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World imbalances, exchange rates and macroeconomic adjustments: a three countries model stock flow consistent

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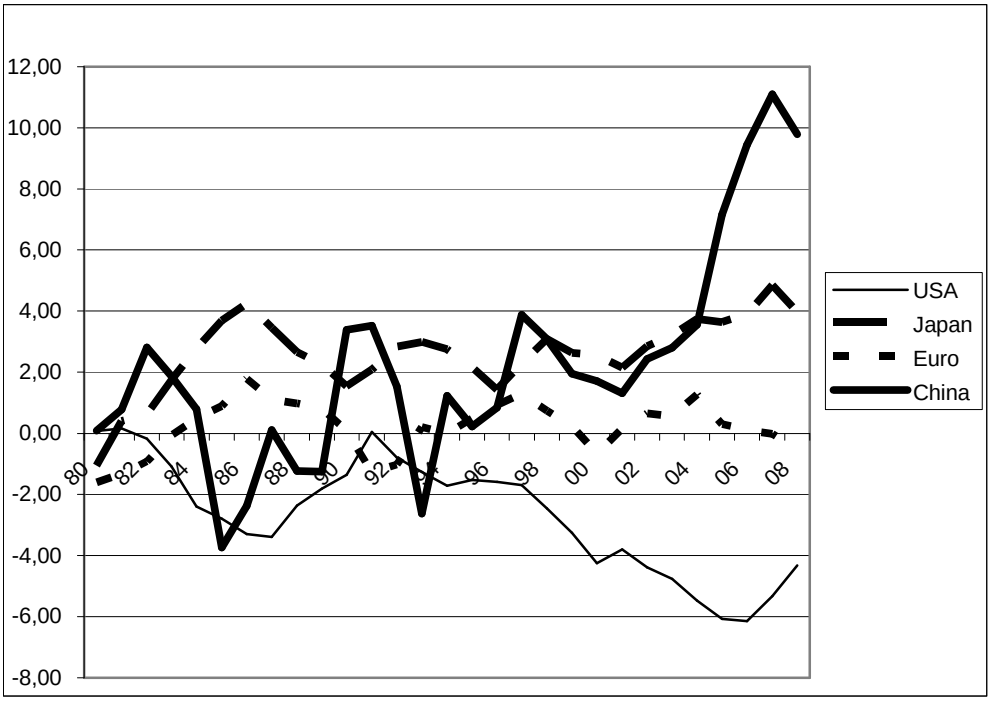
Abstract:
World imbalances have been increasing since the end of the 1990s, mainly with a large US current account deficit facing Asian surpluses. World macroeconomic adjustments are usually analysed with general equilibrium model or simpler portfolio models which are not always consistent at the world 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 Lavoie and Zhao (2006, 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. Two 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.
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 and the euro appreciation, but not in a radical manner. International imbalances are amplified with larger Chinese surplus and EU deficit, the US deficit being only slightly reduced.
In the second configuration the dollar-yuan parity is floating according to various mechanisms. 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 with a fixed dollar-yuan parity. 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 similar proportions as a pure floating regime. This approach doesn't detail the institutional forms of such exchange rates regimes. 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.

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 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, in spite of the "Bretton Woods 2" thesis which is sometimes advocated. During the last years only limited adjustments have been achieved with a small reduction of the US deficit following with delay the dollar depreciation and the world slowdown since 2007. The actual financial crisis can be regarded as an indirect consequence of these US imbalances.

Figure 1: Current account balances (in % of GDP)

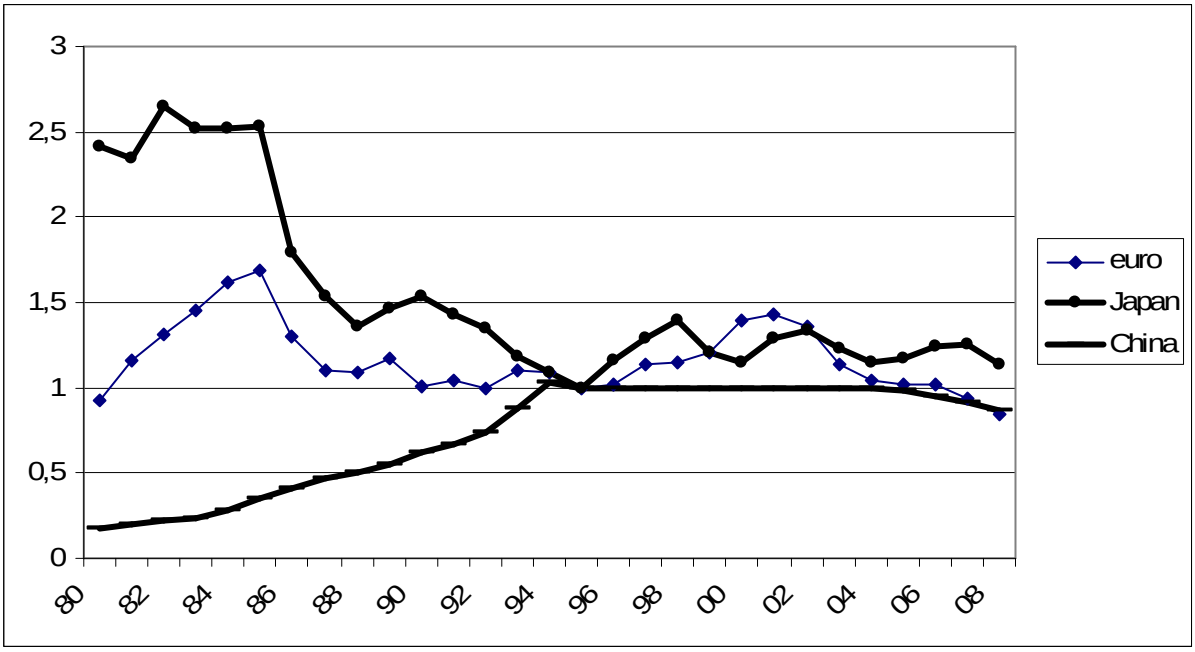


Source: IMF (2008 P)

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 only 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 2). 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 3).

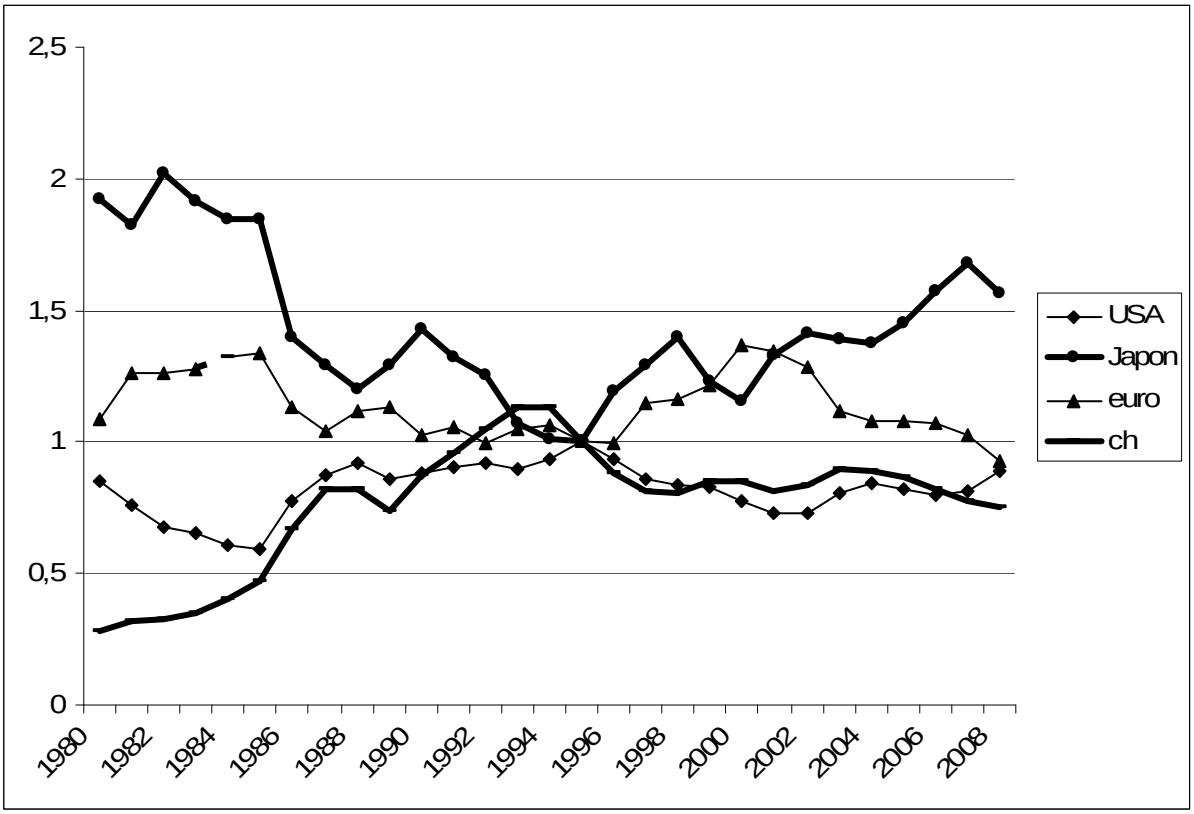
These evolutions can contribute to explain the persistence of large world imbalances. The depreciation of the dollar has been too limited to have a significant impact on the US deficit. The yen's real depreciation and the persistency of a large undervaluation of the yuan have amplified the external surpluses 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 2: Bilateral nominal exchange rates (base 1 in 1995)



Source : IMF

Figure 3: Real effective exchange rates (base 1 in 1995)



Source: IMF

The future of 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. Stock flow consistent (SFC) models in the lines of Godley and Lavoie (2007) and Lavoie and Zhao (2006) 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.
The paper is organized as follow. A second section resumes the theoretical background. A third section presents a SFC three-country model with the USA, China and the euro zone. Two versions will be considered, the first one with a fixed dollar-yuan parity including 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, will be presented in a fourth 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). 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 is evaluated (around 40%) and alternative scenarios are 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.

Two SFC three countries models will be considered in this paper. The first one, close to Lavoie and Zhao (2008), 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.

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$=xr1€=xr2¥ and 1€=1/xr1$= xr3¥. Table 1 describes the balance sheet of each sector. National accounts in flows and equations of the model are given in annex.

Table 1: The balance sheet of the three areas

	€ = euro area				$ = USA				¥ = China				
	H	F	Gov	CB	H	F	Gov	CB	H	F	Gov	CB	Sum
Capital		$K^{€}$				$K^{\$}$				$K^{¥}$			$\sum K$
Money	$M^{€}$			$-M^{€}$	$M^{\$}$			$-M^{\$}$	$M^{¥}$			$-M^{¥}$	0
Bills €	$B^{€}_{€}$		$-\mathbf{B}^{€}$	$B^{€}_{cb€}$	$B^{€}_{\$}/xr^{1}$			$B^{€}_{cb\$}/xr^{1}$	$B^{€}_{¥}.xr^{3}$			$B^{€}_{¥cb.}\ xr^{3}$	0
Bills $	$B^{\$}_{€}.xr^{1}$			$B^{\$}_{cb€}.xr^{1}$	$B^{\$}_{\$}$		$-\mathbf{B}^{\$}$	$B^{\$}_{cb\$}$	$B^{\$}_{¥}.xr^{2}$			$B^{\$}_{¥cb}.xr^{2}$	0
Bills ¥	$B^{¥}_{€}/xr^{3}$				$B^{¥}_{\$}/xr^{2}$				$B^{¥}_{¥}$		$-\mathbf{B}^{¥}$	$B^{¥}_{cb¥}$	0
Loan		$-L^{€}$		$L^{€}$		$-L^{\$}$		$L^{\$}$		$-L^{¥}$		$L^{€}$	0
Wealth	$-V^{€}_{h}$	$-V^{€}_{f}$	$\mathbf{B}^{€}$	$-V^{€}_{cb}$	$-V^{\$}_{h}$	$-V^{\$}_{f}$	$\mathbf{B}^{\$}$	0	$-V^{¥}_{h}$	$-V^{¥}_{f}$	$\mathbf{B}^{¥}$	$-V^{¥}_{cb}$	$\sum V$
Sum	0	0	**0**	0	0	0	**0**	0	0	0	**0**	0	0

Equilibrium of goods and services

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

$Y^{\$} \equiv C^{\$} + G^{\$} + I^{\$} + X^{\$} - IM^{\$}$

$Y^{¥} \equiv C^{¥} + G^{¥} + I^{\$} + X^{¥} - IM^{¥}$

Foreign trade

Exports

(2) $X^{€} = X^{€}_{\$} + X^{€}_{¥}$

(3) $X^{€}_{\$} = IM^{\$}_{€}.xr^{1}$

(4) $X^{€}_{¥} = IM^{¥}_{€}/\ xr^{3}$

$X^{\$} = X^{\$}_{€} + X^{\$}_{¥}$

$X^{\$}_{€} = IM^{€}_{\$}/\ xr^{1}$

$X^{\$}_{¥} = IM^{¥}_{\$}/\ xr^{2}$

$X^{¥} = X^{¥}_{€} + X^{¥}_{\$}$

$X^{¥}_{€} = IM^{€}_{¥}.\ xr^{3}$

$X^{¥}_{\$} = IM^{\$}_{¥}.\ xr^{2}$

Imports

(5) $IM^{€} = IM^{€}_{\$} + IM^{€}_{¥}$

$IM^{\$} = IM^{\$}_{¥} + IM^{\$}_{€}$

$IM^{¥} = IM^{¥}_{\$} + IM^{¥}_{€}$

(6) $LogIM^{€}_{\$} = \mu_{e1} + \mu_{e2}.LogS^{€} - \mu_{e3}\ Log.xr^{1}$

(7) $LogIM^{€}_{¥} = \mu_{e4} + \mu_{e5}.LogS^{€} + \mu_{e6}.Logxr^{3}$

$LogIM^{\$}_{¥} = \mu_{u1} + \mu_{u2}.LogS^{\$} + \mu_{u3}.Logxr^{2}$

$LogIM^{\$}_{€} = \mu_{u4} + \mu_{u5}.LogS^{\$} + \mu_{u6}.Logxr^{1}$

$LogIM^{¥}_{\$} = \mu_{c1} + \mu_{c2}.LogS^{¥} - \mu_{c3}\ Logxr^{2}$

$LogIM^{¥}_{€} = \mu_{c4} + \mu_{c5}.LogS^{¥} - \mu_{c6}.Logxr^{3}$

Sales equals domestic and foreign demand in each country

(8) $S^{€} = C^{€} + G^{€} + I^{€} + X^{€}$

$S^{\$} = C^{\$} + G^{\$} + I^{\$} + X^{\$}$

$$S^{¥} = C^{¥} + G^{¥} + I^{¥} + X^{¥}$$

Households

Disposal income

(9) $YD^{€}_{r} = W^{€} + r^{€}_{-1} .B^{€}_{€d-1} + r^{\$}_{-1} .B^{\$}_{€d-1} + r^{¥}_{-1} .B^{¥}_{€d-1} + r^{€}_{d-1} M_d{}^{€}_{-1} - T^{€}$

