World macroeconomic adjustments are analysed with Stock Flow Consistent (SFC) models in the lines of Godley and Lavoie (2005) and Lavoie and Zhao (2010). Three SFC three-country models are considered, the first one with a fixed dollar-yuan parity including a version with Chinese foreign reserves’ diversification, the second with a flexible dollar-yuan parity which can be freely floating or following a more managed float, the third one being a generalisation of the two others with flexible prices instead of constant prices. The fixity of the dollar-yuan parity limits the adjustments facing shocks and world imbalances while a more flexible dollar-yuan exchange rate appears as a powerful adjustment mechanism to reduce these imbalances.

Résumé:
Les ajustements macroéconomiques au niveau mondial sont analysés en utilisant un modèle “stock flux cohérent” à trois pays dans la lignée de Godley et Lavoie (2007) et Zhao et Lavoie (2008). Trois versions sont considérées, la première avec une parité dollar-yuan fixe, mais pouvant inclure un comportement de diversification des réserves de la Banque Centrale chinoise, la seconde avec une parité dollar-yuan flexible selon un régime de flottement pur ou un régime plus administré, la troisième version étant une généralisation des deux précédentes avec des prix flexibles au lieu de prix fixes.
Face à des chocs la fixité de la parité du yuan limite la réduction des déséquilibres mondiaux au bénéfice de la Chine et au détriment des États-Unis et de l’Europe. Une diversification des réserves de change chinoises modifie la nature des ajustements, surtout au détriment de l’Europe en raison de la dépréciation du dollar qui en résulte. La flexibilité de la parité dollar-yuan apparaît en revanche comme un moyen efficace pour réduire les déséquilibres. Si un flottement pur du yuan apparaît peu réaliste dans le contexte actuel, un régime de change plus administré de la parité yuan-dollar, où la Banque Centrale chinoise intervient pour atteindre une cible, soit de réserves de change, soit de balance courante, donne des mécanismes d’ajustement assez similaires. Enfin, le modèle avec des prix flexibles confirme les principaux résultats obtenus dans le cas des prix fixes.

Key words: Three-country model; world imbalances; dollar, euro, yuan exchange rates

JEL classification: F41, F42, F47

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1. **INTRODUCTION**

World imbalances have been increasing since the end of the 1990s with a large US current account deficit towards Asian surpluses, mainly Chinese and Japanese ones (figure 1). The European current account has remained close to equilibrium, but with huge intra-European imbalances. These imbalances are far larger than what had been observed in the past and can hardly be regarded as sustainable. They reflect internal imbalances in each area, mainly the over-indebtedness of US households and declining US competitiveness on the one hand, and the insufficient Chinese consumption on the other hand. These world imbalances have been lasting thanks to financial liberalization, which has made their financing easier. The actual financial crisis has been the consequence of these imbalances, starting with the US subprime mortgage market and getting diffused throughout the world. Since 2007 partial adjustments have been achieved, mainly through the impact of production decline, which has reduced imports of the deficit countries and cut the exports of the surplus countries, although Asian surpluses have remained huge.

Contrary to what was expected by many observers, world imbalances and, especially the US deficit, did not lead to large exchange rate adjustments with a dollar crisis. However, after the nominal appreciation of the dollar against the euro and the yen between 1995 and 2002, the dollar has depreciated significantly against the euro, but more moderately against the yen. It is well known that the yuan has remained pegged to the dollar since 1994 with only a limited amount of appreciation between 2005 and 2008 (figure 2). In real effective terms, evolutions are slightly different. The real depreciation of the dollar has been rather moderate between 2002 and 2008, with an inverse evolution of the euro and the yen. The euro has appreciated in sharp contrast to the real depreciation of the yen until 2007. Lastly the yuan has only slightly appreciated (figure 3).
Figure 1: Current account balances (in % of GDP)

![Graph showing current account balances over time for EU9, United States, Japan, and China.]

Source: IMF (2010 P)

Figure 2: Bilateral nominal exchange rates against the dollar (base 1 in 2000)

![Graph showing bilateral nominal exchange rates from 1980 to 2010 for Euro, Yen, and Yuan.]

Source: OECD (2010P)
These evolutions can contribute to explain the remaining world imbalances. The depreciation of the dollar has been too limited to have a sufficient impact on the US deficit. The yen’s real depreciation until 2008 and the persistency of a large undervaluation of the yuan have amplified the external surpluses of these two countries. In spite of a marked euro appreciation between 2002 and 2009 the European current account has been only moderately deteriorated due to the poor growth performance of the EU.

These global imbalances can be studied in various ways. World macroeconomic adjustments are usually analysed with the help of a general equilibrium model (Obstfeld and Rogoff, 2005) or with simpler portfolio models (Blanchard et al., 2005). These models provide an interesting analysis of the impact of exchange rates adjustments, the rates of return differential or the valuation effect. But these models can be criticized at different levels. In particular, they consider that all the adjustments are realised through relative prices with production and income remaining constant, which is rather unrealistic when a large dollar depreciation occurs. This hypothesis doesn’t fit at all with the sharp decline in real production that occurred during the global financial crisis. Stock-flow consistent (SFC) models along the lines of Godley and Lavoie (2007a, b) and Lavoie and Zhao (2010) are more appropriate, because they give a comprehensive description of the real and financial flows and stocks at the world level, can include most of ingredients of the previous models and do not presuppose that adjustments are limited to relative prices. However these SFC models don’t pretend to give an explanation of the current crisis.

The paper is organized as follows. A second section summarizes the theoretical background. A third section presents a SFC three-country model with the USA, China and the euro zone. Three versions will be considered. The first one, with fixed dollar-yuan parity, includes an active policy of the Chinese central bank regarding the diversification of its reserves. It is directly inspired by Lavoie and Zhao (2010). The second version, presented in the fourth section, has a flexible dollar-yuan parity, which can either be freely floating or be the result of a policy target of the Chinese Central Bank, based either on the level of the current account or on the desired level of foreign reserves. This version emphasises the role that a more flexible dollar-yuan parity could play to reduce world imbalances. The third version, presented in the fifth section, generalises the
previous results with a flexible-price model instead of a fixed-price one. The last section concludes.

Figure 3: Real effective exchange rates (base 1 in 2000)

Source: BIS

2. THEORETICAL BACKGROUND

Applied forecasting macroeconomic models pay little attention to the financial sector, due to the difficulty of modeling financial variables. At a more theoretical level, world macroeconomic adjustments are usually analysed with two kinds of models.

General equilibrium models (Obstfeld and Rogoff, 2005) give a representation of the world economy with a distinction between home and foreign produced traded goods and between traded and non-traded goods, using two or three countries. The general pattern of these models is based on traditional consumer choice theory, where the role of relative prices is formalized in great detail. In each market, supply and demand adjust through relative prices, with production assumed to remain constant. Using net foreign assets, current accounts can be computed for each country. Given the structure of gross assets and liabilities in each currency, valuation effects can be introduced. It is also possible to analyse the effects of changing interest rates. The model is used to evaluate different scenarios describing how the US current account can return to equilibrium thanks to exchange rate adjustments of the dollar, euro and yuan.
The model is rather powerful, as it can incorporate a whole set of effects (valuation effects, differentials in interest rates, traded and non-traded goods). One of the main results is the importance of the terms of trade between traded and non-traded goods, which are often underestimated in this kind of analysis. Conversely, the valuation effect seems less important than in other studies (Gourinchas and Rey, 2005). But the model suffers from several weaknesses. First, production levels are supposed to be given, which seems rather unrealistic with regards to the amplitude of exchange rate adjustments (around 30% in real terms, of even more) and considering the size of actual declines in production over the last few years. Second, the model is focused on the real sphere. The link with the financial sphere is realised only through a rigid matrix that describes the structure of assets and liabilities in each currency, without a consistent analysis of the stock-flow dynamics. Third, as it is usual in this kind of model, there is no analysis of the investment of firms. Last, the model is only in real terms. Inflation is introduced in a very simplified way, through the assumption that central banks control inflation rates.

A simpler portfolio model of exchange rate and current account (Blanchard et al., 2005) is only focused on the USA and the rest of world. Two equations are considered, one describing the portfolio balance, the second the current account balance, with two main variables: US net debt and the dollar exchange rate. The model incorporates valuation effects and, in an exogenous manner, the difference between US and foreign rates of return. The dollar devaluation necessary to return to a balanced US current account is evaluated (at around 40%) and alternative scenarios are built in. The model is more elegant and easier to manage than the previous one. But it suffers from the same weaknesses. Production is supposed to remain constant and all the adjustments are realised through relative prices. The description of financial variables is highly simplified with only one asset, the supply of which is taken as exogenous. As in the Obstfeld and Rogoff model, there is no real capital accumulation. With constant production and assets, international macroeconomic adjustments are analysed in an overly restrictive way. The integration between real and financial variables, although central in the core of the model, appears to be limited.
Stock-flow consistent (SFC) models along the lines of Godley and Lavoie (2005) and Lavoie and Zhao (2010) are more appropriate. They give a consistent analysis of the real and financial flows and stocks at the world level, with a comprehensive description of the main agents: households, firms, banks and government. Starting with two countries, the USA and the rest of the world, they have been enlarged to three countries to analyse US, European and Chinese imbalances. They can include most of ingredients of the previous models, such as valuation effects and differences between the rates of return. They do not assume that adjustments are limited to relative prices, since production is determined by aggregate demand, as in the Keynesian tradition. Exchange rates result from an explicit confrontation between the supply of and the demand for assets, although exchange rates require adjustments operating throughout the whole model. Fixed exchange rates can also be introduced. These SFC models resemble Taylor’s (2004) approach, but they do not include an additional exchange rate expectation equation. This is an important difference.

A SFC three country model will be considered in this paper. A comparison of two exchange rate regimes with fixed or adjustable dollar-yuan parity will show its key role for global rebalancing. This doesn’t exclude other mechanisms, such as reducing US demand or increasing Chinese domestic demand, which could be studied with this model but are not presented due to a lack of space. The introduction of flexible prices will try to appreciate the constraints induced by the yuan revaluation and the risk of deflation.

3. A THREE-COUNTRY MODEL WITH A FIXED DOLLAR-YUAN PARITY

The world economy is divided into three blocks: the USA, Europe (the euro area) and China. The dollar and the euro are floating while the yuan-dollar parity is fixed. Two kinds of assets are considered in each country, banking deposits and treasury bills, issued by each government and held by households and the banking sector of each country. Firms accumulate fixed capital and finance their investments by profit and credit. The wage share and prices are assumed to be constant. World adjustments are realised both through income and exchange rates. The model describes how the different parts of the world economy react to demand shocks (such as a decline in domestic demand) or supply shocks (a decline of competitiveness). The impact of a
change in the foreign reserves behaviour of the Chinese central bank, more precisely a
diversification of foreign reserves towards European bills, is also studied.

3.1. The structure of the model

Each area is composed of four sectors (households, firms, government and banks, the
latter sector including the central bank). Exchange rates are defined as 1$ = xr1€ = xr2¥
and 1€ = 1/xr1$ = xr3¥. Table 1 describes the balance sheet of each sector. National
accounts in flows are given in the appendix. In the following paragraphs equations are
written for only one country, with indications in case of national specificities. At this
stage of the work, the three countries are supposed very similar, except with regards to
exchange rate policy and central bank behaviour. More realistic hypotheses will be
introduced later

Table 1: The balance sheet of the three areas

<table>
<thead>
<tr>
<th></th>
<th>€ = euro area</th>
<th>$ = USA</th>
<th>¥ = China</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>F</td>
<td>Gov</td>
<td>CB</td>
</tr>
<tr>
<td>Capital</td>
<td>$K^€$</td>
<td>$L^€$</td>
<td>$M^€$</td>
</tr>
<tr>
<td>Money</td>
<td>$-M^€$</td>
<td>$M^$,</td>
<td>$-M^¥$</td>
</tr>
<tr>
<td>Bills €</td>
<td>$B^€_1, yr1$</td>
<td>$B^€_2, yr1$</td>
<td>$B^€_3, yr1$</td>
</tr>
<tr>
<td>Bills $</td>
<td>$B^$, yr1$</td>
<td>$B^$, yr1$</td>
<td>$B^$, yr1$</td>
</tr>
<tr>
<td>Bills ¥</td>
<td>$B^¥, yr1$</td>
<td>$B^¥, yr1$</td>
<td>$B^¥, yr1$</td>
</tr>
<tr>
<td>Loan</td>
<td>$-L^€$</td>
<td>$L^€$</td>
<td>$-L^¥$</td>
</tr>
<tr>
<td>Wealth</td>
<td>$-V^h$</td>
<td>$V^f$</td>
<td>$-V^h$</td>
</tr>
<tr>
<td>Sum</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 1: The balance sheet of the three areas
Equilibrium of goods and services

\[ Y^e \equiv C^e + G^e + I^e + X^e - IM^e \]  

(1)

Foreign trade

Exports

\[ X^e = X^e_S + X^e_Y \]  

(2)

\[ X^e_S = IM^e_s \cdot x \tau 1 \]  

