

Post-Keynesian stock-flow-consistent modelling: a survey

Eugenio Caverzasi and Antoine Godin*

The aim of the paper is to provide an overview of the current stock-flow-consistent (SFC) literature. Indeed, we feel the SFC approach has recently led to a blossoming literature, requiring a new summary after the work of Dos Santos and above all after the publication of the main reference work on the methodology, Godley and Lavoie's *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*. The paper is developed along the following lines. First, a brief historical analysis investigates the roots of this class of models that can be traced as far back as 1949 and the work of Copeland. Second, the competing points of view regarding some of its main controversial aspects are underlined and used to classify the different methodological approaches followed in using these models. Namely, we discuss (i) how the models are solved, (ii) the treatment of time and its implication and (iii) the need (or not) for microfoundations. These results are then used in the third section of the paper to develop a bifocal perspective, which allows us to divide the literature reviewed according to both its subject and the methodology. We explore various topics such as financialisation, exchange rate modelling, policy implication, the need for a common framework within the post-Keynesian literature and the empirical use of SFC models. Finally, the conclusions present some hypotheses (and wishes) for the possible lines of development of SFC models.

Key words: Stock-flow consistent, Post-Keynesian, Literature review

JEL classifications: B5, C69, E12

1. Stock-flow-consistent models

Recent post-Keynesian literature has witnessed the rise of a relatively new family of models: the so-called post-Keynesian stock-flow-consistent (PK-SFC) models. As we will show, the roots of these models date rather far back in time. However, only in the last 10 years have they seemed to attract a wider consensus, at least in the heterodox academic community. This paper analyses the most important contributions in this area of research, with a particular focus on the latest works. What we aim to obtain is a clear picture of the current state of the art of PK-SFC models as well as an improved understanding of their possible lines of development.

Manuscript received 31 January 2013; final version received 18 November 2013.

Address for correspondence: Antoine Godin, Kemmy Business School, University of Limerick, Limerick, Ireland; email: godin.antoine@gmail.com

* Marche Polytechnic University (EC) and University of Limerick (AG). We wish to thank Alessandro Caiani, Stephen Kinsella, Marc Lavoie, Edwin Le Heron, Marco Missaglia, Gennaro Zezza and two anonymous referees for their valuable comments. As usual, all errors remaining are ours.

The outline of the paper is as follows. In this introductory section, we first present some of the most generic findings of our investigation. We then trace the steps that led to this class of model in a brief historical survey. The second section presents some of the methodological and theoretical debates about these models: the solution of the model, the role of time and the microfoundations. Sections 3–5 include a review of the most recent papers discussing PK-SFC models, divided according to their methodology and subjects: (i) theoretical models with a discursive solution, (ii) theoretical models solved via simulation and (iii) empirical models. The second group has been further partitioned according to the subjects treated. In this case, we individuated four macro areas: financialisation, open economies, policy implications and theoretical debate. Finally, the conclusion uses the evidence emerging from the analysis of the previous sections to develop some hypotheses (and wishes) for the possible lines of development of PK-SFC models.

1.1 Graphical overview

Before entering the core of our paper and analysing the characteristics of the PK-SFC framework, we would like to provide a rapid overview of some of the results of our investigation with the help of three graphs. [Figure 1](#) shows the network of all authors cited in this paper.¹ Each author is a node and each connection represents a paper co-authorship. We have highlighted in black all authors with five or more cited publications. What emerges from this figure are two subnetworks: the first centred around the contributions of Wynne Godley, Marc Lavoie, Gennaro Zezza and Claudio Dos Santos, which we could characterise as the North American network, and the second emerging from the works of Jacques Mazier, Stephen Kinsella and Edwin Le Heron, which we could call the European network. It is important to bear in mind that this graph only provides for a partial representation of the links among authors. Indeed, the connections between points only represent co-authorships; other kinds of relations are not captured. Furthermore, the proximity in our network does not indicate actual vicinity, either geographical or otherwise. These deficiencies emerge as self-evident when looking, for example, at the European group that appears to be split. There seems to be an isolated ‘galaxy’ centred on Le Heron, while French scholars have in fact created a network of collaboration that goes beyond co-authorships.

The second analysis we conducted, based on the bibliography we have gathered, regards the appearance of different assets and sectors. Indeed, while the first models were relatively simple, the development of the literature has witnessed an increase in the number of assets and sectors modelled. [Figures 2](#) and [3](#) show the timelines of the appearance of each asset and sector, according to the network in which the paper was published. It also indicates the frequency of modelling: the darker the cell, the more frequently the asset/sector was modelled in that year. For example, in 2008, equities were more frequent than bonds in the same year or than equities two years before.

The first observation to be made regards the age of each network. We see that the European network is much younger than its North American counterpart. As a result of this earlier start, the North American network shows more diversity in assets ([Figure 2](#)) and in sectors ([Figure 3](#)). However, we can observe that the European

¹ All graphs presented in this section are automatically generated using the Bibliography as a database; the R source code is available from the authors upon request.

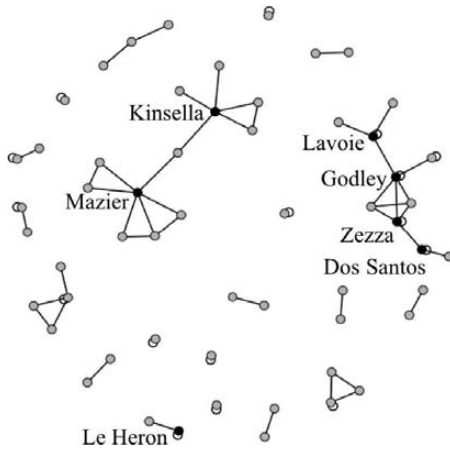


Fig. 1. Network of authors working in the SFC framework.

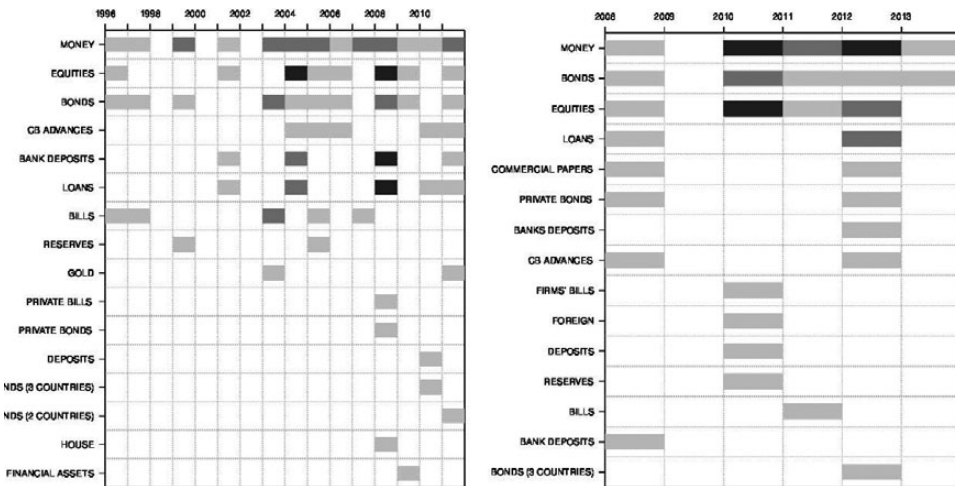


Fig. 2. Assets' appearance through time in SFC models.

Note: Left, North American network; right, European network. The darker the cell, the more frequently the asset was modelled.

network started diversifying assets and sectors from the beginning, while the North American network had a more incremental diversification.

These timelines allow us to see not only the diversity of assets modelled, but also the trends. It seems that diversification is driven by real-life events, indicating that PK-SFC practitioners are using their models to try to understand these events. For example, in 2008, just after the burst of the housing bubble in the USA, we observe that the housing market is modelled. We observe that, at first, assets were not diversified that much, but that the current crises compelled authors to develop more and more complex models of the financial market.

The evolution of sectors presents a lower level of diversification than that of assets. This can be explained easily. An increase in the number of assets or sectors determines a significant amount of growth of the complexity of the models. It thus seems that the

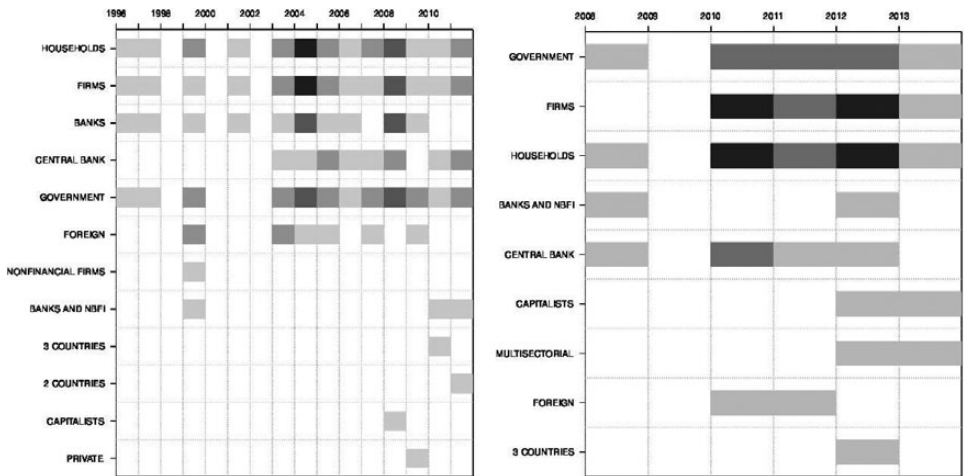


Fig. 3. Sectors' appearance through time in SFC models.

Note: Left, North American network; right, European network. The darker the cell, the more frequently the sector was modelled.

authors concentrated on modelling a more realistic financial market, rather than a more realistic productive structure or household structure. Nonetheless, the appearance of the differentiation between households and capitalists indicates that distributive issues have been addressed.

1.2 brief historical recollection

The main characteristics of PK-SFC models will be extensively addressed in this paper, but for the moment we will try to describe their very basic characteristics, rapidly answering these two questions: what are PK-SFC models? And where do they come from? With respect to the first question, we can say that PK-SFC models are a specific kind of post-Keynesian macromodel that follows distinctive accounting rules, ensuring the consistent integration of the stocks and flows of all the sectors of the economy. This led to reaching three important achievements: first, the consistency of the overall economy, since one sector's outflow is always another sector's inflow just as one sector's liability is always another sector's asset; second, the integration of the real and the financial side of the economy; and third, the construction of the long run as a chain of the short run. Nothing is lost, neither in space nor in time.

Broadly speaking, we can identify two main components: (i) the accounting framework and (ii) the behavioural equations—see the Appendix for an example of a transaction-flow matrix (Table A1) and a balance sheet (Table A2) for model PC (see Godley and Lavoie, 2007C, ch. 4). The Appendix also contains the model's behavioural equations. The accounting framework usually relies on a set of matrices reproducing the balance sheets, transactions and capital gains of each of the institutional sectors into which the economy is subdivided. The second component is a set of behavioural equations modelling all the transactions not directly determined by the accounting structure of the economy. Therefore the accounting represents the framework, which then becomes a post-Keynesian model once the behavioural equations come into play.

Where do PK-SFC models come from? Their roots are to be identified in the work of Morris A. Copeland (1949), who, with his study on ‘money flows’, is the father of the flow of funds (for the USA, the Federal Reserve Board’s Z.1 release). The intuition of Copeland was to enlarge the social accounting perspective, which had been until then used mainly in the study of national income, to the study of money flows. Hence, with his attempts to find answers to fundamental economic questions such as ‘when total purchases of our national product increase, where does the money come from to finance them’ and ‘When purchases of our national product decline, what becomes of the money that is not spent’, he laid the foundation for an economic approach able to integrate real and financial flows of the economy (Copeland, 1949, p. 254). A concrete example of his legacy is represented by the quadruple-entry system, which is a cardinal feature of today’s PK-SFC models. Since someone’s inflow is someone else’s outflow, the standard double-entry system of accounting, in its social version, is doubled in a quadruple-entry system.

