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The Post-Keynesian view on exchange rates: towards the consolidation of the different contributions in the ABM and SFC frameworks

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The Post-Keynesian view on exchange rates: towards the consolidation of the different contributions in the ABM and SFC frameworks

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Abstract

The article contributes to the consolidation of the post-Keynesian (PK) view on nominal exchange rates on two interconnected steps. Firstly, it presents a critical assessment of the different PK works on this issue, dividing them into two strands: one highlights the role of technical analyses, financial convention and behavioural insights in investors' decision-making process in advanced countries' FX markets, while the other focuses on the dynamics of emerging market economies' (EME) currencies, analysing how a currency's position in the current International Monetary and Financial System (IMFS) influences money managers' decisions. Secondly, the article suggests the use of the agent-based (AB) and stock-flow consistent (SFC) equations for consolidating the main PK arguments in a common framework. The flexibility of the AB-SFC framework allows for a complex, detailed and realistic account of expectations formation in FX markets and international portfolio allocation, enhancing the theoretical debate and formal PK models.

Keywords: Exchange rates; Currency hierarchy; Agent-based modelling; Stock-flow consistent modelling.
JEL codes: B5, F31, F37.

1 Introduction

The behaviour of nominal exchange rates has long been a puzzle in mainstream economics[3]. Unsurprisingly, the interest on this key issue has flourished in two periods featured by the predominance of floating exchange rates – the first years of the interwar period and after the collapse of the post-Bretton Woods regime – when the research on its determinants has become theoretically relevant (Macdonald 2007). In the case of the post-Keynesian (PK) approach[4], focus of this paper, exchange rates started to drawn attention of some scholars in the early 1980's following the high instability of the new International Monetary and Financial System (IMFS).

The different PK contributions share a view of exchange rates in this historical setting as a result from bank dealers' and, mainly, money managers' portfolio decisions, predominantly, institutional investors, whose increasing importance is a major feature of the current phase of capitalism (Minsky 1986, Bonizzi 2017a). These decisions, in turn, are based on social conventions due to fundamental uncertainty. Some of authors also call attention to the differences in exchange rate dynamics according to the level of sophistication of foreign exchange (FX) markets and/or to the

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(3) We adopt the sociological definition of mainstream economics proposed by Dequech (2007, p. 281), namely, 'that which is taught in the most prestigious universities and colleges, gets published in the most prestigious journals, receives funds from the most importante research foundations, and wins the most prestigious awards'.

(4) Although there are controversies on the set up of the PK approach, its institutionalization started in the 1970s with the creation of the Cambridge Journal of Economics (CJE) and the Journal of Post Keynesian Economics (JPKE) (Lavoie 2014).

position of the currency in the IMFS. While advanced countries' exchange rates would present a zigzag pattern, Emerging-Market Economies (EME) ones would face cycles of continuous appreciation trends interrupted by sudden depreciations. These cycles would be associated with different balance-sheet constraints of these investors that derive, in turn, from specificities of EME currencies. Moreover, the PK approach on exchange rate are in line with what Lavoie (2014) calls the school's pressupositions, such as realism, historical and irreversible time, and the importance of institutions.

Yet, the PK contributions on such crucial topic on open macroeconomics has been rather disperse and, maybe because of that, has received relatively small attention of PK scholars. For instance, Lavoie (2014) does not include the nominal exchange rate as one of the school's main themes. A consolidation of these contributions in what we could call the PK view on the nominal exchange rate has not been drawn up yet and could contribute for the dissemination of the school's contributions.

This article contributes to fill this gap in the PK literature in two interconected steps. Firstly, we present a critical assessment of the different PK works on this issue, which highlight the role of technical analyses, financial convention and behavioural insights in the decision-making process in advanced countries FX markets (section Two), and the dynamics of EME currencies linked to their position in the current IMFS that influences money managers'decisions (section Three)[5]. Secondly, in section Four, we suggest the use of the agent-based (AB) and stock-flow consistent (SFC) equations for consolidating the main PK arguments in a common framework useful for theoretical and empirical analysis of exchange rates. The flexibility of the AB-SFC framework allows to consolidate and to provide a more complex, detailed and realistic account of expectations formation in FX markets and international portfolio allocation. As it will be seen, although expectations and the concept of fundamental uncertainty are at the core of PK analysis in general, up to now their treatment in formal PK models has been incipient, making use of many simplifications. Section Five presents concluding remarks.

2 Decision making in the Foreign Exchange market: technical analyses, behaviour insights and financial convention

The PK approach has a valuable contribution to the understanding of the dynamics of exchange rates in the international financial and monetary system (IMFS) that emerged after the collapse of the Bretton Woods regime. Important contributions to this understanding are the works of Schulmeister (1987, 1988, 2008, 2009, 2009b) and Harvey (1991, 1998, 1999, 2009) that have in common the aim at explaining the actual decision-making process in FX markets, which underlies the high volatility of exchange rates in this environment. Hence, coherently with the PK approach, both works search for realisticness in their assessments (Lavoie 2014), and provide important insights on the behaviour of technical (Schulmeister) and fundamentalist (Harvey) traders.

