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**World imbalances, exchange rates and macroeconomic adjustments:  
a stock flow consistent approach**

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**Abstract:**

*World imbalances have been partly reduced since 2007 but Asian surpluses remain huge. World macroeconomic adjustments are usually analysed with general equilibrium model or simpler portfolio models which are not always consistent at the world level in terms of assets and consider that all the adjustments are realised through relative prices with production remaining constant. Stock flow consistent (SFC) models in the lines of Godley and Lavoie (2004) and Zhao and Lavoie (2008) are more appropriate, as 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. Three SFC three countries models have been 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 Chinese Central Bank's targeted policy on the level of the current account or of the reserves, the third one being a generalisation of the two others with flexible prices instead of constant prices.*

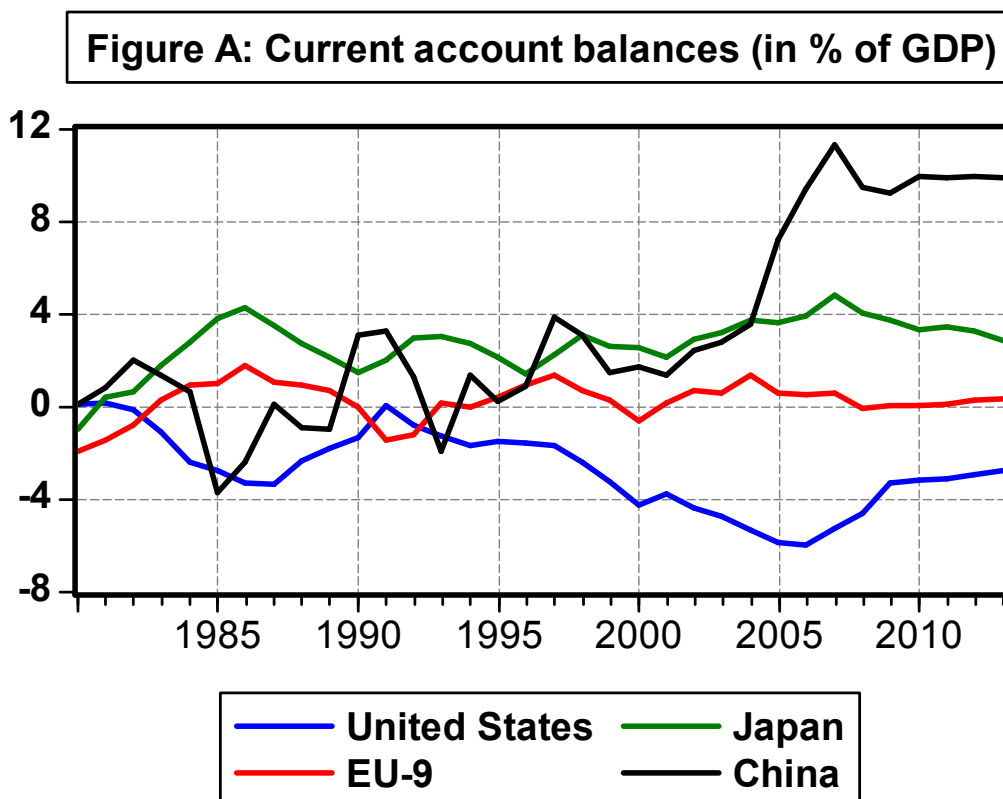
*In the first configuration, with fixed dollar-yuan parity, supply shocks like a loss of competitiveness have a significant impact on world imbalances. Initial shocks are partly compensated thanks to the euro-dollar variations but the fixity of the dollar-yuan parity limits the adjustments at the benefit of China and at the expense of the USA and the EU. The introduction of a diversification of China's foreign reserves changes the adjustments mechanisms at the international level, mainly at the expense of the EU due to the dollar depreciation, but not in a radical manner.*

*In the second configuration a flexible dollar-yuan exchange rate appears as a powerful adjustment mechanism to reduce world imbalances characterised by a US deficit and a Chinese surplus. The contrast is clear with the first configuration where only the euro-dollar exchange rate was floating. A freely floating yuan is unrealistic in the actual state of the Chinese monetary and financial system. But more managed exchange rate regimes for the dollar-yuan parity, where the Chinese Central Bank intervenes to reach a target, either on foreign reserves in dollars or on current account level, give rather similar adjustment mechanisms. Lastly, the model with flexible prices has confirmed the main results obtained with fixed prices, although some differences might appear for some evolutions.*

Key words: Three-country model; world imbalances; dollar, euro, yuan exchange rates  
JEL classification: F41, F42, F47

## 1. Introduction

World imbalances have been increasing since the end of the 1990s with a large US current account deficit facing Asian surpluses, mainly Chinese and Japanese ones (figure A). 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, in spite of the “Bretton Woods 2” thesis which has been sometimes advocated. They reflect internal imbalances in each area, mainly the over-indebtedness of US households and declining US competitiveness on the one hand, the insufficient Chinese consumption on the other hand. These world imbalances have been lasting thanks to the financial liberalisation which made their financing easier. The actual financial crisis has been the consequence of these imbalances, starting with the US subprime market and diffusing at the world level. Since 2007 partial adjustments have been achieved, mainly through the effects of the production decline which has reduced imports of the deficit countries and cut the exports of the surplus countries, but the Asian surpluses remain huge.



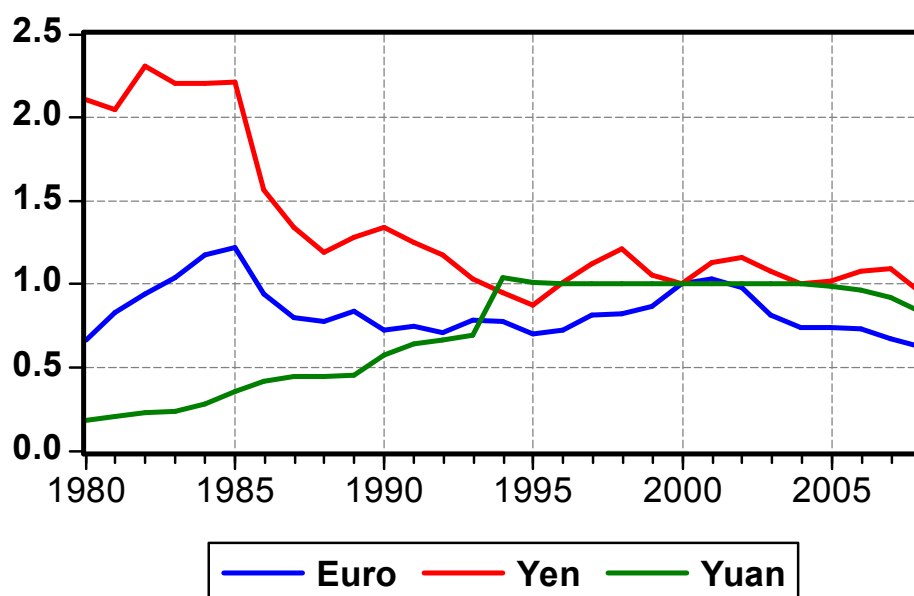
Source: IMF (2009 P)

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 between 1995 and 2002 against the euro and the yen, 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 appreciation since 2005 (figure B). During the first part of 2009 the dollar has been stronger

while the yuan has stopped its moderate appreciation. In real effective terms evolutions are slightly different. The real depreciation of the dollar has been rather moderate between 2002 and 2008 with opposite evolution of the euro and the yen. The euro has appreciated significantly, in sharp contrast with the real depreciation of the yen. Lastly the yuan has only slightly appreciated (figure C).

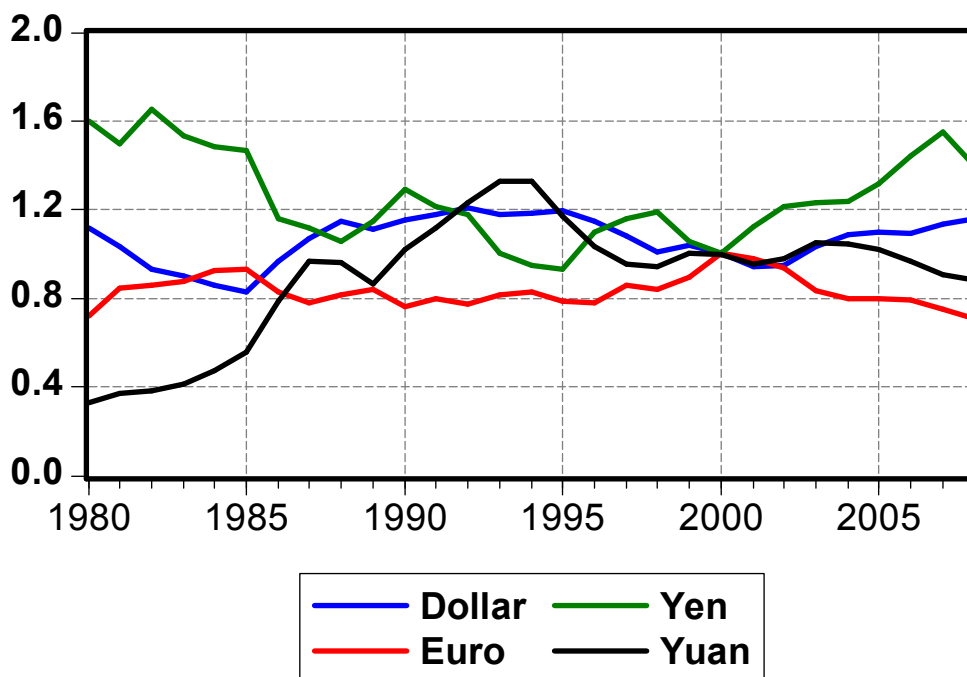
These evolutions can contribute to explain the remaining world imbalances. The depreciation of the dollar has been too limited to have a sufficient impact on the US deficit. The yen's real depreciation until 2008 and the persistency of a large undervaluation of the yuan have amplified the external surpluses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

**Figure B: Bilateral nominal exchange rates against US dollar  
(base 1 in 2000)**



Source: OECD

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



Source: BIS (2009P)

These global imbalances can be studied in various ways. World macroeconomic adjustments are usually analysed with general equilibrium model (Obstfeld and Rogoff, 2005) or more simple portfolio models (Blanchard et al., 2005) which give 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. Especially, they consider that all the adjustments are realised through relative prices with production and income remaining constant, which is rather unrealistic facing large dollar depreciation. This hypothesis doesn't fit also with the sharp decline of the actual crisis. Stock flow consistent (SFC) models in the lines of Godley and Lavoie (2007a, b) and Zhao and Lavoie (2008) are more appropriate, as 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 actual crisis.

The paper is organized as follow. 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 two ones with constant prices, the third one with flexible prices. The first one with fixed dollar-yuan parity includes an active policy of the Chinese Central Bank regarding its reserves' diversification. The second version with a flexible dollar-yuan parity, which can be freely floating or following a Chinese Central Bank's targeted policy on the level of the current account or of the reserves, is presented in a fourth section. The third version generalises the previous ones with flexible prices instead of fixed prices (fifth section). A last section concludes.

## 2. Theoretical background

Applied forecasting macroeconomic models pay few attention to financial sector, due to the difficulty of modelling of the 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 consumers' choices according to relative prices which are formalized in detail. On each market supply and demand adjust through relative prices with production which are supposed to be constant. Using the 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. Last, 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, differential in the 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 of several weaknesses. First, productions are supposed given, which seems rather unrealistic with the amplitude of exchange rate adjustments (around 30% in real terms, of even more) and which doesn't suit with the actual decline of production during the last two years. Second, the model is focused on the real sphere. The link with the financial sphere is realised only through a rigid matrix of the structure of assets and liabilities in each currency without consistent analysis of the stock-flow dynamics. Third, as it is usual in this kind of model, there is no analysis of firms' investment. Last, the model is only in real terms. Inflation is introduced in a very simplified way with the hypothesis 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 the 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 was evaluated (around 40%) and alternative scenarios were built.

The model is more elegant and easier to manage than the previous one. But it suffers of 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, whose supply is taken exogenous. Like in the previous model there is no real capital accumulation. With constant productions and assets, international macroeconomic adjustments are analysed in a too restrictive way. The integration between real and financial variables, although central in the core of the model, appears limited

Stock flow consistent (SFC) models in the lines of Godley and Lavoie (2005) and Lavoie and Zhao (2008) are more appropriate, although less wide spread in the economic literature. 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 and Chinese imbalances. They can include most of ingredients of the previous models, as valuation effects and differences between the rates of return. They do not presuppose that adjustments are limited to relative prices, as production is determined by the global demand like in the Keynesian tradition. Exchange rates result from an implicit determination by confrontation of supply and demand of assets, but depend of adjustments of the whole model. Fixed exchange rate can be introduced in some configuration, as in a simplified version of the Chinese exchange rate policy. These SFC models are also close to Taylor's (2004) approach, but without including an additional exchange rate expectation equation, which is an important difference.

Three SFC three countries models will be considered in this paper. The first one, with constant prices, directly inspired from Zhao and Lavoie (2008) with some simplifications, will mix a floating exchange rate for the euro-dollar parity and a fixed dollar-yuan parity, with a version including an active policy of the Chinese Central Bank regarding its reserves' diversification. The second model will introduce a flexible dollar-yuan parity which can be freely floating or following a Chinese Central Bank's targeted policy on the level of the current account or of the reserves. The third model will generalise the two previous ones by introducing flexible prices.

### **3. A SFC three countries model with fixed dollar-yuan parity**

The world economy is divided in 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. Wage share and prices are supposed 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 (like decline of domestic demand) or supply shock (decline of competitiveness). The impact of a change in the foreign reserves behaviour of the Chinese Central Bank with a diversification in favour of European bonds is also studied.

#### **3.1. The structure of the model**

Each area is composed of four sectors (households, firms, government and banks, including Central Bank). Exchange rates are defined as  $1\$ = x_{r1}\text{€} = x_{r2}\text{¥}$  and  $1\text{€} = 1/x_{r1}\$ = x_{r3}\text{¥}$ . Table 1 describes the balance sheet of each sector. National accounts in flows and equations of the model are given in annex. Equations are given 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 on exchange rate policy and Central Bank behaviour. More realist hypothesis will be introduced later.

**Table 1: The balance sheet of the three areas**

	€ = euro area				\$ = USA				¥ = China				Sum
	H	F	Gov	CB	H	F	Gov	CB	H	F	Gov	CB	
Capital		K <sup>€</sup>				K <sup>\$</sup>				K <sup>¥</sup>			ΣK
Money	M <sup>€</sup>			-M <sup>€</sup>	M <sup>\$</sup>			-M <sup>\$</sup>	M <sup>¥</sup>			-M <sup>¥</sup>	0
Bills €	B <sup>€</sup> <sub>e</sub>		-B <sup>€</sup>	B <sup>€</sup> <sub>cb€</sub>	B <sup>€</sup> <sub>s/xr<sup>1</sup></sub>			B <sup>€</sup> <sub>cb\$/xr<sup>1</sup></sub>	B <sup>€</sup> <sub>¥.xr<sup>3</sup></sub>			B <sup>€</sup> <sub>¥cb.Xr<sup>3</sup></sub>	0
Bills \$	B <sup>€</sup> <sub>e.xr<sup>1</sup></sub>			B <sup>€</sup> <sub>cb€xr<sup>1</sup></sub>	B <sup>\$</sup> <sub>s</sub>		-B <sup>\$</sup>	B <sup>\$</sup> <sub>cb\$</sub>	B <sup>\$</sup> <sub>¥.xr<sup>2</sup></sub>			B <sup>\$</sup> <sub>¥cb.Xr<sup>2</sup></sub>	0
Bills ¥	B <sup>€</sup> <sub>e/xr<sup>1</sup></sub>				B <sup>¥</sup> <sub>s/xr<sup>2</sup></sub>				B <sup>¥</sup> <sub>¥</sub>		-B <sup>¥</sup>	B <sup>¥</sup> <sub>cb¥</sub>	0
Loan		-L <sup>€</sup>		L <sup>€</sup>		-L <sup>\$</sup>		L <sup>\$</sup>		-L <sup>¥</sup>		L <sup>€</sup>	0
Wealth	-V <sup>€</sup> <sub>h</sub>	-V <sup>€</sup> <sub>f</sub>	B <sup>€</sup>	-V <sup>€</sup> <sub>cb</sub>	-V <sup>\$</sup> <sub>h</sub>	-V <sup>\$</sup> <sub>f</sub>	B <sup>\$</sup>	0	-V <sup>¥</sup> <sub>h</sub>	-V <sup>¥</sup> <sub>f</sub>	B <sup>¥</sup>	-V <sup>¥</sup> <sub>cb</sub>	ΣV
Sum	0	0	0	0	0	0	0	0	0	0	0	0	0

*Equilibrium of goods and services*

$$(1) \quad Y^€ \equiv C^€ + G^€ + I^€ + X^€ - IM^€$$

*Foreign trade**Exports*

$$(2) \quad X^€ = X^€_s + X^€_¥$$

$$(3) \quad X^€_s = IM^s_{e.xr^1}$$

$$(4) \quad X^€_¥ = IM^¥_{e/xr^3}$$

*Imports*

$$(5) \quad IM^€ = IM^€_s + IM^€_¥$$

$$(6) \quad \text{Log}IM^€_s = \mu_{e1} + \mu_{e2} \cdot \text{Log}S^€_{-1} - \mu_{e3} \text{Log}xr^1_{-1}$$

$$(7) \quad \text{Log}IM^€_¥ = \mu_{e4} + \mu_{e5} \cdot \text{Log}S^€_{-1} + \mu_{e6} \cdot \text{Log}xr^3_{-1}$$

Sales equal domestic and foreign demand in each country

$$(8) \quad S^€ = C^€ + G^€ + I^€ + X^€$$

*Households**Disposal income*

$$(9) \quad YD^€_r = W^€ + r^€_{-1} \cdot B^€_{ed-1} + r^s_{-1} \cdot B^s_{ed-1} + r^¥_{-1} \cdot B^¥_{ed-1} + r^€_{d-1} M^€_{d-1} - T^€$$

*Haig-Simons disposal income including capital gains*

$$(10) \quad YD^€_{hs} = YD^€_r + \Delta(xr^1) \cdot B^s_{es-1} + \Delta(1/xr^3) \cdot B^¥_{es-1}$$

*Taxes*

$$(11) \quad T^€ = \theta^€ (W^€ + r^€_{-1} \cdot B^€_{ed-1} + r^s_{-1} \cdot B^s_{ed-1} + r^¥_{-1} \cdot B^¥_{ed-1} + r^€_{d-1} M^€_{d-1})$$

*Households' consumption with wealth effect*

$$(12) \quad C^€ = \alpha_{e1} YD^€_{hs} + \alpha_{e2} V^€_{h-1}$$

*Households' wealth accumulation*

$$(13) \quad \Delta V^€_h = YD^€_{hs} - C^€$$

*Households' bonds demand*

According to Godley-Tobin's approach, assets' demand depends of the rate of return of the different assets. For foreign assets expected exchange rates variations would have to be included, which would improve the determination of exchange rates. However this approach raises many difficulties. The model is more difficult to manage. Econometric estimations of this kind of equation are fragile. This question will be developed later on. It can be supposed, for simplicity, following Godley and Lavoie, that expected exchange rate variation is constant (positive or négative) and is considered as equal to zero on average.

$$(14) \quad B^€_{ed} = V^€_h (\gamma_{e10} + \gamma_{e11} r^€ + \gamma_{e12} r^s + \gamma_{e13} r^¥ + \gamma_{e14} r^€_d)$$

$$(15) \quad B^s_{ed} = V^s_h (\gamma_{e20} + \gamma_{e21} r^€ + \gamma_{e22} r^s + \gamma_{e23} r^¥ + \gamma_{e24} r^€_d)$$

$$(16) \quad B^¥_{ed} = V^¥_h (\gamma_{e30} + \gamma_{e31} r^€ + \gamma_{e32} r^s + \gamma_{e33} r^¥ + \gamma_{e34} r^€_d)$$

$$(17\text{bis}) \quad M^€_d = V^€_h (\gamma_{e40} + \gamma_{e41} r^€ + \gamma_{e42} r^s + \gamma_{e43} r^¥ + \gamma_{e44} r^€_d)$$

Coefficients must respect some constraints according to Godley and Tobin's approach (see in annex)

$$(17) \quad M_d^\epsilon = V_h^\epsilon - B_{ed}^\epsilon - B_{ed}^s - B_{ed}^\forall$$

Given the accountable constraint on households' wealth, only three assets' demand equations are independent. Deposits' demand  $M_d$  (17bis) will not be written in the model.

