Rebalancing Growth in China: An International Perspective

Agnès Bénassy-Quéré*, Benjamin Carton† and Ludovic Gauvin‡

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Abstract

Based on simulations of an original DGE model of the US, Chinese and Euro area economies with financial frictions and various monetary regimes, the paper shows that the contribution of China in global rebalancing should primarily rely on structural policies aiming at reducing aggregate savings in China. The role of the exchange-rate regime would be minor under standard monetary policies, although more important if monetary policies in advanced countries are constrained, as they are today. Finally, relying only on a change in China's monetary regime (without structural reforms) could end up in delaying rather than accelerating the rebalancing, depending on China's policy regarding accumulated reserves.

1 Introduction

Since the early 2000s, China has been the center of repeated criticism by the international community concerning its export-oriented growth strategy based on an artificially weak currency. In 2005, Ben Bernanke famously pointed the aggregate trade surplus of emerging countries as one key explanation for the growing US deficit: corresponding capital inflows in the US was preventing upward adjustment of US savings rates through maintaining real interest rates at a low level.[1] Although few economists and officials did endorse Bernanke's "savings glut" approach in full (Bernanke himself recognized the own responsibility of the United States), the G7 consistently called for a reduction in current-account surpluses especially in emerging Asia, and its leaders queued up in Beijing to try to persuade Chinese officials to allow the renminbi to appreciate.

Global imbalances temporary retreated during the 2007-2009 global crisis, as a consequence of the trade collapse and financial de-globalization. When the global economy started to pick up in mid-2009, it however became clear that the crisis had not wiped up the problem which was deemed to soon re-emerge (see Blanchard & Milesi-Ferretti (2010)). The G20, which at that time had replaced the G7 as the main forum for international coordination, refocused the debate on current-account imbalances

*CEPII, 113 rue de Grenelle, Paris, France. Corresponding author agnes.benassy@cepii.fr. We are grateful to the participants of the 7 december 2010 at CEPII and the 8 March 2011 RES seminar at the IMF, for useful comments. All errors remain ours. This paper has been prepared for the Bruegel-CEPII research project "Reform options for the global reserve currency system and their implications for the EU economy" for the European Commission (contract No. ECFIN/220/2010/573686). Financial support by DG ECFIN of the European Commission is gratefully acknowledged.

†CEPII, France

‡CEPII, France

[1] Bernanke (2005).

themselves, as opposed to the G7 insistence on exchange rates.[2] China responded by announcing far-reaching structural reforms aiming, in particular, at improving social safety nets, which would allow Chinese households to reduce their savings rates. However China failed to satisfy advanced economies through letting its currency appreciate, despite continuous pressure.

This paper aims at analyzing the complementarity or substitutability of structural and monetary reforms in China, for the domestic economy as for the global rebalancing agenda. Specifically, we study the impact of a several reforms that all involve a reduction in Chinese saving rate, under various regimes for capital flows and the exchange rate; reciprocally, we analyze the rebalancing impact of a change in China's monetary regime, absent structural reforms, hence in a situation of cumulated surpluses in China.

Our analysis follows-up on the pre-crisis literature on global imbalances and adjustment scenarios. Two groups of explanations have been suggested to global imbalances (Bernanke, 2005; Dooley et al., 2003; Mendoza et al., 2007; Caballero et al., 2008): (i) macroeconomic and structural factors, such as high saving rates in emerging countries triggered by energy windfalls, deficient social safety nets, or financial under-development, low investment rates in some emerging countries following the Asian crisis, or lax monetary policy in the United States; and (ii) the international monetary system (IMS hereafter) itself, through the key role of the United States as a supplier of international reserve assets, the lack of trust in multilateral financial safety nets which led emerging countries especially in Asia to self-insure through reserve accumulation, and the success of export-oriented growth strategies that encouraged fixed or quasi-fixed exchange-rate regimes. Contrasting with this two-pillar understanding of global imbalances, researches on rebalancing scenarios have tended to focus on real exchange-rate adjustment, especially for the United States, abstracting from the IMS (Obstfeld & Rogoff, 2005; Blanchard et al., 2005). Few studies have been devoted to the interconnection between real adjustments and monetary regimes. One exception is Blanchard and Giavazzi (2006) mentioning the needs to combine a nominal appreciation of the renminbi with a fall in China's saving rate, in order to secure internal balance while reducing the current-account surplus. Another one is Faruqee et al. (2007) who contrast the impact of a fiscal adjustment in the US depending on China's monetary regime, within a four-region dynamic general equilibrium (DGE) model.

The present paper is interested in the interconnection between global rebalancing and monetary regimes. The main case in point being the Chinese economy, where excess savings result in official reserve accumulation due to the fixed exchange-rate regime, we choose to focus on this country, while acknowledging that China is by no way the only contributor to global imbalances. According to Prasad (2009), China accounted for 62 percent of gross national savings in Asia excluding Japan in 2008, which provides an additional motivation for focusing on Chinese savings. We start by briefly reviewing the literature that has tried to explain the very high gross saving rate in China (50% of GDP on average between 2005 and 2008, according to Ma & Yi (2010)). We then build a DGE model of two countries (China and the United States) with overlapping generations, nominal rigidities and financial constraints, and simulate different structural reforms in China that all result in declining saving rates, under different monetary regimes. The reforms successively considered are an increase

[2] In its Pittsburgh meeting in September 2009, the G20 launched the so-called *Framework for strong, sustainable and balanced growth* relying on a *Mutual assessment process*: each G20 member was supposed to provide a compact of how it would contribute to global growth and to the reduction of global imbalances, the IMF providing technical support to aggregate national prospects. The bottom line of this approach was to rebalance growth both from the public to the private sector, and from deficit to surplus countries (see Blanchard, 2009; IMF, 2010).

in the generosity of China's pension system, a financial reform that facilitates the access of private companies to debt markets, and an increase in the government debt target. As for monetary regimes, they include the status quo (a fixed exchange rate backed by capital controls and foreign-exchange interventions), a relaxation of capital controls, and a move to a flexible exchange-rate regime. We successively consider the impact of a structural reform under different monetary regimes, and the impact of a monetary regime change in itself, in a context of global imbalances. Finally, we introduce a third country (the Euro area) in the model in order to study the asymmetries stemming from China's bilateral peg on the dollar and from its preference for dollar-denominated assets.

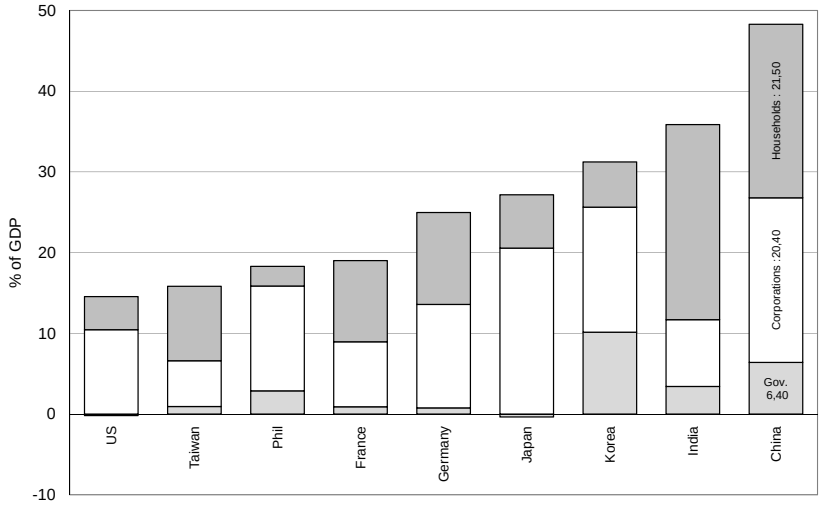
We find that a fall in China's saving rate would contribute to global rebalancing whatever the exchange rate regime, provided international capital flows do react to interest-rate differentials (which implies less-than-complete capital controls in China). Under a flexible exchange-rate regime, the reduction of the bilateral current-account imbalance between the United States and China is quicker (because the renminbi appreciates in nominal terms against the US dollar), but it is not stronger than under a fixed exchange-rate regime. Still, only under a flexible exchange-rate regime is China able to control inflation stemming from more dynamic domestic demand, consistent with the intuition of Blanchard & Giavazzi (2006). This feature provides strong incentive for China to move away from its fixed peg, although the advantage for the United States of such move is only short lived.

We also find that, should the United States refrain from hiking its interest rate when global savings are reduced, then the rebalancing would be muted and the exchange-rate regime of China would become crucial both for global rebalancing and for the domestic Chinese economy. As for the Euro area, despite the asymmetric exchange-rate regime of China (where the renminbi is pegged on the dollar), it reacts in a similar way as the United States to structural reforms in China. The reason is high capital mobility between the United States and the Euro area, that tends to equalize real interest rates between the two countries.

Absent structural reforms reducing the aggregate saving rate of China, a move to a flexible renminbi is found unable to rebalance the global economy, except if the People's Bank of China decides to sell off its accumulated reserves. The reason is that high savings in China, combined with capital controls, result in a relatively low policy interest rate: removing capital controls while allowing the Chinese currency to float could then result in a sudden capital outflows and depreciation of the renminbi in the short run, although in the longer run the Chinese currency would appreciate.

On the whole, our results suggest that the contribution of China to global rebalancing should primarily rely on structural policies aiming at reducing aggregate savings in China. The role of the exchange-rate regime would be minor under standard monetary policies, although more important if monetary policies in advanced countries are constrained. Finally, relying only on a change in China's monetary regime could end up in delaying rather than accelerating the rebalancing, depending on China's policy regarding accumulated reserves.

The remaining of the paper is organized as follows. In Section 2, we review the literature on the determinants of China's high savings rate. Section 3 presents the model. In Section 4, we simulate structural reforms in China under different monetary regimes. Section 5 studies the impact of a monetary reform in China after the latter has accumulated a large amount of official reserves. Section 6 adds the Euro area to the analysis and discusses the impact of a diversification of China's official reserves. Section 7 concludes.



Source: Ma & Yi (2010)

Figure 1: Saving in selected countries

2 China's saving rate under scrutiny

The very high saving rate in China has attracted much attention from both policy-makers and researchers. Ma & Yi (2010) note that gross national savings reached 54 percent of GDP in 2008, up from 39 percent in 1990 and 36 percent in 2000. They argue that what is special in China is the conjunction of high saving rates in the three sectors of the economy: households, corporations, and the government (see Figure 1). Hence, explanations for the high level of the aggregate saving rate must address the three sectors simultaneously in a consistent way.

Many explanations have been suggested for high saving rates in China.[3] They can be summarized as follow:

- Households: The steady decline in the share of households in national income during the 2000s has been a major contribution to the fall in the consumption-to-GDP ratio and subsequent rise in the saving-to-GDP one. It can be related to the downward pressure on labor income (especially in farming and unincorporated activities), a reduction in social transfers, a low level of capital income (low interest rates), and growing taxes and social contributions. As for the rise in households saving rates (as a percentage of disposable income), it is generally attributed to the attrition of the social safety nets (the retreat of enterprise-based safety nets having not been taken over by the public system), together with a general rise in uncertainty due to structural change and the rising share of education expenditures falling on families. The rise in private home ownership and the 1997 pension reform (with a reduction in its generosity) have also played a role, in combination with the delayed effect of the one-child policy (and the subsequent lack of support expected for the old age). All these factors were amplified by financial underdevelopment, which has limited the access of households to bank loans as well as

[3] See, e.g., Ma & Yi (2010), Guo & N'Diaye (2010), Jha et al. (2009), Horioka & Wan (2007), Feng et al. (2009), Chamon & Prasad (2010), Baker & Orsmond (2010), Cui & Aziz (2007), Chamon et al. (2010), Prasad (2009), Bayoumi et al. (2010), Huang & Wang (2010).

the diversification opportunities for their assets. In contrast, the impact of ageing is generally downplayed by the literature, saving rates displaying an uncommon U-shape along the life cycle.

- Corporations: as a mirror effect, corporations have reaped a growing share of national income during the 2000s. Their high profitability has also come from subsidized inputs such as land, energy and environment. State-owned enterprises were not required to pay dividends on their profits before 2008. As for private firms, they may have faced financial constraints that have obliged them to accumulate savings to self-finance their investments. Although corporations do have seen their share in national income increase over the decade, the reality of excess savings has however been challenged in the recent literature based on firm-level data.

- Government: the shares of the government in national income and national saving rose more than those of the corporate sector in the 2000s. One major reason was the surge in tax receipts that was not matched by equal increase in expenditures. In fact, government consumption *declined* as a proportion of GDP, since the priority was (and local incentives were) given to public investment and the building-up of public-pension assets (consistent with the switch decided in 1997 in favor of a partially-funded pension assets), and taxes were not much redistributed to local governments that were in charge of social spending.

In the following, we propose a model that allows for some of the main causes of high saving rates to be mitigated:

- A pension reform: according to Chamon et al. (2010), "rising income uncertainty and pension reforms can account for over half of the increase in the urban saving rate in China since the mid-1990s" (p.1). Consistently, we simulate a pension reform that would increase the generosity of the pay-as-you-go system. By extension, this simulation covers any reform of the social safety net that would reduce uncertainty about the ability of households to cover "big ticket" expenses (such as health care).

- A financial reform: much of the literature (see, e.g., Cui & Aziz (2007); or Ma & Yi (2010)) stresses the declining share of households' share in national GDP as a major cause of the rise in China's aggregate saving rate. Consistently, we simulate a financial reform in China that relies on three pillars: (i) enterprises get the opportunity to massively increase leverage, which raises the value of the firms; (ii) simultaneously, the subsidy on corporate investment is removed; (iii) the combination of higher firm value and lower incentive to invest leads to a transfer of income from the corporate sector to the households one, possibly transiting through a public body.

- A government spending reform: we finally assume a permanent increase in public spending that is engineered through a rise in the public-debt target. Subsequent public transfers are channelled to old households through the PAYG pension system. In the long run, the tax rate increases to stabilize the debt ratio at its new inflated target level.

These various simulations are run under different regimes in terms of exchange-rate regime (either fixed or flexible) and capital flows (restricted or freed), and the results are systematically compared. It can be argued however that the problem today is less that of carrying out structural reforms that will reduce China's saving rate and ultimately contribute to global rebalancing, than to allow the

exchange rate to correct accumulated disequilibria. Consistently, we run a reverse simulation where a reduction in the generosity of the pension system (like after the 1997 reform) or an increase in the official reserve target that both raise China's saving rate and trade balance, under fixed exchange-rate regime. After a few years, the exchange rate is allowed to float freely, and we study the impact of the sole monetary reform on the curent account and the economy.

