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Assessing the Marshall-Lerner Condition in a SFC Model

The Paradox of Stabilising Sticky Prices

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Abstract. We derive the general equilibrium condition for the terms of trade in a two-country economy model. We show that the Marshall-Lerner condition is only a special case of this condition, in which a full exchange rate pass-through to import prices is assumed. In fact, the Marshall-Lerner condition is not even a 'useful approximation' of the general condition. For the full pass-through assumption has destabilising, rather than stabilizing, effects, when it is introduced in a stock-flow consistent dynamic model. More generally, the higher (lower) the pass-through, the slower (quicker) is the adjustment of the economy towards the equilibrium. This is tantamount to saying that the speed of adjustment is a positive function of the strategic behaviour of the exporters, who attempt to retain their market share by keeping their foreign currency-denominated prices unchanged.

Keywords: Marshall-Lerner Condition, Stock-Flow Consistent (SFC) Models, Exchange Rate, Sticky Prices

JEL codes: E12, F41, F47.

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> It has been showed many times in empirical studies that the pass-through of exchange rate movements to import prices and exports' behaviour has been consistently declining in the context of the new global supply chain structures and pricing-to-markets.
>
> Victor Constâncio (Former ECB Vice-President), April 2019

1. Introduction

Despite the different assumptions they are built upon, both Neoclassical and Keynesian macroeconomic models hold that a currency depreciation (or devaluation) improves the trade balance, under clearly specified hypotheses. In the most popular frameworks – such as the Mundell-Fleming (MF) model – these hypotheses are defined by the well-known *Marshall-Lerner condition* (MLC). The MLC requires the sum of the price elasticities of export and import, both taken as absolute values, being greater than one (Robinson 1937, Lerner 1944). Although usually neglected, the MLC relies on the assumption that exporting firms will not adjust their unit prices following changes in the exchange rate.

In this paper, we show that a more general set of conditions can be derived when the strategic behaviour of the exporters is considered. We use standard equations for import and export quantities coupled with Godley (1999) equations defining import and export prices. We then test different conditions and regimes using an open-economy stock-flow consistent (SFC) model.[1] We argue that the Marshall-Lerner condition is only a special case, in which a full exchange rate pass-through to import prices is assumed. In fact, the Marshall-Lerner condition is not even a 'useful approximation' of the general rule, for the full pass-through assumption has destabilising effects. More generally, the higher (lower) the pass-through, the slower (quicker) is the adjustment of the economy towards the equilibrium. This is tantamount to saying that the speed of adjustment is a positive function of the strategic behaviour of the exporters, who attempt to retain their market share by keeping their foreign currency-denominated prices unchanged. For this reason, it can be maintained that the sticky prices of exports (expressed in the currency of the country of destination) are stabilising, while exchange rate-sensitive export prices are destabilising.

The study of the strategic behaviour of economic agents in an open economy is usually put forward by considering the effects on the exchange rates of heterogeneous expectations. For instance, Federici and Gandolfo (2011) use the heterogeneous expectations of economic agents to explore non-linearities and chaotic behaviour in a (continuous-time) exchange rate model. Lavoie and Daigle (2011) analyse the impact of expectations on the stabilising properties of a floating exchange rate in a (discrete-time) SFC open economy model. However, there is little analysis focusing on the real side, especially on the impact on international trade of the strategic price-setting behaviour of exporters[2]. A noteworthy exception is Nielsen (1991), who uses a model of a small open economy to study the effect of

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[1] Stock-flow consistent (SFC) dynamic models are a class of medium-scale Keynesian macro-econometric models based on a rigorous accounting framework, which integrates the flows and stocks of a financially-sophisticated capitalist economy (e.g. Godley and Lavoie 2007a; Nikiforos and Zezza 2017).

[2] The so-called Thirlwall's Law is also based on the assumption of a full pass-through (Thirlwall 1979).

currency devaluation on the current account balance. However, he focuses on wages and the duration of contracts, rather than on prices and the strategic decisions of the exporters.

The rest of the paper is organised as follows. Section 2 provides a short survey of the literature on the MLC. Section 3 develops analytically the new terms-of-trade condition. We also present the open-economy SFC model in order to test our condition against the MLC and alternative conditions, under a variety of exchange rate regimes and scenarios. Our findings are presented by means of computer simulations and discussed in Section 4. Theory and policy implications are further discussed in Section 5.

2. Literature review

Our work builds upon two different strands of literature. The first strand includes the works on the MLC and the so-called *J-curve effect*. The second strand includes recent works on open-economy stock-flow consistent (SFC) dynamic models. The former is dominated by empirical research. The latter can be regarded as an autonomous branch of SFC modelling, which has been developed since the late-2000s.

As mentioned, the MLC is one of the key mechanisms of the MF model, or IS-LM-BP model. The latter was developed in the early 1960s by Robert Mundell and Marcus Fleming (see Mundell 1960, 1961a, 1961b, 1963; Fleming 1962). Along with the Uncovered Interest Parity (UIP) theory, the MF model still occupies centre stage in academic discussions about stabilisation policies for the open economy (e.g. Isard 1995; Boughton 2003; Bernanke 2017; Aizenman 2018).[3] The MF model is based on the twofold assumption of perfect *capital mobility* and *financial asset substitutability*. If these assumptions hold and firms do not behave strategically then the MLC is a necessary and sufficient condition for the trade balance to improve following currency depreciation or devaluation. Since the MLC is derived deductively starting from simple assumptions, it has been implicitly regarded as a theoretical benchmark, or at least a useful approximation, since its early formulation. As a result, the vast majority of MLC papers have been focusing on the empirical significance of the condition, rather than on the assumptions it was based upon. However, in a recent literature review, Bahmani at al. (2013) show that only 30% of empirical investigations have found evidence supporting the MLC. This result is in line with their own econometric tests, which reject the MLC.

Turning to open-economy SFC models, several works have been published in the last decade. For instance, Godley and Lavoie (2007b) extend the original two-country structure to analyse the interaction between three economies (the US and two Euro Area's member-states) with two currencies (USD and EUR). They show that, while the Euro Area taken as a whole recovers from an external negative shock affecting one member country, each member of the currency union taken individually pursues a diverging path (see also Lequain 2003). Lavoie and Zhao (2010) use a three-country model to simulate the impact of the diversification of the foreign reserves of China, away from US dollars and towards euros. They argue that China and the US both benefit from diversification, while the Euro Area slows down. Lavoie and Daigle (2011) use a two-country model to assess the impact of exchange rate expectations on exchange rate movements and trade account. They show that a flexible exchange rate provides stabilising properties, as long as the proportion of 'chartist' agents (i.e.

[3] A well-known modern rendition of the Mundell-Fleming model is the DD-AA model developed by Krugman et al. (2015).

those who expect the latest change in the exchange rate to be repeated in the next period) relative to 'conventionalist' agents (i.e. those who stick to some exogenously given convention about the long-run exchange rate value) is not overly large. Mazier and Tiou-Tagba Aliti (2012) use a three-country model to analyse the impact of different exchange rate regimes on the world economy. They find that a flexible USD-RMB exchange rate is a powerful adjustment mechanism to reduce world imbalances. Mazier and Valdecantos (2015) use a four-country model to explore different exchange-rate arrangements that may help to reduce imbalances between surplus and deficit countries in the Euro Area. They find that a multi-speed union produces better results compared to the one that based on the Euro. Mazier and Valdecantos (2019) use an open-economy SFC model to test the effects of Keynes' Bancor on the Euro Area. They find that "the implementation of Keynes' ideas may conduct European countries to a stronger and more sustainable growth cycle" (Mazier and Valdecantos 2019, p. 8). Greenwood-Nimmo (2014) allows for persistent inflation and endogenous cyclicality in a two-country SFC model. He shows that a coordinated fiscal and monetary policy is the most effective option to stabilise the economy. Valdecantos and Zezza (2015) discuss how to use open-economy or multi-country SFC models to explore potential reforms of the international monetary system. Ioannou (2018) uses an open economy model to study the impact of credit assessments by rating agencies in? reactions to negative shocks. More recently, Carnevali et al. (2019a, 2019b) have extended an open-economy SFC model to include the impact of/on global warming and the interaction with the ecosystem.

All the works above are implicitly based on Godley and Lavoie (2007a), in which the MLC is considered as a useful empirical approximation (although not an accurate analytical formulation) of the terms of trade improvement condition. In the next sections, we show that the correct implicit condition is different and less restrictive than usually assumed.

3. Analysis and method

3.1 General condition for a trade balance improvement: new analytical solution

Although usually neglected, the MLC relies on the assumption that the price of export (expressed in the domestic currency) will not be affected by the depreciation of the domestic currency. The price of import will increase in line with the depreciation instead. In other words, there is a complete exchange rate *pass-through* to import prices. The terms of trade are assumed to fall by the full amount of the depreciation (Godley and Lavoie 2007a). While the MLC is based on a quite restrictive assumption (full pass-through), a more general condition can be derived from Godley (1999)'s equations defining prices and quantities of import and export, respectively. For this purpose, we consider an artificial economy made up of two countries, country A and country B.[4] In line with Godley and Lavoie (2007a), we define country A's import and export unit prices as follows:

$$\log(p_m^A) = v_0 - v_1 \cdot \log(xr^A) + (1 - v_1) \cdot \log(p_y^A) + v_1 \cdot \log(p_y^B), \qquad 0 < v_1 < 1 \tag{1}$$

$$\log(p_x^A) = u_0 - u_1 \cdot \log(xr^A) + (1 - u_1) \cdot \log(p_y^A) + u_1 \cdot \log(p_y^B), \qquad 0 < u_1 < 1 \tag{2}$$

[4] Godley and Lavoie (2007a) name it 'the United Kingdom', as opposed to 'the United States'. Since the purpose of our paper is purely theoretical, we prefer to label the two economies 'Country A' and 'Country B', respectively. See Appendix A for a key to symbols and Appendix C for the full set of equations. Notice that equations (1) to (4) of section 3 match equations (C21) to (C24) of the complete model.

where p_y^A is the price level of country A output, p_y^B is the price level of country B output,[5] and xr^A is the exchange rate, defined as the amount of B currency per unit of A currency. As a result, a fall in the exchange rate reflects a depreciation of A currency relative to B currency.