As observed after 25 years by Cohen (1972), the work of Copeland certainly had a great influence on economics—mainly as a source of financial data—but its potential disruptive impact on the study and modelling of the interdependences between real and financial flows failed to occur, at least until the time in which Cohen was writing. As to the possible causes of this missed evolution of economics, Cohen indicates ‘the lack of a so-called “organizing theory”’, or in other words, ‘they lack their Keynes’ (Cohen, 1972, p. 13). Albeit in the 1970s, several authors within the orthodox tradition tried to formulate models able to include coherently real and financial stocks and flows, but all failed to comprehend the potential theoretical contribution of the work of Copeland and their efforts did not result in a well-suited alternative macroeconomic framework. Among others, Denizet (1967) based his analysis on a framework very similar to the PK-SFC methodological approach, proposing ‘a transactions flow matrix that has implicitly all the features of the matrices that were later produced explicitly by Tobin ... and systematically by Godley’ (Lavoie, 2011, p. 4). Turnovsky (1977) tried to include financial markets in the standard IS/LM (investment saving–liquidity preference money supply) framework, expanding the work of previous authors, such as May (1970) on continuous and discrete time in the analysis of stocks and flows and Meyer (1975) on the coherence between stocks and flows (‘conservation principle’).

It was only in the 1980s, with the work of James Tobin, that these efforts culminated in the organising theory advocated by Cohen. The article Tobin wrote with David Backus, William C. Brainard and Gary Smith (Backus *et al.*, 1980) perhaps represents his path-breaking contribution in the foundation of PK-SFC models. Indeed, in developing an empirical model of the US economy in both its financial and non-financial sides, the authors combined the theoretical hypothesis on the behaviour of the economy with a rigorous accounting framework based on the flow-of-funds social account developed by Copeland. The result is an SFC model that includes some of the characteristics still peculiar in the literature, such as the matrices-based accounting approach, discrete time (a practical reason reflecting the quarterly availability of data in the flow of funds) and other features (e.g. stock-flow identity), which are fundamental in any model of this type. The importance of Tobin’s contribution is probably more evident if we take into consideration his Nobel lecture (Tobin, 1982), which in specific passages resembles a manifesto of this approach since it neatly defines and illustrates its components. Tobin identifies five defining features underlying the innovative character of his work with respect to existing macromodels:

- (i) Precision regarding time.
- (ii) Tracking of stocks.
- (iii) Several assets and rates of return.
- (iv) Modelling of financial and monetary policy operations.
- (v) Walras's Law and adding up constraints.

These are still central in any SFC model and have been used as a definition of the PK-SFC approach (Dos Santos, 2006). Godley and Lavoie (2007c, p. 15) however stress that differences between Tobin and the PK-SFC approach can be found in the specification of the behavioral equations. The lesson of Tobin was unheeded by the new Keynesian tradition because of the rise of the representative agent-based macromodels.

Next to Tobin and to the Yale School he led, the other scholar who played an essential role in the development of this family of models is Wynne Godley. Godley, head of the new Cambridge School (or Cambridge Economic Policy Group) in the 1980s, started developing models coherently integrating stocks and flows (Godley and Cripps, 1983; Godley and Zezza, 1989). His efforts culminated in the organised framework he developed in his more recent publications (Godley, 1996, 1997, 1999A, 1999C), with which—albeit belonging to a different theoretical tradition—he collected the legacy of Tobin. Godley's contribution probably finds its peak in the book he wrote together with Marc Lavoie (Godley and Lavoie, 2007C), which is still the main reference for current PK-SFC practitioners. Whether Tobin or Godley is to be considered the father² of PK-SFC models (or the 'Keynes of the flow of funds', in the words of Cohen) is controversial. We believe it depends on whether the label 'stock-flow consistent' is applied specifically to the models in the post-Keynesian tradition (such as the papers analysed in this paper and therefore the father would clearly be Godley) or to any model with the characteristics we recall above (in this case the father would be Tobin).

This paper, although not taking sides in this debate, focuses on the tradition descending from the work of Wynne Godley; hence the choice of talking of PK-SFC models rather than just SFC models, following the call of Zezza (2009). This, indeed, represents the main aspect of the novelty of our work, since we believe a comprehensive review of older SFC models can be found in Godley and Lavoie (2007C), whereas an insightful analysis of the link between these models and Keynesian macroeconomic literature has been developed by Dos Santos (2006).

The taxonomy of the PK-SFC models proposed with this paper aims to be descriptive rather than normative. We try to provide a picture of the PK-SFC literature. However, the boundaries of the PK-SFC approach are controversial; whether a model should or should not be considered PK-SFC can be debatable. A significant example is represented by the work presented in Asada *et al.* (2011, ch. 4). Their model enlarges the Keynes–Metzler–Goodwin (KMG) model of Chiarella and Flaschel (2000A) to include the financial sector according to the approach developed by Tobin. According to the authors there are two differences between their approach and the PK-SFC literature. First, the theoretical assumptions adopted in the behavioral equations, above all the exogeneity of money; and, second, the use of continuous time.

² On this matter, it is interesting to notice PK-SFC models are defined 'à la Godley' by Zezza (2004), 'à la Godley and Tobin' by Dos Santos and Zezza (2004B) and more recently 'à la Godley and Tobin' by Clévenot *et al.* (2009).

We do not fully agree. As we will show in Section 2.1, there exist examples of models solved analytically abandoning discrete time in favour of continuous time. Therefore, albeit the precision regarding time and the rigorous tracking of stocks and flows of the economy is one of the quintessential features of PK-SFC literature, we do not believe that this is a sufficient condition to differentiate between classes of models. Furthermore, a more significant difference in the Tobinesque KMG model is represented by the absence of private banks (this is linked with the authors' use of the exogenous money approach). An explicit inclusion of the banking sector is, according to [Zeza \(2009\)](#), one of the defining characteristics of PK-SFC models. One of the questions that led to the development of the flow-of-funds analysis was indeed 'Where does money come from and where does it go?' The role of money is indeed central. Hence, we believe that the reproduction of a monetary economics with a developed banks sector is an escapable requirement for a PK-SFC model.

2. Theoretical considerations

In this section, we introduce three debates on methodological and theoretical issues regarding PK-SFC modelling. We believe indeed that a brief overview of these debates can facilitate the understanding of both the peculiarities of the approach and its level of development.

2.1 *Solving the model: analytical versus simulated*

There exist two main ways of solving an economic model: numerically and analytically. This paper identifies a third possible way: a discursive solution. However, since this does not represent a proper solution of the model, it will be treated briefly in Section 3.

Solving a model numerically implies dealing with the following fundamental questions: (i) how to determine the values of parameters and initial endogenous variables; and (ii) how to use the results of the simulations.

The first question can be answered with two methodologies: (a) estimation and (b) calibration. Estimation is a statistical methodology determining the value of parameters and initial values using time series. Section 5 analyses in detail the few articles offering estimated models; we will nonetheless address here two important issues related to estimation. The first issue is related to the implicit assumption that parameters are constant when they are estimated. Obviously, econometrics tools allow testing for such assumptions. Furthermore, it is up to the modeller to arbitrate between realistic behavioral equations and the complexity of the model.

Once a model is estimated, it can be used for prediction making as out-of-sample values can be computed for all endogenous flows and stocks. However, the further from last observed values, the less statistically significant are those predictions. Furthermore, alternative scenarios can be computed by assuming a change in certain parameters. However, here issues related to the so-called Lucas critique arise: is it reasonable to assume that the other parameters will remain constant? To our knowledge, there is no correct answer to that question. It is again up to the modeller to justify his choice and find the right balance between model complexity and realistic behaviours.

On the other hand, calibration is the process of assigning numerical values for the parameters and initial values of endogenous variables using stylised facts or rules of thumb. The question of how to use the results of simulation rises again. In our opinion, two approaches

exist: (i) the model starts from a stationary/steady-state situation (see Section 2.2) and is then shocked; or (ii) the model is run for a baseline scenario, without being constrained to a stationary/steady state, and various scenarios are then run, changing certain parameters.

Calibration is the most widely used methodology among PK-SFC practitioners. The main reason behind this is that it permits the inclusion of virtually any specification and therefore the construction of more realistic models without losing the possibility of identifying the causal relations among variables. However, the numerical approach to the solution of the model, in addition to its manifest advantages, presents some drawbacks. As Lavoie and [Godley \(2001–02, p. 296\)](#) note, ‘the disadvantage is that we can only analyze local stability: we do not know if there are other equilibria, or if these other equilibria are stable’.

[Dos Santos and Macedo e Silva \(2009, p. 9\)](#) identify two further problems related to this methodology, which, in their view, might have been unfavourable to the diffusion of PK-SFC models. First, their mathematical complexity, which, especially in very large models, can make the economic intuition nebulous; and, second, the dependency on the value of the parameters, as recognised as well by Lavoie and [Godley \(2002, p. 296\)](#): ‘the results could be, and in many cases certainly are, sensitive to the values taken by the assumed parameters’. Even assuming that the starting values of parameters are founded on a perfectly solid empirical ground, this inevitably adds a certain degree of arbitrariness due to the calibration step. [Taylor \(2008\)](#) points out the importance of these stock-flow norms and notes that some non-realistic values have been used throughout Godley and Lavoie’s book.

The alternative is to find an analytical solution. Certainly, this forces us to develop a much simpler model, causing a loss of realism and not allowing for a complete representation of the most complex theories. However, it can still provide for interesting economic insights. In particular, as observed by [Dos Santos and Macedo e Silva \(2009\)](#) in their analysis of [Dos Santos and Zezza \(2008\)](#), in equilibrium, all flows and stocks grow at the same rate and, as a consequence, the ratios among variables are fixed. It is therefore possible to analyse the equilibrium according to the determinants of these ratios. In particular, they produce a graphical representation of the equilibrium conditions based on the considerations that the growth rates of the stocks of debt, capital and households’ wealth (rentiers in the original paper, since households are assumed to consume all their wage income) must equate. According to the authors, this not only provides for a more intuitive approach to PK-SFC models, but also represents a sensible development in the heterodox literature:

No one has ever stated clearly that the key to Post-Keynesian/structuralist/heterodox dynamic analyses might be to take a close look at the dynamics of both the size and composition of the sectorial balance sheets ... This simple point is perhaps lost amidst the complex SFC algebra and dynamic simulations, but this does not make it any less true. ([Dos Santos and Macedo e Silva, 2009, p. 31](#))

A further interesting outcome of analytical solutions (and therefore not very complex models) is their potential as theoretical and didactical tools. A rare example is represented by [Taylor \(2004B, chs 8–9\)](#), where the model from Godley and [Lavoie \(2001–02\)](#) and its analytical solution are used to show the post-Keynesian position on debt and growth in an endogenous money framework. The same model is then enlarged to reproduce a Minskyan cycle driven by animal spirits (in line with [Taylor and O’Connell, 1985](#)).

A third possibility in our taxonomy of the approaches to solve PK-SFC models is to use the accounting part of SFC models, and eventually the behavioral hypothesis, as a reference for a theoretical discursive paper. This approach will be more extensively investigated in Section 3.

2.2 Time matters

As emphasised by [Dos Santos and Zezza \(2008, p. 444\)](#), PK-SFC models provide ‘a natural and rigorous link between “adjacent short periods”’. In each period, stocks are generating flows that then update these stocks. These stocks will then generate new flows, etc. The long-run dynamics of PK-SFC models are thus composed of a path of short-run periods interconnected with each other via the stocks. This definition of long-run dynamics is close to what [Keynes \(1936, ch. 5\)](#), [Robinson \(1956, pp. 180–1\)](#) or [Kalecki \(1971, p. 165\)](#) defined as long-run, as noted by [Macedo e Silva and Dos Santos \(2011\)](#).

Two fundamental time-related characteristics of PK-SFC modelling should be highlighted. First, we believe that a PK-SFC model should exhibit path dependency. Up to now, most of the papers have not demonstrated this characteristic, with the notable exception of [Lavoie and Zhao \(2010\)](#). Obviously, if a model shows path dependency, short-term realisation will impact the steady or stationary state values³ (SS from now on). Second, SS values of a model will impact its short-term realisations. If a simulated model is at its SS and is shocked, the further the new SS is from its current value, the more likely it is that the reaction of the economy will be strong, depending, of course, on persistence and inertia of the model at hand.