Haig-Simons disposal income including capital gains

(10) $YD^{€}_{hs} = YD^{€}_{r} + \Delta(xr^{1}).B^{\$}_{€s-1} + \Delta(1/xr^{3}). B^{¥}_{€s-1}$

$YD^{\$}_{r} = W^{\$} + r^{\$}_{-1} .B^{\$}_{\$d-1} + r^{€}_{-1} .B^{€}_{\$d-1} + r^{¥}_{-1} .B^{¥}_{\$d-1} + r^{\$}_{d-1} M_d{}^{\$}_{-1} - T^{\$}$

$YD^{\$}_{hs} = YD^{\$}_{r} + \Delta(1/xr^{1}).B^{€}_{\$s-1} + \Delta(1/xr^{2}).B^{¥}_{\$s-1}$

$YD^{¥}_{r} = W^{¥} + r^{¥}_{-1} .B^{¥}_{¥d-1} + r^{€}_{-1} .B^{€}_{¥d-1}. + r^{\$}_{-1} .B^{\$}_{¥d-1}.+ r^{¥}_{d-1} M_d{}^{¥}_{-1} - T^{¥}$

$YD^{¥}_{hs} = YD^{¥}_{r} + \Delta(xr^{3}). B^{€}_{¥s-1} + \Delta(xr^{2}). B^{\$}_{¥s-1}$

Taxes

(11) $T^{€} = \theta^{€} (W^{€} + r^{€}_{-1} .B^{€}_{€d-1} + r^{\$}_{-1} .B^{\$}_{€d-1} + r^{¥}_{-1} .B^{¥}_{€d-1} + r^{€}_{d-1} M_d{}^{€}_{-1})$

$T^{\$} = \theta^{\$} (W^{\$} + r^{\$}_{-1} .B^{\$}_{\$d-1} + r^{€}_{-1} .B^{€}_{\$d-1} + r^{¥}_{-1} .B^{¥}_{\$d-1} + r^{\$}_{d-1} M_d{}^{\$}_{-1})$

$T^{¥} = \theta^{¥} (W^{¥} + r^{¥}_{-1} .B^{¥}_{¥d-1} + r^{€}_{-1} .B^{€}_{¥d-1}. + r^{\$}_{-1} .B^{\$}_{¥d-1}.+ r^{¥}_{d-1} M_d{}^{¥}_{-1})$

Households' consumption with wealth effect

(12) $C^{€} = \alpha_{€1} YD^{€}_{hs} + \alpha_{€2} V^{€}_{h-1}$

$C^{\$} = \alpha_{\$1} YD^{\$}_{hs} + \alpha_{\$2} V^{\$}_{h-1}$

$C^{¥} = \alpha_{¥1} YD^{¥}_{hs} + \alpha_{¥2} V^{¥}_{h-1}$

Households' wealth accumulation

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

$\Delta V^{\$}_{h} = YD^{\$}_{hs} - C^{\$}$

$\Delta V^{¥}_{h} = YD^{¥}_{hs} - C^{¥}$

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, especially econometric ones. It will be developped 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 avearge.

(14) $B^{€}_{€d} = V^{€}_{h} (\gamma_{e10} + \gamma_{e11} r^{€} + \gamma_{e12} r^{\$} + \gamma_{e13} r^{¥} + \gamma_{e14} r^{€}_{d})$

(15) $B^{\$}_{€d} = V^{€}_{h} (\gamma_{e20} + \gamma_{e21} r^{€} + \gamma_{e22} r^{\$} + \gamma_{e23} r^{¥} + \gamma_{e24} r^{€}_{d})$

(16) $B^{¥}_{€d} = V^{€}_{h} (\gamma_{e30} + \gamma_{e31} r^{€} + \gamma_{e32} r^{\$} + \gamma_{e33} r^{¥} + \gamma_{e34} r^{€}_{d})$

(17bis) $M^{€}_{d} = V^{€}_{h} (\gamma_{e40} + \gamma_{e41} r^{€} + \gamma_{e42} r^{\$} + \gamma_{e43} r^{¥} + \gamma_{e44} r^{€}_{d})$

$B^{\$}_{\$d} = V_h{}^{\$} (\gamma_{u10} + \gamma_{u11} r^{€} + \gamma_{u12} r^{\$} + \gamma_{u13} r^{¥} + \gamma_{u14} r^{\$}_{d})$

$B^{€}_{\$d} = V_h{}^{\$} (\gamma_{u20} + \gamma_{u21} r^{€} + \gamma_{u22} r^{\$} + \gamma_{u23} r^{¥} + \gamma_{u24} r^{\$}_{d})$

$B^{¥}_{\$d} = V_h{}^{\$} (\gamma_{u30} + \gamma_{u31} r^{€} + \gamma_{u32} r^{\$} + \gamma_{u33} r^{¥} + \gamma_{u34} r^{\$}_{d})$

$M^{\$}_{d} = V_h{}^{\$} (\gamma_{u40} + \gamma_{u41} r^{€} + \gamma_{u42} r^{\$} + \gamma_{u43} r^{¥} + \gamma_{u44} r^{\$}_{d})$

$B^{¥}_{¥d} = V_h{}^{¥} (\gamma_{c10} + \gamma_{c11} r^{€} + \gamma_{c12} r^{\$} + \gamma_{c13} r^{¥} + \gamma_{c14} r^{¥}_{d})$

$B^{€}_{¥d} = V_h{}^{¥} (\gamma_{c20} + \gamma_{c21} r^{€} + \gamma_{c22} r^{\$} + \gamma_{c23} r^{¥} + \gamma_{c24} r^{¥}_{d})$

$B^{\$}_{¥d} = V_h^{¥} (\gamma_{c30} + \gamma_{c31} r^{€} + \gamma_{c32} r^{\$} + \gamma_{c33} r^{¥} + \gamma_{c34} r^{¥}_{d})$
$M^{¥}_{d} = V_h^{¥} (\gamma_{c40} + \gamma_{c41} r^{€} + \gamma_{c42} r^{\$} + \gamma_{c43} r^{¥} + \gamma_{c44} r^{¥}_{d})$

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

(17) $M^{€}_{d} = V_h^{€} - B^{€}_{€d} - B^{\$}_{€d} - B^{¥}_{€d}$
$M^{\$}_{d} = V_h^{\$} - B^{\$}_{\$d} - B^{€}_{\$d} - B^{¥}_{\$d}$
$M^{¥}_{d} = V_h^{¥} - B^{¥}_{¥d} - B^{€}_{¥d} - B^{\$}_{¥d}$

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

Government

Public deficit is financed by issuing Treasury bills.

(18) $\Delta B^{€}_{s} = G^{€} - T^{€} + r^{€}_{-1}.B^{€}_{s-1} - P^{€}_{cb}$
$\Delta B^{\$}_{s} = G^{\$} - T^{\$} + r^{\$}_{-1}.B^{\$}_{s-1} - P^{\$}_{cb}$
$\Delta B^{¥}_{s} = G^{¥} - T^{¥} + r^{¥}_{-1}.B^{¥}_{s-1} - P^{¥}_{cb}$

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

(19) $P^{€}_{cb} = r^{€}_{-1} .B^{€}_{cb€s-1} + r^{\$}_{-1} .B^{\$}_{cb€s-1}.xr^{1} + r^{€}_{l-1} L^{€}_{-1} - r^{€}_{d-1} M_d^{€}_{-1}$
$P^{\$}_{cb} = r^{\$}_{-1}.B^{\$}_{cb\$s-1} + r^{€}_{-1}.B^{€}_{cb\$s-1}/xr1 + r^{\$}_{l-1} L^{\$}_{-1} - r^{\$}_{d-1} M_d^{\$}_{-1}$
$P^{¥}_{cb} = r^{¥}_{-1} .B^{¥}_{cb¥s-1} + r^{\$}_{-1} .B^{\$}_{cb¥s-1}.xr^{2} + r^{€}_{-1} .B^{€}_{cb¥s-1}.xr^{3} + r^{¥}_{l-1} L^{¥}_{-1} - r^{¥}_{d-1} M_d^{¥}_{-1}$

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) $B^{€}_{s} = B^{€}_{€s} + B^{€}_{cb€s} + B^{€}_{\$s} + B^{€}_{\$cbs} + B^{€}_{¥s} + B^{€}_{¥cbs}$
$B^{\$}_{s} = B^{\$}_{\$s} + B^{\$}_{cb\$s} + B^{\$}_{€s} + B^{\$}_{cb€s} + B^{\$}_{¥s} + B^{\$}_{¥cbs}$
$B^{¥}_{s} = B^{¥}_{¥s} + B^{¥}_{cb¥s} + B^{¥}_{€s} + B^{¥}_{\$s}$

Equilibrium between supply and demand of assets by households

(21) $B^{¥}_{€s} = B^{¥}_{€d}.xr^{3}$
(22) $B^{\$}_{€s} = B^{\$}_{€d}/ xr^{1}$
(23) $B^{€}_{€s} = B^{€}_{€d}$
$B^{€}_{\$s} = B^{€}_{\$d}. xr^{1}$
$B^{¥}_{\$s} = B^{¥}_{\$d.} xr^{2}$
$B^{\$}_{\$s} = B^{\$}_{\$d}$
$B^{€}_{¥s} = B^{€}_{¥d}/ xr^{3}$
$B^{\$}_{¥s} = B^{\$}_{¥d}/ xr^{2}$
$B^{¥}_{¥s} = B^{¥}_{¥d}$

Firms

Wage share is supposed constant.

(24) $W^{€} = \lambda_{€} Y^{€}$
$W^{\$} = \lambda_{\$} Y^{\$}$
$W^{¥} = \lambda_{¥} Y^{¥}$

Profit is determined as a sold.

(25) $P^{€} = Y^{€} - W^{€} - r^{€}_{l-1} L^{€}_{-1}$
$P^{\$} = Y^{\$} - W^{\$} - r^{\$}_{l-1} L^{\$}_{-1}$
$P^{¥} = Y^{¥} - W^{¥} - r^{¥}_{l-1} L^{¥}_{-1}$

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) $I^{€} = \gamma_{€} (K^{T€} – K^{€}_{-1})$

(27) $K^{€} = (1 – \delta_{€})K^{€}_{-1} + I^{€}$

(28) $K^{T€} = \kappa_{€} \ . Y^{€}_{-1}$

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

(29) $\Delta L^{€}_{d} = I^{€} – P^{€}$

Firms' wealth is given by:

(30) $V^{€}_{f} = K^{€} - L^{€}$

or

$\Delta V^{€}_{f} = P^{€} - \delta_{€} K^{€}$

$I^{\$} = \gamma_{\$} (K^{T\$} – K^{\$}_{-1})$

$K^{\$} = (1 – \delta_{\$})K^{\$}_{-1} + I^{\$}$

$K^{T\$} = \kappa_{\$} \ . Y^{\$}_{-1}$

$\Delta L^{\$}_{d} = I^{\$} – P^{\$}$

$V^{\$}_{f} = K^{\$} - L^{\$}$

$I^{¥} = \gamma_{¥} (K^{T¥} – K^{¥}_{-1})$

$K^{¥} = (1 – \delta_{¥})K^{¥}_{-1} + I^{¥}$

$K^{T¥} = \kappa_{¥} \ . Y^{¥}_{-1}$

$\Delta L^{¥}_{d} = I^{¥} – P^{¥}$

$V^{¥}_{f} = K^{¥} - L^{¥}$

Banks

We considered 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 ($B^{€}_{cb\$} = 0$). 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) $M_s^{€} = L^{€}_{s} + B^{€}_{cb€s} + B^{\$}_{cb€s} xr1 \ -V_B^{€}$

(32) $M_s^{€} = M_d^{€}$

(33) $L^{€}_{s} = L^{€}_{d}$

$M_s^{\$} = L^{\$}_{s} + B^{\$}_{cb\$s} + B^{€}_{cb\$s}/xr1 – V_B^{\$}$

$M_s^{\$} = M_d^{\$}$

$L^{\$}_{s} = L^{\$}_{d}$

$M_s^{¥} = L^{¥}_{s} + B^{€}_{cb¥s} \ xr3 + B^{\$}_{cb¥s} xr2 + B^{¥}_{cb¥} \ -V_B^{¥}$

$M_s^{¥} = M_d^{¥}$

$L^{¥}_{s} = L^{¥}_{d}$

Equilibrium between bonds supply and demand by banks.

(34) $B^{€}_{cb€d} = B^{€}_{€cbs}$

$B^{\$}_{cb\$d} = B^{\$}_{\$cbs}$

$B^{¥}_{cb¥d} = B^{¥}_{¥cbs}$.

