Stock-Flow Consistent Macroeconomic Models: a Survey

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Abstract

The Stock-Flow-Consistent modeling approach, grounded in the pioneering work of Wynne Godley and James Tobin in the 1970s, is being adopted by a growing number of researchers in macroeconomics, especially after the publication of Godley and Lavoie (2007), which provided a general framework for the analysis of whole economic systems, and after the recognition that macroeconomic models integrating real markets with flow-of-fund analysis had been particularly successful in predicting the Great Recession of 2007. We introduce the general features of the SFC approach for a closed economy, showing how the core model has been extended to address issues such as financialization and income distribution. We next discuss the implications of the approach for models of open economies, and we compare the methodologies adopted in developing SFC empirical models for whole countries. We review the contributions where the SFC approach is being adopted as the macroeconomic closure of microeconomic agent-based models, and how the SFC approach is at the core of new research in ecological macroeconomics. Finally, we discuss the appropriateness of the name "Stock-Flow-Consistent" for the class of models we survey.

Keywords: macroeconomic models, stock-flow consistency, financial models, economic policy

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1. INTRODUCTION

The stock-flow consistent (henceforth SFC) approach to macroeconomic modeling has become increasingly popular among economists of different persuasions. Despite, as we will shortly see, its roots going back at least five decades, it popularity has increased exponentially after the recent crisis of 2007–09. Two factors played a significant role for that. First, the 2007 publication of *Monetary Economics* by Wynne Godley and Marc Lavoie (2007a), a book that summarizes and synthesizes the basic principles and modeling methods that far. Second, the recognition that models and policy analyses based on the SFC framework (e.g. Godley, 1999a) were able to accurately predict the crisis, which caught the majority of the profession by surprise. For these two reasons the years of the Great Recession are a demarcation point in time that separates the early period of the development of the SFC approach from the more recent period afterwards.

The main characteristic and advantage of the SFC approach is that it provides a framework for treating the real and the financial side of the economy in an *integrated* way. In a modern capitalist economy, the behavior of the real side of the economy cannot be understood without reference to the financial side (money, debt, and assets markets). Although this is a general statement, it became particularly evident during the recent crisis and the slow recovery that followed (hence the aforementioned surge in the popularity of SFC models). For that reason, the SFC approach is an essential tool if one wants to examine the political economy of modern capitalism in a rigorous and analytical way.

The roots of the SFC approach go back almost half a century, to the late 1960s and 1970s, a "hard time" for Keynesian economists, who saw their influence decline in favor of monetarism and later neoclassical economics (Dos Santos, 2006). The two main figures in these nascent years were Wynne Godley at the University of Cambridge and James Tobin at Yale University. Godley, after working for fourteen years at the Treasury, joined the University of Cambridge as the director of the Department of Applied Economics, within which he also formed the Cambridge Economic Policy Group. His writings at the time—most done together with Francis Cripps—contain the basic elements of the principles of SFC modeling that we will discuss below (Godley and Cripps, 1974 and 1983; Cripps and Godley, 1976 and 1978). Since these early days, the two basic characteristics of Godley's approach are an effort to combine economic theory and policy (not surprising for someone who had spent fourteen years at the Treasury) and successive attempts to build rigorous models that combine the real and the financial side of the economy.

At the same time, on the other side of the Atlantic, James Tobin developed a similar approach, which came to be known as the “pitfalls” approach. The approach was developed in a series of papers, many of which were coauthored with William Brainard (Brainard and Tobin, 1968; Tobin, 1969; Backus et al., 1980), and was summarized in Tobin’s lecture when he received the Nobel prize (Tobin, 1982a). According to Tobin, the main pitfall in financial model building is the failure to explicitly model that “the prices and interest rates determined in these [financial] markets and the quantities to which they refer *both influence and are influenced by the ‘real economy’* [...]. These *interdependences* are easy to acknowledge in principle but difficult to honor in practice, either in theoretical analysis or in empirical investigation” (Brainard and Tobin, 1968: 99, emphasis added). The aim of Tobin’s research project was thus to provide an analysis that properly honors these interdependencies. As we will discuss in more detail in section 2.2, among other things, Tobin set out the principles that determine portfolio choice within these models.

The SFC approach is also highly influenced by the work of Post-Keynesian economists. Among the Cambridge economists it was Nicholas Kaldor that had the largest influence on Wynne Godley. They met while Godley was at the Treasury and it was Kaldor who brought him to Cambridge. In the preface of Godley and Lavoie (2007: xxxvii), Godley writes that Kaldor “was touched by genius.” Among other things, it was discussions with Kaldor that led Godley to identify and recognize the importance of the “three balances” (for Godley’s recollection see ibid: xxxvi), which we will discuss in some detail in section 4. Kaldor had already mentioned these balances three decades earlier, during the war (Kaldor and Barna, 1944), though without then recognizing their importance.

On the other side of the pond, one can recognize the influence of Minsky (1975 and 1986) on the SFC approach. A lot of Godley’s models and analyses—intentionally or not—formalize Minskyan ideas, while (as we shall see in section 3) there is a considerable number of more recent papers that treat Minskyan themes in an SFC framework (Minsky also played an instrumental role in Godley’s coming to the Levy Economics Institute).

The SFC approach also has a certain intellectual kinship to national accounts based macroeconomic models, first introduced by Richard Stone (e.g., Stone and Brown, 1962) as part of his wider pioneering work on national accounts. Stone preceded Godley as the first director of the Department of Applied Economics at the University of Cambridge. Stone's methodology was further developed as a base for fixed-price multiplier-type analysis based on large social accounting matrices (Pyatt and Round, 1977and 1979; Pyatt, 1988; Round, 2003a and 2003b) and also then used as the accounting framework for computable general equilibrium (CGE) models (Johansen, 1960; Taylor and Black, 1974; Adelman and Robinson, 1978; Taylor et al., 1980; Dervis et al., 1982; Taylor, 1990; Dixon and Jorgenson, 2013).

The latest part of this long first phase of the formation of the SFC approach started in 1994 when Godley arrived at the Levy Economics Institute of Bard College and ends with the publication of *Monetary Economics* (the book was the result of a long research project that was undertaken together with Marc Lavoie from the University of Ottawa). At the same time, and in accordance with his preference for a combination of theory and policy, Godley created the Levy Macroeconomic Model, a policy model based on SFC principles that was successful in predicting the downturn of 2001 and the Great Recession.

As we mentioned above, after the publication of *Monetary Economics* there have been extensive contributions to the literature adopting the SFC method to examine a variety of issues. The purpose of this paper is to provide a detailed survey of this literature. Towards that goal, in the next section we provide an overview of the basic principles of SFC modeling, which will also act as an entry and a reference point for the discussion that will follow. These principles can be divided into two broad categories. First, the building of the models starts with a lot of attention to accounting consistency. In the words of Taylor (2004, 206) making sure that the accounting is right is often "the best way to attack a problem in economics." Careful accounting can lead to interesting conclusions in its own right because it imposes certain constraints and reduces the degrees of freedom of the model. The second category consists of the closure and the behavioral specification of the model. SFC models have a post-Keynesian closure, in the sense that demand matters and full employment is not considered the general state of the economy. Moreover, and based on the early insights of Godley and Tobin, there is a thorough modeling of the real and the financial side of the economy and their *interdependences*. The accounting structure of the model provides the basis for these modeling exercises.

Finally, it is worth mentioning that the principles of SFC analysis in one form or another were advocated and used by various scholars in parallel and sometimes crossing paths with the abovementioned protagonists. Paul Davidson (1968) was one of the first to emphasize that money balances need to be taken into account in models of capital accumulation. In the same year, Davidson (1968b) provided an early exploration of the implications of portfolio choice for economic growth. Stock-flow consistency is also a central element in the work of Alfred Eichner (e.g. 1987), who also emphasized the interdependences of the real and the financial sector and the need for a combined treatment in order to understand the capitalist economy. Lance Taylor arrived at the SFC approach through his extensive work on CGE models (cited above) and the Structuralist theory of growth, distribution, and finance (see Taylor, 1983and 1991; Taylor and O'Connell, 1985; Taylor [2008] provides a review of *Monetary Economics*). Another author within the Post-Keynesian tradition who has consistently been using rigorous analytical SFC models is Peter Skott (e.g. 1989). Finally, in addition to these Keynesian scholars, Duncan Foley (1982, 1986) uses an essentially SFC model to formalize the circuit of capital originally proposed by Marx (1978) in volume II of *Capital*.

The rest of the paper proceeds as follows. The basic principles of SFC modeling are laid out in section 2. In the first subsection (2.1), we discuss the accounting principles and in the second (2.2) the closure and the treatment of the real and financial side of the economy in a generic SFC model. Section 3 then presents how various contributions have extended and/or modified this generic treatment to examine issues related to the monetary circuit, financialization, and changes in income distribution. In section 4 we discuss how the more abstract closed economy model can be extended to deal with the implications of open economy macroeconomics. The open economy model allows us to introduce the "three balances approach," which is one of the main building blocks of SFC analysis. The theoretical open economy models allow us to discuss—in section 5—SFC models for whole countries as concrete economic policy tools. Then, in section 6, we present recent contributions of SFC applications to environmental issues. Finally, in recent years there has been an effort to use the SFC approach together with the Agent Based Modelling method, which we discuss in section 7.

In section 8, we conclude with a discussion of the name "stock-flow consistent." We argue that the name is sometimes misleading and confusing. As we already mentioned in the previous paragraphs, accounting consistency is just one side of the SFC approach, with a demand-led economy and an explicit treatment of the financial side being the other.

Finally, we need to say that there have been two excellent survey papers of the SFC literature before this one. The first one is Dos Santos (2006), written in the early era of SFC modeling, which tries to locate the SFC approach within different strands of Keynesian macroeconomic thought. The second one is Caverzasi and Godin (2014). The purpose of our paper is of course to update these surveys with the burgeoning recent literature, but also approach some issues from a different angle. Finally, our paper discusses some issues that cannot be found in these papers, like the meaning of the name SFC. In any case, our contribution should be taken as complementary to these two previous surveys.

2. BASIC PRINCIPLES

2.1 Accounting Consistency

We can identify four main accounting principles of SFC macroeconomic modeling:

i. *Flow consistency*. Every monetary flow comes from somewhere and goes somewhere. As a result, there are no "black holes" in the system. For example, the income of a household is the payment for a firm, the deficit of one sector is the surplus of another sector, and the exports of a country are the imports of another country. In the jargon of the National Accounts (European Commission et al., 2009), this type of flow consistency between units (household-firm; country A-country B) is called "horizontal" consistency. Another type of flow consistency is "vertical" consistency, meaning that every transaction involves at least two entries within each unit, usually referred to as credit and debit. For example, when a household receives income, its deposits are credited by the same amount.

ii. *Stock consistency*. The financial liabilities of an agent or sector are the financial assets of some other agent or sector. For example, a loan is a liability for a household and an asset for a bank: a Treasury bond is a liability for the government and an asset for its holder. As a result, the net financial wealth of the system as a whole sums up to zero.

iii. *Stock-flow consistency*. Every flow implies the change in one or more stocks. As a result, the end-of-period stocks are obtained by cumulating the relevant flows—and taking into account possible capital gains. More formally, $\Omega_t = \Omega_{t-1} + F_t + CG_t$, where Ω_t is the monetary value of the stock at the end of period *t*, F_t is the relevant flow, and CG_t are net capital gains (i.e., the effect of changes in the market price to the value of Ω). Thus, stock-flow consistency implies that positive net saving leads, *ceteris paribus*, to an increase in net wealth and vice versa. For example, when the net saving of a household is positive one or more of its assets increase (or one or more liabilities decrease) and its net wealth—save for capital gains—also increases. Obviously, this equation can be rewritten as $\Delta\Omega_t = F_t + CG_t$, where Δ is the difference operator. From this perspective the *change* in the stock, which is a flow in itself, is equal to the related flow and the capital gains. Stock-flow consistency is thus a logical corollary of the "vertical" flow consistency. The flow-of-funds (FoF) accounts usually have separate tables for the flows ($\Delta\Omega_t$) and the level of stocks (Ω_t) of financial assets.[1]

iv. These three principles, then, imply a fourth one: that every transaction involves a *quadruple entry* in accounting. For example, when a household purchases a product from a firm, the accounting registers an increase in the revenues of the firm and the expenditure of the household and at the same time a decrease in at least one asset (or increase in a liability) of the household and correspondingly an increase in at a least one asset of the firm. Quadruple-entry bookkeeping was introduced by (Copeland, 1947 and 1949) and is now the fundamental accounting system underlying the System of National Accounts (SNA) because it ties together the various types of accounting consistency and therefore guarantees the accounting consistency of the system as a whole (European Commission et al., 2009: 50).