These interconnections between short-term and long-term realisation imply that PK-SFC models are inherently at the heart of the short-run/long-run debate. However, only a few authors using PK-SFC models have focused on the debate ([Dos Santos and Zezza, 2008](#); [Dos Santos and Macedo e Silva, 2009](#); [Skott and Ryoo, 2007](#)). Interestingly, all of these papers have concentrated their analysis on the analytical solution of their models, rather than on the simulated resolution. We find this to be very refreshing.

The rationality of the SS state has to be questioned. In order to obtain an SS state, some or all parameters have to be assumed constant and stock-flow ratios have to be constant. A couple of questions then arise:

- (i) Is it relevant to analyse such an SS state and is an economy likely to attain such a steady state? We believe, as do [Dos Santos and Zezza \(2008\)](#) and [Dos Santos and Macedo e Silva \(2009\)](#), that even if it is very unlikely that an economy reaches a situation where stocks and flows are constant (or growing at a constant rate in the case of a steady state) over time, analysing it is relevant because the stationary (resp. steady) state affects the dynamics of short-run realisations. Furthermore, it is easier to compare different policies using stationary states. Indeed, during

³ We differentiate between long-run and steady state or stationary state (SS). The stationary state is a logical construction where all stocks and flows do not change over time while the steady state is a logical construction where all stocks and flows grow at the same rate. The SS could be reached if all the behaviours were fixed forever, after a transition period. However, in the real world, behaviours are constantly changing, preventing the economy from ever reaching any SS. Furthermore, as the SS in a logical-mathematical construct, the values stocks or flows take might not make any economical sense (e.g. negative income). In such a case, a model might not be able to reach its SS as the simulation is stopped before.

non-steady state, the stocks and flows vary from period to period and it is complicated to distinguish what comes out of the dynamics of the model as it settles and what emerges from the policy change.

- (ii) What parameters should be assumed constant and how are the varying parameters related to the constant ones? The choice of the constant parameters and the determining stock-flow norm is essential in defining an SS state and, in general, it characterises the whole model. Each assumption will impact both the SS state stock levels and the influence a shock might have on these values. This is clearly shown by [Skott and Ryoo \(2007\)](#), who define different economies leading to different steady-state long-run equilibria and observe how financialisation impacts each one of these steady states.

[Ryoo \(2010\)](#) is an interesting example of medium- to long-run analysis without focusing on the steady state.⁴ He presents a continuous time PK-SFC model based on short-run (variation in demand implying capacity utilisation movements) and long-run (leverage and equity to deposit ratio movements) interactions. These two movements generate short cycles and long waves in an attempt to integrate two types of instability principles: Minsky's financial instability hypothesis and Harrod's instability principle.

The paper by [Lavoie and Zhao \(2010\)](#) is of great interest to this discussion, since the authors highlight the path dependency of their model. Their paper will be discussed in Section 4.2. However, here, we want to stress this interesting outcome. The model shows how the same set of values of the parameters in the behavioral equations can lead to different steady states, depending on the velocity at which the economy responds to the shock that hits it. This clearly shows again that the long run (i.e. the transition period from the initial situation when the shock is applied to the economy to the new steady state) is composed of short-run periods, but also that these short-run periods impact the long-run dynamics and thus lead to different steady-state situations. We believe that this path dependency is essential for any macroeconomic model and should be a characteristic of PK-SFC models. Models that are not path dependent are unable to explain the different outcomes of the same policies applied in similar environments. Time matters.

2.3 *Microfoundations*

Recently, a new way to use the PK-SFC framework has emerged. It consists of the combination of PK-SFC and agent-based modelling (ABM).⁵ A common limit of ABM, in general, is that they do not usually have consistency between stocks and flows. Furthermore, as [Bezemer \(2011\)](#) points out, adding agent interactions instead of a representative agent in mainstream models—such as dynamic stochastic general equilibrium (DSGE) models—does not solve the incapacity of these models to forecast financial crises such as the 2007–08 crisis. This is why Bezemer calls for the combination of ABM with PK-SFC models that specifically account for the financial sector. We believe, as do Bezemer and others, that the combination of the flexibility of agent-based modelling with the consistency between stocks and flows of the system provides a framework that ensures the compatibility of real and financial variables.

⁴ [Ryoo \(2010\)](#) is based on the work of [Skott \(1988, 1989\)](#).

⁵ For more information regarding ABM, see [Epstein and Axtell \(1996\)](#), [Tesfatsion and Judd \(2006\)](#) and [Borrill and Tesfatsion \(2010\)](#).

Sepecher (2012A) adds that ABM within the PK-SFC framework allow for the solution of some paradoxes and difficulties arising from the use of aggregated models. He argues that the ABM methodology would bring three important characteristics: (i) the possibility of different lengths of the production process among agents; (ii) the possibility of asynchronous decisions in consumption, investment and other behaviours; and (iii) the possibility to account for gross intrasectorial flows and stocks, rather than net sectorial ones.

The possibility of different production process lengths allows us to solve the paradox of profit, as shown by Sepecher.⁶ Furthermore, the discrepancy in the length of processes leads inevitably to asynchronous behaviours, which can bring about the possibility of temporal disequilibrium, and thus rejects the notion of optimising behaviours. Indeed, because some decisions have to be made before the results of other decisions are known, agents have to use rule of thumb and cannot optimise their behaviours. Finally, we believe that the possibility to account for gross intrasectorial flows and stocks may allow us to solve some fallacy of composition, such as the critique of Lavoie and Seccareccia (2001) on Minsky's financial instability hypothesis. Indeed, it could well be the case that a sector as a whole does not show any sign of instability while agents within the sector encounter financial difficulties, which could lead to sectorial instability.

To our knowledge, only three models have been explicitly using a PK-SFC-ABM methodology: the Eurace Project (see www.eurace.org [date last accessed: 30 June 2014]; Cincotti *et al.*, 2010; Raberto *et al.*, 2011; Teglio *et al.*, 2012), Sepecher (2012B) and Kinsella *et al.* (2011). However, the way in which the methodology has been used differs radically.

Eurace is an EU-funded project presented as an alternative to DSGE macromodels. They built a large agent-based model, scalable up to millions of agents (www.eurace.org [date last accessed: 30 June 2014]). Once the model was up and running (a three-year process), they could analyse various issues such as quantitative easing impacts (Cincotti *et al.*, 2010), debt deleveraging and business cycles (Raberto *et al.*, 2011) or banks' capital adequacy ratios (Teglio *et al.*, 2012).

Pascal Sepecher has developed JAMEL, a Java agent-based macroeconomic laboratory, which allows him to simulate the interactions of households, firms and banks. Sepecher (2012B) presents his first results and analyses the impacts of wage rigidity and minimum wages on the economy. All behaviours are fairly simple and are based on rule of thumb rather than optimisation, following Herbert Simon and to some extent Keynes. It is interesting to note that although it does not demonstrate any explicit behaviour aiming at a macroeconomic equilibrium, the model reaches it. The stringency of the macroeconomic PK-SFC framework allows the author to observe interdependencies among otherwise independent microeconomic entities.

Kinsella *et al.* (2011) follow a more traditional trend in the ABM literature. The model simulates many complex behaviours, such as investment in innovation both for firms (via innovative capital) and households (via education) or labour market dynamics. They model households, firms, banks and a government and analyse the rise of

⁶ See Messori and Zazzaro (2004, 2005) for more on the paradox of profits. Sepecher cites Zezza (2012) as another author having worked on the necessity of having different production times in order to solve the paradox of profits, even if Zezza demonstrates his results within an aggregated PK-SFC model.

inequality among households. They show how, starting from a materialist equality, inequality emerges through competition.

We believe, as do [Bezemer \(2011\)](#), [Sepecher \(2012A\)](#) and the Eurace Project, that PK-SFC–ABM is one way to challenge DSGE models. They offer a better microfoundation to macroeconomic models and allow us to respond to critiques such as the fallacy of composition. Furthermore, they allow us to see how, as a simple rule of thumb, micro behaviour generates complex macro trends. The drawback of these models is their tractability. In fact, because of the multiplicity of interactions between agents and the resulting feedback, it is difficult—if not impossible—to grasp all the dynamics. In our opinion, PK-SFC–ABM models should remain fairly simple and concentrate on a few selected behaviours, rather than try to fit the real world if they want to be of any explicative use.

3. Theoretical models, discursive resolution

The PK-SFC approach is usually developed along three steps: ‘(1) do the (SFC) accounting; (2) establish the relevant behavioral relationships; and (3) perform “comparative dynamics” exercises (generally with the help of computer simulations)’ ([Dos Santos, 2005](#), p. 713). The third of these steps—the so-called solution of the model—allows for the understanding of how the economy behaves in time, if it tends towards equilibrium or if it presents an explosive behaviour (more on this below). However, as we stated previously, a model can be considered completed even before it has fulfilled this last step. PK-SFC modelling is based on a comprehensive accounting framework, which, in the methodology developed by Godley, is based on a set of three matrices: (i) a stock matrix, representing the initial stocks of the economy; (ii) a flow matrix, showing all the flows implied by initial stocks and by the decisions of the agents; and (iii) a stocks revaluation matrix, making explicit how the flows of the period determine different stocks at the end of it. The consistency of the accounting is ensured by precise rules.

Next to the quadruple-entry system (see Section 1.2), the most important accounting rule is with respect to budget constraints, both of individual sectors and of the economy as a whole. This is defined alternatively as ‘Walras’ law and adding up constraint’ ([Tobin, 1982](#)) and ‘budget constraint or system-wide consistency requirement’ ([Godley and Lavoie, 2007C](#), p. 14) and guarantees⁷ that ‘there are no black holes’ ([Godley, 1996](#)). Indeed, the three matrices *per se* represent a powerful tool in economic modelling since they provide for the solid foundations over which a model is erected, ensuring that nothing can be built in the air. It is not surprising therefore that a strand of the PK-SFC literature is based exclusively on the accounting part of this approach.

This section of our paper presents some of the main contributions of this kind, which we define as models with a discursive solution. A good example is represented by [Dos Santos \(2006\)](#). The author develops an insightful comparison of the views

⁷ Referring to the variables of the model, this rule can be phrased simply saying that the n th variable must be logically implied by the $n-1$ variables of the system or, more extensively, ‘if there are M columns and N non-ordinary rows in the transactions matrix, then there are only $(M + N - 1)$ independent accounting identities in the model. Due to this principle, highly similar to Walras’ Law, one equation must be kept out’ ([Le Heron and Mouakil, 2008](#)).

of four ‘old financial Keynesian’ scholars (definition drawn from the author): Paul Davidson, Wynne Godley, Hyman Minsky and James Tobin. With some simplification, in particular with respect to the microfoundations, their theories are presented as different ‘closures’ of the same PK-SFC model. The translation of the views (more or less formalised in their original version) of these authors into a PK-SFC model, both in its accounting part and in its behavioral equations and closures, requires a thorough theoretical analysis, which is the core of the paper together with the thesis that ‘the stock-the PK-SFC approach ‘can be seen as a natural “outcome” of the path taken by Keynesian macroeconomic thought in the 1960s and 1970s’ (Dos Santos, 2006, p. 542).

A similar position is taken by Lavoie (2009), who identifies in the PK-SFC approach a possible locus for the reconciliation of the fundamentalist (American) post-Keynesians and the Cambridge post-Keynesians. The higher interest of the first of the two groups in the monetary and financial side of the economy and the deeper focus of the second group on the real side, in the eye of the authors, can be integrated into this modelling framework, which allows us ‘to entertain both monetary and real issues within a single model’ (Lavoie, 2009, p. 15).

The possibility of formally tracking the source and the end of economic flows makes this approach particularly powerful and fruitful when applied to the analysis of monetary theories. The pioneering work in this direction is the paper by Lavoie (2004), in which the author elucidates the different stages—under different banking systems—of the monetary circuit (see Graziani, 2003) relying on transaction and revaluation matrices. Zezza (2012) follows the road traced by Lavoie and uses the PK-SFC approach to tackle specific puzzles of the circuitist literature. The ‘paradox of profits’ is such that in a credit economy, in a single period, the revenues of firms can at most equal the initial finance received for production costs and they do not cover interest payment. The accounting framework allows Zezza to show how, by taking into account banks’ profits in an attempt to consistently model the banking sector, the initial finance can be considered to include interest payment.