(103) $B^{€}_{cb¥s} = B^{€}_{cb¥d} \ / \ xr^3$

(104) $B^{€}_{cb\$s} = B^{€}_{cb\$d} \ xr1$

(105) $B^{\$}_{cb€s} = B^{\$}_{cb€d} / xr^1$
(106) $B^{\$}_{cb¥d} = B^{\$}_{cb¥s.} xr^2$

The US Central Bank has no reserves
(107) $B^{€}_{cb\$\,d} = 0$
Banks' wealth increase is due to valuation effects. The US banks' wealth is equal to zero due to the lack of reserves.
(108) $\Delta V^{€}_{b} = B^{\$}_{cb€s-1}\,\Delta xr1$
(109) $\Delta V^{\$}_{b} = B^{€}_{cb\$s-1}\,\Delta(1/xr1)$
(110) $\Delta V^{¥}_{b} = B^{€}_{cb¥s-1}\,\Delta xr3 + B^{\$}_{cb¥s-1}\,\Delta xr2$

Interest rates are exogenous in each country. Margin behaviour could be introduced later.
$r = r_l = r_d$

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 bis) $xr1 = B^{\$}_{€d} / B^{\$}_{€s}$
(111) $B^{\$}_{cb€d}$ = 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) $xr^3 = xr^2/xr^1$
(113) $B^{€}_{cb¥d}$ = 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) $B^{€}_{s} = B^{€}_{€} + B^{€}_{cb€} + B^{€}_{\$s} + B^{€}_{cb\$s} + B^{€}_{¥s} + B^{€}_{cbs}$

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 incertitude. However Taylor's explanation is not fully convincing and his model might not fully 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.

$$CAB^{€} = X^{€} - IM^{€} + r^{\$}_{-1}\,.B^{\$}_{€d-1} + r^{¥}_{-1}\,.B^{¥}_{€d-1} + r^{\$}_{-1}\,B^{\$}_{cb€d-1} - r^{€}_{-1.}(B^{€}_{-1} - B^{€}_{€\,-1} - B^{€}_{cb€-1})$$

$$CAB^{\$} = X^{\$} - IM^{\$} + r^{€}_{-1}\,.B^{€}_{\$d-1} + r^{¥}_{-1}\,.B^{¥}_{\$d-1} - r^{\$}_{-1.}(B^{\$}_{-1} - B^{\$}_{\$\,-1} - B^{\$}_{cb\$-1})$$

$CAB^{¥} = X^{¥} - IM^{¥} + r^{€}_{-1} .B^{€}_{¥d-1} + r^{\$}_{-1} .B^{\$}_{¥d-1} + r^{€}_{-1} B^{€}_{cb¥d-1} + r^{\$}_{-1} B^{\$}_{cb¥d-1} - r^{¥}_{-1.}(B^{¥}_{-1} - B^{¥}_{¥ -1} - B^{¥}_{cb¥-1})$

$KAB^{€} = (\Delta B^{€}_{\$s} + \Delta B^{€}_{¥s} + \Delta B^{€}_{¥cbs}) - (\Delta B^{\$}_{€d} + \Delta B^{\$}_{cb€d} + \Delta B^{¥}_{€d})$ = capital inflows – capital outflows

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

$KAB^{¥} = (\Delta B^{¥}_{\$s} + \Delta B^{¥}_{€s}) - (\Delta B^{€}_{¥d} + \Delta B^{€}_{¥cbd} + \Delta B^{\$}_{¥d} + \Delta B^{\$}_{cbd\,¥})$

$CAB^{€} + KAB^{€} = 0$

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

$CAB^{¥} + KAB^{¥} = 0$

This result remains if international monetary assets held by banks ($M^{€}_{cb\$}$ et $M^{\$}_{cb€}$) 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.

$(V_h + V_f + V_g + V_b)^{€} + (V_h + V_f + V_g + V_b)^{\$}\,xr1 + (V_h + V_f + V_g + V_b)^{¥}/xr3 = K^{€} + xr1\,K^{\$} + K^{¥}/xr3$

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

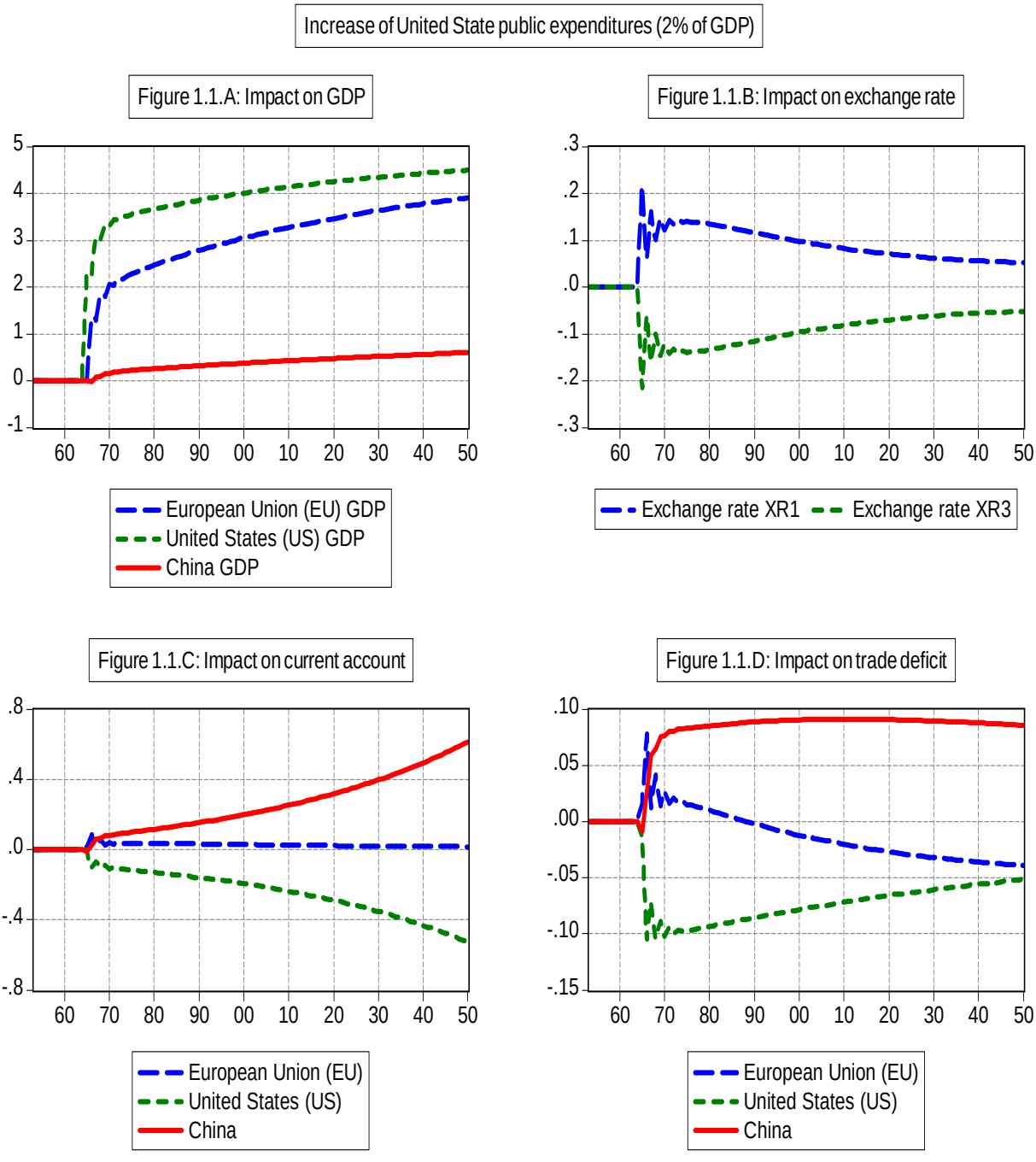
An increase of public expenditures equivalent to 2% of GDP successively in each country has rather contrasted effects (figures 1).

An increase of US public expenditures stimulates without surprise growth in the USA and, by diffusion, in the EU with an increasing US public deficit and current account deficit. The dollar is slightly appreciated, in spite of US deficits, thanks to larger demand of US bonds at world level. On the opposite, China benefits only moderately of the US and European recoveries with a slight appreciation of the yuan against the euro.

An increase of European expenditures has rather similar effects with rising EU deficits. The euro slightly depreciates against the dollar thanks to larger issue of euro bonds and stronger squeeze between demand and supply of US bonds. Once again, China benefits only weakly of the recovery with a moderate appreciation of the yuan.

Lastly an increase of Chinese public expenditures stimulates growth only in China with limited diffusion effects outside. Chinese current account deficit and public deficit increase while the yuan and the dollar are depreciated against the euro.

Figure 1: Increase of public expenditures (2% of GDP)



Increase of the European Union public expenditures (2% of GDP)

Figure 1.2.A: Impact on GDP

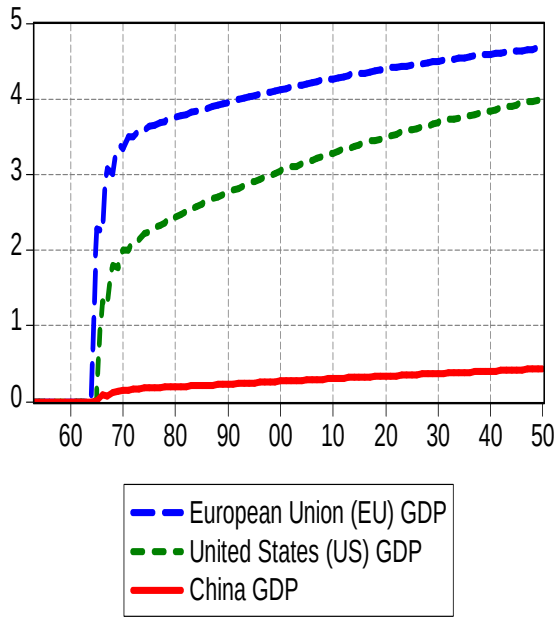


Figure 1.2.B: Impact on exchange rate

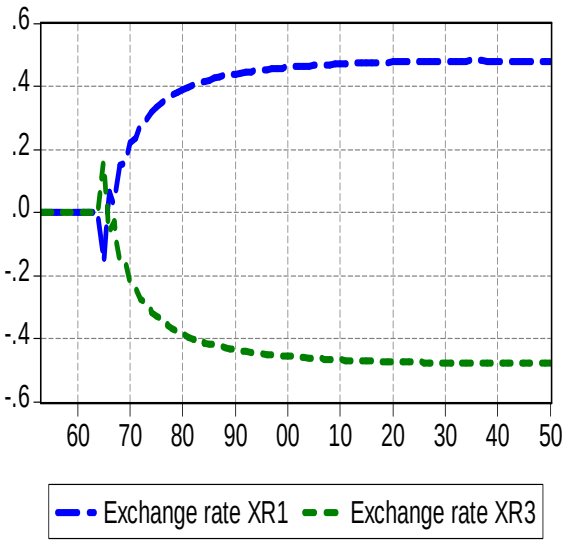


Figure 1.2.C: Impact on current account

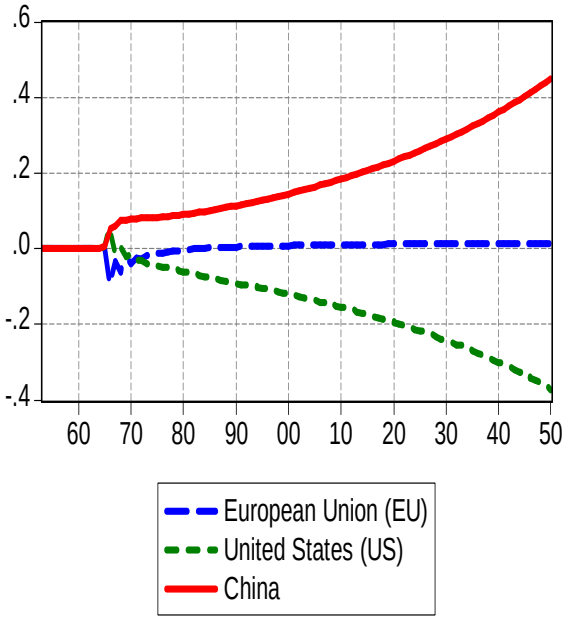
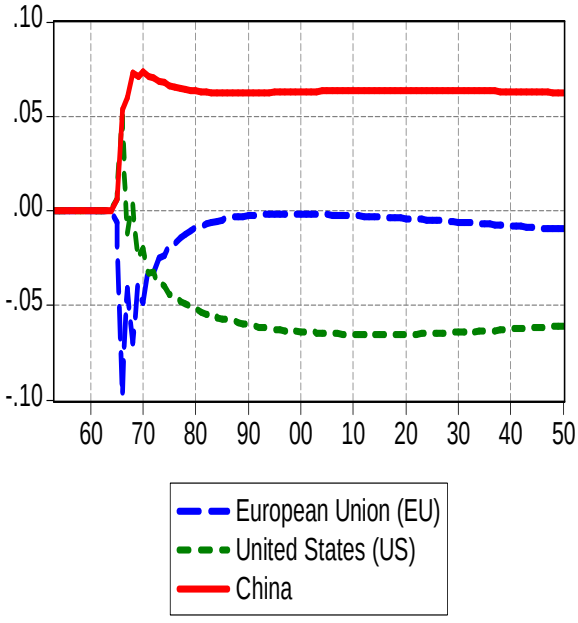


Figure 1.2.D: Impact on trade deficit



Increase of China public expenditures (2% of GDP)

Figure 1.3.A: Impact on GDP

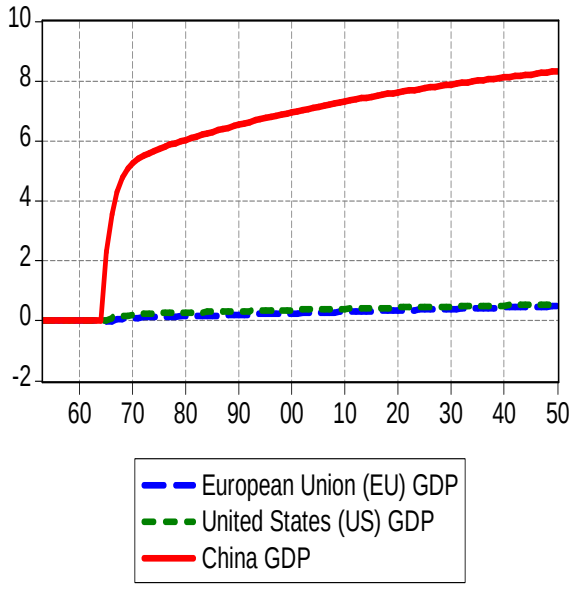


Figure 1.3.B: Impact on exchange rate

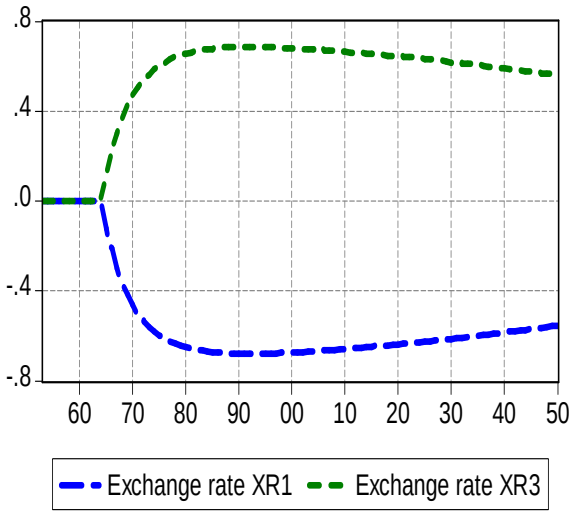


Figure 1.3.C: Impact on current account

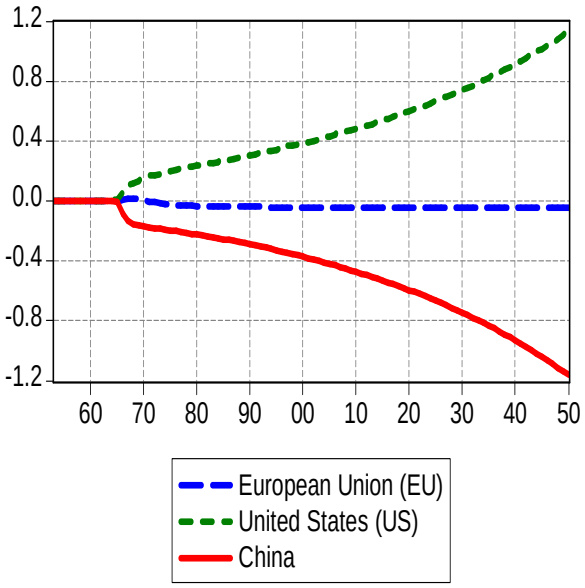
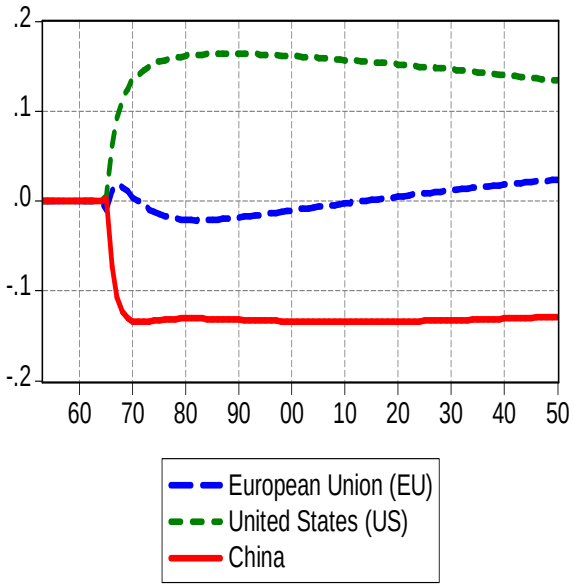