(3)

\[ X^e_Y = IM^e_Y / x \tau 3 \]  

(4)

Imports

\[ IM^e = IM^e_S + IM^e_Y \]  

(5)

\[ \log IM^e_s = \mu m^e_1 + \mu m^e_2 \cdot \log S^e_{t-1} - \mu m^e_3 \cdot \log (x \tau 1_{t-1}) \]  

(6)

\[ \log IM^e_Y = \mu m^e_4 + \mu m^e_5 \cdot \log S^e_{t-1} + \mu m^e_6 \cdot \log (x \tau 3_{t-1}) \]  

(7)

Sales equal domestic and foreign demand in each country

\[ S^e = C^e + G^e + I^e + X^e \]  

(8)

Households

Disposable income

\[ Y^{d,e} = W^e + r^e_{t-1} B^e_{d,t-1} + r^s_{t-1} B^s_{d,t-1} + r^v_{t-1} B^v_{d,t-1} + r^e_{d,t-1} M^e_{t-1} - T^e \]  

(9)

Haig-Simons disposable income including capital gains

\[ Y^{d,e}_{hs} = Y^{d,e} + \Delta (x \tau 1) B^e_{s,s,t-1} + \Delta \left( \frac{1}{x \tau 3} \right) B^v_{e,s,t-1} \]  

(10)

Taxes

\[ T^e = \theta^e \cdot (W^e + r^e_{t-1} B^e_{d,t-1} + r^s_{t-1} B^s_{d,t-1} + r^v_{t-1} B^v_{d,t-1} + r^e_{d,t-1} M^e_{t-1}) \]  

(11)

Households’ consumption with wealth effect

\[ C^e = \alpha^1 Y^{d,e}_{hs} + \alpha^2 V^e_{h,t-1} \]  

(12)

Households’ wealth accumulation

\[ \Delta V^e_h = Y^{d,e}_{hs} - C^e \]  

(13)

Households’ bills demand

According to Godley-Tobin’s approach, the demand for assets depends on the rates of return of the various assets. For foreign assets, expected exchange rates variations would have to be included for a better understanding of exchange rate determination.
However this question has been examined by Daigle and Lavoie (2011) in a simple two-country model. They introduced fundamentalist and chartist expectation based on some assessed conventional value and past trends respectively. They found that, as long as the proportion of chartist actors relative to fundamentalist agents is not too large, the main conclusions of the model without exchange rate expectation hold up, although the introduction of exchange rate expectations have a significant impact on the actual exchange rate. When chartists dominate fundamentalists, the model becomes more unstable and there is no convergence when a shock occurs. This unstable case will not be considered here, and fundamentalists will be assumed to be dominant. Since it doesn’t deeply change results, it will also be supposed, following Godley and Lavoie’s previous works, that the expected exchange rate variation is constant (positive or negative) and equal to zero on average.

\begin{align}
B_{e,d}^e &= V_h^e (y_{10}^e + y_{11}^e r^e + y_{12}^e r^s + y_{13}^e r^v + y_{14}^e r_d^e) \quad (14) \\
B_{s,d}^s &= V_h^e (y_{20}^e + y_{21}^e r^e + y_{22}^e r^s + y_{23}^e r^v + y_{24}^e r_d^e) \quad (15) \\
B_{y,d}^v &= V_h^e (y_{30}^e + y_{31}^e r^e + y_{32}^e r^s + y_{33}^e r^v + y_{34}^e r_d^e) \quad (16) \\
M_d^e &= V_h^e (y_{40}^e + y_{41}^e r^e + y_{42}^e r^s + y_{43}^e r^v + y_{44}^e r_d^e) \quad (17 \text{ bis})
\end{align}

Coefficients must respect some constraints according to Godley and Tobin's approach (Godley and Lavoie, 2007a).

\[ M_d^e = V_h^e - B_{e,d}^e - B_{s,d}^s - B_{y,d}^v \quad (17) \]

Given the accountable constraint on households’ wealth, only three asset demand equations are independent. The equation describing the demand for deposits (17 bis) will not be written down.

**Government**

The public deficit is financed by issuing Treasury bills.

\[ \Delta B_s^e = G^e - T^e + r_{t-1} B_{s,t-1}^e - P_{CB}^e \quad (18) \]

Public expenditures \( G \) are exogenous. Banks’ profit is completely transferred to government as taxes. Consequently banks’ saving is nil.

\[ P_{CB}^e = r_{t-1} B_{e,CB,t-1}^e + r_{t-1} B_{s,CB,t-1}^s + x r^1 + r_{t-1} L_{t-1}^e - r_{d,t-1} M_{t-1}^e \quad (19) \]
American and European Treasury bills are bought by households and banks of the three areas. On the opposite Chinese bills are bought only by Chinese banks and households of the three areas.

\[
B_{s}^{e} = B_{e,s}^{e} + B_{e,cb,s}^{e} + B_{s,s}^{e} + B_{s,cb,s}^{e} + B_{y,s}^{e} + B_{y,cb,s}^{e} \quad (20)
\]

\[
B_{s}^{s} = B_{s,s}^{s} + B_{s,cb,s}^{s} + B_{e,s}^{s} + B_{e,cb,s}^{s} + B_{y,s}^{s} + B_{y,cb,s}^{s} \quad (21)
\]

\[
B_{y}^{y} = B_{y,s}^{y} + B_{y,cb,s}^{y} + B_{e,s}^{y} + B_{s,s}^{y} \quad (22)
\]

The equilibrium between the supply of and the demand for assets by households is given by:

\[
B_{e,s}^{y} = B_{e,d}^{y} \ast x + 3 \quad (23)
\]

\[
B_{e,s}^{s} = B_{e,d}^{s} / x + 1 \quad (24)
\]

\[
B_{e,s}^{e} = B_{e,d}^{e} \quad (25)
\]

**Firms**

The wage share is supposed constant.

\[
W^{e} = \lambda^{e} \ast Y^{e} \quad (26)
\]

Profit is determined as a residual:

\[
p^{e} = Y^{e} - W^{e} - r_{t-1}^{e}I_{t-1}^{e} \quad (27)
\]

Investment is determined following an accelerator principle, with a desired capital stock \(K^{T}\) and a constant capital productivity in the long run. The influence of the rate of profit and of the credit cost could be added later.

\[
I^{e} = Y^{e}(K_{t}^{T,e} - K_{t-1}^{e}) + \delta^{e}K_{t-1}^{e} \quad (28)
\]

\[
K^{e} = (1 - \delta^{e})K_{t-1}^{e} + I^{e} \quad (29)
\]

\[
K^{T,e} = k^{e}y_{t-1}^{e} \quad (30)
\]

Investment is financed by retained earnings and debt. Firms can obtain all the credit being demanded, without rationing.

\[
\Delta I_{d}^{e} = I^{e} - p^{e} \quad (31)
\]
The wealth of firms is given by:

$$V^e_f = K^e - L^e \quad \text{or} \quad \Delta V^e_f = P^e - \delta^e K^e$$  \hspace{1cm} (30)

**Banks**

We consider an aggregated banking system with both commercial banks and a central bank. We suppose the US central bank doesn’t hold foreign bills, due to the international status of the dollar. It doesn’t need foreign reserves ($B^e_{S,CB} = 0$). By contrast, the European and Chinese central banks hold foreign bills: US bills for the European Central Bank (ECB), US and European bills for the People’s Bank of China (PBC). There are valuation effects due to exchange rate variations and European and Chinese banks accumulate net wealth in spite of the lack of saving. Foreign reserves are described in a simplified way without a specific line like “gold and currencies” or “foreign reserves”. Banks supply all the credit demanded by firms. The money supply is endogenous. Banks supply all the credit demanded by firms. Money supply is endogenous.

$$M^e_s = I^e_s + B^e_{e,CB,s} + B^s_{e,CB,s} \times r1 - V^e_{CB}$$  \hspace{1cm} (31)

$$M^e_s = M^e_d$$  \hspace{1cm} (32)

$$L^e_s = L^e_d$$  \hspace{1cm} (33)

**Equilibrium conditions for bills supply and demand by banks.**

$$B^e_{e,CB,d} = B^e_{e,CB,s}$$  \hspace{1cm} (34)

$$B^s_{e,CB,d} = B^s_{e,CB,s} \times r3$$  \hspace{1cm} (103)

$$B^e_{e,CB,d} = B^e_{e,CB,s} / r1$$  \hspace{1cm} (104)

$$B^s_{e,CB,d} = B^s_{e,CB,s} \times r1$$  \hspace{1cm} (105)

$$B^e_{e,CB,d} = B^e_{e,CB,s} \times r2$$  \hspace{1cm} (106)

The US central bank has no reserves:

$$B^e_{S,CB,s} = 0$$  \hspace{1cm} (107)

The wealth of banks increases as a result of valuation effects. The wealth of US banks is equal to zero due to the lack of reserves.

$$\Delta V^e_{CB} = B^s_{e,CB,s,t-1} \times \Delta r1$$  \hspace{1cm} (108)

$$\Delta V^s_{CB} = B^e_{S,CB,s,t-1} \times \Delta \left( \frac{1}{r1} \right) = 0$$  \hspace{1cm} (109)
\[ \Delta V_{CB}^r = B_{\psi, CB, s, t-1}^s \Delta x r 3 + B_{\psi, CB, s, t-1}^s \Delta x r 2 \]  

(110)

Interest rates are exogenous in each country. Margin behaviour could be introduced later.

\[ r_i^e = r_d^e = r_t^e \]

*Exchange rate determination*

Equation (22) describing the supply of and demand for US bills by European households serves to determine the euro-dollar exchange rate \( x r 1 \) in an explicit manner. As the euro-dollar exchange rate is floating, we suppose that foreign reserves held by the ECB are constant.

\[ x r 1 = B_{\psi, d}^s / B_{\psi, s}^s \]  

(22 bis)

\[ B_{\psi, CB, s}^s = \text{constant} \]  

(111)

The Chinese currency is anchored to the dollar and the yuan-dollar exchange rate \( x r 2 \) is constant. The euro-yuan exchange rate \( x r 3 \) is floating and the foreign reserves of the PBC in euros are supposed constant.

\[ x r 3 = x r 2 / x r 1 \]  

(112)

\[ B_{\psi, CB, s}^e = \text{constant} \]  

(113)

All the accounting equations are written down, except one. Equation (20) describing the equilibrium between the supply of and the demand for European bills will not be written and will be used to check the accounting consistency of the model.

\[ B_{\psi, s}^e = B_{\psi, s}^e + B_{\psi, CB, s}^e + B_{\psi, CB, s}^e + B_{\psi, CB, s}^e + B_{\psi, CB, s}^e \]  

(20)

Equation (22bis) giving the euro-dollar exchange rate seems to suggest that this exchange rate is only determined by the confrontation between the demand for and the supply of US bills by European households. This is not the case. All the other parts of the model, including the trade balance, are playing a role. If exchange rate expectations were introduced in the asset demands, as in Daigle and Lavoie (2011), these expectations would play a role in the determination of exchange rates. This approach differs from Taylor (2004) who claims that the exchange rate is indeterminate in portfolio models or in macroeconomic models “based on fundamentals”. Consequently, according to him, it
is necessary to introduce a supplementary equation describing explicitly exchange rates expectations with uncertainty. However the question remains open.

On the whole, our model contains 112 equations for 112 endogenous variables. The current account balance (CAB) and the capital account balance (KAB) can be added.

\[
\begin{align*}
CAB^e &= X^e - IM^e + r_{t-1} B_{e,d,t-1}^s + r_{t-1} B_{e,d,t-1}^y + r_{t-1} B_{e,\text{CB},d,t-1}^s - r_{t-1} (B_{s,t-1}^e - B_{e,\text{CB},s,t-1}^e) \\
KAB^e &= (\Delta B_{s,s}^e + \Delta B_{y,s}^e + \Delta B_{e,\text{CB},s}^e) - (\Delta B_{e,d}^s + \Delta B_{e,d}^y + \Delta B_{e,\text{CB},d}^y) \\
CAB^e + KAB^e &= 0
\end{align*}
\]

This result remains if international monetary assets held by banks \((M_{s,\text{CB}}^e \text{ and } M_{e,\text{CB}}^e)\) or international credit are introduced. This result can surprise as it seems to mean that the increase in foreign currency reserves would always be nil, the current account balance being equal to the capital account balance. This result only reflects the way we treat the reserves of central banks, which in our model are only made up of foreign bills (US or European) held by the Chinese or European central banks.

Finally, the world’s net wealth equals the total amount of accumulated fixed capital.

\[
(V_h^e + V_f^e + V_g^e + V_{\text{CB}}^e) + (V_h^g + V_f^g + V_g^g + V_{\text{CB}}^g) = (K^e + \frac{xr1}{3}.K^e + \frac{K^y}{3})
\]

with \(V_g = -B\)

3.2. Adjustments following supply shocks with a fixed dollar-yuan parity

Simulations will be conducted by assuming a single kind of supply shock, which will be a loss of competitiveness of the USA towards either China or the EU. These supply shocks are described through an increase in the relevant propensity to import. In all the forthcoming tables or figures, GDP and exchange rates are relative deviations with regard to the baseline case, in percentages \(((X - X_b)/X_b)\); for the current account, measured in % of GDP, the absolute deviation is given \((CAB - CAB_b)\).
A loss of US competitiveness towards China induces, without surprise, a large decline of US production (table 2 and figure 4). China benefits from the decline of US competitiveness and, consequently, Chinese production is strongly stimulated. The US public deficit and current account deficit increase widely, in contrast to the rising Chinese surpluses. European production hardly changes, because the gains arising from exports to the Chinese market are being compensated by losses on the US market.