Bellofiore and Passarella (2010) do not enter directly into the theoretical debate on the possible relation between PK-SFC and the monetary circuit. The two authors, in a wider effort to adapt the financial instability hypothesis of Minsky to the current economic system, create a PK-SFC model to reproduce a financialised version of the monetary circuit. The main differences are (i) money can now enter the circuit also through households’ demand for loans and (ii) the creation of derivatives is stimulated by the growing bulk of savings of non-financial firms. Passarella (2012) deepens the investigation on the formalisation of the theory of Minsky. The author builds a PK-SFC model with the aim of analysing the financial instability hypothesis, highlighting its flaws (both theoretical and empirical) and proposing modifications to make it coherent with the new evidence emerging with the subprime crisis.

Among the authors who used the PK-SFC approach in this way (hence employing the first and second steps to develop a theoretical discussion), Michell and Toporowski (2012) put forward an interesting perspective. They start from what they define as a ‘classical’ system to build an increasingly complex model (still remaining on a high level of simplification) to make explicit the role of different sources of finance. Their conclusions are critical of the PK-SFC approach as they underline how the lack of inter-sectorial flows dismiss the possibility of representing important features of active financial markets.

4. Theoretical models, simulation resolution

The vast majority of PK-SFC papers are numerically simulated.⁸ This section presents an attempt to review the most important contributions of simulated models, organised according to their subject. We identified three main topics: financialisation, open economies and policy. It is self-evident that these classifications are subjective and boundaries are not often totally neat (e.g. it is possible to identify policy indications in almost all the papers analysed). This classification has, indeed, an organising scope limited to the needs of our paper.

4.1 Financialisation

Probably the main advantage of the social accounting approach to money flows is its possibility to integrate the real and the financial side of the economy. The accounting framework can be adapted to reproduce virtually any level of complexity (as, for any model, one must face a trade-off between realism and handiness). Sources of financing, portfolio choices, consumption and investment decisions, etc. can all be included in the same model. Furthermore, the PK-SFC framework presents an interesting modelling feature in that it explicitly accounts for *capital gains*. Equation (1) shows that the variation in value and in quantities of an asset (e.g. bonds) may be divided into two components: the variation due to the emission of bonds and the capital gain (or loss) due to the change in the price level Godley and Lavoie (2007C, p. 135) use an ingenious diagram, the so-called *Ostergaard* diagram, to explain how capital gains are accounted for. When modelling a sector holding financial assets, it is important to account for capital gains and add them (or remove in the case of a loss) from the desired variation in quantities held of that asset, otherwise the variation in stock is not explained by the flows and the model is no longer consistent.

$$\Delta(p_{BL} \cdot BL) = p_{BL} \cdot BL - p_{BL,-1} \cdot BL_{-1} = (\Delta BL) \cdot p_{BL} + (\Delta p_{BL}) \cdot BL_{-1} \quad (1)$$

In equation (1), $(\Delta BL) \cdot p_{BL}$ is equal to the new investment in that asset, i.e. the increase in quantity held multiplied by its price. However, because the price has changed, the nominal variation in asset held is equal to the new investment plus capital gains. We thus have, in general, that the wealth of a sector in period t is equal to the wealth of that sector in period $t - 1$ plus savings plus capital gains (equation 2):

$$V_t = V_{t,-1} + sav_t + CG_t \quad (2)$$

All these features made PK-SFC modelling a valuable tool in the recent economic debate on financialisation and in the analysis of the financial crisis, which started in the USA in 2007.

The concept of financialisation has been thoroughly investigated in the heterodox tradition and different aspects have been at the centre of the analysis of different authors (see, e.g., Bhaduri, 2011; Duménil and Levy, 2011; Onaran *et al.*, 2011). Similarly, the PK-SFC contributions to this topic tend to focus on specific aspects of

⁸ In order to prove the scientific validity of the results presented in simulated papers, it is now the norm to publish the code of the model. The web site www.sfc-models.net contains a large selection of these codes (on top of bibliographic references), allowing the newcomer to find a good starting point.

the problem. [Lavoie \(2008\)](#) expands the model of the second chapter of [Godley and Lavoie \(2007C\)](#) to include further financial aspects. Firms are assumed to borrow in order to finance inventories, while investments are financed through retained profits and equities. Households borrow money to consume and banks set the interest rate according to the liquidity measure they want to reach. The effects of financialisation are analysed through four simulations representing changes in the financial behaviour of firms and households (i.e. firms' equity issued and retained profits and households' desire to hold equities and demand for loans), and two simulations representing the current financial crisis (i.e. lower loans and profit margins of banks). [Zeza \(2008\)](#) also expands a previous paper ([Dos Santos and Zeza, 2004B](#)) to include the new evidence emerging from the 2007 subprime mortgage crisis. Therefore, households are differentiated between the top 5% of earners and the rest and the housing market is explicitly considered.

A more specific approach is developed by [van Treeck \(2009\)](#), whose focus is on shareholder value orientation. The model includes several features typical of the debate over financialised economies. Besides the degree of capacity utilisation, the determinants of investment decisions are Tobin's q , the retention rate and the leverage. Furthermore, households become indebted to consume. The role of shareholder value orientation is assessed via two main simulations: a change in the proportion of equity issued and an increase in the dividends payout rate. The results are in line with empirical evidence (a negative correlation between investment and shareholder orientation), but sensitive to changes in parameters; in particular they depend on the relative strength of the wealth and debt effects.

[Le Heron \(2011, 2012A, 2013\)](#) focuses on the state of confidence as a transmission channel of the crisis, from the US economy to the French economy. The state of confidence enters the model, influencing both firms in their investing decisions and banks in their financing decisions. The author, in his analysis of the crisis, recalls the theory of Minsky and individuates in the borrower's risk and lender's risk key variables in the decision of the sectors. In particular he accounts for the possibility of a credit rationing by banks towards firms. The economy is tested for changes in confidence parameters, reaction to financial and monetary policy and (in [Le Heron, 2012A](#)) changes in income distribution.

The analysis of Minsky returns and becomes central in [Ryoo \(2010\)](#). His model reproduces dynamics of short- and long-wave cycles. The interaction between aggregated demand and the labour market determines the first, while the long waves are the result of an endogenous Minskyan dynamic, driven by the ratio of profit to debt service commitments, and lead to crisis. A further interesting feature of the paper is that, besides the standard simulation resolution, it presents an analytical one. This allows for understanding the dynamic of the model without the need to rely on the value of parameters (which involves several problems). [Tymoigne \(2006; 2008, ch. 5\)](#) also develops a Minskyan PK-SFC model. In this case the particularity lies in the use of system dynamics. This allows the author to include different time spans (short and long run). Simulations are then used to test the coherence of the analysis of Minsky and to provide policy indications. The main result of the paper is that the endogenous destabilising forces described by Minsky only materialise if the central bank tries to control the economy actively using its interest rate. Hence the author concludes that the central bank interest rate should be kept low in order to maintain financial stability.

We decided to include Clévenot *et al.* (2009) as the last paper in this section, as it follows a different methodology from the other works on financialisation presented here. In fact the model serves for macroeconomic analysis and does not present a simulated solution. The issue of financialisation is accounted for as an increase of financial assets in the balance sheet of non-financial firms. The determinants of the level of equity issued and loans demanded by firms are empirically tested for the French economy. Equity issued appears positively correlated with the real rate of interest, the economic rate of profit and the level of indebtedness at the end of the previous period. According to the paper, the level of indebtedness is negatively correlated with the real rate of interest and the economic rate of profit, whereas it is positively correlated with the level and rate of accumulation of capital and the equities rate of return.

4.2 Open economies

The SFC framework is well known for two main original features: the Tobinesque representation of portfolio choice and Godley's analysis of world imbalances. It is thus natural that many PK-SFC models represent open economies and examine open economies' issues. This section will go through what we retain as the three phases to open-economy modelling within the PK-SFC framework. The first phase corresponds to Godley's seminal whistle-blowing of world imbalances at the turn of the century. The second one is composed of the papers constructing the formal representation of open economies within the PK-SFC literature, ending with chapters 6 and 12 of Godley and Lavoie (2007C). The last phase is made up of all the papers analysing particular points of the real world, based on the formal representation described in the second phase. These analyses, as we will see, are based on two main arguments: (i) the European construction and its monetary union; and (ii) financialisation, world imbalances, exchange rates, foreign reserves, etc.

Godley famously used flow-of-funds accounts to analyse the turbulent phase of the turn of the century (Godley, 1999B). He rightly pointed out the increasing risk that was developing in the US economy, identifying seven unsustainable processes:

(1) the fall in private saving into ever deeper negative territory, (2) the rise in the flow of net lending to the private sector, (3) the rise in the growth rate of the real money stock, (4) the rise in asset prices at a rate that far exceeds the growth of profits (or of GDP), (5) the rise in the budget surplus, (6) the rise in the current account deficit, (7) the increase in the United States' net foreign indebtedness relative to GDP. (Godley, 1999B, p. 2)

He then repeated the analysis in 2004 (Godley and Izurieta, 2004), followed by other authors at the Levy Institute of Bard College (see, e.g., Papadimitriou *et al.*, 2006; Godley *et al.*, 2007; Zezza, 2009). The rise of the crisis has shed light on the methodology that compelled more mainstream economists and institutions to use it: see Bê Duc and Le Breton (2009), Barwell and Burrows (2011) and Zezza (2009) for statements on the use of flow of funds. The analysis undertaken not only concerned the USA but also Europe, as in Semieniuk *et al.* (2011). This empirical use of the PK-SFC framework has been further developed at the Levy Institute, where a more complex and complete empirical world model has been designed. See Section 5 for further discussion of empirics in the literature.

Apart from empirical analysis, a more formal representation of open economies inside the PK-SFC framework has been developed, starting with Godley and Zezza (1989) describing the Danish economy. Godley (1999A) presents the first formal

model, to our knowledge, of an open economy. The works of Godley and Lavoie (2003, 2006) and Taylor (2004A) have led the way towards the two models described in Godley and Lavoie (2007C). Most of the modelling features concern the European construction or exchange rate dynamics, but aspects such as foreign reserves, gold reserves, balances of payments and others are also addressed.

Analysis of occurring world events was then conducted based on this formal model. Among these events, the European construction and its monetary union have attracted many analyses. Lavoie (2003) is a first attempt, based on the work of Godley (1999A), to formalise the eurozone. He presents a two-country eurozone model and analyses policy response for a southern country affected by a twin deficits situation that is a current account deficit and a budget deficit. He shows that a fiscal policy will have a stabilising effect, but at the cost of a slowdown of the southern country. On the other hand, a monetary policy will make the situation only worse. Finally, Lavoie concludes that the southern country should not worry about its external balance position, but only about the evolution of its public debt-to-income ratio.

Godley and Lavoie (2007A) concentrate on the dynamics of a three-country model with two currencies. They show how traditional results such as a twin deficit do not hold within the eurozone and how the quasi-stationary state emerging from shocks might lead to exploding situations, depending on the European Central Bank's behaviour. They use this analysis to criticise the Maastricht Treaty and the successive Stability and Growth Pact. Duwicquet and Mazier (2010) analyse the stabilisation effects of foreign asset holding and intrazone credit using a two-country model with one shared currency model. They conclude that a foreign asset model might mitigate asymmetric shocks, but only with a smaller effect than usually accounted, while foreign loans have no effect whatsoever. Khalil and Kinsella (2010) also analyse financial integration, but work on three different levels of integration: autarky, free trade and monetary union. They conclude that policies promoting financial integration might have clear positive impacts if executed with fiscal and monetary policies.

Kinsella and Khalil (2011) simulate the macroeconomic effect of a small open economy experiencing a debt deflation. They consider two different cases: in the first the economy is within a free-floating exchange rate; and in the second the economy is in a monetary union. Their simulations show that being in a monetary union prolongs and extends the debt deflation of the small open economy. Duwicquet *et al.* (2012) offer an analysis of the implicit transfers occurring within the eurozone due to exchange rate misalignment. Their model is composed of two countries, south and north, where the southern country is suffering from an overevaluated euro given its balance of payments and capital account, thus implying that it faces more difficulties to export, whereas the northern country enjoys an underevaluated euro, boosting its exports. The authors then propose various policies in order to counter these implicit transfers from the south to the north: a federal budget with a system of eurobonds and three different levels of federalism: (i) only fiscal transfers; (ii) fiscal transfers and part of the implicit transfers countered by explicit transfers from the north to the south; and (iii) fiscal transfers and implicit transfers fully compensated by explicit transfers. This allows them to show that the eurobonds system is equivalent to a federal budget with part of the implicit transfers being countered by explicit transfers on top of fiscal transfers.