Figure 1.3.D: Impact on trade deficit



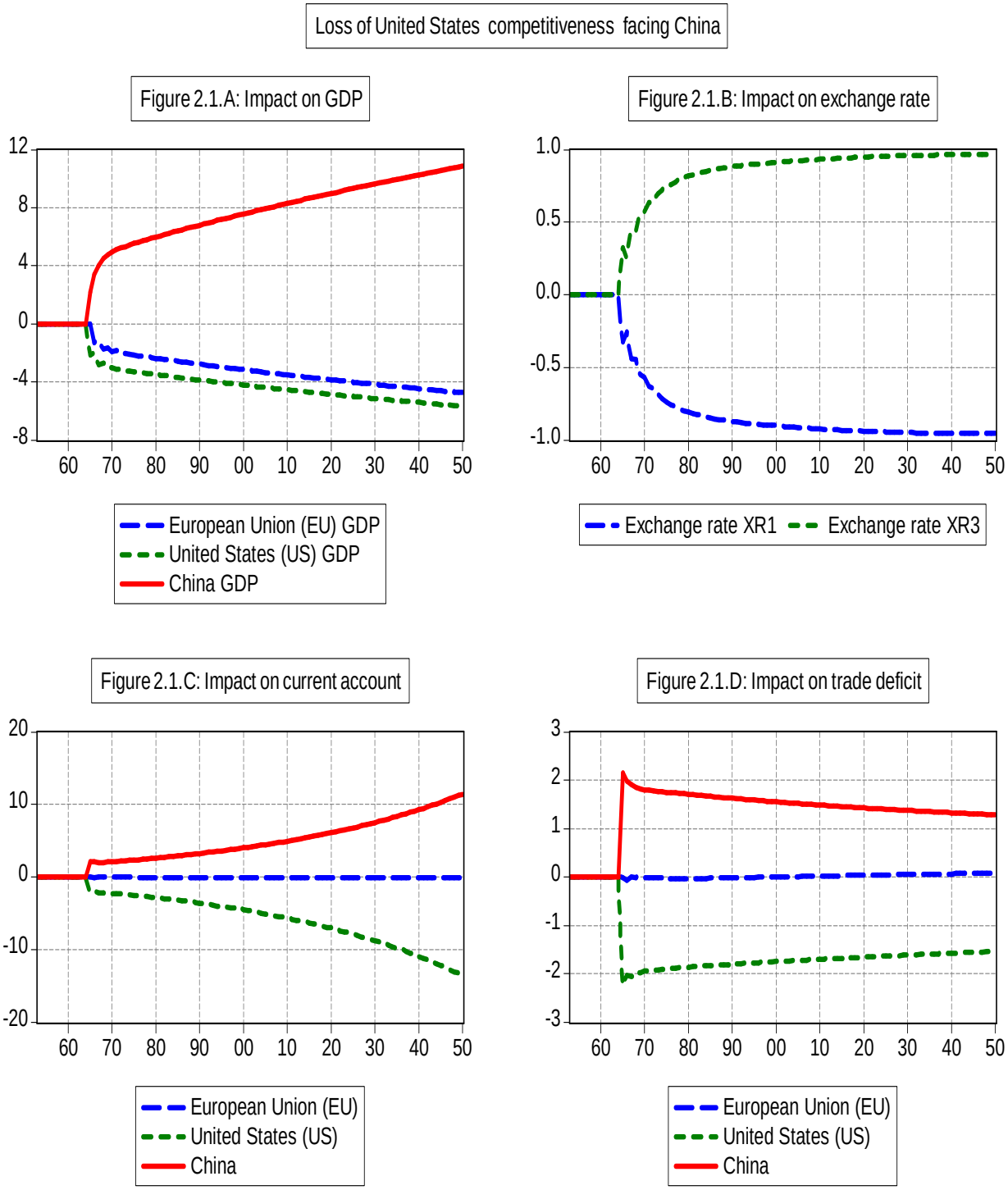
Supply shocks and loss of competitiveness

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 (figure 2). A loss of competitiveness facing China induces without surprise a decline of US production. The dollar depreciates, but moderately, due to the rising US current account and public deficits. China benefits, both, of the decline of US competitiveness and of the yuan depreciation. Consequently, Chinese production is largely stimulated. On the opposite the EU is negatively affected by the US decline and the euro appreciation. The European production decreases. 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.

A loss of US competitiveness against the EU has rather different effects. US production is also negatively affected, but less than in the previous case (-2%). Thanks to increasing US deficits, the dollar depreciates largely against the euro (-10%). Consequently, the European recovery is limited at short term and the EU production declined at medium term, due to the impact of the euro appreciation and the US slowdown. The European current account surplus is reduced at medium term. US trade deficit is also almost offset at medium term but US current account remains due to the interests paid. China appears once again as the winner thanks to the impact of the yuan depreciations. On the whole, the decline of the US production is limited and the US trade deficit is partly reduced thanks to the dollar depreciation 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: Loss of US competitiveness



Loss of United States competitiveness facing the European Union

Figure 2.2.A: Impact on GDP

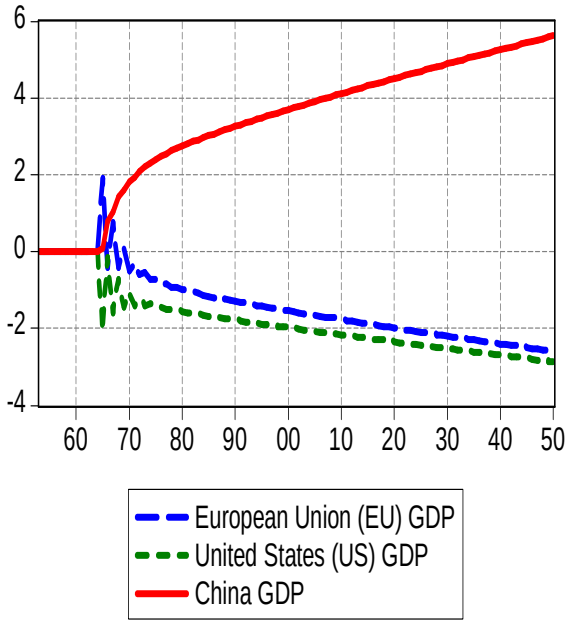


Figure 2.2.B: Impact on exchange rate

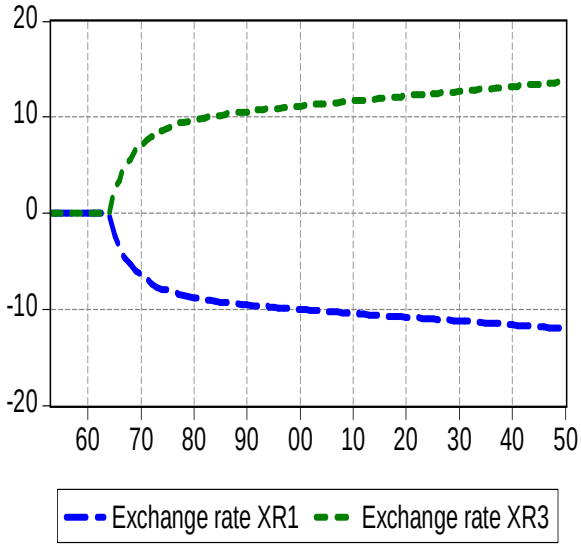


Figure 2.2.C: Impact on current account

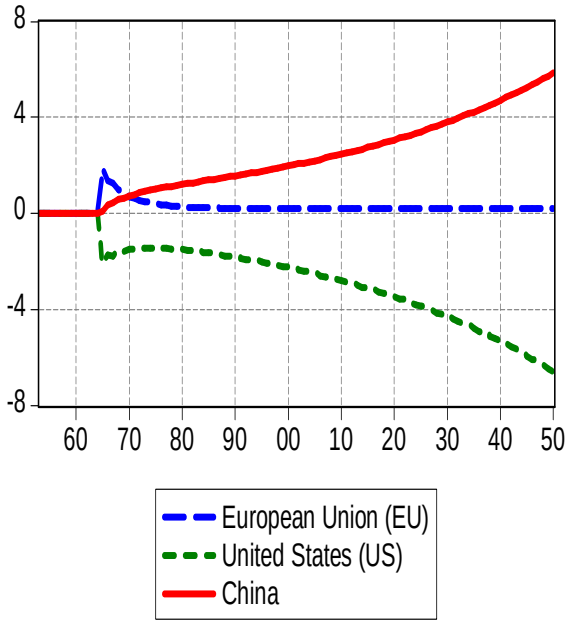
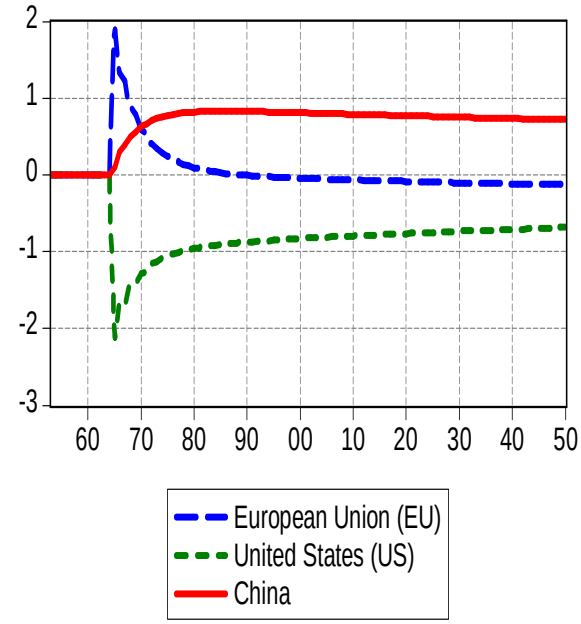
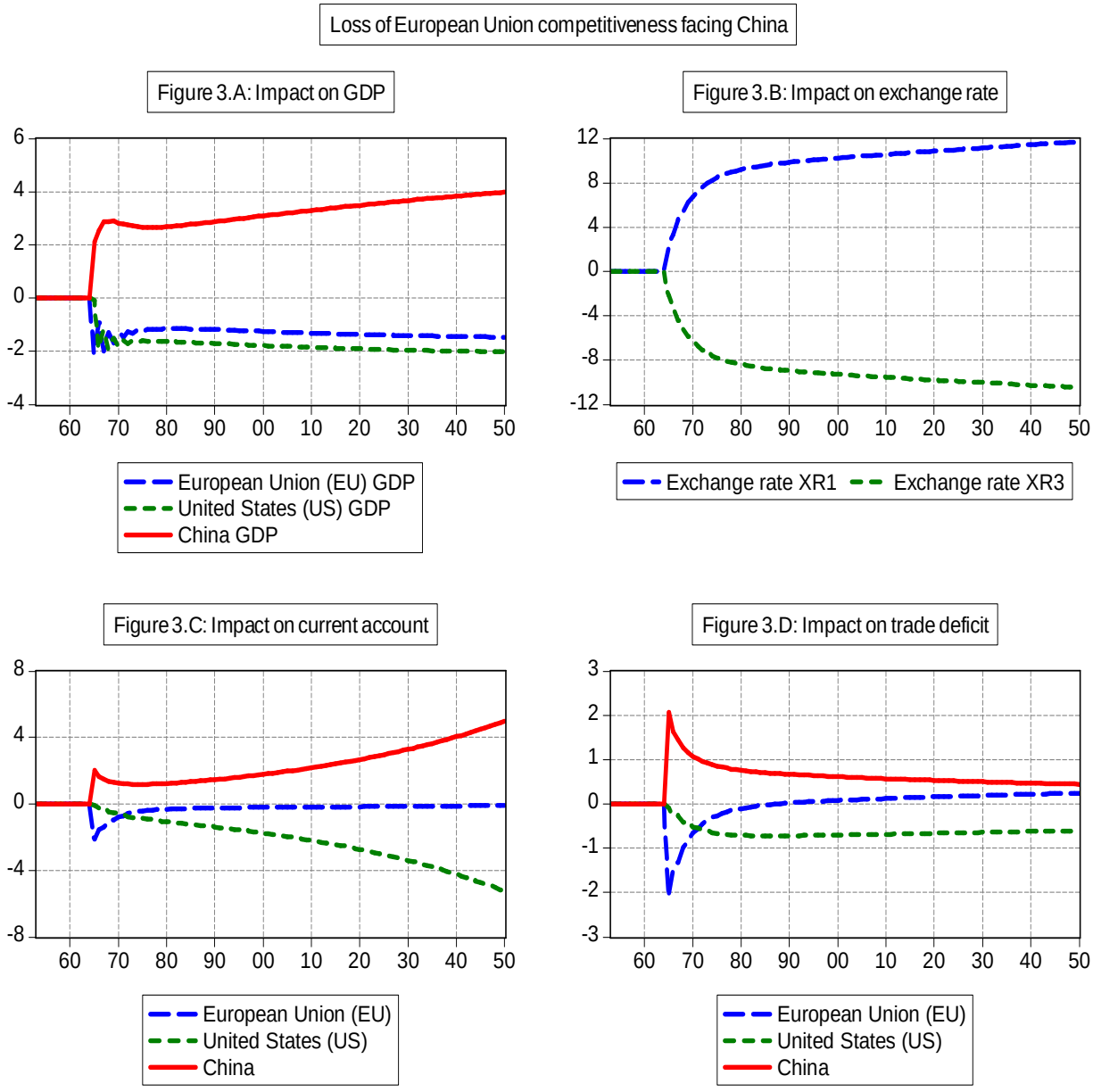


Figure 2.2.D: Impact on trade deficit



A loss of European competitiveness facing China induces logically a European slowdown (-2%) with a trade deficit and a public deficit (figure 3). The euro depreciates against the dollar (-10%) and allows at medium term a balanced current account and a stabilisation of the slowdown. The USA are penalised by the dollar appreciation with a decline of the US production, a trade deficit and an increasing current account deficit. China benefits of the gains of competitiveness with the EU in spite of the yuan appreciation. The Chinese production increases (3%) with a trade surplus which is progressively reduced, but with an increasing current account surplus. 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 at the expend of the USA and the EU.