The evolutions of exchange rates are more surprising. The dollar ends up with a slight appreciation against the euro, while the yuan depreciates against the euro. This evolution is all the more striking since the rising US public deficit induces a large issue of US treasury bills while the US demand for US bills declines due to the slowdown of US activity. This should lead to a dollar depreciation against the euro. However, there is a countervailing force, arising from the strong demand for US bills by the Chinese central bank, in its efforts to keep fixed the dollar-yuan parity. Consequently, the amount of US bills being supplied to European households declines slightly, while the European demand for US bills hardly changes. This explains the slight dollar appreciation against the euro, despite the decline in US competitiveness. This result enlightens the evolution of the end of the 1990s and beginning of the 2000s when the dollar was appreciating relative to the euro despite rising US current account deficits. This configuration began to change later, due to the progressive modification of the behaviour of the Chinese central bank, as will be discussed further in the paper. On the whole, in the case of a loss of US competitiveness towards China, the rigidity of the dollar-yuan parity limits adjustments at the world level. US production declines but the US current account deficit remains and the dollar can appreciate somewhat against the euro.

A loss of US competitiveness towards the EU has very different effects (table 2 and figure 4). US production is also negatively affected, but due to rising US current account and public deficits, the dollar depreciates against the euro (-9%). Consequently, the European increase in GDP does not last, and the gains in European output all get nearly wiped out in the medium run, due to the impact of the euro appreciation, the US slowdown and the Chinese gains in competitiveness arising from the yuan depreciation relative to the euro. The European current account surplus is reduced to almost zero in the medium run. The US trade deficit is also reduced in the medium run, but the US
current account remains in deficit because of interest payments. China appears once again as the winner with an increased GDP (+9% in the medium run) and a surplus current account, thanks to the impact of the yuan depreciation. On the whole, the decline in US production remains, but the US trade deficit is smaller than in the case of a loss of competitiveness towards China, thanks to the dollar depreciation against the euro. The fixity of the dollar-yuan parity reduces the amplitude of possible adjustments, at the benefit of China and at the expense of the EU.

Table 2: Loss of US competitiveness with fixed dollar-yuan parity

<table>
<thead>
<tr>
<th></th>
<th>$\mu m_{¥}$ = 0.4 to 0.5</th>
<th>$\mu m_{€}$ = 0.6 to 0.7</th>
<th>$\mu m_{¥}$ = 0.4 to 0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US GDP</strong></td>
<td>T=1</td>
<td>T=5</td>
<td>T=10</td>
</tr>
<tr>
<td></td>
<td>-3,53</td>
<td>-7,05</td>
<td>-7,77</td>
</tr>
<tr>
<td><strong>CHINA GDP</strong></td>
<td>3,12</td>
<td>6,26</td>
<td>6,86</td>
</tr>
<tr>
<td><strong>EU GDP</strong></td>
<td>0,01</td>
<td>-0,03</td>
<td>0,01</td>
</tr>
<tr>
<td><strong>Dollar/Euro</strong></td>
<td>0,06</td>
<td>0,47</td>
<td>0,57</td>
</tr>
<tr>
<td><strong>US CUR</strong></td>
<td>-3,72</td>
<td>-2,95</td>
<td>-3,05</td>
</tr>
<tr>
<td><strong>CHINA CUR</strong></td>
<td>2,96</td>
<td>2,05</td>
<td>2,03</td>
</tr>
<tr>
<td><strong>EU CUR</strong></td>
<td>0,01</td>
<td>-0,02</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: authors’ calculation
3.3. Introduction of a diversification of China’s foreign reserves

Instead of having Chinese foreign reserves mainly composed of US bills with constant reserves in euros, the Chinese central bank could have, and actually has, pursued a more diversified strategy, especially in the context of large US deficits and uncertainty regarding future values of the dollar. Different scenarios could be considered with increasing foreign reserves held in euros by the PBC, but we will limit ourselves to one, already proposed by Lavoie and Zhao (2010). As soon as current account surpluses appear, the PBC decides to diversify its foreign reserves, but in a gradual manner, with a target structure of foreign reserves in dollar and euro bills and hence through a partial adjustment mechanism. This behaviour is rather close to what has been observed since
2008, but the dollar-yuan parity is supposed to remain constant at this stage of the paper.

\[ B_{c,B,d}^e = \beta B_{c,CB,d}^s \]

\[ \beta = \beta_{t-1} + \theta (\beta^e - \beta_{t-1}) \]

\( \beta^e \) is the target share of reserves held by the CCB in euros, in percentage of the reserves in dollars. \( \theta \) is an adjustment coefficient reflecting a more or less pronounced inertia in the PBC behaviour. \( \beta^e \) is equal to 0.7 in the simulation, which means that the foreign reserves are composed of 59% \((1/1.7)\) of US bills and 41% of bills issued in euros. Only the case of the loss of US competitiveness towards China will be considered, since this case gives particularly contrasted results compared to the case without diversification (see table 2 and figure 5). As before, US production declines and Chinese output increases. But with diversification, the dollar depreciates against the euro, because of the reduced demand for dollars coming from the PBC. Consequently, while US production is less badly affected than without diversification, EU output now decreases instead of remaining roughly constant. The structure of international imbalances is modified by the decision of the the Chinese monetary authorities to diversify their foreign reserves, but these imbalances remain important. While the US current account deficit as a percentage of GDP is smaller than without diversification, the EU current account deficit now deteriorates significantly while the Chinese economy sees its current account surplus increase. The EU now carries the burden of the adjustment.

Figure 5: Loss of US competitiveness towards China with diversification of Chinese foreign reserves
Sensitivity tests\(^2\) can be done to appreciate how the value of the target share of reserves held in euros (\(\beta^e\)) influences growth paths, exchange rates and external imbalances. In the case of a loss of US competitiveness towards China, \(\beta^e\) varies from 0 (the basic model without diversification) to 1 (foreign reserves equally shared between US and European bills). Without surprise, simulations show that the more the Chinese reserves are diversified, the more the dollar depreciates against the euro due a declining demand for US bills. European output is more and more negatively affected, at the benefit of Chinese output and at the benefit of US output which declines less. World imbalances increase, with larger external Chinese surpluses and European external deficits, while the US current account deficit gets reduced thanks to the dollar depreciation.

These conclusions are similar to those already obtained by Lavoie and Zhao (2010). However they are obtained with the hypothesis of a fixed dollar-yuan parity, an assumption which we find overly restrictive. Since 2005 the PBC has managed a progressive appreciation of the yuan with regards to the dollar, although this experience has been (temporarily) suspended from the beginning of 2009 to the middle of 2010 as a consequence of the global financial crisis. We now wish to analyze global adjustments assuming a flexible dollar-yuan parity, either of the freely floating or managed float type.

4. A THREE-COUNTRY MODEL WITH FLOATING OR MANAGED DOLLAR-YUAN PARITY

4.1. *New versions of the model*

In order to analyse what could be the adjustments at the world level in the future when the Chinese exchange rate policy would be progressively liberalised, new versions of the previous model can be written with different modes of determination of the dollar-yuan parity. A first version corresponds to a pure mechanism of floating exchange rates which cannot pretend to be a realistic description of the Chinese exchange rate regime in the near future, due to the still very incomplete financial liberalisation in China. But, as it will be shown, this theoretical regime can represent a useful reference to understand the adjustment mechanisms prevailing in more plausible exchange rate regimes.

\(^2\) See more details in figures 12, 13, 14 and 15
In this configuration the foreign reserves of the PBC in US bills are constant \( B_{\text{CB,d}}^S = \text{constant} \). Equation (106) is replaced by (106bis) which determines the dollar-yuan parity \( x_{r2} \) (1 dollar = \( x_{r2} \) yuan).

\[(106\text{bis}) \ x_{r2} = B_{\text{CB,d}}^S / B_{\text{CB,s}}^S \]

A second version corresponds to an impure mechanism of floating exchange rates with inertia due to interventions of the CCB which are not explicitly described. The foreign reserves of the PBC in US bills are always constant \( B_{\text{CB,d}}^S = \text{constant} \). Equation (106) is replaced by (106*) where \( x_{r2}^* \) represents the equilibrium exchange rate. The actual exchange rate is determined with inertia by equation (106ter).

\[x_{r2}^* = B_{\text{CB,d}}^S / B_{\text{CB,s}}^S \quad (106^*)\]
\[x_{r2} = x_{r2_{t-1}} + \epsilon (x_{r2}^* - x_{r2_{t-1}}) \quad (106\text{ter})\]

A third version corresponds to a managed exchange rate regime with a target fixed by the Chinese central bank either in terms of foreign reserves in dollars or in terms of a current account surplus. The foreign reserves of the CCB in US bills are once again endogenous (non modified equation (106) from the initial version of the model). The dollar-yuan parity \( x_{r2} \) can be managed by the CCB with a target, either on the reserves in US bills \( (R_e^\text{y}) \) is a percentage of GDP beyond which the yuan is revaluated) or on the current account, also in percentage of GDP \( (CAB^\text{y}/Y^\text{y})^e \).

\[B_{\text{CB,d}}^S = B_{\text{CB,s}}^S \times x_{r2} \quad (106)\]
\[x_{r2} = x_{r2_{t-1}} + \gamma_1 \left( B_{\text{CB,d}}^S / Y^\text{y} - R^e^\text{y} \right) \]

or
\[x_{r2} = x_{r2_{t-1}} + \gamma_2 \left( CAB^\text{y}/Y^\text{y} - (CAB^\text{y}/Y^\text{y})^e \right) \]

\( \gamma_1 \) et \( \gamma_2 \) are negative adjustment parameters of the exchange rate which can be considered as controlled by the PBC.
These new versions of the model are used in the same way as in the previous section to analyse the adjustment mechanisms towards global imbalances. Comparisons with the results of the previous section will show the new adjustment possibilities arising from a more flexible yuan.

4.2. The different floating exchange rate regimes of the yuan

The three floating exchange rate regimes previously defined can be simply compared by examining the consequences of a shock, the loss of US competitiveness towards China (simulated through an increase in the propensity to import of the same magnitude than in the initial case). In the case of a freely floating yuan, there is still a short-run reduction in US production and a short-run rise in Chinese production, accompanied by a deteriorating US current account and an improving Chinese current account (table 3 and figure 6). However, the floating exchange rates and the depreciation of the dollar lead to a substantial reduction of these imbalances (the dollar moves by -7% against the yuan and -3.6% against the euro). The US production recovers while the Chinese growth slows down. The US current deficit and Chinese surplus get offset. The main difference with the case of the fixed dollar-yuan parity (table 2 and figure 4) is that global imbalances can now be reduced by exchange rate adjustments thanks to the floating yuan. By contrast, in the fixed yuan regime, changes in output levels were the main adjustment tool, but this tool was unable to reduce the external imbalances between USA and China. In the case of an impure floating yuan with inertia in adjustments, results are very similar to the freely floating regime. They are slightly affected by the value of the adjustment coefficient $\varepsilon$. The smaller the adjustment coefficient, the slower the exchange rate adjustment is and the larger the adjustments on production are. But the differences remain very small (figures are not shown to gain space).
Table 3: Loss of US competitiveness towards China with various regimes of floating yuan

<table>
<thead>
<tr>
<th></th>
<th>A pure floating dollar-yuan</th>
<th>A yuan managed regime and a target on foreign reserves in dollars</th>
<th>A yuan managed regime and a target on current account</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T=1</td>
<td>T=5</td>
<td>T=10</td>
</tr>
<tr>
<td>US GDP</td>
<td>-2.581</td>
<td>-0.628</td>
<td>-0.349</td>
</tr>
<tr>
<td>CHINA GDP</td>
<td>2.403</td>
<td>0.754</td>
<td>0.459</td>
</tr>
<tr>
<td>EU GDP</td>
<td>-0.042</td>
<td>0.091</td>
<td>0.057</td>
</tr>
<tr>
<td>US CUR</td>
<td>-2.629</td>
<td>-0.187</td>
<td>-0.092</td>
</tr>
<tr>
<td>CHINA CUR</td>
<td>2.350</td>
<td>0.164</td>
<td>0.098</td>
</tr>
<tr>
<td>EU CUR</td>
<td>-0.042</td>
<td>0.034</td>
<td>0.015</td>
</tr>
</tbody>
</table>

$\mu_{d,y} = 0.4$ to $0.5 \quad \mu_{d,y} = 0.4$ to $0.5 \quad \mu_{d,y} = 0.4$ to $0.5$

Source: authors’ calculation

Figure 6: Loss of US competitiveness towards China in case of a pure floating yuan

In the case of a managed exchange rate regime with a target fixed by the Chinese central bank for the level of foreign reserves in dollars, the impact of a loss of US competitiveness towards China also closely resembles the impact observed in a freely floating regime where foreign reserves in dollars are assumed constant (table 3). In the managed regime these reserves are not constant but the PBC tries to reach a foreign reserve target as a percentage of Chinese GDP. External imbalances are reduced within a few years. The proximity of the two scenarios can be easily understood but is interesting to take notice of them. A managed exchange rate regime with a percentage target on foreign reserves in dollars is very similar to a freely floating exchange rate regime.
Indeed, visually, this regime is no different from the free-floating regime described by figure 6, and hence it will not be shown here to save space.