3 The model

3.1 General overview

The world is divided into two countries: the United-States (u) and China (c). In an extension of the model, we include a third region: the Euro area (e). Countries trade both goods and financial assets. The model explicitly takes into account the saving behavior of the three main economic sectors: households, firms and the public sectors.[4]

The model is depicted in Figure 2, and detailed in Appendix, together with its standard calibration. Each country is populated with overlapping generations of households *à la* Blanchard (1985) and Yaari (1965). On aggregate, households supply labor, receive wages and the proceeds of their savings (interests and dividends), pay taxes on their labor endowment and receive transfers from the government. Depending on their age, the flow of funds differs: as they become older, households accumulate financial wealth (hence they receive more dividend and interest payments), their labor endowment decreases (labor income decreases), and they receive rising transfers from the PAYG pension system. They also benefit from a complete set of contingent securities (perfect risk sharing among alive households). In addition, when they die, their bequest (financial assets) is redistributed to surviving households through an insurance scheme. The pension system is introduced as the main policy tool that influences aggregate saving of households: the higher the replacement rate, the lower the saving rate for a given real interest rate. As already mentioned, this stylized pension system can account for any insurance scheme (e.g. health insurance) that will reduce the incentive for precautionary savings.

There are two categories of firms. The first category hires labor L and capital K to produce goods Y that are indifferently used for consumption and investment. These goods are differentiated and sold to domestic and foreign customers under monopolistic competition. The firms face a price rigidity *à la* Calvo (1983): at each period, each firm has a fixed probability of being unable to reset its price. Wages are also sticky with staggered contracts.

The second category of firms specializes in accumulating capital K and renting it to the first category of firms. Capital accumulation can be financed either by diverting dividends (internal financing) or by borrowing Bf on the bond market (external financing). In China, firms' borrowings are constrained by financial frictions. The saving behavior of capital firms is influenced by these constraints: absent external financing, firms have to self-finance their investments, hence they pay low dividends and their saving rate is high. With financial liberalization, firms can borrow more, hence they save less and distribute higher dividends. In China, the savings behavior of capital firms is also influenced by

[4]We do not distinguish the financial from the households sector: firms are assume to borrow directly from domestic or foreign households.

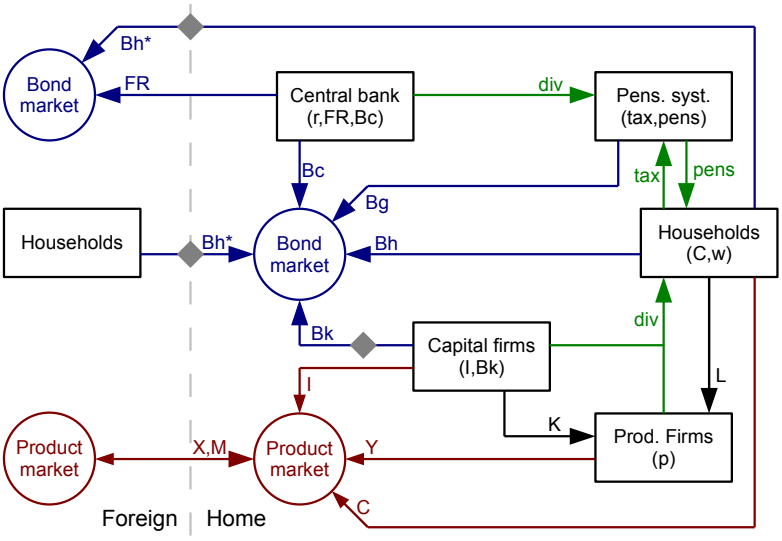


Figure 2: Diagram of the model

public subsidies on capital.[5]

The government receives contributions from households, positive or negative transfers from the central bank, issues debt, provides subsidies to capital firms and pays pensions to old households. The pension level is determined by the government budget constraint, with exogenous debt target, tax rate and, in the case of China, capital subsidies.

Finally, the central bank sets the interest rate according to a modified Taylor rule. In the United States, the interest rate simply reacts to inflation deviations from target.[6] In China, the rule is augmented with an impact of official reserve accumulation. To (partially) sterilize its interventions, the central bank issues sterilization bonds Bc. Depending on the amount of sterilization and on return differentials between foreign-exchange reserves (which yield the foreign policy rate) and sterilization bonds (which yield the Chinese policy rate), the central bank generates a positive or negative profit that is immediately transferred to the pension system, hence indirectly transferred to old households.

In the benchmark model, there are capital controls in China: foreign investors cannot buy as many yuan-denominated assets as they would like, and Chinese investors cannot buy as many foreign-denominated assets as they would like: the uncovered interest parity does not hold. This grants the Chinese central bank some independence in the conduct of monetary policy even when the exchange rate is fixed. Alternatively, capital controls can be relaxed, in which case UIP does hold, impeding China from monitoring domestic inflation unless the renminbi is allowed to float.

The key equations are presented in the next sub-sections, the model being detailed in Appendix.

[5] In our model, investment is restricted to the corporate sector. Alternatively, capital firms could be viewed as intermediaries investing in real estate and renting their capital to the households. Aggregating households and capital firms would then reproduce the impact of financial frictions on households' saving, in relation with housing.

[6] Including the output-gap in the monetary rule does not change the results qualitatively, although it complicates the resolution since the model then needs to be simulated at first with nominal rigidities in order to derive potential output.

3.2 Households

The representative household of the cohort born at time a and still living at time t consumes $C_{a,t}$, has a time-endowment for work of $\bar{L}_{t-a}$ hours, and effectively works $L_{a,t}$.[7] At a given period, each previously-born household has a constant probability θ_g to survive, and new households appear at rate $(1-\theta_g)\bar{N}$, where $\bar{N}$ is the population, which thus is constant. Let $0 < \beta < 1$ denote the subjective discount factor. The inter-temporal utility function of household a at time t, $U_{a,t}$, is increasing in consumption and in leisure:

$$U_{a,t} = \sum_{s=0}^{\infty} (\theta_g \beta)^s \left[(1-\kappa) \log(C_{a,t+s}) + \kappa \log(\bar{L}_{t+s-a} - L_{a,t+s}) \right], \tag{1}$$

with $0 < \kappa < 1$.

In each country, the portfolio $\mathcal{A}_t$ of households consists in (i) domestic equities (ii) a complete set of domestic contingent claims and (iii) foreign assets in the form of short-term bonds.[8] Life-insurance companies *à la* Yaari (1965) pay a premium to alive households against the promise of inheriting their assets when they are dead. We assume that insurance companies always accept contingent claims and bonds (whether domestic or foreign), but are reluctant to insure equities. The share ν_E of equities eligible to life insurance is the first indicator of financial-market development. It leads households to discount future dividends using a discount factor lowered by the factor $\theta_E = \nu_E + (1-\nu_E)\theta_g < 1$. Non-insured equities of dead households are assumed to be distributed to the newborns. The budget constraint, the first-order conditions at the cohort level, aggregate consumption and labor supply are detailled in Appendix A.1 (page 31).

The international portfolio of households consists in foreign bonds only: equities and contingent claims are assumed not to be internationally tradable.[9] Imperfect capital mobility is taken into account by assuming that domestic households of country j hold an amount $Bh^{jj'}$ of foreign bonds (of country j') such that their share in the portfolio is proportional to the excess expected return compared to the uncovered interest-rate parity:

$$\underbrace{\frac{E_t^{jj'} Bh_t^{jj'}}{\mathcal{A}_t^j}}_{\text{Share in domestic portfolio}} = \frac{\gamma^{jj'}}{1-\gamma^{jj'}} \underbrace{\left(\mathbf{E}_t \left\{ \mathcal{F}_t^{t+1,j} R_t^{j'} \frac{E_t^{jj'}}{E_{t+1}^{jj'}} \right\} - 1 \right)}_{\text{UIP deviation}} \tag{2}$$

where $\mathcal{F}_t^{t+1,j}$ is the stochastic discount factor of country j, $R_t^{j'}$ is the nominal interest rate on foreign bonds, $E^{jj'}$ is the nominal exchange rate between j and j', and $0 < \gamma^{jj'} < 1$ is a proxy for capital mobility between the two countries. If $\gamma \to 0$, the model reproduces capital controls: even when the excess expected return is high, the ability of foreign households to buy domestic assets (or of domestic households to sell foreign assets) is limited. On the contrary, $\gamma \to 1$ denotes an absence of capital control as a tiny excess return motivates large capital flows between the two countries. In the

[7] The retirement schedule and associated pension are assumed inverse, geometric functions of the remaining lifetime labor endowment of the household.

[8] The complete set of contingent claims are traded only among domestic households so that, when aggregating households, the net holding is a domestic bond.

[9] This assumption avoids perfect international risk-sharing. Since the stochastic discount factor will then be region-specific, it is convenient to also assume that equities are not internationally traded in order to properly define the program of the firms.

following, we assume that γ may take one of the two following values: $\underline{\gamma} = 0.5$ (low capital mobility) or $\overline{\gamma} = 0.9$ (high capital mobility).

3.3 Production, investment and nominal rigidities

Wage rigidities. Unions are used as a way to introduce monopolistic competition and wage stickiness in the labor market. Specifically, each union is assumed to hire hours from households on a competitive market. In turn, it rents these hours to the firms on a monopolistic competition market where labor demand depends on the relative wage charged by the union with an elasticity of substitution denoted ϵ_w. Wages are sticky *à la* Calvo, with $1-\theta_w$ denoting the probability for the union to be able to reset the wage level. The first-order condition on wage setting and the derivation of aggregate-wage inflation are derived in Appendix A.2 (page 32).

Production and price rigidities. The representative production firm i hires labor $N_t(i)$ from the unions and capital $K_t(i)$ from capital firms to produce a differentiated good along a Cobb-Douglas production function $Y_t(i) = A_t K_t(i)^{\alpha} N_t(i)^{1-\alpha}$, where $0 < \alpha < 1$ and A_t denotes the exogenous level of total factor productivity. The good is sold under monopolistic competition. The elasticity of substitution of demand is denoted ϵ_p. Calvo-type price stickiness is introduced so that, at each period, the representative firm is able to reset its price with a probability $1-\theta_p$. Factor demand and optimal price setting and aggregate inflation dynamics are derived in Appendix A.3.

Investment. Capital accumulation is carried out by specialized firms that rent it to producing firms on a competitive market. The level of capital $K_t(k)$ made available by a capital firm k at the end of period t for the next production period depends on the capital stock at the end of period $t-1$ and on $I_t(k)$, the gross investment during period t: $K_t(k) = K_{t-1}(k)\Phi\left(\frac{I_t(k)}{K_{t-1}(k)} - \delta\right)$, where δ is the depreciation rate and Φ is a non-decreasing concave function with $\Phi(0) = \Phi'(0) = 1$ encompassing real rigidities on capital accumulation. Although the market of physical capital is perfectly competitive, capital firms can make profit due to entry barrier formed by their initial level of capital.

Due to out-of-model financial frictions, the level of borrowing $Bf_t(k)$ (negative when actually the firm borrows) is constrained by the expected value of the firm at the date the loan is paid back $(t+1)$. This leads to:

$$\underbrace{-Bf_t(k)}_{\text{borrowing at } t} \leq \frac{\xi}{1-\xi} \underbrace{\mathbf{E}_t\left\{\mathcal{F}_t^{t+1} Vk_{t+1}(k)\right\}}_{\text{expected value of the firm at repayment time}}, \tag{3}$$

where $Vk_t(k)$ is the market value of the capital firm and $0 < \xi < 1$.[10] First-order conditions on capital accumulation and the financial structure of the firm (debt or equities) are derived in appendix A.4 (page 33).

[10] At the steady-state, ξ will be equal to the share of capital financed by external funds and so it is a second indicator for financial development.

3.4 Government

The role of the government is to run the PAYG pension system, distribute capital subsidies (China only), and to conduct the monetary/exchange-rate policy.

Monetary and exchange-rate policies. In the United States (and, in the extension of the model, in the Euro area), monetary policy is modeled through a simple interest-rate rule:

$$\log\left(\frac{R_t}{R^*}\right) = \rho_R \log\left(\frac{R_{t-1}}{R^*}\right) + (1-\rho_R)\alpha_\pi \log(\pi_t), \tag{4}$$

where R_t is the nominal interest rate, R^* its steady-state value, π_t the production-price inflation, $\alpha_\pi > 1$ the long run reaction of interest rate to inflation and $\rho_R = 0.8$ a smoothing parameter.[11] Note that, consistent with the Taylor rule (Taylor (1993)), the real interest rate rises whenever inflation increases.[12] Since the model is not used to study cost-push shocks, we can safely drop the output-gap from the Taylor rule, since the output-gap will be perfectly correlated with inflation.[13]

This simple feedback rule is augmented in the case of China to account for the fixed exchange-rate regime.[14] Specifically, the Chinese peg is maintained through foreign-exchange reserve accumulation in the form of dollar-denominated bonds $Bc_t^{\$}$ (and, in the three-country extension of the model, of euro-denominated bonds $Bc_t^{€}$). These interventions are partially sterilized through the issuance of sterilization bonds. Denoting by $FR_t > 0$ the total amount of official reserves at the end of period t and by $Bc_t^{c} < 0$ the stock of central bank liabilities in terms of sterilization bonds, we have: $Bc_t^{c} = -\nu_{\text{steril}} FR_t$, where $0 < \nu_{\text{steril}} < 1$ is the degree of sterilization of foreign-exchange interventions. According to Greenwood (2008), the sterilization of official interventions in China during the 2000s was also channeled through a rise of reserve requirements of commercial banks. Here the banking sector is not modeled, hence sterilization is performed only through the issuance of sterilization bonds that are directly (rather than indirectly) purchased by households. Following Greenwood's evidence of a high degree of sterilization, we set $\nu_{\text{steril}} = 0.9$.[15] However, if China removes capital controls while maintaining its peg, the amount of interventions becomes very large and it is unlikely to be widely sterilized. In this case, we set $\nu_{\text{steril}} = 0.1$.

To the extent that official interventions are not fully sterilized, they feed money creation, which in turn exerts downward pressure on the interest rate. This effect is accounted for here through adding a second term in the interest-rate rule for China:

$$\log\left(\frac{R_t}{R^*}\right) = \rho_R \log\left(\frac{R_{t-1}}{R^*}\right) + (1-\rho_R)\left[\alpha_\pi \log(\pi_t) - (1-\nu_{\text{steril}})\alpha_{FR}\left(FR_t - FR^*\right)\right], \tag{5}$$

with FR^* the target level for official reserves, and $\alpha_{FR} > 0$.[16]

[11] Interest rates and inflation are expressed as one plus the rate itself.

[12] For the sake of simplicity, it is assumed here that the inflation target is zero.

[13] We have checked the robustness of our results when introducing the output gap in the Taylor rule

[14] The ability of central banks to peg exchange rate with partial capital mobility has been discussed by Mundell (1963) and Obstfeld (1980).

[15] This figure also corresponds to Ouyang et al. (2010) who find that almost 90% of reserves accumulation is sterilized in China.

