain on average, it is low. The UK model projects accurately the net lending positions of all the sectors but the financial ones. The discrepancies regarding the financial balance of the banking sector and the ICPF vary from 2 to 4 p.p. of GDP. Miess/Schmelzer (2016) do not provide in-sample projections for their model for Austria. However, they do not estimate parameters econometrically but calibrate them. In addition, there is an extended use of constant shares to GDP for endogenous variables. This is particularly important for the out-of-sample projections, as in most cases the evolution of the parameters follow a very divergent path as compared to in-sample values. This is evident in the financial variables, including the sector's financial balances. The in-sample inaccuracies of the French model have to do with the trade balance, prices and the financial balance of the public sector, especially after the outburst of the European debt crisis (at max the discrepancies amount to two p.p. of GDP). In the Dutch model, the in-sample projections have a very good fit with respect to the real side of the economy but vary wildly off the actual values of banks' net wealth and net reserves of the foreign sector. Regarding the model of Zezza/Zezza (2022), in-sample projections are very accurate concerning aggregate demand components and financial stocks. However, the authors refer to discrepancies when targeting financial flows. The other Italian model (Hermitte et al. 2023) presents enormous discrepancies as the in-sample projections miss the actual values of several financial variables by almost one-third of the GDP.

4 WAYS FORWARD

So far, the discussion elaborated on the trade-off between complexity and the goodness of fit. This implies that the necessity to exhibit good fitness poses constraints on its structure. In turn, this would implicitly mean that there are constraints in the further development of the empirical SFC models. However, this is not entirely true. There is a particular need to improve the behavioural framework. This might lead to more complex structures, though not necessarily. In some cases, reducing complexity at one part of the behavioural framework and increasing it at another part can be equally effective in improving the model.

For the following discussion, it is rather more convenient to conceptualise the economy in terms of structures, as presented in a simplified form in Figure 2. There are three structural blocks that operate in the economy, namely the productive block, the financial

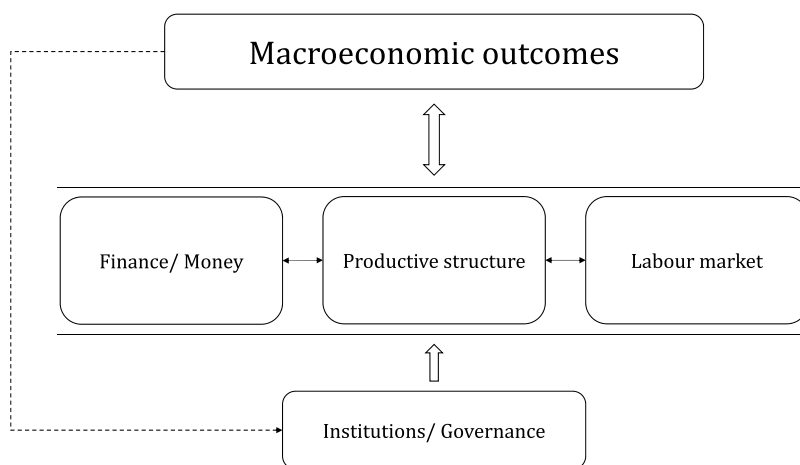


Figure 2 *Structural blocks of the economy*

block and the labour market structural block. Institutions⁹ and governance in their various forms (fiscal, monetary etc.) dictate the statutory and monetary framework in which the three structural blocks operate and all in conjunction determine the macroeconomic outcomes. In turn, the macroeconomic outcomes feed back to both the structural blocks and the institutions and governance. Not that the arrows indicate a suggestive causality, without, however, taking into account the time dimension.¹⁰ In addition, the environment is excluded from the figure, as it is not a separate structural block within the economy, but rather the opposite. The economy operates within the environment. In what follows, I discuss candidate extensions in each of the three structural blocks. Small steps towards all directions have already been made, though it is necessary to frame, these tendencies, analytically and consequently to generalise their application in the models.