Schulmeister has analysed the pattern of exchange rate movements from a both inductive and microstructure approach since the 1980s (Schulmeister 2009) stressing that exchange rates do not

(5) We don't include in our acessesment the so called 'cambist view' because this view search to explain the formation of the forward exchange rate, bringing to light why the covered interest parity relation holds very well. For more details, see Lavoie (2004).

follow a random walk (as inferred from Meese and Rogoff 1983), but a systematic pattern that stems from the increasingly important technical trading systems in the foreign exchange (FX) market (spot and derivatives), whose weight in markets is demonstrated by survey studies (Schulmeister 2007, 2008). Exchange rate dynamics would result from the interaction of different strategies and models used by 'chartist traders' (who decide to buy or sell based solely on the information contained in past prices). Some of these models are trend followers, producing buy (sell) signals when prices are rising (falling), while others are contrarians, producing buy (sell) signals when prices are falling (rising) at a declining rate. Models are also differentiated according to the speed of response to changes in prices: based on high frequency data, 'fast models' act before the 'slow models' that are based on hourly or daily data.

According to Schulmeister (2008), such interaction starts after economic or political news set off the trend as traders believe these will cause others to open a new position in the market. Moreover, a trend gets a higher recognition and reaction if the news is in line with the prevailing 'market mood' ('bullish' or 'bearish' bias in expectations that concern only the direction – appreciation or depreciation, not including the expected total impact). Hence, it is possible to interpret this process as the keynesian beauty contest, i.e., the trend is triggered and boosted by the market's convention. Conversely, the trend could end if an increasing number of traders open a position speculating on the reversal of the trend, in other words, if they follow a speculative/non-conventional behaviour. Two other factors could also contribute to the end of the trend: the decline in the number of traders getting into the bandwagon (in a herd behaviour) and the higher incentive for cashing-in profits.

Harvey (2009) consolidates his previous works and builds on Schulmeister's analyses of decision making in currency markets. Yet, Harvey (2009) also focuses, specially on his 'mental model', on the behaviour of agents called 'fundamentalist traders' who consider the changes in macroeconomic variables in forming their exchange rate expectations. His analysis of expectation formation includes, besides Keynesian insights, concepts of behavioural economics that are used to explain the forecast-construction biases in the FX market, which result in the features of the FX market stressed by Schulmeister (2009), e.g., volatility, bandwagons and periodic profit taking (cash-in).

Harvey (2009) stresses that, given fundamental uncertainty, confidence is usually at low levels in asset markets, resulting in forecasts that change rapidly and the need to make quick returns; yet, due to animal spirits, agents are able to act despite their ignorance; and the more confident the participant is, the stronger his/her response to an economic change. Apart from these Keynesian insights, in Harvey's approach heuristics and biases emphazised by behavioural economics also contribute to the forecast-construction biases of agents in the exchange rate market. According to the availability principle, the more available an event is in our memory, the more frequent it is deemed to be, resulting in a forecast bias, as agents overrate the importance of dramatic events. The representativeness principle is related to the calculation of the probability that event A is a result of event B: The more A resembles B, the more people will look for a causal relation between the two. As a result, people constantly look for explanations about exchange rate movements. With the anchoring principle, people make new forecasts having a prior one as reference, putting undue weight on their first forecast, regardless of how it was done.

Harvey's (2009) 'agents' mental model', shows how these forecast-construction biases come into play when agents form expectations. This model is based in three layers: (i) foreign currency demand depends on net exports, net direct foreign investments, and net portfolio foreign investment; (ii) these are influenced by the expected inflation differential between the domestic and the foreign country, the expected relative macroeconomic growth, the expected relative interest rates, and the expected liquidity (the 'base factors'); and (iii) agents keep track of a list of indicators in building expectations concerning changes in these factors (e.g., as GDP growth is not published often, investors use unemployment rates as proxy).

In his 'augmented mental model', in turn, Harvey (2009) introduces exchange rate determination from portfolio investment (that depends on exchange rate forecasts) and the workings of five 'exchange-rate features' highlighted by Schulmeister (2009): volatility, bandwagons, technical analysis, trading limits and cash-in.

It should be noted that, although some of the base factors correspond to 'fundamentals' in mainstream models, in Harvey's approach 'fundamentals' affect the exchange rate dynamic through their influence on agents' expectations. In other words, traders consider that there is a group of variables that may have an impact on the exchange rate and trade accordingly – making these variables have an effective impact on the exchange rate[6], what is different than the mainstream idea that fundamentals directly drive exchange rates to an equilibrium value (Harvey 2001).

Indeed, Harvey's (2009) mental model could be seen as an example of what Orléan (1999) calls 'the financial convention'[7] in his auto-referential approach, i.e., the socially accepted, prevailing quantitative model used to estimate the expected value. In this approach, instead of yielding in an objective and unique value for the asset, fundamentals result in a subjective value, that depends on the workings of the group itself (Orléan 1999). This is clear in Harvey's (2009) argument that 'the foci of expectations formation will emerge as a function of the social context in which the agents interpret their experiences and scholars and professionals engage in research' (Harvey, 2009, p. 54).