Taking the first differences of (1) and (2), we obtain:

$$\dot{p}_m^A = -v_1 \cdot \dot{xr}^A + (1 - v_1) \cdot \dot{p}_y^A + v_1 \cdot \dot{p}_y^B, \tag{1bis}$$

$$\dot{p}_x^A = -u_1 \cdot \dot{xr}^A + (1 - u_1) \cdot \dot{p}_y^A + u_1 \cdot \dot{p}_y^B, \tag{2bis}$$

The main advantage of this formulation is that coefficients v_1 and u_1 define the *degree of exchange rate pass-through* to import prices. More precisely, the condition $v_1 = 1 \wedge u_1 = 0$ entails full pass-through of exchange rate changes to import prices. It holds that the exporters do not behave strategically: they neither adjust export prices to keep their market share stable (following a currency appreciation) nor they attempt at realising extra profits (following a currency depreciation). Notice $1 - u_1$ is the pass-through of exchange rate changes to import prices of the *other country*. As a result, $u_1 = 0$ entails full pass-through for country B.

Turning to real export and import equations for country A, these can be defined as follows:

$$\log(x^A) = \varepsilon_0 - \varepsilon_1 \cdot \left[\log\left(p_{m,-1}^B\right) - \log\left(p_{y,-1}^B\right)\right] + \varepsilon_2 \cdot \log(y^B) \tag{3}$$

$$\log(im^A) = \mu_0 - \mu_1 \cdot \left[\log\left(p_{m,-1}^A\right) - \log\left(p_{y,-1}^A\right)\right] + \mu_2 \cdot \log(y^A) \tag{4}$$

Equations (3) and (4) above were first developed by Houthakker and Magee (1969) and have become quite popular in the international economics literature ever since. They are Cobb-Douglas functions, characterised by *constant elasticities* of import and export with respect to prices.

Building upon equations (1*bis*)-(4), let $\dot{TB}$ be the percentage change in the trade balance and let DTB be the partial derivative of $\dot{TB}$ with respect to the exchange rate (that is, $DTB = \partial\dot{TB}/\partial\dot{xr}^{\boldsymbol{A}}$). It is possible to show that:[6]

$$DTB < 0 \quad iff \quad \varepsilon_1 \cdot (1 - u_1) + \mu_1 \cdot v_1 > v_1 - u_1 \tag{5}$$

Inequality (5) defines the *general condition* for a trade balance improvement following an exchange rate depreciation (or devaluation). Let us consider a depreciation of currency A, meaning a reduction of country A's exchange rate. We name the *weighted price elasticity of import* the elasticity of import (μ_1) multiplied by the exchange rate pass-through of the import price (v_1). Similarly, we name the *weighted price elasticity of export* (ε_1) the elasticity of export multiplied by the exchange rate pass-through of the *other country's* import price $(1 - u_1)$. The trade balance of country A improves *if and only if* the sum of its *weighted* price elasticities of export and import is greater than the difference between the pass-through coefficients of import and export prices. This is the meaning of condition (5).

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[5] This is the formulation proposed by Godley (1999) and Godley and Lavoie (2007a), using output deflators (p_y^A and p_y^B) to measure prices. Arguably, prices of production – call them p_{ymade}^A and p_{ymade}^B, respectively – are a more appropriate choice if goods are produced by means of labour only. Alternatively, the effect of exchange rate variations on the cost of non-labour inputs can be captured by using the following: $p_y^{*i} = \alpha_p \cdot p_{ymade}^i + (1 - \alpha_P) \cdot p_y^i$, with $i = A, B$ and $0 \leq \alpha \leq 1$. However, the terms of trade condition we derive does not depend on the specific price setting chosen.

[6] We refer to Appendix B for the mathematical proof of (5).

In formal terms, the MLC can be seen as a special case or subset of condition (5), in which the first coefficient is unity and the second coefficient is null. If $u_1 = 0 \wedge v_1 = 1$, we obtain:

$$DTB^{MLC} < 0 \quad iff \quad \varepsilon_1 + \mu_1 > 1 \qquad (5bis)$$

Intuitively, the MLC condition holds when exporters do not amend the price of their products, following an appreciation or depreciation of their domestic currency. If firms do not attempt to retain their market share, foreign currency-denominated prices entirely incorporate the change in the exchange rate. As a result, any currency depreciation or appreciation fully affects cross-country competiveness of products. We can name the hypothesis above (that is, $u_1 = 0 \wedge v_1 = 1$) the *Marshall-Lerner assumption* (MLA), to distinguish it from the Marshall-Lerner condition, namely, $|\varepsilon_1| + |\mu_1| > 1$.[7] Although the MLC is sometimes regarded as a useful approximation, it lacks generalizability. Furthermore, in Section 4 we show that the MLA brings about destabilising implications for trade balances when it is introduced in a complete and stock-flow consistent two-country model.

Despite being derived from the same import and export equations, equation (5) is also slightly different from the condition proposed by Godley and Lavoie (2007a, p. 455). Although they do not provide an *explicit* analytical formulation, the *implicit* condition they identify is:

$$DTB^{GL} < 0 \quad iff \quad \varepsilon_1 + \mu_1 > v_1 - u_1 \qquad (5ter)$$

However, Lavoie and Daigle (2011) notice that (5*ter*) does not always hold, due to the presence of feedback or income effects on the balance of trade. In Section 4, we show that condition (5*ter*) is not a *necessary* condition for the trade balance to improve following a currency depreciation *even if feedback effects are assumed away*. In the last few years, this problem has led some authors to reconsider equation (5*ter*) – e.g. Lavoie (2015, pp. 523-524) suggests condition (5), but without providing a proof.

3.2 Assessing the MLA in a stock-flow consistent two-country model

We can now test different pass-through regimes by means of an open-economy SFC model. The model we use resembles OPENFIX and OPENFLEX, namely, the two advanced open-economy models developed by Godley and Lavoie (2007a). Although other open-economy models have been developed in the last decade (see section 2), OPENFIX and OPENFLEX are still the benchmark for SFC macroeconometric modellers.[8] Like Godley and Lavoie (2007a), our model is made up of four main blocks defining accounting identities, cross-country trade equations, income and expenditure functions, financial asset demands and supplies, in a two-country economy. Both a fixed exchange rate regime and a floating exchange rate regime are considered. When a fixed exchange rate regime is modelled, reserves are adjusted by the central banks in such a way to prevent the relative value of currencies from floating. More precisely, we assume that the central bank of country A trades Treasury bills of country B to achieve that target.[9] As our goal is mainly theoretical, *baseline* coefficients and initial values of lagged variables and stocks are not estimated, but borrowed from Godley and Lavoie

[7] Notice that absolute values are redundant here, for elasticities are preceded by a minus sign in the import and export functions.

[8] They have been defined as the 'centre of gravity of the open economy SFC literature' (Nikiforos and Zezza 2017, p. 1220).

[9] We implicitly hold that country B issues the 'anchor' currency of the system.

(2007a). Sectoral balance sheets and the transactions-flow matrix are also quite standard. They are displayed in Table 3 and Table 4, respectively. The complete model is reported in Appendix C, while a key to symbols is provided in Appendix A.

In line with the SFC literature, we maintain the hypothesis of perfect capital mobility, but we reject the assumption of perfect substitutability of financial assets. Uncertainty and asset diversification play a major role in our model. This means that the elasticity of asset holdings to return rates is not infinite, as assumed by standard neoclassical-like models (e.g. the MF model). Policy rates are set by the central banks, which also perform standard sterilisation operations.[10] Differences in return rates are not associated with infinite in- or out-flows of capitals. They only trigger temporary portfolio adjustments. The equilibrium of the balance of payments (BP) is always assured by symmetrical changes in the current account balance (CAB), and in the financial account balance (FAB). Therefore, trade flows, not interest rate differentials, are the main drivers of exchange rates in the medium run.[11] We do not neglect the impact that liquidity preference, interest rates and exchange rate expectations have on current exchange rates. However, our model (like other open-economy SFC models) show that the subsequent change in the trade balance (TB) is a powerful compensation mechanism that may well offset any initial speculative push.

The impact of financial transactions on the exchange rate is due to the gap between the *desired* stock of foreign assets and *actual* (or *current*) holdings. A higher demand (following an increase in the return rate) leads to an appreciation of the currency in which the financial asset is denominated relative to the domestic currency of the investor. The opposite occurs when the cross-country demand for financial assets declines (see Table 1 for a comparison of open-economy SFC models with standard, neoclassical-like, models). The change in the currency value entails a change in households' real holdings of financial assets and in the terms of trade, which, in turn, affect the TB. During the adjustment process, the TB deficit (surplus) is always offset by a corresponding FAB surplus (deficit). Once the agents achieve the new desired portfolio composition, current account imbalances become the main driver of the exchange rate. The new equilibrium is reached only when the CAB, and hence the FAB, get back to zero. Notice that the distinction between desired and actual holdings of financial assets is one of the key features of open-economy SFC models. This distinction is a pure *thought experiment*, as the gap only shows up *within*, but *not across*, the periods. For adjustments in the currency value make the actual holdings of financial assets match the desired amount at the end of each period[12]. This is the main, though *indirect*, mechanism

[10] We assume that the policy rate is the return rate on Treasury bills. The central bank steers it by exchanging Treasury bills with the private sector (households). Changes in foreign reserves are compensated, or sterilised, in the same way. As a result, a current account surplus (deficit) does not necessarily entail a rise (fall) in money supply, due to the inflow of foreign currency, as central banks sell back (purchase) Treasury bills to (from) governments (see Berger 1972, Lavoie 2015, Angrick 2017).