### Government

Public deficit is financed by issuing Treasury bills.

$$(18) \quad \Delta B_s^\epsilon = G^\epsilon - T^\epsilon + r_{-1}^\epsilon \cdot B_{s-1}^\epsilon - P_{cb}^\epsilon$$

Public expenditures  $G$  are exogenous. Banks' profit is completely transferred to government as taxes. Consequently banks' saving is nil.

$$(19) \quad P_{cb}^\epsilon = r_{-1}^\epsilon \cdot B_{cb\epsilon s-1}^\epsilon + r_{-1}^s \cdot B_{cb\epsilon s-1}^s \cdot Xr^1 + r_{-1}^\epsilon L_{-1}^\epsilon - r_{-1}^\epsilon M_{d-1}^\epsilon$$

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.

$$(20) \quad \begin{aligned} B_s^\epsilon &= B_{\epsilon s}^\epsilon + B_{cb\epsilon s}^\epsilon + B_{s s}^\epsilon + B_{s cbs}^\epsilon + B_{\forall s}^\epsilon + B_{\forall cbs}^\epsilon \\ B_s^s &= B_{s s}^s + B_{cb s s}^s + B_{\epsilon s}^s + B_{cb\epsilon s}^s + B_{\forall s}^s + B_{\forall cbs}^s \\ B_s^\forall &= B_{\forall s}^\forall + B_{cb\forall s}^\forall + B_{\epsilon s}^\forall + B_{s s}^\forall \end{aligned}$$

Equilibrium between supply and demand of assets by households

$$(21) \quad B_{\epsilon s}^\forall = B_{ed}^\forall \cdot Xr^3$$

$$(22) \quad B_{\epsilon s}^s = B_{ed}^s / Xr^1$$

$$(23) \quad B_{\epsilon s}^\epsilon = B_{ed}^\epsilon$$

### Firms

Wage share is supposed constant.

$$(24) \quad W^\epsilon = \lambda_\epsilon Y^\epsilon$$

Profit is determined as a sold.

$$(25) \quad P^\epsilon = Y^\epsilon - W^\epsilon - r_{-1}^\epsilon L_{-1}^\epsilon$$

Investissement is determined following an accelerator principle with a desired capital stock  $K^T$  and a constant capital productivity at long term. An influence of the rate of profit and of the credit cost could be added later.

$$(26) \quad I^\epsilon = \gamma_\epsilon (K^{T\epsilon} - K_{-1}^\epsilon) + \delta_\epsilon K_{-1}^\epsilon$$

$$(27) \quad K^\epsilon = (1 - \delta_\epsilon) K_{-1}^\epsilon + I^\epsilon$$

$$(28) \quad K^{T\epsilon} = \kappa_\epsilon \cdot Y_{-1}^\epsilon$$

Investissement is financed by non distributed profit and debt. Firms can obtain all the credit demanded without rationing.

$$(29) \quad \Delta L_d^\epsilon = I^\epsilon - P^\epsilon$$

Firms' wealth is given by:

$$(30) \quad V_f^\epsilon = K^\epsilon - L^\epsilon$$

or

$$\Delta V_f^\epsilon = P^\epsilon - \delta_\epsilon K^\epsilon$$

### Banks

We consider an aggregated banking system with both commercial banks and Central Bank. We suppose the US Central Bank doesn't hold foreign bonds due to the international statue of the dollar. It doesn't need foreign reserves ( $B_{cb\$}^\epsilon = 0$ ). On the opposite European and Chinese Central Banks hold foreign bonds, US for the ECB, US and European for the CCB. There are valuation effects due to exchange rate variations and European and Chinese banks accumualte

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. Money supply is endogenous.

$$(31) \quad M_s^\epsilon = L_s^\epsilon + B_{cb\epsilon s}^\epsilon + B_{cb\epsilon s}^s Xr1 - V_B^\epsilon$$

$$(32) \quad M_s^\epsilon = M_d^\epsilon$$

$$(33) \quad L_s^\epsilon = L_d^\epsilon$$

Equilibrium between bonds supply and demand by banks.

$$(34) \quad B_{cb\epsilon d}^\epsilon = B_{\epsilon cbs}^\epsilon$$

$$(103) \quad B_{cb\yen d}^\epsilon = B_{cb\yen s}^\epsilon Xr^3$$

$$(104) \quad B_{cb\$ d}^\epsilon = B_{cb\$ s}^\epsilon / Xr1$$

$$(105) \quad B_{cb\epsilon d}^s = B_{cb\epsilon s}^s Xr^1$$

$$(106) \quad B_{cb\yen d}^s = B_{cb\yen s}^s Xr^2$$

The US Central Bank has no reserves

$$(107) \quad B_{cb\$ s}^\epsilon = 0$$

Banks' wealth increase is due to valuation effects. The US banks' wealth is equal to zero due to the lack of reserves.

$$(108) \quad \Delta V_b^\epsilon = B_{cb\epsilon s-1}^s \Delta Xr1$$

$$(109) \quad \Delta V_b^s = B_{cb\$ s-1}^\epsilon \Delta(1/Xr1)$$

$$(110) \quad \Delta V_b^\yen = B_{cb\yen s-1}^\epsilon \Delta Xr3 + B_{cb\yen s-1}^s \Delta Xr2$$

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

$$r = r_1 = r_d$$

### *Exchange rate determination*

Equation (22) describing supply and demand of US bonds by European households is used to determine the euro-dollar exchange rate  $xr1$  in an implicit manner. As the euro-dollar exchange rate is floating, we suppose the foreign reserves held by the ECB are constant.

$$(22 \text{ bis}) \quad xr1 = B_{\epsilon d}^s / B_{\epsilon s}^s$$

$$(111) \quad B_{cb\epsilon s}^s = \text{constante}$$

The Chinese currency is anchored on the dollar and the yuan-dollar exchange rate ( $xr2$ ) is constant. The euro-yuan exchange rate ( $xr3$ ) is floating and the foreign reserves of the CCB in euros are supposed constant.

$$(112) \quad xr^3 = xr^2 / xr^1$$

$$(113) \quad B_{cb\yen s}^\epsilon = \text{constante}$$

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

$$(20) \quad B_s^\epsilon = B_\epsilon^\epsilon + B_{cb\epsilon}^\epsilon + B_{\$s}^\epsilon + B_{cb\$s}^\epsilon + B_{\yen s}^\epsilon + B_{cbs}^\epsilon$$

Equation (22bis) giving the euro-dollar exchange rate can suggest that this one is only determined by the confrontation between demand and supply of US bonds by European households. This is not the case. It is an implicit determination and all the other parts of the model, including the trade balance, are playing a role. If behaviours with expected exchange rate are introduced later on in the assets' demand, these factors could play a role in the determination of exchange rates. This approach differs from Taylor (2004) who considers the exchange rate is indeterminate in the portfolio models or in the macroeconomic models « fundamentals-based ». Consequently, according to him, it is necessary to introduce a

supplementary equation describing explicitly the expectations of the exchange rate and the uncertainty. However Taylor's explanation is not fully convincing and his model might not be entirely consistent.

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.

$$CAB^{\epsilon} = X^{\epsilon} - IM^{\epsilon} + r^{\$}_{-1} \cdot B^{\$}_{\epsilon d-1} + r^{\yen}_{-1} \cdot B^{\yen}_{\epsilon d-1} + r^{\$}_{-1} B^{\$}_{cb\epsilon d-1} - r^{\epsilon}_{-1} (B^{\epsilon}_{-1} - B^{\epsilon}_{\epsilon-1} - B^{\epsilon}_{cb\epsilon-1})$$

$$KAB^{\epsilon} = (\Delta B^{\epsilon}_{\$s} + \Delta B^{\epsilon}_{\yen s} + \Delta B^{\epsilon}_{\yen cbs}) - (\Delta B^{\$}_{\epsilon d} + \Delta B^{\$}_{cb\epsilon d} + \Delta B^{\yen}_{\epsilon d}) = \text{capital inflows} - \text{capital outflows}$$

$$KAB^{\$} = (\Delta B^{\$}_{\epsilon s} + \Delta B^{\$}_{cb\epsilon s} + \Delta B^{\$}_{\yen s} + \Delta B^{\$}_{\yen cbs}) - (\Delta B^{\epsilon}_{\$d} + \Delta B^{\yen}_{\$d})$$

$$KAB^{\yen} = (\Delta B^{\yen}_{\$s} + \Delta B^{\yen}_{\epsilon s}) - (\Delta B^{\epsilon}_{\yen d} + \Delta B^{\epsilon}_{\yen cbd} + \Delta B^{\$}_{\yen d} + \Delta B^{\$}_{cbd\yen})$$

$$CAB^{\epsilon} + KAB^{\epsilon} = 0$$

This result remains if international monetary assets held by banks ( $M^{\epsilon}_{cb\$}$  et  $M^{\$}_{cb\epsilon}$ ) or international credit are introduced. This result can surprise as it seems to mean that the increase of foreign currencies reserves would always be nil, the current account balance being equal to the capital account balance. This result only reflects the mode of treatment of Central Banks' reserves which are reduced in our model to foreign bonds (US or European) held by the Chinese or European Central Banks.

Lastly the world's net wealth equals the total fixed capital accumulated.

$$(V_h + V_f + V_g + V_b)^{\epsilon} + (V_h + V_f + V_g + V_b)^{\$} xr1 + (V_h + V_f + V_g + V_b)^{\yen} /xr3 = K^{\epsilon} + xr1 K^{\$} + K^{\yen} /xr3$$

$$\text{with } V_g = -B$$

### 3.2. Adjustments facing demand or supply shocks with fixed dollar-yuan parity

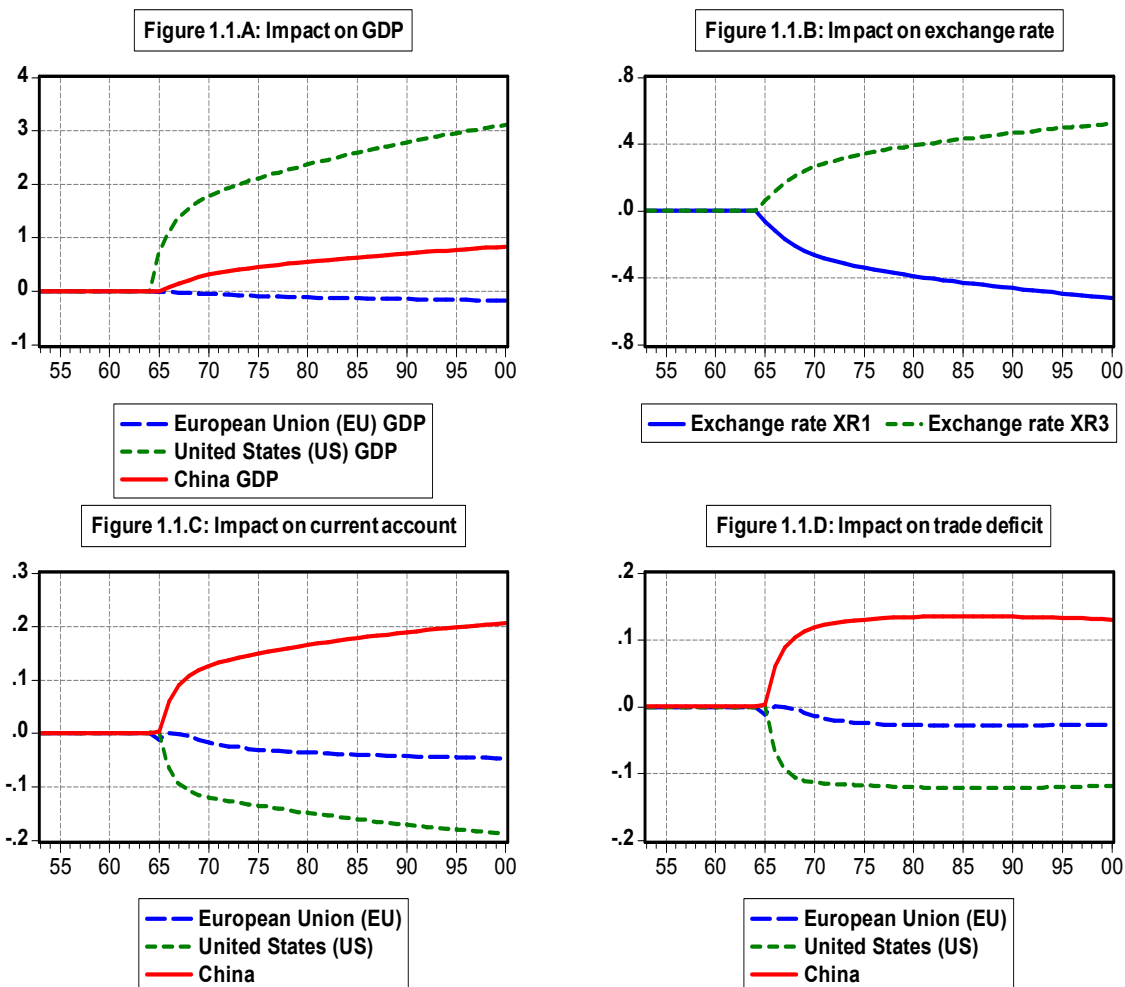
To simplify two kinds of shocks will be considered, demand shocks with an increase of public expenditures, supply shocks with a loss of competitiveness of the USA or the EU. In all the figures, GDP and exchange rates are relative deviations with regard to a central account in percentages ( $X-X_c/X_c$ ); for trade balance and current account, measured in % of GDP, the absolute deviation is given ( $TB-TB_c$ ).

#### Demand shock

An increase of US public expenditures equivalent to 1% of GDP stimulates without surprise growth in the USA and, by diffusion, in China with an increasing US public deficit and current account deficit. The dollar is slightly depreciated against the euro due to the US deficits and larger issue of US bills at world level. On the opposite, the EU doesn't benefit of the US recovery due to the appreciation of the euro against the dollar and yuan (figure 1).

The magnitude of the impact on the current account of this demand shock (around 0.4% of GDP at medium term) may seem limited, but it must be recalled that the rate of openness of the three zones (USA, EU and China) are rather small. The ratio (export + import)/2GDP is around 15% in the simulations, which is close to the observed statistics for the USA and EU, but is a little bit smaller than in China. This moderate degree of openness could explain the rather limited diffusion effect of the shock.

Figure 1.1: Increase of United States public expenditures (1% of GDP)



### Supply shocks and loss of competitiveness

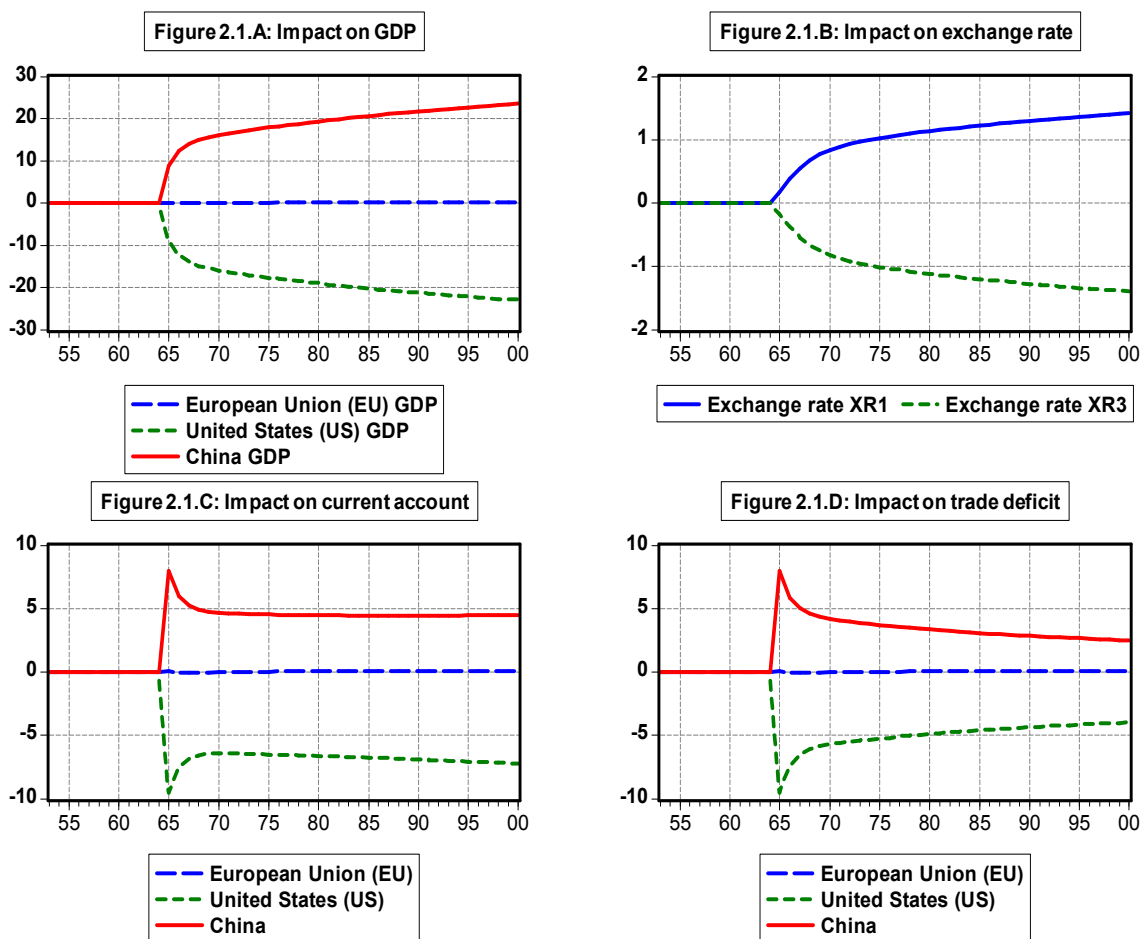
Two kinds of supply shocks can be considered, a loss of competitiveness of USA facing China or EU and a loss of competitiveness of EU facing China, which are described through an increase of the relevant propensity to import (from 0.5 to 0.6).

A loss of US competitiveness can happen either with respect to China or with respect to the EU. A loss of competitiveness facing China induces, without surprise, a large decline of US production (figure 2.1). China benefits of the decline of US competitiveness and, consequently, Chinese production is largely stimulated. The US public deficit and current account deficit increase widely, in contrast with rising Chinese surpluses. The European production remains almost stable, the gains on Chinese market being compensated by losses on the US market.