Among others things, these principles mean that the accounting structure of the SFC models follows that of the SNA—albeit with a varying level of detail determined by the research question that the model wants to address. For example, a closed-economy SFC model respects the basic structure of the national accounts but purposefully abstracts from their parts that are related to the foreign sector. The accounting structure of the SFC models is summarized within two matrices: The balance sheet matrix and the transactions flow matrix.

Table 1 around here

We can make the above clearer by introducing the accounting structure of a baseline model. Table 1 presents the balance sheets matrix of an economy divided into five sectors: households, firms, government, the central bank, and banks. Thus, for the moment we assume a closed economy. We also assume the existence of six financial assets: high power money (HPM), deposits, loans, bills, bonds, and equities. These assets have one important difference related to their rate of return. The nominal rate of return of HPM is zero, while deposits, loans, and bills have a nominal rate of return equal to their respective interest rate. On the other hand, the overall rate of return of bonds and equity consists of their income return (interest and dividends respectively) but also of the possible capital gains due to changes in their market price.

The positive sign in the matrix denotes an asset and the negative a liability; the subscript denotes the holder of the related instrument. For example, bills (B) are a liability for the government but an asset for the households, the banks, and the central bank. The principle of stock consistency is captured in the matrix by the sum of each row of financial assets being equal to zero. To continue with the bills, the amount of liabilities of the government under this form is exactly equal to the holdings of bills on behalf of the other sectors, so that $B_g = B_h + B_h + B_{cb}$. An important conclusion of this careful accounting exercise then is that the common conception that government debt is a liability for the future generations is misguided. Assuming that the government debt is not held by foreigners, table 1 is telling us that it is a liability for the government and thus the taxpayers of the economy but *at the same time* an asset of households and other domestic sectors. The "future generations" that will have to pay for this debt—if they will have to—will also earn the proceeds of these payments.

The only tangible asset in Table 1 is fixed capital, which is an asset of the firms. Because of the stock consistency, all financial assets and liabilities cancel out. As a result, the overall net worth of the economy is equal to the value of the tangible assets—in this case, the fixed capital.

An important decision one needs to make when building an SFC model is how many assets to include. The more assets one includes, the more realistic the model becomes and the more real features of an actual economy it can potentially capture, but this comes at the cost of the model becoming exponentially complicated and less intuitive. A second, related decision has to do with the holders of each asset. In reality every sector holds (almost) everything, but in a model one may choose to focus on only certain holders of each asset to keep the model as simple as possible. As we mentioned above, these questions have to be addressed in relation to the research question at hand.

Table 2 around here

Besides the balance sheet matrix, the accounting skeleton of the model is completed with the Transactions Flows Matrix, presented in table 2. The matrix may seem intimidating to an unexperienced eye but it is not that complicated. Starting from column (2) in the upper part of the table we can see that—following the national accounts—total output is decomposed from the expenditure side into total consumption (*PC*), investment (*PI*), and government expenditure (*PG*), and from the income side into wages (*W*) and profits (*Π*).

A convention of the matrix is that sources of funds are denoted with a plus sign and uses of funds with a minus sign. Horizontal flow consistency requires that for each category of transactions the flow and the uses of funds sum to zero. For example, in row (F) we see that the wages are a use of funds for the firms but a source of funds for the households. The other income sources of funds for the households are the distributed profits ($\Pi_{c,d}$) and the interest income on the various assets they are holding. On the other hand, a household's major uses of funds are the purchase of consumption goods, paying taxes (T_h), and the interest on their loans. The latter is equal to the interest rate on loans times the stock of their loans in the previous period ($r_{l-1}L_{h-1}$).

The difference between the overall sources and uses of funds is equal to the net lending of the sector. In the case of the household sector that is:

$$NL_h = \left[W + \Pi_{f,d} + r_{d-1}D_{h-1} + r_{b-1}L_{h-1} + r_{bl-1}L_{h-1}\right] - \left[PC + T_h + r_{l-1}L_{h-1}\right] \quad (1)$$

Vertical accounting consistency requires specifying where this net lending goes. As we can see at the bottom part of column (1), a positive net lending means an increase in the various financial assets held by the households (denoted with a minus sign since this is a use of funds) or a decrease in their loans. An important decision, which we will discuss in more detail in the following section, is how the households and the other sectors allocate not only their net lending, but also their already accumulated wealth among these assets. Overall, vertical consistency requires that the sum of each column of the table is also equal to zero.

The rest of the matrix can be read in a similar way, so we do not need to go through every entry. Four more comments are in order here. First, whenever a payment implies a change in the stock of real or financial wealth it is a good idea to record it separately in the capital account. Therefore, in principle, all entries in the FoF part of the table should appear in a “financial/capital account” column of each sector, with net lending transferred from the current account to the capital/financial account. In that sense the households would transfer their net lending to their capital account and this account would then record the changes in their assets and liabilities. For reasons of simplicity and economy of space we opted for a simpler layout, with one account for each sector.

The only sector where we cannot apply this simplifying treatment is the corporate sector. Investment (*PI*) is a transaction that takes place within the corporate sector: some firms buy investment goods from other firms that produce them. Similarly, the retained profits gross of taxes and interest payments ($\Pi_{c,c}$) are also an income “transfer” that takes place within the sector. To capture these intrasectoral transactions in a consistent way, we need to have the capital account of the firms in column (3). The difference between retained profits net of taxes and income payments ($\Pi_{c,r} = \Pi_{c,c} - T_c - r_{l-1}L_{h-1}$) and investment is equal to the net lending of firms. At the lower part of the table we see that a negative lending (a net borrowing) is covered either by the issuance of new equity or by assuming more loans.

$$NL_c = \Pi_{c,r} - PI = \Delta L_c + p_e \Delta E \qquad (2)$$

Second, the horizontal consistency applies also to the FoF part of the matrix, so that the overall change in every asset is equal to the change in the corresponding liability. For example, the increase in the loans offered by banks is equal to the increase in the loans assumed by households and firms. In such a way the stock consistency of the system is maintained. Algebraically, that means that the sum of each row in the lower part of the matrix is also zero.

The end-of-period values of the assets in the balance sheet matrix (table 1) are equal to their value at the beginning of the period plus the change during the period (as captured in the lower part of table 2) and possible capital gains. In that sense, the FoF subtable provides the link between the balance sheet matrixes of successive periods. For example, in the case of the stock of loans—which do not have a price and therefore no capital gains are involved—their end of period value is:

$$L_h = L_{h-1} + \Delta L_h \qquad (3)$$

with the latter term of the equation coming from the FoF subtable. In the case of assets with an explicit price, the end-of-period stock needs to take capital gains into account. So, the end of period stock of equities is:

$$p_e E = p_{e-1} \cdot E_{-1} + p_e \cdot \Delta E + \Delta p_e \cdot E_{-1} \qquad (4)$$

where the last term ($\Delta p_e \cdot E_{-1}$) captures the capital gains, which is the change in the value of the stock of equities at the end of the previous period (E_{-1}) due to changes in their prices (Δp_e). The institutions that produce FoF data usually also provide a separate matrix, the so-called revaluation matrix, with information on the revaluation of the assets.

Finally, another important corollary of doing the accounting right is that the sum of the net lending of the sectors of our system is equal to zero:

$$NL_h + NL_c + NL_g + NL_{cb} = 0 \qquad (5)$$

This is an important insight, which was first pursued consistently by Wynne Godley in the late 1970s (Godley and Cripps, 1983). Although it is a simple accounting identity, it has far-reaching consequences for macroeconomic analysis and it is a good example of why a careful specification of the accounting structure of a model is essential.

One of the most important of these consequences is that a negative net lending on behalf of a sector will tend to increase its debt-to-income ratio. For example, if we assume that the net lending of the banking sector in equation (5) is zero and the government is running large surpluses, then the private sector (households and firms) must be running large deficits, which in turn lead, *ceteris paribus*, to an increase in the indebtedness of that sector. A prolonged period with such a configuration can lead the private sector—to use the Minskyan terminology—from a hedge, to a speculative, and then a “Ponzi” position (Minsky, 1975 and 1986). This is an important point of contact between the SFC approach and the Minskyan analysis of financial markets and also emphasizes that the interlinkages between the balance sheets of each sector and the net lending position of the *other* sectors.

Table 3 around here

Another way to portray the accounting skeleton of an economy is the so-called Social Accounting Matrix (SAM). The SAM methodology was first introduced by Richard Stone and then was further developed as a base for multiplier fixed-price as well as for CGE models (see the references in the introduction). Table 3 presents a SAM for our economy. The information conveyed is essentially the same with the transactions flow matrix of table 2, albeit at a different format. The first row decomposes total output from the expenditure side and the first column from the income side. The north-west part of the SAM contains the additional transactions and income transfers between the sectors. Each row contains the sources of funds for each sector and each column the uses of these funds. Accounting consistency requires that sources and uses of funds are equal and therefore the sum of the respective rows and columns of the table are equal. To give an example, the total income of households in row (B) is equal to wages (W), distributed profits ($\Pi_{c,d}$)—which are a use of funds for the firms in column (3)—and income transfers from the government (Q_{gh})—which are a use of funds for the government in column (4)—and income transfers from the banks on their deposits ($r_{d-1}D_{h-1}$).[2] Overall then:

$$PY_h = W + \Pi_{c,d} + Q_{gh} + r_{d-1}D_{h-1} \tag{6}$$

On the other hand, the households use this income—in column (2)—for consumption (PC), paying income taxes to the government (T_h), and interest to the banks on their loans ($r_{h-1}L_{h-1}$); they save what is left, so we end up once again with the household's budget constraint in equation (1). We can read the sources and uses of funds of the remaining sectors in the same way.

The FoF part of the SAM contains exactly the same entries as the respective part of the transactions-flow matrix. The change in the assets follows the same convention, with uses and sources of funds having a negative and positive sign, respectively. The only difference is that we now need to read the table horizontally. Since all rows in this part of the table sum to zero, we again conclude that the sum of the net lending of the various sectors of the economy sums to zero, as in equation (5). In row (H) it becomes clear that the net lending of the firms is equal to their saving (the retained profits) minus investment as in equation (2).

Usually the SAM-based models pay more attention to the real side of the economy and the complications of the financial sector and asset allocation are ignored. Therefore, in the related literature more often than not the SAMs include one row for the FoF accounts with information on the saving of each sector and the negative of the fixed capital formation. The elements of this row sum to zero (in our SAM this row would include all the elements of the left side of the FoF part of the SAM: $NL_h + \Pi_{c,r} + NL_g + NL_{cb} - PI = 0$). This FoF row would correspond with the fixed capital formation column (the way it is now in our SAM), which also sums to zero and as a result the conventional SAM is a square matrix with the sum of each row being equal to the sum of each column. Following this conventional treatment of investment is the reason why we have a separate column for investment. The way we have constructed our SAM it would not have made much difference if investment had been assigned in cell (A3). In this case the cell (H3) would be the net lending of firms and not just retained profits.

The above implies that, for a macro-model, the choice between a transaction flow matrix and a SAM is a matter of taste. If properly constructed both matrices convey the same information and guarantee the accounting consistency of the model. An important advantage of the SAM format is that it is directly compatible with the input-output tables and system of accounts (United Nations, 1999; Eurostat, 2008).