[11] This is starkly at odds with most recent versions of the MF model, such as the DD-AA model developed by Krugman et al. (2015), in which the CAB has no influence on the exchange rate. For they assume that financial assets are perfect substitute and that speculative capital flows overwhelm payments linked to international trade. The idea that speculative investments are more important than trade flows is supported also by some Post-Keynesian economists (e.g. Harvey 2012). However, another strand of Post-Keynesian Economics, the so-called "Harrodian open economy tradition", "puts a substantial amount of weight on the trade flows" in the determination of exchange rates (Lavoie 2015, p. 493).

[12] This is a key difference with Tobin (1969), who focuses on the long-lasting discrepancy between desired and actual holdings of financial assets.

through which financial transactions affect the exchange rate within periods. However, it is only non-financial transactions that can affect *directly* the FAB across periods.

While the scale of the model is too large to allow for the analytical derivation of the results, its behaviour can be assessed through computer simulations. Based upon the analysis provided in Section 3.1, we test the reaction of selected variables (GDP, exchange rate, current account balance, trade balance, factor income, government deficit, internal and external prices) to negative shocks to the exchange rate (i.e. a currency devaluation under a fixed exchange rate regime) and foreign demand (i.e. a fall in export under a floating exchange rate regime), respectively. We compare the model dynamics under the baseline scenarios[13] with alternative scenarios, characterised by different pass-through regimes. For the sake of clarity, we assume that the sum of price elasticities of export and import is unity ($\varepsilon_1 + \mu_1 = 1$). This is a *neutrality condition*, according to the standard MLA-based interpretation (full-pass through assumption, which implies: $u_1 = 0 \wedge v_1 = 1$), meaning that the trade balance would be unaffected by shocks to the exchange rate. We show that this is not the case when the full pass-through condition is relaxed. Besides, we show that, while the model usually achieves a stable equilibrium after a shock, the MLA-based regime may trigger destabilising tendencies.

4. Simulation results and discussion

4.1 Fixed exchange rate regime

Let us start from a fixed exchange rate regime. Figure 1 shows that, if the MLA holds (that is, a full pass-through is assumed: $u_1 = 0 \wedge v_1 = 1$), a negative shock to the exchange rate does not affect the external balances of country A in the medium to long run. This is due to the neutrality condition. However, there is a negative short-run impact on external balances. Both the TB and the current account balance (CAB) worsen, as the increase in import value (due to the increase in its unit price) outstrips the increase in export value (mainly due to the increase in its real level).[14] There is a slightly positive effect on GDP due to the higher real consumption of country A's households.[15] However, this is only one out of many possible scenarios. Despite the MLA-based neutrality condition, incomplete pass-through regimes are associated with improvements in external balances following currency devaluation. More precisely, if the pass-through is *high enough but not unity*, both the TB and the CAB initially worsen, before they recover to higher levels than where they started. This is the well-known *J-curve effect*. If the pass-through is low enough, the initial fall is negligible. In general, the negative effect gets smaller and smaller as the pass-through reduces (i.e. as we move from purple to green lines in Fig. 1). Besides, both balance of payments' factor income (cross-country net interest payments in our model) and the GDP increase, while the government balance records a surplus. There is a reduction in net financial assets held by domestic households. However, the effect is just temporary and low pass-through regimes are associated with higher asset holdings in the medium run. This is the reason the MLC cannot be regarded as a rule. In fact, it is a special case. The point is that different impacts of currency

[13] Baseline coefficients and initial values of lagged variables and stocks are borrowed from Godley and Lavoie (2007a), with the exception of the price elasticities of export and import.

[14] Notice that import and export volumes are affected by the exchange rate with a lag, due to the J-curve effect.

[15] The higher consumption is due to the capital gains realised by country A's households on their holdings of foreign currency-denominated assets.

devaluation under different pass-through regimes are driven by changes in the price structure. Fig. 2 displays and compares three different scenarios: (a) currency devaluation with low pass-through; (b) currency devaluation with high pass-through; (c) and currency devaluation with full pass-through. Under scenario (a), the exporters of country A take advantage from currency depreciation, as the increase in domestic currency-denominated export prices partially offsets the fall in the exchange rate. At the same time, domestic currency-denominated import prices do not vary that much.[16] By contrast, export prices remain almost unchanged when expressed in domestic currency, under scenario (b), while import prices are now much higher. Finally, scenario (c) is the extreme situation in which domestic currency-denominated export prices do not vary. The percentage reduction in prices that the consumers of country B pay (by their own currency) is equal to the depreciation of the currency of country A. By contrast, import prices paid by domestic consumers fully incorporate the higher market value of the foreign currency. Symmetrically, a stronger exchange rate would bring about cheaper imported products for domestic consumers and dearer imported products for foreign consumers, when the pass-through is high. However, this effect fades away as the pass-through reduces, namely, as long as exporters of both countries try to retain their market shares (or to make extra profits) by keeping foreign-denominated prices stable.[17]

Looking at the stock side, we have seen that a currency devaluation brings about an initial fall in the CAB. A current account deficit goes along with an increase in the country's foreign debt stock (or an erosion of its net foreign asset position). This effect gets stronger as the pass-through coefficient increases. It entails an income outflow (that is, interest payments on domestic government bills in our model) towards the foreign sector (country B), which further affects the CAB. By contrast, low pass-through regimes smooth the increase in foreign debt, thus allowing the CAB to benefit from a more competitive currency (despite its depreciation not being completely reflected by the price structure).

4.2 Floating exchange rate regime

Let us move to a floating exchange rate regime.[18] We can test the effect of a negative shock to the exports of country A. Once again, green and yellow lines in quadrants (a) and (b) of Fig. 3 resemble the *J curve*.[19] External balances initially worsen following a negative shock to export (which, in turn, brings about a currency depreciation, see quadrant (f)), before they recover to higher levels than where they started. This occurs despite the MLA-based neutrality condition *if* the exchange rate pass-through to import prices is low enough. By contrast, if the pass-through is high enough (red and purple lines), the temporary recovery is followed by a

[16] We are implicitly assuming that country B exporters target (and try to retain) a certain market share, rather than maximising it.

[17] There can be different explanations about the strategic behaviour of the international traders. Looking at the Post-Keynesian tradition, the extent of pass-through usually depends on the category of goods being traded (homogeneous intermediary products, manufactured goods, etc.) and on the extent to which the domestic industry is dominated or not by external competitors (e.g. Bloch and Olive 1996, Coutts and Norman 2007, Lavoie 2015).

[18] Notice that the exchange rate of country A is simply defined by the market equilibrium condition for international trade of country A's government bonds – see equation (B86b) in Appendix C.

[19] Strictly speaking, the *J-curve* describes the behaviour of the current account following a negative shock to the *exchange rate*. As we are testing a floating exchange rate model, we consider a shock to the propensity to export, which brings about – as an *indirect* effect – a *gradual* depreciation of the currency.

collapse of country A's external balances. The GDP and the government budget are also affected.

The initial negative effect is due to the fall of propensity to export and then to the increase in import value outstripping the increase in export value, while trade volumes take time to adjust to the new conditions. As mentioned, the stabilising properties of low pass-through regimes are at odds with the idea that smooth and rapid price adjustments would speed up the convergence to the equilibrium.[20] In fact, they rather hinder it. For the strategic behaviour of exporters, who try to *counter* or *sterilise* the impact of currency fluctuations on the price of their products, allows reducing the value of imported products and increasing the value of exported products in the medium run. As shown by Fig. 4, changes in relative prices play a crucial role, as they are only partially offset by opposite movements in quantities. In addition, price adjustments allow lower-pass through regimes to limit the accumulation of foreign debt, hence the amount of negative interest payments, when the country records a CAB deficit. If the pass-through coefficient is low enough, the recovery is not hindered by the foreign debt burden. Consequently, a new equilibrium position is rapidly achieved, despite (and, in fact, thanks to) stickier prices.

4.3 Stability issues and sensitivity tests

Our qualitative findings do not dependent on the parameter values chosen. Whatever the sum of price elasticities of import and export, low-pass through regimes are always associated with an improvement of the trade balance and consequently of the CAB, following currency devaluation (quadrant (a) in Fig. 5) and/or a fall in export (quadrant (b)). In fact, quadrant (b) shows that a high pass-through associated with a sum of price elasticities ≤ 1–triggers a destabilising tendency, in which the CAB of country A keeps worsening over time. The reason is the *excessive* depreciation of domestic currency. Up to a certain threshold, a fall in the exchange rate supports competiveness, thus rebalancing the TB. However, the growing external debt, associated with the falling exchange rate, brings about an increase in (net) interest payments. Besides, import value increases as the currency depreciates. If the pass-through is high enough, high debt service and costly imports trigger a self-feeding spiral that erodes the competiveness of country A and drains its income away.[21] As a result, not only is the MLC a poor approximation of the general terms or trade improvement condition; the full pass-through assumption that it is based upon (MLA: $u_1 = 0 \wedge v_1 = 1$) is, in fact, a destabilising condition. As such, it can only be a temporary situation, as it would be unsustainable for a country in the long run.

Despite the destabilising effects of the MLA, a model which incorporates it can still find a stable equilibrium as long as very high price elasticities of import and export are assumed (e.g.

[20] This is a feature of mainstream or neoclassical models, where perfect price flexibility allows achieving the optimal equilibrium of the economy. By contrast, dissenting economists "believe that unbridled prices – highly flexible prices – generate instability rather than stability", whereas "sticky prices with some inertia are more likely to generate stability" (Lavoie 2015, p. 25).