Exchange rates' evolutions are more surprising, as the dollar slightly appreciates against the euro while the yuan depreciates. This evolution is all the more striking as the rising US public deficit induces a large issue of US treasury bills and the US demand of US bills declines with

the slowdown of US activity. This would favour dollar depreciation. But the demand of US bills by the Chinese Central Bank increases strongly to keep fixed the dollar-yuan parity. Consequently, the US bills supplied to the European households decline slightly, facing a European demand of US bills almost stable. It explains the slight dollar appreciation against the euro, in spite of the declining US competitiveness. This result enlightens the evolution of the end of the 1990s and beginning of the 2000s when the dollar was appreciating with increasing US current deficit. Later on, this configuration has begun to change with the progressive evolution of the Chinese Central Bank's behaviour, as it will be discussed further in the paper. On the whole, in case of loss of US competitiveness against China, the rigidity of the dollar-yuan parity limits the adjustments at the world level. US production declines but US current account deficit remains and the dollar can slightly appreciate against the euro.

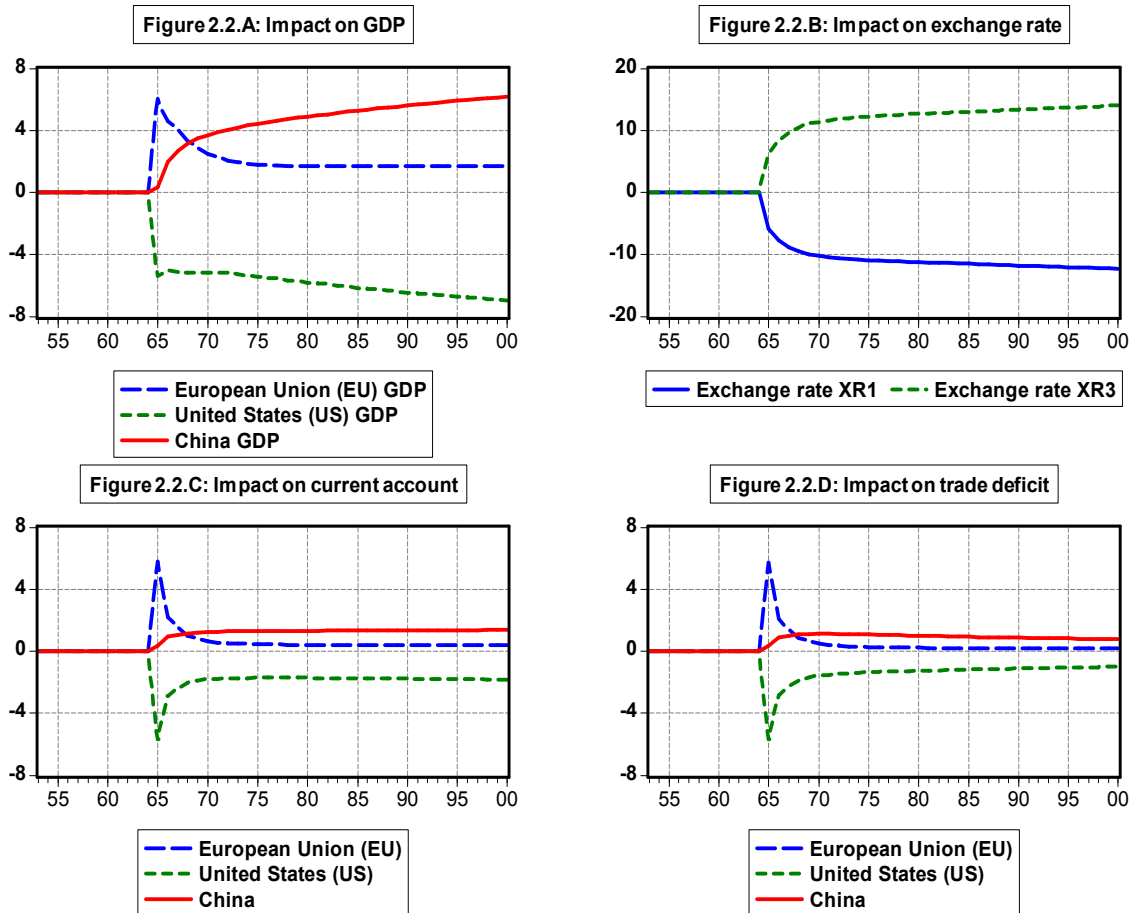
Figure 2.1: Loss of United States competitiveness facing China



A loss of US competitiveness against the EU has very different effects (figure 2.2). US production is also negatively affected, but less than in the previous case (-7%). Thanks to increasing US current account and public deficits, the dollar depreciates largely against the euro (-12%). Consequently, the European recovery is not lasting and the European production's gains are reduced at medium term, due to the impact of the euro appreciation, of the US slowdown and the Chinese gains of competitiveness induced by the dollar and yuan depreciations. The European current account surplus is reduced to almost zero at medium

term. US trade deficit is almost offset at medium term, but US current account remains due to interests paid. China appears once again as the winner with an increasing production (+7% at medium term) and a surplus current account, thanks to the impact of the yuan depreciation. On the whole, the decline of the US production is more limited and the US trade deficit more reduced than in the case of a loss of competitiveness against China, thanks to the dollar depreciation against the euro, but the fixity of the dollar-yuan parity reduces the adjustments at the benefit of China and at the expend of the EU.

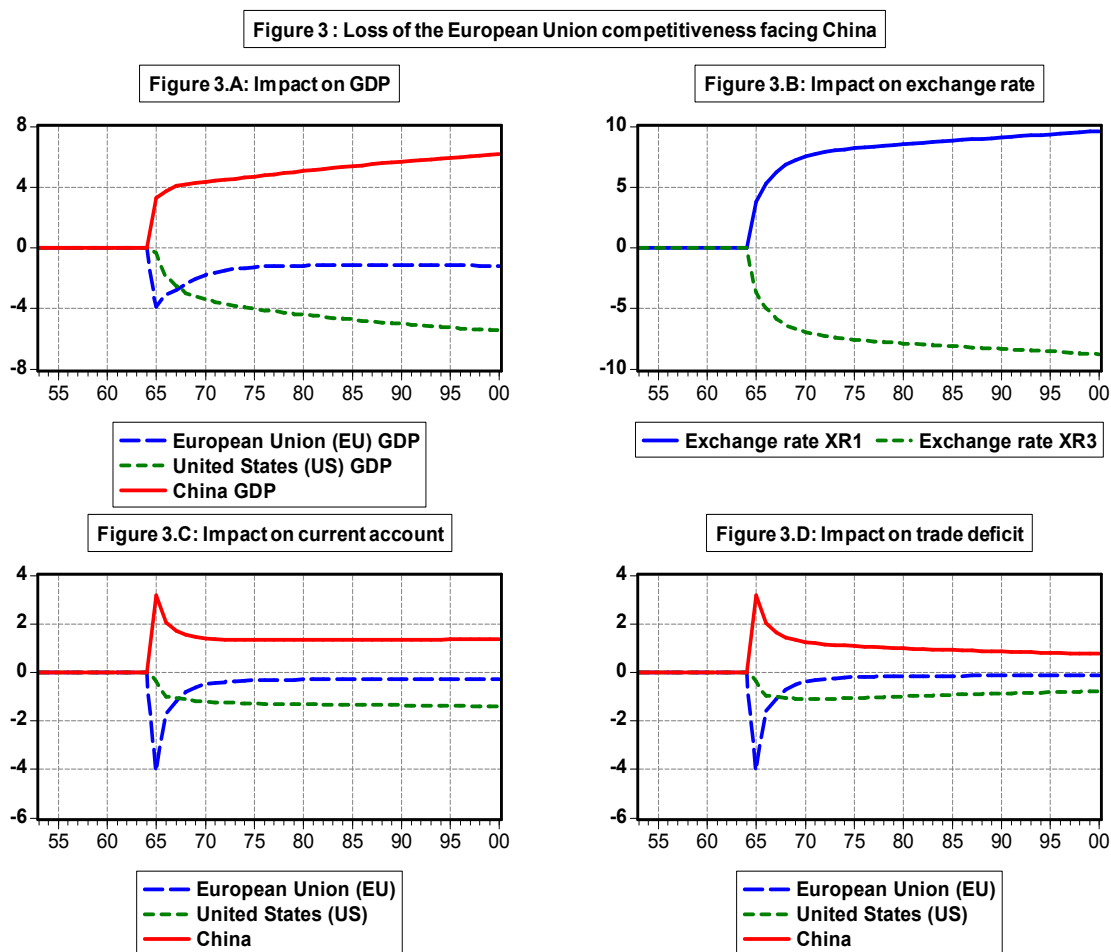
Figure 2.2: Loss of United States competitiveness facing the European Union



A loss of European competitiveness facing China is the last case to be considered. It induces logically a European slowdown (-6% at medium term) with trade deficit and public deficit at short term (figure 3). China benefits of the gains of competitiveness with the EU: Chinese production increases with rising current account and public surpluses. The euro depreciates against the dollar (-10%) but the evolution can be explained more in details. Chinese recovery and surpluses induce an increasing demand of US bonds, especially from the Central Bank to keep the dollar-yuan parity fixed. It reduces the supply of US bonds available at the world level, which favours a dollar appreciation against the euro, even if the European demand of US bills is also declining, but in a less proportion. This euro depreciation allows at medium term a European balanced current account and a reduction of the European slowdown. On the contrary, the USA are penalised by the dollar appreciation with a decline of the US

production, a limited trade deficit and current account deficit. The Chinese production increases (more than 4%) with a trade surplus due to the gains of competitiveness against the EU, but which is progressively reduced thanks to the euro depreciation. The Chinese current account surplus remains larger. Once again, the initial shock is partly compensated thanks to the euro depreciation, but the fixity of the dollar-yuan parity limits the adjustments at the benefit of China and, mainly, at the expend of the USA.

Figure 3: Loss of EU competitiveness facing China



To conclude, demand shocks have traditional impact on growth, but diffusion effects and impact on external imbalances remain limited, mainly due to the rather small degree of openness. The exchange rate adjustments (with depreciation in the country where public expenditures increase) are also of small amplitude. On the contrary, supply shocks, with larger impact on growth, have more effects on 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 and the EU. In case of a loss of US competitiveness facing China, the small appreciation of the dollar can be explained by the increasing Chinese Central Bank's purchase of US bills to keep fixed the yuan-dollar parity.

### Introduction of a diversification of China's foreign reserves

Instead of having Chinese foreign reserves mainly composed of US bonds with constant reserves in euros, the Chinese Central Bank (CCB) could have a more diversified strategy, especially in a context of large US deficit and uncertainty regarding the dollar. Different scenarios could be considered with increasing foreign reserves held in euros by the CCB but we will limit to one, already proposed by Zhao and Lavoie (2008). The Chinese Central Bank diversifies, since the beginning, its foreign reserves both in US and European bonds, but in a gradual manner with a target structure of the foreign reserves and 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.

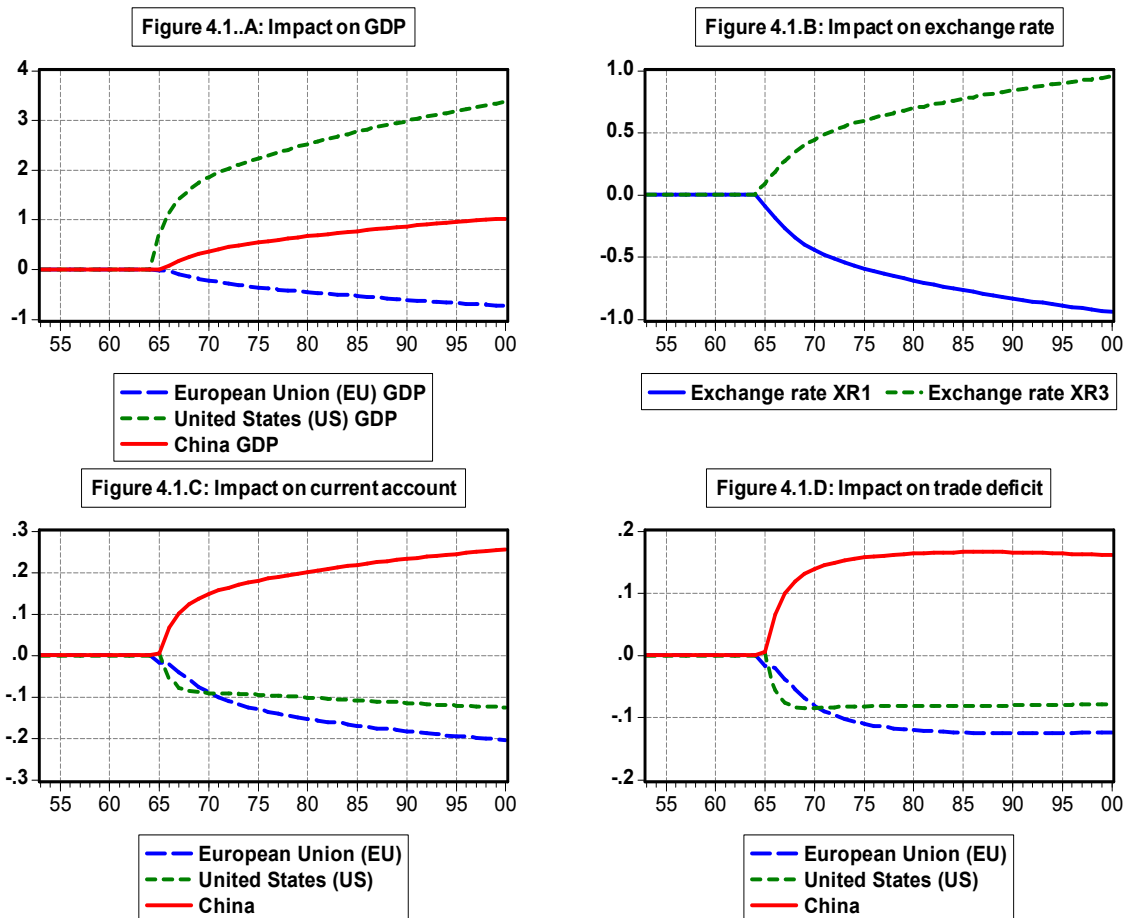
$$B_{YCBd}^e = \beta B_{YCBd}^s$$

$$\beta = \beta_{-1} + \theta(\beta^e - \beta_{-1})$$

$\beta^e$  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 CCB 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 bonds and 41% of bonds in euros.

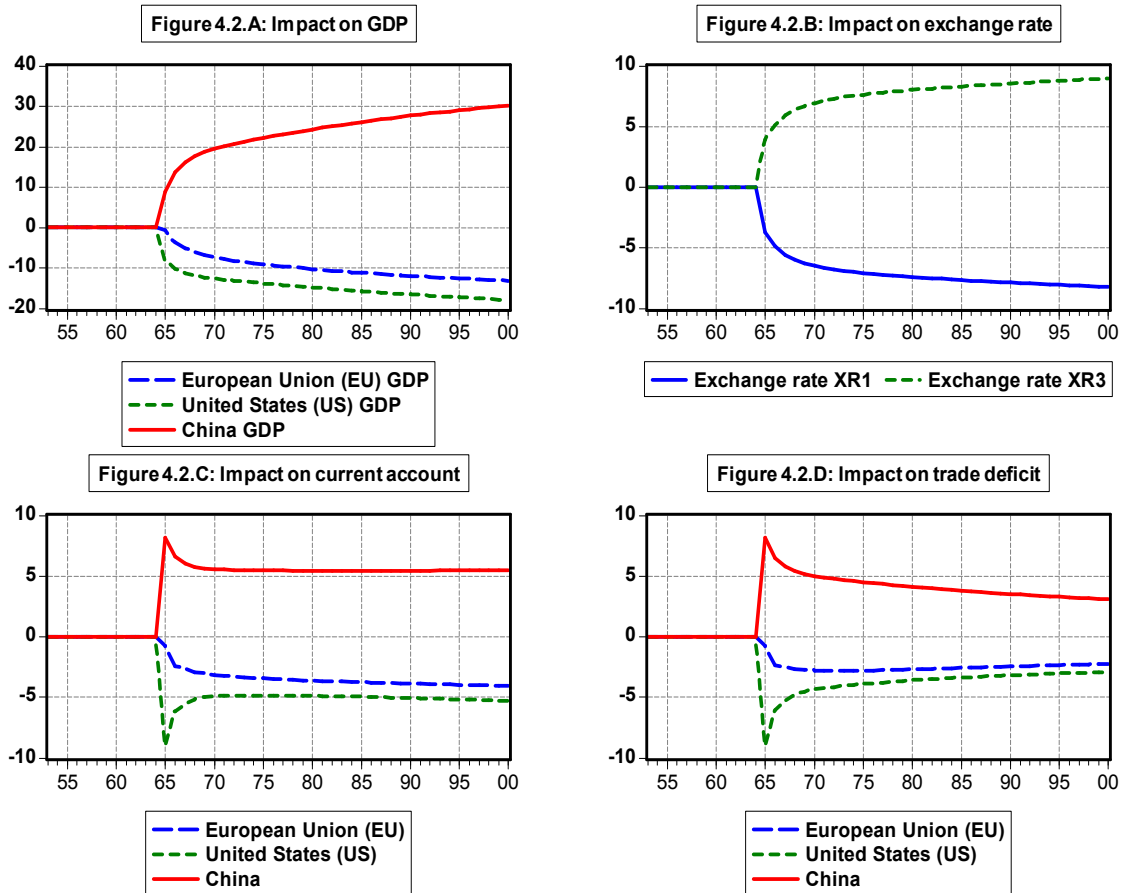
Two kinds of shocks, demand and supply, can be considered as before. An increase of US public expenditures (equivalent to 1% of GDP) gives results close to those of the model without reserves diversification (figure 4.1). The US and, by diffusion, Chinese productions are stimulated. The dollar depreciates progressively and the euro appreciates, due the declining demand of US bonds caused by the CCB diversification behaviour. The dollar depreciation was already observed in the previous model without diversification but it is more marked with the reserves' diversification. However the impact on exchange rates of demand shocks remains limited like previously. The euro appreciation has a negative effect on the EU growth and increases the current account deficit, while the US current deficit is slightly reduced.

Figure 4.1: Increase of United States public expenditures (1% of GDP) with diversification of China



A loss of US competitiveness facing China gives results more contrasted by comparison with the case without diversification of the foreign reserves (figure 4.2). The US production declines and the Chinese one increases. The dollar depreciates (-8%), instead of the slight appreciation in the basic model, due to the declining demand of dollars by the CCB. Consequently, the Chinese growth is more stimulated by the yuan depreciation and the US growth is less affected. On the contrary, EU production decreases. The structure of international imbalances is modified by the Chinese foreign reserves diversification but remain important. The EU deficit deteriorates significantly, the US deficit is reduced thanks to the dollar depreciation and the Chinese surplus is stable in % of GDP.