The contributions of Harvey and Schulmeister led to the description of a detailed and complex dynamics of exchange rates in the current IMFS, bringing to light the different factors underlying the decision making process in FX markets, among which the influence of technical analysis, the current financial convention, the Keynesian concepts and heuristics in agent's expectations and trading. Yet, Schulmeister and Harvey's works have some shortcomings as they disregard key features of the current IMFS. Firstly, they only contemplate the financial side of exchange rate determination: they consider that FDI and trade flows also have an influence on traders' decisions, but do not include those in the determination of exchange rates[8]. These models therefore do not consider the feedbacks from the exchange rate to the economy and vice-versa, being a view of the exchange rate determination disconnected from the economy as a whole. Secondly, they do not account for external debt dynamics, i.e., financial flows linked to international debt that still have a crucial role in capital

(6) Schulmeister's economic news could also be understood as 'fundamentals', although he doesn't give examples. For Schulmeister (2009) the Purchase Power Parity (PPP) defines the equilibrium value of the nominal exchange rates, although these do not present any tendency of convergence towards this equilibrium value.

(7) Orléan (1999) analyses decision making in financial markets, not specifically in FX markets.

(8) The focus on the strictly financial side is also seen in the mainstream literature. Following the failure of models based on macroeconomic fundamentals, this literature has turned its attention to the microstructure of FX markets (see Flood and Rose, 1995).

flow cycles and, then, exchange rate movements. Last but not least, as their analyses focus on the developed or advanced economies' currencies, they cannot explain the specificities of exchange rates of emerging-market economies (EMEs), defined as the developing economies that have engaged in the financial globalization setting (the interpenetration of national monetary and financial markets and their integration in globalised markets; Chesnais 1996). This last gap has been fulfilled by PK works analysed in the next section.

3 Currency hierarchy and the focus on investors' balance-sheet constraints

Another strand of heterodox works aims at understanding the behaviour of exchange rates of EMEs (emerging currencies)[9]. These agree with the works presented above on the relevance of short term capital flows and investors' expectations and decisions (anchored in social conventions due to fundamental uncertainty) in driving exchange rates, but decisions are conditioned by the currencies' characteristics, most of them deriving from the place it occupies on the hierarchical IMFS, i.e., on the so called currency hierarchy.

It is worth mentioning that Harvey (2009) recognizes, implicitly, the hierarchy dimension of this system as he includes the expected liquidity of the assets in the base factors, which 'increases if the currency in which the asset is denominated is one in which many commodities are priced or if it is the *de facto* or *de jure* international reserve currency (the dollar has benefited from both since World War Two'; Harvey 2009, p. 85). Yet, he does not discuss the implications of that hierarchy on the exchange rate dynamics nor the existence of asymmetries between central economies' currencies other than the U.S. dollar and emerging currencies.

As Keynes (1944) pointed out during the Bretton Woods debates, the currency hierarchy has been a fundamental feature of the international monetary systems that have succeeded since the sterling-gold standard: in each of them a national currency has assumed the role of leading or key currency (Andrade and Prates 2013; Kaltenbrunner 2015). In the post-Bretton Woods system, featured by floating exchange rates and a high degree of capital mobility due to financial globalization, the fiduciary and flexible U.S. dollar, placed at the top of the currency hierarchy, has performed such role due to its ability to perform the three functions of money internationally (medium of payment, unit of account and denomination of contracts, and store of value). The currencies issued by the other advanced countries are in an intermediate position as they are used as a means of payment and of denomination of contracts internationally and its financial assets are demanded as a store of value by foreign investors. At the bottom of the hierarchy are the currencies issued by EMEs that are incapable of performing those functions, even marginally (Andrade and Prates 2013). With the increasing importance of the euro as store of value and unit of account, the IMS has arguably gained a fourth layer, where the euro occupies the second-most central place (De Conti et al. 2014).

From the post-Keynesian perspective shared by these works, the currency hierarchy has revealed itself even more deleterious to the EMEs, whose currencies are positioned at its lower end, and the different positions in the IMS would steem from different levels of liquidity premium: the

(9) Andrade and Prates (2013) mix the post-keynesian with the structuralist approach (i.e. Prebisch, 1949; Ocampo and Martin, 2003) that emphasizes the 'centre-periphery' dimension of the international economic system and its resulting asymmetries. Paula et al. (2017) also used these two approaches to analyse the limits and challenges for Keynesian monetary and exchange-rate policies in EMEs.

one of the U.S. dollar being higher than that of advanced currencies, which are higher than of emerging currencies. As the liquidity premium is an attribute of assets in monetary economies, Keynes' equation on an asset's total return (Keynes 1936) has been adapted to open economies to the analysis of emerging currencies dynamics (Andrade and Prates 2013; Kaltenbrunner 2015).