[16] Note that this second term in the interest-rate rule also allows China's net foreign asset position to stabilize in the long run: the downward pressure on the interest rate when the central bank accumulates foreign-exchange reserves reduces the incentives of households to save, hence reduces their accumulation of foreign assets. Here, we set $\alpha_{FR} = 0.1$.

In order for the central bank's balance sheet to stabilize in the long run, we assume the cost (or benefit) from official interventions to be indirectly transferred to households through the pension system. Denoting by $D\text{CB}_t$ the amount of this positive or negative transfer, we have:

$$D\text{CB}_t = E_t^u(Bc_{t-1}^{\text{u}}R_t^{\text{u}} - Bc_t^{\text{u}}) + (Bc_{t-1}^{\text{c}}R_t^{\text{c}} - Bc_{t-1}^{\text{c}}) \tag{6}$$

where E_t^u denotes the exchange rate of the renminbi against the dollar, R_t^u the US interest rate and R_t^c the Chinese one.[17]

Taxes, subsidies and the PAYG pension system. In each country, the government sets the tax rate on labor endowments (τ_t)[18] and issues domestic-currency denominated risk-free bonds, the stock of which is denoted Bg_t at the end of period t, with a negative sign whenever the government is a debtor. The debt level Bg_t is set so that the debt ratio adjusts progressively to a target level Bg_{target}:

$$Bg_t = \rho_{Bg}Bg_{t-1} + (1-\rho_{Bg})Bg_{\text{target}}P_tY_t \tag{7}$$

where P_tY_t represents nominal GDP, and ρ_{Bg} is set to 0.95. In China under a fixed exchange-rate regime, the pension system also receives positive or negative transfers from the central bank, $D\text{CB}_t$, and subsidizes capital accumulation (see Appendix A.4). Finally, the level of pensions, $\mathcal{P}_t$, is set so as to abide with the budget constraint:

$$\mathcal{P}_t = \tau_t W_t \overline{L}_t + Bg_t + D\text{CB}_t - R_{t-1}Bg_{t-1} - (\tau_k - 1)rk_tK_{t-1} \tag{8}$$

3.5 Trade

Domestic demand is the sum of households' consumption and capital firms' investment. This demand in country j is distributed across domestic goods (D_t^j) and imported goods from country j' ($M_t^{jj'}$) according to a Dixit-Stiglitz CES. Imports and domestic demand write:

$$M_t^{jj'} = \eta^{jj'}\left(\frac{E_t^{jj'}P_t^{j'}}{Pc_t^j}\right)^{-\phi}(I_t^j + C_t^j) \qquad \text{and} \qquad D_t^j = \left(1 - \sum_{j'\neq j}\eta^{jj'}\right)\left(\frac{P_t^j}{Pc_t^j}\right)^{-\phi}(I_t^j + C_t^j),$$

where I_t^j, C_t^j and Pc_t^j denote investment, consumption and the consumption price index of country j, respectively, P_t^j is the producer price index of country j, $P_t^{j'}$ that of country j', $\phi > 0$ and $\eta^{jj'} > 0$ represents trade openness of j vis-ï¿½-vis j'.[19] The trade balance writes, in domestic currency:

$$TB_t^j = \sum_{j'\neq j}\left(P_t^j M_t^{j'j} - E_t^{jj'}P_t^{j'}M_t^{jj'}\right)$$

[17] In the three-country extension of the model, a third term is introduced on the right-hand side of the equation to account for earnings on euro-denominated reserves.

[18] Taxing labor endowment rather than hours worked allows us to neglect the efficiency cost of taxation. Here, the tax has no impact on the labor market.

[19] We present here the most general specification of the model that applies whatever the number of countries.

We now turn to two series of simulations of the model. In Section 4, we study the impact of structural policies in China leading to a rise in the national savings rate, under different monetary regimes. In Section 5, we assume that China stays on a high-saving path and study the impact of a monetary reform.

4 Structural policies in China

In this section, we study different structural reforms presented in Section 2, all of which are deemed to impact negatively on China's aggregate savings rate. We contrast the impact of these reforms depending on China's monetary regime. Specifically, we study three monetary regimes, successively:

StatQuo The exchange rate is fixed, with capital controls and almost complete sterilization of interventions;

CapMob Capital controls are relaxed, the nominal exchange rate is kept constant but there is almost no sterilization;

Flex The renminbi is allowed to float freely with no capital controls, no interventions, hence no sterilization.

The corresponding key parameters are reported in Table 1.

Regime	Exchange-rate regime	Capital mobility γ	Sterilization ν_{steril}
StatQuo	Fix	0.5	0.9
CapMob	Fix	0.9	0.1
Flex	Flex	0.9	0

Table 1: Monetary and financial parameters under the three regimes

4.1 A pension reform

We first consider an increase in the generosity of the Chinese PAYG pension system (a 6.5 pp increase in the replacement rate) financed through an increase in the tax rate on labor endowment. In our overlapping-generation model, the reform induces a net transfers from future generations (that will bear a share of higher future pensions through labor income taxation) to alive generations (that benefit from higher future pensions). Hence, aggregate consumption is boosted in the short run.[20] In autarky, the fall in aggregate saving in the long run would induce a higher real interest rate, hence lower capital, GDP, income, and consumption. To the extent that capital controls are not complete, this effect is mitigated by international capital inflows and the Chinese net foreign asset position (NFA hereafter) falls in the long run. Higher capital mobility allows the capital stock to fall less in the long run, thanks to a larger decline in the NFA reduction, as depicted in Table 2.[21]

[20] The reform also induces transfers across alive households since elder households benefit immediately without bearing its cost, whereas younger households bear the bulk of the tax. However, in our overlapping-generation model, this redistribution drives no change in the aggregate saving rate as the propensity to consume wealth is independent from age. The transitory increase in aggregate consumption then comes from the fact that part of the cost of the reform will be borne by future generations.

[21] Equity stocks are not reported in the table since equities are not supposed to be traded internationally here.

Dynamic reaction of the Chinese economy. Consumption in China surges following the shock, but the extent of this surge depends crucially on the monetary and financial regime (see Figure 3). In the status quo regime (currency-peg, low capital mobility), the Chinese interest rate is largely independent from the US one in the short run: it rises sharply as a reaction to higher inflation. This increase in the interest rate mitigates the impact of the reform on consumption (+1% of GDP) and drives investment downwards (-0.3% of GDP). GDP and employment increase in the short run but the hike is short-lived: higher consumption induces households to reduce their labor, which leads to a wage increase that feeds inflation (+0.3 pp); hence the real exchange rate appreciates and the trade balance deteriorates (-0.3% of GDP). The rise in China's interest rate also attracts foreign capital inflows (and reduces incentives for China's residents to invest abroad). Despite low capital mobility, this change in net capital flows exceeds the deterioration of China's trade balance, so the central bank slightly increases its foreign-exchange reserves (+1% of GDP) to keep the nominal exchange rate constant, which in turn mitigates the rise in the interest rate, despite the sterilization policy. Due to higher inflation, the real exchange rate appreciates during the first ten quarters, before falling back to its baseline level.

When capital controls are removed while the peg is maintained (CapMob regime), large capital inflows limit the reaction of the interest rate to the shock in the short run. This feeds higher inflation (+0.6 pp), a limited fall in investment (-0.06% of GDP) and a large increase in consumption (+2.2% of GDP). The trade balance deteriorates more (-0.6% of GDP). Net capital inflows are now much larger. In the short term, this is compensated by larger reserve accumulation. After ten quarters however, the NFA falls much more rapidly than under the StatQuo regime.

In a flexible exchange rate regime (with no capital controls), the central bank no longer accumulates foreign-exchange reserves whenever there is a surge in capital inflows (or a drop in capital outflows). Rather, it allows the nominal exchange rate to appreciate. Hence, following a rise in the generosity of the Chinese pension system (and the subsequent decrease in households' savings in China), there is both a rise in the domestic interest rate and an immediate appreciation of the renminbi.[22] Such policy is successful in curbing inflation, at the expense of consumption that grows less than under the CapMob regime (but as much as under the StatQuo one). Because net exports are also affected by the short-run appreciation of the renminbi, GDP no longer increases in the short run, neither does employment.In all simulations, employment varies like GDP, hence this graph is omitted in the Figures. Interestingly, the fall in Chinese exports is deeper in the short run than under a peg, but after six quarters the level of exports is the same as under the CapMob regime, and the dynamics of the NFA position is similar in the two regimes. This is consistent with the one-off appreciation of the renminbi, contrasting with progressive appreciation through cumulated inflation differentials under a fixed peg.

If Chinese authorities' objective function is close to that of the households, hence if it weighs higher consumption as a positive outcome, then the best regime is the CapMob one since this is the regime yielding the highest increase in consumption. Conversely, if Chinese authorities are mainly concerned with inflation, then the pension reform should be carried out under the Flex regime. Finally, if Chinese authorities consider employment as the main objective, as it has been the case since the mid 1990s, then our simulations suggests that the peg should be maintained while the pension reform is being

[22] The renminbi subsequently depreciates, consistent with the interest-rate differential together with rational expectations.

	Bonds supply				Bonds demand		
	StatQuo	CapMob	Flex		StatQuo	CapMob	Flex
Firms	-3.0	-2.6	-2.5	Households	-4.7	-9.4	-10.3
Government	-0.2	-0.1	-0.1				
Central bank	-0.6	0.1	0	Central bank	-0.7	0.8	0
Nation	-3.8	-2.6	-2.6	Nation	-5.4	-8.6	-10.3
				NFA	-1.6	-6.0	-7.7

Table 2: Long-run impact of the pension reform on China's balance sheet

implemented.

Impact on the US economy. The transmission of the shock to the United States comes from increased imports by Chinese households (which boosts US GDP) and from higher returns on Chinese assets (which offers an incentive for US households to invest in China and reduces the incentive of Chinese residents to invest in the US). Since both channels are the two sides of the same coin, the transmission is magnified when capital is more mobile. Importantly, the rise in US GDP comes along with a rebalancing of the US economy since both consumption and investment fall in this country due to a higher interest rate. But only with high capital mobility is such rebalancing significant. Under a flexible regime, the immediate appreciation of the renminbi stimulates US exports and GDP in the very short run. Simultaneously, the fall in consumption is larger in the very short run than under a fixed peg, because the interest rate itself increases more rapidly. After five quarters, however, US exports, consumption and GDP are similar under the Flex and the CapMob regimes. Hence, except in the short run, a flexible exchange rate in China does not make much difference for the United States to the extent that capital controls are removed.

In the longer run, GDP and consumption fall below the baseline due to the permanent fall in the investment rate (thus in productive capital). Hence, the positive impact of the Chinese pension reform is only short lived for the US economy, although it has a permanent effect on the NFA position.

In Appendix C, robustness checks are performed by comparing the impact of the pension reform with only one monetary regime (StatQuo) but different values of the key parameters of the model.

4.2 Other structural reforms

We now simulate the impact of the two other structural reforms described in Section 2, which both have the direct consequence of reducing aggregate savings in China. The impact on the Chinese and US economies is depicted in Figures B.1 and G.2 in Appendix B, for the three monetary regimes.

A financial reform. Chinese firms are allowed to increase their borrowings by 45 percent of GDP, while loosing a capital subsidy equivalent to 8% percent. The two measures have opposite effects on investment: on the one hand, it becomes easier to finance fixed capital formation; on the other one, the expected return is lowered due to the removal of capital subsidies. On the whole, the investment rate increases by only 0.15 percent of GDP in the short run. The remaining borrowings are channeled back to households through dividends. This one-shot transfer is triggered by a sudden increase in the

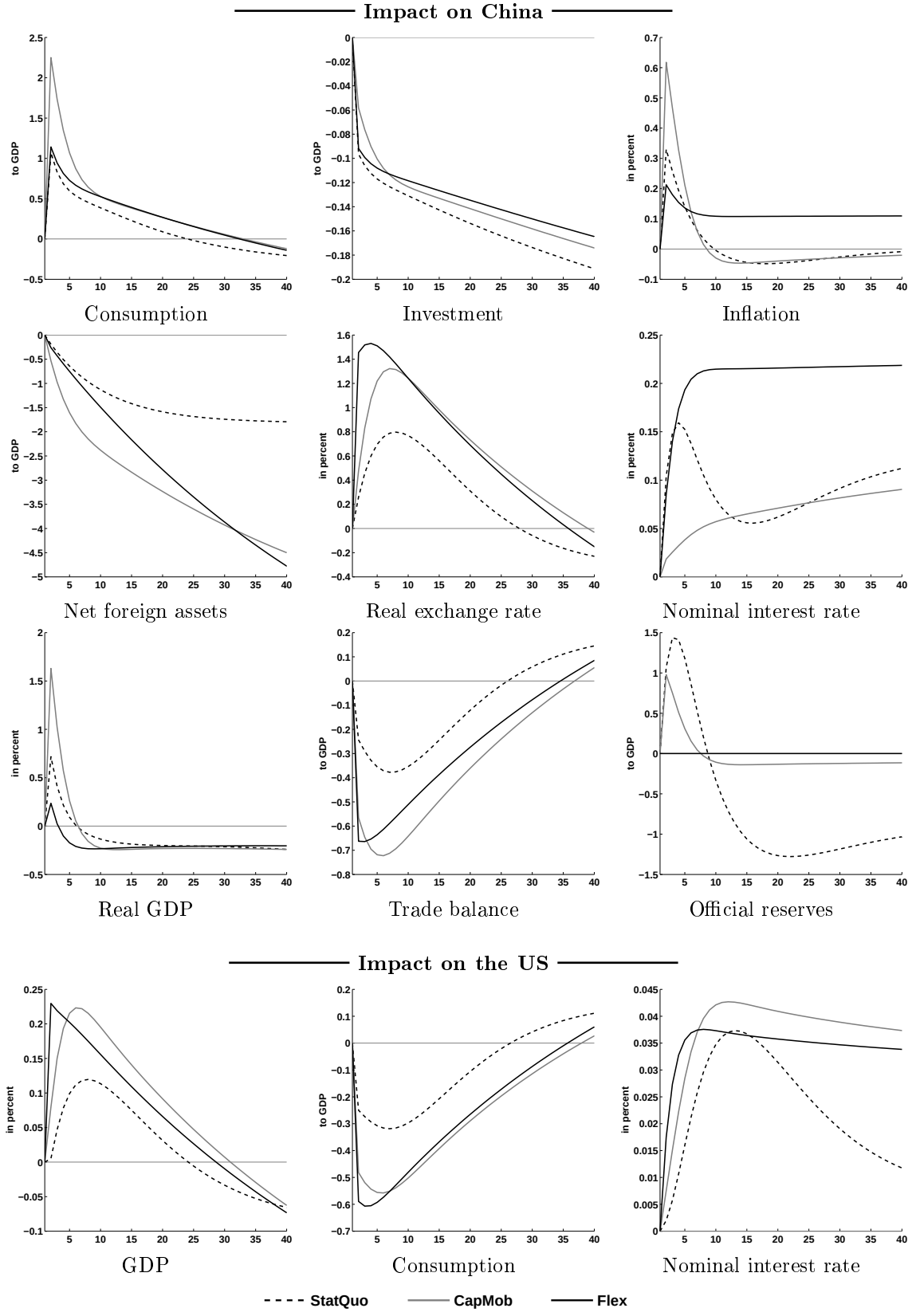


Figure 3: Impact of a pension reform in China

	Bonds supply				Bonds demand		
	StatQuo	CapMob	Flex		StatQuo	CapMob	Flex
Firms	37.1	37.2	37.2	Households	37.1	36.0	36.0
Government	0.2	0.2	0.2				
Central bank	0	0	0	Central bank	-0.1	0.2	0
Nation	37.3	37.4	37.4	Nation	37	36.2	36
				NFA	-0.3	-1.2	-1.4

Table 3: Long-run impact of the financial reform on China's balance sheet

value of capital firms. It boosts consumption in the short run (+0.5 to +1% of GDP, depending on the monetary regime).[23] The interest rate rises to oppose inflationary pressures, which mitigates the rise in consumption and especially investment. The NFA position declines due to net capital inflows and consistent with the fall in the trade balance.