Figure 3: Loss of EU competitiveness facing China



To conclude, demand shocks have limited impact on the euro-dollar parity. The US and European growths remain close, which limits the public and external imbalances. China is rather isolated and doesn't benefit of a US or European recovery while it can afford an autonomous growth. On the contrary, supply shocks have more 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.

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 can have a more diversified strategy, especially in a context of large US deficit and falling dollar. Different scenarios can be considered with increasing foreign reserves held in euros by the CCB.

In a first scenario it is supposed that, after a fall of US competitiveness with larger imports from China as it has been examined previously, the CCB increases in one step the European bonds held (from 5 to 15) with a dollar-yuan parity remaining always constant (figure 4). The larger demand of euro bonds induces a new depreciation of the dollar and an appreciation of the euro stronger than before (+8%). This amplifies the EU slowdown and deteriorates the European trade and current balances. The Chinese production is more stimulated by the yuan depreciation against the euro while the US production decline is reduced. But these adjustments are only at short term. After the shock of the diversification, the dollar appreciates, as the supply of US bonds is reduced, and its parity vis-à-vis the euro returns close to its initial level. The European slowdown and the US stimulus are progressively offset and the impact of the initial shock on US competitiveness remains dominant at long term with increasing US deficit and Chinese surplus. These results are similar to Lavoie & Zhao' (2008) conclusion, although the impact of the diversification of Chinese foreign reserves is more durable in their simulations.

Figure 4: Loss of US competitiveness facing China and increase of foreign reserves held in euros by the Chinese Central Bank

Loss of United States competitiveness facing China
and increase of foreign reserves held in euros by the Chinese Central Bank

Figure 4.A: Impact on GDP

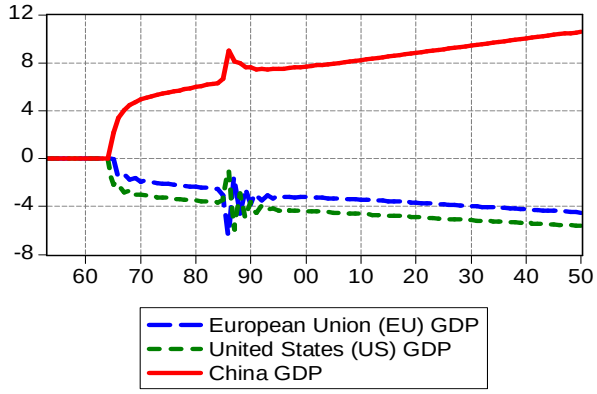


Figure 4.B: Impact on exchange rate

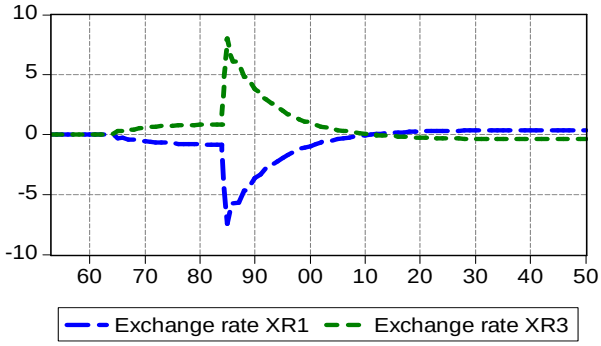


Figure 4.C: Impact on current account

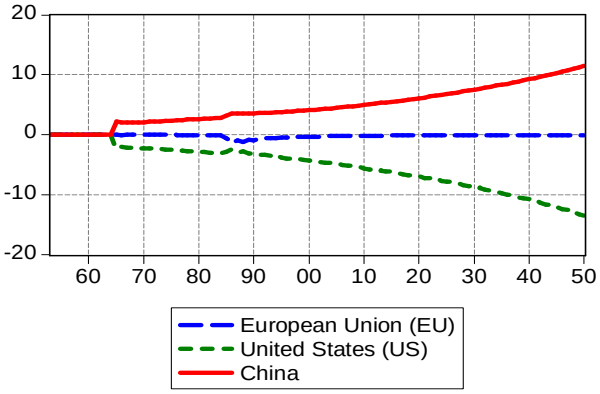
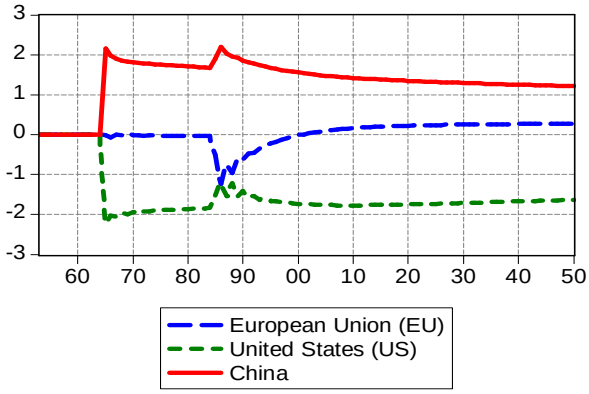


Figure 4.D: Impact on trade deficit



In a second scenario 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, as it has been suggested by Lavoie & Zhao (2008). This behaviour is rather close to what has been observed since 2008 but the dollar-yuan parity is supposed to remain constant.

$B^{€}_{YCBd} = \beta B^{\$}_{YCBd}$

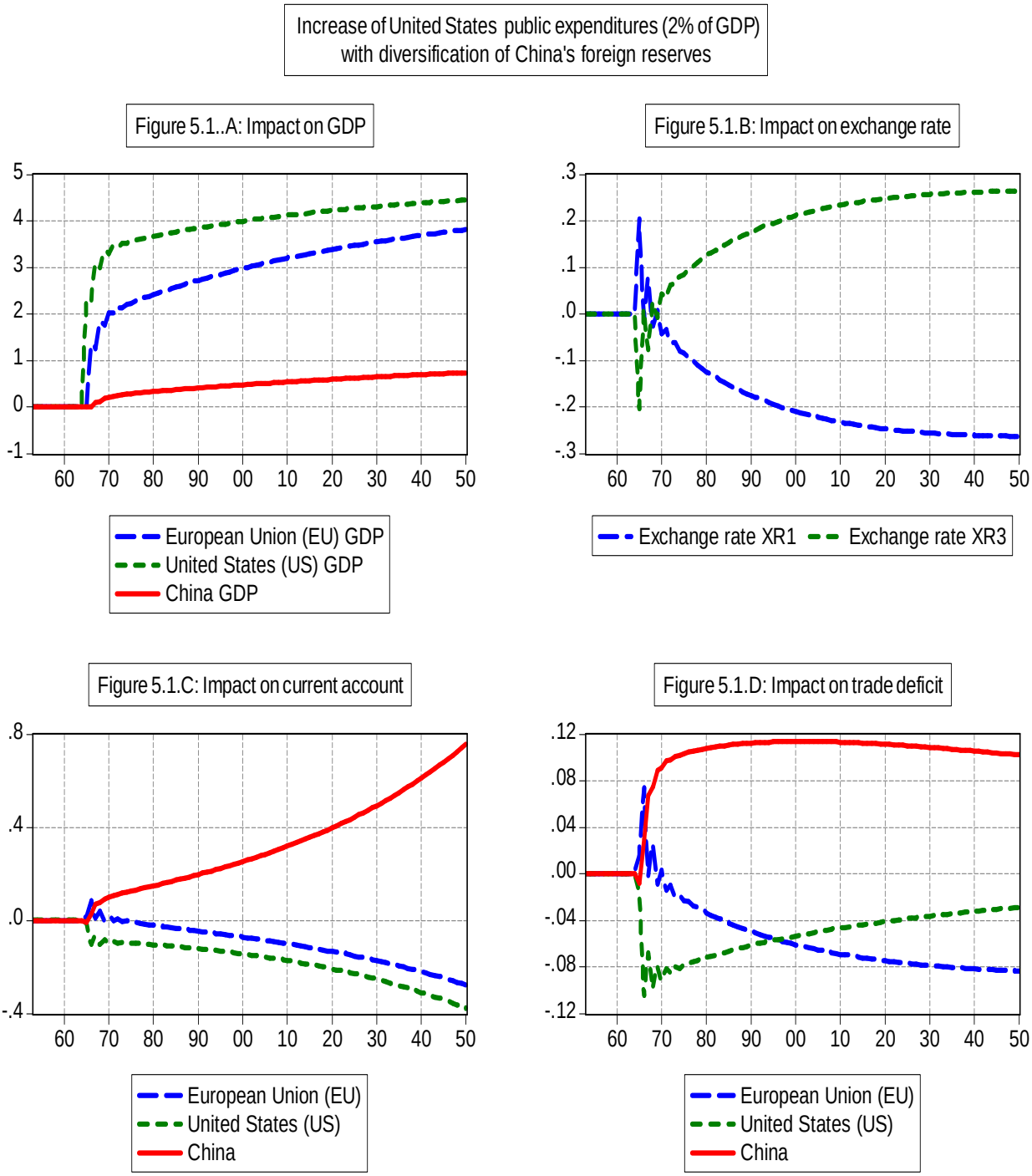
$\beta = \beta_{-1} + \theta(\beta^{e} - \beta_{-1})$

β^{e} is the target share of reserves held by the CCB in euros, in percentage of the reserves in dollars. θ is an adjustment coefficient reflecting a more or less pronounced inertia in the CCB behaviour.

Two kinds of shocks, demand and supply, can be considered as before. An increase of US public expenditures (equivalent to 2% of GDP) gives results close to those of the model without reserves diversification (figure 5.1). The US and, by diffusion, the EU productions are stimulated. The dollar is slightly appreciated at short term thanks to an increased demand of US bonds But, later on, the dollar depreciates progressively and the euro appreciates, due the declining demand of US bonds caused by the CCB diversification behaviour. This constitutes the main change with the previous model without diversification. However the impact on

exchange rates of demand shocks remains limited like previously. The euro appreciation has a small, but negative, effect on the EU recovery.

Figure 5: Diversification of China's foreign reserves



Loss of United States competitiveness facing China with diversification of China's foreign reserves

Figure 5.2.A: Impact on GDP

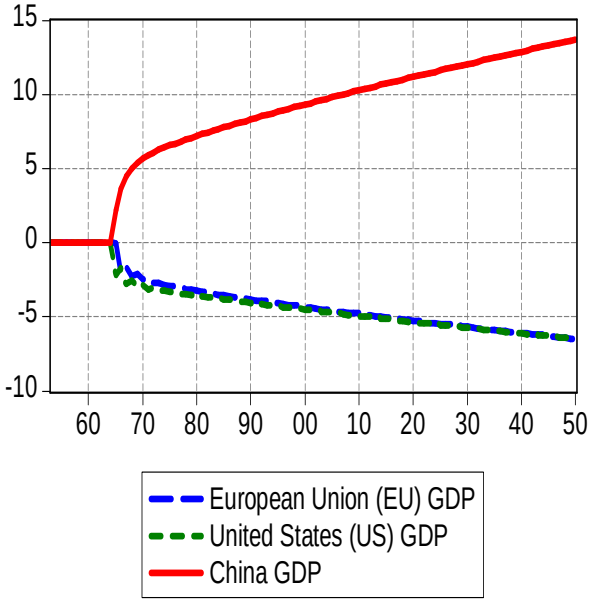


Figure 5.2.B: Impact on exchange rate

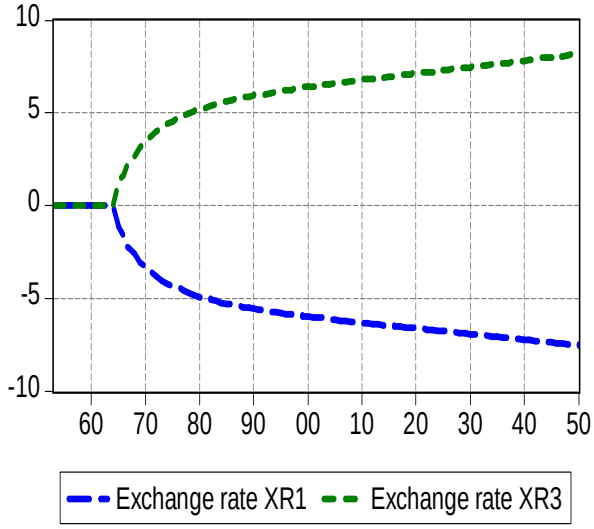


Figure 5.2.C: Impact on current account

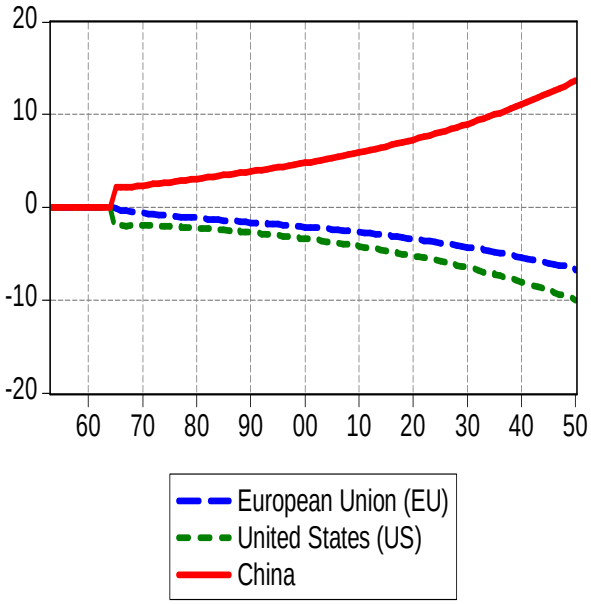
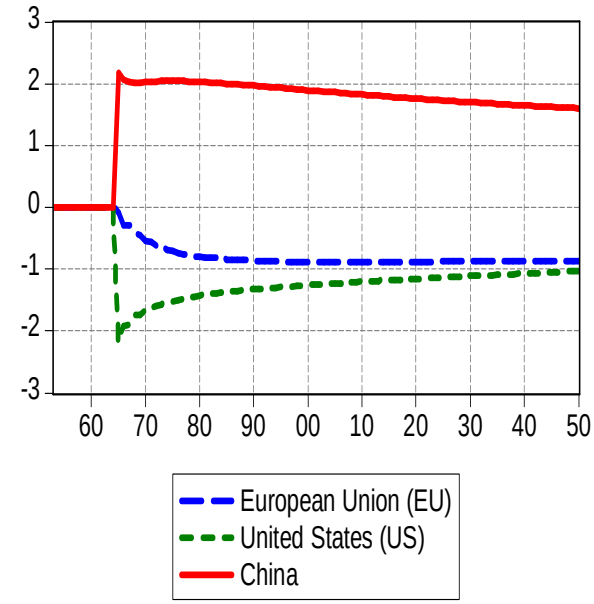


Figure 5.2.D: Impact on trade deficit



A loss of US competitiveness facing China gives results more contrasted by comparison with the case without diversification of the foreign reserves (figure 5.2). The US production declines and the Chinese one increases. The dollar depreciates, but more sharply than in the basic model, due to the declining demand of dollars by the CCB (-8% instead of -1%). Consequently, the Chinese growth is more stimulated by the yuan depreciation and the EU

production decreases more. The international imbalances remain and are even amplified by the Chinese foreign reserves diversification. Chinese surplus is larger, the EU deficit deteriorates significantly and the US deficit is the only one to be slightly reduced thanks to the larger dollar depreciation.