[21] The spiral can be described as follows: deterioration of CAB → currency depreciation → capital gains on foreign assets held by domestic households → increase in stock of wealth → increase in consumption → increase in import → further deterioration of CAB.

$\varepsilon_1 + \mu_1 \sim 1.5$ in our model). However, observed values are usually quite low.[22] In addition, this would affect the status of the MLC, which would be *a necessary but not sufficient condition* for the TB to improve following currency devaluation or depreciation. By contrast, incomplete pass-through coefficients, reflecting the strategic behaviour of exporting firms, always assure the stability of the model. In other words, while the MLC is a necessary but not sufficient condition for a stable recovery of the TB (if the MLA is maintained), it becomes *neither a necessary nor a sufficient* condition once the MLA is dropped (see Fig. 5 and Fig. 6). Alternatively, the destabilising effects of the MLA can be countered by setting interest rates at a very low level (below 1.5% ca in our model). This would allow keeping debt service under control. However, once again, this assumption would be at odds with the empirical evidence, as the average world interest rate on medium-long term government bonds is usually much higher than that.[23] Condition (5*ter*) is also not necessary. Table 2 shows that the TB improves following a shock to the exchange rate (or to export) even when (5*bis*) and (5*ter*) are not met, provided that condition (5) is.

5. Conclusions

This paper has derived the general equilibrium condition for the terms of trade in a two-country economy model, under both a fixed and a floating exchange rate regime. We have shown that the MLC is only a special case, in which a full exchange rate pass-through to import prices is assumed. In fact, the MLC is not even a 'useful approximation' of the general condition. The point is that the complete pass-through assumption has destabilising effects, when it is introduced in a fully stock-flow consistent model. More generally, the higher (lower) the pass-through, the slower (quicker) the adjustment of the economy to the equilibrium. This is tantamount to saying that the speed of adjustment is a positive function of the strategic behaviour of the exporting firms. The latter attempt to retain their market share by keeping their foreign currency-denominated prices unchanged.[24] For this reason sticky prices of exported products are stabilising, whereas non-strategic prices are destabilising. Besides, this could explain why devaluations are still quite popular despite the empirical evidence of low price elasticities of export and import worldwide. For the revised condition does not require the sum of their absolute values to be higher than one to make devaluations (or depreciations following negative shocks) convenient in the medium run.

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[22] For instance, Bahmani et al. (2013) estimate price elasticity for the UK being 0.82064 (sum of the absolute value of import and export elasticities). We refer again the reader to Section 2.

[23] Notice that, if the interest rate is negligible, there is no longer any effect of historical stocks (notably, the stock of public debt held by foreign households) on current flows (notably, the flow of interest payments from country A to country B), which is one of the main channels through which wealth inequality affects the economy.

[24] Analogously, firms based in the other country – meaning, the country whose currency depreciates – can make extra-profits just stabilising the price of their products in foreign markets.

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Tables and charts

Figure 1. Fixed exchange rate: negative shock under different pass-through regimes (with: $\varepsilon_1 + \mu_1 = 1$)

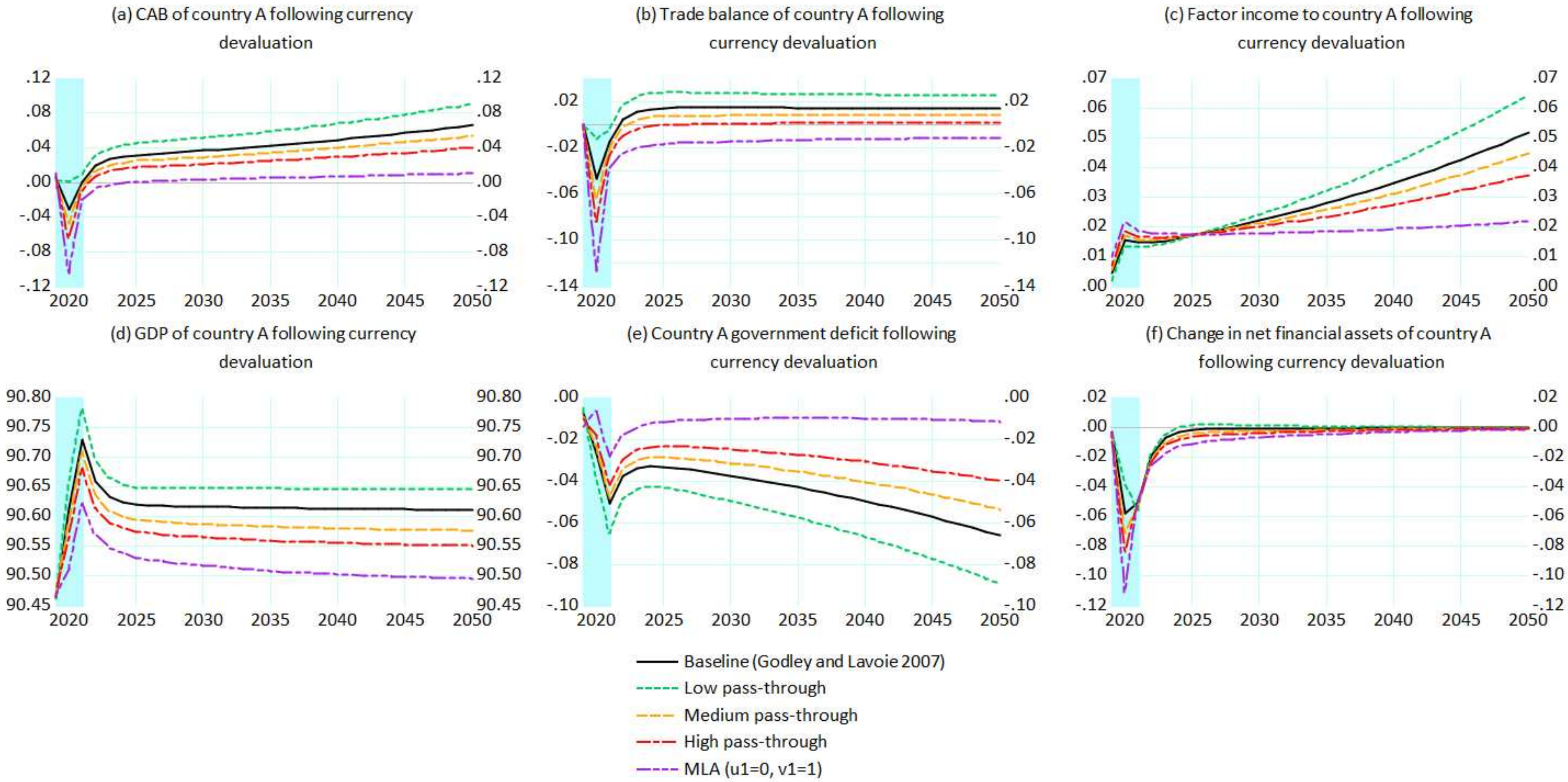

Figure 2. Fixed exchange rate: change in prices following negative shock to the exchange rate under different pass-through regimes (with: $\varepsilon_1 + \mu_1 = 1$)

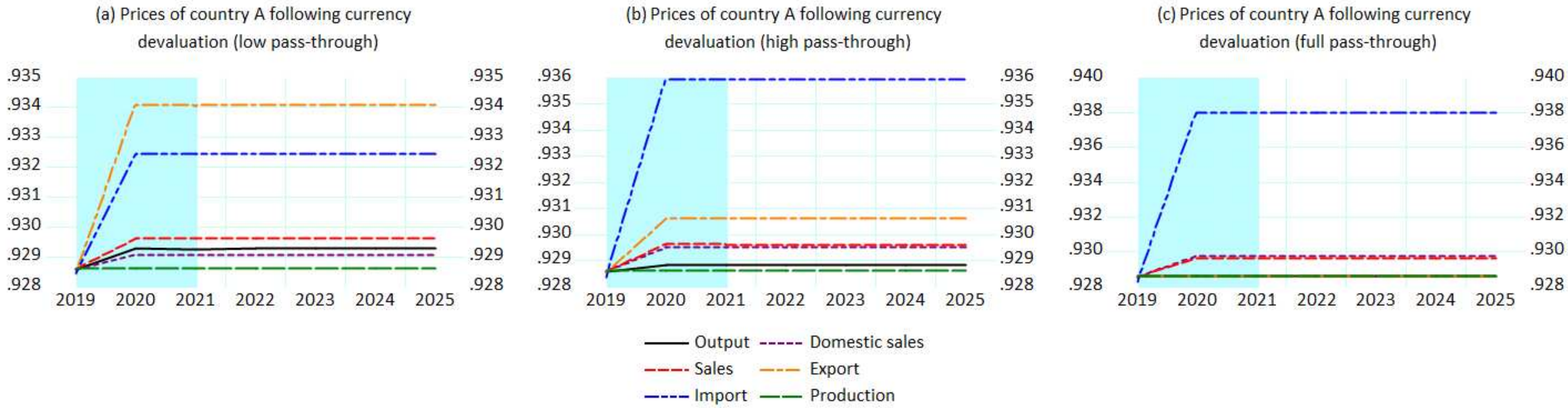

Figure 3. Floating exchange rate: negative shock to export under different pass-through regimes (with: $\varepsilon_1 + \mu_1 = 1$)