Interestingly, the positive impact of the reform on investment is permanent, which allows GDP and consumption to increase in the long run (contrasting with the pension reform). As detailed in Table 3, the stock of corporate bonds increases by 37 percent of GDP in the long run. Most of it is held by Chinese households, but the NFA position is reduced by 0.3 to 1.4 percent of GDP, depending on the monetary regime.

Like for the pension reform, there is more rebalancing when capital controls are removed, while exchange-rate flexibility allows for less inflation and a faster rebalancing effect. In fact, the main advantage of exchange-rate flexibility is its stabilizing impact on China's consumption and inflation.

The effects of the shock on the US economy are similar to those obtained with a pension reform in China: higher exports and GDP in the short run, lower consumption and investment due to a higher interest rate, hence a rebalancing of the economy which very much depends on the extent of capital mobility. Again, GDP falls in the long run. Like for the pension reform, the US economy enjoys higher foreign demand more quickly under a flexible regime than under a fixed peg in China. The evolution of the NFA position of the US is similar under the CapMob and the Flex regimes, except in the short run where exchange-rate flexibility allows for quicker rebalancing. This is paid in the US by a sharper short-term drop in consumption under the Flex regime.

In terms of current-account rebalancing, this reform is much less effective than the pension reform, as can be seen by comparing Tables 3 and 2. In order for the financial reform to have the same long-run impact on the NFA position than with the 6.5 pp pension reform described above, capital firms would need to almost triple the debt-to-GDP ratio. However, since this reform has positive impact on GDP and consumption in the long run, contrasting with the pension reform that depresses income and consumption in the long run, it could make sense for China to combine the two.

Government spending reform. We finally study the impact of a government spending reform. Specifically, the target debt-to-GDP ratio of China is assumed to be increased from zero to 15 percent of the steady-state GDP. Since in our model the government budget constraint determines the level of pensions, the latter increase, so this reform is close to an unfunded pension reform. Indeed, contrasting

[23] In our model, the propensity to consume is the same for labor as for capital income. Hence, we do not consider horizontal redistributive effects amongst households.

	Bonds supply				Bonds demand		
	StatQuo	CapMob	Flex		StatQuo	CapMob	Flex
Firms	-0.6	-0.5	-0.5	Households	11.1	10.0	10.0
Government	12	12	12				
Central bank	-0.1	0	0	Central bank	-0.1	0	0
Nation	11.3	11.5	11.5	Nation	11.0	10.0	10.0
				NFA	-0.3	-1.5	-1.5

Table 4: Long-run impact of the government spending reform on China's balance sheet

with the pension reform studied above, the tax rate on labor endowment does not increase. In the longer run, the stabilization of the debt ratio is obtained through a downward adjustment of pensions (see Figure B.2 in Appendix B).

Not surprisingly, the impact of the shock for China is very similar to that of a pension reform: rise in consumption, fall in investment, surge in inflation, rebalancing. The main difference is that the adjustment spreads over a longer period. Hence, differences across regimes are more marked and long-lived. In the long run (see Table 4), the government debt increases by 12 percent of GDP[24], most of this new debt being held by Chinese households. The NFA position declines by 0.3 to 1.5 percent of GDP, depending on the monetary regime (again, there is more rebalancing when capital flows are freed).

The flexible exchange rate regime in China benefits immediately to US GDP, and the gain compared to the MobCap regime lasts seven quarters (instead of five in the case of the pension reform). The interest rate rises with some delay compared with the pension reform case.

On the whole, this reform is also less powerful than a funded reform of the PAYG pension system to achieve current-account adjustment. This is because the rise in pensions is not permanent, hence young household cannot anticipate higher pensions for their old age, although they will receive interests on their government bonds holdings. For the government spending reform to have the same impact as the 6.5 pp pension reform on the long-run NFA position, the target debt ratio would need to be increased by over 56 percent of GDP.

4.3 Structural reforms in China under a ZIRP in the US

In the above simulation, one impact of Chinese reforms is channeled to the US through the federal Reserve's policy rate, the increase of which lowers aggregate demand. However, the Federal Reserve may oppose such interest-rate increase if it is constrained by the zero bound: if the initial policy rate is above its Taylor level due to the zero bound, then an increase in US inflation does not immediately lead to monetary tightening. To account for this possibility, we assume that, for the next eight quarters following the shock, US monetary policy follows a modified rule where the interest rate smoothing parameter α_R is set to 0.98 instead of 0.8 in the benchmark model.

The results are reported in Figure 4 for the same, three monetary regimes in China as previously: a fixed exchange rate with limited capital mobility (StatQuo), a fixed exchange rate with more capital

[24]Remember that the shock is given as a percentage of the steady-state GDP: due to the price increase, the rise in the debt-to-GDP ratio is only 12% ex post.

mobility (CapMob), and a flexible exchange rate regime with high capital mobility (Flex). Since the ZIRP only binds in the short and medium run, the long-run impact of the pension reform is the same as before, but the dynamics differ. Comparing Figure 4 with Figure 3, it appears clearly that the US policy rate increases much less with the ZIRP than with a Taylor rule during the first eight quarters of the simulation. Consistently, US consumption increases instead of declining during this period. Interestingly then, the amount of rebalancing now is much more dependent on China's monetary regime, as evidenced by the evolution of China's trade balance: under the StatQuo regime, the pension reform in China produces almost no rebalancing in the short run; and the amount of rebalancing is now doubled if the renminbi is not allowed to float, compared to the CapMob and Flex regime.

Turning to China, the main difference between Figures 4 (Taylor rule in the US) and 3 (ZIRP in the US) occurs under the CapMob regime, i.e. when capital controls are removed but the nominal exchange rate is kept constant. In this case, Chinese monetary policy is dependent on the US one. Other things equal, the increase in the Chinese interest rate is muted, which produces more inflation, a larger fall in the real interest rate, hence a higher increase in consumption and a slower decrease in investment. Consequently, the increase in real GDP is doubled compared with the Taylor-rule case: the policy trade-off between employment and inflation is twisted in favor of the former. Under the other two regimes (StatQuo and Flex), the results for China are close whether the Fed follows a Taylor rule or a ZIRP because China's monetary policy is isolated through capital controls (StatQuo) or a flexible exchange rate (Flex).

On the whole, our simulation under a ZIRP in the United States tends to mitigate our previous conclusion that the regime for capital flows is more important than the exchange rate regime as far as global rebalancing is concerned. We find that, under a ZIRP, the exchange rate regime matters much more than under a standard, Taylor-rule type monetary policy.

5 The impact of a monetary reform in China

One limitation of the simulations presented in Section 4 is that they analyze the impact of Chinese reforms as deviations from a baseline which is a balanced steady-state. This feature hardly matches the debate on global imbalances that blames accumulated imbalances and discusses how these imbalances could unfold. Here we tackle this issue by studying the impact of a monetary reform in China when the economy is not at the steady state but rather displays large current-account surpluses.

We proceed in two steps. First, we simulate an "imbalance" shock in the form of (i) a structural shock whereby China's savings rate is permanently increased, or (ii) a shock on the target level of China's official reserves. Second, we assume that, after 15 quarters, China decides to allow its exchange rate to float (and it subsequently keeps the level of official reserves constant). The choice to undertake the monetary reform after 15 quarters results from the necessity to have the reform take place once the economy has already accumulated significant imbalances. It does not change the results qualitatively to select a shorter or a longer period.

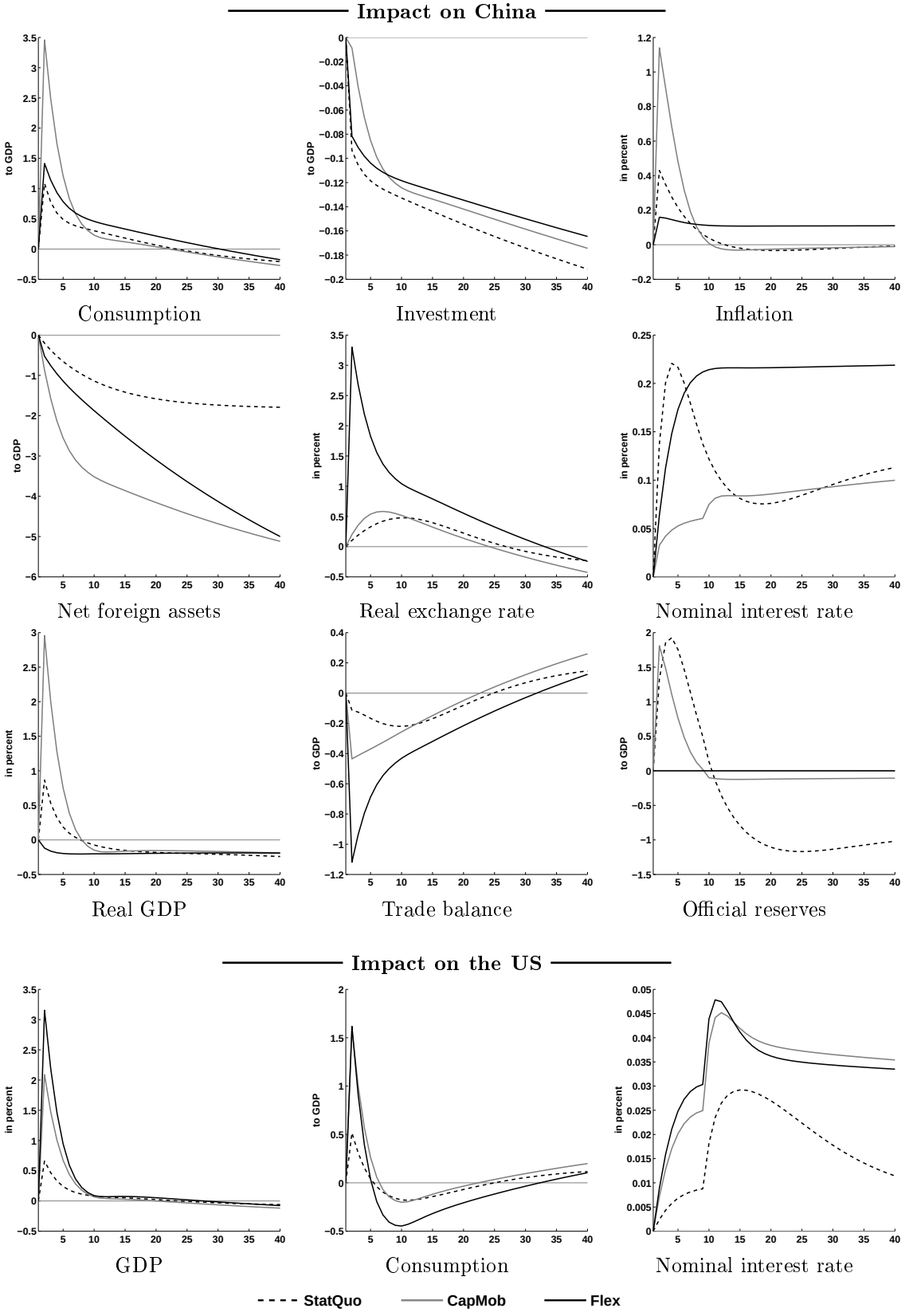


Figure 4: Impact of a pension reform in China with ZIRP in the United-States

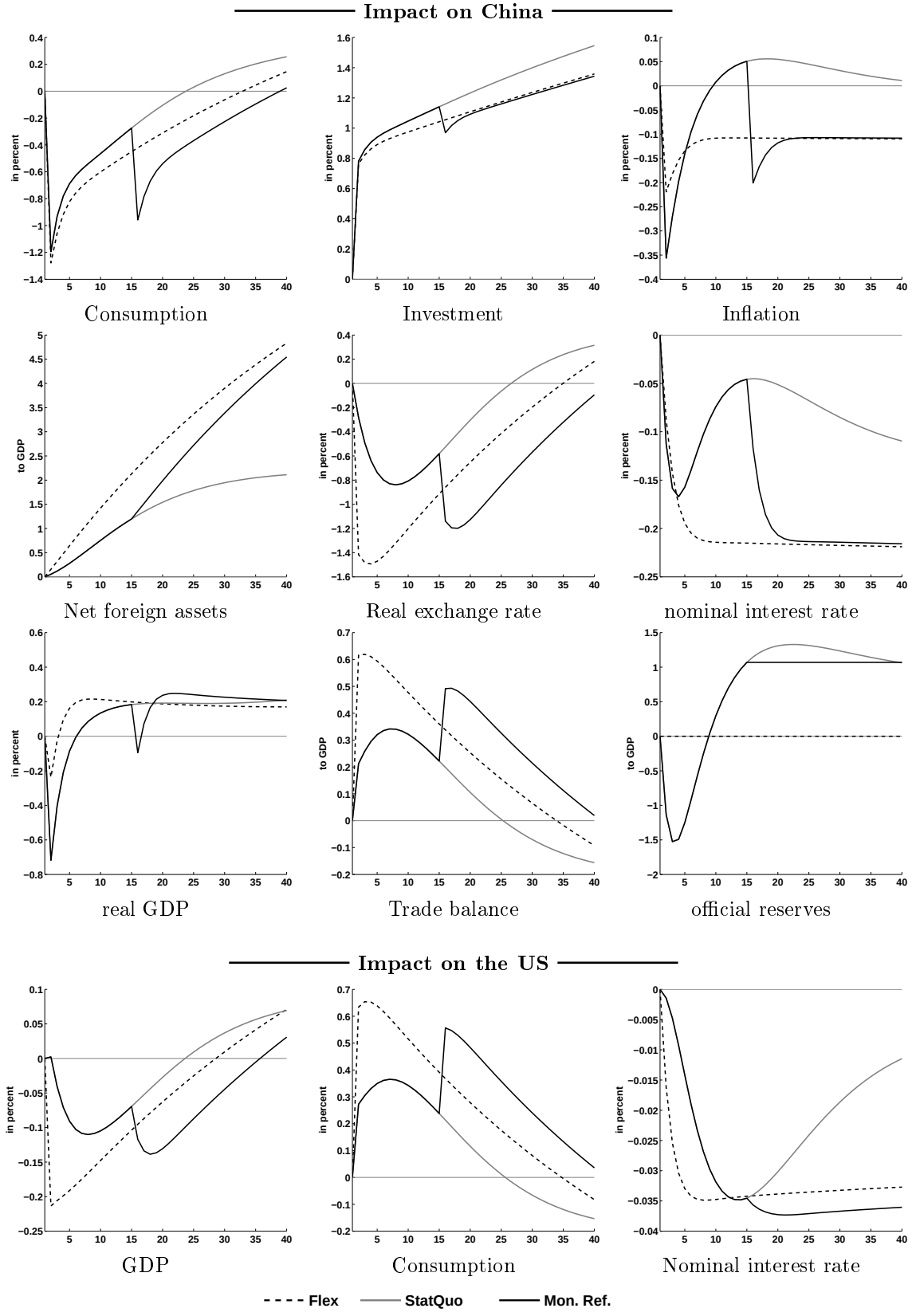


Figure 5: Flexibilization of China's exchange rate after a "reverse" pension reform

5.1 A Pension "reverse" shock

First, we consider a reduction in the generosity of China's pension system, consistent with the 1997 pension reform. Symmetrically to the above pension reform, we assume that the replacement rate is reduced by 6.5 pp. The results are reported in Figure 5. The grey line corresponds to the simulation with a fixed exchange rate (StatQuo); the dotted line assumes a flexible exchange rate from the start of the simulation (Flex); finally, the plain, black line shows the path of the economy when switching from StatQuo to Flex after 15 quarters.