With this equation, Keynes (1936) indicated that in a monetary production economy an asset's 'total expected returns' (or 'own interest rate', *r*) is determined by four main attributes: its expected appreciation (*a*), its quasi-rent (*q*, or yield), its carrying costs (*c*) and its liquidity premium (*l*)[10] – as in Equation (1). When applied to the different currencies, *r* refers to the 'total expected returns' of an asset denominated in a specific currency, *a* to the expected appreciation/depreciation and *q* to the short term interest rate of this currency, and **c** to the degree of financial openness of the issuer country; the lower such degree, the higher the transaction cost to invest in such asset (Andrade and Prates 2013).

$$r = a + q - c + l \qquad (1)$$

While the different liquidity premiums express a monetary asymmetry, EMEs have also faced a financial asymmetry in the current IMFS that is related to the different magnitudes of capital flows to countries positioned at the different layers of the currency hierarchy, those directed to EMEs being marginal in comparison to total flows (Andrade and Prates, 2013). Although marginal, these flows exercise important pressures on EME' FX markets due to their small relative size. Haldane (2011, p. 2) uses the 'Big Fish Small Content' metaphor to illustrate this issue: 'The Big Fish here are the large capital exporting, advanced countries. The Small Ponds are the relatively modest financial markets of capital-importing emerging countries.' EMEs are therefore integrated to international financial markets, but under different conditions than central economies, with currencies that do not offer the same liquidity premium and being subject to more relevant changes in their assets prices (and their currencies') for their relative small size.

Money managers have their liabilities in advanced countries and assets allocated throughout the globe, in advanced and EMEs, creating a network that connects these markets through these institutions balance-sheets (Ramos 2017). As it will be argued in what follows, the exchange rate dynamics put forward by Post-keynesian analyses can be seen as consequence of institutional investors' decisions based on their balance-sheet constraints in a international context featured by monetary and financial asymmetries.

Concerning the asset's side of the balance-sheet, the fact that EMEs' assets are not used as store of value make their currencies prone to sudden depreciation in moments of high liquidity preference in international financial markets, when investors prefer to keep their assets in the most liquid form (Andrade and Prates 2013, p. 402). This can be represented as an increase in liquidity preference (β) in equation (2) – an adaptation of the format proposed by Kaltenbrunner (2015), that is focused on emerging currency's total return relative to the key currency, whose attributes are represented by *). Given that l^* is (structurally) higher than l[11], the liquidity premium differential (l

(10) '(…) a power of disposal that confers a potential convenience or security' (Andrade and Prates, 2013, p. 402).

(11) We follow herein Andrade and Prates (2013), according to whom the liquidity premium *l* is determined by the position of the currency in the currency hierarchy: the lowest this position, the smaller this premium will be. Thus, it could change only in the medium and long term. Kaltenbrunner (2015), in turn, defines the liquidity premium as 'the ease with which the domestic currency can be used to meet future obligations plus the expected stability of its value' (p. 431).

$-l^*$) has a negative effect on the relative return of the emerging currency ($r - r^*$), which is majored with an increase of liquidity preference (β) decreasing the demand for the emerging currency[12].

$$r - r^* = (a - a^*) + (q - q^*) - (c - c^*) + \beta(l - l^*) \qquad (2)$$

If the impact of a hike of liquidity preference in the demand for emerging currencies is quick, the fall of liquidity preference has a prolonged effect: not only its decrease, but also its maintenance at a low level progressively increases investment in EMEs. This phenomenon is explained by changes in investors' perception about a market in a Minskyan (1986) causality: as the memory of a crisis fades, investors that previously decided not to invest in EMEs progressively reconsider this decision as excessively conservative and change opinion, gradually increasing the total amount of investment in this market (Author). An interesting point is the individualization of risk, that instead of being a measurable value, depends on agent's perception – as they varied, in Minsky's (1986) work, according to the famous three types of agents. This dynamic is also in line with the availability principle (discussed in the previous section): right after a crisis, investors will assess the probability of another exchange rate crisis as very high, not investing in the concerned currency. This helps explaining the long waves of appreciation faced by emerging currencies.

Emerging currencies' demand also decreases in moments of capital flight or currency crisis due to investors decisions based on their liabilities: in these moments investors need the central currencies used to denominate liabilities in order to meet their financial commitments. In Kaltenbrunner's words (2015, p. 436), they need to convert assets into 'the currency with which positions in these assets have been funded'.

Besides these reasons related to investors' assets (Andrade and Prates 2013) and liabilities' sides (Kaltenbrunner 2015), two other balance-sheet constraints explain emerging currencies' sudden depreciations. First, in moments of higher uncertainty investors need to decrease the currency mismatch of their balance-sheets (caused by having assets labelled in emerging currencies) eliminating this additional element of risk (Author). Second, if the investor must cover losses in the country where it has its liabilities, markets that are part of this investor's portfolio will face a sell off and currency depreciation, i.e., financial contagion (Ramos 2017). Then, we can conclude that emerging currencies are subject to shocks in markets around the globe for being part of money managers' network also due to these balance-sheet constraints.

Finally, the cyclical pattern of emerging currencies might also emerge from the influence of monetary conditions in central economies. Given that institutional investors have target rates of returns, which determine the growth of their liabilities, they must ensure that the return of their assets grow at the same rate as their liabilities' costs (Bonizzi, 2017a, 2017b). For instance, in case of lower interest rates among advanced countries, where they have most of their assets, an option for achieving the needed growth of assets is to invest in EMEs, whose returns are generally higher. In the short term, this constraint leads to the appreciation of the EME currencies, yet followed by depreciation when monetary policies become more restrictive in these countries.

Hence, these analyses argue that the dynamics of low-liquidity premium and high yield currencies are subordinated to the decisions of money managers, which are related to their balance-sheet constraints, to their assessment of the conditions of financial markets and to their level of

(12) The equation should be seen as providing the relative return of one class of assets in the two economies.

liquidity preference. EME currencies pass through major depreciations in times of higher liquidity preference and financial crisis at the global level, after which they might gradually appreciate as more and more institutional investors evaluate their prior decisions of not investing in these countries/of preferring highly liquid assets as too conservative and decide to invest in them, resulting in a cyclical movement.