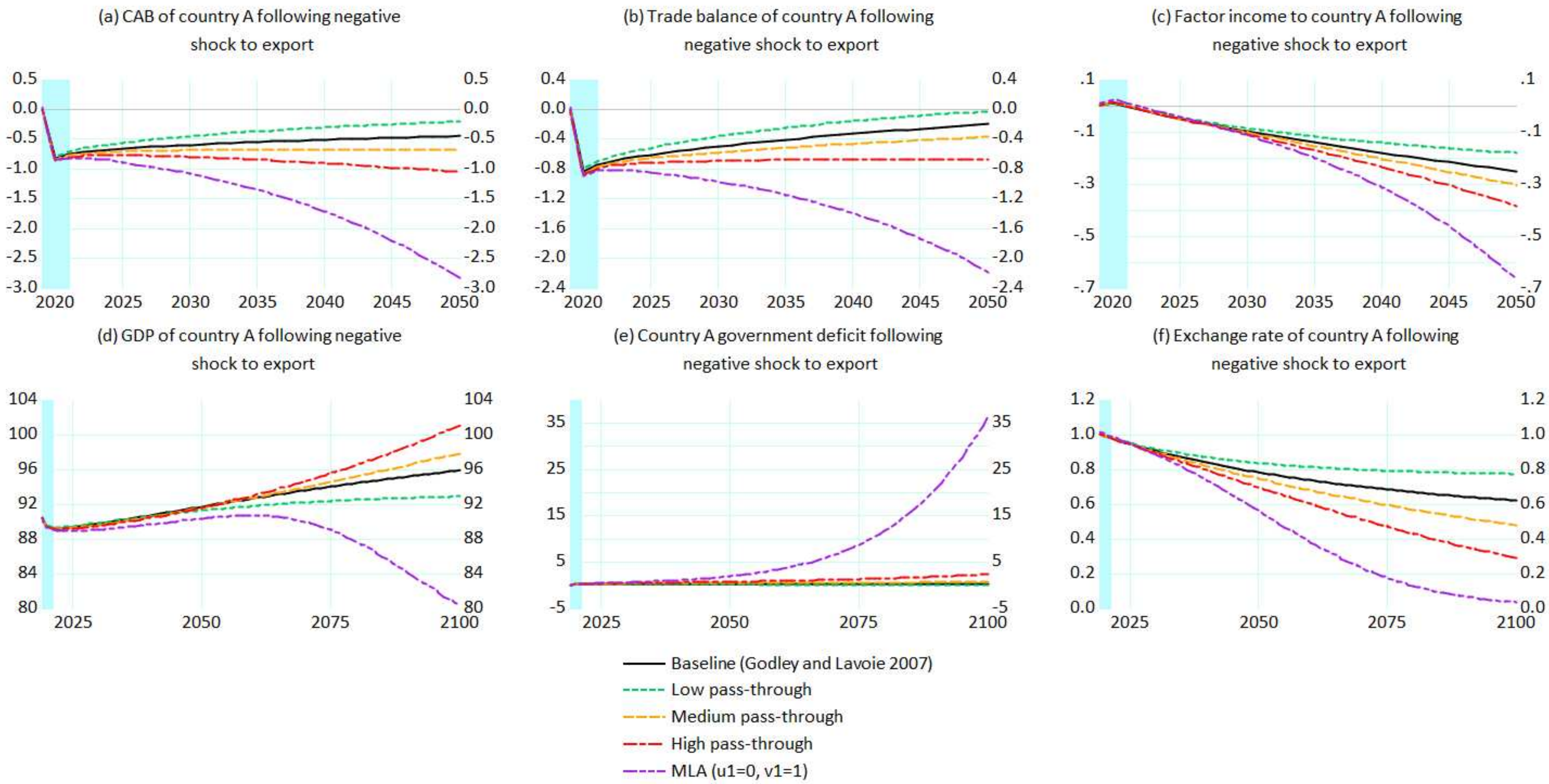

Figure 4. Floating exchange rate: change in prices following negative shock to export under different pass-through regimes (with: $\varepsilon_1 + \mu_1 = 1$)

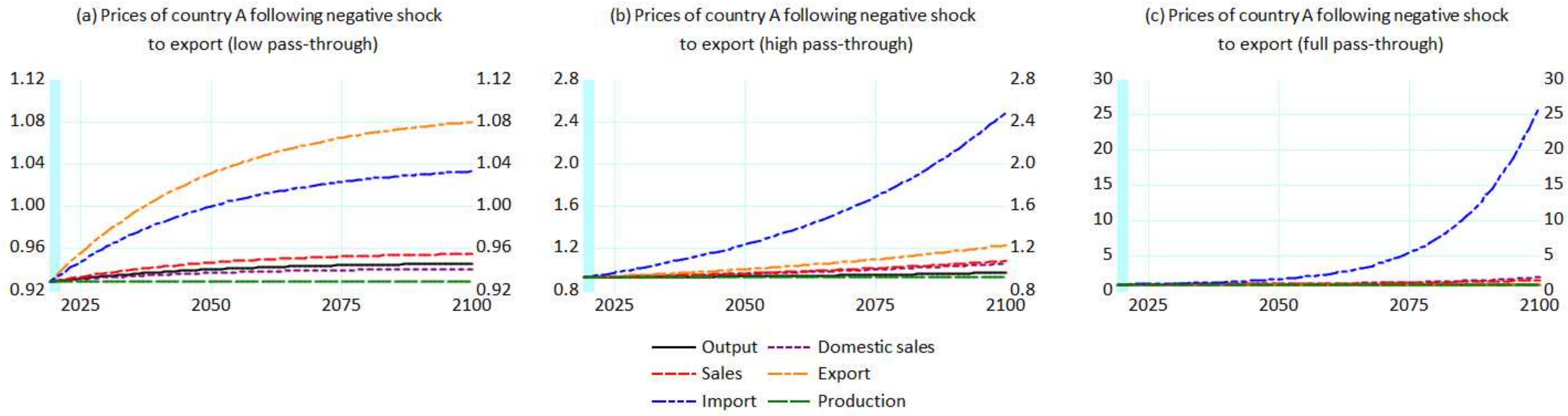

Figure 5. Sensitivity test: different combinations of pass-through coefficients and price elasticities of import and export

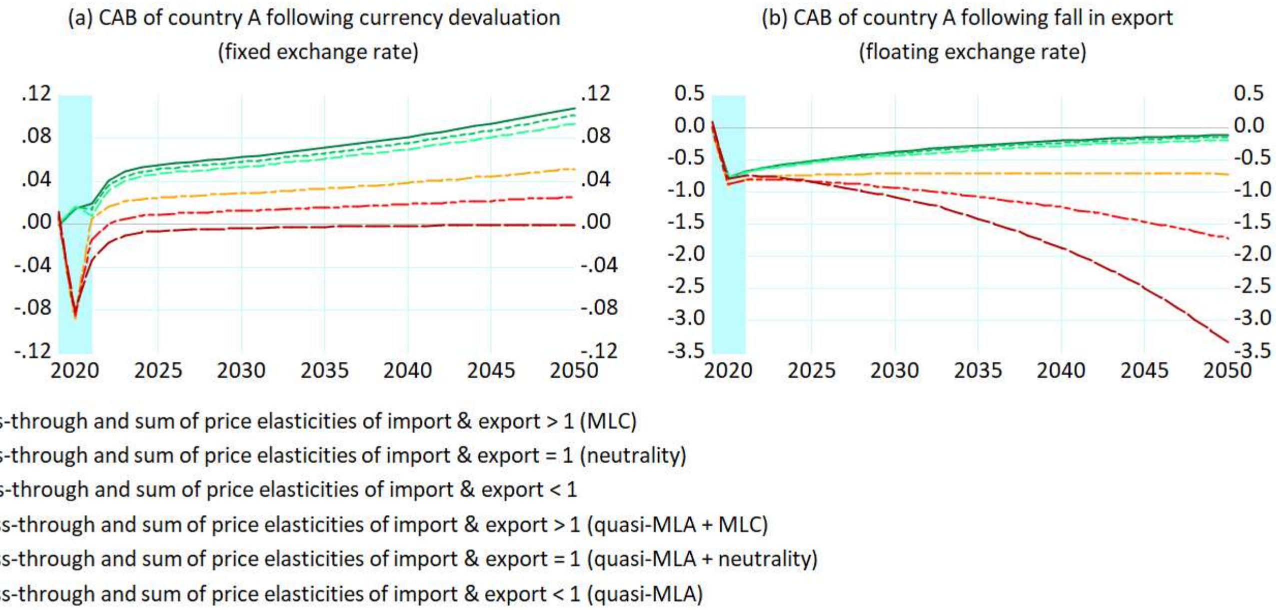

Figure 6. Sensitivity test: MLA and different price elasticities of import and export