The second strand of theoretical models regarding open economies focuses on exchange rate regimes and foreign reserve movements. Izurieta (2003) analyses the case of dollarisation as a response to financial instability. His model, an extended

version of [Godley \(1999A\)](#), shows how a ‘dollarised’ economy facing an exogenous shock will have to give up countercyclical policies to keep financial stability. He concludes that the dollarised economy thus traded income and employment protection for financial stability. [Lavoie and Zhao \(2010\)](#) study two scenarios of Chinese reserve diversification using a three-country (China, euroland and the USA) model with different exchange rate policies: fixed renminbi–dollar parity and a floating euro–dollar exchange rate. They conclude that the diversification of Chinese reserves towards euros will be detrimental to euroland in any case, but that a gradual diversification will imply a less harmful initial shock even if stabilising a worse situation for Europe. The path dependency characteristics the paper presents is due to the fact that the quantity of euros held by the Chinese Central Bank is a nominal value (or rather a share of a nominal value), implying that the exchange rate movement will impact the total quantity of euros held. Because there are feedback dynamics between the exchange rate and the quantity of euros held by the Chinese banks, the model presents path dependency, an interesting feature that was discussed in Section 2.2.

[Lavoie and Daigle \(2011\)](#) investigate exchange rate expectation using a two-country model. The innovation in their paper is that they include expectation formation on the exchange rate. They allow for two different behaviours: chartist or conventionalists. The former behaviour builds exchange rate expectation on trends, the latter on a conventional value. They conclude that exchange rate expectations are a source of persistence in the model and that, depending on the share of chartists in the population, the exchange rate might be stabilising or not. [Mazier and Tiou-Tagba Aliti \(2012\)](#) add prices into the picture presented in [Lavoie and Zhao \(2010\)](#): they analyse exchange rate regimes under inflationary pressures. Their model is composed of three economies with different exchange rate regimes: fixed, managed and floating. Furthermore, they allow for countries to have inflation. They show that having flexible prices might mitigate the results obtained in [Lavoie and Zhao \(2010\)](#).

4.3 Policy indications

This section represents a macro area of research. Several of the papers presented in the other sections include, as well, an analysis of policy implications. We choose not to include them in this section because we believe other aspects of the papers were distinctive or more relevant to our categorisation.

The methodology used to analyse policy implications is common to most aggregated macromodels. Once a stationary or a steady state, depending on whether the model is a growth model or not, is identified, the model is shocked. This means that the value of either one of the exogenous variables or of the parameters is changed according to the policy one wants to reproduce. It is then possible to see how the economy reacts. If it reaches a new stationary or steady state, it can be compared with the initial position. Contrarily, if it presents an explosive behaviour, the modeller can try to identify the causes of the unsustainable processes. An author trying to elucidate the effects of a policy can either attempt to individuate some relation potentially valid in any capitalist economy using a more theoretical approach, or refer to a particular economy with a more empirical approach. In the latter case, the model is usually built so as to reproduce the characterising features of the economy investigated.

The majority of the papers using a theoretical approach to the analysis of policies evolved mainly around the comparison between fiscal and monetary policy. [Dos Santos and Zezza \(2004A\)](#) extend Lavoie and Godley (2001–02) and, including the public sector (i.e. the central bank and government), show how fiscal policy is more effective than monetary policy since an increase in the interest rate has two contrasting effects: a negative impact on the real side of the economy, inhibiting investment; and a positive impact on financial inflows and asset holders' expenditure.

The understanding of recent or actual economic events and a critical examination of the related implemented policies is undoubtedly one of the core activities of the economists. PK-SFC practitioners do not differ in that. [Godley and Lavoie \(2007B\)](#) challenge the New Consensus support for monetary policies as an instrument to reach full employment (only in the short run and not taking into account fiscal policy). Their model shows that 'fiscal policy can deliver sustainable full employment at a target inflation rate within an SFC framework with some arbitrary interest rate' ([Godley and Lavoie, 2007B](#), p. 99).

Interestingly, this was expanded and commented on by two articles relying on only analytical simulations ([Martin, 2008](#); [Pucci and Tinel, 2010](#)). [Martin \(2008\)](#) extends Godley and Lavoie's work, finding an analytical solution of their model. Furthermore, he endorses their view that an 'appropriate' fiscal policy needs to be implemented if monetary policies are actively conducted. Martin concludes by showing that a fiscal policy needs to incorporate a government debt rule in order to avoid instabilities. He then derives the optimal monetary rule. [Pucci and Tinel \(2010\)](#), on the other hand, use Godley and Lavoie's model to focus on the role of tax rebate on income distribution and public deficit. They establish that in France most of the increase the debt to GDP ratio has to be imputed to increased interest rate on public debt that occurred in the 1980s, and income tax cuts imposed by neoliberal policies. They then provide the analytical solution for a model based on Godley and Lavoie's work and show that not only do tax rate cuts imply a redistribution of income in favour of richer households but they also worsen the debt-to-GDP ratio.

[Chatelain \(2010\)](#) also focuses on the latest events and offers an analysis of how capital shortage and financial constraints may evolve at a different pace for a growing economy shocked by either a fall in public expenditures or a rise in the interest rate. By allowing credit constraints to take place and tempering investments otherwise driven by the capacity utilisation rate, Chatelain shows that four different regimes may emerge: the traditional wage led and profit led and two mixed regimes. According to the author, credit constraint may emerge by either a decrease in the rate of profits or an increase in the interest rates. The analysis shows that supply-side policies show their effects later than demand-side policies and thus, depending on the shock and on the fiscal constraints (e.g. the Maastricht Treaty), some policies might be less efficient than others to restore growth.

[Ryoo and Skott \(2011\)](#) enter the very actual debate over austerity. In their paper, full employment is considered to be the final goal of policies and countercyclical spending appears to be an effective policy in the event of a shortage of aggregate demand, even if it might lead to unstable growth. Their point is that active fiscal policies work better than austerity in bringing the economy back to stability. The dynamics of the model are investigated through both simulation-based and analytical results.

The relation between these monetary and fiscal policies has been further and systematically investigated by [Le Heron \(2012B\)](#). His analysis springs from the attempt

to analyse the effects of the monetary policy, netting out the effects of the fiscal one, and reaches the conclusion that the latter can never be neutral due to the high amount of transmission channels. The effects of the policies were at the centre of the analysis of previous works by the author (see [Le Heron, 2009](#); [Le Heron and Mouakil, 2008](#), which focus in particular on the reactions of the banking sector).

[Arestis and Sawyer \(2012\)](#) enter this debate using the same methodology based on shocking the system to investigate how the modelled economy reacts to a fiscal, monetary or mixed policy. The unique characteristic of the paper is that it is based on the Levy model (see Section 5). Their results show the importance of fiscal policy, which they suggest should take a leading role in driving aggregate demand.

Fiscal and monetary policies are not the only ones taken into account by the PK-SFC modellers. Other authors focused on less conventional policies, as did [Godin \(2013\)](#), who presents a multisectoral model in order to analyse the impact of a green job employer of last resort (ELR). The model allows for pricing interdependencies, a critique that is often made of aggregate macromodels. The main results of the paper are that there is a need for industrial policies targeting lower carbon dioxide emissions and that, if the goal of the state is to reduce poverty, an ELR policy is more likely to have better results than Keynesian demand-spur policies.

We conclude this section with the paper by [Oreiro and Lobo \(2012\)](#), which offers an original contribution since the analysis of the two authors on the effects of fiscal and monetary policies is based on a model built to specifically reproduce the Brazilian economy. As such it includes different kinds of government bonds, considers the effectiveness of policy (taking into account inflation) and shows how a polarised income distribution can affect the outcome of a policy. The model represents therefore a valid example of the adaptability of the PK-SFC accounting framework, which can be used to reproduce virtually any institutional setting and to assess very different economic dilemmas.

4.4 Theoretical debate: looking for consensus

In the words of one of the authors who most contributed to the rise and diffusion of the PK-SFC approach, the modelling approach ‘provides a potential for common ground for all heterodox schools, just like the maximising representative agent seems to be the standard of mainstream economics. Stock-flow consistency as defined here fulfils what [Pasinetti \(2005, p. 841\)](#) calls one of the constructive features of the Cambridge School of Keynesian economics: the need for internal consistency and not only formal rigor’ ([Lavoie, 2008, p. 333](#)).

The economic debate (in particular the heterodox one, which lacks a universally accepted modelling framework) can largely benefit from the development of such common ground, which may allow for easier comparison among theories and interpretations. The solid and comprehensive economic theory, which heterodox economists aim to build to challenge the current mainstream, might become a Tower of Babel without the support of a common language. Besides [Dos Santos \(2006\)](#) (see Section 3), several authors have started to rephrase existing theories through PK-SFC models and others have started presenting their contributions to the theoretical debate basing their analysis on this structured framework. A perfect example in this direction is [Lavoie and Godley \(2001–02\)](#). The two authors develop Kaldor’s ‘neo-Pasinetti’ model to further include the source of finance for firms. The model is characterised by several Kaleckian

and Kaldorian features and enters the post-Keynesian theoretical debate of the growth model (with a further focus on capacity utilisation), relying on the solid ground of stock-flow consistency.

[Godley and Shaikh \(2002\)](#) comment on the standard neoclassical model and show that it is inconsistent in that interests distributed by firms might not be equal to firms' profits, thus contradicting the assumption that all profits are distributed. They show how to solve this inconsistency by formalising household income as wage plus interests on firms' bonds. However, once the model is made consistent via this solution, the standard neoclassical dichotomy between real and nominal values falls apart. Furthermore, outcomes of this consistent model differ radically from the original outcome. For example, a rise in money supply can lead to a fall in prices.

[Skott and Ryoo \(2008\)](#) offer a good example of a theoretical debate analysed through the prism of PK-SFC modelling. They distinguish Harroddian from Kaleckian specification, mature from dual economies and elastic from inelastic household behaviours. As do [Dos Santos and Macedo e Silva \(2009\)](#), Skott and Ryoo define the Harroddian specification as the case where firms' capacity utilisation is constant at its desired value. The Kaleckian specification, on the other hand, is a state of affairs where the profit share is constant (utilisation rate being the endogenous value). Skott and Ryoo then differentiate between what they call a mature or labour-constrained economy versus a dual economy, with a perfectly elastic supply of labour. Finally, they distinguish between inelastic households behaviours, where propensities (such as the propensity to save) are independent from return rates, from elastic ones, where these propensities vary through time.

[Dallery and van Treeck \(2011\)](#) develop the analysis of capacity utilisation by Lavoie and Godley (2001–02), showing that when different interests of different groups are taken into account, the equality between the actual and the standard rate of capacity utilisation is not a necessary outcome in the long-run equilibrium. Simulations are run to represent different eras of capitalism with different interests prevailing: a Fordist era with managers and workers as leading groups and adjusting profitability targets; and a financialisation era with fixed profitability goals. A lucid contribution in the search for systematisation of post-Keynesian theory using PK-SFC modelling as a common structured ground is represented by [Dos Santos and Zezza \(2008\)](#). In an attempt to create a benchmark for future works, the two authors associate to practically each step of the model a theoretical explanation that places their modelling choices in the wider theoretical economic debate. Several subjects are hence investigated and analysed, such as capacity utilisation, investment decisions, asset prices and consumption decisions. Furthermore, we believe it is interesting to notice that the paper presents an analytical solution of the model to allow for an easier and deeper understanding of its characteristics. A similar approach is the one used by [Sarquis and Oreiro \(2011\)](#), who develop a post-Keynesian model for open economies based on a thorough theoretical analysis, with the aim of demonstrating that the post-Keynesian approach is a valid and coherent alternative to current economic orthodoxy. A very significant example of this branch, which we might call 'consensus-making theoretical simulated models', is represented by [Le Heron \(2008\)](#). The author tries to reconcile two monetary theories normally considered to be rather antithetical: on the one hand, liquidity preferences with an endogenous interest rate; and, on the other hand, endogenous money with an exogenous interest rate. To reach its goal, the paper focuses on banks' state of confidence (lenders' risk) as well as on the distinctions between short-run and long-run interest rates, which the author formally puts forward in his model.