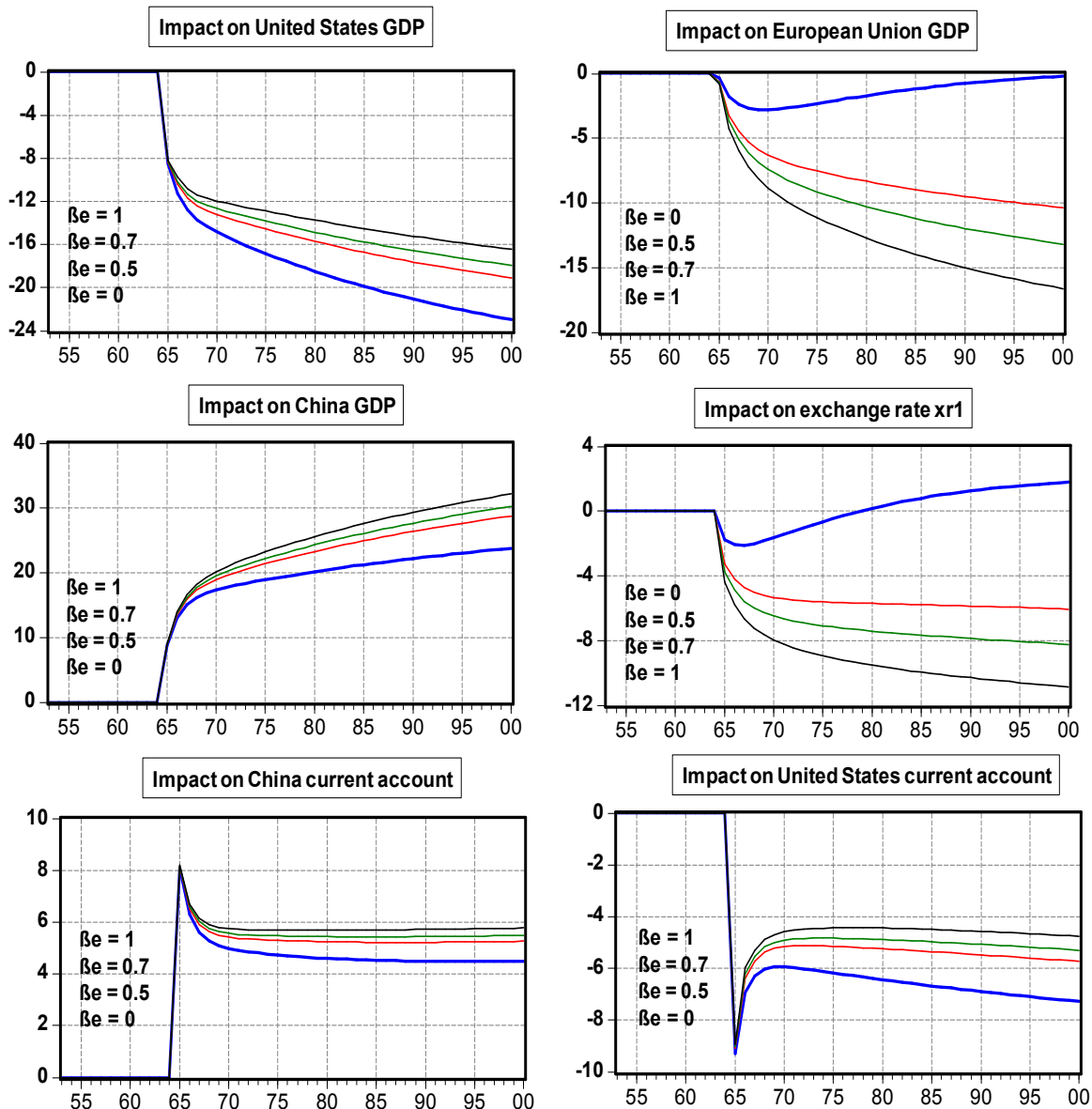
Figure 4.2: Loss of United States competitiveness facing China with diversification of China



Lastly, sensitivity tests 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. Figure 5 gives the results in the case of an increase of a loss of US competitiveness facing China with  $\beta^e$  varying from 0 (basic model without diversification) to 1<sup>1</sup>(foreign reserves equally shared between US and European bonds). Without surprise, it shows that more the Chinese reserves are diversified, more the dollar depreciates against the euro due a declining demand of US bonds. European production is more and more affected at the benefit of US production which declines less and of Chinese production. World imbalances increase with larger Chinese surplus and European deficit but US current deficit is more reduced thanks to the dollar depreciation.

<sup>1</sup> For  $\beta^e=0$ , the evolution of the dollar against euro (xr1) is slightly different from the original model without diversification because the Chinese foreign reserves in euro bills are in that case equal to zero and not simply constant.

Figure 5.2 : Sensitivity tests regarding the structure of China's foreign reserves  
Loss of United States competitiveness facing China



To conclude, the introduction of a diversification of China's foreign reserves changes the adjustments mechanisms at the international level, mainly at the expense of the EU due to the dollar depreciation and the euro appreciation, but not in a radical manner. The impact of demand shock on exchange rates is limited, as in the absence of foreign reserves' diversification. A supply shock like a loss of US competitiveness facing China has more significant effect. In case of a gradual diversification with a target structure of foreign reserves, a loss of US competitiveness induces a dollar depreciation (instead of the small appreciation in the basic model), due to the declining demand of dollars by the CCB. The Chinese growth is more stimulated by the yuan depreciation and the EU production decreases

more. The international imbalances remain important with larger EU deficit and Chinese surplus, but with reduced US deficit.

These conclusions<sup>2</sup> are close to those already obtained by Zhao and Lavoie (2008). However they are obtained with the hypothesis of a fixed dollar-yuan parity which is restrictive and limits the magnitude of the adjustments. Since 2005 a progressive appreciation of the yuan vis-à-vis the dollar has been managed already by the CCB but has been stopped at the beginning of 2009. This question can be examined in an enlarged model with floating or managed dollar-yuan parity according to various mechanisms.

#### 4. A SFC three countries 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.

In this configuration the foreign reserves of the CCB in US bonds are constant:

$$B_{\text{¥CBd}}^{\text{\$}} = \text{constant}$$

Equation (106) is replaced by :

$$(106\text{bis}) \text{ xr2} = B_{\text{¥CBd}}^{\text{\$}} / B_{\text{¥CBs}}^{\text{\$}}$$

which determines the dollar-yuan parity  $\text{xr2}$  (1 dollar =  $\text{xr2}$  yuans)

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 CCB in US bonds are always constant:

$$B_{\text{¥CBd}}^{\text{\$}} = \text{constante}$$

Equation (106) is replaced by :

$$(106^*) \text{ xr2}^* = B_{\text{¥CBd}}^{\text{\$}} / B_{\text{¥CBs}}^{\text{\$}}$$

where  $\text{xr2}^*$  represents the equilibrium exchange rate. The actual exchange rate is determined with inertia:

$$(106\text{ter}) \text{ xr2} = \text{xr2}_{-1} + \varepsilon(\text{xr2}^* - \text{xr2}_{-1})$$

A third version corresponds to a managed exchange rate regime with targets fixed by the Chinese Central Bank for the level of foreign reserves in dollars or current account. The foreign reserves of the CCB in US bonds are once again endogenous (non modified equation (106) from the initial version of the model)

$$(106) B_{\text{¥CBd}}^{\text{\$}} = B_{\text{¥CBs}}^{\text{\$}} \text{ xr2}$$

The dollar-yuan parity  $\text{xr2}$  can be managed by the CCB with a target, either on the reserves in US bonds  $\text{US} (R^{\text{e¥}}$  is a percentage of GDP beyond which the yuan is revalued) or on current account  $(\text{CAB}^{\text{¥}} / Y^{\text{¥}})^{\text{e}}$  :

<sup>2</sup> Other sensitivity tests are given in annex to assess the confidence band of the results obtained with the model. In most of cases the results appeared quite stable.

$$xr2 = xr2_{-1} + \gamma_1 (B_{\text{CBd}}^s / Y^{\text{¥}} - R^{e\text{¥}})$$

or

$$xr2 = xr2_{-1} + \gamma_2 (CAB^{\text{¥}} / Y^{\text{¥}} - (CAB^{\text{¥}} / Y^{\text{¥}})^e)$$

$\gamma_1$  et  $\gamma_2$  are negative adjustment parameters of the exchange rate which can be considered as controlled by the CCB.

These new versions of the model are used in the same way as in the previous section to analyse the adjustment mechanisms at the world level facing global imbalances with now a dollar-yuan parity floating or managed by the CCB. Comparisons with the results of the previous section will show the new possibilities of adjustment which can appear with a more flexible yuan.

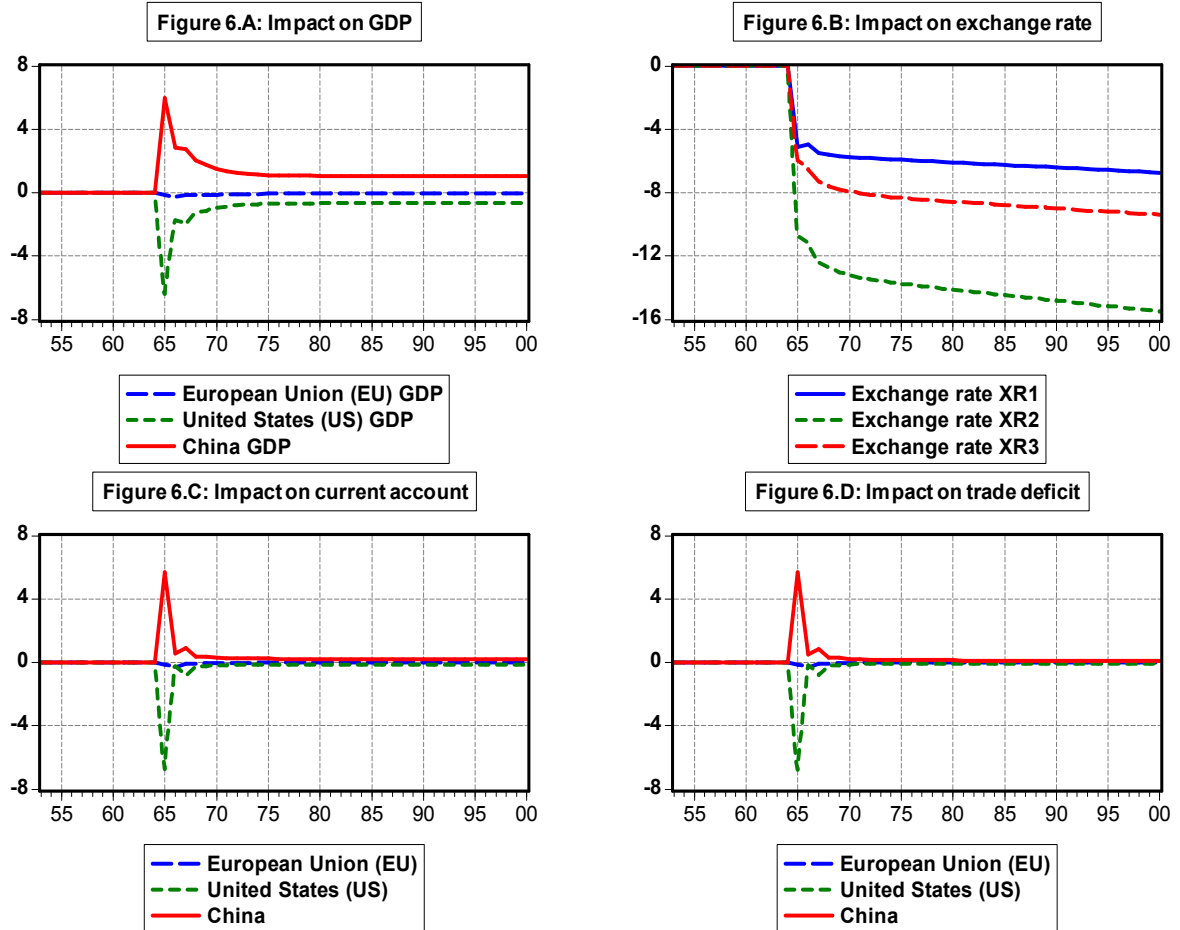
#### 4.2. Comparison of the different floating exchange rate regimes

The three floating exchange rate regimes previously defined can be simply compared by examining the consequences of a supply shock, such as a loss of US competitiveness facing China (simulated through an increase of the propensity to import).

In case of freely floating yuan, a loss of US competitiveness with China induces at short term a sharp decrease of US production (-7%) and a boom of Chinese production while the US current account deteriorates (-7% of GDP) and the Chinese one improves (figure 6). The reduction of these imbalances is mainly realised through a depreciation of the dollar (-15% against the yuan, -6% against the euro) and of the euro against the yuan (-9%). The US production recovers while the Chinese growth slows down. The US current deficit and Chinese surplus are offset.

The main difference with the case of the fixed dollar-yuan parity (figure 2.1) is that global imbalances can now be reduced by exchange rate adjustments with the floating yuan. On the contrary, productions were the main tools of adjustment in the fixed yuan regime without being able to reduce the external imbalances between USA and China.

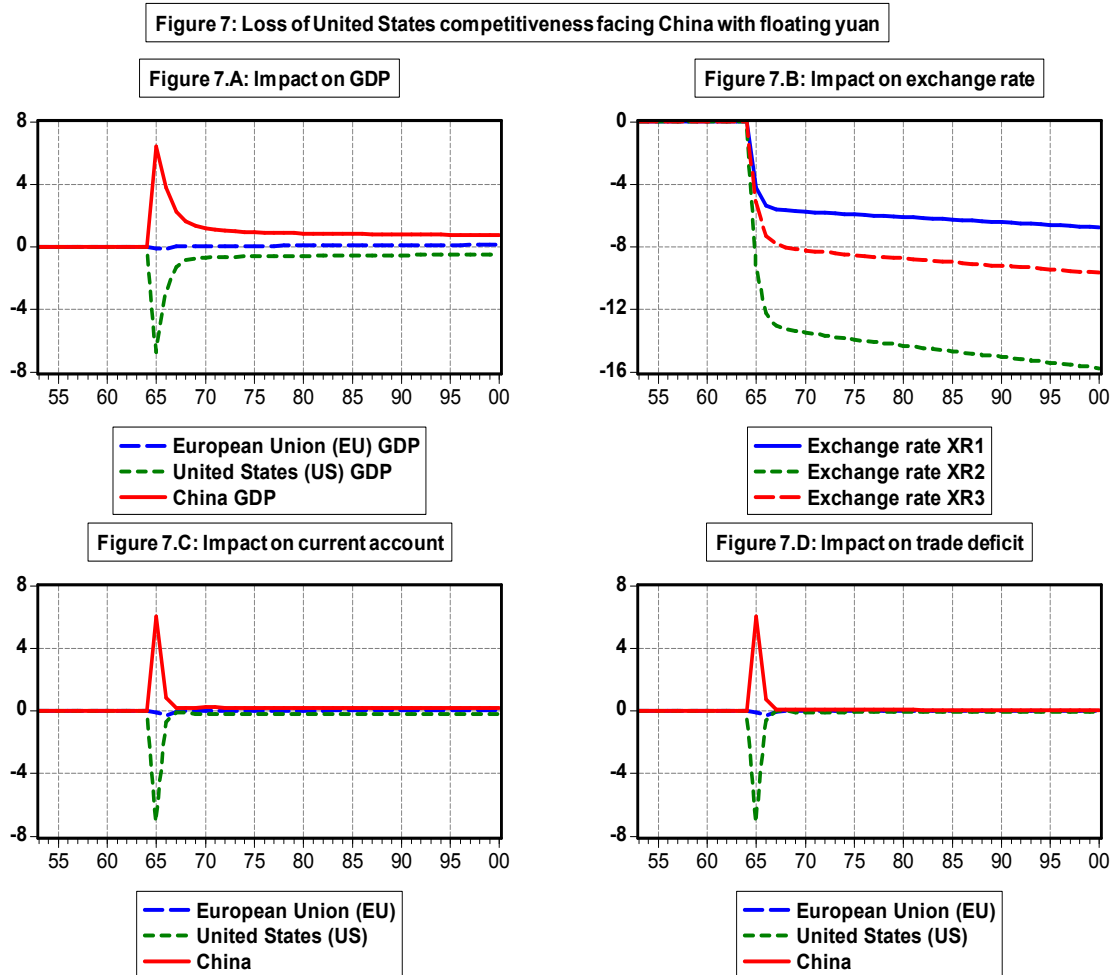
Figure 6 : Loss of United States competitiveness facing China with floating yuan



In case of 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  $\epsilon$ . 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. The figure is not presented to save place.

In case of a managed exchange rate regime with target fixed by the Chinese Central Bank for the level of foreign reserves in dollars, the impact of a loss of US competitiveness with China is also close to the freely floating regime where the foreign reserves in dollars are supposed constant (figure 7). In the managed regime these reserves are not constant but the CCB tries to reach a target. As previously, the Chinese production is stimulated, the dollar-yuan parity is depreciated and the US production decreases. External imbalances are reduced in few years. The proximity of the two scenarios can be easily understood but is interesting to underline. A managed exchange rate regime with a target on the foreign reserves in dollars is close to a freely floating exchange rate regime.

Figure 7: Loss of US competitiveness facing China with a yuan managed regime and a target on foreign reserves in dollars

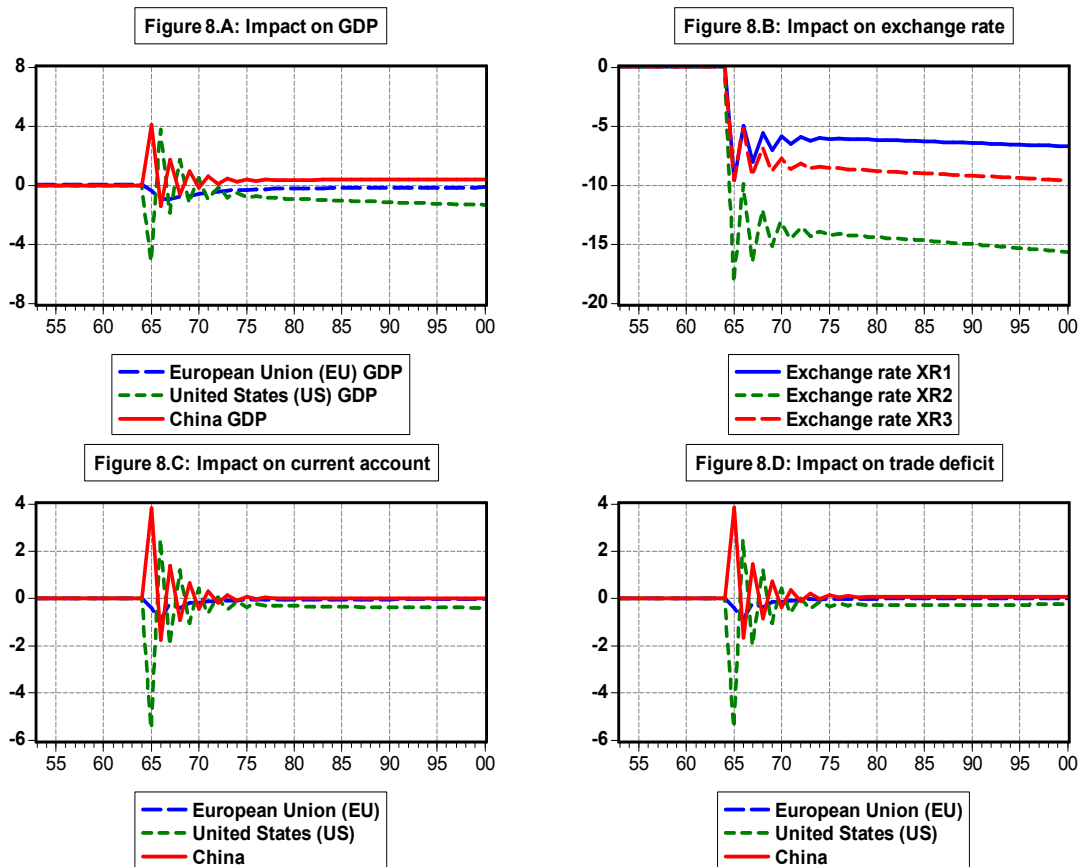


Lastly, a managed exchange rate regime with target on current account fixed by the Chinese Central Bank gives also rather similar results but more instable evolutions (figure 8). A loss of US competitiveness with China induces, as before, a decline of US production, a depreciation of the dollar against the yuan and the euro, a boom of Chinese production. Exchange rate adjustments lead to a progressive reduction of external imbalances. The smaller the adjustment parameters, the slower the exchange rate adjustments are and the larger the production's adjustments are. The differences between the simulations according to the value of the adjustment parameter are larger than previously but remained limited<sup>3</sup>.