Not surprisingly, the restrictive pension shock leads to a fall in Chinese consumption in the short run. The interest rate decreases due to deflationary pressures. This has two consequences: (i) a rise in investment, and (ii) a net outflow of capital. Consistently, the trade balance surges and the NFA position rises until it stabilizes at a higher level (+2.3% of GDP in the StatQuo regime, with low capital mobility, and +9.7% of GDP in the Flex regime, with high capital mobility). The real exchange rate depreciates during several quarters before appreciating towards a long run equilibrium that lies above its baseline level (+0.2% in the StatQuo regime and +2% in the Flex regime). Under a fixed peg, the central bank of China initially reduces its official reserves to counter-balance the (limited) outflow of capital. After two quarters, it starts accumulating reserves to ensure the equilibrium of the balance of payment with higher trade surplus and lower private capital outflows due to the increase in China's interest rate towards its initial level. Under a flexible regime, official reserves stay constant and the nominal exchange rate depreciates in the short run before appreciating steadily along the adjustment path of the economy. There is less deflation in this regime but the increase in the trade balance is doubled compared to the status quo regime, due to capital mobility.

The switch from a fixed to a flexible regime freezes official reserves at an inflated level compared to the steady state.[25] The switch takes place while the nominal, policy interest rate is still depressed in China relative to the United States. Since the monetary change includes a relaxation of capital controls, there is a sudden outflow of private capital, and the renminbi initially *depreciates* by 0.5% (although it appreciates in the long run by 2.5% in real terms).[26] Due to lower purchasing power, consumption declines. Inflation is subsequently reduced. On the whole, the regime shift triggers an increase in the trade surplus, before accompanying the economy back to its balanced path through a strong appreciation of the real exchange rate.

When the regime shift takes place, US GDP is negatively affected (because the dollar appreciates) but US consumption is boosted (due to the higher purchasing power of US households). This mirror image of China confirms the failure of the regime shift to rebalance the US economy.

The lack of rebalancing following a switch of China from a pegged regime to a flexible one arises from the relaxation of capital controls and from the reluctance of the PBoC to sell its accumulated stock of reserves. It should be kept in mind that the relaxation of capital controls is a precondition for the switch to a flexible exchange-rate regime, since the proper functioning of the foreign-exchange market

[25] Alternatively, we could have assumed that the PBoC progressively reduces its excess reserves when switching to a flexible regime. However, this would have amounted to piling up two shocks: a change in the monetary regime, and a portfolio shock. The results would have been less clear cut.

[26] One may wonder why moving to exchange-rate flexibility while the exchange rate is *undervalued* leads to an immediate depreciation rather than an appreciation. The reason is the uncovered interest parity with rational expectations: the exchange rate initially jumps to a path where it can then appreciate at a pace that is consistent with the interest-rate differential. Before the monetary reform takes place, the exchange-rate is undervalued compared to its long-run, equilibrium level, not compared to its short-term, market level

necessitates both residents and non-residents to be able to trade the renminbi for other currencies. What the model says is that switching to a flexible regime (with free capital mobility) in a situation of depressed demand would put downward rather than upward pressure on the renminbi in the short run unless (i) structural reforms are simultaneously (or previously) carried out to reduce aggregate savings in China and/or (ii) the PBoC decides to sell excess reserves. Of course, this stylized result may be mitigated by the initial return differential between China and the United States. It should be reminded here that only bonds yielding the policy rate are traded between the two countries: in our model, relaxing capital controls does not induce US investors to buy high-return Chinese stocks, which may put upward pressure on the RMB. Still, the model highlights the complementarity between monetary and structural reforms to engineer a fast rebalancing of the economy.

5.2 Reserve accumulation shock

Even though a "reverse" pension shock may have contributed to the high saving rate in China and the growing imbalances, this shock is not sufficient to explain official reserve accumulation. As argued by Cova et al. (2009), the rise in emerging Asia's current account surplus after 2001 may also be related to an increase in the desired net foreign asset position. In the case of China, due to capital controls, this suggests an increase in the target level for official reserves. Here, we assume that this target increases progressively by 38 percent of GDP in 20 years. Accordingly, the interest rate rule of the Chinese central bank is shifted upward in order to be consistent with the constant exchange rate constant (see Equation (5)). Like in the previous exercise, China is assumed to shift to a flexible regime after 15 quarters.

The results are displayed in Figure 6.[27] To the extent that this policy is well anticipated, the real interest rate is expected to be higher until the level of reserves has reached its new target. As a consequence, consumption initially drops (intertemporal substitution effect). Inflation decreases in the short run, the real interest rate increases but the nominal interest rate starts by a large fall to mitigate the decline in Chinese inflation. Despite the fixed nominal exchange rate, the real exchange rate depreciates. Due to nominal rigidities, the depreciation is spread over several quarters.

The Chinese economy progressively accumulates trade surpluses, hence assets on the US economy in the form of official reserves. Symmetrically, consumption increases in the US thanks to a lower expected level of nominal interest rate in the medium run, whereas GDP is lowered as domestic demand shifts to imported goods. After a few years, when a sizable amount of official reserves has been accumulated, the real interest rate in China starts declining, increasing consumption and reducing the current account surplus. The real exchange rate appreciates through a recovery of inflation in China (by 15% from its value in quarter 15 to its long run equilibrium value).

At this stage, a monetary reform that encompasses the relaxation of capital controls, a shift to a flexible exchange rate regime and the end of official reserve accumulation (that are frozen at their inflated, current value, +11.5% of GDP) induces a large appreciation of the renminbi, by 10%, and simultaneously removes any inflationary pressure in China. It also rebalances the world economy as consumption drops in the US, the nominal interest rate increases and GDP recovers.

[27] Here, we do not report the results when China is running a Flex regime during the whole period since, by definition, there is no reserve accumulation under a Flex.

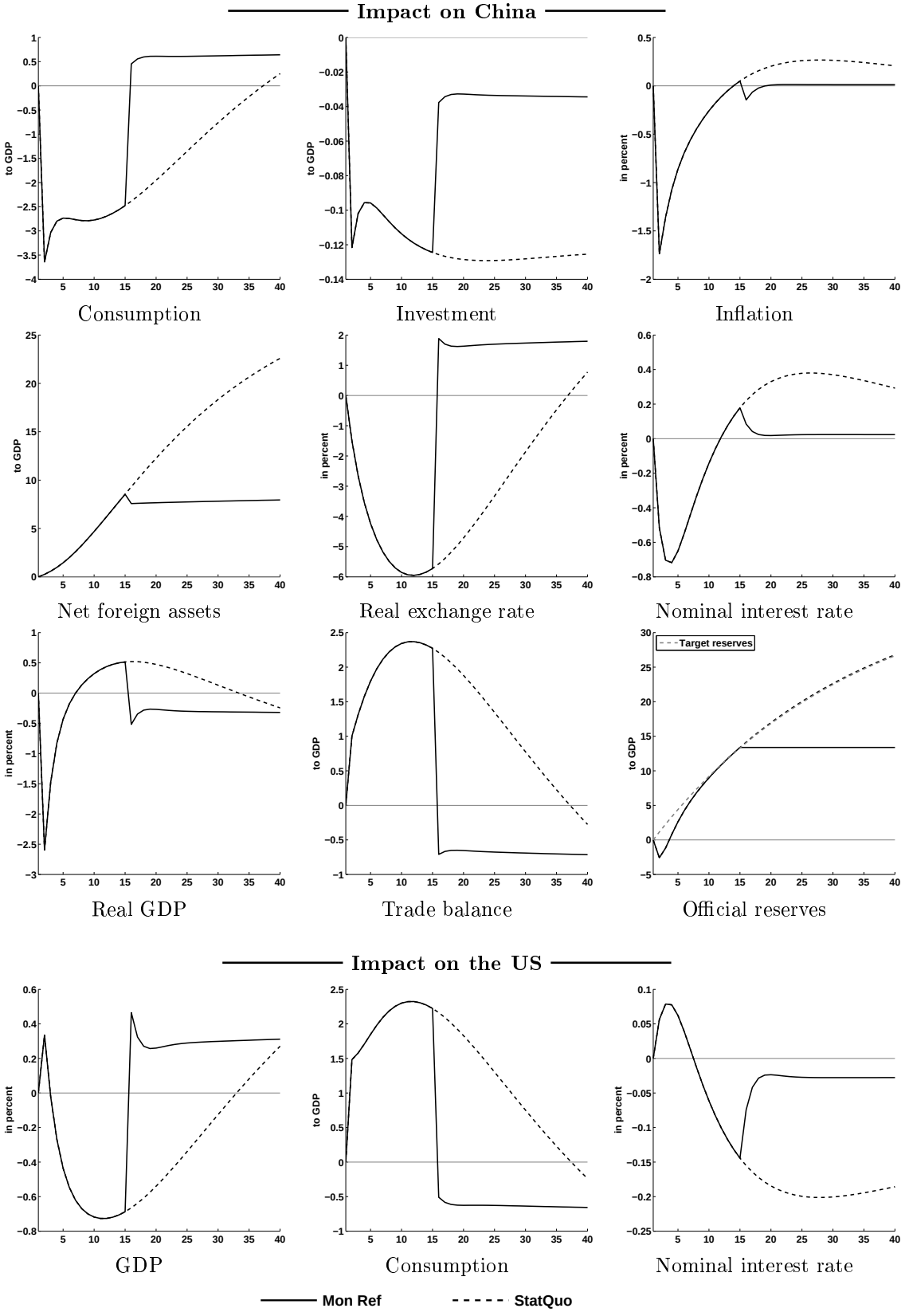


Figure 6: Flexibilization of China's exchange rate after a reserve accumulation shock

On the whole, these two successive simulations suggest that the key factor of rebalancing is less the flexibility of the exchange rate by itself than its implications in terms of official reserves, and that a exchange-rate flexibility can usefully complement but not be a substitute for structural reforms.

6 A third country: the Euro area

Finally, we add the Euro area to the model which therefore becomes a three-country model. The model of the Euro area is the same as for the United States, except for the share of their respective currencies in Chinese official reserves. Here, we assume that foreign exchange reserves in China amount to 60% of Chinese GDP, dollar-denominated assets represent 80% of the total and euro-denominated assets the remainder 20%.[28] We also assume that euro and dollar are not perfect substitutes: capital mobility between the United States and the Euro area is however high, with $\gamma = 0.9$.

This three-country model is then used to perform three series of simulations: (i) a pension reform in China (as in Section 4.1), (ii) a diversification of China's official reserves, and (iii) a diversification of China's official reserves under a ZIRP in both the United States and the Euro area.

6.1 Impact of a pension reform in China in a three-country setting

The impact of an increase in the generosity of China's pension system is similar for the Euro area as for the United States (see Figure 7). The minor differences come from the higher share of the dollar in Chinas' reserves.[29]

The Chinese reform is a symmetric shock for the United States and the Euro area. The rebalancing occurs both between China and the United States and between China and the Euro area. However, as long as the Chinese peg is maintained (StaQuo and CapMob regimes), there is more rebalancing in the United States than on the Euro area, as the drop in Chinese demand for reserves falls relatively more on the dollar than on the euro. As a result, the interest rate increases more in the US, lowering investment and stimulating household saving. The differences between the US and Euro area are benign such that the EUR/USD exchange rate is not significantly affected by the Chinese reform. The large sale of dollar compared to euro by the Chinese central bank triggers a depreciation of the dollar against the euro that induces private agents in the US and in the euro area, who enjoy free capital mobility, to buy more dollars. This stabilizing effect contributes to the absence of euro-dollar reaction in the first period. We now turn to simulating the impact of a change in PBoC's portfolio allocation.

6.2 Impact of a diversification of China's official reserves

We now simulate a diversification of China's foreign exchange reserves out of the dollar into the euro, with the renminbi still being pegged on the dollar. Specifically, the share of the euro in China's

[28] At the end of 2010, foreign reserves reached USD 2800 bn whereas Chinese GDP amounted to USD 5100 bn. The currency composition of Chinese reserves is not released, but the share of the euro is generally estimated around 20%.

[29] In the steady state, the PBoC holds official reserves equivalent to 60% of GDP. In the simulations performed under a Flex regime, this amount stays constant but the asymmetric distribution of existing Chinese reserves across the two currencies produces some asymmetric valuation effects.