Note that emerging currencies' dynamics are, according to these explanations, marked by a specific type of volatility associated with extreme depreciations but not necessarily by significant deviations every day (what is in line with empirical findings; De Conti 2011). This type of volatility is different from that analysed by Schulmeister (2009), depicted as zigzags, that emerge from technical trading, bandwagon and herd behaviour. EMEs that count with deep and sophisticated FX markets might also be subject to this type of volatility; yet, the above analyses point to an additional source of volatility for low-liquidity currencies: one that emanates from external shocks due to their use in international portfolio allocation and their specificities.

Although the use of the Keynesian equation contributes to synthesize and clarify the debate about EME currencies' demand, it cannot capture the insights brought by Schulmeister (2009) and Harvey (2009) and is too simple for exchange rate analyses, whose dynamics is also influenced by other economic variables. In the next section, these insights and the specificities of EME currencies are include in the analysis of exchange rate dynamics though the use of the ABM and SFC frameworks.

4. Consolidating the PK views through the ABM and SFC frameworks

The PK views on exchange-rates emerged from different approaches: Schulmeister's work is inductive, based on empirical assessments of the current workings of FX markets; both his and Harvey's work incorporates psychological insights; and the discussion of the specificities of EME currencies are based on historical and institutional analyses of the evolution of the IMFS. The following aims at suggesting ways to use the different insights brought by these works in the ABM and SFC frameworks. This effort contributes to the PK exchange rate literature for providing a common basis for theoretical and empirical analysis on exchange rate determination, besides adding realism to the treatment of exchange rates.

4.1 The advantages of the ABM and SFC frameworks for exchange rate discussion

SFC models are built from different sectors' balance-sheets and the relation between them, with the aim of providing a rigours description of economic relations – without 'black holes' (Godley and Lavoie 2005, p. 3). They are among the most prominent type of modeling in the PK tradition (Asensio et al. 2011) and seen as 'crucial to the consolidation of the broad post-Keynesian research programme' (Macedo e Silva and Dos Santos 2011, p. 105) for allowing the analysis of several of this school's features. With regards to exchange-rate analysis, SFC features that stand out are the consideration of stocks and flows, monetary and productive sides of the economy, historical time and feedback effects.

SFC models clearly present the evolution of stocks, including flows and revaluations what, with regards to exchange rate analyses, allows accurate analyses of portfolio reallocation and countries' vulnerabilities for considering the total amount of capital available at a given moment for

leaving the country. A model with no absence of black holes and with all economic sectors tied together also allows analyses of contagion among markets that are part of an investor's network – as the importance of a fall in returns in a market on the others.

More broadly, a complete model allows for a detailed examination of other models' dynamics and of the validity of their conclusions. As argued by Taylor (2009, p. 2) SFC macro modeling helps to 'remove many degrees of freedom from possible configurations of patterns of payments at the macro level, making tractable the task of constructing theories to 'close' the accounts into complete models'. Therefore, differently from literary analyses, in the SFC approach the dynamics are forced to interact with all other variables of the economic system, requiring an explicit recognition of such 'system-wide constraints', as well as of the potential limitations of the analyses (Dos Santos 2006, p. 564). In this sense, Godley (2012) argues that SFC is an interesting framework for allowing more detailed and precise discussions than the narrative method.

In addition, their flexibility allows for institutionally rich models (Macedo e Silva and Dos Santos 2011) through the inclusion of not only specific country-features and dynamics, but also the consideration of different parameters. With respect to exchange rate dynamics, it would for instance be interesting to analyse models for developed countries with sizeable portfolio flows, models including EMEs and considering the consequences of their peripheral currencies, models for commodity exporters with a height weight of the price of a good in trade flows and in agents' expectations, among others.

Another advantage is the possibility of considering not only the monetary side, as in the models presented above, but also the productive one, as through the inclusion of trade flows. This derives from the fact that in SFC models exchange rates are a 'fully interdependent system', 'part of a complete, self-contained, economic system' (Lavoie and Daigle 2011, p. 244). Considering productive economy variables is key for EME currencies' analyses given their higher potential of facing terms-of-trade shocks, but is also important for analyses of central currencies due to the need of considering feedback effects such as those from the exchange rate to trade balance, domestic income, and thus income effects on the trade balance (Lavoie and Daigle 2011) – feedbacks also ignored in mainstream analyses of timeless equilibrium (Godley and Lavoie 2003). The consideration of feedback effects is enabled by the treatment of time as historical – or for its 'period by period' balance sheet dynamics (Macedo e Silva and Dos Santos 2011). Apart of feedback analyses, historical time also allows analyses of volatility and the identification of phenomena as volatility clustering and fat tails, that are major puzzles raised by the exchange rate literature (Lux and Marchesi 2000).