The relative strength of the SFC models is that they treat the macroeconomy and the finance as an inseparable system. In this context, the underlining transmission mechanisms are exposed efficiently, even though the modelling of the financial sector is far from being ideal. Apart from the difficulty in replicating financial outcomes, the behavioural framework could be improved by introducing structuralist and Minskyan considerations. The former requires the introduction of specific targets that banks are expected to meet under the Basil III regulatory framework. This is already the case in the models for the Netherlands (Meijers/Muysken 2022) and Tunisia (Yilmaz et al. 2023), but ought to be generalised. Some features, such as banks being accommodative, could be set aside depending on the research question, while others like the introduction of credit constraints critically depend on data availability. Minskyan considerations, such as the introduction of sector financial fragility ratios,¹¹ can improve the insights that the model provides, without adding to complexity.

9. By 'institutions', I refer to what both Old and New Institutionalists imply by the same term.

10. For instance, the impact of macroeconomic outcomes on the labour market is immediate, while the impact on institutions becomes effective only after an extensive passage of time.

11. See for instance, Argitis/Nikolaïdi (2014).

Recently small steps have been made in developing further the productive structure of the economy, as in the case for Argentina (Valdecantos 2021) and Canada (Jackson/Victor 2020). This is not an easy task given the rather expected data unavailability with regard to the productive sectors of the economy. This is particularly important, as data on Input–Output tables, which allow for a large diversification of the productive structure, do not include financial data. Nonetheless, the current inflationary episode brought forth the need for gaining insights in terms of interlinkages and productive capacities. In addition, further research is required with regard to the use of the capacity utilisation rate, which is an important constituent of the investment functions, though its estimation is rudimentary given the absence of the appropriate data. Finally, pricing decisions rely excessively on a cost-plus pricing form, when in practice prices in some sectors vary according to the forces of demand (Kalecki 2013). The model for Colombia addresses this issue by integrating simultaneously both pricing forms.

Finally, even more steps forward are required in modelling the labour market. In the first place, labour demand usually depends on the GDP, after Okun's law and the productivity of labour, measured in persons employed. However, the deregulation of the labour market that has taken place in the past decades has broadened the difference between the labour productivity and the mean wage, on the one hand, and between the labour productivity measured in persons employed and that in hours worked, on the other hand. The latter is an efficient candidate explanation of the labour market slack, which has dominated the past decade (ECB 2017). In advance, wage setting is overly simplified in almost all models, while collective bargaining considerations such as coverage and coordination are absent, whatsoever. There are some attempts to introduce non-linearities (Byrialsen et al. 2024), the efficiency wage (Canelli et al. 2021) or labour market institutions such as the minimum wage (Pierros 2021). However, these are only small, initial steps towards the right direction, as more is required.

5 CONCLUDING REMARKS

The paper has provided a systematic review of empirical SFC models, distinguishing them according to their structure and amount of financial and physical assets. The models can be divided into three types: (a) the New Cambridge, which are more suitable for medium-term projections and tracing imbalances as their in-sample projections are very close to the actual data; (b) the Goldey and Lavoie type, which have a more symmetrical treatment of the institutional sectors and are more flexible in terms of policy assessment; and (c) the High Complexity models, the structure of which is expanded according to the research question. The latter have in general a poorer fit to actual data as compared to the other types, with discrepancies between projections and actual data occurring mostly in the financial side of the economy. On the other side of the coin, they are apt in providing more in-depth insights concerning specific research questions.

The actual choice of the structure of the empirical SFC model, regarding the trade-off between good fit and complexity, should depend on the research question. Models that provide medium-term projections should have a light structure in order to reduce the discrepancies with the actual data, which accumulate as residuals. In the middle ground stand the GL models, which have a more generic, but also versatile structure.

Regardless of the aforementioned trade-off, the empirical SFC models reflect efficiently some specific aspects of real economies but neglect others. Research has been mostly directed towards the interplay between the real and the financial side of the economy, in which interconnection is where the main advantage of the SFC models lies. Nonetheless,

there is ample space for the improvement of the financial sector. The same applies to the non-financial corporate sector. The less developed structural block in empirical, as well as theoretical, SFC models is the labour market. Finally, it is expected that the environmental dimension would be even more present in the structure of the models, as addressing the climate change becomes even more pressing.

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