Figure 8: Loss of US competitiveness facing China with a yuan managed regime and a target on current account

<sup>3</sup> More detailed sensitivity tests are given in annex.

Figure 8 : Loss of United States competitiveness facing China with a yuan managed regime and a target on current account



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 deficit and Chinese surplus. The contrast appears clearly with the configuration where only the euro-dollar exchange rate was floating with a fixed dollar-yuan parity.

Second, a freely floating yuan is unrealistic in the actual state of the Chinese monetary and financial system. But more managed exchange rate regimes for the dollar-yuan parity, where the Chinese Central Bank intervenes to reach a target, either on foreign reserves in dollars or on current account level, give rather similar adjustment mechanisms. They can reduce world imbalances in the same proportions as a pure floating regime.

This approach doesn't detail the institutional forms of such exchange rates regimes, nor the internal consequences for the Chinese economy of a yuan revaluation, which could be investigated later. It limits to more general considerations at the world level. In spite of its theoretical aspect, the pure floating yuan regime can be used as a useful reference to examine in more details the differences between fixed and floating exchange rate regimes.

## 5. A SFC three countries 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-wages loop is introduced to determine the GDP price (PY) and the nominal wage per capita (w). The GDP price depends of unit wage cost and import prices with an adjustment to the desired level and a short term effect of the capacity rate of utilization (TUC). The wage per capita is determined by a simplified Philips curve with an effect of the capacity rate of utilization, an indexation on the internal demand price<sup>4</sup> and on the labour productivity (PR).

$$\begin{aligned}\text{Log PYdes}^e &= \mu_e \text{Log PM}^e + (1 - \mu_e) \text{Log}(w^e / \text{Prod}^e) \\ \text{Log PY}^e &= \pi_{e1} \text{Log PYdes}^e + (1 - \pi_{e1}) \text{Log PY}_{-1}^e + \pi_{e2} \text{Log TUC}^e \\ \text{Log } w^e &= \lambda_{e1} \text{Log wdes}^e + (1 - \lambda_{e1}) \text{Log } w_{-1}^e \\ \text{Log wdes}^e &= \lambda_{e2} \text{Log PDI}^e + \lambda_{e3} \text{Log TUC}^e + \lambda_{e4} \text{Log PR}^e \\ \text{TUC}^e &= Y^e / K^e\end{aligned}$$

Foreign trade equations are enlarged to include a price competitiveness effect and a simple analysis of foreign trade prices.

#### *Exports*

$$\begin{aligned}\text{Log } X_{\$}^e &= \mu_{e1} + \mu_{e2} \text{Log } Y_{\$}^e - \mu_{e3} \text{Log } \text{PX}_{\$}^e / \text{PY}_{\$}^e * \text{xr}^1 \\ \text{Log } X_{\text{¥}}^e &= \mu_{e4} + \mu_{e5} \text{Log } Y_{\text{¥}}^e - \mu_{e6} \text{Log } \text{P } X_{\text{¥}}^e * \text{xr}^3 / \text{P } Y_{\text{¥}}^e\end{aligned}$$

#### *Export price*

$$\begin{aligned}\text{Log } \text{P } X_{\$}^e &= p_{e2} \text{Log } \text{PY}_{\$}^e * \text{xr}^1 + (1 - p_{e2}) \text{Log } \text{PY}^e \\ \text{Log } \text{P } X_{\text{¥}}^e &= p_{e4} \text{Log } \text{PY}_{\text{¥}}^e / \text{xr}^3 + (1 - p_{e4}) \text{Log } \text{P } Y^e\end{aligned}$$

Usual equations relating variables in constant and current prices are added<sup>5</sup>.

Last, a kind of simple Taylor rule, only dependent of the rate of inflation, has been added to avoid incoherent evolution of the real rate of interest.

$$r^e = r_e^e + 0.8(\Delta \text{PDI} / \text{PDI}_{-1} - 0.02)$$

On the whole, the model has now 163 endogenous variables, public expenditures and labour productivity being exogenous.

This new version of the model is used in the same way as in previous sections to analyse adjustment mechanisms at the world level facing global imbalances with, alternatively, fixed or floating dollar-yuan parity. Results must be regarded as preliminary.

<sup>4</sup> The internal demand price is given by an accounting equation relating internal demand in constant and current prices.

<sup>5</sup> The determination of households' real Haig-Simons disposal income and wealth can be explicated as it is less straightforward.

$$\begin{aligned}\Delta \text{Vval}_h^e &= \text{YDval}_{hs}^e - \text{Cval}^e \\ \text{YD}_{hs}^e &= \text{YDval}_{hs}^e / \text{PDI}^e - \text{Vval}_{hs-1}^e * \Delta \text{PDI}^e / \text{PDI}^e \\ \text{V}_h^e &= \text{Vval}_h^e / \text{PDI}^e\end{aligned}$$

## 5.2. Complementary results with flexible prices

Results obtained using the model with flexible prices broadly confirm those obtained in case of fixed prices. The different configurations of the model can be successively considered.

### *Fixed dollar-yuan parity*

A demand shock (an increase of 1% of GDP of US public expenditures) gives evolutions close to the fixed prices case: stronger US growth, depreciation in nominal and real terms of the dollar, deficit of the US current account, positive impact on the Chinese growth but negative impact on the European growth due to the euro appreciation. Compared with the fixed prices case, the effect on current account is equally limited but the negative impact on the European growth is stronger as the dollar depreciation is larger (figure 9).

A supply shock with a loss of US competitiveness facing China gives also rather similar results, at least in qualitative terms<sup>6</sup> (figure 10). 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 demand of US bonds 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 of the US prices, which is a difference with the constant prices case. However, like in this case, the rigidity of the dollar-yuan parity limits the adjustments at the world level.

As in the fixed prices case, a loss of US competitiveness facing the European Union has a more contrasted impact (figure 11). The US production is negatively affected at short term at the benefit of the EU and the dollar depreciates in nominal and real terms due to current account and public deficits, in spite of rising US prices. Actually the dollar depreciation is larger than in the case of constant prices and the US production recovers at medium term at the expense of the European production which declines, while China appears once again as the winner thanks to the depreciation of the yuan linked to the dollar.

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<sup>6</sup> 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 0.5 to 0.6 in the constant prices case).

Figure 9: An increase of US public expenditures (1% of GDP) with fixed dollar-yuan parity and flexible prices

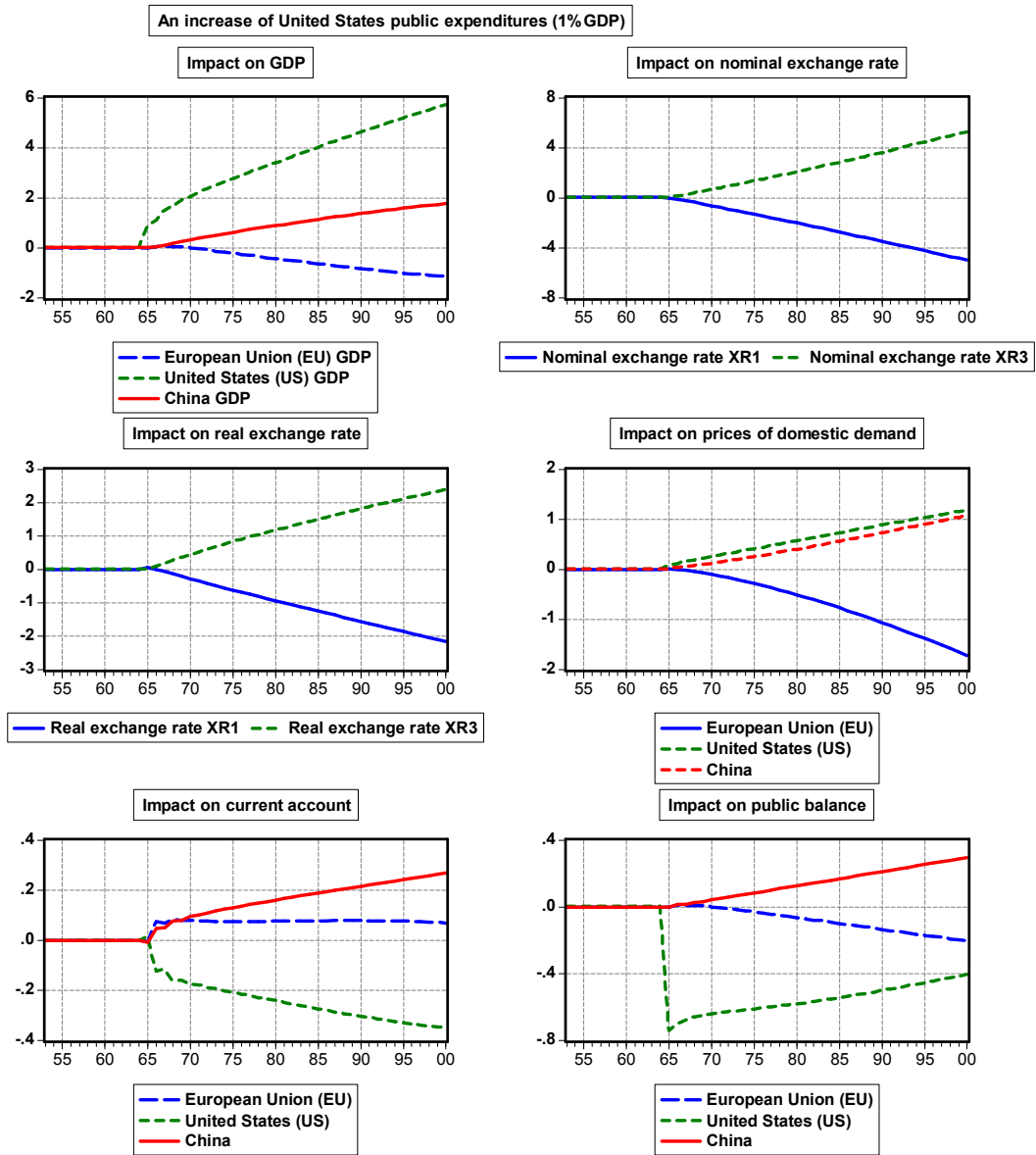


Figure 10: A loss of US competitiveness facing China with fixed dollar-yuan parity and flexible prices

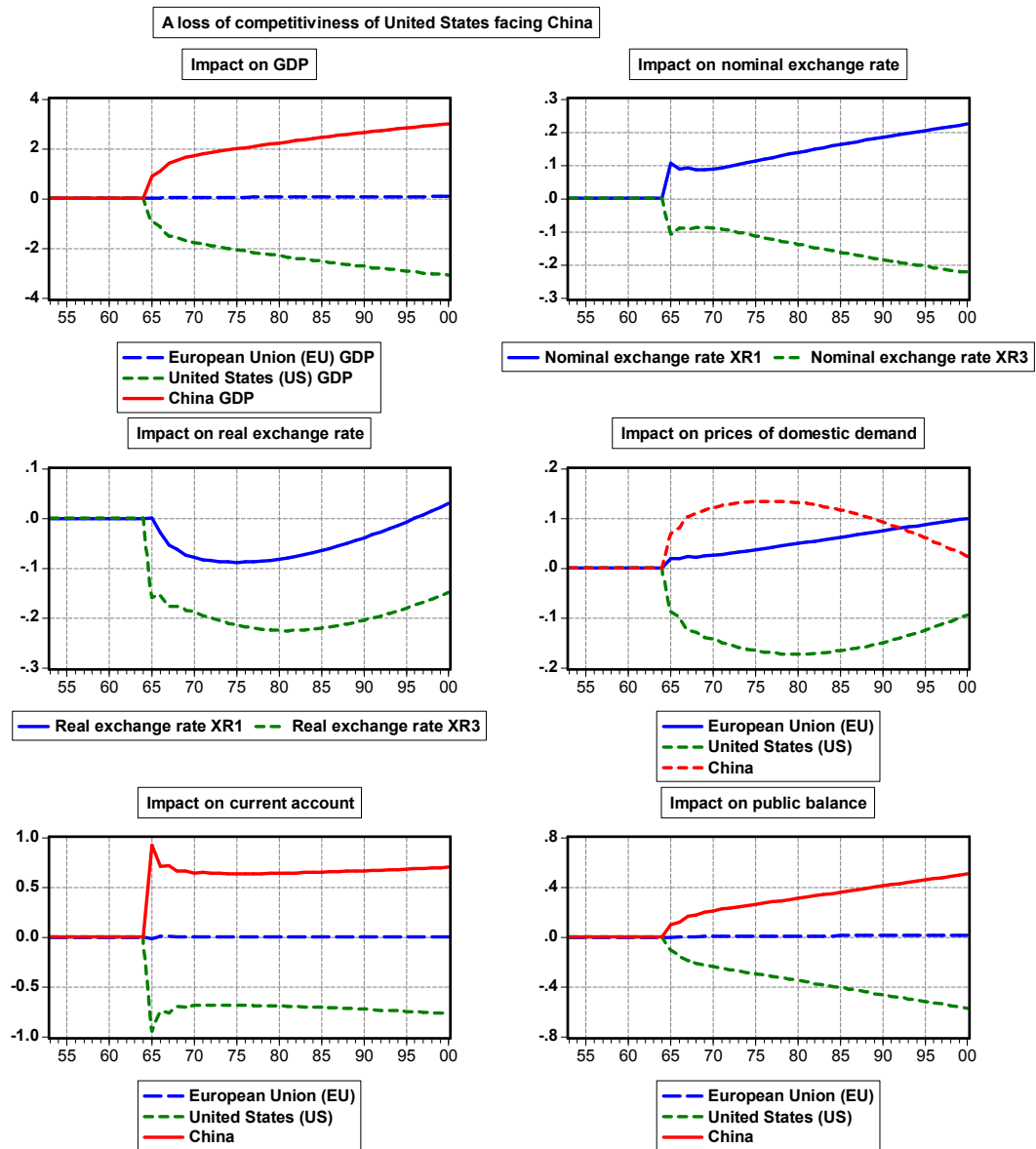
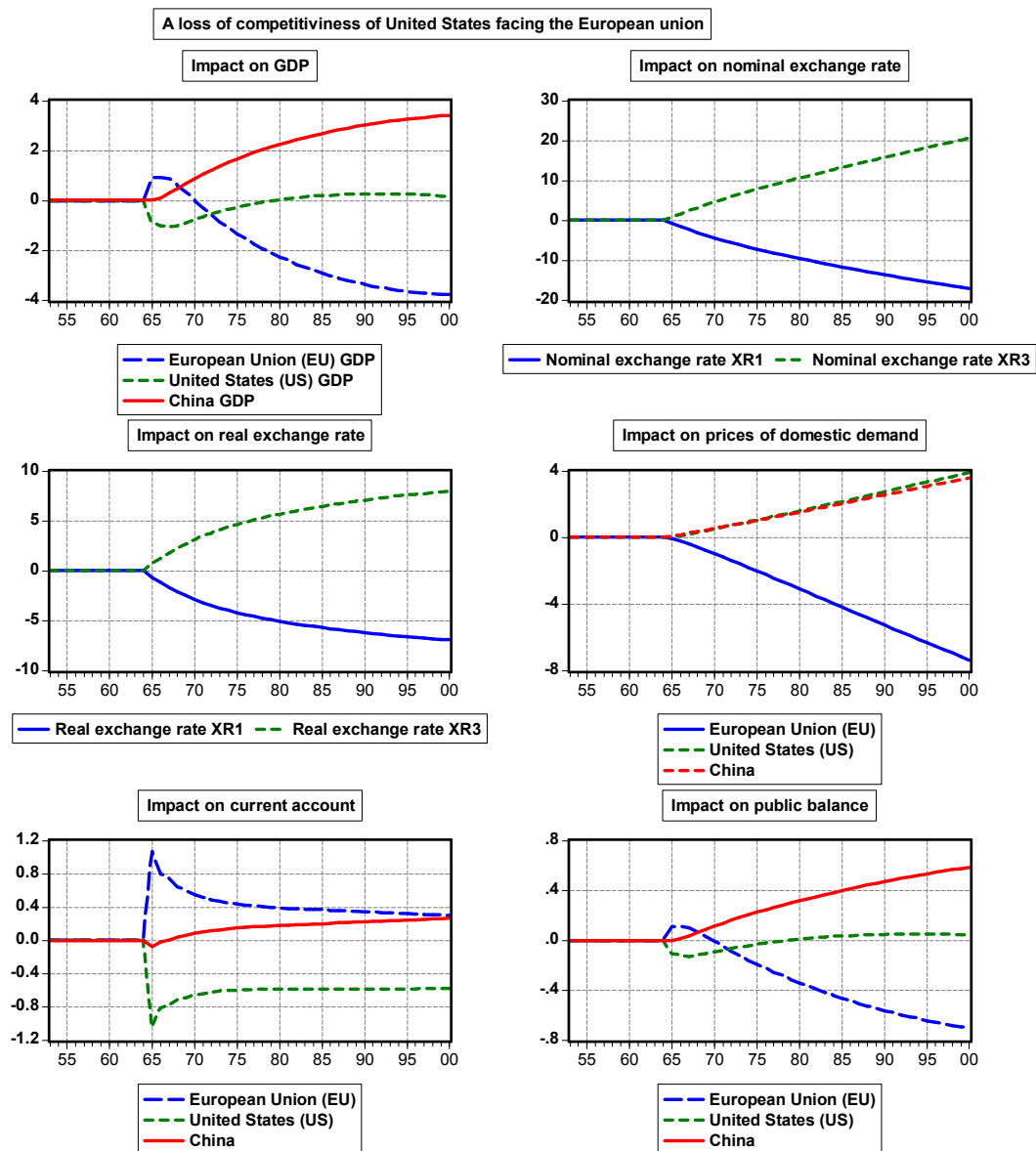
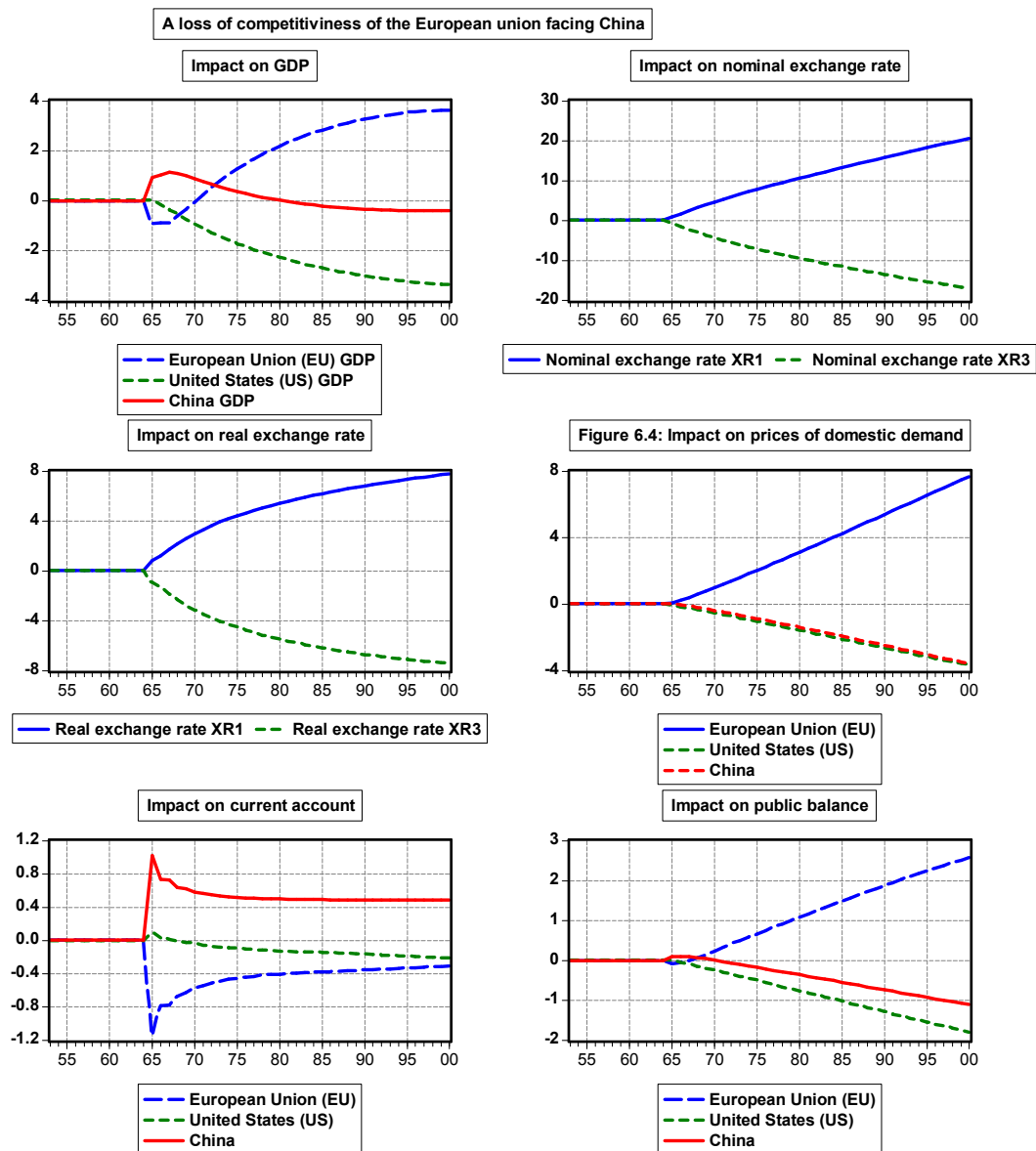


Figure 11: A loss of US competitiveness facing the European Union with fixed dollar-yuan parity and flexible prices



Lastly a loss of European competitiveness facing China induces, like in the case of constant prices, a dollar appreciation in nominal and real terms (figure 12). This dollar appreciation is linked to the increasing Chinese current account and the stronger demand of US bonds by the Chinese Central Bank to keep the yuan-parity fixed. This dollar appreciation, which means an euro depreciation, induces a reversal larger than in the case of fixed prices. The EU production recovers at medium term and the EU deficit is reduced. Although the Chinese surplus remains, the Chinese production recovery is progressively offset. On the whole, the euro depreciation is an efficient tool to compensate the initial loss of European competitiveness but, as in the fixed prices case, the fixity of the dollar-yuan parity reports more heavily the adjustment on the US production.