Other authors used the PK-SFC modelling approach to tackle specific subjects. Zezza and Dos Santos (2006), who enter the traditional—at least in the heterodox research agenda—debate on income distribution, develop a growth model with a rich financial structure. Their results show that the economy is demand led and the paradox of thrift holds, as an increase in savings slows growth. Furthermore, while an increase in tax unequivocally has a depressing effect on the economy, the effects of the attempt by the other sectors (banks and firms) to increase their share of income depend on the choice of parameters. The income distribution is also the focus of the two-sector model developed by J. H. Kim (2006). His demand-led economy validates both the ‘paradox of thrift’ and the ‘paradox of costs’ (higher costing margins—hence lower real wages—do not lead to an increase in profit, but cause a decrease in output). The model includes several specifications in its real side, among which are target-return pricing, conflicting claims inflation and endogenous labour-saving technical progress.

Dafermos (2012, p. 750) tries to fill what he seems to consider a gap in the PK-SFC literature: ‘an integrated consideration of the macroeconomic implications of liquidity preference and uncertainty is still lacking in the SFC literature’. The model succeeds in reproducing a recessionary process, thanks to its characteristic of simultaneously taking into account the liquidity preferences of households, firms and banks.

An interesting attempt to create a more coherent post-Keynesian paradigm can be found in Caiani *et al.* (2012). The authors try to build the grounds for a wider analysis of the implications of the technological progress and structural change processes in a Schumpeterian perspective within a PK-SFC framework. They insist on the nexus between innovation and finance, a point often missing, according to them, in the relevant literature. The authors also show how technological change cannot only be seen as a productivity shock, as it also brings about a change in the structure of the productive sectors, leading to redistributive processes among sectors.

5. Empirical models

As seen in Section 4.2, the work of Godley on empirical analysis of unsustainable processes has shed light on the need to build empirical models to be used as a structured tool for economic predictions. We will not repeat here the historical development path of these models; we will rather concentrate on the methodological aspects of the existing literature. We will concentrate here on ‘fully’ empirical models. We distinguish between *fully empirical* models and *empirical* models in the following way: in fully empirical models, not only are all the parameters estimated, but—starting from the present state of economy—the models are also applied to predict variations in endogenous variables based on different scenarios. Empirical models extract stylised facts from empirical data and then conduct simulations on the impact of these facts. The simulations start from a steady state that is not necessarily connected to the present situation.

To our knowledge, only two groups of authors have been working on fully empirical models:⁹ Godley, Zezza and authors related to the Levy Institute (hereafter the Levy model; see, e.g., Godley and Zezza, 1989; Zezza, 2009, 2011; Papadimitriou *et al.*, 2011); and Kinsella and Tiou-Tagba Aliti (hereafter the Limerick model; see Kinsella

⁹ Davis (1987A, 1987B) developed an econometric SFC model for the UK. Since our paper focuses on ‘modern’ SFC models, these papers will not be discussed here.

and Tiou-Tagba Aliti, 2012). It is also worth mentioning the work of Clévenot *et al.* (2009, 2010), who estimate the parameters basing their econometric analysis on their own model. However, no simulation has been conducted based on these estimated values. The way in which these fully empirical models are estimated/calibrated differs. On the one hand, the Levy model assumes fixed parameters estimated using econometrics. On the other hand, the Limerick model estimates fixed parameters only when necessary (if there is more than one parameter per independent equation) and calibrates the others.¹⁰ This difference is fundamental since the Levy model allows us to predict future variations, while the Limerick model allows us only to conduct simulations on past data. PK-SFC models explicitly account for the discrepancies between *ex post* realisations, which are given on the one hand by statistical accounting equilibria (every spending of someone is the income of someone else) and on the other are the result of modelled behaviours based on *ex ante* values. These discrepancies are incredibly relevant in that they represent dynamical adjustment processes such as capital gains.

Godley and Zezza (1989) is, to our knowledge, the first empirical use of a PK-SFC model, the first empirical model being Godley and Zezza (1986). It presents a simple model of a small open economy applied to Danish data. The model is then estimated and used to draw some medium-term forecasting. The subsequent works of the Levy Institute are based on a more developed model, applied to US data and used for predictions, which, it is worth noting, have been fairly good. They have been consistently warning, since Godley's unsustainable processes in 2001, about the risk of financial crises. However, while Godley in the 1980s and others afterwards have been using balance sheets and flow-of-funds analysis to observe imbalances and rising instability, the Levy model is the first one to be able to make some predictions in a more systematic way since it allows for comparison of different scenarios resulting from different policies.

The Limerick model is still under construction and Kinsella and Tiou-Tagba Aliti (2012) is still a working paper, but it gives us sufficient insight into their work. There are two main differences in the approach and in the data used when compared with the Levy model. First, the Limerick model is based on the balance sheets of the Irish economy and is thus based on stock data, while the Levy model is based on stock and flow data. Second, as already expressed, the Limerick model is calibrated over the dataset used. The model, even if still rough, already allows us to simulate changes in policies in the past and see the impact they would have had if implemented.

The paucity of empirical models can be seen as a signal of the difficulty and probably the controversy in estimating the parameters of the behavioral equations¹¹ (see Section 2.1 and Taylor, 2008). Indeed, estimating parameters for a model implies assuming the parameters are stable over time. During relatively stable time, this assumption is not

¹⁰ We define estimation as when a parameter is assumed constant over a time span and estimated using econometric methods such as ordinary least squares, maximum likelihood, etc. Calibration is the process of finding a value for each parameter, in each period, such that the model replicates the dataset. In that sense, calibration has no predictive power since it does not give any insight on parameters' future values. However, filtering techniques can be used on these calibrated parameters in order to obtain a trend and thus predict future values.

¹¹ Belabed *et al.* (2014) is an interesting example of explicit calibration. The authors provide an ample description of the calibration process they used, explaining how the data were adjusted to the model specificities and how each of the three countries they model (China, Germany and the USA) was calibrated. We believe this approach should be included in any paper analysing country-specific behaviours.

to too spurious. However, given the recent turmoil, this hypothesis should at least be tested via the appropriate tools.

A word should be said on the proliferation of parameters. Indeed, more parameters allow for the representation of more subtle behaviours. However, this is at the cost of more complexity when trying to estimate or analytically solve the model. If one believes that PK-SFC modelling should be used merely as a reference within an argumentative theoretical debate (see Section 3), or for simple didactical purposes, a just balance between realistic behaviours and the number of parameters has to be found.¹² This joins the call of [Dos Santos and Zezza \(2008\)](#), among others, for simple models targeted at specific subjects, rather than large models including numerous sectors or assets.

6. Conclusion and the way forward

The primary goal of this paper was to depict the state of the art of PK-SFC models. To reach our goal, we divided the main publications we gathered according to their subjects and methodology. This not only provides a more structured overview of the literature, but allows as well for some conjecture on the possible lines of development of this class of model.

If one believes in the importance of microfoundation, the PK-SFC–ABM model represents an alternative to DSGE and is more solid since it does not include fallacies of composition (see Section 2.3):

- (i) PK-SFC models can provide a useful tool in the consensus-making attempt within the post-Keynesian tradition, since the theoretical discussion and the comparisons are based on a coherent, structured and at the same time adaptable framework (as shown in Section 4.4).
- (ii) Empirical and policy indications models, combined, can lead to an economy-specific analysis, which is more useful at the policy level. We have read a few articles, still very preliminary, that seem to go in that direction. We believe that this approach to PK-SFC modelling should be pursued.
- (iii) The possibility of modelling the financial side of the economy has represented an incentive in developing models including complex financial sectors. This has its counterpart in the real side, which we feel has been a bit overlooked and could be further investigated. Among others, a direct benefit would be a more complete understanding of the interdependences between the two sides of the economy.

As we have shown, PK-SFC is a relatively recent class of models. With this paper, along with a literature review, we tried to develop a taxonomy of different approaches of PK-SFC and to underline some important issues, both theoretical and technical. Our aim was to provide a systemisation of the literature so as to ease the process of approaching and understanding this class of model. We are fully aware that several topics would deserve a much deeper analysis, including the theoretical differences between Tobin's and Godley's approach and the path dependency of model outcomes. However, we believe that this goes beyond the aim of our work, but it could represent a valid starting point for future papers.

¹² We wish to highlight the work of [E. Le Heron \(2012B, 2013\)](#) in this respect. He indeed endogenised 'animal spirits', using the state-of-confidence index as a proxy.

We wish to conclude with a personal consideration. We encourage a didactical use of PK-SFC models, since we believe that their completeness can ease the comprehension of economic dynamics and interdependencies. To this end, both more complete empirical and simulated models and simple theoretical models with analytical solutions (see [Dos Santos and Macedo e Silva, 2009](#)) can represent useful tools.

Bibliography

- Arestis, P. and Sawyer, M. 2012. The effectiveness of fiscal policy in the Levy Institute's stock flow model, pp. 300–20 in Papadimitriou, D. B. and Zezza, G. (eds), *Contributions in Stock-flow Consistent Modeling: Essays in Honor of Wynne Godley*, Basingstoke, Palgrave Macmillan
- Asada, T., Flaschel, P., Mouakil, T. and Proano, C. 2011. *Asset Markets, Portfolio Choice and Macroeconomic Activity: A Keynesian Perspective*, Basingstoke, Palgrave Macmillan
- Backus, D., Brainard, W. C., Smith, G. and Tobin, J. 1980. A model of US financial and non-financial economic behaviour, *Journal of Money, Credit and Banking*, vol. 12, no. 2, 259–93
- Barwell, R. and Burrows, O. 2011. 'Growing Fragilities? Balance Sheets in the Great Moderation', Financial Stability Paper no. 10, Bank of England
- Bê Duc, L. and Le Breton, G. 2009. 'Flow-of-funds Analysis at the ECB: Framework and Applications', Occasional Paper no. 105, European Central Bank
- Belabed, C. A., Theobald, T. and van Treeck, T. 2014. 'Income Distribution and Current Account Imbalances', Working paper no. 126, IMK at the Hans Boeckler Foundation, Macroeconomic Policy Institute
- Bellofiore, R. and Passarella, M. 2010. Minsky, the Monetary Circuit and the Current Crisis: A SFC Monetary Accounting Framework, paper presented at the 'Can It Happen Again? Sustainable Policies to Mitigate and Prevent Financial Crises' conference, University of Macerata, 1–2 October
- Bezemer, D. J. 2011. 'Causes of Financial Instability: Don't Forget Finance', Working Paper no. 655, Levy Economics Institute of Bard College
- Bhaduri, A. 2011. A contribution to the theory of financial fragility crisis, *Cambridge Journal of Economics*, vol. 35, no. 6, 995–1014
- Borrill, P. L. and Tesfatsion, L. 2010. 'Agent-based Modeling: The Right Mathematics for the Social Sciences?' Working Paper no. 10023, Department of Economics, Iowa State University
- Caiani, A., Godin, A. and Lucarelli, S. 2012. 'Innovation and Finance: An SFC Analysis of Great Surges of Development', Working Paper no. 733, Levy Economics Institute of Bard College
- Chatelain, J. 2010. The profit–investment–unemployment nexus and capacity utilization in a stock-flow consistent model, *Metroeconomica*, vol. 61, no. 3, 454–72
- Chiarella, C. and Flaschel, P. 2000. *The Dynamics of Keynesian Monetary Growth. Macro Foundations*. Cambridge, UK, Cambridge University Press.
- Cincotti, S., Raberto, M. and Teglio, A. 2010. Credit money and macroeconomic instability in the agent-based model and simulator Eurace, *Economics: The Open-Access, Open-Assessment E-Journal*, vol. 4, no. 2010–26, 1–32
- Clévenot, M., Guy, Y. and Mazier, J. 2009. 'Equity and Debt in a Financialised Economy: The French Case', CEPN Working Paper, <http://hal.archives-ouvertes.fr/hal-00435685/> [date last accessed: 21 December 2012]
- Clévenot, M., Guy, Y. and Mazier, J. 2010. Investment and the rate of profit in a financial context: the French case, *International Review of Applied Economics*, vol. 24, no. 6, 693–714
- Cohen, J. 1972. Copeland's moneyflows after twenty-five years: a survey, *Journal of Economic Literature*, vol. 10, no. 1, 1–25
- Copeland, M. A. 1949. Social accounting for moneyflows, *Accounting Review*, vol. 24, no. 3, 254–64
- Dafermos, Y. 2012. Liquidity Preference, uncertainty, and recession in a stock-flow consistent model, *Journal of Post Keynesian Economics*, vol. 34, no. 4, 749–75
- Dallery, T. and van Treeck, T. 2011. Conflicting claims and equilibrium adjustment processes in a stock-flow consistent macroeconomic model, *Review of Political Economy*, vol. 23, no. 2, 189–211