2.2 Closure, Behavioral Specification, and Equilibrium

Accounting consistency is a very important part of SFC methodology. Doing the accounting correctly reduces the degrees of freedom of a model and provides some important insights by itself. However, as Taylor and Lysy (1979) have demonstrated in the context of CGE models, the conclusions of a model crucially depend on its "closure," or the direction of causality among the macroeconomic variables. In that respect, the SFC literature has developed mostly inside the Keynesian school; it is aggregate demand that sets the tone for the economy in the short run but also in the long run. Neoclassical macroeconomic models based on a forward-looking, representative agent maximizing utility are—or should be—stock-flow consistent and thus satisfy the principles of the previous subsection. However, in such models stocks and flows are always at their optimal level, when the system is not shocked, stock-flow consistency is not a particularly relevant issue.[3]

Another important part of the model is its behavioral specification. From a technical point of view, if a model needs to determine *n* endogenous variables, and its accounting skeleton provides us with *k* independent accounting identities, we need *n-k* more equations to solve the model.[4] These equations are provided by the specification of the behavior of the various agents and sectors of the model.

There are five broad categories of behavioral assumptions that one needs to make. First, we need to specify how the agents determine their expenditure. In the model of tables 2 and 3 we need to specify a consumption function, an investment function, and a government expenditure function. The latter is usually treated as a discretionary policy instrument, or modeled as a reaction function. The most common specification of the consumptions function is:

$$C_h = \alpha_0 + \alpha_1 Y_{h,d} + \alpha_2 (\frac{V_{h-1}}{P_{-1}}) \tag{7}$$

where $PY_{h,d} = PY_h - T_h$ is the nominal disposable income of the households and α_0, α_1, α_2 are positive constants. In other words, real consumption is assumed to be a function of real disposable income and the lagged real wealth. On the other hand, the investment function is usually a variant of the following specification:

$$g = \frac{I}{K} = \beta_0 + \beta_1 \frac{\Pi_{c,r-1}}{(PK)_{-1}} - \beta_2 \frac{L_{c-1}}{(PK)_{-1}} + \beta_3 \frac{L_{c-1} + p_{e-1}E_{c-1}}{(PK)_{-1}} + \beta_4 \frac{Y_{-1}}{K_{-1}} \tag{8}$$

Investment (normalized for capital stock) is a positive function of retained profits ($\Pi_{c,r-1}/ (PK)_{-1}$), the degree of indebtedness ($L_{c-1}/ (PK)_{-1}$), the valuation ratio ($q = [L_{c-1} + p_{e-1}E_{c-1}]/ (PK)_{-1}$), and capacity utilization (Y_{-1}/ K_{-1}).[5]

An important feature of both consumption and investment as specified above is that they depend on past values of stocks of assets and liabilities: the stock of wealth, of loans, of capital, etc. In other words, the stocks, as determined at the end of each period, feed back into the flows of the next period, which in turn determine the stocks of that period and so on. This makes the model dynamic and the position of the system at every time period is determined by its historical path.

The second category of behavioral assumptions is related to how the agents finance their expenditure and a possible net borrowing position. In our example, one needs to specify: how the government decides the portion of its deficit that it is covered through short-term bills and long-term bonds; how the firms will cover a possible discrepancy between investment and retained profits—with the two possibilities being assuming more loans or issuing more equity; and finally how households decide how much of their expenditure will be financed with new loans. It is common to specify this set of decisions as simple linear functions, e.g., the demand for loans on behalf of the households is a constant proportion of their income (Godley and Lavoie, 2007a: ch.11) or that the firms finance a fixed proportion of their investment with new equities (Lavoie and Godley, 2001b; Taylor, 2004a: ch. 8; Godley and Lavoie, 2007a: ch. 11). It goes without saying that a more sophisticated specification is possible, albeit with the cost of increasing the complexity of the model. We provide some examples in the next section.

The third category of behavioral assumptions is how agents, especially households, allocate their wealth. With reference to tables 1 and 2, we can see that a household's decision on how much to consume and borrow also implies how much they will save, which in turn—together with the stock of wealth of the previous period and possible capital gains—determines the value of their stock of wealth at the end of the period. The question then is how households allocate this wealth between the various possible assets. If there are *m* possible assets, one needs to specify the demand for *m-1* of them, with the demand for the last one following residually.

Assets are usually allocated according to "Tobinesque" principles (Tobin, 1969 and 1982b; Godley, 1999b; Godley and Lavoie, 2007a: ch. 5). More formally the demand for the various assets is specified as:

$$\boldsymbol{a} = \boldsymbol{\lambda_0} + \boldsymbol{\Lambda R} + \boldsymbol{\lambda_m}(Y_{d,h}/V_h) \quad (9)$$

where $\boldsymbol{a}$ is a vector of the demand for the *m* assets as a share of total wealth, $\boldsymbol{\lambda_0}$ is a vector of constants, $\boldsymbol{R}$ is a vector with the (expected) real rates of returns of the various assets, and $\boldsymbol{\Lambda}$ is a square matrix with the effects of the returns of the assets on their demand and the demand of the other assets (with the main diagonal of the matrix capturing the effect of the rate of return of each asset on its own demand). Finally, $\boldsymbol{\lambda_m}$ is a vector that captures the effect of the demand for liquidity related to transactions on portfolio allocation. The size of the vectors and the order of $\boldsymbol{\Lambda}$ is *m*. The real rate of returns of each asset is comprised by its income yield (interest or dividend) and capital gains corrected for inflation.

The logical constraints on these vectors are: i) that the sum of the elements of $\boldsymbol{\lambda_0}$ is equal to unity, meaning that the sum of the shares of each asset are equal to unity; and ii) that the sum of each of the columns of $\boldsymbol{\Lambda}$ and the elements of $\boldsymbol{\lambda_m}$ are equal to zero, meaning that the increase in the demand for an asset—due to a change in the return on an asset or disposable income—needs to be matched with an equiproportional decrease in one or more other assets. To close the specification of the parameters of equation (9), Godley (1996) proposed an additional constraint, the sum of each row of $\boldsymbol{\Lambda}$ needs to be equal to zero, meaning that the effect of a change in the return on an asset, all other returns remaining equal, should, in principle, be the same as the effect of an equiproportional change of the other returns, with the specific return remaining constant. A common alternative to this horizontal constraint follows Friedman (1978) and Karacaoglu (1984) and assumes that the $\boldsymbol{\Lambda}$ is symmetric. The symmetry constraint implies the horizontal adding-up constraint, but not the other way around.

A fourth set of behavioral assumptions is related to the specification of productivity growth, wages, and inflation. The SFC literature so far has not focused on productivity issues. As a result, productivity is usually assumed to be constant or in some cases to grow at an exogenously given rate. Inflation is the result of the conflict between wage earners and their employers. The former are posited to have certain real wage aspirations that depend on labor productivity and the state of the labor market, and the nominal wage reacts—through a certain parameter—to the gap between the targeted and actual wage. The price level is then determined with a markup on the unit cost of production.

To close the system, one then needs to specify a final (fifth) set of assumptions about the behavior of the financial system. More specifically, we need to specify the behavior of the banks and and how monetary policy is conducted. For example, with regard to the latter, a common assumption is that the central bank buys any quantity of government liabilities that are not demanded by the private sector and issues an equal amount of HPM. In that way, it is able to exogenously set the interest rate and the quantity of money becomes endogenous; in opposition to the common neoclassical quantity theory of money, where it is the central bank that exogenously determines the quantity of money. When it comes to the banks, we again need to specify what assets are issued by other entities, what quantities of these assets they choose to hold and, very importantly, how they supply credit. Common specifications include a purely Wicksellian type of banking sector, where banks supply whatever loans are demanded (for example this is the running assumption in most chapters of Godley and Lavoie [2007a]) or some kind of credit rationing (e.g., Caiani et al., 2016).

The accounting skeleton, as sketched in the previous section, *together with* the demand-led closure, *and* the behavioral assumptions for the components of aggregate demand *and* the explicit treatment of financial, assets allow for an *integrated* analysis of the real and the financial sides of the economy. This kind of models is diametrically opposed to models that have dominated macroeconomic discourse over the last three decades, where the real variables are independent from the monetary variables. In SFC models, decisions made by the agents of the economy on debt, credit, assets, and liabilities allocation have an impact on the determination of the real variables and vice versa. As the recent crisis made very clear, this is a better way to understand a modern capitalist economy.

In the short run, “equilibrium” is reached through price adjustments in financial markets, while output adjustments guarantees that overall saving is equal to investment. However, such “equilibrium” is not a state of rest, since expectations that drive expenditure and portfolio decisions may not be fulfilled, and/or the end-of-period level for at least one stock in the economy is not optimal, so that such discrepancies influence decisions in the next period.

In theoretical SFC models, the long-run equilibrium is defined as the state where the stock-flow ratios are stable. In other words, the stocks and the flows grow at the same rate. The system converges towards that equilibrium with a sequence of short-run equilibria, and thus follows the Kaleckian dictum that “the long-run trend is but a slowly changing component of a chain of short-run situations; it has no independent entity” (Kalecki, 1971: 165). The adjustment takes place because stocks and stock-flow ratios are relevant for the decisions of the agents of the economy.

If stocks did not feed back into flows, the model may generate ever-increasing (or decreasing) stock-flow ratios: a result that might be stock-flow consistent, but at the same time highly implausible. The convergence towards the long-run equilibrium also depends on more conventional hypotheses regarding the parameters of the model.

Besides its theoretical interest, at a practical level and in more policy-oriented analyses a so-defined long-run equilibrium can act as a benchmark because a situation that is characterized by a constant increase (or decrease) of a stock-flow ratio is unsustainable. For example, Godley (1999a) characterized the configuration of the US economy as unsustainable because of the high net borrowing of the private sector, which led to a continuous increase in its debt-to-income ratio.

3. EXTENSIONS: FINANCE, THE MONETARY CIRCUIT, AND INCOME DISTRIBUTION

As mentioned above, the main purpose of the SFC approach is to provide an integrated framework for treating the linkages between the real and financial sector. For that reason, the baseline model of the previous section can be, and has been, extended to examine issues of this kind, the treatment of which does not allow abstraction from either the real or the financial side of the economy.

Some important extensions of the model are related to financialization, "the increasing role of financial motives, financial markets, financial actors and financial institutions in the operation of the domestic and international economies" (Epstein, 2005: 3). Two integral parts of the process of financialization—that have also been treated in the literature—are the new perspective on corporate governance that prioritizes the value of the shareholders as the ultimate goal of a firm (Lazonick and O'Sullivan, 2000) and the increase in income inequality that has accompanied these trends over the last three–and-a-half decades.

Moreover, the SFC approach, in highlighting real-financial interactions, has many similarities to the Theory of the Monetary Circuit (TMC), usually associated with Augusto Graziani (2003). Such similarities were noted early (Godley, 2004; Lavoie, 2004) and paved the way for a number of circuitist analyses of the developments in the financial sector (Bellofiore and Passarella, 2010; Passarella 2012 and 2014; Botta et al., 2015; Sawyer and Passarella, 2015), as well as comparisons between the TMC and SFC approaches (Zezza, 2012).

In a fairly complex model, Botta et al. (2015) expand our transaction matrix for a closed economy (table 2). They disaggregate the household sector into "workers" and "rentiers," and introduce Special Purpose Vehicles, Money Market Mutual Funds, Investment Funds and "Broker and dealers", as parts of the financial sector, with a high level of detail in the balance sheet for each sector, where they consider two real assets (productive capital and housing) and nine financial assets (loans; mortgages; deposits; obligations of financial and non-financial firms; money shares; longer shares; Asset-Backed Securities; and Repos). They provide a very rich and enlightening view of a complex, modern financialized economy, but do not attempt to provide formal behavioral rules for portfolio management, nor a closure for their model, which therefore is limited to a—very interesting—accounting framework.

Sawyer and Passarella (2015) adopt a simpler accounting structure, distinguishing only banks from Other Financial Intermediaries, and only consider loans, deposits, securities, and derivatives; however, they provide a full-blown "behavioral" model, which they use for simulating the impact of different shocks on the economy. They show how the TMC distinction between "initial finance" (the creation of liquidity to finance the start of the production process) and "final finance" (the sources of funds for investment) is very relevant for understanding financialization. They also distinguish between workers and rentiers in order to examine the role of changes in the personal distribution of income due to financialization, showing that the transformation of household loans into financial products, along with the effect of the class divide on access to bank credit, are the main drivers of a worsening in income distribution and an increase in household debt.