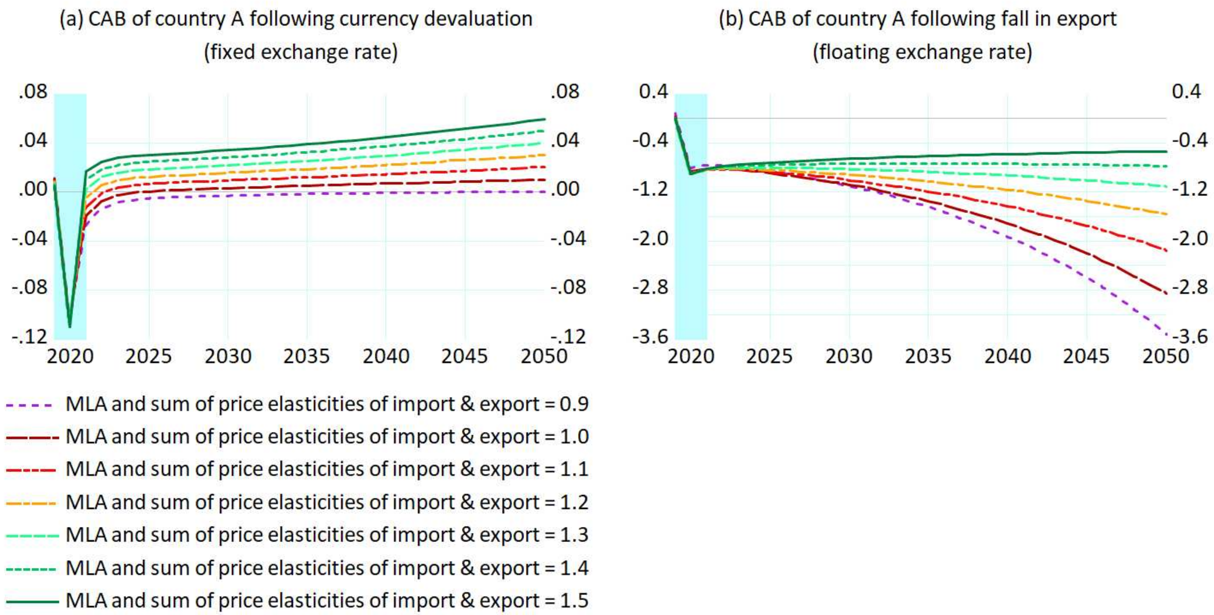

Table 1. Comparison between standard open-economy models and SFC models

Main differences	**Neoclassical-like models**	**SFC models**
Perfect capital mobility	Yes	Yes
Perfect asset substitutability	Yes	No
Short-run interest rate	Determined by income and supply of money	Set by the Central Bank
Long-run interest rate	(Uncovered) interest rate parity	Set by the Central Bank
Compensation mechanism	No	Yes
Influence of trade flows on exchange rate	Negligible	Relevant
International accounting consistency (non-financial transactions do not affect the financial account)	No	Yes
Pass-through of exchange rate variations on import prices	Complete	Partial
Condition for a positive impact of exchange rate depreciation on trade balance	Marshall-Lerner condition: $\varepsilon + \mu > 1$	Implicit condition: $\varepsilon_1 \cdot (1 - u_1) + \mu_1 \cdot v_1 > v_1 - u_1$
Other differences*	**Neoclassical-like models**	**SFC models**
Control of monetary policy under fixed exchange rates regime	No	Yes
Nature of money (degree of endogeneity)	Supply-led under fixed exchange rate regime	Always demand-led
Effectiveness of fiscal policy under flexible exchange rate regime	No	Yes
Consequence of expansionary fiscal policy on domestic currency	Appreciation	Depreciation

* Differences that do not affect models' reactions to shocks to exchange rate and export

Table 2. Value of pass-through coefficients under different scenarios and model's reactions to shocks

Scenarios (strength of pass-through)	Coefficient values	TB Improvement conditions			Medium-run responses of TB following shocks*	
		Equation (5) $[\varepsilon_1 \cdot (1-u_1)+\mu_1 \cdot v_1 > v_1 - u_1]$	Equation (5*bis*) [MLC: $\varepsilon + \mu > 1$]	Equation (5*ter*) $[\varepsilon + \mu > v_1 - u_1]$	To exchange rate (fixed exchange rate)	To export (floating exchange rate)
Baseline	$u_1 = 0.5, v_1 = 0.7$	Met	Not met (neutrality)	Not met	CAB and TB better off	Both stable
Very low	$u_1 = 0.7, v_1 = 0.3$	Met	Not met (neutrality)	Not met	CAB and TB better off	Both stable
Low	$u_1 = 0.6, v_1 = 0.4$	Met	Not met (neutrality)	Not met	CAB and TB better off	Both stable
Fairly Low	$u_1 = 0.4, v_1 = 0.6$	Met	Not met (neutrality)	Not met	CAB and TB better off	Both stable
Medium	$u_1 = 0.3, v_1 = 0.7$	Met	Not met (neutrality)	Not met	CAB and TB better off	Both stable
High	$u_1 = 0.2, v_1 = 0.8$	Met	Not met (neutrality)	Not met	CAB and TB better off	TB almost stabilises but CAB does not
Very High	$u_1 = 0.1, v_1 = 0.9$	Met	Not met (neutrality)	Not met	CAB better off but TB worse off	Neither stabilise
MLA	$u_1 = 0, v_1 = 1$	Not met (neutrality)	Not met (neutrality)	Not met (neutrality)	CAB unchanged but TB worse off	Neither stabilise

Note: we assume that $\varepsilon = 0.5$ and $\mu = 0.5$ in simulations displayed by Fig. 1 to 6. * Medium run = 30 periods after the shocks.

Table 3. Balance sheet of the two-country economy

	Country A					Country B				
	Households	**Firms**	**Government**	**Central bank**		**Households**	**Firms**	**Government**	**Central bank**	**Σ**
Money (cash)	$+H_h^A$			$-H_s^A$		$+H_h^B$			$-H_s^B$	0
A gov. bills	$+B_d^A$		$-B_s^A$	$+B_{cb}^{AA}$		$+B_d^{BA} \cdot xr_A$				0
B gov. bills	$+B_d^{AB} \cdot xr_B$			$+B_{cb}^{AB} \cdot xr_B$	$\cdot\, xr_A$	$+B_d^{BB}$		$-B_s^B$	$+B_{cb}^{BB}$	0
Gold				$+or^A \cdot p_g^A$					$+or^B \cdot p_g^B$	$+\Sigma or^B \cdot p_g^B$
Balance (net worth)	$-V_h^A$		$-NW_g^A$	$-NW_{cb}^A$		$-V_h^B$		$-NW_g^B$	0	$-\Sigma or^B \cdot p_g^B$
Σ	0		0	0		0	0	0	0	0

Notes: A '+' before a magnitude denotes an asset, whereas '–' denotes a liability.

Table 4. Transactions-flow matrix of the two-country economy

	Country A					Country B				
	Households	**Firms**	**Government**	**Central bank**		**Households**	**Firms**	**Government**	**Central bank**	**Σ**
Consumption	$-C_A$	$+C_A$				$-C_B$	$+C_B$			0
Conv. gov. spend.		$+G_A$	$-G_A$				$+G_B$	$-G_B$		0
A exports to B		$+X_A$					$+X_B$			0
B exports to A		$-IM_A$					$-IM_B$			0
GDP	Y_A	$-Y_A$			$\cdot xr_A$	$+Y_B$	$-Y_B$			0
Taxes	$-T_A$		$+T_A$			$-T_B$		$+T_B$		0
Interests on A bills	$+r_{A,-1} \cdot B^{AA}_{d,-1}$		$-r_{A,-1} \cdot B^{A}_{s,-1}$	$+r_{A,-1} \cdot B^{AA}_{cb,-1}$		$+r_{A,-1} \cdot B^{BA}_{d,-1} \cdot xr_A$				0
Interests on B bills	$+r_{B,-1} \cdot B^{AB}_{d,-1} \cdot xr_B$					$+r_{B,-1} \cdot B^{BB}_{d,-1}$		$-r_{B,-1} \cdot B^{B}_{s,-1}$	$+r_{B,-1} \cdot B^{BB}_{cb,-1}$	0
CB profits			$+F^A_{cb}$	$-F^A_{cb}$				$+F^B_{cb}$	$-F^B_{cb}$	0
Δ in cash	$-\Delta H^A_h$			$+\Delta H^A_s$		$-\Delta H^B_h$			$+\Delta H^B_s$	0
Δ in A bills	$-\Delta B^{AA}_d$		$+\Delta B^A_s$	$-\Delta B^{AA}_{cb}$	$\cdot xr_A$	$-\Delta B^{BA}_d \cdot xr_A$				0
Δ in B bills	$-\Delta B^{GB}_d \cdot xr_B$					$-\Delta B^{BB}_d$		$+\Delta B^B_s$	$-\Delta B^{BB}_{cb}$	0
Δ in gold				$-or^A \cdot p^A_g$					$-or^B \cdot p^B_g$	0
Σ	0	0	0	0		0	0	0	0	0

Notes: A '+' before a magnitude denotes a receipt or a source of funds, whereas '–' denotes a payment or a use of funds.

Appendix A. Key to symbols

I. Macroeconomic Variables

YD_r^A = Regular disposable income of *A*

YD_r^B = Regular disposable income of *B*

Y^A = Nominal income of *A* (GDP at current prices)

Y^B = Nominal income of *B* (GDP at current prices)

B_{As}^A = *A* bills held by *A* households

B_{As}^B = *B* bills held by *A* households

B_{Bs}^B = *B* bills held by *B* households

B_{Bs}^A = *A* bills held by *B* households

xr^A = Exchange rate of *A* (value of *A* currency in terms of *B* currency)

xr^B = Exchange rate of *B* (value of *B* currency in terms of *A* currency)

YD_{hs}^A = *A* households Haig-Simons disposable income (nominal terms)

YD_{hs}^B = *B* households Haig-Simons disposable income (nominal terms)

V^A = *A* households' private wealth

V^B = *B* households' private wealth

T^A = Taxes paid by *A* households

T^B = Taxes paid by *B* households

F_{cb}^A = *A* Central Bank's profits

F_{cb}^B = *B* Central Bank's profits

B_s^A = *A* public debt (total *A* bills issued)

B_s^B = *B* public debt (total *B* bills issued)

TB^A = *A* trade balance

TB^B = *B* trade balance

$FINC^A$ = *A* factor income

$FINC^B$ = *B* factor income

DEF^A = Deficit of government *A*

DEF^B = Deficit of government *B*

$NAFA^A$ = Net financial asset accumulation of *A*

$NAFA^B$ = Net financial asset accumulation of *B*

CAB^A = *A* current account balance

CAB^B = *B* current account balance

X^A = *A* exports (nominal terms)

X^B = *B* exports (nominal terms)

IM^A = *A* imports (nominal terms)

IM^B = *B* imports (nominal terms)