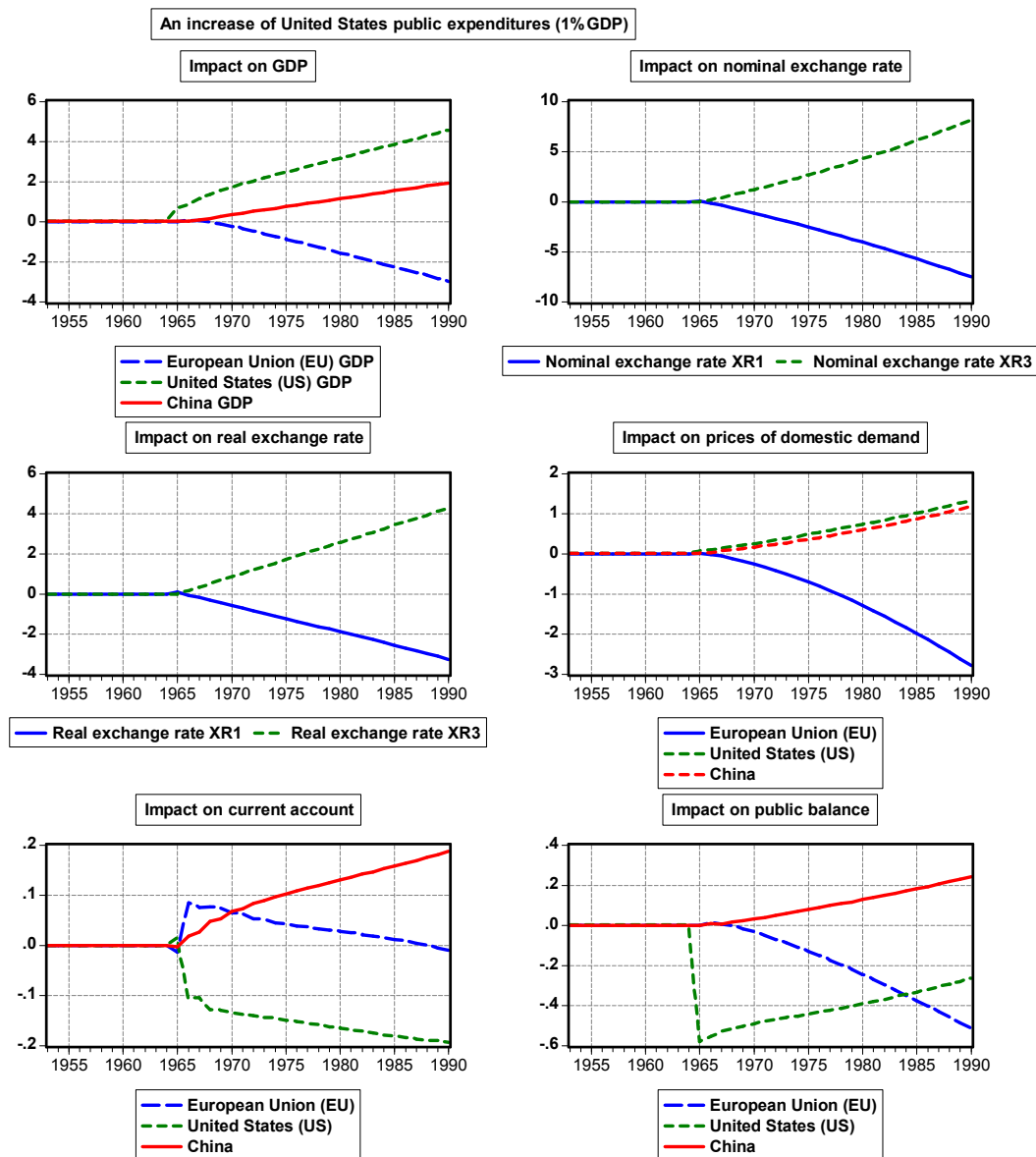
Figure 12: A loss of EU competitiveness facing China with fixed dollar-yuan parity and flexible prices



*Fixed dollar-yuan parity with diversification of China's foreign reserves*

An increase of US public expenditures (0.8% of GDP) gives once again the same kind of evolutions (figure 13). The US production increases and the dollar depreciates in nominal and real terms. The Chinese production is stimulated while the euro appreciation has a negative impact on the EU production. Like in the fixed prices model, the Chinese foreign reserves diversification amplifies the dollar depreciation and the euro appreciation at the expend of the European growth.

Figure 13: An increase of US public expenditures (0.8% of GDP) with fixed dollar-yuan parity, Chinese foreign reserves diversification and flexible prices

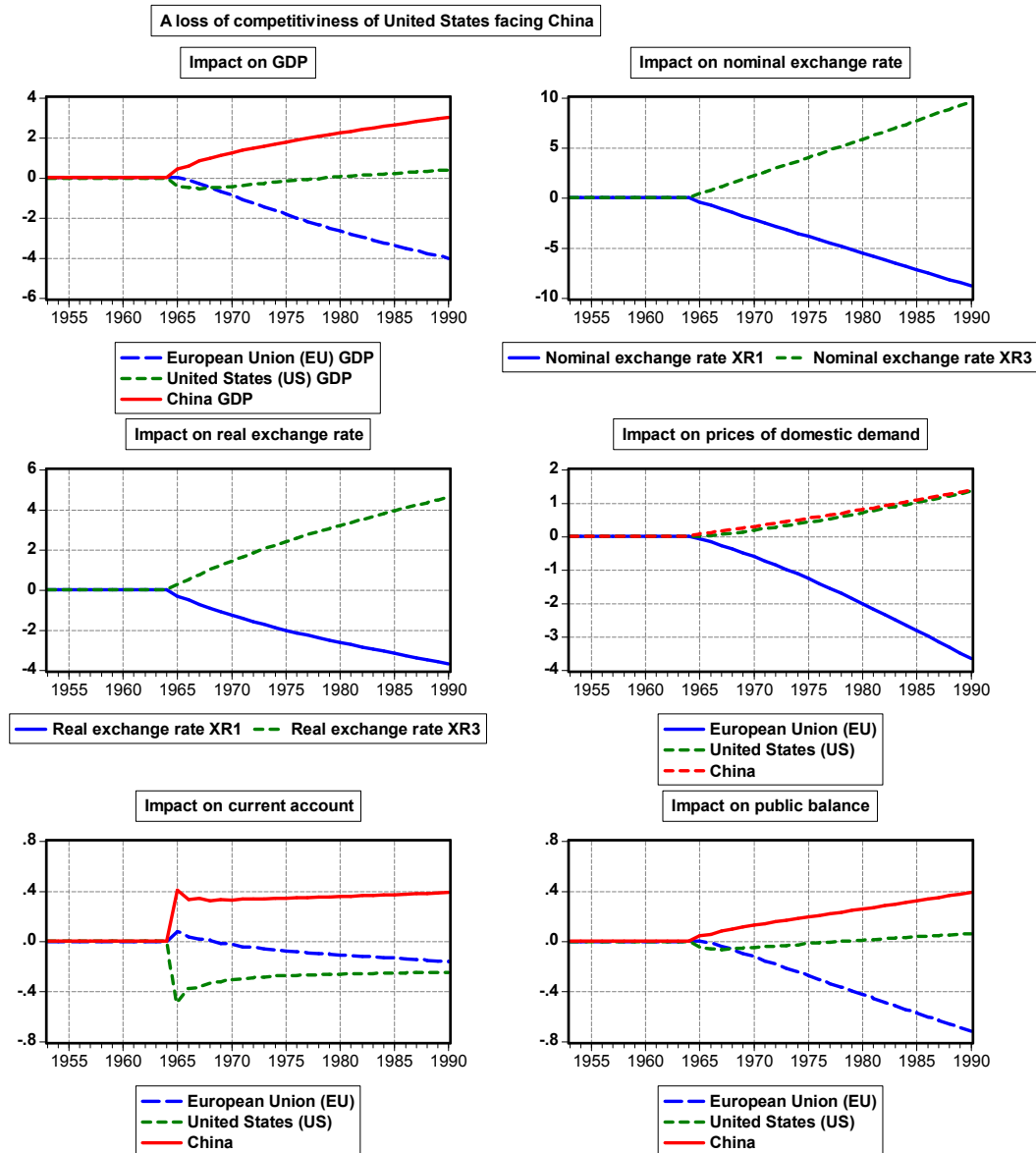


A supply shock with a loss of US competitiveness facing China<sup>7</sup> gives more contrasted results by comparison with the case without foreign reserves diversification, as it was the case with the fixed prices model (figure 14). The Chinese production increases and the US one declines at short term. Due to the declining demand of US bonds by the Chinese Central Bank, the dollar depreciates in nominal and real terms. As a consequence, the Chinese growth is more stimulated by the yuan depreciation and the US production recovers. On the opposite, the euro appreciation induces a decline of the 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

<sup>7</sup> The increase of the import propensity is from 0.5 to 0.51

Chinese Central bank diversifies its foreign reserves while keeping fixed the dollar-yuan parity.

Figure 14: A loss of US competitiveness facing China with fixed dollar-yuan parity, Chinese foreign reserves diversification and flexible prices



### *Floating yuan*

A single shock, a loss of US competitiveness facing China<sup>8</sup>, is examined. It induces at short term a decrease of the US production and an increase of the Chinese production (figure 15). The US current account deteriorates while the Chinese one improves. The dollar depreciates strongly against the yuan and less strongly against the euro. This dollar depreciation is linked

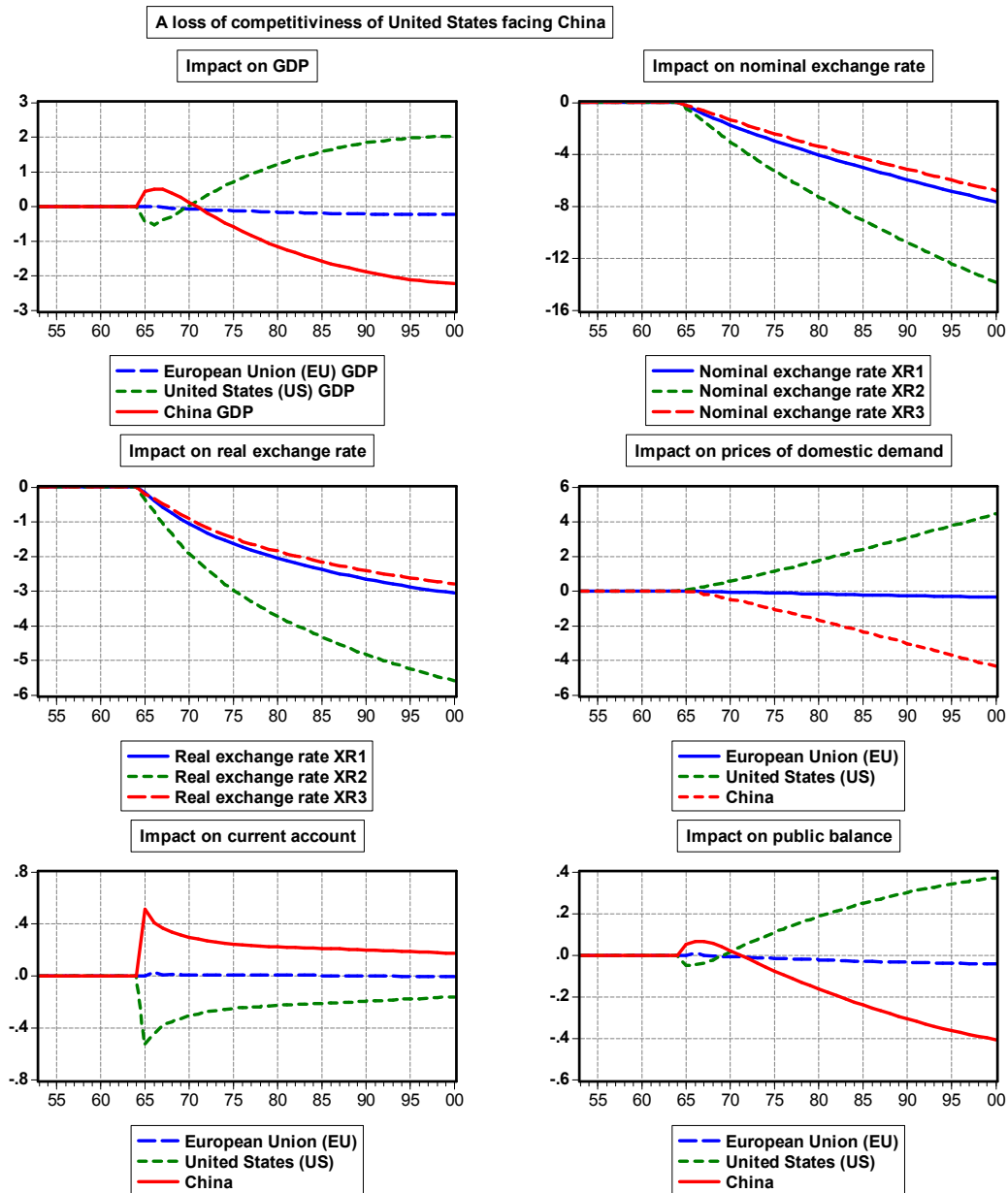
<sup>8</sup> The increase of the import propensity is from 0.5 to 0.51

to a larger supply of US bonds outside while the foreign reserves of the Chinese Central Bank in US bonds is held constant. These dollar depreciations remain in real terms in spite of the US prices increase. Consequently, the US production recovers and the Chinese production 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 (figure 10), the main difference is that the dollar depreciation allows an important recovery of the US production and a reduction of the US current imbalance. Global imbalances are more reduced by relative prices than by production. Compared with the case with Chinese foreign reserves diversification (figure 14), the difference is that the EU production is now preserved and the current imbalances, specially the Chinese surplus, more reduced. But Chinese growth is more affected. These conclusions are close to what was observed with the fixed prices models with, however, a more important reversal of the productions induced by the exchange rates adjustments.

Without presenting the other shocks, like a loss of US competitiveness facing the EU or a loss of European competitiveness facing China, a last remark can be done. With floating exchange rates, responses of the three countries facing each shock are very symmetric, as the main source of asymmetry, the fixed dollar-yuan parity, has been suppressed.

Figure 15: A loss of US competitiveness facing China with floating yuan and flexible prices



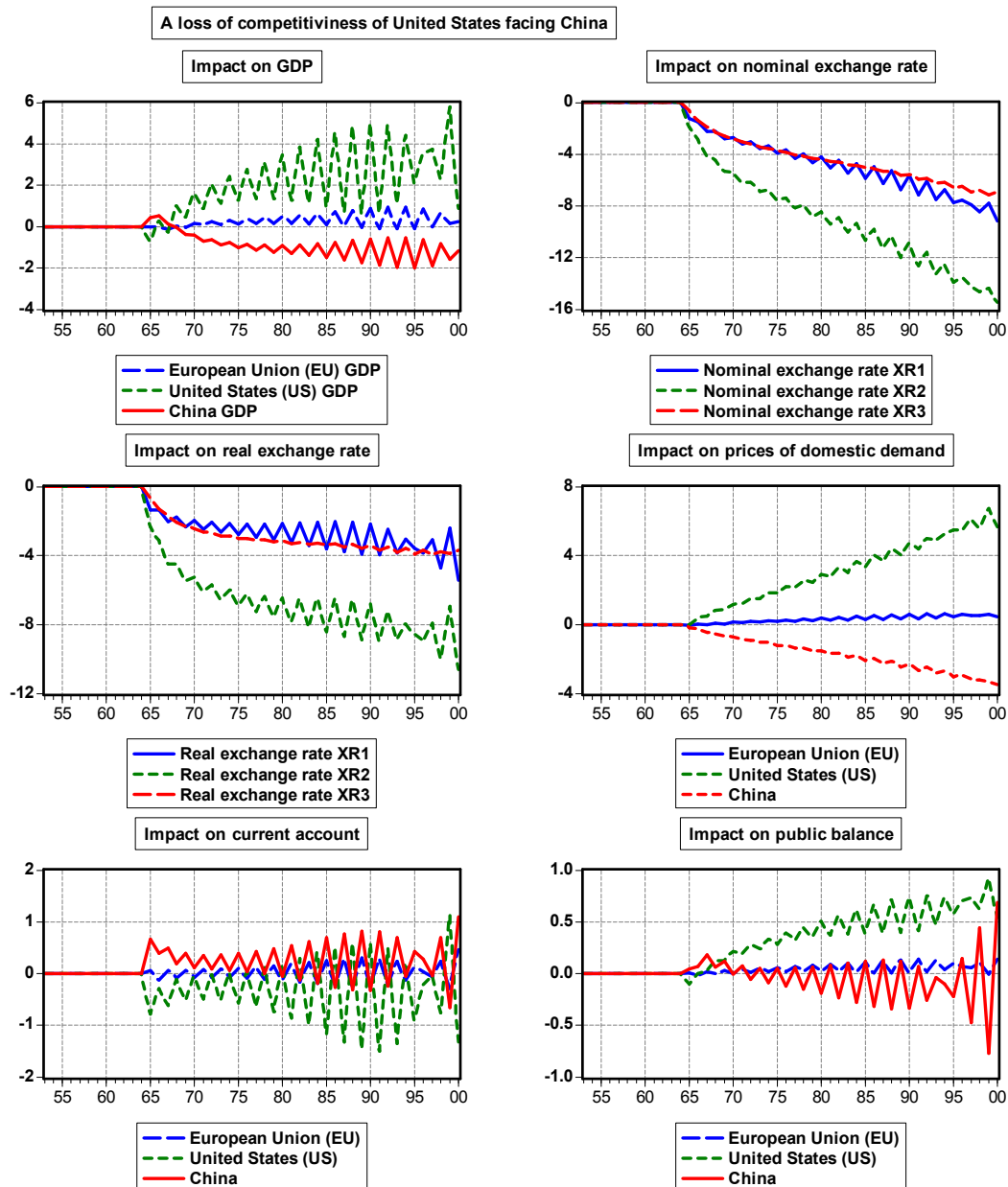
### Comparison of different floating exchange rate regimes

An impure floating yuan with inertia in adjustments or a managed exchange rate regime with target fixed by the Chinese Central Bank for the level of foreign reserves in dollars gives results very similar to the freely floating regime. Figures are not presented to save place.