An early SFC treatment of financialization (not explicitly linked to TMC) is Skott and Ryoo (2008). They demonstrate that the effects of financialization critically depend on whether we assume a labor-constrained, "mature" economy or a "dual" economy. Further work that addresses financialization and income distribution is van Treeck (2009), who pays particular attention on the shareholder value orientation. The simulations of his model reproduce some central stylized facts of financialization, like the decoupling of profitability from investment and the increase in income inequality. Related to that, Dallery and van Treeck (2011) develop a model to study the conflicting claims among workers, shareholders, and managers, using model simulations to generate patterns resembling the stylized facts of a "Fordist regime," where capital accumulation is the primary objective of managers, and a "financialization regime," where the maximization of shareholder value is the primary goal.

A large number of contributions adopt the SFC methodology to formalize Minskyan concepts, especially after the 2009 recession, which brought Minsky back to fashion (Dos Santos, 2005; Dos Santos and Macedo e Silva, 2009; Bellofiore and Passarella, 2010; Morris and Juniper, 2012; Dafermos, 2015). Well before the 2007 recession, Dos Santos (2005) noted that the attempts at formalizing Minsky's "financial instability hypothesis" were lacking a common ground, while the SFC approach could provide a framework where many of Minsky's insights, such as the interrelation among balance sheets, could be better dealt with. Later contributions, such as Dos Santos and Macedo e Silva (2009), tried to show how SFC models could provide a starting point for a dynamic analysis of a business cycle with Minskyan features, a result that is achieved with a model of greater complexity by Dafermos (2015), who combines Godley's New Cambridge approach with some Minskyan assumptions. In his model, private expenditure is driven by a target net-assets-to-income ratio, but such target ratio—following Minsky—changes over the cycle as a result of changes in expectations and the conventions of borrowers and lenders. In this way the model is useful for understanding how instability can emerge and which policies are appropriate to counter such instability.

The SFC approach to a closed economy has also been used for a more detailed treatment of the household sector, which allows one to deal with issues related to the distribution of income. Dafermos and Papatheodorou (2015) develop a model with a rich detail in household groups, which are split among low and high skilled, employed and unemployed, and entrepreneurs. This framework allows the authors to consistently address the link between the functional and the personal distribution of income.

In a more recent paper, Nikiforos (2017) presents a pseudo-SFC model that shows how in the face of an increase in income inequality, the decrease in the saving rate (and thus the increase in the indebtedness) of the households at the bottom 90 percent of the distribution was a prerequisite for the maintenance of full employment in the three decades before the crisis. In turn, the asset bubbles of the period were necessary for sustaining this process. Nikiforos, following Godley (1999a) and Papadimitriou et al. (2014), calls the increase in income inequality the eighth unsustainable process of the US economy and argues that a decrease in inequality is necessary for sustainable growth in the future.

The core model has also been extended to include more than one real asset. The role of the housing market bubble in the Great Recession of 2007 led to SFC models that treated residential capital separately and examined the relation between real estate prices and income distribution. Zezza (2007 and 2008) built models to explore the distributional implications of the housing market boom. Similar arguments have been put forward by Lavoie (2008) and Nikolaidi (2015). Finally, in a recent paper, Herbillon-Leprince (2016) extends the model to include—in additional to residential capital—land owned by a capitalist-landowner sector and whose supply is constant.

4. MODELING THE OPEN ECONOMY

The discussion so far has been limited to closed economy models. However, open economy models are able to provide significant insights at a theoretical and practical level. This is a statement that applies to all macroeconomic models, but is especially true in SFC models.

Introducing the open economy in a consistent way means that one needs to specify the structure of the domestic *and* the foreign economy, as well as the interactions between them. As in the case of the closed economy, we can start from the balance sheets. Table 4 presents the balance sheets of various sectors for a two-economy model. The sectoral decomposition of the two economies is the same as in the closed economy model of section 2, as are the available assets. The difference is that there are financial assets issued domestically and in the foreign country. Agents hold assets and assume liabilities issued both in their country and abroad. The symbol * denotes abroad. When it comes to assets, the superscript * denotes assets issued abroad, while the subscript * refers to assets held abroad. So, for example H_h^* is foreign HPM held by domestic households, while H_{h*}^* is foreign HPM held by households abroad. The balance sheets of each economy are denominated in local currency. Therefore, the assets issued abroad are converted into the local currency with the use of the exchange rate (ε), i.e., the number of domestic currency units per foreign currency unit. As a result, all the assets issued in the foreign economy are included on the domestic balance sheets, multiplied with ε and vice versa.

In table 4 we have assumed that the agents of each economy hold the same types of domestic and foreign assets. For example, households in both countries hold all types of assets and assume loans issued both from the banks of their countries and banks abroad. The only exception is the central banks of the two countries. Implicitly, an underlying assumption for table 4 is that foreign currency has the special status of a reserve currency so the domestic central bank holds foreign assets as reserves.

As before, accounting consistency dictates that the financial assets of someone are the liabilities of others. So, each row of the table (adjusted with the exchange rate) sums to zero and the overall net financial asset position (NFA) of the whole system is zero as well. The overall net worth of the two economies combined is equal to their tangible assets, whose value in domestic currency units is $PK + \varepsilon P^{*} K^{*}$. Since, the overall NFA of the system is zero, if a country has a positive NFA, then the other country has a negative one: $NFA = -NFA_{*}$.

The transactions-flow matrix (table 5) is also easily understood based on the principles laid out in section 2. A few comments are important. First, as we can see in rows (E) and (F), accounting consistency dictates that the exports of one country are the imports of the other country. This is a trivial but often neglected point. The policy recommendations of big international organizations that all countries should try to increase their competitiveness and pursue export-led growth violate this principle. One country cannot pursue export-led growth if at least one other country is not willing to absorb these exports.

Another difference of the open economy transactions-flow matrix is that the sectors receive and pay income abroad based on the respective foreign denominated assets and liabilities they hold. For example, domestic households now receive dividends from abroad ($\varepsilon \Pi^{*}_{c,d}$)—because they hold equities of foreign firms—as well as interest income on deposits in foreign banks and bills and bonds issued abroad. In turn, they pay interest for loans they have taken from foreign banks. The net income transfers together with the trade balance sum up to the current account balance, or the net lending of the foreign sector (NL_f). A positive trade balance and a positive net interest income contribute to a positive current account balance (or to a negative NL_f; the foreign sector is a "net borrower").

As in the case of the closed economy, positive net lending for a sector leads to an increase in the sector's NFA. For reasons of economy of space, the FoF part of table 5 does not present the changes in every asset and liability in detail. It summarizes the change in the net financial position in domestic and foreign assets.

Moreover, as before, the sum of the net lending of the various sectors of the economy is equal to zero. The important thing here is that now the net lending of the foreign sector is included in this identity. If we group the domestic sectors into a private and a government sector, this implies that:

$$NL_p + NL_g + NL_f = 0 \tag{10}$$

where NL_p is the net lending position of the private sector. In the related literature, equation (10) is often referred to as "the three balances." The examination of the three balances in conjunction with total income can help us identify which component of aggregate demand contributes to growth. The net lending position of each sector also gives us information about the trajectory of its debt and net worth.

This kind of analysis based on "the three balances" was the central axis of Wynne Godley's *Seven Unsustainable Processes* (1999a), the most famous piece on economic policy based on the SFC methodology. The main idea of Godley's argument was that during the 1990s, the United States experienced a large exogenous decrease in their current account balance (due to the "successful invasion" of their markets by foreign competitors) and at the same time the government consolidated its budget (2000 was the only year in the postwar period that the government sector achieved a surplus). As a result, and based on equation (10), the only way for the economy to sustain the robust growth of the period was through a large increase in the net borrowing of the private sector. In turn, because of the vertical consistency, this implied a continuous increase in the debt-to-income ratio of the private sector—a Minskyan process where the private sector moves from a hedge, to a speculative, and then a Ponzi position. As we explained above, such a process that entails a continuous increase of a stock-flow ratio is unsustainable. A recent, more formal discussion of Godley's argument can be found in Nikiforos (2017).

Therefore, the "three balances" approach ties together the performance of the foreign sector and the fiscal stance of the government with the trajectory of the balance sheets of the private sector and the performance of the economy. This approach remains a central aspect of the policy analyses of the Levy Institute for the US economy, which are produced with updated versions of the SFC model that Godley originally created in the 1990s and used for the *Seven Unsustainable Processes* (Papadimitriou et al., 2013, 2014, 2015, and 2016b). The same is true for the SFC macroeconometric model that we recently developed for the Greek economy (Papadimitriou et al., 2013). One of the main underlying assumptions of the austerity policies in Greece and elsewhere in Europe is that austerity (a steep increase in NL_g) will improve the competitiveness of the country and thus decrease NL_f without a negative effect on the growth rate. In reality, although austerity has led to an increase in NL_g and a decrease in NL_f, the adjustment took place through the output. The operation succeeded, but the patient died (Papadimitriou et al. 2013, 2014a, 2014b, 2014c, 2015, and 2016a). An analysis of eurozone imbalances through the prism of the "three balances" is also provided in Semieniuk et al. (2011).

Notice, that the analysis of the three balances requires the specification of the closure of the model. More precisely one needs to define: (i) if the economy is demand- or supply-led; and (ii) how the causality runs between the net lending of the three sectors. For example, in the *Seven Unsustainable Processes*, Godley assumes a demand-led economy where the increase in the trade deficit is exogenous—due to the successful invasion of the US markets—and thus the causality runs from NL_f to the domestic sector. In the case of the US, the possibility that the causality is running this way has also been highlighted by Darrat (1988) and Stiglitz (2010: ch. 8). In the case of the eurozone, many authors have argued that the high private and public deficits of the peripheral countries are simply the mirror image of the exogenous decrease of the current account balance, due to the real exchange rate appreciation, the decrease in the transfers to these countries, and the structural deficiencies of the eurozone (Arghyrou and Chortareas, 2008; Eichengreen, 2010; Flassbeck and Lapavitsas, 2013; Chen et al., 2013; Nikiforos et al., 2015; Kang and Shambaugh, 2016).

On the other end, neoclassical economists usually maintain a different causal story, where the causality runs from the domestic sector—especially the government—to the foreign. This is the so-called "twin-deficits hypothesis" (Volcker, 1984; Abell, 1990). According to this hypothesis, a decrease in NL_g (or NL_p) creates inflation and thus has a negative impact on competitiveness, with the result being that NL_f increases. Thus austerity can help increase competitiveness without a negative impact on the growth rate. This was one of the theoretical underpinnings of the austerity policies in eurozone periphery based on several studies that supported this diagnosis (Blanchard and Giavazzi, 2002; Jaumotte and Sodsriwiboon, 2010; Decressin and Stavrev, 2009; Schmitz and von Hagen, 2011). A different neoclassical closure is the so-called "Ricardian equivalence," where a change in NL_g leads to an equivalent change in NL_p in the opposite direction, leaving NL_f unchanged (Barro, 1974).

The three balances approach can be extended within a two-country framework, like that of table 5. In this case the accounting identity of equation (10) needs to hold for each country individually, with the additional constraint that the net lending of one country is equal to the net borrowing of the other:

$$NL_p + NL_g + NL_f = 0$$

$$NL_p^* + NL_g^* + NL_f^* = 0 \qquad (11)$$

$$NL_f = -NL_f^*$$

Combing these three equations we get:

$$NL_p + NL_g = -NL_f = NL_f^* = -(NL_p^* + NL_g^*) \qquad (12)$$

Equation (12) shows how the balance of the sectors of the two countries—and therefore also their balance sheets—are connected. From this equation it becomes clear that by accounting principle it is impossible for both countries to simultaneously increase their current account balance. As we mentioned above, the surpluses of one country need to be absorbed by another. Another implication of this equation is that it is impossible to have foreign surpluses in one country and at the same time domestic surpluses—private or public—in the other. This simple accounting rule is often forgotten in the eurozone, where officials defend the trade surpluses of the north and demand the south decreases its public and private domestic borrowing.

Another complication that arises in an open economy framework is that one needs to define the mechanisms that determine the exchange rate. The economic performance of the economy, the portfolio choice of the agents, and the decisions of the policymakers are the main determinants of the exchange rate. In turn, the exchange rate will affect the performance of the exports and imports, but also the portfolio choice of the agents (since it will affect the price of the foreign assets in domestic currencies). This is yet another channel where the real and financial side of the economy is integrated within the SFC framework. For example, a change in the portfolio preferences of the agents will tend to change the exchange rate and this will feed back into the real economy.