In a third scenario sensitivity tests can be done to appreciate how the value of the target share of reserves held in euros (β^e) influences growth paths, exchange rates and external imbalances.

Figure 6: Sensitivity tests regarding the structure of China's foreign reserves

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 one-step increase of the foreign reserves in euros, the impact is sensible with an appreciation of the euro vis-à-vis the dollar. The EU growth is slowdown while the US and Chinese productions benefit. But this evolution is at short term and the dollar appreciates progressively thanks to a reduction of issued US bonds. The European slowdown and the US gains are progressively offset while increasing US deficit and Chinese surplus remain.
In case of a more gradual diversification with a target structure of foreign reserves, a loss of US competitiveness induces sharper dollar depreciation than 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 are amplified with larger Chinese surplus and EU deficit, the US deficit being only slightly reduced.
These conclusions[1] are rather 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 the magnitude of the adjustments. Since 2005 a limited appreciation of the yuan vis-à-vis the dollar has been managed already by the CCB. This question can be examined in an enlarged model with floating dollar-yuan parity according to various mechanisms.

4. A SFC three countries model with floating 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,

[1] 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.

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:
$B^{\$}_{¥CBd}$ = constant
Equation (106) is replaced by :
(106bis) $xr2 = B^{\$}_{¥CBd} / B^{\$}_{¥CBs}$
which determines the dollar-yuan parity xr2 (1dollar= 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:
$B^{\$}_{¥CBd}$ = constante
Equation (106) is replaced by :
(106*) $xr2^* = B^{\$}_{¥CBd} / B^{\$}_{¥CBs}$
where xr2* represents the equilibrium exchange rate. The actual exchange rate is determined with inertia:
(106ter) $xr2 = xr2_{-1} + \varepsilon(xr2^* - xr2_{-1})$

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) $B^{\$}_{¥CBd} = B^{\$}_{¥CBs}\ xr2$

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

$xr2 = xr2_{-1} + \gamma_1 (B^{\$}_{¥CBd} / Y^{¥} - R^{e¥})$
or
$xr2 = xr2_{-1} + \gamma_2 (CAB^{¥} / Y^{¥} - (CAB^{¥} / Y^{¥})^{e})$

γ_1 et γ_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 chock, 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 decrease of US production (-2%) and a boom of Chinese production while the US current account deteriorates (-2% of GDP) and the Chinese one improves (figure 7). The reduction of these imbalances is mainly realised through a depreciation of the dollar (-12% against the yuan, -6% against the euro) and of the euro against the yuan (-6%). The US and EU production recover while the Chinese growth slowdowns. The US current deficit and Chinese surplus are offset.

The main difference with the case of the fixed dollar-yuan parity (figure 2a) 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 7: Loss of US competitiveness facing China with floating yuan

Loss of United States competitiveness facing China with floating yuan

Figure 7.A: Impact on GDP

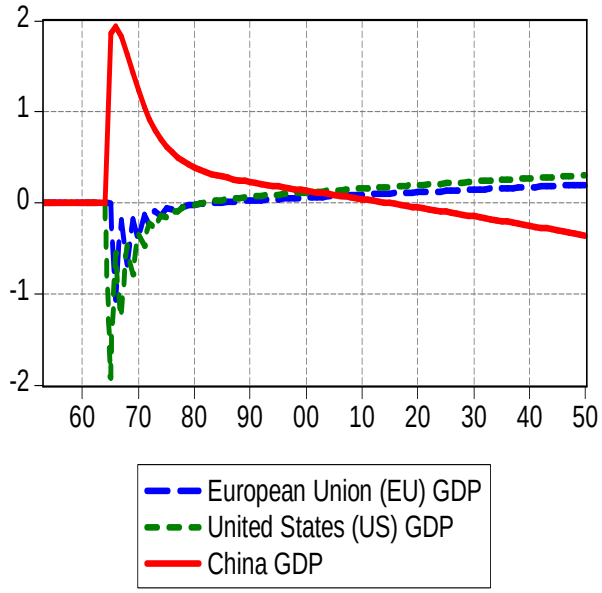


Figure 7.B: Impact on exchange rate

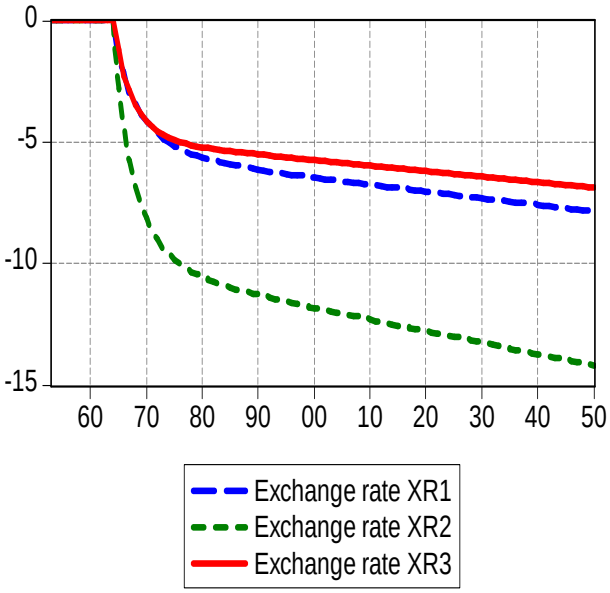


Figure 7.C: Impact on current account

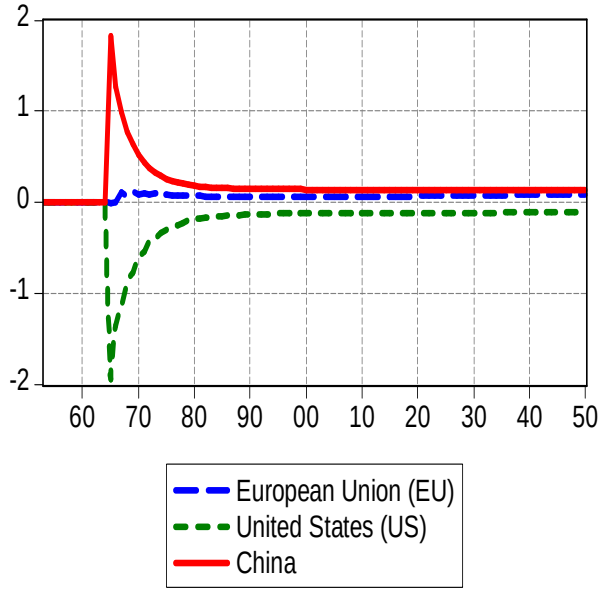
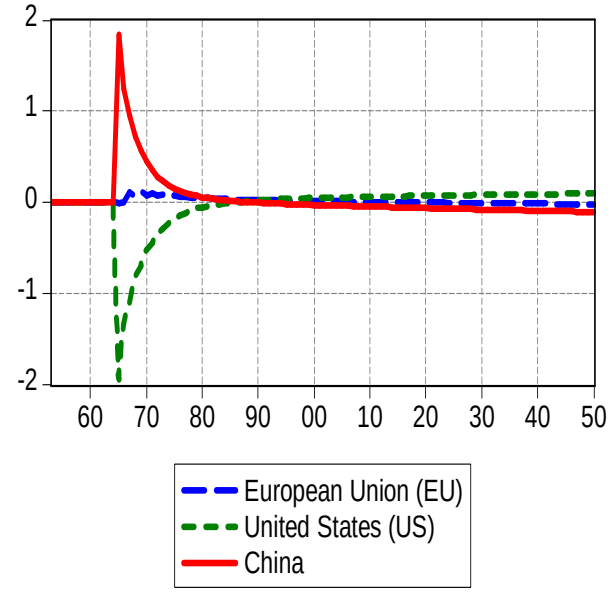


Figure 7.D: Impact on trade deficit



In case of impure floating yuan with inertia in the adjustments, the results are very similar to the freely floating regime. They are slightly affected by the value of the adjustment coefficient ε. 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 8). In the managed regime these reserves are not constant but the CCB tries to reach a target. The Chinese production is stimulated, slightly more than in a freely floating regime, the dollar-yuan parity is depreciated slightly more quickly and the US production decreases. Most of the external imbalances are reduced in 5 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 8: Loss of US competitiveness facing China with a yuan managed regime and a target on foreign reserves in dollars

Loss of United States competitiveness facing China
with a yuan managed regime and a target on foreign reserves in dollars

Figure 8.A: Impact on GDP

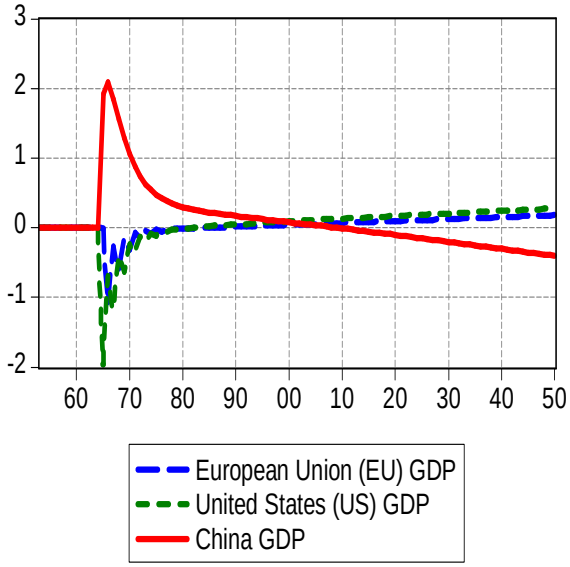


Figure 8.B: Impact on exchange rate

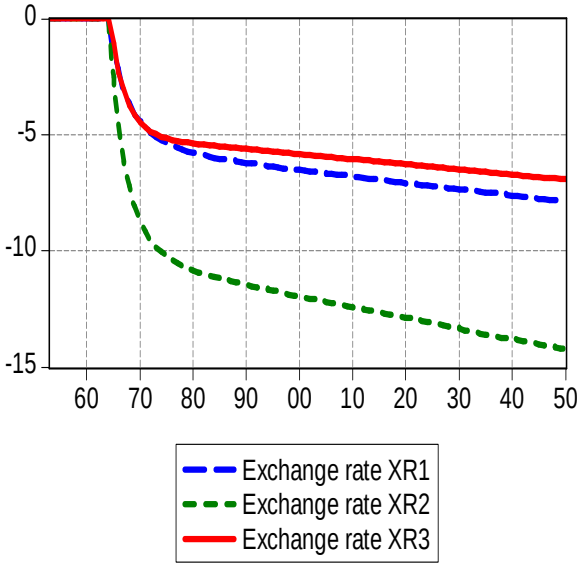


Figure 8.C: Impact on current account

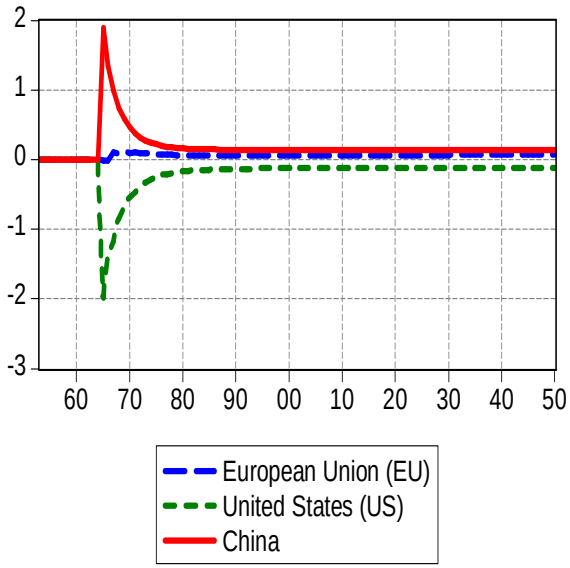
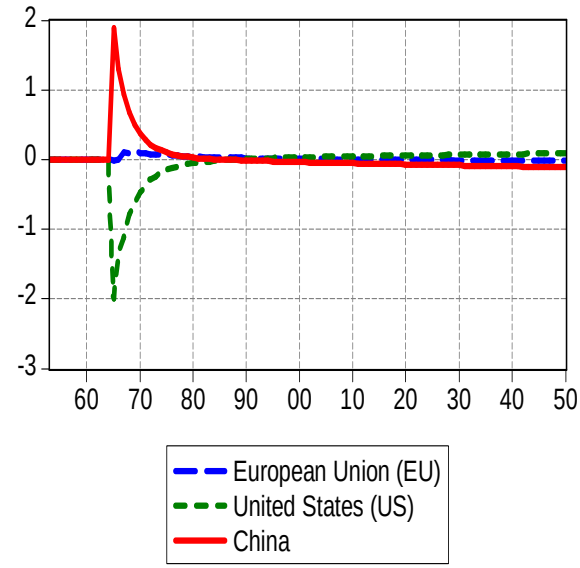