Another interesting point of the SFC framework is that its constraints can be added to an Agent-Based model (ABM), resulting in a AB-SFC model. While most SFC models are used to represent the macroeconomic sphere, the equations of an AB-SFC model generaly describe the microeconomic level. For being constructed in this form, AB models do not include any hypothesis of a single stylized behaviour for a whole institutional sector allowing the inclusion of heterogeneous agents of decentralized behaviour (Fagiolo and Roventini (2012); Fagiolo and Roventini (2016); Turrell (2016)). AB models are common in areas as physics, biology and ecology. Its application to economics is more recent and has taken place in tandem with the growing view of the economy as a complex system (Arthur 2013, Turrell 2016) – an understanding that is seen as a fundamental shift in the economics profession (Colander et al, 2010, Holt et al, 2011).

The inclusion of microeconomic behaviour is interesting for exchange rate analyses for allowing for heterogeneous agents – especially with regards to how they form their expectations and to the magnitude of their portfolios. AB models also allow for specific and slow changes in behaviour, in line with the argument of individual and gradual change in liquidity preference (Author).

4.2 Exchange-rate expectations in current SFC models

As shown, PK exchange rate analyses have exchange rate expectations at their core and are very rich in institutional details. Exchange rate modeling in PK works, on the other hand, is very incipient and make use of important simplifications with regards to expectations – indeed, in comparison with closed economy SFC models, there are relatively few open-economy ones; see Caverzasi and Godin (2015). Most models use static expectations ($e^e = 0$[13]*;* as in Godley and Lavoie 2007) what contradicts the findings of Schulmeister (2009) on the cyclical nature of exchange rates and exchange rate expectations. Taylor (2004) uses the uncovered interest-rate parity (UIP) to close his model, a questionable take, in view of its large statistical failure.

Models focused on exchange rates can have a combination of traders who expect a given exchange-rate change ($e^e = x$), or a given exchange-rate value ($E^e = x$), representing, respectively, chartist and fundamentalist traders. This configuration is drawn from the mainstream behavioural finance literature (as De Grauwe and Grimaldi 2006). The idea of FX market participants who trade knowing the fundamental value of the exchange rate is subject to criticisms related to the very existence of fundamental values and of efficient market models. A fundamentalist trader might however be seen as a participant that would knows what (part of) the other participants think about future exchange-rate value, coherently with Orleans's (1999) concept of an 'auto-referential' market where forecasts reflect the current financial convention. In both Lavoie and Daigle (2011) and De Grauwe and Grimaldi (2006) the forecast is an external value (respectively a given value and a stochastic process). In this sense, in both cases the modeling of the exchange rate forecast through a 'fundamentalist trader' does not necessarily imply the convergence to an equilibrium exchange rate, but only that traders believe this price exists. The simplification, in these cases, is not the assumption that there are fundamentalist traders, but the fact that the fundamental value does not evolve with the economy – it is static irrespective of changes in the economy or in the exchange rate itself. Static expectations in a context of exchange-rate fluctuation are also not in line with the representativeness principle, according to which traders would look for reasons for these fluctuations and adapt their expectations accordingly. Possibilities of modeling an endogenous fundamentalist behaviour are presented below.

4.3 PK insights on exchange rates through ABM and SFC frameworks

In what follows, we use the ABM and SFC frameworks to provide interesting ways to model exchange rate expectations and portfolio allocation decisions in more complex and realistic forms than in the SFC models summarized above and the current exchange rate models described in Sections 2 and 3. These frameworks enable considering the insights of the two strands of the PK view on exchange rates presented in the previous sections: the impact of the different types of strategies adopted by heterogenous agents in FX markets through expectations equations; and the influence of

(13) The exchange rate is given as the price of the foreign currency in terms of the domestic one.

the liquidity premium and the liquidity preference of global investor on EME currencies'dynamics by detailing the portfolio allocation equations.

Starting with expectations formation, Harvey (2009) suggests that traders consider the following variables in forming their exchange rate forecasts: trade balance, relative output growth, and interest-rate differential (equation (3)); country $ issues a central currency and country # issues an EME currency in all equations of this section). In an ABM approach with heterogeneous agents their focus on each of these variables can be varied by adjusting the parameters γ, Ω, and θ.

$$E^{e}_{\#fHarvey} = E_{\#t-1} - E_{\#t-1}[\gamma(X_{\#} - IM_{\#}) + \Omega(y_{\#} - y_{\$}) + \theta(r_{\#} - r_{\$})] \quad (3)$$

One could also consider an endogenous fundamentalist behaviour based on the UIP and the PPP. The former is to say that a decrease of interest rates ($r_{\#}$) is expected to be associated with an appreciation of the country's currency (a decrease of $E_{\#}$; $E^{e}_{\#fUIP} < E^{e}_{\#t-1}$; equation (4)). A PPP-fundamentalist trader, on the other hand, would expect higher prices ($p_{\#}$) to be associated with a exchange rate depreciation (a rise of $E_{\#}$; $E^{e}_{\#fPPP} > E_{\#t-1}$; equation (5)).

$$E^{e}_{\#fUIP} = E_{\#t-1} + (r_{\$} + r_{\#})E_{\#t-1} \quad (4)$$

$$E^{e}_{\#fPPP} = E_{\#t-1} + (p_{\#} - p_{\$})E_{\#t-1} \quad (5)$$

Both the anchoring principle, analysed by Harvey, and the medium-term expectations, analysed by Schulmeister, have a similar effect: new forecasts depend on past forecasts (equation (6), where x is one of the endogenous fundamentalist rules discussed above and 0.5 is an arbitrary value).