- Davis, E. P. 1987A. A stock-flow consistent macro-econometric model of the UK economy: part I, *Journal of Applied Econometrics*, vol. 2, no. 2, 111–32
- Davis, E. P. 1987B. A stock-flow consistent macro-econometric model of the UK economy: part II, *Journal of Applied Econometrics*, vol. 2, no. 4, 259–307
- Denizet, J. 1967. *Monnaie et Financement, Essai de Théorie dans un Cadre de Compatibilité Économique*, Paris, Dunod
- Dos Santos, C. H. 2005. A stock-flow consistent general framework for formal Minskyan analyses of closed economies, *Journal of Post Keynesian Economics*, vol. 27, no. 4, 712–35
- Dos Santos, C. H. 2006. Keynesian theorising during hard times: stock-flow consistent models as an unexplored frontier of Keynesian macroeconomics, *Cambridge Journal of Economics*, vol. 30, no. 4, 541–65
- Dos Santos, C. and Macedo e Silva, A. C. 2009. ‘Revisiting (and Connecting) Marglin–Bhaduri and Minsky: An SFC Look at Financialization and Profit-led Growth’, Working Paper no. 567, Levy Economics Institute of Bard College
- Dos Santos, C. H. and Zezza, G. 2004A. The role of monetary policy in post-Keynesian stock-flow consistent macroeconomic growth models: preliminary results, pp. 183–210 in Lavoie, M. (ed.), *Central Banking in the Modern World: Alternative Perspectives*, Cheltenham, Edward Elgar
- Dos Santos, C. H. and Zezza, G. 2004B. ‘A Post-Keynesian Stock-flow Consistent Growth Model: Preliminary Results’, Working Paper no. 402, Levy Economics Institute of Bard College
- Dos Santos, C. H. and Zezza, G. 2008. A simplified, benchmark, stock-flow consistent post-Keynesian growth model, *Metroeconomica*, vol. 59, no. 3, 441–78
- Duménil, G. and Levy, D. 2011. Modeling monetary macroeconomics: Kalecki reconsidered, *Metroeconomica*, vol. 63, no. 1, 170–99
- Duwicquet, V. and Mazier, J. 2010. Financial integration and macroeconomic adjustments in a monetary union, *Journal of Post Keynesian Economics*, vol. 33, no. 2, 333–70
- Duwicquet, V., Mazier, J. and Saadaoui, J. 2012. Exchange Rate Misalignments, Fiscal Federalism and Redistribution: How to Adjust in a Monetary Union, preliminary paper presented at the Ninth EUROFRAME Conference on Economic Policy Issues in the European Union, Kiel, 8 June
- Epstein, J. and Axtell, R. 1996. *Growing Artificial Societies: Social Science from the Bottom Up*, Washington, DC, MIT Press/Brooking Press
- Godin, A. 2013. Green Jobs for full employment, a stock flow consistent analysis, in Murray, M. and Forstater, M. (eds), *Employment Guarantee Schemes: Job Creation Policy in Developing Countries and Emerging Market*, Basingstoke, Palgrave Macmillan, pp. 7–46
- Godley, W. 1996. ‘Money, Finance, and National Income Determination’, Working Paper no. 167, Levy Economics Institute of Bard College
- Godley, W. 1997. ‘Macroeconomics without Equilibrium or Disequilibrium’, Working Paper no. 205, Levy Economics Institute of Bard College
- Godley, W. 1999A. ‘Open Economy Macroeconomics Using Models of Closed Systems’, Working Paper no. 285, Levy Economics Institute of Bard College
- Godley, W. 1999B. Seven unsustainable processes: medium-term prospects and policies for the United States and the world, *Strategic Analysis*, Levy Economics Institute of Bard College
- Godley, W. 1999C. Money and credit in a Keynesian model of income determination, *Cambridge Journal of Economics*, vol. 23, no. 4, 393–411
- Godley, W. and Cripps, F. 1983. *Macroeconomics*, Oxford, Oxford University Press
- Godley, W. and Izurieta, A. 2004. ‘Balances, Imbalances and Fiscal Targets: A New Cambridge View’, Seminar Paper, Cambridge Endowment for Research in Finance, February
- Godley, W. and Lavoie, M. 2003. ‘Two-country Stock-flow-consistent Macroeconomics Using a Closed Model within a Dollar Exchange Regime’, Finance Working Paper no. 10, Cambridge Endowment for Research
- Godley, W. and Lavoie, M. 2006. Comprehensive accounting in simple open economy macroeconomics with endogenous sterilization or flexible exchange rates, *Journal of Post Keynesian Economics*, vol. 28, no. 2, 241–76
- Godley, W. and Lavoie, M. 2007A. A simple model of three economies with two currencies: the eurozone and the USA, *Cambridge Journal of Economics*, vol. 31, no. 1, 1–23

- Godley, W. and Lavoie, M. 2007B. Fiscal policy in a stock-flow consistent (SFC) model, *Journal of Post Keynesian Economics*, vol. 30, no. 1, 79–100
- Godley, W. and Lavoie, M. 2007C. *Monetary Economics: An Integrated Approach to Credit, Money, Income, Production and Wealth*, New York, Palgrave Macmillan
- Godley, W., Papadimitriou, D., Hannsgen, G. and Zezza, G. 2007. The US economy: is there a way out of the woods? *Strategic Analysis*, Levy Economics Institute of Bard College
- Godley, W. and Shaikh, A. 2002. An important inconsistency at the heart of the standard macroeconomic model, *Journal of Post Keynesian Economics*, vol. 24, no. 3, 423–41
- Godley, W. and Zezza, G. 1986. 'A Simple Real Stock Flow Monetary Model of the Italian Economy', Working Paper, University of Cambridge
- Godley, W. and Zezza, G. 1989. 'A Simple Real Stock-flow Model Illustrated with the Danish Economy', Working Paper no. 8901, Department of Applied Economics, University of Cambridge
- Graziani, A. 2003. *The Monetary Theory of Production*, Cambridge, UK, Cambridge University Press
- Izurieta, A. 2003. Dollarization as a tight rein on the fiscal stance, in Rochon, L.-P. and Seccareccia, M. (eds), *Dollarization: Lessons from Europe and the Americas*, London, Routledge
- Kalecki, M. 1971. *Selected Essays on the Dynamics of the Capitalist Economy*, Cambridge, UK, Cambridge University Press
- Keynes, J. M. 1936. *The General Theory of Employment, Interest and Money*, London, Macmillan
- Khalil, S. and Kinsella, S. 2010. 'Simulating Financial Integration: A Stock-flow Consistent Perspective', unpublished
- Kim, J. H. 2006. 'A Two-sector Model with Target-return Pricing in a Stock-flow Consistent Framework', Working Paper no. 06-01, Research on Banking International and National Systems or Networks, University of Ottawa
- Kinsella, S., Greiff, M. and Nell, E. J. 2011. Income distribution in a stock-flow consistent model with education and technological change, *Eastern Economic Journal*, vol. 37, no. 1, 134–49
- Kinsella, S. and Khalil, S. 2011. Debt-deflation in a stock-flow consistent macromodel, pp. 235–65 in Papadimitriou, D. B. and Zezza, G. (eds), *Contributions in Stock-flow Consistent Modeling: Essays in Honor of Wynne Godley*, Basingstoke, Palgrave Macmillan
- Kinsella, S. and Tiou-Tagba Aliti, G. 2012. 'Towards a Stock Flow Consistent Model for Ireland', *SSRN eLibrary*, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2011462 [date last accessed: 31 October 2013]
- Lavoie, M. 2003. A fully coherent post Keynesian model of the euro zone, pp. 98–126 in Arestis, P., Baddeley, M. and McCombie, J. S. L. (eds), *Globalisation, Regionalism and Economic Activity*, Cheltenham, Edward Elgar
- Lavoie, M. 2004. Circuit and coherent stock-flow accounting, pp. 134–49 in Arena, R. and Salvadori, N. (eds), *Money, Credit, and the Role of the State: Essays in Honour of Augusto Graziani*, Aldershot, Ashgate
- Lavoie, M. 2008. Financialisation issues in a post-Keynesian stock-flow consistent model, *Intervention: European Journal of Economics and Economic Policies*, vol. 5, no. 2, 331–56
- Lavoie, M. 2009. Towards a post-Keynesian consensus in macroeconomics: reconciling the Cambridge and Wall Street views, pp. 75–99 in Hein, E., Niechoj, T. and Stockhammer, E. (eds), *Macroeconomic Policies on Shaky Foundations: Wither Mainstream Economics?* Marburg, Metropolis Verlag
- Lavoie, M. 2011. Assessing some structuralist claims through a stock-flow framework, in Moore, B. J. and Rochon, L. P. (eds), *Post Keynesian Monetary Theory: Horizontalism and Structuralism Revisited: Reflections and Development*, Cheltenham, Edward Elgar, forthcoming
- Lavoie, M. and Daigle, G. 2011. A behavioural finance model of exchange rate expectations within a stock-flow consistent framework, *Metroeconomica*, vol. 62, no. 3, 434–58
- Lavoie, M. and Godley, W. 2001–02. Kaleckian models of growth in a coherent stock-flow monetary framework: a Kaldorian view, *Journal of Post Keynesian Economics*, vol. 24, no. 2, 277–311
- Lavoie, M. and Seccareccia, M. 2001. Minsky's financial fragility hypothesis: a missing macroeconomic link? pp. 76–96 in Bellofiore, R. and Ferri, P. (eds), *Financial Fragility and Investment in the Capitalist Economy: The Economic Legacy of Hyman Minsky*, vol. 2, Cheltenham, Edward Elgar
- Lavoie, M. and Zhao, J. 2010. A study of the diversification of China's foreign reserves within a three-country stock-flow consistent model, *Metroeconomica*, vol. 61, no. 3, 558–92