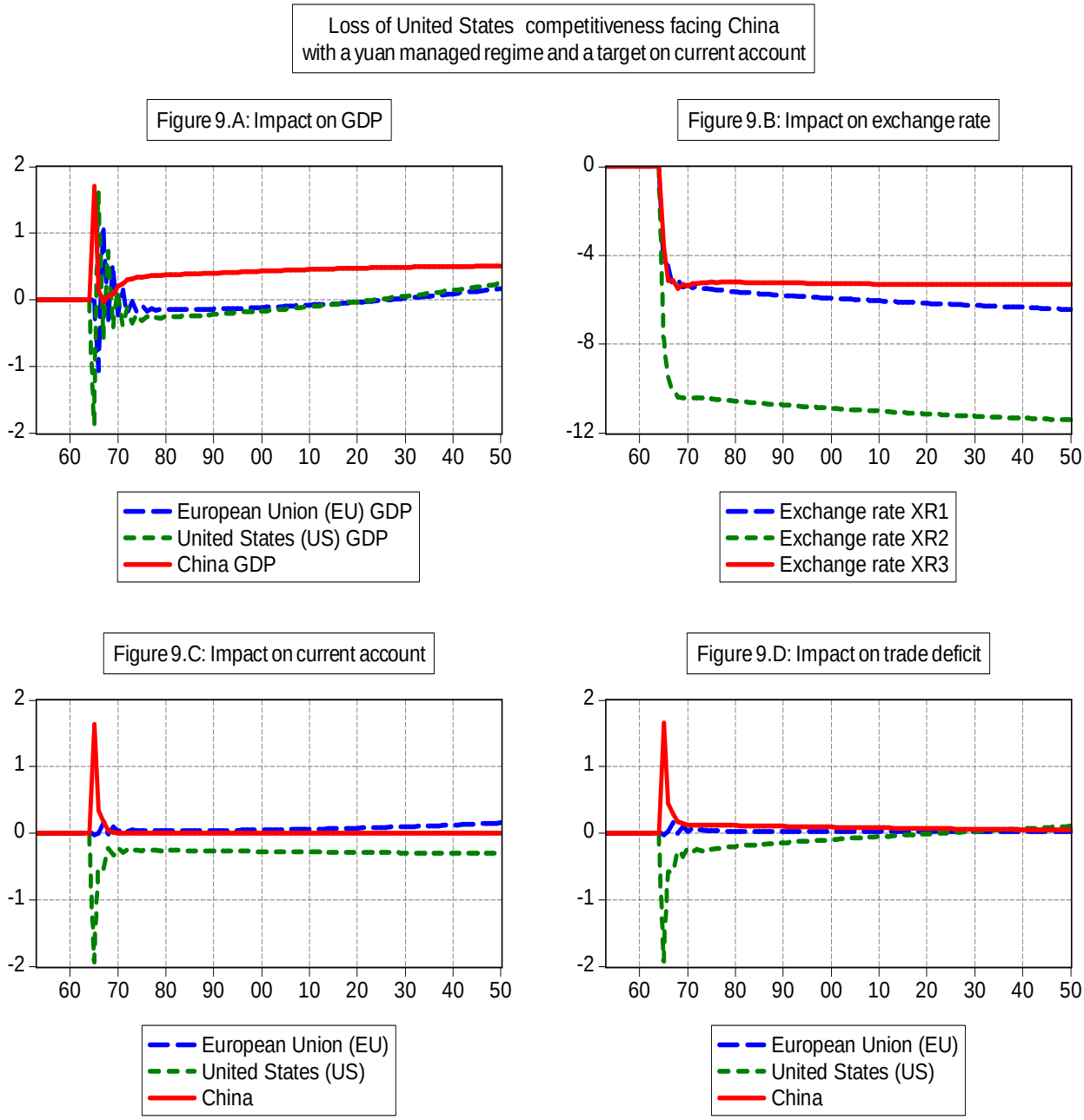
Figure 8.D: Impact on trade deficit



Lastly, a managed exchange rate regime with target on current account fixed by the Chinese Central Bank for the level of foreign reserves in dollars give also rather similar results. 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[2].

Figure 9: Loss of US 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 a US deficit

[2] More detailed sensitivity tests are given in annex.

and a 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.

4.3. Complementary considerations on the opposition between fixed and floating dollar-yuan parity

The case of the loss of US competitiveness with China has already been examined to illustrate the opposition between the two exchange rate regimes. This opposition is confirmed by the examination of two other supply shocks, a loss of US competitiveness with the EU and a loss of EU competitiveness with China[3].

With a floating yuan a loss of US competitiveness with the EU is easily compensated (figure 10). The US current deficit increases to -2% of GDP in opposition with the EU current surplus. The US production declines (-2%) in contrast with the growth of the EU production. China remains almost isolated. But the dollar is devalued facing the euro (-8% after 5 years) and also facing the yuan (-5%) due the larger amount of issued US bonds. Consequently the euro is revalued against the yuan (4%) but the adjustment is smaller than with the fixed dollar-yuan regime. This more moderate euro appreciation against the yuan, counterpart of the revaluation of the yuan against the dollar, authorizes a progressive rebalancing of the initial disequilibrium which is in clear opposition with which was observed in the fixed dollar-yuan regime.

Figure 10: Loss of US competitiveness facing the EU with a floating dollar-yuan parity

[3] The analysis of demand shocks would also show that the floating dollar-yuan regime allows a reduction of external imbalances. These cases are not presented here as the external imbalances are already limited in the fixed dollar-yuan regime and the exchange rate variations are also of small amplitude.

Loss of United States competitiveness facing the European Union with a floating dollar-yuan parity

Figure 10.A: Impact on GDP

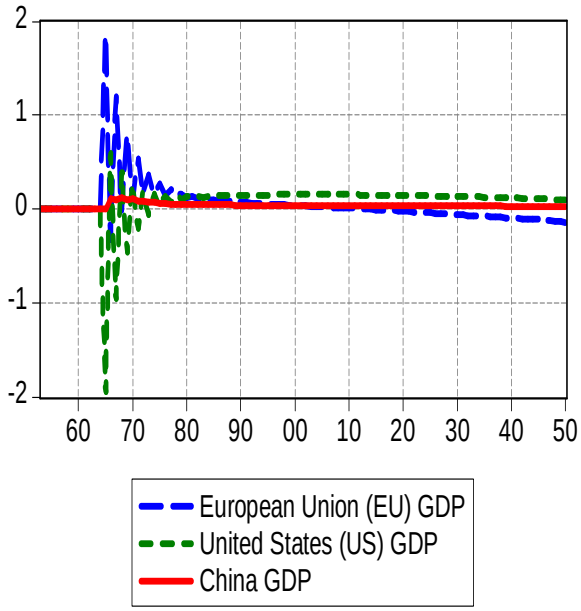


Figure 10.B: Impact on exchange rate

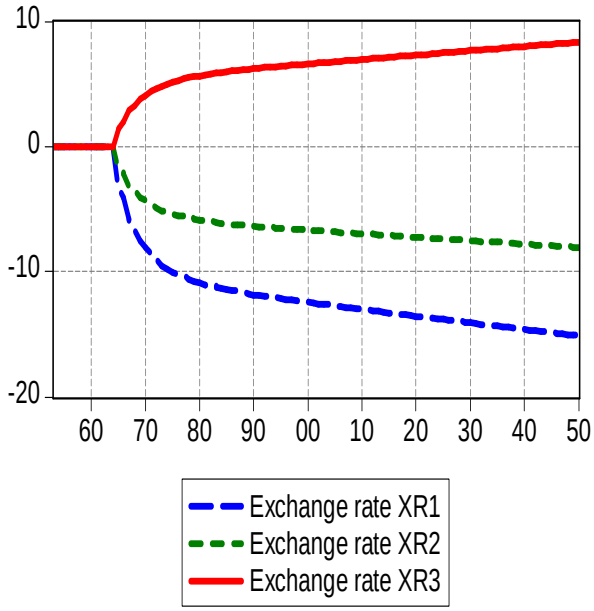


Figure 10.C: Impact on current account

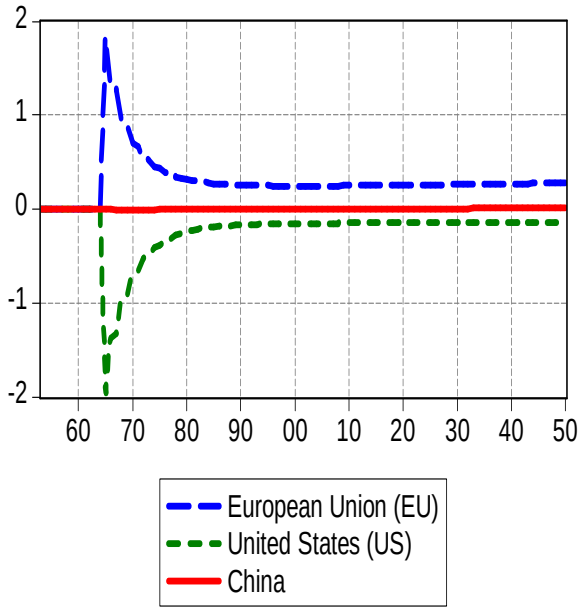
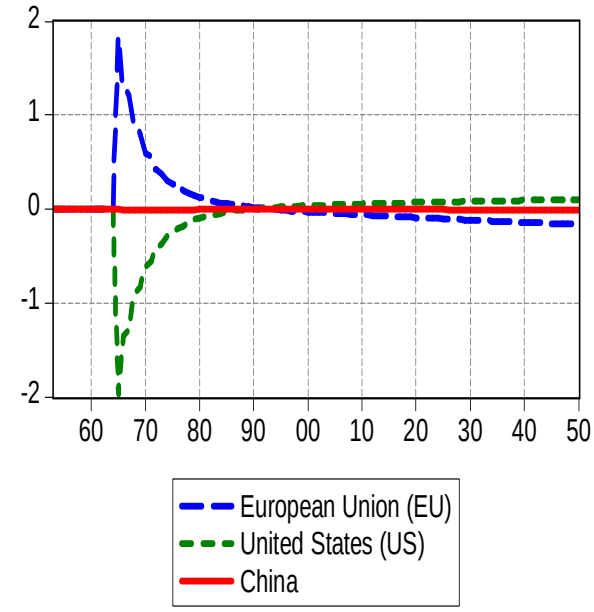


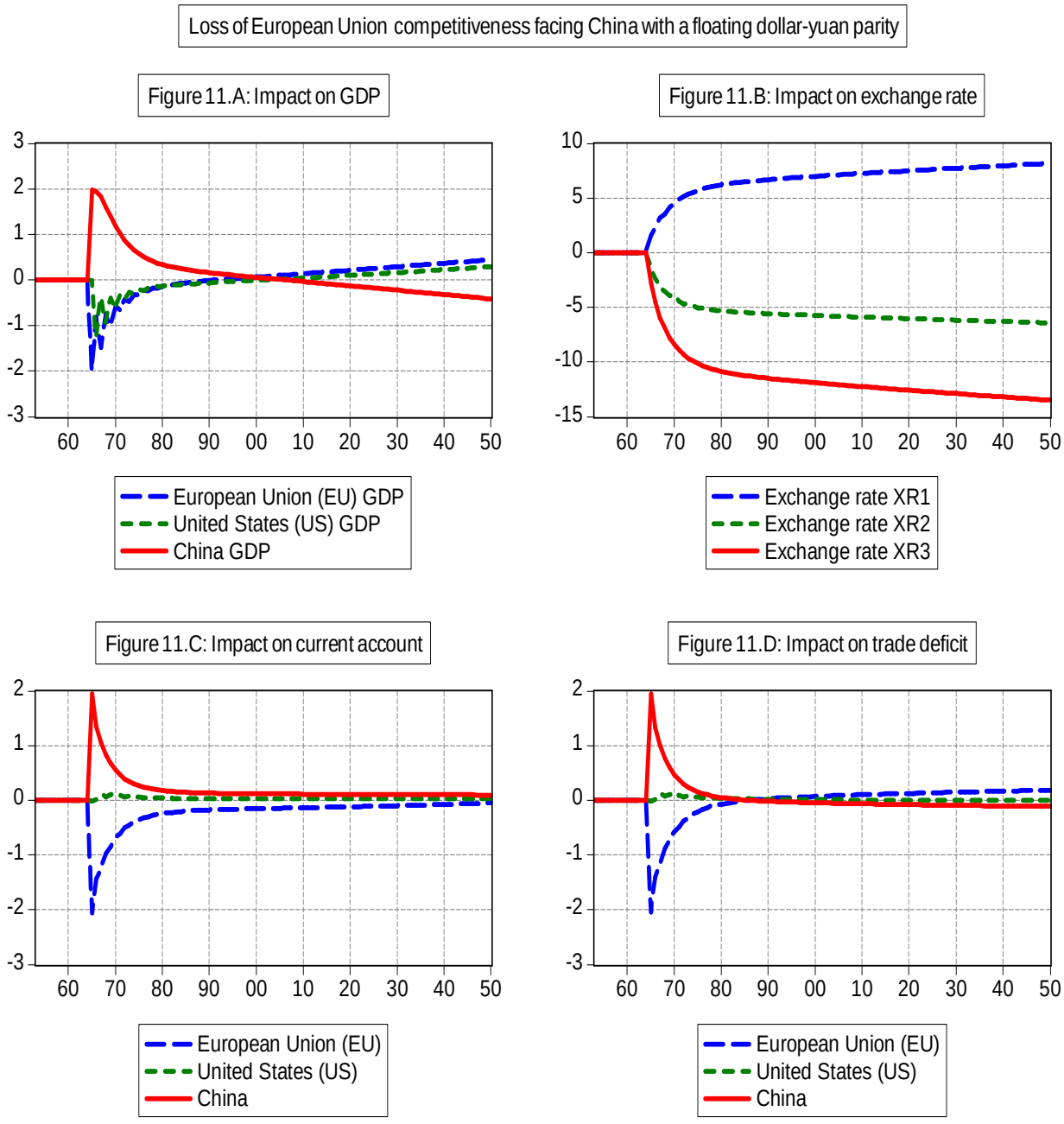
Figure 10.D: Impact on trade deficit



In the same way, in a floating dollar-yuan regime a loss of European competitiveness with China is easily compensated, contrary to what was observed in the fixed dollar-yuan parity case (figure 11). Initially the EU current account deteriorates (-2% of GDP) while the Chinese current surplus increases. The EU production declines (-2%) in contrast with the progression

of the Chinese production. But exchange rate adjustments allow a return to a more equilibrated configuration. The euro is more devalued against the yuan than in the fixed dollar-yuan system. The yuan is revalued against the dollar while the dollar appreciates against the euro but less than in the fixed dollar-yuan regime. On the whole Chinese current surplus and GDP growth are progressively reduced while EU performances improve.