$$E^{e}_{fAnc} = (0.5)x + (0.5)E^{e}_{t-1} \quad (6)$$

Complex chartist behaviour can be modelled based on Schulmeister's (2009) fast and slow technical systems: slow chartists take into account a longer average change than fast chartists (respectively equations (7) and (8), where $m > n$).

$$E^{e}_{cSlow} = E_{t-1} + \frac{E_{t-1} - E_{t-m}}{E_{t-m}} \quad (7)$$

$$E^{e}_{cFast} = E_{t-1} + \frac{E_{t-1} - E_{t-n}}{E_{t-n}} \quad (8)$$

Schulmeister (2009) 'contrarian' traders sell assets when their prices increase at a declining rate, and buy when the rate at which prices decrease is dfalling. In other words: if the exchange-rate change of period t (e_t) is greater than the average observed since period $t - n$, the contrarian agent expects the future exchange rate change to be in the opposite direction of the current trend (equation (9) for an expectation of trend reversal after three periods of falling pace).

$$e^{e}_{t+1} = -e_t \qquad \begin{array}{l} if\ e_t < e_{t-1} < e_{t-2}\ and\ e\ is\ positive, \text{ or} \\ if\ e_t > e_{t-1} > e_{t-2}\ and\ e\ is\ negative \end{array} \quad (9)$$

Harvey's (2009) analysis of cash-in can be included through a limit in the profits accumulated (L^{i} , in equation (10) for n periods). In a ABM framework, its modeling asks for a rule where an agent sell an asset when the cumulated profits achieve a given percentage of her wealth. Although a

rough approximation, this feature might be an important inclusion given that it partly explains the reversal of a trend. Ideally, it should be modelled for profits made with individual asset classes, what demands splitting V^i into $V_{\$}^{i\#}$ and $V_{\#}^{i\#}$ for the wealth of a central country investor in its country and in the EME country, respectively.

$$L^i = \frac{V_t^i - V_{t-n}^i}{V_{t-n}^i} \quad (10)$$

Therefore, the suggestions above enable to model exchange rate expectations in more complex and realistic forms, taking into account the fact that FX markets are formed by heterogenous types of traders, adopting different strategies, as Schulmeister (2009) and Harvey (2009) stress. Together with exchange rate expectations, the treatment of global investors' portfolio decisions is also another area where economic models have been excessively unrealistic, with very restrictive hypotheses. In the sequence we make use of the flexibility of the AB-SFC framework to provide a more complex, detailed and realistic account of these decisions through portfolio allocation equations that encompass advanced and EME currencies and consider the influence of currencies' liquidity premiuns and investors' liquidity preference in exchange rates dynamics. The suggestions below can also be applied to analyses of two advanced currencies (whose liquidity premium diverge) and/or assets denominated in these currencies.

The analyses of the inpact of the specificities of EME currencies is done through changes in the portfolio allocation equations of SFC models (see Godley and Lavoie 2007). In these equations, total wealth (V_i) of investors based in an advanced country $\$$ is allocated among domestic ($B_{\$}^{\$}$) and EMEs' financial assets ($B_{\$}^{\#}$)[14]. The demand ($_d$) functions for each of these assets is given by equations (11) to (14), where r_i stands for the assets' respective returns and e_i^e the expected exchange rate change (a positive value denoting an expectation of appreciation of the currency *i*):

$$B_{\$d}^{\$} = V_{\$}(\lambda_{20} + \lambda_{21}(r_{\$}) - \lambda_{22}(r_{\#} + e_{\#}^e)) \quad (11)$$

$$B_{\$d}^{\#} = V_{\$}(\lambda_{30} - \lambda_{31}(r_{\$}) + \lambda_{32}(r_{\#} + e_{\#}^e)) \quad (12)$$

$$B_{\#d}^{\#} = V_{\#}(\lambda_{50} + \lambda_{51}(r_{\#}) - \lambda_{52}(r_{\$} + e_{\#}^e)) \quad (13)$$

$$B_{\#d}^{\$} = V_{\#}(\lambda_{60} - \lambda_{61}(r_{\#}) + \lambda_{62}(r_{\$} + e_{\#}^e)) \quad (14)$$

According to the liquidity-premium asymmetry, investors prefer investments in a central ($), rather than in a peripheral (#) currency even if the return differential is the same ($B_{\$d}^{\$} > B_{\$d}^{\#}$ and $B_{\#d}^{\#} < B_{\#d}^{\$}$ even if $r_{\$} = r_{\#} + e_{\#}^e$) due to the non-pecuniary returns of holding a more liquid currency (Andrade and Prates 2013). This bias can be accounted for through the definition of simple rules when defining the value of the equations' parameters, as the consideration that $\lambda_{20} > \lambda_{30}$ and $\lambda_{60} > \lambda_{50}$. If we also want to consider country bias (the preference for its own country's assets) and that this is more important than the liquidity –premium asymmetry, $\lambda_{60} < \lambda_{50}$ and

(14) Similarly, the demand of an investor based on an EME is split among investment in its own country's assets ($B_{\#}^{\#}$) and assets from a central economy ($B_{\#}^{\$}$).