KAB^A = *A* financial account balance

KAB^B = *B* financial account balance

or^A = *A* gold reserves

or^B = *B* gold reserves

p_g^A = Price of gold in *A*

p_g^B = Price of gold in *B*

p_m^A = *A* import prices

p_x^A = *A* export prices

p_m^B = *B* import prices

p_x^B= *B* export prices

p_{ymade}^A = Production price of "made in *A*" goods

p_{ymade}^B = Production price of "made in *B*" goods

p_y^A = Output deflator in *A*

p_y^B = Output deflator in *B*

p_{ds}^A = *A* price of domestic sales

p_{ds}^B = *B* price of domestic sales

p_s^A = Average price of all sales in *A*

p_s^B = Average price of all sales in B

x^A = *A* exports (real terms)

im^A = *A* imports (real terms)

x^B = *B* exports (real terms)

im^B = *B* imports (real terms)

v^A = *A* households private wealth (real terms)

v^B = *B* households private wealth (real terms)

yd_{hs}^A = *A* households Haig-Simons disposable income (real terms)

yd_{hs}^B = *B* households Haig-Simons disposable income (real terms)

c^A = *A* real consumption

c^B = *B* real consumption

yd^A_{hse}= *A* households Haig-Simons expected disposable income (real terms)

yd^B_{hse}= *A* households Haig-Simons expected disposable income (real terms)

s^A = Total volume of sales in A

s^B = Total volume of sales in B

g^A = *A* pure government expenditure (real terms)

g^B = *A* pure government expenditure (real terms)

S^A = Value of sales in *A*

S^B = Value of sales in B

N^A = Employment level in *A*

N^B = Employment level in *B*

DS^A = *A* domestic sales value

DS^B = *B* domestic sales value

ds^A = *A* domestic sales volume

ds^B = *B* domestic sales volume

Y^A = Nominal *A* GDP

Y^B = Nominal *B* GDP

y^A = Real *A* GDP

y^B = Real *B* GDP

C^A = Value of consumption in *A*

C^B = Value of consumption in B

pr^A = *A* productivity (output per worker)

pr^B = *B* productivity (output per worker)

B^A_{Ad}= Demand for *A* bills by *A* households

B^B_{Ad}= Demand for *B* bills by *A* households

B^B_{Bd}= Demand for *B* bills by *B* households

B^A_{Bd}= Demand for *A* bills by *B* households

H^A_h = Money held by *A* households

H^B_h = Money held by *B* households

H^A_s = *A* money supply

H^B_s = *B* money supply

B^A_{cbAs} = *A* bills held by *A* central bank

B^B_{cbBs} = *B* bills held by *B* central bank

B^A_{cbAd} = Demand for *A* bills by *A* central bank

B^B_{cbBd} = Demand for *B* bills by *B* central bank

II. Exogenous variables

G^A = *A* pure government expenditure (nominal terms)

G^B = *B* pure government expenditure (nominal terms)

W^A = Wage rate in A

W^B = Wage rate in B

r^A = Interest rate on *A* bills

r^B = Interest rate on *B* bills

III. Model Parameters

θ^A = *B* tax rate

θ^B = *B* tax rate

v_0 = First parameter of *A* import prices equation

v_1 = Second parameter of *A* import prices equation

u_0 = First parameter of *A* export prices equation

u_1 = Second parameter of *A* export prices equation

ε_0 = Constant of the *A* export equation

ε_1= Elasticity of *A* exports with respect to *B* import prices relative to prices of made in *B* goods

ε_2 = Elasticity of *A* export with respect to *B* output

μ_0 = Constant of *A* import equation

μ_1 = Elasticity of *A* imports with respect to *A* import prices relative to prices of made in *A* goods

μ_2 = Elasticity of *A* import with respect to *A* output

α_1^A = *A* propensity to consume out of income

α_1^B = *B* propensity to consume out of income

α_2^A = *A* propensity to consume out of wealth

α_2^B = *B* propensity to consume out of wealth

φ^A = Mark-up on unit cost in *A*

φ^B = Mark-up on unit cost in *B*

λ_{ij}= Portfolio equations parameters

Appendix B. Derivation of the general condition for the trade balance to improve following currency depreciation

Recalling the properties of exponential transformations, equations (3) and (4) can be rearranged as follows:

$$x^A = \varepsilon_3 \cdot \left(\frac{p^B_{m,-1}}{p^B_{y,-1}}\right)^{-\varepsilon_1} \cdot y^{A^{\varepsilon_2}}$$

$$im^A = \mu_3 \cdot \left(\frac{p^A_{m,-1}}{p^A_{y,-1}}\right)^{-\mu_1} \cdot y^{A^{\mu_2}}$$

where $\varepsilon_3 = e^{\varepsilon_0}$ and $\mu_3 = e^{\mu_0}$. Besides, using $p^{\mathrm{B}}_m = p^{\mathrm{A}}_x \cdot xr^{\mathrm{A}}$ and taking the first differences of equations above, we obtain:

$$\dot{x}^A = -\varepsilon_1 \cdot \left(\dot{p}^A_{x,-1} + \dot{xr}^A_{-1} - \dot{p}^B_{y,-1}\right) + \varepsilon_2 \cdot \dot{y}^B$$

$$\dot{im}^A = -\mu_1 \cdot \left(\dot{p}^A_{m,-1} - \dot{p}^A_{y,-1}\right) + \mu_2 \cdot \dot{y}^A$$

As we are looking for the steady-state solution, we can drop the lags from equations above:

$$\dot{x}^A = -\varepsilon_1 \cdot \left(\dot{p}^A_x + \dot{xr}^A - \dot{p}^B_y\right) + \varepsilon_2 \cdot \dot{y}^B \quad (3bis)$$

$$\dot{im}^A = -\mu_1 \cdot \left(\dot{p}^A_m - \dot{p}^A_y\right) + \mu_2 \cdot \dot{y}^A \quad (4bis)$$

Starting from a balanced position, the (percentage) change in the trade balance of country A over the level of import or export is approximately[25]:

$$\dot{TB} = (\dot{p}^A_x + \dot{x}^A) - (\dot{p}^A_m + \dot{im}^A)$$

Using (1*bis*), (2*bis*), (3*bis*) and (4*bis*) in $\dot{TB}$, we obtain:

$$\dot{TB} = -u_1 \cdot \dot{xr}^A + \varepsilon_1 \cdot u_1 \cdot \dot{xr}^A + v_1 \cdot \dot{xr}^A - \mu_1 \cdot v_1 \cdot \dot{xr}^A - \varepsilon_1 \cdot \dot{xr}^A + (1-u_1) \cdot \dot{p}^A_y + u_1 \cdot \dot{p}^B_y - \varepsilon_1 \cdot u_0 - \varepsilon_1 \cdot (1-u_1) \cdot \dot{p}^A_y - \varepsilon_1 \cdot u_1 \cdot \dot{p}^B_y + \varepsilon_1 \cdot \dot{p}^B_y + \varepsilon_2 \cdot \dot{y}^B - (1-v_1) \cdot \dot{p}^A_y - v_1 \cdot \dot{p}^B_y + \mu_1 \cdot v_0 + \mu_1 \cdot (1-v_1) \cdot \dot{p}^A_y + \mu_1 \cdot v_1 \cdot \dot{p}^B_y - \mu_1 \cdot \dot{p}^A_y - \mu_2 \cdot \dot{y}^A$$

Taking the partial derivative of $\dot{TB}$ with respect to the exchange rate, we obtain:

$$\frac{\partial \dot{TB}}{\partial \dot{xr}^A} = -u_1 + \varepsilon_1 \cdot u_1 + v_1 - \mu_1 \cdot v_1 - \varepsilon_1 = DTB$$

It is now easy to verify that: $DTB < 0 \;\; iff \;\; \varepsilon_1 \cdot (1-u_1) + \mu_1 \cdot v_1 > v_1 - u_1$.

[25] Obviously, import matches export in a balanced position. In principle, the most accurate definition of the percentage change of the trade balance is: $\Delta TB/TB_{-1}$, with: $TB = X - M$. However, its value is undefined under the initial condition of a balanced trade balance ($TB = 0$). This is the reason we use the definition above.

Appendix C. Model equations

I. Accounting identities

$YD_r^A = Y^A + r_{-1}^A B_{As-1}^A + r_{-1}^B B_{As-1}^B xr^B - T^B$ (C1)

$YD_{hs}^A = YD_r^A + \Delta xr^B B_{As-1}^B$ (C2)

$\Delta V^A = (YD_r^A - C^A) + \Delta xr^B B_{As-1}^B$ (C3)

$YD_r^B = Y^B + r_{-1}^B B_{Bs-1}^B + r_{-1}^A B_{Bs-1}^B xr^A - T^A$ (C4)

$YD_{hs}^B = YD_r^B + \Delta xr^A B_{Bs-1}^A$ (C5)

$\Delta V^B = (YD_r^B - C^B) + \Delta xr^A B_{Bs-1}^A$ (C6)

$T^A = \theta^A (Y^A + r_{-1}^A B_{As-1}^A + r_{-1}^B B_{As-1}^B xr^B)$ (C7)

$T^B = \theta^B (Y^B + r_{-1}^B B_{Bs-1}^B + r_{-1}^A B_{As-1}^A xr^A)$ (C8)

$F_{cb}^A = r_{-1}^A B_{cbAs-1}^A + r_{-1}^B B_{cbAs-1}^B xr^B$ (C9)

$F_{cb}^B = r_{-1}^B B_{cbBs-1}^B$ (C10)

$\Delta B_s^A = G^A - T^A + r_{-1}^A B_{As-1}^A - F_{cb}^A$ (C11)

$\Delta B_s^B = G^B - T^B + r_{-1}^B B_{Bs-1}^B - F_{cb}^B$ (C12)

$TB^A = X^A - IM^A$ (C13)