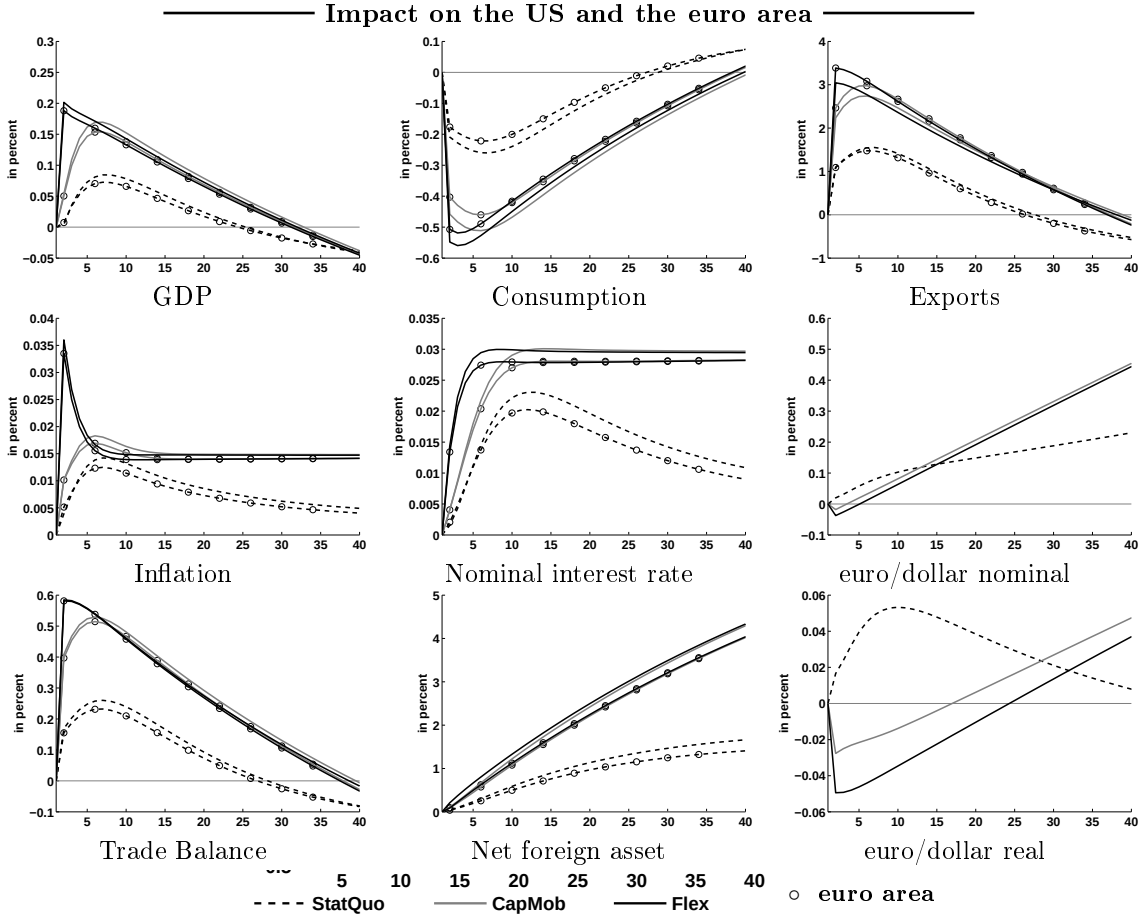


Figure 7: Impact of a pension reform in China, three-country model

reserves is assumed to increase to 30% from 20%. As a first step, monetary policy is assumed to follow a Taylor rule in both the Euro area and the United States. The results are displayed in Figure 8, where the plain line represents the status quo regime (limited capital mobility) and the dotted one shows the same simulation when capital controls are relaxed in China.

This diversification induces large capital inflows into the Euro area, hence a sizable appreciation of the euro and a fall in Euro area's growth rate. However potential growth increases in the medium run due to a lower interest rate. The impact is opposite in the US: the dollar depreciation promotes growth in the short run, but the potential is reduced in the long run due to lower capital accumulation.

6.3 Impact of a diversification of China's official reserves under a ZIRP

Our last exercise is to study the impact of the same diversification of Chinese reserves under a zero interest-rate policy in the Euro area and in the United States (see Figure 9). Due to the zero bound, the ECB is unable to cut its interest rate, whereas monetary tightening in the United States is also muted. Hence, the fall in European GDP is larger than under a standard Taylor-rule type monetary policy, whereas the increase in GDP is magnified in the United States. The bilateral exchange rate of the euro vis-a-vis the dollar appreciates much more than under unconstrained monetary policy.

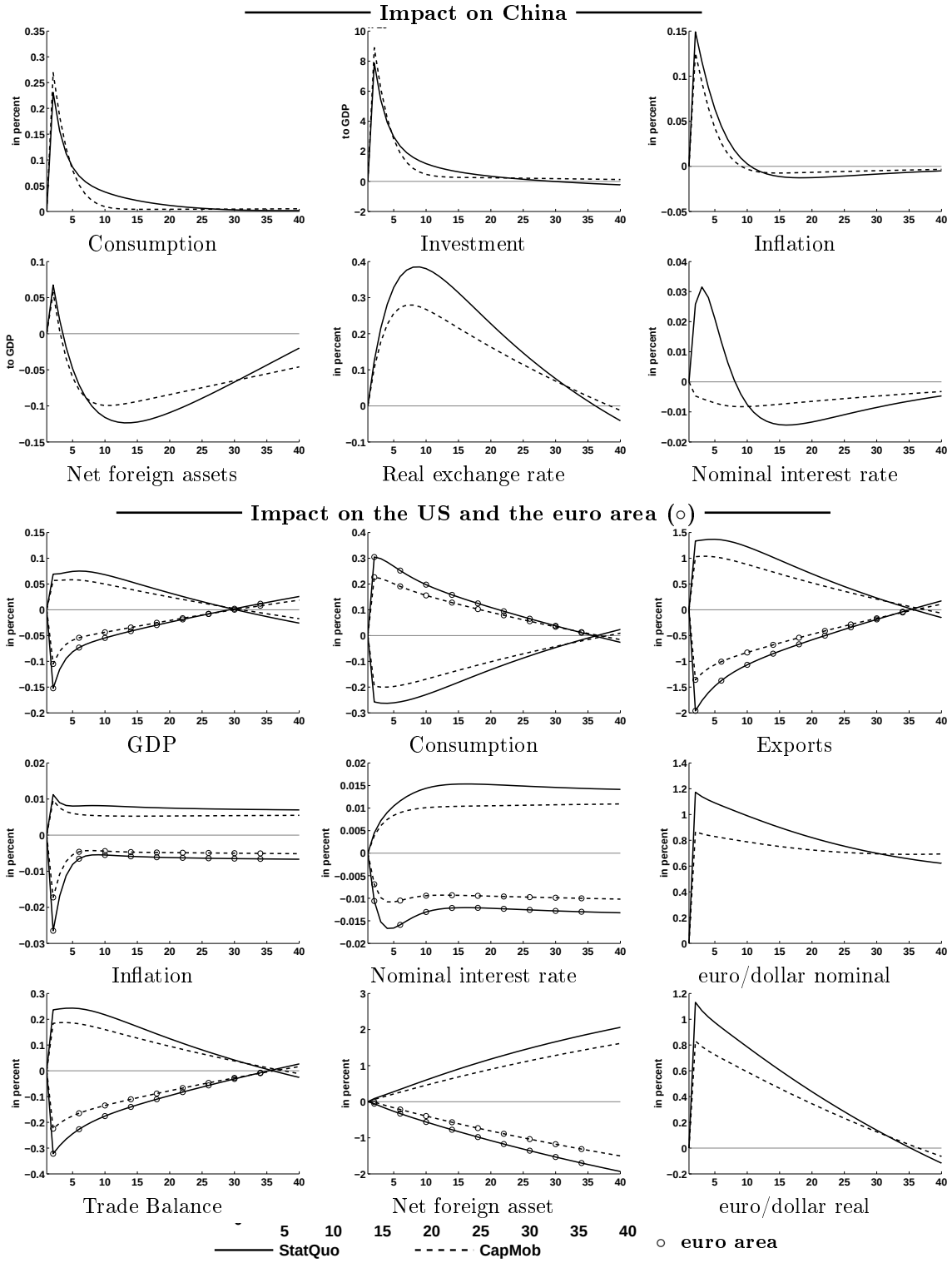


Figure 8: Impact of a diversification of China's official reserves, three country model

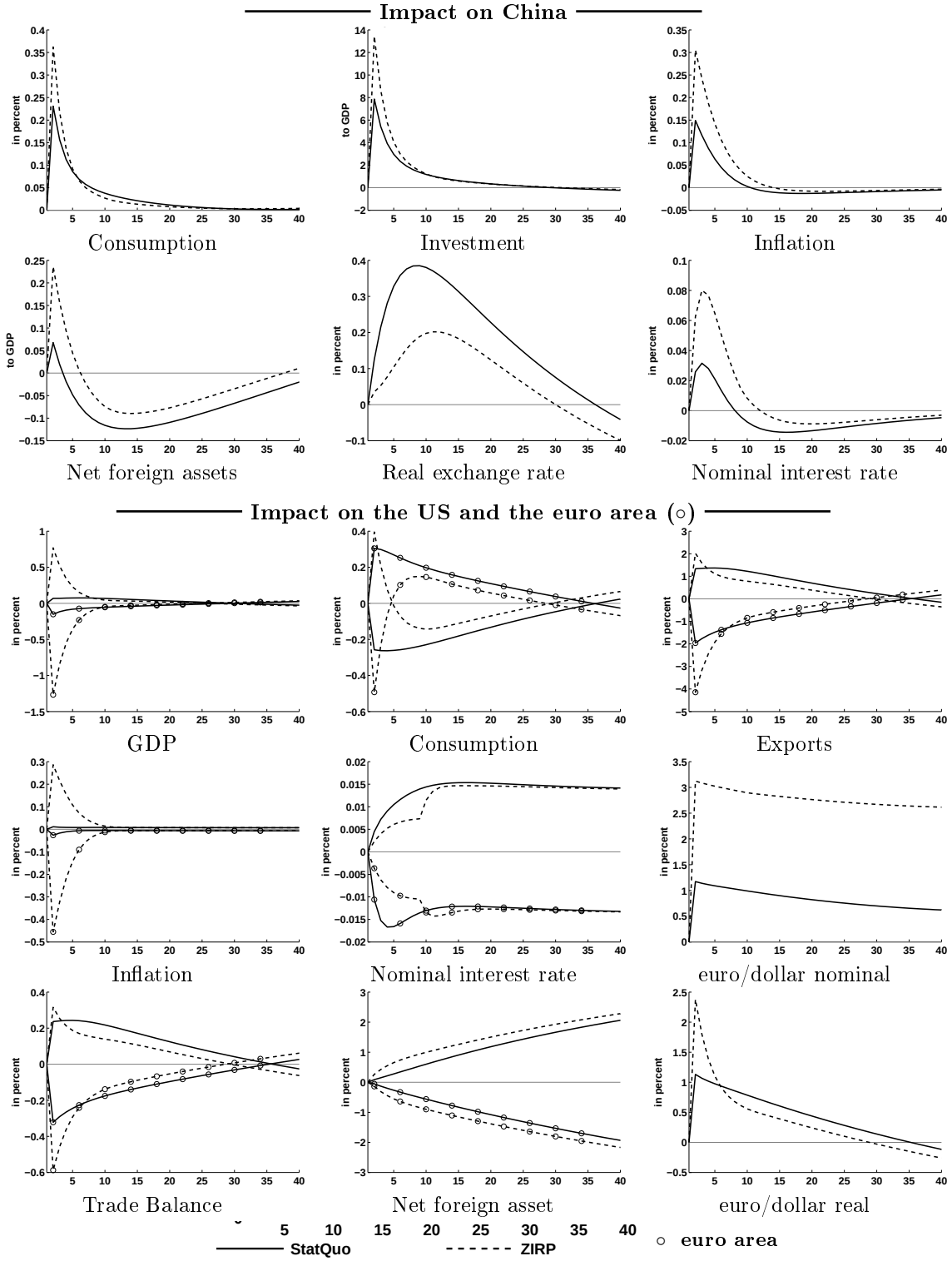


Figure 9: Impact of a diversification of China's reserves with a ZIRP in the United states and the Euro Area

7 Conclusion

We have constructed a two-country model to study different scenarios of global rebalancing depending on (i) structural reforms decided in China, (ii) the monetary regime of China, (iii) the constraints on monetary policy in the United States and (iv) the initial level of cumulated imbalances. Our simulations suggest that, if monetary policy follow a standard, Taylor rule in the United States, then structural reforms in China that reduce aggregate savings are a powerful driver of global rebalancing, provided there is some relaxation of capital controls. A flexibilization of the renminbi can accelerate the rebalancing but has only a minor effect on its extent. For China, switching to a flexible exchange-rate regime during the reform raises a clear trade-off between inflation (which would be stabilized with a flexible regime) and employment (which would suffer). The possibility that China moves close to the "Lewis turning point" may change the terms of this trade-off and could favor a flexible exchange rate.

Now, if the US monetary policy is committed to a zero interest rate, then a move to a flexible exchange-rate regime in China has more impact on the amount of the rebalancing. In this case, the Federal Reserve refrains from hiking its interest rate when global savings are reduced. Hence the rebalancing can only come from a depreciation of the dollar against the renminbi, hence from a more flexible exchange-rate regime in China. The US ZIRP also modifies the policy trade-off in China since removing capital controls while keeping a fixed peg on the dollar would amount to adopting the US ZIRP, hence let Chinese inflation would develop without control.

We then perform the reverse exercise where an initial reduction in the generosity of China's pension system (as with the 1997 reform) raises the saving rate of households, triggering net foreign asset accumulation under a fixed peg, before the renminbi is eventually allowed to float. To the extent that the switch from a peg to a float is accompanied by a relaxation of capital controls but not by structural reforms reducing the saving rate, and assuming that China's official reserves are frozen at their observed level when switching to the floating regime (not sold out), then the regime shift involves downward pressure on the renminbi, which delays rather than accelerating the rebalancing. The reason is the large outflow of private capital involved by the conjunction of a low policy rate in China (related to excess savings) and the relaxation of capital controls.

Alternatively, if Chinese current-account surpluses are the result not of a depressed consumption but of a rise in the official reserve target, then the move to a flexible regime (with frozen reserves) does produce the desired rebalancing features.

Finally, we introduce the Euro area as a third country in the model. We find here that despite the peg of the renminbi on the dollar, a structural reform in China produces very similar effects on the Euro area as on the US economy. Conversely, a diversification of China's official reserves depresses the economy of the Euro area through an appreciation of the euro against both the dollar and the renminbi. Interestingly, this detrimental effect is magnified by having a ZIRP in both the United States and the Euro area.

We conclude that the contribution of China in global rebalancing should primarily rely on structural policies that reduce aggregate savings in China and on simultaneous opening up of the Chinese economy. The role of the exchange-rate regime would be minor under standard monetary policies, although more important if monetary policies in advanced countries are constrained. Finally, relying

only on a change in China's monetary regime could end up in delaying rather than accelerating the rebalancing, depending on China's policy regarding accumulated reserves.