$\lambda_{20}/\lambda_{30} > \lambda_{60}/\lambda_{50}$. Standard restrictions related to Tobinesque portfolio allocation parameters still hold (Godley and Lavoie 2007; Kemp-Benedict and Godin 2017).

Appart from this structural aspect of liquidity preference, the liquidity-premium asymmetry, a conjunctural aspect of liquidity preference is also key to exchange rate analysis. For taking the two into consideration, the above discussed parameters λ_{i0} could be splited into a structural one, related to the liquidity-premium asymmetry, λ_{i0}^{lpm} and a conjunctural one, relate to the cyclical aspect of liquidity preference, λ_{i0}^{lpf} (equation (15)). The parameter λ_{i0}^{lpf} increases in times of turbulence, leading to a shift of demand from EME to central economy's assets from both types of investors. Such a change in liquidity preference can be analysed with a SFC model through as a shock on λ_{i0}^{lpf}, or, in an AB model through the use of an exogenous series. In the latter case, the series could be modelled to resemble the VIX index (the most used proxy for uncertainty and liquidity preference in the PK literature and as risk-aversion by the mainstream): mostly stable with eventual peaks.

$$\lambda_{i0}^{lp} = \lambda_{i0}^{lpm} . \lambda_{i0}^{lpf} \qquad (15)$$

The Minskyan aspect that agents gradually change their decisions with the establishment of tranquillity (Author) can be modelled in an ABM framework. The result of this dynamic is the gradual growth of EMEs' assets demand following the fall of uncertainty. It could be modelled through the consideration of individual and subjective preference for liquid assets (λ_t^{lpf}) that floats according to changes in a general level of uncertainty (σ_t). Liquidity preference of investor i at period t ($\lambda_{i,t}^{lpf}$), would be a positive function of uncertainty in period t (σ_t) and, in case of low uncertainty ($\sigma_t < x$), would decrease with time – equation (16), where a higher n is given to the investor that takes longer to react to a fall of uncertainty. This inclusion significantly improve Tobin-inspired portfolio allocation equations used in SFC models for adding the risk feature[15] and for treating it as a personal perception, not as a measurable and single value (in line with the PK concept of fundamental uncertainty and the behaviour economics' concept of framing).

$$\lambda_{i,t}^{lpf} = \begin{cases} f\left(\frac{1}{n}\sum_{t-1}^{-n}, \sigma\right) & if\ \sigma_t < x \\ f(\sigma_t) & otherwise \end{cases} \qquad (16)$$

The inclusion of equity markets is interesting given the circular dynamics it triggers in EMEs, of asset and exchange rate appreciation and expectation of future exchange rate appreciation, due to the magnitude of foreign investors' assets relative to the size of EMEs' markets and given its increasing weight among EMEs' foreign liabilities (Kaltenbrunner and Painceira 2014). The modeling of equity markets is out of the scope of this article, but its impact on portfolio equations asks for a distinction of the return of a countries' assets into returns from bonds and from equities, that can be simplified to the expected change in stocks prices (sp_j^e). This would demand adding $\lambda_{i3}\left(sp_j^e + e_j^e\right)$ to equations (11) to (14), as exemplified by equation (17).

$$B_{\$d}^{\$} = V_{\$}(\lambda_{20} + \lambda_{21}(r_{\$}) - \lambda_{22}(r_{\#} + e_{\#}^e) - \lambda_{23}\left(sp^e{}_{\#} + e_{\#}^e\right)) \qquad (17)$$

(15) Kemp-Benedict and Godin (2017) suggest a way to add risk considerations in a Tobin model, resulting in a dynamic where risk tolerance increases in bull markets and decreases in bear markets. This would also be the result of the modeling proposed here, but without including the idea of individual risk perceptions.

5 Concluding remarks

Exchange rates have long been a puzzle in economic literature. Post-Keynesian analyses in this field have arisen after the breakdown of the Bretton Woods system, yet they are rather disconnected with each other, and not broadly disseminated even in the PK field. This article has contributed to the consolidation of the PK view on nominal exchange rate in several manners.

On the one hand, it has critically analysed the main PK works in the field, consolidating their arguments, their common views and limitations. The PK exchange rate view calls attention to the role of institutional investors whose decisions are guided by expectations and social conventions, given fundamental uncertainty and the characteristics of Money Manager capitalism (Minsky, 1986). PK works also highlight that different currencies can have varied dynamics related to the place they occupy in the IMFS and the balance-sheet constraints these cause to investors. As shown in sections Two and Three, some dynamics emerge from money managers' decisions related to their assets' side, others to their liabilities, others on the relationship between the two. The fact that EMEs' assets are part of money managers' assets make their exchange rates subject to changes in any market where these institutions have assets or liabilities, resulting in long appreciation trends interrupted by sudden depreciations, subordinated to international financial conditions.

On the other hand, the article used the ABM and SFC equations for providing a common framework for theoretical and empirical analysis of exchange rates dynamics coherent with the PK approach. The flexibility inherent to the AB-SFC framework allows to consolidate the main PK works on the topic, and to enhance PK modeling, through a more complex, detailed and realistic account of expectations formation in FX markets and of international portfolio allocation in the current IMFS, being coherent with PK pressupositions of realisim, historical time and the crucial role of institutions.

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