The center of gravity of the open economy SFC literature is—as with other themes—the treatment in Godley and Lavoie (2007a). In chapter 6, they first introduce an economy with two regions but a common government. This simple model allows them to discuss the three balances of each region and reach some of the aforementioned conclusions on the relation between the balances of the sectors of the two regions. Then they sketch a "gold-standard"–like model, where two countries trade with each other and the central bank of each country holds gold reserves in addition to the domestic government bills; the exchange rate is treated as constant. As a result, the foreign deficit of a country is matched by gold outflows and vice versa. An increase in the foreign deficit of a country, say due to a negative shock in the trade balance, leads to an increase in the government deficit and an increasing trajectory of the government and foreign debt-to-income ratios through the three balances identity.

There are two important results of this simple model, which carry over to the more complicated models they introduce later. First, after the negative shock to net exports, the private sector does not receive any strong signal that is something is wrong—besides the initial drop in the income of the economy due to the trade shock. Therefore, its demand for assets and money will not be affected—save for the change in the income. Second, on the asset side of the balance sheets of the central bank there is going to be a reduction in its gold reserves, but at the same time an increase in its holding of government securities (since the foreign deficit that leads to the former leads to government deficits and the latter). As a result, there is an automatic sterilization of the decrease in the gold reserves, and the quantity of money, on the liability side of the balance sheet, is able to adjust—endogenously—to meet the demand on behalf of the households. These results come in stark contrast with conventional wisdom, which posits that there is some automatic mechanism that guarantees the adjustment of the foreign balance.[6] In the absence of an automatic correction, Godley and Lavoie argue that the government needs to intervene and correct the imbalances either through an administrative restriction of imports or with a decrease in government expenditure that will deflate the economy and reduce imports. Finally, they show that an increase in the interest rate—a recipe that is usually advocated by international organizations for countries with balance of payment problems—can be destabilizing.

In chapter 12 of the book, Godley and Lavoie introduce a two-country model with an endogenous exchange rate. The exchange rate is determined endogenously to clear the international transactions for goods and financial assets. In other words, the exchange rate has to be such that the imports of each country are equal to the exports of the other country and that the demand for each financial asset abroad is equal to its supply. To close the model, they assume that private sector demand for foreign financial assets is always satisfied and therefore the exchange rate is pinned down by the demand for and supply of the reserves of the central bank (of the country that does not issue the reserve currency). This is a common closure for the exchange rate in the literature, although there are several other possibilities. They distinguish between a regime where the central bank chooses to keep its reserves constant and allows the exchange rate to fluctuate, and three regimes with fixed exchange rates along the lines of their model in chapter 6: one regime with endogenous reserves (now in the form of reserve currency bills), one with endogenous adjustment of the interest rate, and one with endogenous fiscal policy. Their model shows again that there is no intrinsic mechanism that will correct possible foreign imbalances and that there has to be active government intervention. In their model, the exchange rate adjustment can be effective in correcting foreign imbalances. Finally, a change in the liquidity preference of households can affect the exchange rate and then the real economy through the asset markets, at least in the short and medium run.

The analysis of these two chapters builds on the work of the two authors in the years before the publication of the book. The first attempt towards that direction is Godley (1999c). Lavoie (2003) builds a fixed exchange rate model for the eurozone, which forms the basis for the analysis of chapter 6, and in Godley and Lavoie (2003 and 2005) one can find the first insights for chapter 12. Finally, in Godley and Lavoie (2007b), they present a three-country model that discusses the eurozone economy. In a somewhat prophetic manner, they stress that the situation in eurozone in the presence of imbalances would be sustainable as long as the European Central Bank was willing to accumulate an ever-rising quantity of bills of the "weak" country (the country with external deficits). If this is not possible, the only alternative would be for the government of the "weak" country to endogenize fiscal policy: essentially to create a recession that will decrease imports and rebalance the current account. These are important insights if one wants to understand the current situation in the eurozone and the policies that have been adopted in the last seven years. Another paper of this first generation of open economy SFC models is by Izurieta (2003), who was working with Godley at the Levy Institute at the time. The paper presents a two-country model and examines the implications of the dollarization of an economy. The conclusions of the paper echo the results of the fixed exchange rate models of Godley and Lavoie.

Another fully articulated open economy SFC model from the same period was built by Lance Taylor (2004a: ch. 10; and 2004b), who employs a different closure for the model. Internally in each economy the interest rate is determined endogenously based on an IS-LM mechanism and then the exchange rate is determined based on the Uncovered Interest Parity condition through arbitrage. Taylor reaches the same conclusion with regards to the (in)ability of an economy to self-correct external imbalances.

These insights and the techniques of this first generation of open economy SFC models have been used in more recent contributions on various topics. Lavoie and Zhao (2010) build a three-country model (US, eurozone, and China, where the exchange rate between China and the US is fixed), and examine the results of diversification of the Chinese foreign reserves. They show that both the Chinese and US economy benefit, because the increase in the demand for European assets leads to the appreciation of the euro. Their model also generates path dependence. Lavoie and Daigle (2011) examine the role of exchange rate expectations. Based on chapter 12 of Godley and Lavoie (2007a), they build a model of exchange rate expectations with two types of agents: the so-called "fundamentalists" and "chartists." The former expect that the exchange rate will revert to a level that they perceive as fundamental, while the latter follow the market trend. The model shows that indeed the expectations play a role and if the "chartists" are overrepresented, expectations can be destabilizing.

Mazier and Tiou-Tagba Aliti (2012) build a three-country model along the lines of Lavoie and Zhao (2010) and examine scenarios with pegged and flexible dollar-yuan parity. They conclude that the flexible parity could be an important way to address the global imbalances. Addressing the global imbalances is also the subject of Valdecantos and Zezza (2015). Within a four-country model, they examine the effects of introducing an International Clearing Union and a Bancor model, as proposed by Keynes's at Bretton Woods, and show that the implementation of these proposals leads to an elimination of the global imbalances.

The discussion above shows that the SFC framework is particularly appropriate for examining issues related to a monetary union like the eurozone. As we explained, Lavoie (2003) and Godley and Lavoie (2007b) present models specifically for the eurozone, while much of the discussion in their book implicitly or explicitly refers to it. The publication of the book, together with the increasing popularity of the SFC approach and the fact that many scholars who have adopted it are based in Europe, has led to a series of contributions that examine eurozone-related issues.

Duwicquet and Mazier (2010) examine the usual argument that financial integration can help make a currency union an optimum currency area. In particular, they examine the stabilization effects of holding foreign assets and intrazone credits. They conclude that the former indeed has stabilizing effects, albeit small, while the latter does not have specific stabilization effects. An extension of this analysis is provided in Duwicquet and Mazier (2012), where it is argued that intrazone credit has a stabilization effect if the nonresident banks do not ration their purchases of T-bills from deficit countries. The adjustment mechanisms of the eurozone is the topic of another paper (Duwicquet, Mazier, and Saadaoui, 2012), where they argue that a federal budget and issuing eurobonds could have a stabilizing role. In a similar vein, Mazier and Valdecantos (2015) use a four-country model and suggest that the introduction of a "multi-speed" Europe, with separate currencies for the north and the south, could have a stabilizing role. The same model is used by Mazier and Valdecantos (2014), who propose the introduction of a clearing union and a Bancor system for the eurozone, arguing that the TARGET2 system provides the necessary infrastructure for the implementation of such a proposal. Finally, Kinsella and Khalil (2011) build a two-country model and discuss the process of debt deflation in a small, open economy (an appropriate issue for Ireland, where Kinsella was based at that time). They conclude that within a monetary union, the duration of the debt deflation spiral is prolonged.

5. EMPIRICAL MODELS FOR WHOLE COUNTRIES

One of the main reasons for the recent surge in the popularity of SFC modeling is certailny related to the recognition that Wynne Godley and models based on the SFC approach were able to predict the 2001 US recession (e.g., Godley, 1999a), and later the Great Recession of 2007 (Godley and Zezza, 2006; Godley et al., 2007). This recogenition came from academic economists (e.g., Bezemer, 2010), but was also widely shared in the press (Chancellor, 2010; Wolf, 2012; Schlefer, 2013).

Although the SFC theoretical methodology was fully formalized later, as discussed in the previous sections, the central features of SFC empirical models were already present in Godley's work at the time of the Cambridge Economic Policy Group in the 1970s (Godley and Cripps, 1974 and 1983; Cripps and Godley, 1976 and 1978). This early SFC empirical approach was aimed at determining the drivers of sectoral financial balances (see eq. 10, above) by building a set of accounting identities for monetary transactions and determining the components of trade, aggregate private demand, and prices through econometric estimates. From that point of view, the modeling methodology was in the "Cowles Commission" tradition of other Keynesian empirical models of the time (Fair, 2012). An important difference was the choice to treat private domestic demand as an *aggregate*—i.e., the combination of household consumption, business investment, and change in inventories. This approach, aimed at promoting what was labeled the "New Cambridge hypothesis" on the private sector financial balance, as a contribution to the Keynesian debate of the time on the UK economy. As Dos Santos and Macedo e Silva (2010: 22–23) explain the "private financial balance of the British economy had been relatively small and stable for many years—so that any (conventional Keynesian) attempts to increase effective demand by means of a relaxation of fiscal policy would only worsen the British current account balance."

This same approach guided the development of models for Denmark (Godley and Zezza, 1992), the US (Godley, 1999a; Zezza, 2009), and, more recently, Greece (Papadimitriou, et al. 2013). The models for the US (Papadimitriou et al., 2013, 2014, 2015, and 2016b) and Greece (Papadimitriou et al., 2013, 2014a, 2014b, 2014c, 2015, and 2016a) have routinely been used by the Levy Institute to examine the medium-run prospects of the US economy and simulate the effects of alternative policy options or other macroeconomic scenarios. Their ability to project the trajectories of these economies, much better relative to other neoclassical–oriented DSGE-type models, has contributed to spreading the interest in the SFC approach.

The main features of what could be labeled as “Godley-Levy” empirical SFC models are thus the attention to modeling real aggregate private sector demand as a function of real disposable wealth and the real opening stock of net financial wealth, determining an implicit stable stock-flow ratio towards which the economy would converge in the absence of external shocks. The introduction of additional variables—mainly related to credit and net capital gains—determine deviations from the stock-flow ratio, where such deviations may take a very long time for dying out (Zezza, 2009). On the other hand, the Tobinesque approach to portfolio management is kept to a minimum—or it is absent—in Godley-Levy SFC models. What is captured in these models is the main channel of transmission from the financial side of the economy to the real side, namely:

i. every stock of financial assets implies a flow of income from capital from the debtor to the creditor (this usually implies a considerable amount of work reconstructing who-to-whom payments from national accounts, whenever they are not available);
ii. flows of new credit have an impact on expenditure decisions; and
iii. the end-of-period stock of net financial wealth (or debt) has an impact on expenditure and saving decisions.

What is neglected, given the absence of portfolio management, are the macroeconomic consequences of shifts in financial portfolios, which are likely to be small in many practical cases.

Since the purpose of the Godley-Levy SFC models are performing policy simulations, in order to minimize concerns over the *Lucas critique* (Lucas, 1976), model parameters are estimated with econometric techniques that ensure—as far as possible—that their values would not change over a shocked simulation period.

A somewhat different methodology has been applied to developing empirical SFC models for Ireland (Kinsella and Aliti, 2012a). In this case, the focus is on reconstructing the balance sheets of the main sectors of the economy for a country where statistical information for flows and stocks is not complete. This leads the authors (Kinsella and Aliti, 2012b) to proposing the adoption of calibration methods for determining parameter values, where parameters may change over time, and in some cases the calibration method can also produce time series for missing statistical information (Godin, Aliti, and Kinsella, 2012). This approach is certainly useful in adapting a theoretical model to empirical time series in order to get "informed intuition" (Godley and Lavoie, 2007a: 9) on how the economy actually works, but may pose severe limitations in using the model for forecasting purposes, whenever the future value of parameters may not be assumed to remain stable.