Lastly, a managed exchange rate regime based on a target current account surplus set by the Chinese central bank yields similar results but with some unstable trajectories (table 3 and figure 7). A loss of US competitiveness towards China induces, as before, a decline of US production, a depreciation of the dollar against the yuan and the euro, and an increase in Chinese production. Exchange rate adjustments lead to a progressive reduction of external imbalances in this case also. The smaller the adjustment parameters, the slower the exchange rate adjustments are and the larger the production adjustments are. The value taken by the adjustment parameter plays a larger role than was the case previously, but this role remains limited, as can be shown by sensitivity tests.

Figure 7: Loss of US competitiveness towards China with a yuan managed regime and a target set on the current account balance

To conclude, two points can be underlined. First, a floating dollar-yuan exchange rate is a powerful adjustment mechanism to reduce world imbalances characterised by US deficits and Chinese surpluses. The contrast appears clearly when the model based on a fixed dollar-yuan parity is compared to the model with a freely floating dollar-yuan parity. Second, such a freely floating yuan is unrealistic under current circumstances. But a managed float for the dollar-yuan parity, where the Chinese central bank
intervenes to achieve a target, either on foreign reserves in dollars or on its current account balance, yields similar adjustment mechanisms. They can reduce world imbalances in the same proportions as a pure floating regime. This approach does not detail the institutional forms that such exchange rates regimes would take, nor does it describe the internal consequences for the Chinese economy of a yuan revaluation. It is limited to general considerations at the world level. In spite of its doubtful relevance today, the pure floating yuan regime can be used as a useful reference to examine the main differences between fixed and floating exchange rate regimes in a world context.

5. A THREE-COUNTRY SFC MODEL WITH FLEXIBLE PRICES

5.1. New version of the model with flexible prices

The previous model can be enlarged with a simple modelling of prices and wages. The structure of the model remains unchanged. A price-wage loop is introduced to determine the GDP price (PY) and the nominal wage per capita (w). The GDP price depends on unit wage costs and import prices, with an adjustment to the desired level and a short-term effect of the rate of capacity utilization (TUC). The wage per capita is determined by a simplified Philips curve with an effect of the capacity rate of utilization, an indexation formula based on internal demand prices\(^3\) (PDI) and on labour productivity (PR).

\[
W^c = w^c \ast N^c
\]

\[
logPY^c_{des} = \mu^c \ast logPM^c + \left(1 - \mu^c\right) \ast log\left(w^c / PR^c\right)
\]

\[
logPY^c = \pi_0^c + \pi_1^c \ast log\left(PY^c_{des}\right) + \left(1 - \pi_1^c\right) \ast log\left(PY^c_{t-1}\right) + \pi_2^c \ast log\left(TUC^c\right)
\]

\[
logw^c = \lambda_1^c \ast log\left(w^c_{des}\right) + \left(1 - \lambda_1^c\right)logw^c_{t-1}
\]

\[
logw^c_{des} = \lambda_2^c \ast logPDI^c + \lambda_3^c \ast logTUC^c + \lambda_4^c \ast logPR^c
\]

\[
TUC^c = Y^c / K^c
\]

\[
\Delta logPR^c = \varphi_0^c + \varphi_1^c \Delta logY^c
\]

\[
N^c = Y^c / PR^c
\]

\(^3\) The internal demand prices (PDI) is given by an accounting equation relating internal demand in constant and current prices.
Foreign trade equations are enlarged to include a price competitiveness effect and a simple analysis of foreign trade prices.

**Exports**

\[
\begin{align*}
\log X^e_s &= \mu \alpha^e_1 + \mu \alpha^e_2 \times \log Y^e_s - \mu \alpha^e_3 \times \log \left( \frac{PX^e_s}{(PY^s \times xr_1)} \right) \\
\log X^e_v &= \mu \alpha^e_4 + \mu \alpha^e_5 \times \log Y^e_v - \mu \alpha^e_6 \times \log \left( \frac{(PX^e_v \times xr_3)}{PY^v} \right)
\end{align*}
\]

**Export price**

\[
\begin{align*}
\log PX^e_s &= \rho^e_1 + \rho^e_2 \times \log PY^s \times x_1 + (1 - \rho^e_3) \times \log (PY^e) \\
\log PX^e_v &= \rho^e_5 + \rho^e_6 \times \log PY^v \times x_3 + (1 - \rho^e_5) \times \log (PY^e)
\end{align*}
\]

Usual equations relating variables in constant and current prices are added\(^4\). Finally, a kind of simple Taylor rule, only dependent on the rate of inflation, has been added to avoid an incoherent evolution of the real rate of interest.

\[
r^t = r^e + 0.8 \times (\Delta \log PDI^e - 0.02)
\]

On the whole, the model has now 176 endogenous variables, public expenditures being exogenous. This new version of the model is used in the same way as in previous sections to analyse adjustment mechanisms towards global imbalances with, alternatively, fixed or floating dollar-yuan parity.

### 5.2. Complementary results with flexible prices

Results obtained with the flexible prices model broadly confirm those obtained with fixed prices. The different configurations of the model will be successively considered.

**Fixed dollar-yuan parity**

A supply shock with a loss of US competitiveness towards China gives results rather close to those obtained in the fixed-price case, at least in qualitative terms\(^5\) (table 4 and figure 8). The US production declines and the current account becomes imbalanced at the benefit of China. The dollar slightly appreciates in nominal terms due to increasing

\(^4\) The determination of households’ real Haig-Simons disposal income and wealth can be explicated as it is less straightforward.

\[
\Delta Y^e_{v,k} = \Delta Y^d_{v,h,s} - \Delta Y^e_v, \quad Y^d_{v,h,s} = \frac{V^d_{v,h,s}}{PDI^e_s} - V^d_{v,h,t-1} \times \frac{\Delta PDI^e_s}{PDI^e_s} \text{ and } V^e_{h} = \frac{V^e_{v,h}}{PDI^e_s}
\]

\(^5\) The results cannot be compared directly as the shock is smaller in the case of flexible prices with an increase of the propensity to import from 0.5 to 0.52 (instead of 0.4 to 0.5 in the constant prices case).
demand for US bills by the Chinese central bank in order to maintain the yuan-dollar parity. But the dollar depreciates moderately in real terms due to a decline in US prices, in contrast to the constant-price case. However, as in this case, the rigidity of the dollar-yuan parity limits the adjustments at the world level.

As in the fixed-price case, a loss of US competitiveness towards the European Union yields a more contrasted impact (table 4 and figure 9). US production is negatively affected in the short run, at the benefit of the EU, and the dollar depreciates in nominal and real terms due to current account and public deficits, despite rising US prices. Actually the dollar depreciation is larger than in the case of constant prices and US production recovers in the medium run, at the expense of European production which declines, while China appears once again as the winner thanks to the depreciation of the yuan versus the euro.

Figure 8: Loss of US competitiveness with fixed dollar-yuan parity and flexible prices
A supply shock with a loss of US competitiveness towards China gives contrasted results by comparison with the case without foreign reserves diversification, as was the case with the fixed prices model (table 4 and figure 9). Chinese production increases and US output declines in the short run. Due to the declining demand for US bills by the Chinese central bank, the dollar depreciates relative to the euro in nominal and real terms. As a consequence, Chinese output gets stimulated by the yuan depreciation and US production recovers. On the opposite, the euro appreciation induces a decline in European production. The Chinese current surplus remains high and stable. The initial US current deficit is reduced but doesn’t disappear while the European deficit increases. This can be regarded as a possible scenario for the future if the Chinese central bank were to decide to diversify its foreign reserves while keeping fixed the dollar-yuan parity.

Table 4: A loss of US competitiveness with fixed dollar-yuan parity and flexible prices

<table>
<thead>
<tr>
<th></th>
<th>Loss of United States competitiveness</th>
<th>towards China</th>
<th>towards the European Union</th>
<th>towards China with diversification of China’s foreign reserves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T=1</td>
<td>T=5</td>
<td>T=10</td>
<td>T=20</td>
</tr>
<tr>
<td>US GDP</td>
<td>-0,99</td>
<td>-1,71</td>
<td>-1,89</td>
<td>-2,17</td>
</tr>
<tr>
<td>CHINA GDP</td>
<td>0,98</td>
<td>1,74</td>
<td>1,95</td>
<td>2,25</td>
</tr>
<tr>
<td>EU GDP</td>
<td>0</td>
<td>0,04</td>
<td>0,04</td>
<td>0,03</td>
</tr>
<tr>
<td>PDI US</td>
<td>-0,09</td>
<td>-0,14</td>
<td>-0,16</td>
<td>-0,16</td>
</tr>
<tr>
<td>PDI CHINA</td>
<td>0,07</td>
<td>0,12</td>
<td>0,13</td>
<td>0,12</td>
</tr>
<tr>
<td>PDI EU</td>
<td>0,02</td>
<td>0,02</td>
<td>0,03</td>
<td>0,03</td>
</tr>
<tr>
<td>Dollar/Euro</td>
<td>0,10</td>
<td>0,07</td>
<td>0,07</td>
<td>0,07</td>
</tr>
<tr>
<td>Real Dollar/Euro</td>
<td>-0,01</td>
<td>-0,09</td>
<td>-0,12</td>
<td>-0,13</td>
</tr>
<tr>
<td>US CUR</td>
<td>-1,03</td>
<td>-0,72</td>
<td>-0,73</td>
<td>-0,76</td>
</tr>
<tr>
<td>CHINA CUR</td>
<td>1,02</td>
<td>0,68</td>
<td>0,68</td>
<td>0,7</td>
</tr>
<tr>
<td>EU CUR</td>
<td>-0,02</td>
<td>0</td>
<td>0,01</td>
<td>0,01</td>
</tr>
</tbody>
</table>

\[\mu_{x5}^{¥} = 0.5 \text{ to } 0.52 \quad \mu_{x5}^{€} = 0.5 \text{ to } 0.52 \quad \mu_{x5}^{¥} = 0.5 \text{ to } 0.52\]

PDI = Internal demand prices

Source: authors’ calculation
Floating yuan

With a floating yuan, adjustments through real dollar depreciation are larger. In the short run, a loss of US competitiveness towards China° induces a decrease of US production and an increase of Chinese production (table 5 and figure 10). The US current account deteriorates while the Chinese one improves. But the dollar depreciates strongly against the yuan and less strongly against the euro. This dollar depreciation is linked to a larger supply of US bills abroad while the Chinese foreign reserves in US bills are held constant. The nominal dollar depreciation holds up in real terms despite US price increases. Consequently, US production recovers and Chinese slows down. The Chinese current surplus and the US current deficit are reduced. The EU production is preserved as the appreciation of the euro against the dollar is compensated by the depreciation of the euro against the yuan. Compared with the fixed dollar-yuan parity regime without Chinese foreign reserves diversification (table 4 and figure 8), the main difference is that the dollar depreciation allows an important recovery in US production and a reduction of the US current account deficit, while China is penalised by the yuan appreciation. Global imbalances are more reduced by relative prices than by production. Compared with the case with Chinese foreign reserves diversification (table 4 and figure

° The increase of the import propensity is from 0.5 to 0.51
9), two differences can be underlined. EU production is now less adversely hit, thanks to the euro depreciation against the yuan. Furthermore, current account imbalances, especially the Chinese surplus, are more reduced. Also, Chinese GDP is more negatively affected due to the consequences of the yuan revaluation.

These conclusions are qualitatively similar to those that were observed with the fixed-price models, as a floating dollar-yuan exchange rate allows a reduction of global imbalances. However, this reduction is less marked than in the previous case and more important reversals of the production are induced by the exchange rates' adjustments in favour of the US production and at the detriment of the Chinese one. The negative impact on Chinese growth of the yuan revaluation is mainly induced by the loss of competitiveness and is more marked in case of flexible prices. However the risk of deflation cannot be studied in more details with the present model as there is no impact of the debt ratio on firms' behaviour. Conversely, the wealth effect on households plays positively in case of deflation.