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Appendix

A Details of the model

A.1 Households' program

Households at the cohort level In region j, the inter-temporal budget constraint of a household born at time a and still living at time t writes (we skip the j superscript for clarity):

$$Pc_t C_{a,t} + \mathcal{A}_{a,t} = W_t L_{a,t} - \tau_t W_t \bar{L}_{t-a} + \Omega_{a,t} + \mathcal{P}_{a,t}, \tag{9}$$

where Pc_t denotes the consumption price index, $\mathcal{A}_{t,a}$ is the end-of-period asset holding, $W_t L_{t,a} - \tau_t W_t \bar{L}_{t-a}$ is the after-tax wage income,[30] $\Omega_{a,t}$ represents beginning-of-period financial wealth, and $\mathcal{P}_{a,t}$ pensions received from the government. Asset holding consist in equities on domestic firms ($Z_{a,t}(f)$, where f is the firm index), a complete set of contingent claims in domestic currency ($Bh^{j,j}_{a,t+1}$) and risk-free nominal bonds in foreign currency ($Bh^{j,j'}_{a,t}$). The value of the portfolio $\mathcal{A}$ at the end of period t writes:

$$\mathcal{A}^j_{a,t} = \mathbf{E}_t \left\{ \mathcal{F}^{t+1,j}_t Bh^{j,j}_{a,t+1} \right\} + \sum_{j' \neq j} E^{j,j'}_t Bh^{j,j'}_{a,t} + \int_f Q^j_t(f) Z^j_{a,t}(f) df \tag{10}$$

Where $\mathcal{F}^{t+1,j}_t$ is the stochastic discount factor and $Q^j_t(f)$ is the nominal equity price.

Name	Description	Name	Description
$C_{a,t}$	consumption in volume	$\mathcal{P}_{a,t}$	pension received from the government
$L_{a,t}$	effective labor time	$\bar{L}_{t-a}$	time endowment
$\Omega_{a,t}$	beginning of period financial wealth	$\mathcal{A}_{a,t}$	end-of-period financial wealth
$Bh^{j,j'}_{a,t}$	end-of-period foreign bonds holding	$Bh^{j,j}_{a,t+1}$	end-of-period holding of contingent (on date $t+1$ shocks realization) claims

Table A.1: Households variables at the cohort level in country j

Given the asset accumulation at period $t-1$, and conditionally on the survival of the household at t, the financial wealth is augmented thanks to the life-insurance contract where bonds are fully eligible whereas equities are partially eligible (a share ν_E). Let $\theta_E = \nu_E + (1-\nu_E)\theta_g$.

$$\Omega^j_{a,t} = \begin{cases} \frac{1}{\theta_g} \left(Bh^{j,j}_{a,t} + \sum_{j' \neq j} E^{j,j'}_t R^j_{t-1} Bf^{j,j'}_{a,t-1} \right) + \frac{\theta_E}{\theta_g} \int_f (Q^j_t(f) + D^j_t(f)) Z^j_{a,t-1}(f) df & \text{if } a < t \\ (1-\nu_E) Vk^j_t / \bar{N}^j & \text{if } a = t \end{cases} \tag{11}$$

Where Vk^j_t is the capital firm value and $D^j_t(f)$ is the dividend received by households. Each household decides his level of consumption, labor supply and asset holdings so as to maximize his intertemporal utility (1) under the budget constraint (9). The optimality conditions implied by the household program are the following:

Euler equation	$\mathcal{F}^{t+1}_t = \frac{\beta}{\pi^c_{t+1}} \frac{C_{a,t}}{C_{a,t+1}}$
Labor supply	$L_{a,t} = \bar{L}_{a-t} - \frac{\kappa}{1-\kappa} \frac{C_{a,t}}{MRS_t}$
Firm's stock price:	$Q_t = \mathbf{E}_t \left\{ \mathcal{F}^{t+1}_t (D_{t+1} + Q_{t+1}) \right\}$
Foreign bonds holding	$\frac{E^{jj'}_t Bh^{jj'}_{a,t}}{\mathcal{A}^j_{a,t}} = \frac{\gamma^{jj'}}{1-\gamma^{jj'}} \left(\mathbf{E}_t \left\{ \mathcal{F}^{t+1,j}_t R^{j'}_t \frac{E^{jj'}_t}{E^{jj'}_{t+1}} \right\} - 1 \right)$

[30] In order to disentangle the redistributive from the allocation effect of labor taxation, we assume that the government is able to tax time endowment rather than labor supply.

It can be shown that, at the cohort level, consumption is a linear function of total wealth, i.e. financial wealth (Ω) and human wealth HW (the future stream of labor an pension income) which is defined by:

$$HW_{a,t} = \sum_{s=0}^{\infty} \mathcal{F}_t^{t+s} \theta_g^s \left[(1-\tau_{t+s}) W_{t+s} \bar{L}_{t+s-a} + \mathcal{P}_{a,t+s} \right]$$

where $\mathcal{P}_{a,t+s}$ represents the pension received by generation a at time $t+s$.

symbol	description	possible values
j, j'	region	u (the United States), c (China), e (euro area)
	agent	h (households), g (government), b (central bank), f (firms)

Table A.2: Notations for regions and agents

Aggregation The aggregate household behavior is described by two main relations: (i) aggregate labor supply and (ii) aggregate consumption. The former is easily derived through direct aggregation of cohort-specific labor supplies and is similar to the representative-agent case. The latter is proportional to total wealth, *i.e.* human wealth, HW, (discounted sum of future net of tax labor income and pensions of already alive households), plus financial wealth, Ω, (the market value of equities and bonds).

$$L_t = \overline{L} - \frac{\kappa}{1-\kappa} \frac{C_t}{MRS_t}, \qquad (12) \qquad\qquad Pc_t C_t = \Theta_t \left(HW_t + \Omega_t \right) \qquad (13)$$

To evaluate the nominal stochastic discount factor, $\mathcal{F}_t^{t+1}$, we introduce a new variable, the relative consumption of the young rcy_t, which is specific to overlapping-generation models. One then has:

$$\mathcal{F}_t^{t+1} = \frac{\theta_g \beta}{1-(1-\theta_g) rcy_t} \frac{Pc_{t-1} C_{t-1}}{Pc_t C_t}, \qquad (14)$$

where

$$rcy_t = \frac{HW_{t,t} + \Omega_{t,t}}{HW_t + \Omega_t} \qquad (15)$$

A.2 Unions and wage setting

The representative union allowed to resets its wage at period t chooses W_t^{*j} so as to maximize the following objective function:

$$\mathbf{E}_t \sum_{s=0}^{\infty} (\theta_g \theta_w)^s \mathcal{F}_t^{t+s} \left(W_t^* - MRS_{t+s} Pc_{t+s} \right) \left(\frac{W_t^{*j}}{W_{t+s}^j} \right)^{-\epsilon_w} L_{t+s}^j \qquad (16)$$

where MRS_{t+s} denotes the marginal rate of substitution between consumption and leisure in period t+s. The union receives W_t^{*j} from firms and pays $MRS_t Pc_t$ to households. The first order condition of the program defined by Equation (16) writes

$$W_t^* = \frac{\epsilon_w}{1-\epsilon_w} \frac{\mathcal{X}_t^w}{\mathcal{Z}_t^w} W_t,$$

where

$$\mathcal{X}_t^w = \mathbf{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_g \theta_w)^s \mathcal{F}_t^{t+s} \left(\frac{W_t}{W_{t+s}} \right)^{-1-\epsilon_w} Pc_{t+s} MRS_{t+s} L_{t+s} \right\} \qquad \text{and}$$

$$\mathcal{Z}_t^w = \mathbf{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_g \theta_w)^s \mathcal{F}_t^{t+s} \left(\frac{W_t}{W_{t+s}} \right)^{-\epsilon_w} L_{t+s} \right\}.$$

A.3 Production-firms and price setting

At time t, the production firm i chooses labor and capital inputs so as to maximize profit, given the demand function $Y_t(i)$. Letting W_t and rk_t denote the nominal wage and the rent cost of capital, respectively, the marginal cost MC_t writes

$$MC_t = \frac{1}{A_t} \left(\frac{1}{\alpha} \right)^{\alpha} \left(\frac{1}{1-\alpha} \right)^{1-\alpha} rk_t^{\alpha} W_t^{1-\alpha}. \tag{17}$$

A firm that resets its price at period t will choose P_t^* that maximizes its market value $Vp_t(i)$:

$$Vp_t(i) = \mathbf{E}_t \sum_{s=0}^{\infty} (\theta_p \theta_E)^s \mathcal{F}_t^{t+s} \left[P_t^* - MC_{t+s} \right] \left(\frac{P_t^*}{P_{t+s}} \right)^{-\epsilon_p} Y_{t+s}, \tag{18}$$

where Y_{t+s} is aggregate demand at time $t+s$ and P_{t+s} the aggregate production-price level at the same time.

The representative firm maximizes the objective function given by Equation (18) which leads to the following first order condition

$$P_t^* = \frac{\epsilon_p}{1-\epsilon_p} \frac{\mathcal{X}_t^p}{\mathcal{Z}_t^p} P_t,$$

where

$$\mathcal{X}_t^p = \mathbf{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_g \theta_p)^s \mathcal{F}_t^{t+s} \left(\frac{P_t}{P_{t+s}} \right)^{-1-\epsilon_p} MC_{t+s} Y_{t+s} \right\} \qquad \text{and}$$

$$\mathcal{Z}_t^p = \mathbf{E}_t \left\{ \sum_{s=0}^{\infty} (\theta_g \theta_p)^s \mathcal{F}_t^{t+s} \left(\frac{P_t}{P_{t+s}} \right)^{-\epsilon_p} L_{t+s} \right\}.$$

A.4 Capital-firms and capital accumulation

Each capital firm k chooses investment I and external funding Bf in order to maximize its market value, equal to the expected discounted sum of future dividends, taking as given the rental price of capital rk, the subsidies to capital accumulation τ_k, the price of investment Pi and the nominal interest rate on loans R.[31] The capital-firm so chooses the level of capital K, the level of investment I and the amount of external financing (Bf) in order to maximize its market value:

$$Vk_t(k) = \mathbf{E}_t \left\{ \sum_{s=0}^{\infty} \mathcal{F}_t^{t+s} \theta_E^s \left[\begin{array}{c} (1+\tau_k) rk_{t+s} K_{t+s-1}(k) - Pi_{t+s} I_{t+s}(k) \\ +R_{t+s-1} Bf_{t+s-1}(k) - Bf_{t+s}(k) \end{array} \right] \right\}. \tag{19}$$

[31] At date t, dividends are the residual of the flow of funds: previous borrowing enters negatively as it has to be reimbursed whereas fresh borrowing enters positively as it can increases investment or... dividends. Capital firms as also assumed not to be able to sell their entire capital stock. This assumption does not modify their optimization program.

under the financing constraint (Equation (3), p.9) and the capital accumulation:

$$K_{t+s}(k) = K_{t+s-1}(k)\Phi\left(\frac{I_{t+s}(k)}{K_{t+s-1}(k)} - \delta\right).$$

Because dividend flows are more discounted than bonds, the borrowing constraint (3) is always binding. Thanks to this binding condition, the value of the capital firm can then be rewritten in a simpler way that can be interpreted as the "book value" (see Box).

$$Vk_t(k) = \mathbf{E}_t\left\{\sum_{s=0}^{\infty}\mathcal{F}_t^{t+s}\left(\xi + (1-\xi)\theta_E\right)^s\left[(1+\tau_k)rk_{t+s}K_{t+s-1}(k) - Pi_{t+s}I_{t+s}(k)\right]\right\} + R_{t-1}Bf_{t-1}(k). \tag{20}$$

This last expression shows the positive effect of financial development on the value of capital firms, hence on capital accumulation. At the steady-state, the marginal productivity of capital has to cover the depreciation rate δ and the internal financing cost, that equals R/θ_E in absence of external borrowing ($\xi = 0$). With developed financial markets, the internal financing cost drops to $R/(\xi + (1-\xi)\theta_E)$ and the level of capital rises.

Box: The value of the firm with borrowing constraints
Let $Vk_t^1(k) = Vk_t^0(k) - R_{t-1}Bf_{t-1}(k)$. $Vk_t^1(k)$ verifies the following recursive relation

$$Vk_t^1(k) = (1+\tau_k)rk_tK_{t-1}(k) - Pi_tI_t(k) - (1-\theta_E)Bf_t(k) + \mathbf{E}_t\left\{\mathcal{F}_t^{t+1}\theta_E Vk_{t-1}^1(k)\right\}$$

As $\theta_E < 1$, the borrowing constraint (3) is binding which leads to

$$-Bf_t(k) = \frac{\xi}{1-\xi}\mathbf{E}_t\left\{\mathcal{F}_t^{t+1}Vk_{t+1}^0(k)\right\}, \qquad \text{i.e.} \qquad -Bf_t(k) = \xi\mathbf{E}_t\left\{\mathcal{F}_t^{t+1}Vk_{t+1}^1(k)\right\},$$

$Vk_t^1(k)$ is rewritten as follows:

$$Vk_t^1(k) = (1+\tau_k)rk_tK_{t-1}(k) - Pi_tI_t(k)\left[(1-\theta_E)\xi + \theta_E\right]\mathbf{E}_t\left\{\mathcal{F}_t^{t+1}Vk_{t+1}^1(k)\right\}.$$

One can then derive Equation (20)

We find two first order conditions

$$\mu_t = \frac{Pi_t}{\Phi'(\frac{I_t}{K_{t-1}})},$$

$$\mu_t = \mathbf{E}_t\left\{\mathcal{F}_t^{t+1}((1-\theta_E)\xi + \theta_E)\left[(1+\tau_k)rk_{t+1} + \mu_{t+1}\left(\Phi\left(\frac{I_{t+1}(k)}{K_t(k)}\right) - \frac{I_{t+1}(k)}{K_t(k)}\Phi'\left(\frac{I_{t+1}(k)}{K_t(k)}\right)\right)\right]\right\}.$$

where μ_t is the investment's Lagrange-multiplier.
We can write the cost of capital at the steady-state

$$rk = \frac{Pi}{1+\tau_k}\left[\frac{R}{(1-\theta_E)\xi + \theta_E} - (1-\delta)\right].$$

A.5 Market equilibria

Good markets equilibrium

$$\forall j, \qquad Y_t^j = D_t^j + \sum_{j'\neq j} M_t^{j'j} \tag{21}$$

Name	Description	Value
θ_g	Probability to survive	0.966
β	Discount factor	0.99
κ	Leisure preference	0.3
ϵ_w	Elasticity of substitution on the labor market	7
ϵ_p	Elasticity of substitution on the goods market	7
ν_E	Share of equities eligible to life-insurance	0.9
α	Share of capital in the production	0.3
ξ	Share of capital financed by external funds (at the steady-state)	0.6^a
α_π	Inflation parameter in the Taylor rule	2
ρ_R	smoothing parameter in the Taylor rule	0.8
α_{FR}	Official reserves parameter in the Chinese augmented Taylor rule	0.1
ν_{steril}	Degree of sterilization	0.1 or 0.9
ρ_{Bg}	Smoothing parameter for government debt level	0.95
Bg_{target}	Government debt target	0.6^b
η	Share of import in consumption	0.1^c
ϕ	Elasticity of substitution in trade	2
θ_w	Wages rigidity parameter	0.75
θ_p	Prices rigidity parameter	0.67
τ_k	Rate of subsidy on corporate investment	0.08^d
$\gamma^{jj'}$	Proxy of capital mobility between country j and j'	0.5 or 0.9^e
δ	Depreciation rate of the capital	0.02

[a] $\xi = 0.3$ in China before the financial liberalization shock.
[b] 0 in China before the government spending reform.
[c] In the three countries model, imports are shared equally between the two other regions.
[d] In China before the financial liberalization shock, $\tau_k = 0$ otherwise.
[e] 0.5 for low capital mobility and 0.9 for high capital mobility.