Lastly, a managed exchange rate regime with target on current account fixed by the Chinese Central Bank gives also rather similar results but with more instable evolutions (figure 16).

These conclusions are once again close to what has been obtained with the fixed prices model.

Figure 16: A loss of US competitiveness facing China with yuan managed regime and a target on current account and with flexible prices



## 5. General conclusion

World imbalances have been increasing since the end of the 1990s with a large US current account deficit facing Asian surpluses. The European current account has remained close to equilibrium. These world imbalances reflect internal imbalances in each area, mainly the over-indebtedness of US households and declining US competitiveness on the one hand, the insufficient Chinese consumption on the other hand. They have been lasting thanks to the financial liberalisation which made their financing easier. The actual financial crisis has been the consequence of these imbalances, starting in the USA and diffusing at the world level.

Since 2007 partial adjustments have been achieved, mainly through the effects of the production decline, but the Asian surpluses remain huge.

Macroeconomic adjustments at the world level have been analysed in this paper using Stock Flow Consistent (SFC) models in lines of Godley and Lavoie (2004) and Zhao and Lavoie (2008). 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 of the portfolio models (Obstfeld and Rogoff, 2005; Blanchard et al., 2005) and do not presuppose that adjustments are limited to relative prices.

Three 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 from Zhao and Lavoie (2008), with a fixed dollar-yuan parity including a version with an active policy of the Chinese Central Bank regarding its reserves' diversification. The second one has introduced a flexible dollar-yuan parity which can be freely floating or following a Chinese Central Bank's targeted policy on the level of the current account or of the reserves. The third one has dropped the hypothesis of constant prices and combined a simple modelling of prices and wages with the two previous versions.

In the first configuration, with fixed dollar-yuan parity, demand shocks have traditional impact on growth, but diffusion effects and impact on external imbalances remain limited, mainly due to the rather small degree of openness. Exchange rate adjustments (with depreciation in the country where public expenditures increase) are also of small amplitude. On the contrary, supply shocks, with larger impact on growth, have more effects on 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 and the EU. In case of a loss of US competitiveness facing China, the small appreciation of the dollar against the euro, in spite of US deficits, can be explained by the increasing Chinese Central Bank's purchase of US bills to keep fixed the yuan-dollar parity.

The introduction of a diversification of China's foreign reserves changes the adjustment mechanisms at the international level, mainly at the expense of the EU due to the dollar depreciation and the euro appreciation, but not in a radical manner. The impact of demand shock on exchange rates is limited, as in the absence of foreign reserves' diversification. A supply shock like a loss of US competitiveness facing China has more significant effect. In case of a gradual diversification with a target structure of foreign reserves, a loss of US competitiveness induces a dollar depreciation, due to the declining demand of dollars by the CCB. The Chinese growth is more stimulated by the yuan depreciation and the EU production decreases more. International imbalances remain important with large Chinese surplus and EU deficit, but with reduced US deficit.

These conclusions are close to those already obtained by Lavoie and Zhao (2008). However they are obtained with the hypothesis of a fixed dollar-yuan parity which is restrictive and limits adjustments' magnitude. From 2005 to 2008 a limited appreciation of the yuan vis-à-vis the dollar has been already managed by the CCB.

This question has been examined in an enlarged model with floating dollar-yuan parity according to various mechanisms. Two points can be underlined. First, a floating dollar-yuan exchange rate is a powerful adjustment mechanism to reduce world imbalances characterised by US deficit and Chinese surplus. The contrast appears clearly with the first configuration where only the euro-dollar exchange rate was floating with a fixed dollar-yuan parity.

Second, a freely floating yuan is unrealistic in the actual state of the Chinese monetary and financial system. But more managed exchange rate regimes for the dollar-yuan parity, where the Chinese Central Bank intervenes to reach a target, either on foreign reserves in dollars or on current account level, give rather similar adjustment mechanisms. They can reduce world imbalances in the same proportions as a pure floating regime.

This approach doesn't detail the institutional forms of such exchange rates regimes, nor the internal consequences for the Chinese economy of a yuan revaluation, which could be investigated later. It limits to more general considerations at the world level. In spite of its theoretical aspect, the pure floating yuan regime can be used as a useful reference to examine in more details the differences between fixed and floating exchange rate regimes.

Lastly, the model with flexible prices has confirmed the main results obtained with fixed prices, although some differences might appear for some evolutions, especially on the magnitude of impacts on growth.

Two other remarks can be made from a larger point of view. First, in 2008-2009 world imbalances have been partly reduced, mainly due to the effects of the crisis and of the production decline which has cut US imports and exports of surplus countries. The dollar crisis, which has been announced many times, didn't occur. 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 (see table 2 for the FEER approach). The undervaluation of the yuan would still be around 20% in real and nominal terms in 2009. The euro is close to equilibrium, but with important intra-European imbalances. In case of Chinese reserves diversification and dollar depreciation against euro, the cost would be high for many Southern European countries. This constitutes an other argument in favour of a more flexible yuan-dollar parity.

Table 3: Under-valuation ( $e_i > 0$  and  $r_i > 0$ ) or overvaluation ( $e_i < 0$  and  $r_i < 0$ ) for Japan, the United States, the euro area, China, United Kingdom and the rest of the world

	<i>BILATERAL</i>					<i>REER</i>					
	<i>ejp</i>	<i>euk</i>	<i>ech</i>	<i>eeu</i>	<i>erow</i>	<i>rjp</i>	<i>Ruk</i>	<i>rch</i>	<i>rus</i>	<i>reu</i>	<i>rrow</i>
<b>2000</b>	-2.5	4.4	10.6	7.4	8.5	-6.4	-1.0	6.8	-9.0	1.9	4.9
<b>2001</b>	-2.2	3.3	1.9	12.0	5.4	-4.2	-2.8	0.3	-6.7	8.5	1.9
<b>2002</b>	3.1	3.9	11.0	16.9	9.3	-1.5	-5.4	5.9	-10.9	11.0	2.8
<b>2003</b>	5.5	4.9	13.7	15.2	12.9	-1.5	-5.1	6.0	-11.3	7.3	4.9
<b>2004</b>	8.5	1.7	18.8	26.8	18.3	0.3	-14.7	10.8	-16.2	16.0	7.7
<b>2005</b>	13.3	4.8	29.9	25.6	22.0	0.6	-13.1	17.2	-20.2	11.5	8.8
<b>2006</b>	15.0	5.0	32.2	21.9	20.0	2.0	-11.2	19.2	-19.4	8.5	7.5
<b>2007</b>	12.4	0.9	29.2	10.5	10.8	4.5	-7.2	21.8	-12.0	3.2	4.0
<b>2008</b>	6.4	0.7	21.5	5.7	8.3	-1.1	-5.1	14.4	-8.3	-0.2	2.7
<b>2009</b>	-2.5	-5.8	19.2	0.3	1.5	-3.7	-5.8	19.7	-2.7	0.4	1.6

Source: Mazier and Saadaoui (2009)

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 stabilisation appeared at the mid 2009 may not last at medium term. Sustain by public stimulus cannot remain for ever. Households' consumption recovery will be limited by the level of their debt. Export led growth (and less imports) may help and could be sustained by a cheaper currency. Beyond direct effects on foreign trade, a weaker dollar could facilitate structural adjustments of the productive sector, which are always painful, with huge shift resources from sectors like finance, housing and cars to more tradable activities.

In China domestic demand will grow by at least 10% in 2009, which is welcome, thanks to fiscal stimulus and loosening of credit. But the structural unbalance between consumption and investment remains. The weakness of Chinese consumption can be explained by many factors, a saving rate too high due to an insufficient social safety net, an increasing income inequality which induces more savings. But the main factor seems to be that the share of income going to households 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. A more labour intensive growth would imply a whole set of complex reforms. Among them, an appreciation of the yuan would play an important role by discouraging excessive investment in the manufacturing 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.

These structural issues could be analysed later on. In the actual model the three countries are of the same size and have the same structural characteristics. It could be useful to individualize more each country, especially China which is smaller and more open than the two others, and to introduce a fourth country, the rest of the world, whose size would be large compared with the three others.

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Annex

Table 2 : National accounts in flows

	Euro area = €					USA = \$					China = ¥					
	H	F		G	BC	H	F		G	BC	H	F		G	BC	
		Courant	Capital				Crt	Cpl				Crt	Cpl			
B & S	-C <sup>€</sup>	Y <sup>€</sup>	-I <sup>€</sup>	-G <sup>€</sup>		-C <sup>\$</sup>	Y <sup>\$</sup>	-I <sup>\$</sup>	-G <sup>\$</sup>		-C <sup>¥</sup>	Y <sup>¥</sup>	-I <sup>¥</sup>	-G <sup>¥</sup>		0
IM	IM <sup>€</sup>					IM <sup>\$</sup>					IM <sup>¥</sup>					0
X	-X <sup>€</sup>					-X <sup>\$</sup>					-X <sup>¥</sup>					0
Wages	W <sup>€</sup>	-W <sup>€</sup>				W <sup>\$</sup>	-W <sup>\$</sup>				W <sup>¥</sup>	-W <sup>¥</sup>				0
Taxes	-T <sup>€</sup>			T <sup>€</sup>		-T <sup>\$</sup>			T <sup>\$</sup>		-T <sup>¥</sup>			T <sup>¥</sup>		0
Interest	r <sup>€</sup> .B <sup>€</sup> <sub>€</sub>			-r <sup>€</sup> .B <sup>€</sup> <sub>cb€</sub>	r <sup>€</sup> .B <sup>€</sup> <sub>cb€</sub>	r <sup>€</sup> .B <sup>€</sup> <sub>s/xr<sup>1</sup></sub>				r <sup>€</sup> .B <sup>€</sup> <sub>cb\$/xr<sup>1</sup></sub>	r <sup>€</sup> .B <sup>€</sup> <sub>¥.xr<sup>3</sup></sub>				r <sup>€</sup> .B <sup>€</sup> <sub>¥cb. xr<sup>3</sup></sub>	0
	r <sup>\$</sup> .B <sup>\$</sup> <sub>€xr<sup>1</sup></sub>				r <sup>\$</sup> .B <sup>\$</sup> <sub>cb€.xr<sup>1</sup></sub>	r <sup>\$</sup> .B <sup>\$</sup> <sub>s</sub>			-r <sup>\$</sup> .B <sup>\$</sup>	r <sup>\$</sup> .B <sup>\$</sup> <sub>cb\$</sub>	r <sup>\$</sup> .B <sup>\$</sup> <sub>¥.xr<sup>2</sup></sub>				r <sup>\$</sup> .B <sup>\$</sup> <sub>¥cb.xr<sup>2</sup></sub>	0
	r <sup>¥</sup> .B <sup>¥</sup> <sub>€/xr<sup>3</sup></sub>					r <sup>¥</sup> .B <sup>¥</sup> <sub>s/xr<sup>2</sup></sub>					r <sup>¥</sup> .B <sup>¥</sup> <sub>¥</sub>			-r <sup>¥</sup> .B <sup>¥</sup>	r <sup>¥</sup> .L <sup>¥</sup> <sub>cb¥</sub>	0
					r <sup>€</sup> .L <sup>€</sup>				-r <sup>\$</sup> .L <sup>\$</sup>		r <sup>\$</sup> .L <sup>\$</sup>				-r <sup>¥</sup> .L <sup>¥</sup>	
	r <sup>€</sup> <sub>d</sub> .M <sup>€</sup>				-r <sup>€</sup> <sub>d</sub> .M <sup>€</sup>	r <sup>\$</sup> <sub>d</sub> .M <sup>\$</sup>				-r <sup>\$</sup> <sub>d</sub> .M <sup>\$</sup>	r <sup>¥</sup> <sub>d</sub> .M <sup>¥</sup>				-r <sup>¥</sup> <sub>d</sub> .M <sup>¥</sup>	0
Profit		-P <sup>€</sup>	P <sup>€</sup>	P <sup>€</sup> <sub>cb</sub>	-P <sup>€</sup> <sub>cb</sub>											0
Chgin																
Money	-ΔM <sup>€</sup>				ΔM <sup>€</sup>	-ΔM <sup>\$</sup>				ΔM <sup>\$</sup>	-ΔM <sup>¥</sup>				ΔM <sup>¥</sup>	0
Bills €	-ΔB <sup>€</sup> <sub>€</sub>			ΔB <sup>€</sup>	-ΔB <sup>€</sup> <sub>cb€</sub>	-ΔB <sup>€</sup> <sub>s/xr<sup>1</sup></sub>				-ΔB <sup>€</sup> <sub>cb\$/xr<sup>1</sup></sub>	-ΔB <sup>€</sup> <sub>¥.xr<sup>3</sup></sub>				-ΔB <sup>€</sup> <sub>¥cb. xr<sup>3</sup></sub>	0
Bills \$	-ΔB <sup>\$</sup> <sub>€xr<sup>1</sup></sub>				-ΔB <sup>\$</sup> <sub>cb€.xr<sup>1</sup></sub>	-ΔB <sup>\$</sup> <sub>s</sub>			ΔB <sup>\$</sup>	-ΔB <sup>\$</sup> <sub>cb\$</sub>	-ΔB <sup>\$</sup> <sub>¥.xr<sup>2</sup></sub>				-ΔB <sup>\$</sup> <sub>¥cb.xr<sup>2</sup></sub>	0
Bills ¥	-ΔB <sup>¥</sup> <sub>€/xr<sup>3</sup></sub>					-ΔB <sup>¥</sup> <sub>s/xr<sup>2</sup></sub>					-ΔB <sup>¥</sup> <sub>¥</sub>			ΔB <sup>¥</sup>	-ΔB <sup>¥</sup> <sub>cb¥</sub>	0
ΔLoan		ΔL <sup>€</sup>			-ΔL <sup>€</sup>		ΔL <sup>\$</sup>			-ΔL <sup>\$</sup>		ΔL <sup>¥</sup>			-ΔL <sup>¥</sup>	0
Sum	0	0		0	0	0	0		0	0	0	0		0	0	0

### Constraints on the coefficients in households' assets demand

$$B_{ed}^e = V^e (\gamma_{e10} + \gamma_{e11} r^e + \gamma_{e12} r^s + \gamma_{e13} r^y + \gamma_{e14} r^d)$$

$$B_{ed}^s = V^e (\gamma_{e20} + \gamma_{e21} r^e + \gamma_{e22} r^s + \gamma_{e23} r^y + \gamma_{e24} r^d)$$

$$B_{ed}^y = V^e (\gamma_{e30} + \gamma_{e31} r^e + \gamma_{e32} r^s + \gamma_{e33} r^y + \gamma_{e34} r^d)$$

$$M_d^y = V^e (\gamma_{e40} + \gamma_{e41} r^e + \gamma_{e42} r^s + \gamma_{e43} r^y + \gamma_{e44} r^d)$$

$$B_{sd}^s = V^s (\gamma_{u10} + \gamma_{u11} r^e + \gamma_{u12} r^s + \gamma_{u13} r^y + \gamma_{u14} r^d)$$

$$B_{sd}^e = V^s (\gamma_{u20} + \gamma_{u21} r^e + \gamma_{u22} r^s + \gamma_{u23} r^y + \gamma_{u24} r^d)$$

$$B_{sd}^y = V^s (\gamma_{u30} + \gamma_{u31} r^e + \gamma_{u32} r^s + \gamma_{u33} r^y + \gamma_{u34} r^d)$$

$$M_d^s = V^s (\gamma_{u40} + \gamma_{u41} r^e + \gamma_{u42} r^s + \gamma_{u43} r^y + \gamma_{u44} r^d)$$

$$B_{yd}^y = V^y (\gamma_{10} + \gamma_{11} r^e + \gamma_{12} r^s + \gamma_{13} r^y + \gamma_{14} r^d)$$

$$B_{yd}^e = V^y (\gamma_{20} + \gamma_{21} r^e + \gamma_{22} r^s + \gamma_{23} r^y + \gamma_{24} r^d)$$

$$B_{yd}^s = V^y (\gamma_{30} + \gamma_{31} r^e + \gamma_{32} r^s + \gamma_{33} r^y + \gamma_{34} r^d)$$

$$M_d^y = V^y (\gamma_{40} + \gamma_{41} r^e + \gamma_{42} r^s + \gamma_{43} r^y + \gamma_{44} r^d)$$

The coefficients must respect some constraints in the Godley and Tobin's approach.