Table 5: A loss of US competitiveness towards China with various regimes of floating yuan and flexible prices

<table>
<thead>
<tr>
<th>Loss of United States competitiveness towards China</th>
</tr>
</thead>
<tbody>
<tr>
<td>A pure floating dollar-yuan</td>
</tr>
<tr>
<td>T=1</td>
</tr>
<tr>
<td>US GDP</td>
</tr>
<tr>
<td>CHINA GDP</td>
</tr>
<tr>
<td>EU GDP</td>
</tr>
<tr>
<td>PDI US</td>
</tr>
<tr>
<td>PDI CHINA</td>
</tr>
<tr>
<td>PDI EU</td>
</tr>
<tr>
<td>Dollar/Euro</td>
</tr>
<tr>
<td>Dollar/Yuan</td>
</tr>
<tr>
<td>Real Dollar/Euro</td>
</tr>
<tr>
<td>Real Dollar/Yuan</td>
</tr>
<tr>
<td>US CUR</td>
</tr>
<tr>
<td>CHINA CUR</td>
</tr>
<tr>
<td>EU CUR</td>
</tr>
</tbody>
</table>

\( \mu_{x5} = 0.5 \) to 0.52 \( \mu_{x5} = 0.5 \) to 0.52 \( \mu_{x5} = 0.5 \) to 0.52

Source: authors' calculation
Comparison of different floating exchange rate regimes for the yuan
An impure floating yuan with inertia in adjustments or a managed exchange rate regime with a target on the level of Chinese foreign reserves in dollars gives results very similar to the freely floating regime, as could be seen from table 5. Finally, a managed exchange rate regime with a target on the Chinese current account balance also gives rather similar results, but once again with more unstable trajectories in the long run (table 5 and figure 11).
5. CONCLUSION

Macroeconomic adjustments at the world level towards global imbalances have been analysed in this paper using stock-flow consistent models along the lines of Godley and Lavoie (2005, 2007a). This approach gives a comprehensive description of the real and financial flows and stocks at the world level, can include most of the ingredients of the traditional general equilibrium models or portfolio models, and do not presuppose that adjustments are limited to relative prices.

Three kinds of SFC three countries models have been considered, the first two ones with constant prices, the third one with flexible prices. The first model was inspired by Lavoie and Zhao (2010), with a fixed dollar-yuan parity, including a version where the Chinese central bank proceeds to reserve diversification. The second model introduced a flexible dollar-yuan parity which can be freely floating or managed by the Chinese central bank on the basis of some external target. The third model dropped the hypothesis of constant prices and combined a simple modelling of prices and wages with the two previous versions.

This paper studies the impact of supply shocks, mainly a loss of US competitiveness towards China, to analyse macroeconomic adjustments at the world level. With a fixed dollar-yuan parity, a loss of competitiveness towards either China or the EU has a large impact on GDP and world imbalances. Initial shocks are partly compensated thanks to the euro-dollar variations, but the fixity of the dollar-yuan parity limits the adjustments at the benefit of China and at the expense of the USA. In case of a loss of US competitiveness towards China, the small appreciation of the dollar against the euro, despite large US fiscal and current account deficits, can be explained by the large purchases of US bills by the Chinese central bank as the latter acts to keep constant the yuan-dollar parity. However, when China diversifies its foreign reserves towards the euro currency, the dollar depreciates relative to the euro, because of the smaller demand for US bills by the Chinese central bank. While this diversification is favourable to the US economy, international imbalances remain important with large Chinese current account surpluses and large increases in Chinese production, while new imbalances are
created in the case of the EU, with the appearance of EU current account deficits and reduced EU GDP.

From 2005 to 2008 the Chinese central bank has permitted a limited appreciation of the yuan relative to the dollar. We have examined what happens in an enlarged model with a floating dollar-yuan parity. Two points can be underlined. First, a floating dollar-yuan exchange rate is a powerful adjustment mechanism to reduce world imbalances characterised by a US deficit and a Chinese surplus. Second, while a freely floating yuan is unrealistic in the actual state of the Chinese monetary and financial system, a managed float, where the Chinese central bank intervenes to reach a target expressed as a percentage of GDP, either based on the amount of foreign reserves in dollars or on a current account balance, yield adjustment mechanisms that are roughly similar. The pure floating yuan regime can thus be used as a useful reference to examine what would occur to world imbalances if the Chinese monetary authorities were to revert to a managed float regime.

Lastly, the previous models with fixed prices have been enlarged by introducing flexible prices. Using the same shocks as before, the main results obtained with fixed prices have been confirmed in the case of flexible prices, although some differences appeared. In case of a floating dollar-yuan parity, the reduction of world imbalances is less marked than in the case of fixed prices and Chinese production is more reduced by a yuan appreciation.

Two other remarks can be made. First, during the 2008-2010 period, world imbalances have been partly reduced, mainly because of the US recession and the reduction in US imports. The dollar crisis, which has been announced many times, has not yet occurred. However previous results suggest that exchange rate adjustments, especially regarding the yuan-dollar parity, could play a significant role to reduce global imbalances. Estimations of exchange rate misalignments tend to show that important misalignments remain and that it could be possible to go further to reduce them. The undervaluation of the yuan would still be around 20% in real and nominal terms in 2009 (Jeong and al., 2010; Cline and Williamson, 2010). The euro would be close to its equilibrium value, but with important intra-European imbalances. If the Chinese were to diversify their
reserves and if the dollar were to depreciate against the euro, the cost would be high for many Southern European countries. This constitutes another argument in favour of a flexible yuan-dollar parity.

Second, a dollar depreciation and a revaluation of the yuan could help to solve structural imbalances which remain at the internal level. In the USA, the recovery that appeared in mid-2009 seems to be running out of steam. Public stimulus policies cannot be expected to go on forever. The resumption of household consumption is limited by the level of their debt to personal income ratio. Export-led growth (and less imports) may help and could be sustained by a cheaper currency, but it is instead the euro currency that has depreciated in 2010. In China, domestic demand has grown at a 10% rate in 2009, thanks to fiscal stimulus and a loosening of credit. But the structural imbalance between consumption and investment remains. The weakness of Chinese consumption can be explained by many factors, notably a high saving rate generated by an inappropriate social safety net and rising income inequality. But the main factor seems to be that the share of income going to workers has fallen due to a capital-intensive growth which didn’t create enough employment. The undervaluation of the yuan has favoured a manufacturing-led growth oriented towards the external sector. An appreciation of the yuan would discourage excessive investment in the export sector. Furthermore, a persistent yuan undervaluation might incite other East Asian countries to adapt their exchange rate policy in order to avoid an undervaluation against the yuan. This persistent export-led strategy would maintain world imbalances.

REFERENCES


Lavoie, M., J. Zhao (2010): “A study of the diversification of China’s foreign reserves within a three country stock-flow consistent model”, Metroeconomica  61:3 (2010), pp 558-592,


### APPENDIX

**Table 6: National accounts in flows**

<table>
<thead>
<tr>
<th>Euro area = €</th>
<th>USA = $</th>
<th>China = ¥</th>
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<tr>
<td>H</td>
<td>F</td>
<td>G</td>
</tr>
<tr>
<td>B &amp; S</td>
<td>(-C^\xi)</td>
<td>(Y^\xi)</td>
</tr>
<tr>
<td>IM</td>
<td>(IM^\xi)</td>
<td>(-X^\xi)</td>
</tr>
<tr>
<td>Wages</td>
<td>(W^\xi)</td>
<td>(-W^\xi)</td>
</tr>
<tr>
<td>Taxes</td>
<td>(-T^\xi)</td>
<td>(T^\xi)</td>
</tr>
<tr>
<td>Interest</td>
<td>(r^\xi B^\xi_{k,e})</td>
<td>(-r^\xi B^\xi_{e})</td>
</tr>
<tr>
<td></td>
<td>(r^\xi B^\xi_{k,e,cb}/x3)</td>
<td>(-r^\xi L^\xi)</td>
</tr>
<tr>
<td>Profit</td>
<td>(-P^\xi)</td>
<td>(P^\xi)</td>
</tr>
<tr>
<td>Chg</td>
<td>(-\Delta M^\xi)</td>
<td>(\Delta M^\xi)</td>
</tr>
<tr>
<td>Money €</td>
<td>(-\Delta B^\xi_{e})</td>
<td>(\Delta B^\xi_{e})</td>
</tr>
<tr>
<td>Bills €</td>
<td>(-\Delta B^\xi_{k,e,cb}/x1)</td>
<td>(-\Delta B^\xi_{k,e,cb}/x1)</td>
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<tr>
<td>Bills $</td>
<td>(-\Delta B^\xi_{k,e,cb}/x3)</td>
<td>(-\Delta B^\xi_{k,e,cb}/x3)</td>
</tr>
<tr>
<td>Bills ¥</td>
<td>(-\Delta B^\xi_{k,e,cb}/x3)</td>
<td>(-\Delta B^\xi_{k,e,cb}/x3)</td>
</tr>
<tr>
<td>ΔLoan</td>
<td>(\Delta L^\xi)</td>
<td>(-\Delta L^\xi)</td>
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<tr>
<td>Sum</td>
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<td>0</td>
</tr>
</tbody>
</table>
List of variables

\[ \begin{align*}
B_{s,s}^h &= \text{Supply of US Treasury bills to US households} \\
B_{s,d}^h &= \text{Demand of US Treasury bills by US households} \\
B_{s,\text{CB},s}^h &= \text{Supply of US Treasury bills to Chinese banks} \\
B_{s,\text{CB},d}^h &= \text{Demand of US Treasury bills by Chinese banks} \\
B_{d,d}^h &= \text{Demand for US Treasury bills by households in the euro area} \\
B_{s,d}^e &= \text{Supply of US Treasury bills to households in the euro area} \\
B_{d,\text{CB},d}^e &= \text{Demand of US Treasury bills by U.S. banks} \\
B_{s,\text{CB},s}^e &= \text{Supply of US Treasury bills to banks in the euro area} \\
B_s^i &= \text{Issue of US Treasury bills (same notation for European and Chinese Treasury bills)} \\
C &= \text{Consumption} \\
\text{CAB} &= \text{Current account balance} \\
G &= \text{Public spending} \\
I &= \text{Investment} \\
IM_s^h &= \text{U.S. imports} \\
IM_s^c &= \text{U.S. imports from China} \\
IM_e^c &= \text{U.S. imports from the euro area} \\
IM_s^h &= \text{Chinese imports} \\
IM_s^c &= \text{Chinese imports from the United States} \\
IM_e^c &= \text{Chinese imports from the euro area} \\
IM_e^e &= \text{Imports of the euro area} \\
IM_s^e &= \text{Imports of the euro zone from the United States} \\
IM_e^c &= \text{Imports of the euro zone from China} \\
K &= \text{Capital stock} \\
KAB &= \text{Capital account balance} \\
K^d &= \text{Desired capital stock} \\
L_s &= \text{Loans supply} \\
L_d &= \text{Loans demand} \\
M_d &= \text{Demand for money} \\
M_s &= \text{Money supply} \\
P &= \text{Profit firms} \\
P_{\text{CB}} &= \text{Profit banks} \\
r &= \text{Interest rate on bills} \\
r_d &= \text{Interest rate on deposits} \\
r_l &= \text{Interest rates on loans} \\
S &= \text{Sales} \\
T &= \text{Taxes} \\
V_h &= \text{Households' wealth} \\
V_{\text{CB}} &= \text{Banks' wealth} \\
V_f &= \text{Firms' wealth} \\
W &= \text{Wages} \\
X_s^h &= \text{U.S. exports} \\
X_s^c &= \text{U.S. exports to China} \\
X_e^c &= \text{U.S. exports to countries of the euro area} \\
X_c^c &= \text{Chinese exports} \\
X_c^s &= \text{Chinese exports to the USA} \\
X_e^c &= \text{Chinese exports to the euro area} \\
X_e^e &= \text{Euro area exports} \\
X_s^e &= \text{Euro area exports to the USA}
\end{align*} \]
\[ X^E \] = Euro area exports to China
\[ x_r1 \] = Exchange rate euro-dollar
\[ x_r2 \] = Exchange rate dollar-yuan
\[ x_r3 \] = Exchange rate Euro-yuan
\[ Y^d_{hs-} \] = Haig-Simons disposal income

**Exogenous variables**
\[ \gamma = 0.01 \]
\[ \Delta \log G = 0.02 \]

**Parameters**
\[ \alpha_1 \] = propensity to consume income = 0.8
\[ \alpha_2 \] = wealth effect coefficient = 0.0182 (USA), 0.0243 (EU), 0.0235 (China)
\[ \kappa \] = capital income ratio = 2.5
\[ \lambda \] = wage share = 0.75
\[ \gamma_1 \text{ et } \gamma_2 \] = adjustment parameters of the dollar-yuan parity = -5
\[ \delta \] = depreciation rate of capital = 0.1
\[ \theta \] = tax rates = 0.0964 (USA), 0.1067 (EU), 0.0942 (China)
\[ \varepsilon \] = adjustment parameter of the dollar-yuan parity = 0.5

**Parameters reaction of households’ portfolio choice**

<table>
<thead>
<tr>
<th>China</th>
<th>European Union</th>
<th>United States</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

**Imports elasticity**

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<th>United States</th>
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<td>[ \mu m_3^E = -1 ]</td>
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<td>[ \mu m_4^S = 0.5 ]</td>
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<tr>
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<td>[ \mu m_5^E = 1 ]</td>
<td>[ \mu m_5^S = 0.8 ]</td>
</tr>
</tbody>
</table>
Parameters of the model with flexible prices