A similar approach in terms of parameter calibration has been adopted in (Miess and Schmelzer, 2016a and 2016b). They develop a model for Austria with a rich institutional detail, disaggregating the financial sector into the Central Bank; Deposit taking corporations and Money Market Funds; Other investment funds; Other financial institutions; Insurance corporations and Pension funds, with seven classes of financial assets. Parameters are calibrated over the observed sample, and their trend is used to project their value over the out-of-sample period. In practice most parameters are projected to remain fixed at their last value in out-of-sample simulations. The authors use the model to produce a baseline scenario up to 2025, which is used as a benchmark to evaluate alternative scenarios for different fiscal policies.

A recent model for the UK (Burgess et al., 2016) is probably the most complex SFC model so far estimated for a real economy from national accounting statistics. As for the Godley-Levy models, their purpose is to perform scenario analysis over the medium term. On the other hand, compared to the Godley-Levy models, there is greater institutional detail, with the economy disaggregated into six sectors (households, non-financial corporations, government, banks, insurance companies and pension funds, and the foreign sector). The approach used for identifying parameter values is a mixture of econometric estimation, calibration, and (arbitrary) coefficient restrictions, which allow for a rich and complex model for portfolio management that would probably not have been feasible by adopting only econometric techniques.

In all the aforementioned applied SFC post-Keynesian models, output is driven by demand, with little attention to supply-side constraints. As pointed out by Valdecantos (2012), several complication may arise when supply constraints are binding, especially in the context of less-developed economies. Escobar-Espinoza (2016) builds an applied SFC model for Colombia and shows that even in this case the SFC approach can perform satisfactorily.

We are not aware of other complete SFC models for whole countries. Several authors employ econometric techniques to estimate parameters of their theoretical models, thus partially calibrating them to a specific country (e.g., Clevenot, Guy, and Mazier, 2010).

6. SFC & AGENT BASED MODELLING

The use of agent based models (henceforth ABM) is an approach that is gaining currency very quickly the last few years. Epstein and Axtell (1996), Tesfatsion and Judd (2006), and LeBaron and Tesfatsion (2008) provide an extensive treatment of the use of Agent Based Computational models in economics and the social sciences. Most of the papers cited in this section explain the advantages of ABMs, as well. The basic idea of the ABM is that a modern capitalist economy is a *complex* system of *interacting* agents and we can gain a lot in our effort to understand such a system by precisely studying its complexity (Farmer and Foley, 2009). Such an approach is obviously diametrically opposed to the neoclassical idea that one can understand the basic features of a capitalist economy by studying the behavior of a Robinson Crusoe.

Thus, economic processes are studied through the interaction of numerous heterogeneous agents, classified in various sectors; the classification as in any model follows the related theory and the issue under examination. The properties of the model emerge from the (microeconomic) behavior of the agents, from the "bottom-up." In that sense, ABM can shed light on how the macroeconomic variables and phenomena (e.g., GDP, leverage, economic fluctuations) are determined endogenously through the interaction of multiple heterogeneous agents. In that sense, ABM are able to provide the sought-after microfoundations. More interestingly, in ABM there is an endogenous emergence of various distributions and networks within the economy (e.g., the distribution of the size of the firms or the income and wealth of households, or the network structure of the banking sector).

ABM is a *methodological* approach and therefore the conclusions one reaches with the use of a related model crucially depend on the theory behind the model and the specification of the behavior of the agents. Therefore, although the overall vision of most of the scholars who develop ABM for economic applications is not neoclassical, one could reach neoclassical results by assuming an "appropriate" behavior for the agents of the model.

The advantages of the ABM and SFC models has led many researchers to call for a combination of the two approaches. The basic idea is that in an ABM-SFC model each sector of the transactions-flow matrix is populated with several agents (e.g., *n* households, *m* firms and *k* banks). The government and the central bank are usually treated as one agent each. Moreover, instead of specifying behavioral rules for each sector as a whole, the modeler specifies rules for the behavioral of the individual agents, and on the matching between the agents (e.g., how do the household choose where to buy their consumption goods among the different firms; how do the firms and households choose where to deposit their money and where to take their loans from among the banks).

The first systematic effort to build an ABM-SFC model has been the EURACE model, the outcome of a collaborative effort of researchers at various European universities. In the words of Deissenberg, et al. (2008), EURACE is a "massive" model; at a spatial level it is subdivided at the so-called NUTS-2 regional level, while its temporal resolution is the business day. There are three types of agents (households, firms, and the banks) each located in a specific region, and five types of markets (consumption goods, investment goods, labor, credit, and financial assets). Cincotti et al. (2010) use the EURACE model to study the business cycle and show that when firm pay a higher fraction of their earnings as dividends, the amplitude of the business cycle increases because they compensate for the lower retained earnings with more borrowing and leverage. In a related study Raberto et al. (2012) examine the relation between debt and the macroeconomic performance of an economy. They show the effect of debt on growth is not certain *a priori*: more debt can foster or inhibit growth, a result that echoes the debt-led and debt-burdened classification of Taylor (2004a: ch. 8).

The EURACE model has been further developed more recently by researchers at the University of Bielefeld, and renamed "Eurace@Unibi" (Dawid et al., 2011, 2012, and 2016). This latest incarnation of the model has been used for various applications.[7] For example, Dawid et al. (2014) use the model to study economic convergence across European regions. With fully integrated labor markets, they show that investment in human capital in weaker regions has a positive effect on the performance of the stronger regions, but a negative effect for the weaker ones. On the contrary, subsidies for high technology production in the weaker regions leads to convergence. In a related paper, Dawid et al. (2016) examine economic convergence in relation to fiscal policy. They show that debt-burden sharing does not have a significant effect on convergence. Convergence of per capita consumption can emerge as a result of fiscal transfers, although the authors show that technology-oriented subsidies are the most sustainable way for regional convergence. Finally, van der Hoog and Dawid (2015) examine business fluctuations in relation to banking regulation. They find that liquidity regulations, as opposed to capital requirements, dampen the business cycle more effectively.

An early explicitly ABM-SFC model is built by Kinsella et al. (2011). They show how in such a model power-law dynamics emerge for several variables, such as the size of the firm and income distribution. In the same year, another early call to combine ABM with the SFC approach is found in Bezemer (2011). He shows that a careful modeling of an economy's financial structure can give rise to nonlinear behaviors and endogenous crises, unlike the DSGE models. However, the model utilized towards that purpose is an aggregate macromodel and not agent based.

The combination of ABM and the SFC approach also lies at the heart of "Jamel," an acronym for "Java Agent-based Macro Economic Laboratory," which is a platform for modeling and simulating complex monetary economies (Seppecher, 2012b). Jamel has been used for various interesting modeling exercises. Seppecher (2012a) presents a model of a monetary theory of production, which explicitly takes into account the relations between production, money, and time and how these determine interest and profits. Seppecher (2012c) presents a model where the introduction of more flexibility in wages and the labor market creates instability and leads to the formation of deflationary spirals; a result that echoes the famous chapter 19 of *The General Theory* (Keynes, 2013). Seppecher and Salle (2015) augment the Jamel platform with endogenous waves of optimism, which affect the leverage decisions of firms and households. This mechanism exacerbates the usual credit cycle. Finally, and related to that, Seppecher et al. (2016) propose a model where firms adapt and explore new strategies of leverage. This kind of behavior of the firms leads to oscillations in the macroeconomic performance of the economy. In the upswing, firms tend to adopt more and more high-leverage strategies. At that phase, firms that resist this kind of strategy face the danger of low profitability and extinction. However, when the leverage of the overall system increases too much, the downswing begins. At this phase, individual firms are unable to adapt fast enough and there is a "brutal" cleaning of the high-leverage firms and the firms with low leverage have better chances of survival.

Credit cycles as the result of firm leverage are also modeled in Riccetti et al. (2015), where the firms are assumed to have an endogenous leverage target level. In a similar vein, Carvalho and Di Guilmi (2014) model credit cycles, which however originate from the household and not from the firm sector. A distinctive characteristic of their approach as opposed to the majority of the literature is that they are able to solve their model analytically and not numerically.

Finally, Caiani et al. (2016) propose an ABM-SFC model as a benchmark for future related research. They pay special attention to how the model can be validated based for real data and they propose rules for the calibration and display of such a model. Based on this model, Schasfoort et al. (2016) examine the transmission mechanisms of monetary policy and conclude that the transmission of monetary policy depends on the composition of the balance sheets of the sectors of the economy.

The above show that there is a nascent but very active and growing literature that aims at combining the SFC approach with agent-based microfoundations. These kinds of models can be complementary to the more standard macroeconomic models mentioned above and shed light into corners where an aggregate model does no thave much to say.

7. SFC ECOLOGICAL MODELS

Many environmental processes that interact with the economy, such as pollution or the availability of natural resources, exhibit a process that can be formalized through the stock-flow relationship. For instance, the flow of CO2 emissions will depend on industrial processes in a given region, and cumulates in a stock of CO2 pollution, which in turn has adverse consequences on quality of life and the economy. These aspects, together with the formal rigor of the SFC literature, are stimulating a number of studies that adopt the SFC approach to address environmental problems.[8]

One simple aspect bridging economic models to environmental sustainability goes through the determination of sustainable economic growth rates. Jackson and Victor (2015) develop a SFC model to show that when interest rates are positive the system can replicate itself in a stationary state, and therefore diminish threats to environmental sustainability. In Jackson and Victor (2016) they show that under specific assumptions slower growth would not imply an increase in inequality, and would therefore be socially sustainable. In Jackson et al. (2014) they discuss how the links between the impact on the environment and the economy can be detailed using input-output matrices, although these issues have not been developed in later works.

Berg, Hartley, and Richters (2015) develop a formal integration of the SFC and the input-output approach, taking energy into account. They use their model to study energy-related problems, with particular attention to the conditions for system stability.

A complex SFC model with an explicit treatment of the energy sector and calibrated for the European Union is presented in Naqvi (2015). The model is simulated to examine policies that can address growth, distribution, and a sustainable environment. The same model structure, albeit without the energy sector, is deployed in a two-region north-south model in Dunz and Naqvi (2016), where the purpose is to study the impact of inter-regional transfers to foster "clean investment."

Finally, an ambitious model in Dafermos et al. (2016) provides additional insights. In this model, the monetary and the physical stocks are determined based on SFC accounting principles and the laws of thermodynamics. The authors adopt the distinction, proposed by Georgescu-Roegen, between stock-flow resources and fund-service resources. Output is, as usual, demand determined; however, supply constraints might arise as a result of environmental change or the exhaustion of natural resources. Climate change and finance have direct and indirect effects on aggregate demand and investment plans. This is important because "green" investment is treated separately from "conventional" investment in the economic part of the model, and therefore investment shifts affect ecological efficiency.

The model is calibrated using global data, and simulated over a very long (100 years) time horizon. The authors use the model to investigate the trajectories of economic and environmental variables under different assumptions of the impact of financial fragility on macroeconomic activity, as well as on the financing of green investment. In their simulations, the negative impact of environmental change is reinforced as the contractionary effects of a high leverage increase. Finally, they show that better terms of credit for green investment have positive effects both for environmental sustainability and financial fragility.

Summing up, SFC models that treat the economy as part of a more global system (i.e., where the environment plays a relevant role) are one of the most promising areas of research for SFC modelers. However, greater attention needs to be paid to a number of other systemic variables—such as population growth and migration, constraints to growth given by scarcity of natural resources, etc.— in order to provide a valid alternative to mainstream models, which are usually more detailed in their treatment of the environment, but lack any attention to the role of the financial sector, and are empirically weak because of their assumption of full employment.

8. INSTEAD OF CONCLUSION: ONOMASTICS

The present paper discussed the stock-flow consistent approach in macroeconomic modeling. We started with a short outline of the intellectual roots of the approach, pioneered by the work of Wynne Godley in Cambridge and James Tobin at Yale. In section 2 we explained the basic principles of the model: the accounting consistency, the demand-led closure and the various alternative behavioral specifications, and the treatment of the financial side of the economy. Section 3 presented how the basic model has been used and modified to address various issues related to the monetary circuit, financialization, and income distribution. In section 4, we surveyed the literature on open economy SFC models and in section 5 the empirical models for whole countries. Section 6 discussed how the SFC approach has been used in conjunction with the Agent Based Modeling approach, and finally section 7 explained the usefulness of SFC modeling for treating environmental issues. Instead of a conclusion, we can discuss one last issue: the name "Stock-Flow Consistent." The related analysis that follows—besides being interesting in its own right—can act as a summary and further clarify the issues we discussed in the previous sections.