- Le Heron, E. 2008. Monetary and fiscal policies in a post Keynesian stock-flow consistent model, in Wray, L. R. and Forstater, M. (eds), *Keynes and Macroeconomics after 70 Years: Critical Assessments of the General Theory*, Cheltenham, Edward Elgar
- Le Heron, E. 2009. Fiscal and monetary policies in a Keynesian stock-flow consistent model, pp. 145–75 in Creel, J. and Sawyer, M. (eds), *Current Thinking on Fiscal Policy*, Basingstoke, Palgrave Macmillan
- Le Heron, E. 2011. Confidence and financial crisis in a post-Keynesian stock-flow consistent model, *European Journal of Economics and Economic Policies*, vol. 8, no. 2, 361–88
- Le Heron, E. 2012A. Financial crisis, state of confidence and economic policies in a post-Keynesian stock-flow consistent model, pp. 83–111 in Rochon, L.-P. and Olawoye, S. (eds), *Monetary Policy and Central Banking: New Directions in Post-Keynesian Theory*, Cheltenham, Edward Elgar
- Le Heron, E. 2012B. Debate with Wynne Godley on the Neutrality of fiscal policy, pp. 266–99 in Papadimitriou, D. B. and Zezza, G. (eds), *Contributions in Stock-flow Consistent Modeling: Essays in Honor of Wynne Godley*, Basingstoke, Palgrave Macmillan
- Le Heron, E. 2013. Confidence, increasing risks and crisis in a post Kaleckian stock-flow consistent model, pp. 118–47 in Bellofiore, R., Karwowska, E. and Toporowski, J. (eds), *Economic Crisis and Political Economy*, Basingstoke, Palgrave Macmillan
- Le Heron, E. and Mouakil, T. 2008. A post-Keynesian stock flow consistent model for dynamic analysis of monetary policy shock on banking behaviour, *Metroeconomica*, vol. 59, no. 3, 405–40
- Macedo e Silva, A. C. and Dos Santos, C. H. 2011. Peering over the edge of the short period? The Keynesian roots of stock-flow consistent macroeconomic models, *Cambridge Journal of Economics*, vol. 35, no. 1, 105–24
- Martin, B. 2008. Fiscal policy in a stock-flow consistent model: a comment, *Journal of Post Keynesian Economics*, vol. 30, no. 4, 649–68
- May, J. 1970. Period analysis and continuous analysis in Patinkin's macroeconomic model, *Journal of Economic Theory*, vol. 2, no. 1, 1–9
- Mazier, J. and Tiou-Tagba Aliti, G. 2012. World imbalances and macroeconomic adjustments: a three-country stock-flow consistent model with fixed or flexible prices, *Metroeconomica*, vol. 63, no. 2, 358–88
- Messori, M. and Zazzaro, A. 2004. 'Monetary Profits within the Circuit: Ponzi Finance or "Mors Tua, Vita Mea"?' Working Paper no. 200, Department of Economics, Marche Polytechnic University
- Messori, M. and Zazzaro, A. 2005. 'Single period analysis: financial markets, firms' failures and the closure of the monetary circuit', pp. 111–24 in Fontana, G. and Realforzo, R. (eds), *The Monetary Theory of Production*, Basingstoke, Palgrave Macmillan
- Meyer, J. H. 1975. The balance sheet identity of the government financing constraint and the crowding out effect, *Journal of Monetary Economics*, vol. 1, no. 1, 65–78
- Michell, J. and Toporowski, J. 2012. The stock-flow consistent approach with active financial markets, pp. 173–96 in Papadimitriou, D. B. and Zezza, G. (eds), *Contributions in Stock-flow Consistent Modeling: Essays in Honor of Wynne Godley*, Basingstoke, Palgrave Macmillan
- Onaran, O., Stockhammer, E. and Grafl, L. 2011. Financialisation, income distribution and aggregate demand in the USA, *Cambridge Journal of Economics*, vol. 35, no. 4, 637–61
- Oreiro, J. L. and Lobo, B. S. 2012. 'Gestão da Dívida Pública em um Modelo Pós-Keynesiano Macrodinâmico de Simulação com Consistência entre Estoques e Fluxos: O Caso Brasileiro', unpublished
- Papadimitriou, D. B., Hannsgen, G. and Zezza, G. 2011. Jobless Recovery Is No Recovery: Prospects for the US Economy, *Strategic Analysis*, Levy Economics Institute of Bard College
- Papadimitriou, D. B., Zezza, G. and Hannsgen, G. 2006. Can global imbalances continue? Policies for the US economy, *Strategic Analysis*, Levy Economics Institute of Bard College
- Pasinetti, L. L. 2005. The Cambridge School of Keynesian Economics, *Cambridge Journal of Economics*, vol. 29, no. 3, 837–48
- Passarella, M. 2012. A simplified stock-flow consistent dynamic model of the systemic financial fragility in the 'new capitalism', *Journal of Economic Behavior & Organization*, vol. 83, no. 3, 570–82
- Pucci, M. and Tinel, B. 2010. Réductions d'impôts et dette publique: un lien à ne pas occulter, Documents de travail du Centre d'Economie de la Sorbonne, 2010.85

- Raberto, M., Tegli, A. and Cincotti, S. 2012. Debt, deleveraging and business cycles: an agent-based perspective. *Economics: The Open-Access, Open-Assessment E-Journal*, vol. 6, no. 2012–27, 1–49.
- Robinson, J. 1956. *The Accumulation of Capital*, London, Macmillan
- Ryoo, S. 2010. Long waves and short cycles in a model of endogenous financial fragility, *Journal of Economic Behavior & Organization*, vol. 74, no. 3, 163–86
- Ryoo, S. and Skott, P. 2011. ‘Public Debt and Full Employment in a Stock-flow Consistent Model of a Corporate Economy’, Economics Department Working Paper no. 134, University of Massachusetts Amherst
- Sarquis, A. M. F. and Oreiro, J. L. 2011. ‘Um Modelo Macrodinâmico Pós-Keynesiano de Consistência entre Estoques e Fluxos para uma Economia Aberta’, unpublished
- Semieniuk, G., van Treeck, T. and Truger, A. 2011. ‘Reducing Economic Imbalances in the Euro Area: Some Remarks on the Current Stability Programs, 2011–14’, Working Paper no. 694, Levy Economics Institute of Bard College
- Sepecher, P. 2012A. Monnaie Endogène et Agents Hétérogènes dans un Modèle Stock-Flux Cohérent, paper presented at the ‘Political Economy and the Outlook for Capitalism’ conference, Paris, 5–7 July
- Sepecher, P. 2012B. Flexibility of wages and macroeconomic instability in an agent-based computational model with endogenous money, *Macroeconomic Dynamics*, vol. 16, Suppl. 2, 284–97
- Skott, P. 1988. Finance, saving and accumulation, *Cambridge Journal of Economics*, vol. 12, no. 3, 339–54
- Skott, P. 1989. *Conflict and Effective Demand in Economic Growth*, Cambridge, UK, Cambridge University Press
- Skott, P. and Ryoo, S. 2007. ‘Macroeconomic Implications of Financialization’, Economics Department Working Paper no. 41, University of Massachusetts Amherst
- Skott, P. and Ryoo, S. 2008. Macroeconomic implications of financialisation. *Cambridge Journal of Economics*, vol. 32, no. 6, 827–62
- Taylor, L. 2004A. Exchange rate indeterminacy in portfolio balance, Mundell–Fleming and uncovered interest rate parity models, *Cambridge Journal of Economics*, vol. 28, no. 2, 205–27
- Taylor, L. 2004B. *Reconstructing Macroeconomics: Structuralist Proposals and Critiques of the Mainstream*, Cambridge, MA, Harvard University Press
- Taylor, L. 2008. A foxy hedgehog: Wynne Godley and macroeconomic modelling, *Cambridge Journal of Economics*, vol. 32, no. 4, 639–63
- Taylor, L. and O’Connell, S. A. 1985. A Minsky crisis, *Quarterly Journal of Economics*, vol. 100, Suppl., 871–85
- Tegli, A., Raberto, M. and Cincotti, S. 2012. The impact of banks’ capital adequacy regulation on the economic system: an agent-based approach, *Advances in Complex Systems*, vol. 15, Suppl. 2, 361–400
- Tesfatsion, L. and Judd, K. 2006. *Handbook of Computational Economics*, vol. 2, *Agent-based Computational Economics*, Amsterdam, North Holland
- Tobin, J. 1982. Money and finance in the macroeconomic process, *Journal of Money, Credit and Banking*, vol. 14, no. 2, 171–204
- Turnovsky, S. 1977. *Macroeconomic Analysis and Stabilization Policy*, Cambridge, UK, Cambridge University Press
- Tymoigne, E. 2006. ‘The Minskyan System, Part III: System Dynamics Modeling of a Stock Flow-Consistent Minskyan Model’, Working Paper no. 455, Levy Economics Institute of Bard College
- Tymoigne, E. 2008. *Central Banking, Asset Prices and Financial Fragility*, London, Routledge
- van Treeck, T. 2009. A synthetic, stock-flow consistent macroeconomic model of ‘financialisation’, *Cambridge Journal of Economics*, vol. 33, no. 3, 467–93
- Zeza, G. 2004. ‘Some Simple, Consistent Models of the Monetary Circuit’, Working Paper no. 405, Levy Economics Institute of Bard College
- Zeza, G. 2008. US growth, the housing market, and the distribution of income, *Journal of Post Keynesian Economics*, vol. 30, no. 3, 375–401
- Zeza, G. 2009. Fiscal policy and the economics of financial balances, *Intervention: European Journal of Economics and Economic Policies*, vol. 6, no. 2, 289–310

- Zeza, G. 2011. Income distribution and borrowing: tracking the US economy with a ‘New Cambridge’ model, pp. 99–120 in Brancaccio, E. and Fontana, G. (eds), *The Global Economic Crisis: New Perspectives on the Critique of Economic Theory and Policy*, London, Routledge
- Zeza, G. 2012. Godley and Graziani: stock-flow consistent monetary circuits, pp. 154–72 in Papadimitriou, D. B. and Zeza, G. (eds), *Contributions in Stock-flow Consistent Modeling: Essays in Honor of Wynne Godley*, Basingstoke, Palgrave Macmillan
- Zeza, G. and Dos Santos, C. H. 2006. Distribution and growth in a post-Keynesian stock-flow consistent model, pp. 100–24 in Salvadori, N. (ed.), *Economic Growth and Distribution: on the Nature and Causes of Wealth of Nations*, Cheltenham, Edward Elgar

Appendix: Model PC

Model PC is the second simplest model presented in [Godley and Lavoie \(2007C\)](#). [Table A1](#) shows the transaction-flow matrix and [Table A2](#) the balance sheet. The economy is closed and composed of four sectors: households who receive an income Y in exchange for labour and interests (r) on bill they hold (B_h), pay taxes T and consume C out their disposable income YD ; firms who produce an output Y , which is sold to households and the government, and pay wages in exchange for labour; a government that buys output G from the firms, receives taxes from the household sector and profits from the central bank, and pays interests on bills; and a central bank that emits money, buys bills and receive interests on these bills. There are two assets: money stock H and government bills B . All income that is not consumed by households is thus distributed between these assets via a portfolio choice system of equations. If households have positive savings, then the government has to have a deficit. The following equations describe the model. Equation (A.13) is the hidden equation.

$$Y = C + G \quad (\text{A.1})$$

$$YD = Y - T + r_{-1} \cdot B_{h-1} \quad (\text{A.2})$$

$$T = \theta \cdot (Y + r_{-1} \cdot B_{h-1}) \quad \theta < 1 \quad (\text{A.3})$$

$$V = V_{-1} + (YD - C) \quad (\text{A.4})$$

$$C = \alpha_1 \cdot YD + \alpha_2 \cdot V_{-1} \quad 0 < \alpha_2 < \alpha_1 < 1 \quad (\text{A.5})$$

$$H_h = V - B_h \quad (\text{A.6})$$

$$\frac{B_h}{V} = \lambda_0 + \lambda_1 \cdot r - \lambda_2 \cdot \left(\frac{YD}{V} \right) \quad (\text{A.7})$$

$$\frac{H_h}{V} = (1 - \lambda_0) - \lambda_1 \cdot r + \lambda_2 \cdot \left(\frac{YD}{V} \right) \quad (\text{A.8})$$

$$\Delta B_S = B_S - B_{S-1} = (G + r_{-1} \cdot B_{S-1}) - (T + r_{-1} \cdot B_{cb-1}) \quad (\text{A.9})$$

$$\Delta H_S = H_S - H_{S-1} = \Delta B_{cb} \tag{A.10}$$

$$B_{cb} = B_S - B_h \tag{A.11}$$

$$r = \bar{r} \tag{A.12}$$

$$H_h = H_S \tag{A.13}$$

Table A1. Transaction-flow matrix of model PC

	Households	Production	Government	Central bank		Σ
				Current	Capital	
Consumption	$-C$	$+C$				0
Government expenditure		$+G$	$-G$		$-G$	0
Income = GDP	$+Y$	$-Y$				0
Interest payments	$+r_{-1} \cdot B_{h-1}$		$-r_{-1} \cdot B_{S-1}$	$+r_{-1} \cdot B_{cb-1}$		0
Central bank profits			$+r_{-1} \cdot B_{cb-1}$	$-r_{-1} \cdot B_{cb-1}$		0
Taxes	$-T$		$+T$		$+T$	0
Change in money	$-\Delta H$				$+\Delta H$	0
Change in bills	$-\Delta B_h$		$+\Delta B_S$		$-\Delta B_{cb}$	0
Σ	0	0	0	0	0	0

Table A2. Balance sheet of model PC

	Households	Production	Government	Central bank	Σ
Money	$+H$			$-H$	0
Bills	$+B_h$		$-B_S$	$+B_{cb}$	0
Balance (net worth)	$-V$		$+V$		0
Σ	0		0	0	0