Table A.3: Main parameters

Balance of payments

$$\forall j, \qquad \sum_{j' \neq j} \left[\underbrace{E_t^{jj'} \left(Bh_t^{jj'} + Bc_t^{jj'} \right)}_{\text{j holding of j' assets}} - \underbrace{\left(Bh_t^{j'j} + Bc_t^{j'j} \right)}_{\text{j' holding of j assets}} \right] =$$
$$\sum_{j'} \left[E_t^{jj'} \left(Bh_{t-1}^{jj'} + Bc_{t-1}^{jj'} \right) R_{t-1}^{j'} - \left(Bh_{t-1}^{j'j} + Bc_{t-1}^{j'j} \right) R_{t-1}^{j} \right] + TB_t^j \tag{22}$$

Bond markets equilibrium For the record, $Bh_t^{i,j}$ and $Bg^{i,j}$ denote the level of bonds denominated in the currency of region j and owned by the household sector and the government sector of region i respectively. Bf_t^j is the (opposite of) the total borrowing of capital-firms in region j. The following equilibrium holds:

$$\forall j, \qquad \sum_{j'} \left(Bh_t^{j'j} + Bg_t^{j'j} + Bc^{j'j} \right) + Bf_t^j = 0 \tag{23}$$

A.6 Calibration of the model

See Table A.3 page 35.

B Simulations of alternative structural reforms in China

See Figure B.1 and B.2 pages 37 and 38.

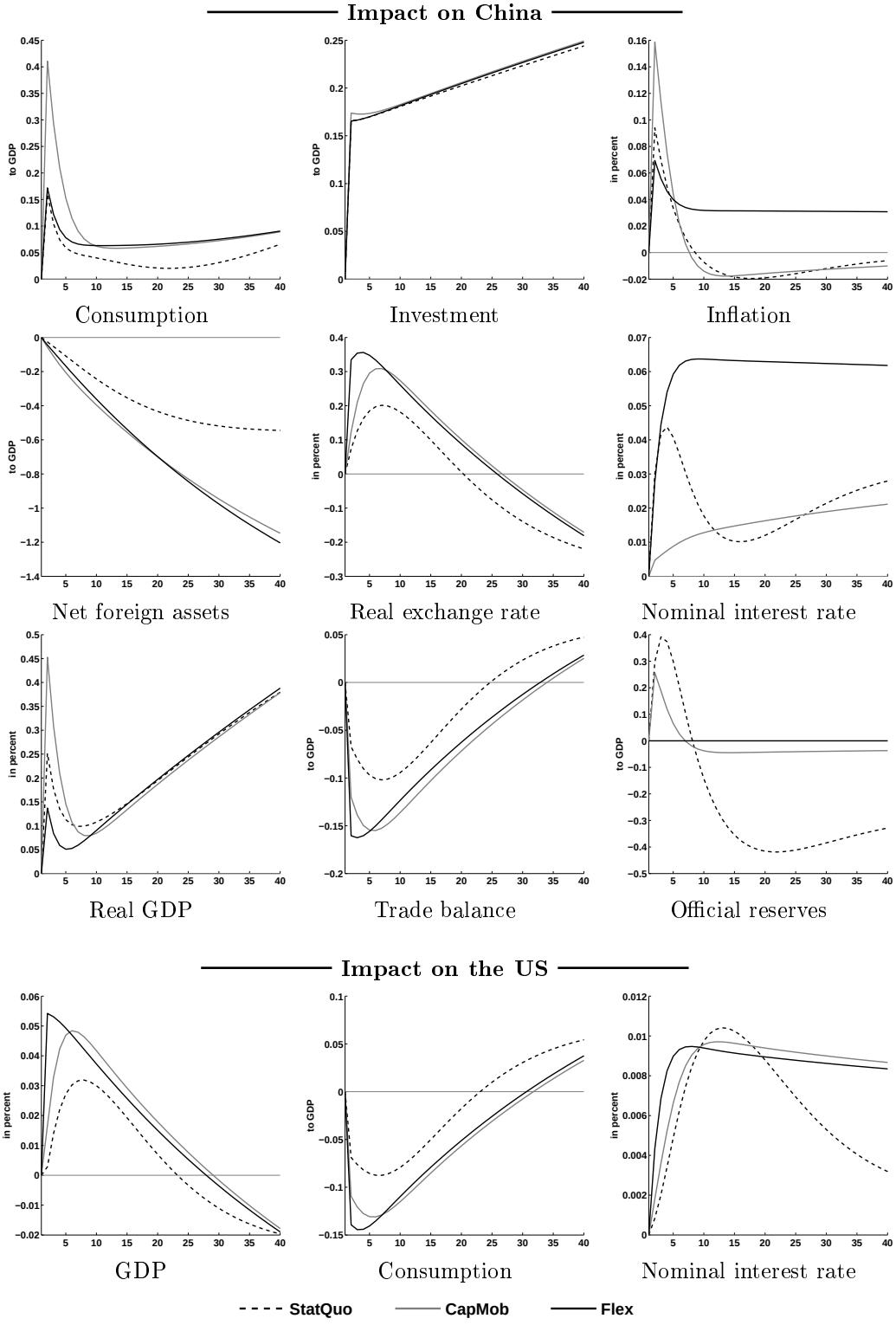

Figure B.1: financial liberalization

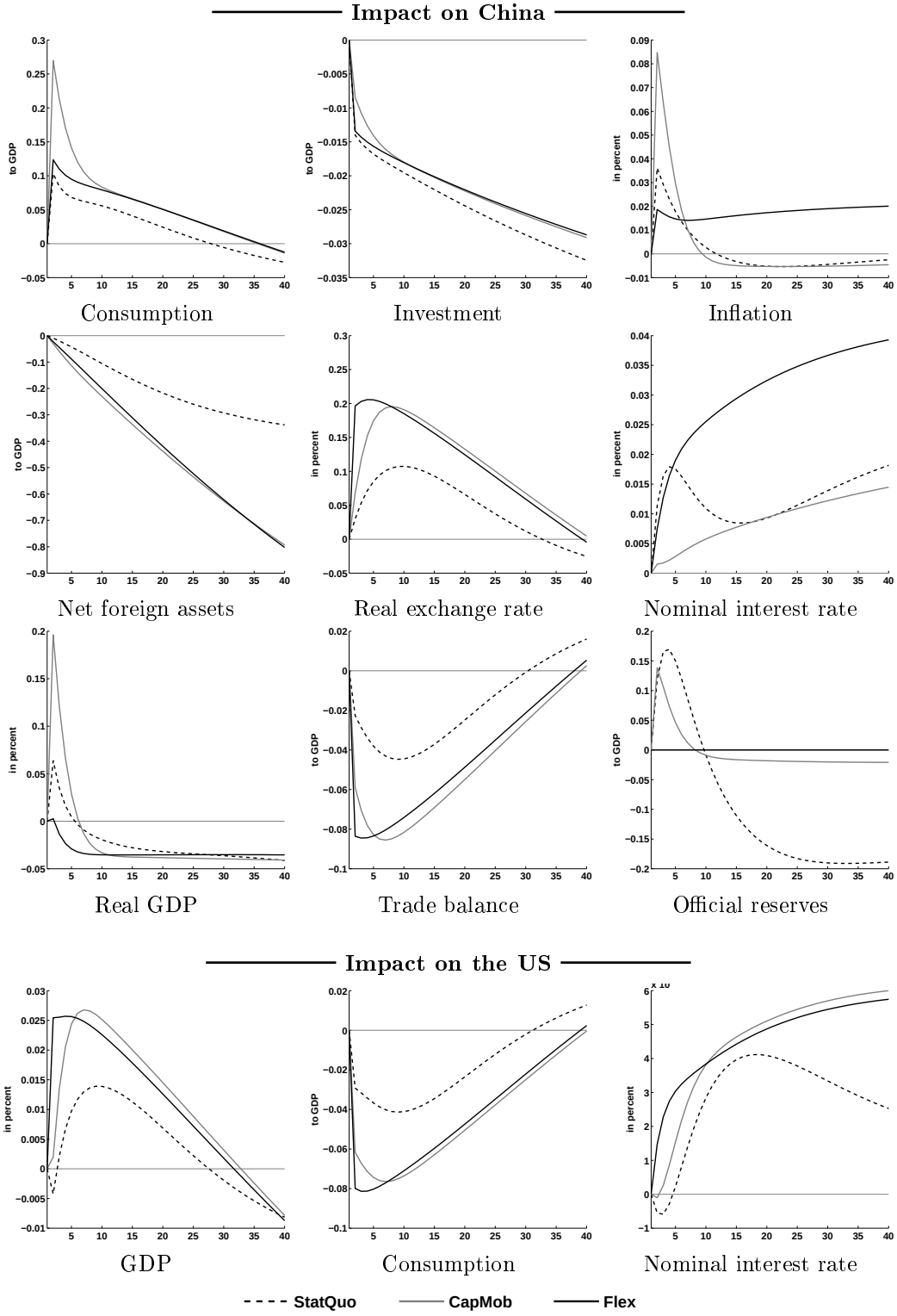

Figure B.2: Government reform

C Robustness of the model

We now test the robustness of our model by changing some parameters. To do so, we simulate the pension reform shock with three different sets of parameters, successively, and compare these simulations with the "StatQuo" simulation of Section 4.

Elasticity of labor supply. First, we change κ (the share of leisure in utility, see Equation (1)) from 0.3 to 0.2. According to the labor supply (Equation (12)) the elasticity of labor supply to wage is given by:

$$\epsilon_{L_t,W_t} = \frac{\kappa}{1-\kappa}\frac{C_t}{MRS_t L_t}$$

Thus, an increase in κ involve a decrease in the elasticity of labor supply. As we can see in Figure C.3, the increase in the real wage involve a less important increase of the labor supply in the case where κ is greater, but the differences remain limited.

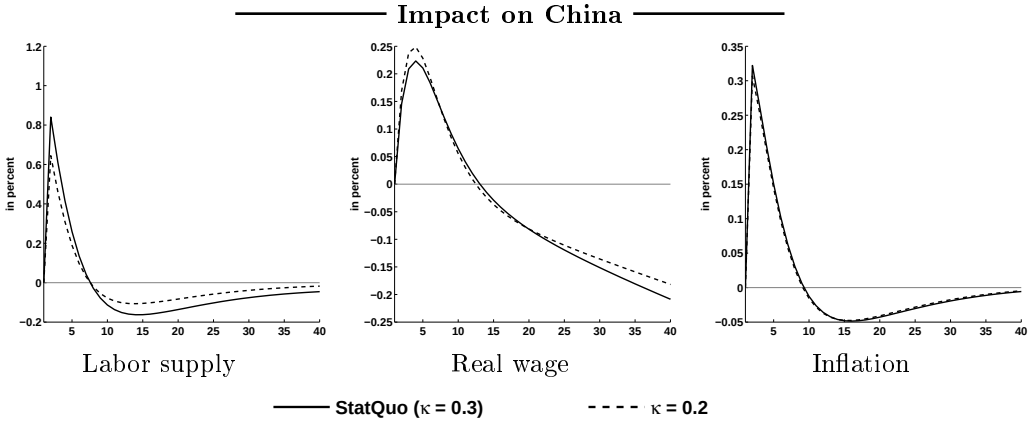

Figure C.3: Change of the elasticity of labor supply

Elasticity of substitution between goods. The calibrated elasticity of substitution between goods produced in China and goods produced in the US (ϕ) is set to 2. Figure C.4 shows the impact of changing this parameter to 5.
A rise in this parameter (both in China and USA) involves more competition between goods of the two countries. Thus, the pension reform shock involves a larger decrease in China's trade balance and a more limited real appreciation of the renminbi.

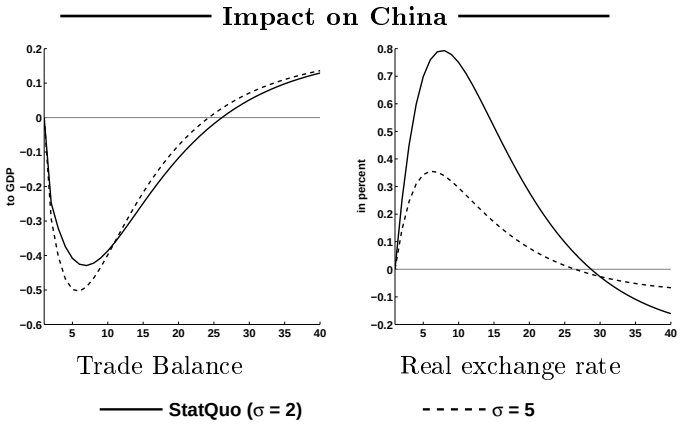

Figure C.4: Change of the Elasticity of substitution of goods

Share of imports in consumption The calibrated trade openness of the US and China is set to 10%. Figure C.5 shows the impact of changing this parameter to 20%. The pension reform has now more limited impact on the real exchange rate and on the export level, but the results are qualitatively unchanged.

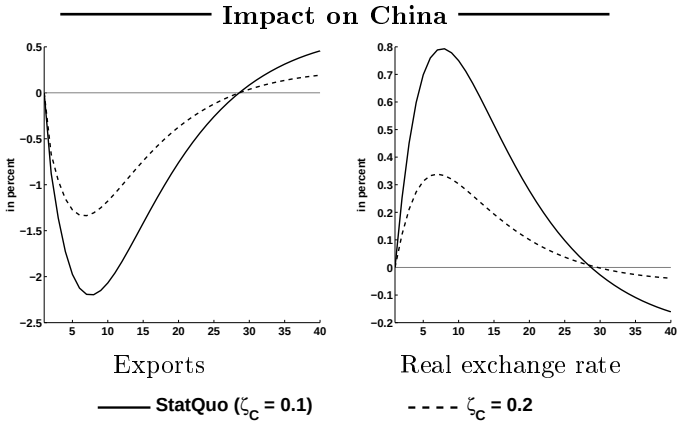

Figure C.5: Change of the share of imports in consumption