$TB^B = X^B - IM^B$ (C14)

$FINC^A = r_{-1}^B B_{As-1}^B xr^B - r_{-1}^A B_{Bs-1}^A + r_{-1}^B B_{cbAs-1}^B xr^B$ (C15)*

$FINC^B = r_{-1}^A B_{Bs-1}^A xr^A - r_{-1}^B B_{As-1}^B - r_{-1}^B B_{cbAs-1}^B$ (C16)*

$CAB^A = TB^A + FINC^A$ (C17)

$CAB^B = TB^B + FINC^B$ (C18)

$KAB^A = \Delta B_{Bs}^A - \Delta B_{As}^B xr^B - (\Delta B_{cbAs-1}^B xr^B + \Delta or^A p_g^A)$ (C19)

$KAB^B = \Delta B_{As}^B - \Delta B_{Bs}^A xr^a - \Delta or^B p_g^B$ (C20)

II. International trade equations

$log(p_m^A) = v_0 - v_1 \cdot log(xr^A) + (1 - v_1) \cdot log(p_{ymade}^A) + v_1 \cdot log(p_{ymade}^B), \quad 0 < v_1 < 1$ (C21)*

$log(p_x^A) = u_0 - u_1 \cdot log(xr^B) + (1 - u_1) \cdot log(p_{ymade}^A) + u_1 \cdot log(p_{ymade}^B), \quad 0 < u_1 < 1$ (C22)*

$log(x^A) = \varepsilon_0 - \varepsilon_1 \cdot [log(p_{m-1}^B) - log(p_{ymade,-1}^B)] + \varepsilon_2 \cdot log(y^B)$ (C23)*

$log(im^A) = \mu_0 - \mu_1 \cdot [log(p_{m-1}^A) - log(p_{ymade,-1}^A)] + \mu_2 \cdot log(y^A)$ (C24)*

$p_x^B = p_m^A xr^A$ (C25)

$p_m^B = p_x^A xr^A$ (C26)

$x^B = im^A$ (C27)

$im^B = x^A$ (C28)

$$X^A = x^A p_x^A \tag{C29}$$

$$X^B = x^B p_x^B \tag{C30}$$

$$IM^A = im^A p_m^A \tag{C31}$$

$$IM^B = im^B p_m^B \tag{C32}$$

III. Income and expenditure

$$v^A = \frac{V^A}{p_{ds}^A} \tag{C33}$$

$$v^B = \frac{V^B}{p_{ds}^B} \tag{C34}$$

$$yd_{hs}^A = \frac{YD_r^A}{p_{ds}^A} - \Delta p_{ds}^A \frac{V_{-1}^A}{p_{ds}^A} + \frac{\Delta xr^B B_{As-1}^B}{p_{ds}^A} = \frac{YD_{hs}^A}{p_{ds}^A} - \Delta p_{ds}^A \frac{V_{-1}^A}{p_{ds}^A} \qquad \text{(C35)*}$$

$$yd_{hs}^B = \frac{YD_r^B}{p_{ds}^B} - \Delta p_{ds}^B \frac{V_{-1}^B}{p_{ds}^B} + \frac{\Delta xr^A B_{Bs-1}^A}{p_{ds}^B} = \frac{YD_{hs}^B}{p_{ds}^B} - \Delta p_{ds}^A \frac{V_{-1}^B}{p_{ds}^B} \qquad \text{(C36)*}$$

$$c^A = \alpha_1^A yd_{hse}^A + \alpha_2^A v_{-1}^A \tag{C37}$$

$$c^B = \alpha_1^B yd_{hse}^B + \alpha_2^B v_{-1}^B \tag{C38}$$

$$yd_{hse}^A = \left(yd_{hs}^A + yd_{hs-1}^A\right) \cdot 0.5 \tag{C39}$$

$$yd_{hse}^B = \left(yd_{hs}^B + yd_{hs-1}^B\right) \cdot 0.5 \tag{C40}$$

$$s^A = c^A + g^A + x^A \tag{C41}$$

$$s^B = c^B + g^B + x^B \tag{C42}$$

$$S^A = s^A p_s^A \tag{C43}$$

$$S^\$ = s^\$ p_s^\$ \tag{C44}$$

$$p_{ymade}^A = (1 + \varphi^A) \cdot \frac{W^A N^A}{s^A - im^A} \qquad \text{(C45)*}$$

$$p_{ymade}^B = (1 + \varphi^B) \cdot \frac{W^B N^B}{s^B - im^B} \qquad \text{(C46)*}$$

$$p_s^A = p_{ymade}^A \cdot \frac{s^A - im^A - x^A}{s^A} + p_m^A \cdot \frac{im^A}{s^A} + p_x^A \cdot \frac{x^A}{s^A} \qquad \text{(C47)*}$$

$$p_s^B = p_{ymade}^B \frac{s^B - im^B - x^B}{s^B} + p_m^B \cdot \frac{im^B}{s^B} + p_x^B \cdot \frac{x^B}{s^B} \qquad \text{(C48)*}$$

$$p_{ds}^A = \frac{S^A - X^A}{s^A - x^A} \tag{C49}$$

$$p_{ds}^B = \frac{S^B - X^B}{s^B - x^B} \tag{C50}$$

$$DS^A = S^A - X^A \tag{C51}$$

$$DS^B = S^B - X^B \tag{C52}$$

$$ds^A = s^A - x^A \tag{C53}$$

$$ds^B = s^B - x^B \tag{C54}$$

$$Y^A = S^A + IM^A \tag{C55}$$

$$Y^B = S^B + IM^B \quad \text{(C56)}$$

$$y^A = s^A + im^A \quad \text{(C57)}$$

$$y^B = s^B + im^B \quad \text{(C58)}$$

$$p_y^A = \frac{Y^A}{y^A} \quad \text{(C59)}$$

$$p_y^B = \frac{Y^B}{y^B} \quad \text{(C60)}$$

$$C^A = c^A p_{ds}^A \quad \text{(C61)}$$

$$C^B = c^B p_{ds}^B \quad \text{(C62)}$$

$$G^A = g^A p_{ds}^A \quad \text{(C63)}$$

$$G^B = g^B p_{ds}^B \quad \text{(C64)}$$

$$N^A = \frac{y^A}{pr^A} \quad \text{(C65)}$$

$$N^B = \frac{y^B}{pr^B} \quad \text{(C66)}$$

IV. Demands for financial assets

$$B_{Ad}^A = V^A \cdot (\lambda_{10} + \lambda_{11} \cdot r^A - \lambda_{12} \cdot r^B) \quad \text{(C67)}$$

$$B_{Ad}^B = V^A \cdot (\lambda_{20} + \lambda_{21} \cdot r^A - \lambda_{22} \cdot r^B) \quad \text{(C68)}$$

$$B_{Bd}^B = V^B \cdot (\lambda_{40} + \lambda_{41} \cdot r^B - \lambda_{42} \cdot r^A) \quad \text{(C69)}$$

$$B_{Bd}^A = V^B \cdot (\lambda_{50} + \lambda_{51} \cdot r^B - \lambda_{52} \cdot r^A) \quad \text{(C70)}$$

$$H_h^A = V^A - B_{As}^A - B_{As}^B xr^B \quad \text{(C71)*}$$

$$H_h^B = V^B - B_{Bs}^B - B_{BS}^A xr^A \quad \text{(C72)*}$$

V. Supplies of financial assets

$$H_s^A = H_h^A \quad \text{(C73)*}$$

$$B_{As}^A = B_{Ad}^A \quad \text{(C74)}$$

$$B_{cbAs}^A = B_{cbAd}^A \quad \text{(C75)}$$

$$H_s^B = H_h^B \quad \text{(C76)*}$$

$$B_{Bs}^B = B_{Bd}^B \quad \text{(C77)}$$

$$B_{cbBs}^B = B_{cbBd}^B \quad \text{(C78)}$$

$$\Delta B_{cbAd}^A = \Delta H_s^A - \Delta B_{cbAs}^A - \Delta or^A p_g^A \quad \text{(C79)}$$

$$B_{cbBd}^B = H_s^B - or^B p_g^B \quad \text{(C80)}$$

$$p_g^A = p_g^B xr^B \quad \text{(C81)}$$

$$xr^A = \overline{xr}^A \quad \text{(C82)**}$$

$$xr^A = \frac{B^B_{As}}{B^B_{Ad}}$$ (C82b)***

$$xr^B = \frac{1}{xr^A}$$ (C83)

$$B^A_{Bs} = B^A_{Bd} xr^B$$ (C84)

$$B^B_{cbAd} = B^B_{cbAs} xr^B$$ (C84b)

$$B^B_{As} = B^B_{Ad} \cdot xr^A$$ (C85)**

$$B^B_{As} = B^B_s - B^B_{Bs} - B^B_{cbBs} - B^B_{cbAs}$$ (C85b)***

$$B^B_{cbAs} = B^B_s - B^B_{Bs} - B^B_{cbBs} - B^B_{cbAs}$$ (C86)**

$$B^B_{cbAs} = \bar{B}^B_{cbAs}$$ (C86b)***

VI. Additional identities

$$DEF^A = G^A + r^A_{-1} B^A_{s,-1} - T^A - F^A_{cb}$$ (C87)

$$DEF^B = G^B + r^B_{-1} B^B_{s,-1} - T^B - F^B_{cb}$$ (C88)

$$NAFA^A = DEF^A + CAB^A$$ (C89)

$$NAFA^B = DEF^B + CAB^B$$ (C90)

VII. Redundant equation

$$B^A_{cbAs} = B^A_s - B^A_{As} - B^A_{Bs}$$

Notes: * key amendments or additions to original model by Godley and Lavoie (2007a); ** fixed exchange rate only; *** floating exchange rate only.