Export prices: $\rho_{m}^e = \rho_{sf}^e = 0$ (price maker)

GDP price: $\mu = 0$, $\pi_1^e = 0.15$, $\pi_2^e = 0.12\log2$

Wage equations: $\lambda_1^e = 0.5$, $\lambda_2^e = 1$, $\lambda_3^e = 0.1\log2$, $\lambda_4^e = 1$

Labour productivity: $\phi_0 = 0.02$, $\phi_1 = 0$

**Sensitivity tests**

**Figure 12:** Sensitivity tests regarding the structure of China's foreign reserves

Loss of United States competitiveness towards China
Figure 13: Sensitivity tests regarding the imports elasticity $\mu u_1$
Increase of United States public expenditures (1% of GDP)
(Dollar-Yuan floating)
Figure 14: Sensitivity tests regarding the imports elasticity $\mu_2$
Loss of United States competitiveness towards China
(Dollar-Yuan floating)
Figure 15: Sensitivity tests regarding the adjustment parameters of the exchange rate XR2
Loss of United States competitiveness towards China

Tables below give the coefficient of dispersion of relative deviations with regard to baseline (b) for
different sets of coefficients in the case of shock (loss of US competitiveness towards China or a demand
shock). For example, in the case of propensity to consume equal to 0.8 in the basic model or 0.9 in the
sensitivity test, we obtain for the relative deviation of European GDP (\(Y^c\)) the following coefficient of
dispersion measured in absolute value:

\[
\frac{y^c_b - y^c}{y^c_b}
\]

\(\alpha_b = 0.9 \quad \frac{y^c_b - y^c}{y^c_b}
\]

\(\alpha_b = 0.8
\)

For the current account balance in % of GDP (CAB) the coefficient of dispersion is measured with the
simple deviation:
On the whole, the coefficients of dispersion of relative deviations with regard to baseline (measured in %) appear small. It illustrates the relative stability of the model regarding the value of the different parameters. Results are given for the model with floating yuan.

Table 7: Coefficient of dispersion of relative deviations with regard to baseline (in %)

<table>
<thead>
<tr>
<th>$\alpha_t^e = 0.8$</th>
<th>$Y^\nu$</th>
<th>$Y^\varepsilon$</th>
<th>$Y^\delta$</th>
<th>$x_r1$</th>
<th>$CAB^\nu$</th>
<th>$CAB^\varepsilon$</th>
<th>$CAB^\delta$</th>
</tr>
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<td>0.7</td>
<td>1970</td>
<td>0.15</td>
<td>0.00</td>
<td>0.17</td>
<td>0.00</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>0.08</td>
<td>0.00</td>
<td>0.09</td>
<td>0.05</td>
<td>0.02</td>
<td>0.00</td>
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<td>0.9</td>
<td>1970</td>
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<td>0.20</td>
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<td>0.02</td>
</tr>
<tr>
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<td>0.09</td>
<td>0.00</td>
<td>0.10</td>
<td>0.05</td>
<td>0.03</td>
<td>0.00</td>
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<table>
<thead>
<tr>
<th>$\lambda_t^e = 0.75$</th>
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<th>$Y^\varepsilon$</th>
<th>$Y^\delta$</th>
<th>$x_r1$</th>
<th>$CAB^\nu$</th>
<th>$CAB^\varepsilon$</th>
<th>$CAB^\delta$</th>
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<tbody>
<tr>
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<td>0.03</td>
<td>0.00</td>
<td>0.06</td>
<td>0.12</td>
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<td></td>
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<td>0.14</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
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<td>0.06</td>
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<th>$x_r1$</th>
<th>$CAB^\nu$</th>
<th>$CAB^\varepsilon$</th>
<th>$CAB^\delta$</th>
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<th>$x_r1$</th>
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<th>$CAB^\delta$</th>
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<th>$Y^\delta$</th>
<th>$x_r1$</th>
<th>$CAB^\nu$</th>
<th>$CAB^\varepsilon$</th>
<th>$CAB^\delta$</th>
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<th>$Y^\delta$</th>
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<th>$CAB^\nu$</th>
<th>$CAB^\varepsilon$</th>
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$\alpha_t^e$ = European propensity to consume
$\lambda_t^e$ = European wage share
$\gamma_{20}^e$ = US bills’ share in European households’ assets
$\mu m_3^2$ = imports volume elasticity
\( \mu \) = imports price elasticity
\( \gamma \) = exchange rate's adjustment parameter on the reserves

Shock of loss of US competitiveness towards China, except for \( \mu \) with a demand shock (increase of US public expenditures)

**Equations of the model with fixed yuan-dollar parity and fixed prices**

**Equilibrium of goods and services**

1. \[ Y^e \equiv C^e + G^e + I^e + X^e - IM^e \]
2. \[ Y^s \equiv C^s + G^s + I^s + X^s - IM^s \]
3. \[ Y^y \equiv C^y + G^y + I^y + X^y - IM^y \]

**Exports**

4. \[ X^e = X^e_s + X^e_y \]
5. \[ X^s = IM^s_e \cdot x_{r1} \]
6. \[ X^y = IM^y_e / x_{r3} \]

7. \[ X^s = X^s_e + X^s_y \]
8. \[ X^e = IM^e_s / x_{r1} \]
9. \[ X^y = IM^y_s / x_{r2} \]

10. \[ X^v = X^v_e + X^v_y \]
11. \[ X^v = IM^v_e \cdot x_{r3} \]
12. \[ X^v = IM^v_s \cdot x_{r2} \]

**Imports**

13. \[ IM^e = IM^e + IM^e_y \]
14. \[ IM^s = IM^s + IM^s_y \]
15. \[ IM^y = IM^y + IM^y_y \]

16. \[ \log IM^e = \mu_m^e + \mu_m^e \cdot \log S^e_{t-1} + \mu_m^e \cdot \log (x_{r1_{t-1}}) \]
17. \[ \log IM^s = \mu_m^s + \mu_m^s \cdot \log S^s_{t-1} + \mu_m^s \cdot \log (x_{r3_{t-1}}) \]
18. \[ \log IM^e = \mu_m^e + \mu_m^e \cdot \log S^e_{t-1} + \mu_m^e \cdot \log (x_{r1_{t-1}}) \]
19. \[ \log IM^s = \mu_m^s + \mu_m^s \cdot \log S^s_{t-1} + \mu_m^e \cdot \log (x_{r2_{t-1}}) \]
20. \[ \log IM^v = \mu_m^e + \mu_m^e \cdot \log S^e_{t-1} - \mu_m^e \cdot \log (x_{r3_{t-1}}) \]
21. \[ \log IM^s = \mu_m^s + \mu_m^s \cdot \log S^s_{t-1} - \mu_m^e \cdot \log (x_{r2_{t-1}}) \]

Sales equal domestic and foreign demand in each country

22. \[ S^e = C^e + G^e + I^e + X^e \]
23. \[ S^s = C^s + G^s + I^s + X^s \]
24. \[ S^y = C^y + G^y + I^y + X^y \]
Households

Disposal income

\[
\gamma^{d,e} = W^e + r_{t-1}^e B_{e,d,t-1}^e + r_{t-1}^s B_{e,d,t-1}^s + r_{t-1}^v B_{e,d,t-1}^v + r_{d,t-1}^e M_{t-1}^e - T^e
\]

Haig-Simons disposal income including capital gains

\[
\gamma^{d,s} = W^s + r_{t-1}^s B_{s,d,t-1}^s + r_{t-1}^v B_{s,d,t-1}^v + r_{t-1}^s M_{t-1}^s - T^s
\]

\[
\gamma^{d,v} = W^v + r_{t-1}^v B_{v,d,t-1}^v + r_{t-1}^s B_{v,d,t-1}^s + r_{t-1}^v M_{t-1}^v - T^v
\]

Taxes

\[
T^e = \theta^e \ast (W^e + r_{t-1}^e B_{e,d,t-1}^e + r_{t-1}^s B_{e,d,t-1}^s + r_{t-1}^v B_{e,d,t-1}^v + r_{d,t-1}^e M_{t-1}^e)
\]

\[
T^s = \theta^s \ast (W^s + r_{t-1}^s B_{s,d,t-1}^s + r_{t-1}^v B_{s,d,t-1}^v + r_{t-1}^s M_{t-1}^s)
\]

\[
T^v = \theta^v \ast (W^v + r_{t-1}^v B_{v,d,t-1}^v + r_{t-1}^s B_{v,d,t-1}^s + r_{t-1}^v M_{t-1}^v)
\]

Households’ consumption with wealth effect

\[
C^e = \alpha^e Y_{hs}^{d,e} + \alpha^s V_{h,t-1}^e
\]

\[
C^s = \alpha^s Y_{hs}^{d,s} + \alpha^s V_{h,t-1}^s
\]

\[
C^v = \alpha^v Y_{hs}^{d,v} + \alpha^s V_{h,t-1}^v
\]

Households’ wealth accumulation

\[
\Delta V^e_{h} = Y_{hs}^{d,e} - C^e
\]

\[
\Delta V^s_{h} = Y_{hs}^{d,s} - C^s
\]

\[
\Delta V^v_{h} = Y_{hs}^{d,v} - C^v
\]

Households’ bonds demand

\[
B_{e,d}^e = V_{h}^e (Y_{10} + Y_{11} r^e + Y_{12} r^s + Y_{13} r^v + Y_{14} r^d)
\]

\[
B_{s,d}^e = V_{h}^e (Y_{20} + Y_{21} r^e + Y_{22} r^s + Y_{23} r^v + Y_{24} r^d)
\]

\[
B_{v,d}^e = V_{h}^e (Y_{30} + Y_{31} r^e + Y_{32} r^s + Y_{33} r^v + Y_{34} r^d)
\]

\[
M^e_d = V_{h}^e (Y_{40} + Y_{41} r^e + Y_{42} r^s + Y_{43} r^v + Y_{44} r^d)
\]

\[
B_{s,d}^s = V_{h}^s (Y_{10} + Y_{11} r^e + Y_{12} r^s + Y_{13} r^v + Y_{14} r^d)
\]

\[
B_{s,d}^s = V_{h}^s (Y_{20} + Y_{21} r^e + Y_{22} r^s + Y_{23} r^v + Y_{24} r^d)
\]

\[
B_{v,d}^s = V_{h}^s (Y_{30} + Y_{31} r^e + Y_{32} r^s + Y_{33} r^v + Y_{34} r^d)
\]

\[
M^s_d = V_{h}^s (Y_{40} + Y_{41} r^e + Y_{42} r^s + Y_{43} r^v + Y_{44} r^d)
\]

\[
B_{s,d}^v = V_{h}^v (Y_{10} + Y_{11} r^e + Y_{12} r^s + Y_{13} r^v + Y_{14} r^d)
\]

\[
B_{s,d}^v = V_{h}^v (Y_{20} + Y_{21} r^e + Y_{22} r^s + Y_{23} r^v + Y_{24} r^d)
\]

\[
B_{v,d}^v = V_{h}^v (Y_{30} + Y_{31} r^e + Y_{32} r^s + Y_{33} r^v + Y_{34} r^d)
\]

\[
M^v_d = V_{h}^v (Y_{40} + Y_{41} r^e + Y_{42} r^s + Y_{43} r^v + Y_{44} r^d)
\]
\( M_d^e = V_n^e - B_{e,d}^e - B_{d}^s - B_{e}^v \)
\( M_d^s = V_n^s - B_{s,d}^s - B_{s}^e - B_{v}^s \)
\( M_d^v = V_n^v - B_{v,d}^v - B_{e}^v - B_{s}^v \)

Government
\( \Delta B_s^e = G^e - T^e + r_{t-1} B_{s,t-1}^e - P_{CB}^e \)
\( \Delta B_s^s = G^s - T^s + r_{t-1} B_{s,t-1}^s - P_{CB}^s \)
\( \Delta B_s^v = G^v - T^v + r_{t-1} B_{s,t-1}^v - P_{CB}^v \)

\( p_{CB}^e = r_{t-1} B_{CB,s,t-1}^e + r_{t-1} B_{CB,s,t-1}^s + r_{t-1} M_{t-1}^e - r_{d,t-1} M_{t-1}^v \)
\( p_{CB}^s = r_{t-1} B_{CB,s,t-1}^s + r_{t-1} B_{CB,s,t-1}^e + r_{d,t-1} M_{t-1}^s \)
\( P_{CB}^v = r_{t-1} B_{CB,s,t-1}^v + r_{t-1} B_{CB,s,t-1}^e + r_{t-1} M_{t-1}^v - r_{d,t-1} M_{t-1}^v \)

\( B_s^e = B_{s}^e + B_{e CB,s}^e + B_{s}^s + B_{s CB,s}^s + B_{v}^s + B_{v CB,s}^v \)
\( B_s^s = B_{s}^s + B_{s CB,s}^s + B_{e}^s + B_{e CB,s}^e + B_{v}^s + B_{v CB,s}^v \)
\( B_s^v = B_{v}^s + B_{v CB,s}^v + B_{s}^e + B_{e CB,s}^e \)