Figure 11: Loss of EU competitiveness facing China with a floating dollar-yuan parity



5. General conclusion

World imbalances have been increasing since the end of the 1990s, mainly with a large US current account deficit facing Asian surpluses. During the last years only limited adjustments have been achieved in spite of the dollar depreciation and of the world slowdown, but with the yuan-dollar parity remaining almost unchanged.
Macroeconomic adjustments have been analysed at the world level using Stock Flow Consistent (SFC) models in the lines of Godley and Lavoie (2004) and Lavoie and Zhao (2006, 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.
Two SFC three countries models have been considered, the first one with a fixed dollar-yuan parity including a version with an active policy of the Chinese Central Bank regarding its 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.

In the first configuration, with fixed dollar-yuan parity, demand shocks have limited impact on the euro-dollar parity. The US and European growths remain close, which limits the public and external imbalances. China is rather isolated and doesn't benefit of a US or European recovery while it can afford an autonomous growth. On the contrary, supply shocks like a loss of competitiveness have more 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 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 one-step increase of the foreign reserves in euros, the impact is sensible with an appreciation of the euro vis-à-vis the dollar. The EU growth is slowdown while the US and Chinese productions benefit. But this evolution is at short term and the dollar appreciates progressively thanks to a reduction of issued US bonds. The European slowdown and the US gains are progressively offset while increasing US deficit and Chinese surplus remain.
In case of a more gradual diversification with a target structure of foreign reserves, a loss of US competitiveness induces sharper dollar depreciation than 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 are amplified with larger Chinese surplus and EU deficit, the US deficit being only slightly reduced.
These conclusions are rather 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 the magnitude of the adjustments. Since 2008 a limited appreciation of the yuan vis-à-vis the dollar has been managed already 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 a US deficit and a 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.

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Annex

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	$-C^{€}$	$Y^{€}$	$-I^{€}$	$-G^{€}$			$-C^{\$}$	$Y^{\$}$	$-I^{\$}$	$-G^{\$}$			$-C^{¥}$	$Y^{¥}$	$-I^{¥}$	$-G^{¥}$		0
IM	$IM^{€}$						$IM^{\$}$						$IM^{¥}$					0
X	$-X^{€}$						$-X^{\$}$						$-X^{¥}$					0
Wages	$W^{€}$	$-W^{€}$					$W^{\$}$	$-W^{\$}$					$W^{¥}$	$-W^{¥}$				0
Taxes	$-T^{€}$			$T^{€}$			$-T^{\$}$			$T^{\$}$			$-T^{¥}$			$T^{¥}$		0
Interest	$r^{€}.B^{€}_{€}$			$-r^{€}.B^{€}$	$r^{€}.B^{€}_{cb€}$		$r^{€}.B^{€}_{\$}/xr^{1}$				$r^{€}.B^{€}_{cb\$}/xr^{1}$		$r^{€}.B^{€}_{¥}.xr^{3}$				$r^{€}.B^{€}_{¥cb}.xr^{3}$	0
	$r^{\$}.B^{\$}_{€}xr^{1}$				$r^{\$}.B^{\$}_{cb€}.xr^{1}$		$r^{\$}.B^{\$}_{\$}$			$-r^{\$}.B^{\$}$	$r^{\$}.B^{\$}_{cb\$}$		$r^{\$}.B^{\$}_{¥}.xr^{2}$				$r^{\$}.B^{\$}_{¥cb}.xr^{2}$	0
	$r^{¥}.B^{¥}_{€}/xr^{3}$						$r^{¥}.B^{¥}_{\$}/xr^{2}$						$r^{¥}.B^{¥}_{¥}$			$-r^{¥}.B^{¥}$	$r^{¥}.B^{¥}_{cb¥}$	0
		$-r^{€}.L^{€}$			$r^{€}.L^{€}$			$-r^{\$}.L^{\$}$			$r^{\$}.L^{\$}$			$-r^{¥}.L^{¥}$			$r^{¥}.L^{¥}$	0
	$r^{€}_{d}.M^{€}$				$-r^{€}_{d}.M^{€}$		$r^{\$}_{d}.M^{\$}$				$-r^{\$}_{d}.M^{\$}$		$r^{¥}_{d}.M^{¥}$				$-r^{¥}_{d}.M^{\$}$	0
Profit		$-P^{€}$	$P^{€}$	$P^{€}_{cb}$	$-P^{€}_{cb}$			$-P^{\$}$	$P^{\$}$	$P^{\$}_{cb}$	$-p^{\$}_{cb}$			$-P^{¥}$	$P^{¥}$	$P^{¥}_{cb}$	$-P^{¥}_{cb}$	0
Chgin																		
Money	$-\Delta M^{€}$				$\Delta M^{€}$		$-\Delta M^{\$}$				$\Delta M^{\$}$		$-\Delta M^{¥}$				$\Delta M^{¥}$	0
Bills €	$-\Delta B^{€}_{€}$			$\Delta B^{€}$	$-\Delta B^{€}_{cb€}$		$-\Delta B^{€}_{\$}/xr^{1}$				$-\Delta B^{€}_{cb\$}/xr^{1}$		$-\Delta B^{€}_{¥}.xr^{3}$				$-\Delta B^{€}_{¥cb}.xr^{3}$	0
Bills $	$-\Delta B^{\$}_{€}.xr^{1}$				$-\Delta B^{\$}_{cb€}.xr^{1}$		$-\Delta B^{\$}_{\$}$			$\Delta B^{\$}$	$-\Delta B^{\$}_{cb\$}$		$-\Delta B^{\$}_{¥}.xr^{2}$				$-\Delta B^{\$}_{¥cb}.xr^{2}$	0
Bills ¥	$-\Delta B^{¥}_{€}/xr^{3}$						$-\Delta B^{¥}_{\$}/xr^{2}$						$-\Delta B^{¥}_{¥}$			$\Delta B^{¥}$	$-\Delta B^{¥}_{cb¥}$	0
ΔLoan		$\Delta L^{€}$			$-\Delta L^{€}$			$\Delta L^{\$}$			$-\Delta L^{\$}$			$\Delta L^{¥}$			$-\Delta L^{¥}$	0
Sum	0	0		0	0		0	0		0	0		0	0		0	0	0

Constraints on the coefficients in the households' assets demands

$B^{€}_{€d} = V^{€}(\gamma_{e10} + \gamma_{e11}\, r^{€} + \gamma_{e12}\, r^{\$} + \gamma_{e13}\, r^{¥} + \gamma_{e14}\, r^{¥}_{d})$
$B^{\$}_{€d} = V^{€}(\gamma_{e20} + \gamma_{e21}\, r^{€} + \gamma_{e22}\, r^{\$} + \gamma_{e23}\, r^{¥} + \gamma_{e24} r^{¥}_{d})$
$B^{¥}_{€d} = V^{€}(\gamma_{e30} + \gamma_{e31}\, r^{€} + \gamma_{e32}\, r^{\$} + \gamma_{e33}\, r^{¥} + \gamma_{e34}\, r^{¥}_{d})$
$M^{¥}_{d} = V^{€}(\gamma_{e40} + \gamma_{e41}\, r^{€} + \gamma_{e42}\, r^{\$} + \gamma_{e43}\, r^{¥} + \gamma_{e44}\, r^{¥}_{d})$

$B^{\$}_{\$d} = V^{\$}(\gamma_{u10} + \gamma_{u11}\, r^{€} + \gamma_{u12}\, r^{\$} + \gamma_{u13}\, r^{¥} + \gamma_{u14}\, r^{¥}_{d})$
$B^{€}_{\$d} = V^{\$}(\gamma_{u20} + \gamma_{u21}\, r^{€} + \gamma_{u22}\, r^{\$} + \gamma_{u23}\, r^{¥} + \gamma_{u24} r^{¥}_{d})$
$B^{¥}_{\$d} = V^{\$}(\gamma_{u30} + \gamma_{u31}\, r^{€} + \gamma_{u32}\, r^{\$} + \gamma_{u33}\, r^{¥} + \gamma_{u34}\, r^{¥}_{d})$
$M^{\$}_{d} = V^{\$}(\gamma_{u40} + \gamma_{u41}\, r^{€} + \gamma_{u42}\, r^{\$} + \gamma_{u43}\, r^{¥} + \gamma_{u44}\, r^{¥}_{d})$

$B^{¥}_{¥d} = V^{¥}(\gamma_{10} + \gamma_{11}\, r^{€} + \gamma_{12}\, r^{\$} + \gamma_{13}\, r^{¥} + \gamma_{14}\, r^{¥}_{d})$
$B^{€}_{¥d} = V^{¥}(\gamma_{20} + \gamma_{21}\, r^{€} + \gamma_{22}\, r^{\$} + \gamma_{23}\, r^{¥} + \gamma_{24} r^{¥}_{d})$
$B^{\$}_{¥d} = V^{¥}(\gamma_{30} + \gamma_{31}\, r^{€} + \gamma_{32}\, r^{\$} + \gamma_{33}\, r^{¥} + \gamma_{34}\, r^{¥}_{d})$
$M^{¥}_{d} = V^{¥}(\gamma_{40} + \gamma_{41}\, r^{€} + \gamma_{42}\, r^{\$} + \gamma_{43}\, r^{¥} + \gamma_{44}\, r^{¥}_{d})$

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

$B^{\$}_{\$s}$	=	Supply of US Treasury bills to US households
$B^{\$}_{\$d}$	=	Demand of US Treasury bills by US households
$B^{\$}_{b¥s}$	=	Supply of US Treasury bills to Chinese banks
$B^{\$}_{b¥d}$	=	Demand of US Treasury bills by Chinese banks
$B^{\$}_{¥d}$	=	Demand of US Treasury bills by Chinese households
$B^{\$}_{¥s}$	=	Supply of US Treasury bills to Chinese households
$B^{\$}_{€d}$	=	Demand for US Treasury bills by households in the euro area
$B^{\$}_{€s}$	=	Supply of US Treasury bills to households in the euro area
$B^{\$}_{b\$d}$	=	Demand of US Treasury bills by U.S. banks
$B^{\$}_{b\$s}$	=	Supply of US Treasury bills U.S. banks
$B^{\$}_{b€d}$	=	Demand of US Treasury bills by banks in the euro area
$B^{\$}_{b€s}$	=	Supply of US Treasury bills to banks in the euro are
$B^{\$}_{s}$	=	Issue of US Treasury bills

(same notation for European and Chinese Treasury bills)

C	=	Consumption
CAB	=	Current account balance
G	=	Public spending
I	=	Investment
$IM^{\$}$	=	U.S. imports
$IM^{\$}_{¥}$	=	U.S. imports from China
$IM^{\$}_{€}$	=	U.S. imports from the euro area
$IM^{¥}$	=	Chinese imports
$IM^{¥}_{\$}$	=	Chinese imports from the United States
$IM^{¥}_{€}$	=	Chinese imports from the euro area
$IM^{€}$	=	Imports of the euro area
$IM^{€}_{\$}$	=	Imports of the euro zone from the United States
$IM^{€}_{¥}$	=	Imports of the euro zone from China
K	=	Capital stock
KAB	=	Capital account balance
K^{T}	=	Desired capital stock
L_{s}	=	Loans supply
L_{d}	=	Loans demand
M_d	=	Demand for money
M_s	=	Money supply
P	=	Profit firms
P_b	=	Profit banks
r	=	Interest rate on bills
r_d	=	Interest rate on deposits
r_l	=	Interest rates on loans
S	=	Sales
T	=	Taxes
V_h	=	Households' wealth
V_b	=	Banks' wealth
V_f	=	Firms' wealth
W	=	Wages
$X^{\$}$	=	U.S. exports

$X^{\$}_{¥}$ = U.S. exports to China
$X^{\$}_{€}$ = U.S. exports to countries of the euro area
$X^{¥}$ = Chinese exports
$X^{¥}_{\$}$ = Chinese exports to the USA
$X^{¥}_{€}$ = Chinese exports to the euro area
$X^{€}$ = Euro area exports
$X^{€}_{\$}$ = Euro area exports to the USA
$X^{€}_{¥}$ = Euro area exports to China
xr1 = Exchange rate euro-dollar
xr2 = Exchange rate dollar-yuan
xr3 = Exchange rate Euro-yuan
Y = National income
$YD_{hs\_}$ = Haig-Simons disposal income

Parameters

α_1 =propensity to consume income = 0.8
α_2 =wealth effect coefficient = 0.0182 (USA), 0.0243 (EU), 0.0235 (China)
κ =capital income ratio = 2.5
λ = wage share = 0.75
γ_1 et γ_2 =adjustment parameters of the dollar-yuan parity = -5
δ =depreciation rate of capital = 0.1
θ = tax rates = 0.0964 (USA), 0.1067 (EU), 0.0942 (China)
ε =adjustment parameter of the dollar-yuan parity = 0.5

Parameters reaction of households' portfolio choice

Chine	European Union	United States
gamma_ch10 = 0.08	gamma_eu10 = 0.142857	Gamma_us10 = 0.13794
gamma_ch11 = - 0.2	gamma_eu11 = -0.2	gamma_us11 = 0.6
gamma_ch12 = -0.2	gamma_eu12 = 0.6	gamma_us12 = -0.2
gamma_ch13 = 0.6	gamma_eu13 = -0.2	gamma_us13 = -0.2
gamma_ch14 = -0.2	gamma_eu14 = -0.2	gamma_us14 = -0.2
gamma_ch20 = 0.04	gamma_eu20 = 0.071429	gamma_us20 = 0.10345
gamma_ch21 = 0.6	gamma_eu21 = 0.6	gamma_us21 = -0.2
gamma_ch22 = - 0.2	gamma_eu22 = -0.2	gamma_us22 = 0.6
gamma_ch23 = -0.2	gamma_eu23 = -0.2	gamma_us23 = -0.2
gamma_ch24 = -0.2	gamma_eu24 = -0.2	gamma_us24 = -0.2
gamma_ch30 = 0.08	gamma_eu30 = 0.07143	gamma_us30 = 0.0690
gamma_ch31 = -0.2	gamma_eu31 = -0.2	gamma_us31 = -0.2
gamma_ch32 = 0.6	gamma_eu32 = -0.2	gamma_us32 = -0.2
gamma_ch33 = -0.2	gamma_eu33 = 0.6	gamma_us33 = 0.6
gamma_ch34 = -0.2	gamma_eu34 = -0.2	gamma_us34 = -0.2

Imports elasticity

Chine	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