The name "Stock-Flow Consistent" has existed in the literature for a long time as a reference to models with the characteristics described in section 2 (e.g., Davis, 1987a and 1987b). However, it was only established as a "brand name" after Claudio Dos Santos's PhD dissertation at The New School for Social Research entitled *Three Essays on Stock-Flow Consistent Macroeconomic Modeling* (Dos Santos, 2003).

The name has been a source of confusion among friends and foes of the SFC approach for two reasons. First, it has misled people to believe that it describes what Krugman (2013) called "hydraulic" macroeconomic models, devoid of behavioral underpinnings; this essentially is "accounting, not economics" (Wren-Lewis, 2016). [9] Second, people who are not familiar with the SFC approach, contend—rightly—that stock-flow consistency is a characteristic of various classes of models. For example, the Solow (1956)-Swan (1956) model or the Ramsey (1928)-type models are indeed stock-flow consistent. From that point of view, it is wrong to use stock-flow consistency as the demarcating characteristic of the type of models described here. We discuss these issues in the following paragraphs.

To begin with, as we explained in the previous sections (especially in section 2.1) proper accounting reduces the degrees of freedom of a model (or an analysis) and protects the modeler from certain common fallacies. In the course of the discussion in the previous sections we gave many related examples. For instance, in our discussion of the "three balances" we explained that by accounting principle the sum of the net lending of the foreign sectors of all the economies taken together is also equal to zero. This simple accounting principle invalidates the growth paradigm proposed by many economists and international organizations who advocate that every country should pursue export-led growth by trying to increase its competitiveness (through "structural reforms," etc.); since the deficit of an economy cannot decrease if the surplus of another economy does not decrease as well. The problem here is that although the models of these economists and organizations are indeed stock-flow consistent at the individual economy/country level, they violate "accounting consistency" at the international level. Certain cases of fallacy of composition like this are due to the violation of simple accounting rules.

Besides that, accounting consistency is the method that brings together the real and financial sides of the economy and allows the modeler to track down how the agent's decisions about their real variables affect the nominal assets of their balance sheets and how these changes feedback on their "real" decisions. The Balance Sheet Matrix (table 1), the Transactions-Flow Matrix (table 2), and the Social Accounting Matrix (table 3) are thus indispensable tools for the analysis of a *monetary* economy. For all these reasons, the best way to start solving an economic problem is by ensuring that the accounting is right.

However, the SFC approach goes beyond simple accounting. As we explained in section 2.2, another very important characteristic is that the basic closure is Keynesian. SFC models do not assume Say's law and full employment in the short run or that the economy will converge towards such a state in the medium/long run. Arguably, this is Keynes's most important contribution to macroeconomic theory. He demonstrated that the *general* state (hence *The General Theory*) of the capitalist economy is not one of full employment and there is not a natural tendency of the economy to gravitate towards full employment. The full employment equilibrium envisaged by neoclassical economics is just a *special* case. This choice of closure allows then for an *integrated* treatment of the real and financial sectors of the economy, where the latter—debt, leverage, the stock market, etc.—matters for the behavior of the agents and therefore the performance of the former. SFC models are driven by this kind of closure and a sophisticated treatment of the financial sector, and are thus far from "hydraulic" or without any behavioral content.

The world of neoclassical models—like the stochastic Ramsey-type DSGE models that are widely used in the academia and policymaking—is on the exact opposite side. These models are indeed stock-flow consistent, in the sense that the flows of the models accumulate into stocks. However, they are supply-side full-employment models at heart: the *general* state is supply determined, characterized by full employment (or a "natural" rate of unemployment). The introduction of (ad hoc) rigidities allows them to derive some Keynesian results in the short run as a special case. However, in the medium run, the economy always returns to full employment or to its natural rate of unemployment. This is not just an esoteric theoretical issue. In the CBO's projections for the US economy (or the projections of the "troika" in the European periphery countries), which are derived with DSGE models, demand effects vanish after a couple of years and the economy reverts to a fully supply-side-determined equilibrium. In these type of models, fluctuations are mainly due to "shocks" to productivity or other variables on the real side of the economy.

Moreover, this kind of closure ties the model in such a way that it allows a very minor role (if any) for finance. There is the so-called dichotomy between the real and the financial sides of the economy, where financial complications do not really matter for the real outcome of the economy. Finance is, to use another classical metaphor, just a "veil" that can affect nominal variables but not the real ones. Various related properties that are widespread in neoclassical economics, like the "neutrality of money" or the Modigliani and Miller (1958) theorem emanate from this basic, supply-side full employment choice of closure.

The only way to break this dichotomy is by introducing some kind of friction. Following Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999) in the related "financial" DSGE literature these frictions usually take the form of informational asymmetries and/or incomplete markets. In these models the financial frictions amplify the effects of shocks to productivity. However, these processes are only transitory and as usual with every kind of "friction" DSGE model, the economy tends to return to its supply-determined full-employment equilibrium in the medium run, where finance does not play any role. It is telling that Bernanke, one of the architects of the "financial frictions" DSGE models, was the same person who coined the term "Great Moderation" three years before the Great Recession of 2007 (Bernanke, 2004).

In that sense, it was no accident that the DSGE models ignored the situation in the financial markets or the build-up of private debt in the 1990s or the 2000s. It was exactly the opposite; these models—albeit stock-flow consistent in the literal sense—*by assumption* keep the real and the financial sides separate. As we explained in the course of this paper the purpose of the Keynesian–type SFC models is antipodal: to provide an *integrated* approach to credit, money, income, production, and wealth (as the subtitle of Godley and Lavoie [2007] reads), where the real and the financial sides matter for each other both in the short and long run.

In conclusion, it is true that the name "Stock-Flow Consistent" is misleading and sometimes confusing for what the post-Keynesian SFC approach wants to convey. Accounting consistency is just one of the pillars of the analysis, which is combined with a demand-led closure and a sophisticated and realistic treatment of the financial side of the economy. It is probably too late to change the name now, but it should be clear what we mean by it.

Onomastics aside, for the reasons explained in this paper, the SFC approach to macroeconomic analysis combines many advantages for a rigorous analysis and understanding of the political economy of capitalism.

NOTES

[1] In the United States, the FoF accounts are released by the Federal Reserve System, and also published as "integrated macroeconomic accounts" by the Bureau of Economic Analysis. In the eurozone, these accounts are usually called "financial accounts" and are published by the national central banks, and by Eurostat, but they have a broadly similar format.

[2] The total income transfers on behalf of the government to the households are equal to the interest paid on bills and bonds, $Q_{gh} = r_{b-1}L_{h-1} + r_{bl-1}L_{h-1}$. We could make this explicit in the SAM—like in the Transactions Flow Matrix —with the addition of some more rows and columns. We do not do that here for reasons of economy of space.

[3] One important counterexample is the famous textbook IS-LM model, which is not stock-flow consistent. For the implications of stock-flow inconsistency in the IS-LM model, see Godley and Shaikh (2002).

[4] Note that the identities resulting from the transaction matrix are such that one can be obtained as a linear combination of the others, and must therefore be dropped. The same applies to the identities embedded in the balance sheet.

[5] The specification of investment is famously difficult and controversial, but at the same time necessary within a Keynesian framework. Equation (8) builds on the recent post-Keynesian and Kaleckian literature (Steindl, 1952; Rowthorn, 1981; Taylor, 1983; Dutt, 1984; Bhaduri and Marglin, 1990; and also Minsky, 1986) and the so-called q-theory of investment as proposed by Nicholas Kaldor (1966) and James Tobin (Brainard and Tobin, 1968; Tobin, 1969). Variants of this specific functional form within an SFC model can be found in Lavoie and Godley (2001) and has been subsequently used in other forms by Taylor (2004: ch. 8) and Godley and Lavoie (2007: ch. 11). Fazzari and Mott (1986) and Ndikumana (1999) have found empirical evidence that supports it.

[6] The automatic stabilization of the foreign balance goes back to the price–specie flow mechanism of David Hume (2008) and are present in the IS-LM-BP type of models (Mundell, 1963; Fleming, 1962). The mechanism of the automatic correction is based on the assumed exogeneity of the quantity of money.

[7] The full list of the publications based on Eurace@Unibi model can be found at: http://www.wiwi.uni-bielefeld.de/lehrbereiche/vwl/etace/Eurace_Unibi/

[8] A useful reference for a post-Keynesian approach to "ecological macroeconomics," which rests on the Monetary Circuit Theory rather than the SFC approach, is in Fontana and Sawyer (2016).

[9] It is worth saying that the term "hydraulic Keynesianism" refers to the neoclassical synthesis, IS-LM type of Keynesianism and not to the kind of Keynesian economics Godley and the Cambridge (UK) economists practiced (Coddington, 1976). Ironically, Krugman has been the most vocal contemporary defender of the IS-LM model (e.g., Krugman, 2000).

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Table 1 Balance Sheet Matrix

		(1)	(2)	(3)	(4)	(5)	(6)
		Households	Production Firms	Government	Central Bank	Banks	Total
(A)	Fixed capital		$+PK$				$+PK$
(B)	HPM	$+H_h$			$-H_{cb}$		*0*
(C)	Deposits	$+D_h$				$-D_b$	*0*
(D)	Loans	$-L_h$	$-L_c$			$+L_b$	*0*
(E)	Bills	$+B_h$		$-B_g$	$+B_{cb}$	$+B_b$	*0*
(F)	Bonds	$+p_{bl}BL_h$		$-p_{bl}BL_g$	$+p_{bl}BL_{cb}$	$+p_{bl}BL_b$	*0*
(G)	Equities	$+p_eE_h$	$-p_eE_c$			$+p_eE_b$	*0*
(H)	Balance (net worth)	$-V_h$	$-V_c$	$-V_g$	$-V_{cb}$	$-V_b$	*-PK*
(I)	Sum	0	0	0	0	0	0

Table 2 Transactions-Flows Matrix

		(1) Households	(2) NFC Current	(3) NFC Capital	(4) Government	(5) Central Bank	(6) Banks	(7) Total
(A)	**Transactions**							
(B)	Consumption	$-PC$	$+PC$					0
(C)	Investment		$+PI$	$-PI$				0
(D)	Gov. Expenditure		$+PG$		$-PG$			0
(E)	*[memo: Output]*		$[PY]$					
(F)	Wages	$+W$	$-W$					0
(G)	NFC Profits	$+\Pi_{c,d}$	$-\Pi_c$	$+\Pi_{c,c}$				0
(H)	Taxes	$-T_h$		$-T_c$	$+T$		$-T_b$	0
(I)	C.B. Profits				$+\Pi_{cb}$	$-\Pi_{cb}$		0
(J)	Interest on Deposits	$+r_{d-1}D_{h-1}$					$-r_{d-1}D_{h-1}$	0
(K)	Interest on Loans	$-r_{l-1}L_{h-1}$		$-r_{l-1}L_{c-1}$			$+r_{l-1}L_{b-1}$	0
(L)	Interest on Bills	$+r_{b-1}B_{h-1}$			$-r_{b-1}B_g$	$+r_{b-1}B_{cb-1}$	$+r_{b-1}B_{b-1}$	0
(M)	Interest on Bonds	$+r_{bl-1}BL_{h-1}$			$-r_{bl-1}BL_g$	$+r_{bl-1}BL_{cb-1}$	$+r_{bl-1}BL_{b-1}$	0
	Flow of Funds							
(N)	*[memo: Net Lending]*	$[NL_h]$		$[NL_c]$	$[NL_g]$	$[NL_{cb}]$	$[NL_b]$	0
(O)	Δ in HPM	$-\Delta H_h$				$+\Delta H$		0
(P)	Δ in Deposits	$-\Delta D_h$					$+\Delta D_b$	0
(Q)	Δ in Loans	$+\Delta L_h$		$+\Delta L_c$			$-\Delta L_b$	0
(R)	Δ in Bills	$-\Delta B_h$			$+\Delta B_g$	$-\Delta B_{cb}$	$-\Delta B_b$	0
(S)	Δ in Bonds	$-p_{bl}\Delta BL_h$			$+p_{bl}\Delta BL_g$	$-p_{bl}\Delta BL_{cb}$	$-p_{bl}\Delta BL_b$	0
(T)	Δ in Equities	$-p_e\Delta E_h$		$+p_e\Delta E_c$			$-p_e\Delta E_b$	0
(Y)	Sum	0	0		0	0	0	0