Equilibrium between supply and demand of assets by households
\( B_{e,s}^v = B_{e,d}^v * x r 3 \)
\( B_{e,s}^s = B_{e,d}^s / x r 1 \)
\( B_{e,s}^v = B_{e,d}^v \)
\( B_{s,s}^e = B_{s,d}^e * x r 1 \)
\( B_{s,s}^s = B_{s,d}^s * x r 2 \)
\( B_{s,s}^v = B_{s,d}^v \)

Firms

Wage share
\( W^e = \lambda^e * Y^e \)
\( W^s = \lambda^s * Y^s \)
\( W^v = \lambda^v * Y^v \)

Profit
\( p^e = Y^e - W^e - r_{t-1} L_{t-1}^e \)
\( p^s = Y^s - W^s - r_{t-1} L_{t-1}^s \)
\( p^v = Y^v - W^v - r_{t-1} L_{t-1}^v \)
Investment

\[(76) \quad I^e = \gamma^e(K^{T,e} - K_{t-1}^e) + \delta^e K_{t-1}^e\]
\[(77) \quad K^e = (1 - \delta^e)K_{t-1}^e + I^e\]
\[(78) \quad K^{T,e} = k^e Y_t^s\]
\[(79) \quad \Delta I_d^e = I^e - P^e\]

Firms' wealth

\[(80) \quad V_f^e = K^e - L^e \quad \text{ou} \quad \Delta V_f^e = P^e - \delta^e K^e\]
\[(81) \quad S = \gamma^s(K^{T,s} - K_{t-1}^s) + \delta^s K_{t-1}^s\]
\[(82) \quad K^s = (1 - \delta^s)K_{t-1}^s + I^s\]
\[(83) \quad K^{T,s} = k^s Y_t^s\]
\[(84) \quad \Delta I_d^s = I^s - P^s\]
\[(85) \quad V_f^s = K^s - L^s \quad \text{ou} \quad \Delta V_f^s = P^s - \delta^s K^s\]

\[(86) \quad I^\nu = \gamma^\nu(K^{T,\nu} - K_{t-1}^\nu) + \delta^\nu K_{t-1}^\nu\]
\[(87) \quad K^{T,\nu} = k^\nu Y_t^\nu\]
\[(88) \quad \Delta I_d^\nu = I^\nu - P^\nu\]
\[(89) \quad V_f^\nu = K^\nu - L^\nu \quad \text{ou} \quad \Delta V_f^\nu = P^\nu - \delta^\nu K^\nu\]

Banks

\[(91) \quad M_s^e = L_s^e + B_{e,\text{CB},s}^e + B_{e,\text{CB},s}^s \times x_r 1 - V_{CB}^e\]
\[(92) \quad M_s^s = M_d^s\]
\[(93) \quad L_s^e = L_d^e\]
\[(94) \quad M_s^s = L_s^s + B_{s,\text{CB},s}^s + B_{s,\text{CB},s}^e \times x_r 1 - V_{CB}^s\]
\[(95) \quad M_s^s = M_d^s\]
\[(96) \quad L_s^s = L_d^s\]

\[(97) \quad M_s^\nu = L_s^\nu + B_{\nu,\text{CB},s}^\nu + B_{\nu,\text{CB},s}^e \times x_r 3 + B_{\nu,\text{CB},s}^s \times x_r 2 - V_{CB}^\nu\]
\[(98) \quad M_s^\nu = M_d^\nu\]
\[(99) \quad L_s^\nu = L_d^\nu\]

Equilibrium between bonds supply and demand by banks

\[(100) \quad B_{e,\text{CB},d}^e = B_{e,\text{CB},s}^e\]
\[(101) \quad B_{s,\text{CB},d}^s = B_{s,\text{CB},s}^s\]
\[(102) \quad B_{\nu,\text{CB},d}^\nu = B_{\nu,\text{CB},s}^\nu\]
\[(103) \quad B_{e,\text{CB},d}^e = B_{e,\text{CB},s}^e \times x_r 3\]
\[(104) \quad B_{s,\text{CB},d}^s = B_{s,\text{CB},s}^s / x_r 1\]
\[(105) \quad B_{e,\text{CB},d}^s = B_{e,\text{CB},s}^s \times x_r 1\]
\[(106) \quad B_{\nu,\text{CB},d}^s = B_{\nu,\text{CB},s}^s \times x_r 2\]
The US Central Bank has no reserves

(107) \( B_{\xi,CB,s}^e = 0 \)

Banks’ wealth

(108) \( \Delta \nu_{CB}^{\xi} = B_{\xi,CB,s,t-1}^{\xi} * \Delta r_1 \)

(109) \( \Delta \nu_{CB}^{\xi} = B_{\xi,CB,s,t-1}^{\xi} * \Delta \left( \frac{1}{x_{r1}} \right) = 0 \)

(110) \( \Delta \nu_{CB}^{\xi} = B_{\xi,CB,s,t-1}^{\xi} * \Delta r_3 + B_{\xi,CB,s,t-1}^{\xi} * \Delta r_2 \)

Interest rates exogenous

\( r = r_d = r_l \)

Exchange rate determination

(22 bis) \( x_{r1} = B_{x,d}^{\xi}/B_{x,s}^{\xi} \)

(111) \( B_{x,CB}^{\xi} = \text{constant} \)

(112) \( x_{r3} = x_{r2}/x_{r1} \)

(113) \( B_{\xi,CB,d}^{\xi} = \text{constant} \)

All the accounting equations are written, except one. Equation (20) describing the equilibrium between supply and demand of European bonds will not be written.

On the whole, our model contains 112 equations for 112 endogenous variables with G exogenous.

Current account balance (CAB) and capital account balance (KAB)

\[
\begin{align*}
\text{CAB}^e &= X^e - IM^e + r_{t-1}^s B_{e,d,t-1}^s + r_{t-1}^y B_{e,y,d,t-1}^y + r_{t-1}^s B_{e,CB,d,t-1}^s - r_{t-1}^e (B_{e,t-1}^e - B_{e,s,t-1}^e) \\
\text{CAB}^s &= X^s - IM^s + r_{t-1}^e B_{x,d,t-1}^e + r_{t-1}^y B_{x,y,d,t-1}^y - r_{t-1}^s (B_{x,t-1}^s - B_{x,s,t-1}^s - B_{x,CB,s,t-1}^s) \\
\text{CAB}^y &= X^y - IM^y + r_{t-1}^e B_{y,d,t-1}^e + r_{t-1}^y B_{y,y,d,t-1}^y + r_{t-1}^e B_{y,CB,d,t-1}^e + r_{t-1}^y B_{y,y,CB,d,t-1} - \\
& r_{t-1}^y (B_{y,t-1}^y - B_{y,s,t-1}^y - B_{y,y,CB,s,t-1}^y) \\
\text{KAB}^e &= (\Delta B_{\xi,s}^e + \Delta B_{\xi,y,s}^e + \Delta B_{\xi,CB,s}^e) - (\Delta B_{\xi,d}^e + \Delta B_{\xi,y,d}^e + \Delta B_{\xi,y,CB,d}^e) = \text{capital inflows - capital outflows} \\
\text{KAB}^s &= (\Delta B_{\xi,s}^s + \Delta B_{\xi,y,s}^s + \Delta B_{\xi,CB,s}^s) - (\Delta B_{\xi,d}^s + \Delta B_{\xi,y,d}^s) \\
\text{KAB}^y &= (\Delta B_{\xi,y,s}^y + \Delta B_{\xi,y,CB,s}^y) - (\Delta B_{\xi,y,d}^y + \Delta B_{\xi,y,CB,d}^y + \Delta B_{\xi,y,y,CB,d}^y + \Delta B_{\xi,y,y,y,CB,d}^y)
\end{align*}
\]

\[
\begin{align*}
\text{CAB}^e + \text{KAB}^e &= 0 \\
\text{CAB}^s + \text{KAB}^s &= 0 \\
\text{CAB}^y + \text{KAB}^y &= 0
\end{align*}
\]
Equations of the model with floating or managed yuan-dollar parity and fixed prices

Pure floating exchange rate of the yuan-dollar

\[ B_{\text{¥,CB},S}^\$ = \text{constant} \]

Equation (106) is replaced by:

\[ (106\text{bis}) \quad x_r^2 = B_{\text{¥,CB},d}^\$ / B_{\text{¥,CB},S}^\$ \quad \text{(1dollar= x}_r^2 \text{yuans)} \]

Impure floating exchange rate

\[ B_{\text{¥,CB},d}^\$ = \text{constant} \]

\[ (106\text{*}) \quad x_r^2^* = B_{\text{¥,CB},d}^\$ / B_{\text{¥,CB},S}^\$ \]

\[ x_r^2^* = \text{equilibrium exchange rate} \]

\[ (106\text{ter}) \quad x_r^2 = x_r^2_{t-1} + \varepsilon (x_r^2^* - x_r^2_{t-1}) \]

Managed exchange rate regime

\[ (106) \quad B_{\text{¥,CB},d}^\$ = B_{\text{¥,CB},S}^\$ \times x_r^2 \]

With target, either on the reserves in US bonds US \((R_e^{\text{¥}})\) is a percentage of GDP beyond which the yuan is revalued) or on current account \((\text{CAB}_{\text{¥}} / Y_{\text{¥}})^e\) :

\[ x_r^2 = x_r^2_{t-1} + \gamma_1 \left( B_{\text{¥,CB},d}^\$ / Y_{\text{¥}} - R_e^{\text{¥}} \right) \quad \text{or} \quad x_r^2 = x_r^2_{t-1} + \gamma_2 \left( \text{CAB}_{\text{¥}} / Y_{\text{¥}} - (\text{CAB}_{\text{¥}} / Y_{\text{¥}})^e \right) \]
Equations of the model with fixed yuan-dollar parity and flexible prices

Equilibrium of goods and services

(1) to (3) \[ Y^i = C^i + G^i + I^i + X^i - IM^i \]
(4) to (18) \[
\begin{align*}
C^i_v &= C^i * PDI^i \\
G^i_v &= G^i * PDI^i \\
I^i_v &= I^i * PDI^i \\
Y^i_v &= Y^i * PY^i \\
PDI^i &= (Y^i_v + IM^i_v - X^i_v)/(C^i + G^i + I^i)
\end{align*}
\]

Foreign trade

(19) to (21) \[ IM^i = \sum_{j \neq i} IM^j \quad i, j = \varepsilon, $, ¥ \]
(22) to (24) \[ X^i = \sum_{j \neq i} X_j^i \]

(25) \[ IM^i_\varepsilon = X^i_\varepsilon /x_r1_0 \]
(26) \[ IM^i_\$ = X^i_\$ * x_r3_0 \]
(27) \[ IM^i_¥ = X^i_¥ * x_r1_0 \]
(28) \[ IM^i_¥ = X^i_¥ * x_r2_0 \]
(29) \[ IM^i_¥ = X^i_¥ /x_r3_0 \]
(30) \[ IM^i_¥ = X^i_¥ /x_r2_0 \]

Exports

(31) \[ \log X^i_\varepsilon = \mu x_1^\varepsilon + \mu x_2^\varepsilon * log Y^\$ - \mu x_3^\varepsilon * log \left( PX^i_\varepsilon /\left( PY^\$ * x_r1 \right) \right) \]
(32) \[ \log X^i_\$ = \mu x_1^\$ + \mu x_2^\$ * log Y^¥ - \mu x_3^\$ * log \left( PX^i_\$ /\left( x_r3 / PY^¥ \right) \right) \]
(33) \[ \log X^i_¥ = \mu x_1^¥ + \mu x_2^¥ * log Y^¥ - \mu x_3^¥ * log \left( PX^i_¥ /\left( x_r2 / PY^¥ \right) \right) \]
(34) \[ \log X^i_¥ = \mu x_1^¥ + \mu x_2^¥ * log Y^¥ - \mu x_3^¥ * log \left( PX^i_¥ /\left( x_r3 / PY^¥ \right) \right) \]
(36) \[ \log X^i_¥ = \mu x_1^¥ + \mu x_2^¥ * log Y^¥ - \mu x_3^¥ * log \left( PX^i_¥ /\left( x_r2 / PY^¥ \right) \right) \]

Export and import prices

(37) \[ \log PX^i_\varepsilon = \rho_1^\varepsilon + \rho_2^\varepsilon * log PY^\$ / x_r1 + \left( 1 - \rho_2^\varepsilon \right) * log \left( PY^\$ \right) \]
(38) \[ \log PX^i_\$ = \rho_1^\$ + \rho_2^\$ * log PY^¥ /x_r3 + \left( 1 - \rho_2^\$ \right) * log \left( PY^¥ \right) \]
(39) \[ \log PX^i_¥ = \rho_1^¥ + \rho_2^¥ * log PY^¥ /x_r1 + \left( 1 - \rho_2^¥ \right) * log \left( PY^¥ \right) \]
(40) \[ \log PX^i_¥ = \rho_1^¥ + \rho_2^¥ * log PY^¥ /x_r2 + \left( 1 - \rho_2^¥ \right) * log \left( PY^¥ \right) \]
(41) \[ \log PX^i_¥ = \rho_1^¥ + \rho_2^¥ * log PY^¥ /x_r3 + \left( 1 - \rho_2^¥ \right) * log \left( PY^¥ \right) \]
(42) \[ \log PX^i_¥ = \rho_1^¥ + \rho_2^¥ * log PY^¥ /x_r2 + \left( 1 - \rho_2^¥ \right) * log \left( PY^¥ \right) \]