Vertical constraints:

$$\gamma_{e10} + \gamma_{e20} + \gamma_{e30} + \gamma_{e40} = 1$$

$$\gamma_{e11} + \gamma_{e21} + \gamma_{e31} + \gamma_{e41} = 0$$

$$\gamma_{e12} + \gamma_{e22} + \gamma_{e32} + \gamma_{e42} = 0$$

$$\gamma_{e13} + \gamma_{e23} + \gamma_{e33} + \gamma_{e43} = 0$$

$$\gamma_{e14} + \gamma_{e24} + \gamma_{e34} + \gamma_{e44} = 0$$

Horizontal constraints:

$$\gamma_{e11} + \gamma_{e12} + \gamma_{e13} + \gamma_{e14} = 0$$

$$\gamma_{e21} + \gamma_{e22} + \gamma_{e23} + \gamma_{e24} = 0$$

$$\gamma_{e31} + \gamma_{e32} + \gamma_{e33} + \gamma_{e34} = 0$$

$$\gamma_{e41} + \gamma_{e42} + \gamma_{e43} + \gamma_{e44} = 0$$

### List of variables

$B_{ss}^s$	=	Supply of US Treasury bills to US households
$B_{sd}^s$	=	Demand of US Treasury bills by US households
$B_{b^s}^s$	=	Supply of US Treasury bills to Chinese banks
$B_{b^d}^s$	=	Demand of US Treasury bills by Chinese banks
$B_{yd}^s$	=	Demand of US Treasury bills by Chinese households
$B_{ys}^s$	=	Supply of US Treasury bills to Chinese households
$B_{ed}^s$	=	Demand for US Treasury bills by households in the euro area
$B_{es}^s$	=	Supply of US Treasury bills to households in the euro area
$B_{bsd}^s$	=	Demand of US Treasury bills by U.S. banks
$B_{bss}^s$	=	Supply of US Treasury bills U.S. banks
$B_{bed}^s$	=	Demand of US Treasury bills by banks in the euro area
$B_{bes}^s$	=	Supply of US Treasury bills to banks in the euro area
$B_s^s$	=	Issue of US Treasury bills

(same notation for European and Chinese Treasury bills)

C	=	Consumption
CAB	=	Current account balance
G	=	Public spending
I	=	Investment
IM <sup>s</sup>	=	U.S. imports

$IM_{\text{Y}}^{\text{S}}$	=	U.S. imports from China
$IM_{\text{E}}^{\text{S}}$	=	U.S. imports from the euro area
$IM_{\text{Y}}^{\text{C}}$	=	Chinese imports
$IM_{\text{S}}^{\text{C}}$	=	Chinese imports from the United States
$IM_{\text{E}}^{\text{C}}$	=	Chinese imports from the euro area
$IM^{\text{E}}$	=	Imports of the euro area
$IM_{\text{S}}^{\text{E}}$	=	Imports of the euro zone from the United States
$IM_{\text{Y}}^{\text{E}}$	=	Imports of the euro zone from China
$K$	=	Capital stock
$KAB$	=	Capital account balance
$K^{\text{T}}$	=	Desired capital stock
$L_{\text{s}}$	=	Loans supply
$L_{\text{d}}$	=	Loans demand
$M_{\text{d}}$	=	Demand for money
$M_{\text{s}}$	=	Money supply
$P$	=	Profit firms
$P_{\text{b}}$	=	Profit banks
$r$	=	Interest rate on bills
$r_{\text{d}}$	=	Interest rate on deposits
$r_{\text{l}}$	=	Interest rates on loans
$S$	=	Sales
$T$	=	Taxes
$V_{\text{h}}$	=	Households' wealth
$V_{\text{b}}$	=	Banks' wealth
$V_{\text{f}}$	=	Firms' wealth
$W$	=	Wages
$X^{\text{S}}$	=	U.S. exports
$X_{\text{Y}}^{\text{S}}$	=	U.S. exports to China
$X_{\text{E}}^{\text{S}}$	=	U.S. exports to countries of the euro area
$X_{\text{Y}}^{\text{C}}$	=	Chinese exports
$X_{\text{S}}^{\text{C}}$	=	Chinese exports to the USA
$X_{\text{E}}^{\text{C}}$	=	Chinese exports to the euro area
$X^{\text{E}}$	=	Euro area exports
$X_{\text{S}}^{\text{E}}$	=	Euro area exports to the USA
$X_{\text{Y}}^{\text{E}}$	=	Euro area exports to China
$xr1$	=	Exchange rate euro-dollar
$xr2$	=	Exchange rate dollar-yuan
$xr3$	=	Exchange rate Euro-yuan
$Y$	=	National income
$YD_{\text{hs}}$	=	Haig-Simons disposal income

## 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
$\gamma_1$ 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

China	European Union	United States
$\gamma_{c10} = 0.08$	$\gamma_{e10} = 0.142857$	$\gamma_{u10} = 0.13794$
$\gamma_{c11} = -0.2$	$\gamma_{e11} = -0.2$	$\gamma_{u11} = 0.6$
$\gamma_{c12} = -0.2$	$\gamma_{e12} = 0.6$	$\gamma_{u12} = -0.2$
$\gamma_{c13} = 0.6$	$\gamma_{e13} = -0.2$	$\gamma_{u13} = -0.2$
$\gamma_{c14} = -0.2$	$\gamma_{e14} = -0.2$	$\gamma_{u14} = -0.2$
$\gamma_{c20} = 0.04$	$\gamma_{e20} = 0.071429$	$\gamma_{u20} = 0.10345$
$\gamma_{c21} = 0.6$	$\gamma_{e21} = 0.6$	$\gamma_{u21} = -0.2$
$\gamma_{c22} = -0.2$	$\gamma_{e22} = -0.2$	$\gamma_{u22} = 0.6$
$\gamma_{c23} = -0.2$	$\gamma_{e23} = -0.2$	$\gamma_{u23} = -0.2$
$\gamma_{c24} = -0.2$	$\gamma_{e24} = -0.2$	$\gamma_{u24} = -0.2$
$\gamma_{c30} = 0.08$	$\gamma_{e30} = 0.07143$	$\gamma_{u30} = 0.0690$
$\gamma_{c31} = -0.2$	$\gamma_{e31} = -0.2$	$\gamma_{u31} = -0.2$
$\gamma_{c32} = 0.6$	$\gamma_{e32} = -0.2$	$\gamma_{u32} = -0.2$
$\gamma_{c33} = -0.2$	$\gamma_{e33} = 0.6$	$\gamma_{u33} = 0.6$
$\gamma_{c34} = -0.2$	$\gamma_{e34} = -0.2$	$\gamma_{u34} = -0.2$

## Imports elasticity

China	European Union	United States
$\mu_{c0} = -1$	$\mu_{e0} = -1$	$\mu_{u0} = -1$
$\mu_{c1} = 0.5$	$\mu_{e1} = 0.5$	$\mu_{u1} = 0.5$
$\mu_{c2} = 0.8$	$\mu_{e2} = 0.8$	$\mu_{u2} = 1$
$\mu_{c3} = -1$	$\mu_{e3} = -1$	$\mu_{u3} = -1$
$\mu_{c4} = 0.5$	$\mu_{e4} = 0.5$	$\mu_{u4} = 0.5$
$\mu_{c5} = 0.8$	$\mu_{e5} = 1$	$\mu_{u5} = 0.8$

## Parameters of the model with flexible prices

## Export prices

$p_{e2} = p_{e4} = 0$  (price maker)

## GDP price

$$\mu_e = 0$$

$$\pi_{e1} = 0.15$$

$$\pi_{e2} = 0.12$$

## Wage equations

$$\lambda_{e1} = 0.5$$

$$\lambda_{e2} = 1$$

$$\lambda_{e3} = 0.1$$

$$\lambda_{e4} = 1$$

Sensitivity tests

Figure 5.3 : Sensitivity tests regarding the imports elasticity  $\mu_1$   
 Increase of United States public expenditures (1% of GDP)  
 (Dollar-Yuan floating)

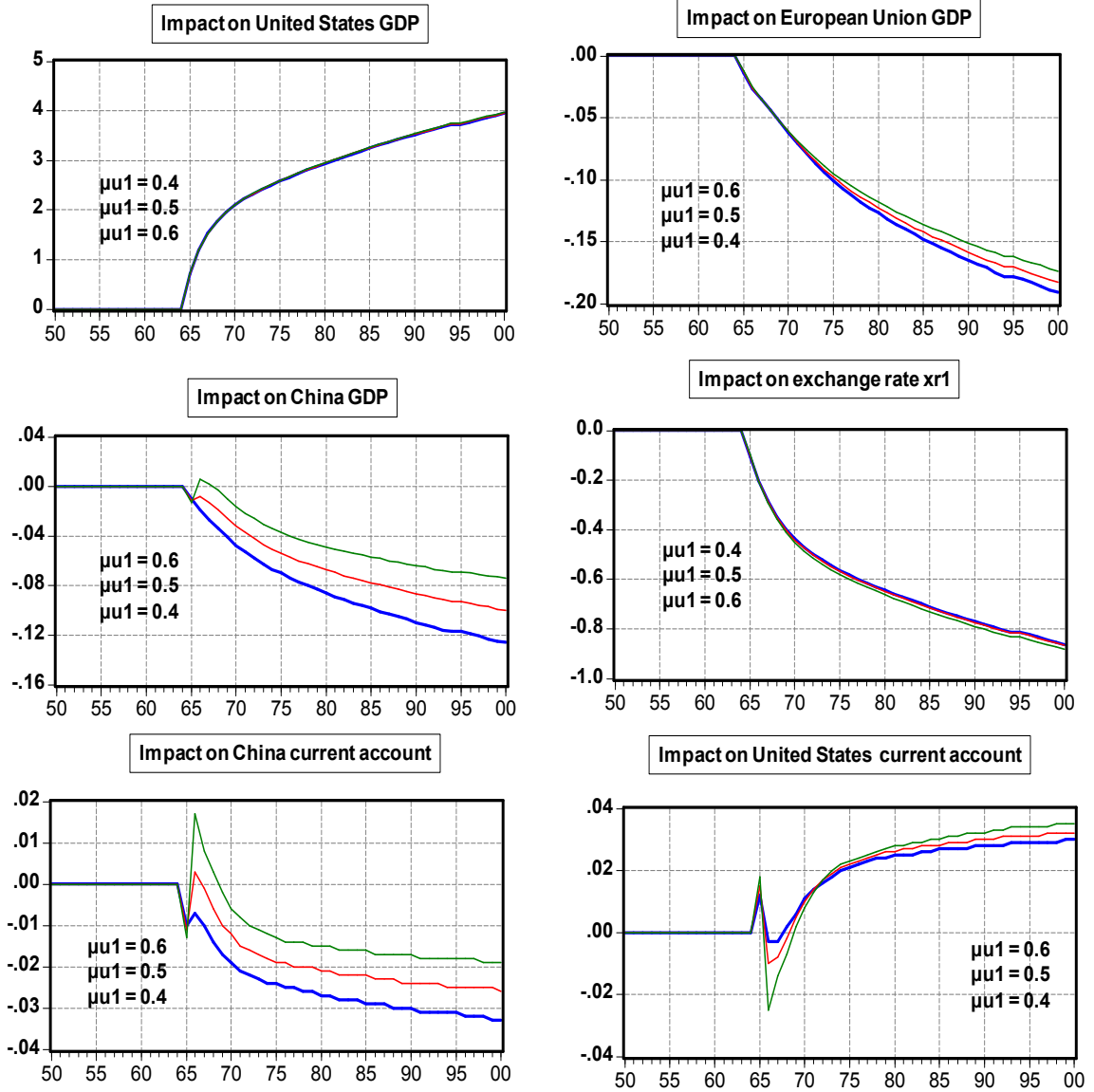


Figure 5.4 : Sensitivity tests regarding the imports élasticity  $\mu_2$   
 Loss of United States competitiveness facing China (Dollar-Yuan floating)

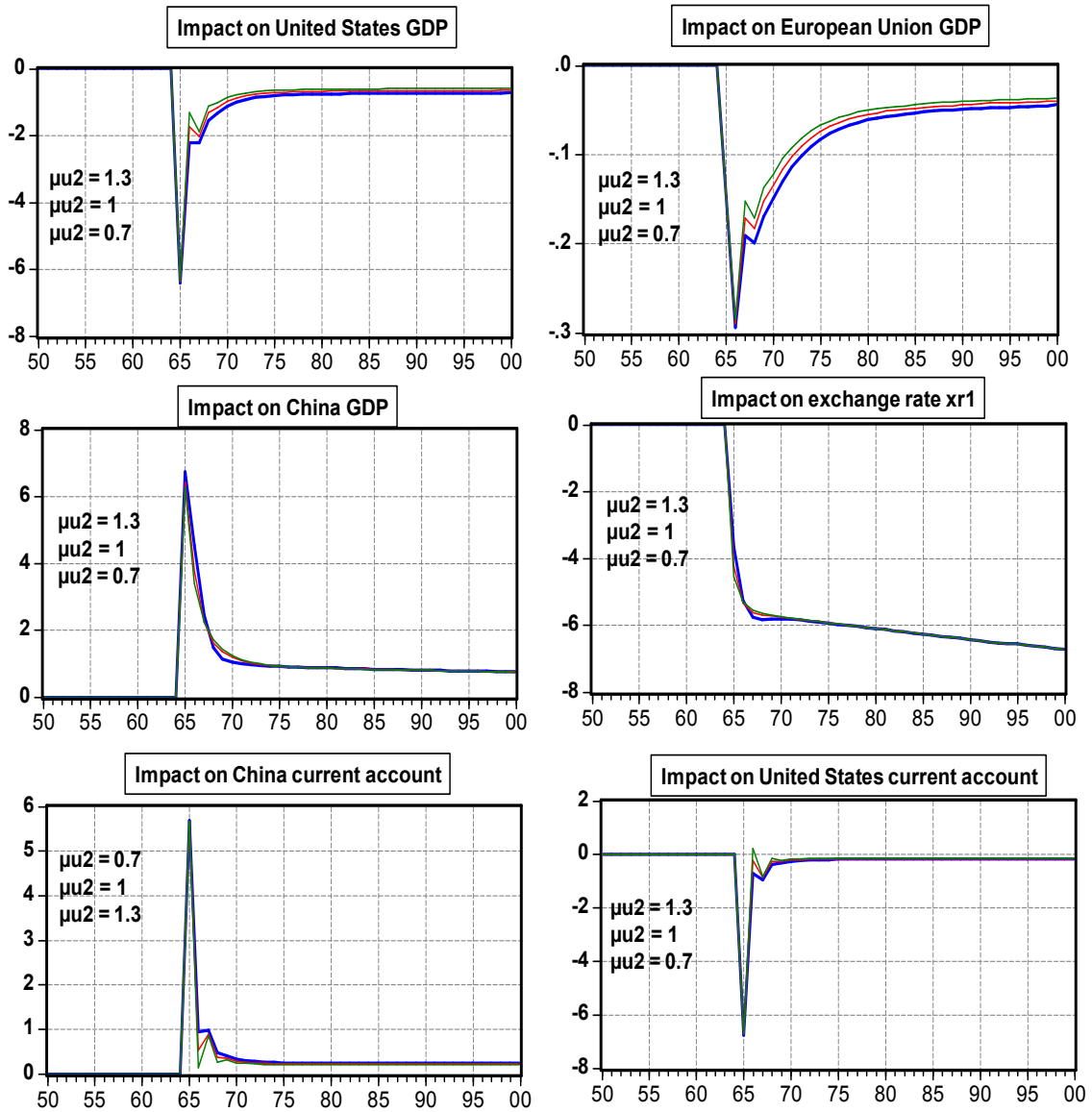
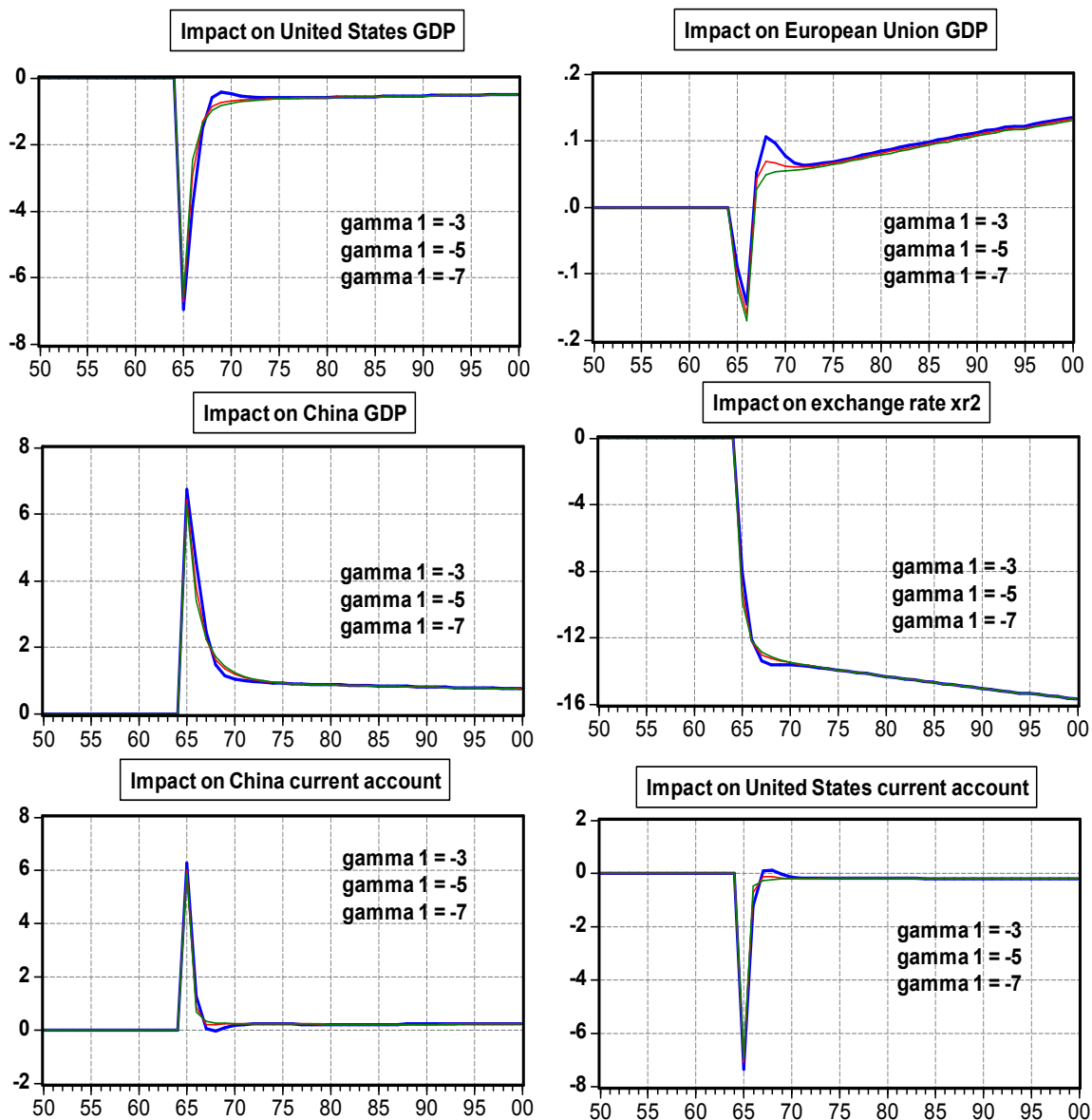


Figure 5.5 : Sensitivity tests regarding the adjustment parameters of the exchange rate XR2  
Loss of United States competitiveness facing China



The table below gives the coefficient of dispersion of relative deviations with regard to central account ( $c$ ) for different sets of coefficients in the case of a shock of loss of US competitiveness facing China. 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 ( $Y_{EU}$ ) the following coefficient of dispersion measured in absolute value:

$$[(Y_{EU} - Y_{EU}^c) / Y_{EU}^c]_{0.9} - [(Y_{EU} - Y_{EU}^c) / Y_{EU}^c]_{0.8}$$

For the current account balance in % of GDP (CAB) the coefficient of dispersion is measured with the simple deviation:

$$[(CAB_{EU} - CAB_{EU}^c)]_{0.9} - [(CAB_{EU} - CAB_{EU}^c)]_{0.8}$$

On the whole, the coefficients of dispersion of relative deviations with regard to central account (measured in %) appear small. It illustrates the relative stability of the model regarding the value of the different parameters.

Table 4: Coefficient of dispersion of relative deviations with regard to central account (in %)

			Ych	Yeu	Yus	XR1	CABch	CABeu	CABus
Pc (0.8)	0.7	1970	0.10	0.01	0.08	0.02	0.03	0.02	0.02
		2000	0.08	0	0.08	0.01	0.02	0	0.01
	0.9	1970	0.20	0.25	0.05	0.36	0.05	0.08	0.08
		2000	0.17	0.19	0.04	0.29	0.04	0.05	0.03
Λ (0.75)	0.7	1970	0.18	0.07	0.11	0.04	0.05	0.02	0
		2000	0.21	0.09	0.09	0.09	0.05	0.02	0.02
	0.8	1970	0.24	0.10	0.11	0.02	0.06	0.03	0
		2000	0.33	0.11	0.11	0.04	0.08	0.04	0.02
γe <sub>20</sub> (0.07)	0.10	1970	0	0	0.01	0.01	0.01	0	0.02
		2000	0.01	0	0.01	0	0.02	0	0.03
	0.14	1970	0	0	0.02	0.03	0.04	0.01	0.05
		2000	0.03	0	0.03	0	0.04	0	0.07

pc= propensity to consume

λ= wage share

γe<sub>20</sub> = share of US bills in the European households' assets