Table 3 A Social Accounting Matrix

		Current Expenditures							Changes in Claims						
		(1) Output Costs	(2) Households	(3) Firms	(4) Government	(5) Central Bank	(6) Banks	(7) Gross Cap. Formation	(8) HPM	(9) Deposits	(10) Loans	(11) Bills	(12) Bonds	(13) Equities	(14) Totals
(A)	Output		PC		PG			PI							PY
	Incomes														
(B)	Households	W		$\Pi_{c,d}$	Q_{gh}		$r_{d-1}D_{h-1}$								PY_h
(C)	Firms	Π_c													PY_c
(D)	Government		T_h	T_c		Π_{cb}	T_b								PY_g
(E)	Central Bank				Q_{gcb}										PY_{cb}
(F)	Banks		$r_{l-1}L_{h-1}$	$r_{l-1}L_{c-1}$	Q_{gb}										PY_b
	Flows of Funds														
(G)	Households		NL_h						$-\Delta H_h$	$-\Delta D_h$	$+\Delta L_h$	$-\Delta B_h$	$-p_{bl}\Delta BL_h$	$-p_e\Delta E_h$	0
(H)	Firms			$\Pi_{c,r}$				$-PI$			$+\Delta L_c$			$+p_e\Delta E_c$	0
(I)	Government				NL_g							$+\Delta B_g$	$+p_{bl}\Delta BL_g$		0
(J)	Central Bank					NL_{cb}			$+\Delta H_{cb}$			$-\Delta B_{cb}$	$-p_{bl}\Delta BL_{cb}$		0
(K)	Banks						NL_b			$+\Delta D_b$	$-\Delta L_b$		$-p_{bl}\Delta BL_b$	$+p_eE_b$	0
(L)	Totals	PY	PY_h	PY_c	PY_g	PY_{cb}	PY_b	0	0	0	0	0	0	0	

Table 4 Balance Sheet Matrix for Two Economies

		Domestic Economy						Foreign Economy					
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Households	Production Firms	Government	Central Bank	Banks	[XR]	Households	Production Firms	Government	Central Bank	Banks	Total
	(A) Fixed capital		$+PK$						$+P^{*}K^{*}$				$+PK+\varepsilon P^{*}K^{*}$
Domestically issued assets	(B) HPM	$+H_h$			$-H_{cb}$		$[\varepsilon]$	$+(1/\varepsilon)H_{h*}$					0
	(C) Deposits	$+D_h$				$-D_b$	$[\varepsilon]$	$+(1/\varepsilon)D_{h*}$					0
	(D) Loans	$-L_h$	$-L_c$			$+L_b$	$[\varepsilon]$	$-(1/\varepsilon)L_{h*}$	$-(1/\varepsilon)L_{c*}$				0
	(E) Bills	$+B_h$		$-B_g$	$+B_{cb}$	$+B_b$	$[\varepsilon]$	$+(1/\varepsilon)B_{h*}$				$+(1/\varepsilon)B_{b*}$	0
	(F) Bonds	$+p_{BL}BL_h$		$-p_{bl}BL_g$	$+p_{bl}BL_{cb}$	$+p_{BL}BL_b$	$[\varepsilon]$	$+(1/\varepsilon)p_{BL}BL_{h*}$				$+(1/\varepsilon)p_{BL}BL_{b*}$	0
	(G) Equities	$+p_eE_h$	$-p_eE_c$			$+p_eE_b$	$[\varepsilon]$	$+(1/\varepsilon)p_eE_{h*}$				$+(1/\varepsilon)p_eE_{b*}$	0
Foreign issued assets	(H) HPM	$+\varepsilon H_h^{*}$			$-\varepsilon H_{cb}^{*}$		$[\varepsilon]$	$+H_*^{*}$			$-H_{cb*}^{*}$		0
	(I) Deposits	$+\varepsilon D_h^{*}$					$[\varepsilon]$	$+D_*^{*}$				$-D_{b*}^{*}$	0
	(J) Loans	$-\varepsilon L_h^{*}$	$-\varepsilon L_c^{*}$				$[\varepsilon]$	$-L_{h*}^{*}$	$-L_{c*}^{*}$			$+L_{b*}^{*}$	0
	(K) Bills	$+\varepsilon B_h^{*}$			$+\varepsilon B_{cb}^{*}$	$+\varepsilon B_b^{*}$	$[\varepsilon]$	$+B_{h*}^{*}$		$-B_{g*}^{*}$	$+B_{cb*}^{*}$	$+B_{b*}^{*}$	0
	(L) Bonds	$+\varepsilon p_{BL}^{*}BL_h^{*}$			$+\varepsilon p_{bl}^{*}BL_{cb}^{*}$	$+\varepsilon p_{bl}^{*}BL_b^{*}$	$[\varepsilon]$	$+p_{BL}^{*}BL_{h*}^{*}$		$-p_{bl}^{*}BL_{g*}^{*}$	$+p_{BL}^{*}BL_{cb*}^{*}$	$+p_{bl}^{*}BL_{b*}^{*}$	0
	(M) Equities	$+\varepsilon p_e^{*}E_h^{*}$				$+\varepsilon p_e^{*}E_b^{*}$	$[\varepsilon]$	$+p_e^{*}E_{h*}^{*}$	$-p_e^{*}E_{c*}$			$+p_e^{*}E_{b*}^{*}$	0
	(N) Net worth	$-V_h$	$-V_c$	$-V_g$	$-V_{cb}$	$-V_b$		$-V_{h*}^{*}$	$-V_{c*}^{*}$	$-V_{g*}^{*}$	$-V_{cb*}^{*}$	$-V_{b*}^{*}$	$-PK-\varepsilon P^{*}K^{*}$
	(O) Sum	0	0	0	0	0		0	0	0	0	0	0

Table 5 Transactions-Flow Matrix for Two Economies

		Domestic Economy							Foreign Economy						
		(1) Households	(2) NFC	(3)	(4) Government	(5) Central Bank	(6) Banks	(7) [XR]	(8) Households	(9) NFC	(10)	(11) Government	(12) Central Bank	(13) Banks	(14) Total
			Current	Capital						Current	Capital				
(A)	**Transactions**														0
(B)	Consumption	$-PC$	$+PC$						$-P^*C^*$	$+P^*C^*$					0
(C)	Investment		$+PI$	$-PI$						$+P^*I^*$	$-P^*I^*$				0
(D)	Gov. Expenditure		$+PG$		$-PG$					$+P^*G^*$		$-P^*G^*$			0
(E)	Domestic Exports		$+PX$					$[\varepsilon]$		$-P^*M*$					0
(F)	Domestic Imports		$-PM$					$[\varepsilon]$		$+P^*X^*$					0
(G)	*[memo: Output]*		$[PY]$							$[P^*Y^*]$					
(H)	Wages	$+W$	$-W$						$+W^*$	$-W^*$					0
(I)	Dom. Profits	$+\Pi_{c,d}$	$-\Pi_c$	$+\Pi_{c,c}$				$[\varepsilon]$	$+(1/\varepsilon)\Pi_{c,d*}$						0
(J)	For. Profits	$+\varepsilon\Pi^*_{c,d}$						$[\varepsilon]$	$+\Pi^*_{c,d*}$	$-\Pi^*_c$	$+\Pi^*_{c,c}$				0
(K)	Taxes	$-T_h$		$-T_c$	$+T$		$-T_b$		$-T^*_h$		$-T^*_c$	$+T^*$		$-T^*_b$	0
(L)	C.B. Profits				$+\Pi_{cb}$	$-\Pi_{cb}$						$+\Pi^*_{cb}$	$-\Pi^*_{cb}$		0
	<u>Interest on</u>														
(M)	Dom. Deposits	$+r_{d-1}D_{h-1}$					$-r_{d-1}D_{b-1}$	$[\varepsilon]$	$+(1/\varepsilon)r_{d-1}D_{h*-1}$						0
(N)	Dom. Loans	$-r_{l-1}L_{h-1}$		$-r_{l-1}L_{c-1}$			$+r_{l-1}L_{b-1}$	$[\varepsilon]$	$-(1/\varepsilon)r_{l-1}L_{h*-1}$		$-(1/\varepsilon)r_{l-1}L_{c*-1}$				0
(O)	Dom. Bills	$+r_{b-1}B_{h-1}$			$-r_{b-1}B$	$+r_{b-1}B_{cb-1}$	$+r_{b-1}B_{b-1}$	$[\varepsilon]$	$+(1/\varepsilon)r_{b-1}B_{h*-1}$					$+(1/\varepsilon)r_{b-1}B_{b*-1}$	0
(P)	Dom. Bonds	$+r^*_{bl-1}BL_{h-1}$			$-r_{bl-1}BL$	$+r_{bl-1}BL_{cb-1}$	$+r_{bl-1}BL_{b-1}$	$[\varepsilon]$	$+(1/\varepsilon)r^*_{bl-1}BL_{h*-1}$					$+(1/\varepsilon)r_{bl-1}BL_{b*-1}$	0
(Q)	For. Deposits	$+\varepsilon r^*_{d-1}D^*_{h-1}$						$[\varepsilon]$	$+r^*_{d-1}D^*_{h*-1}$					$-r^*_{d-1}D^*_{b*-1}$	0
(R)	For. Loans	$-\varepsilon r^*_{l-1}L^*_{h-1}$		$-\varepsilon r^*_{l-1}L^*_{c-1}$				$[\varepsilon]$	$-r^*_{l-1}L^*_{h*-1}$		$-r^*_{l-1}L^*_{c*-1}$			$+r^*_{l-1}L^*_{b*-1}$	0
(S)	For. Bills	$+\varepsilon r^*_{b-1}B^*_{h-1}$				$+\varepsilon r^*_{b-1}B^*_{cb-1}$	$+\varepsilon r^*_{b-1}B^*_{b-1}$	$[\varepsilon]$	$+r^*_{b-1}B^*_{h*-1}$			$-r^*_{b-1}B^*$	$+r^*_{b-1}B^*_{cb*-1}$	$+r^*_{b-1}B^*_{b*-1}$	0
(T)	For. Bonds	$+\varepsilon r^*_{bl-1}BL^*_{h-1}$				$+\varepsilon r^*_{bl-1}BL^*_{cb-1}$	$+\varepsilon r^*_{bl-1}BL^*_{b-1}$	$[\varepsilon]$	$+r^*_{bl-1}BL^*_{h*-1}$			$-r^*_{bl-1}BL^*$	$+r^*_{bl-1}BL^*_{cb*-1}$	$+r^*_{bl-1}BL^*_{b*-1}$	0
	Flow of Funds														
(U)	*[memo: Net Lending]*	$[NL_h]$		$[NL_c]$	$[NL_g]$	$[NL_{cb}]$		$[\varepsilon]$	$[NL^*_h]$		$[NL^*_c]$	$[NL^*_g]$	$[NL^*_{cb}]$	$[NL^*_b]$	0
(V)	Δ in NFA	$-\Delta NFA_h$		$-\Delta NFA_c$	$-\Delta NFA_g$	$-\Delta NFA_{cb}$	$-\Delta NFA_b$	$[\varepsilon]$	$-\Delta NFA_{h*}$		$-\Delta NFA_{c*}$	$-\Delta NFA_{g*}$	$-\Delta NFA_{cb*}$	$-\Delta NFA_{b*}$	0
(W)	Δ in NFA^*	$-\Delta NFA^*_h$		$-\Delta NFA^*_c$	$-\Delta NFA^*_g$	$-\Delta NFA^*_{cb}$	$-\Delta NFA^*_b$	$[\varepsilon]$	$-\Delta NFA^*_{h*}$		$-\Delta NFA^*_{c*}$	$-\Delta NFA^*_{g*}$	$-\Delta NFA^*_{cb*}$	$-\Delta NFA^*_{b*}$	0
(X)	Sum	0	0		0	0	0		0	0	0	0	0	0	0