(43) to (51) \[
\begin{align*}
PX^i &= \frac{\left( \sum_{j \neq i} X^i_j \right) \cdot PX^i}{X^i} \\
PIM^i &= IM^i_\varepsilon / IM^i
\end{align*}
\]
(52) \[ IM^e_v = X^e \cdot P X^e \cdot \frac{X^e}{X^e \cdot P X^e} \]  
(53) \[ IM^s_v = X^s \cdot P X^s \cdot \frac{X^s}{X^s \cdot P X^s} \]  
(54) \[ IM^s_v = X^s \cdot P X^s \cdot \frac{X^s}{X^s \cdot P X^s} \]

**Households' bonds demand**

(55) to (57) \[ Y^{d,i}_v = W^i + r^i - B^{i}_{i,d,t-1} + \sum_{j(f \neq i)} r^j - B^{j}_{j,d,t-1} + r^i - M^{i}_{d,t-1} - T^i \]  
\[ i,j = \€, \$, \¥ \]

(58) \[ v^{d,e}_{v,hs} = Y^{d,e}_v + \Delta(x + r)B^e_{s,t-1} + \Delta(\frac{1}{r^e})B^e_{e,s,t-1} \]
(59) \[ v^{d,s}_{v,hs} = Y^{d,s}_v + \Delta(\frac{1}{r^s})B^s_{s,s,s,t-1} + \Delta(\frac{1}{r^s})B^s_{s,s,s,t-1} \]
(60) \[ v^{d,y}_{v,hs} = Y^{d,y}_v + \Delta(x - r)B^y_{y,s,s,t-1} + \Delta(x - r)B^y_{y,y,s,t-1} \]

**Taxes**

(61) to (63) \[ T^i = \theta^i \cdot (W^i + r^i - B^{i}_{i,d,t-1} + \sum_{j(f \neq i)} r^j - B^{j}_{j,d,t-1} + r^i - M^{i}_{d,t-1}) \]
\[ i,j = \€, \$, \¥ \]

**Consumption with wealth effect**

(64) to (69) \[ C^i = \alpha^1 v^{d,i}_{v,hs} + \alpha^2 v^{d,y}_{v,hs} \]  
\[ \Delta v^i_{v,hs} = v^{d,i}_{v,hs} - C^i \]

**Real income and wealth**

(70) to (75) \[ Y^{d,i}_{hs} = \frac{v^{d,i}_{v,hs}}{P^{DI}} - V^{i}_{v,h,t-1} \cdot \frac{\Delta P^{DI}}{P^{DI}} \]  
\[ i = \€, \$, \¥ \]

**Households' demand**

(76) \[ B^{e}_{e,d} = V^{e}_{e,h} (y^{e}_{0} + y^{e}_{11} r^{e} + y^{e}_{12} r^{s} + y^{e}_{13} r^{y} + y^{e}_{14} r^{d}) \]
(77) \[ B^{s}_{e,d} = V^{e}_{e,h} (y^{e}_{20} + y^{e}_{21} r^{e} + y^{e}_{22} r^{s} + y^{e}_{23} r^{y} + y^{e}_{24} r^{d}) \]
(78) \[ B^{y}_{e,d} = V^{e}_{e,h} (y^{e}_{30} + y^{e}_{31} r^{e} + y^{e}_{32} r^{s} + y^{e}_{33} r^{y} + y^{e}_{34} r^{d}) \]
(79 bis) \[ M^{e}_{d} = V^{e}_{e,h} (y^{e}_{40} + y^{e}_{41} r^{e} + y^{e}_{42} r^{s} + y^{e}_{43} r^{y} + y^{e}_{44} r^{d}) \]

(80) \[ B^{s}_{s,d} = V^{s}_{s,h} (y^{s}_{0} + y^{s}_{11} r^{e} + y^{s}_{12} r^{s} + y^{s}_{13} r^{y} + y^{s}_{14} r^{d}) \]
(81) \[ B^{e}_{e,d} = V^{s}_{s,h} (y^{s}_{20} + y^{s}_{21} r^{e} + y^{s}_{22} r^{s} + y^{s}_{23} r^{y} + y^{s}_{24} r^{d}) \]
(82) \[ B^{y}_{e,d} = V^{s}_{s,h} (y^{s}_{30} + y^{s}_{31} r^{e} + y^{s}_{32} r^{s} + y^{s}_{33} r^{y} + y^{s}_{34} r^{d}) \]
(83 bis) \[ M^{s}_{d} = V^{s}_{s,h} (y^{s}_{40} + y^{s}_{41} r^{e} + y^{s}_{42} r^{s} + y^{s}_{43} r^{y} + y^{s}_{44} r^{d}) \]

(84) \[ B^{e}_{y,d} = V^{e}_{e,h} (y^{e}_{0} + y^{e}_{11} r^{e} + y^{e}_{12} r^{s} + y^{e}_{13} r^{y} + y^{e}_{14} r^{d}) \]
(85) \[ B^{s}_{e,d} = V^{e}_{e,h} (y^{s}_{20} + y^{s}_{21} r^{e} + y^{s}_{22} r^{s} + y^{s}_{23} r^{y} + y^{s}_{24} r^{d}) \]
(86) \[ B^{y}_{e,d} = V^{s}_{s,h} (y^{s}_{30} + y^{s}_{31} r^{e} + y^{s}_{32} r^{s} + y^{s}_{33} r^{y} + y^{s}_{34} r^{d}) \]
(87 bis) \[ M^{e}_{d} = V^{e}_{e,h} (y^{e}_{40} + y^{e}_{41} r^{e} + y^{e}_{42} r^{s} + y^{e}_{43} r^{y} + y^{e}_{44} r^{d}) \]
\[(79), (83) \text{ and } (87) \quad M^i_d = V^i_{v,h} - B^i_{l,d} - (\sum_{j \neq i} B^j_{l,d}) \quad i, j = \text{€, $, ¥} \]

**Government**

\[(88) \text{ to } (90) \quad \Delta B^i_s = G^i_v - T^i + r^i_{t-1}B^i_{s,t-1} - P^i_{CB} \quad i = \text{€, $, ¥} \]

\[(91) \quad P^e_{CB} = r^{e}_{t-1}B^e_{s,\text{CB},s,t-1} + r^s_{t-1}B^s_{s,\text{CB},s,t-1} \ast x + r^{e}_{t-1}L^e_{t-1} - r^e_{d,t-1}M^e_{t-1} \]

\[(92) \quad P^s_{CB} = r^{s}_{t-1}B^s_{s,\text{CB},s,t-1} + r^e_{t-1}B^e_{s,\text{CB},s,t-1} \ast x + r^s_{t-1}L^s_{t-1} - r^s_{d,t-1}M^s_{t-1} \]

\[(93) \quad P^v_{CB} = r^{v}_{t-1}B^v_{s,\text{CB},s,t-1} + r^s_{t-1}B^s_{s,\text{CB},s,t-1} \ast x + r^v_{t-1}B^v_{s,\text{CB},s,t-1} \ast x + r^v_{t-1}L^v_{t-1} - r^v_{d,t-1}M^v_{t-1} \]

\[(94) \text{ to } (96) \quad B^i_s = B^i_{i,s} + B^i_{i,\text{CB},s} + \sum_{j \neq i} B^j_{j,s} + \sum_{j \neq i} B^j_{j,\text{CB},s} \quad i, j = \text{€, $, ¥} \]

\[(97) \text{ to } (99) \quad B^i_{i,s} = B^i_{i,d} \quad i = \text{€, $, ¥} \]

\[(100) \quad B^v_{i,s} = B^v_{i,d} \ast x + 3 \]

\[(101) \quad B^v_{i,s} = B^v_{i,d} \ast x + 1 \]

\[(102) \quad B^v_{i,s} = B^v_{i,d} \ast x + 1 \]

\[(103) \quad B^v_{i,s} = B^v_{i,d} \ast x + 2 \]

\[(104) \quad B^v_{i,s} = B^v_{i,d} \ast x + 2 \]

\[(105) \quad B^v_{i,s} = B^v_{i,d} \ast x + 2 \]

**Firms**

\[(106) \text{ to } (129) \quad W^i = w^i \ast N^i \quad i = \text{€, $, ¥} \]

\[p^i = Y^i_v - W^i - r^i_{t-1}L^i_{t-1} \]

\[l^i = \gamma^i (K^{T,i} - K^i_{t-1}) + \delta^i K^i_{t-1} \]

\[K^i = (1 - \delta^i)K^i_{t-1} + I^i \]

\[\Delta K^i_{t-1} = L^i - p^i \]

\[V^i_{v,f} = K^i_v - L^i_d \quad \text{or} \quad \Delta V^i_{v,f} = p^i - \delta^i K^i_v \]

\[K^i_v = K^i \ast PD^i \quad \text{or} \quad K^i_v = K^i_{v,t-1} + PD^i * \Delta K^i + K^i_{v,t-1} * \Delta PD^i \]

**Banks**

\[(130) \text{ to } (146) \quad M^e_s = L^e_s + B^e_{s,\text{CB},s} + B^e_{s,\text{CB},s} \ast x + 1 - V^e_{v,\text{CB}} \]

\[M^s_s = L^s_s + B^s_{s,\text{CB},s} + B^s_{s,\text{CB},s} / x + 1 - V^e_{v,\text{CB}} \]

\[M^v_s = L^v_s + B^v_{s,\text{CB},s} + B^e_{s,\text{CB},s} \ast x + 3 + B^s_{s,\text{CB},s} \ast x + 2 - V^v_{v,\text{CB}} \]

\[M^i_s = M^i_d \quad i, j = \text{€, $, ¥} \]

\[L^i_s = L^i_d \quad i = \text{€, $, ¥} \]
\[ B_{i,\text{CB},d} = B_{i,\text{CB},s} \quad i = \text{€, $, ¥} \]
\[ B_{\text{€},\text{CB},s} = B_{\text{€},\text{CB},d} * xr1 \]
\[ B_{\text{¥},\text{CB},s} = B_{\text{¥},\text{CB},d}/xr3 \]
\[ B_{\text{¥},\text{CB},d} = B_{\text{¥},\text{CB},s} * xr2 \]
\[ B_{\text{€},\text{CB},s} = B_{\text{€},\text{CB},d}/xr1 \]
\[ B_{\text{¥},\text{CB},d} = 0 \]

(147) \[ \Delta V_{\text{€},\text{CB}} = B_{\text{€},\text{CB},s,t-1} * \Delta xr1 \]
(148) \[ \Delta V_{\text{¥},\text{CB}} = B_{\text{¥},\text{CB},s,t-1} * \Delta \left( \frac{1}{xr1} \right) = 0 \]
(149) \[ \Delta V_{\text{¥},\text{CB}} = B_{\text{¥},\text{CB},s,t-1} * \Delta xr3 + B_{\text{¥},\text{CB},s,t-1} * \Delta xr2 \]

(150) to (152) \[ r^i = r^* + 0.8 * (\Delta logPDI - 0.02) \quad i = \text{€, $, ¥} \]
\[ r^i = r^d = r^i = rt^i \]

Prices-wages

(153) to (173) \[ logPY_{\text{des}} = \mu^i * logPM^i + (1 - \mu^i) * log(w^i / PR^i) \]
\[ logPY^i = \pi_0^i + \pi_1^i * log(PY_{\text{des}}^i) + (1 - \pi_1^i) * log(PY_{t-1}^i) + \pi_2^i * log(TUC^i) \]
\[ logw^i = \lambda_1^i * log(w_{\text{des}}^i) + (1 - \lambda_1^i)w_{t-1}^i \]
\[ logw_{\text{des}}^i = \lambda_2^i * logPDI^i + \lambda_3^i * logTUC^i + \lambda_4^i * logPR^i \]
\[ TUC^i = Y^i / K^i \]
\[ \Delta logPR^i = \phi_0^i + \phi_1^i \Delta logY^i \]
\[ N^i = Y^i / PR^i \]

Exchange rate determination with a fixed dollar-yuan parity (xr2=constant)
(34 bis) \[ xr1 = B_{\text{€,d}} / B_{\text{¥,s}} \]
(174) \[ B_{\text{¥,CB}} = \text{constant} \]
(175) \[ xr3 = xr2/xr1 \]
(176) \[ B_{\text{¥,CB},d} = \text{constant} \]

All the accounting equations are written, except one. Equation (32) describing the equilibrium between supply and demand of European bonds will not be written.

On the whole, our model contains 176 equations for 176 endogenous variables. The closure of the model is realised in the same way as previously for the other exchange rate regimes.

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