Rebalancing through expenditure and price changes

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Abstract

This paper puts forth a Neo-Kaleckian open economy model of two countries in order to investigate adjustment of US-China external imbalances. First, a stylized fixed mark-up model is presented, and discussed based on graphical analysis. Second, we present estimates of bilateral income and price elasticities of imports. Third, we employ the model for simulation analysis. Specifically, we randomly distribute expenditure change across government, investment and imports and calculate the exchange rate change necessary to lead to an equal change in the bilateral external imbalance. Doing so repeatedly allows to estimate probability distributions of endogenous variable changes.

Keywords: Neo-Kaleckian model of demand and distribution, global imbalances, simulations

JEL codes: C2, C68, E12, E27, F32, F47

Introduction

Global imbalances, and specifically the large and persistent external deficit of the US on the one side and the large and persistent surplus of China on the other, have played a prominent role in the analysis of the *Great Recession*. Many—and certainly the deficit countries—believe that a reduction of imbalances should be part of a sustainable recovery. How can imbalances be reduced? And, can imbalances be reduced without a global contraction?[1]

In a Keynesian model of the real side with demand-driven output and prices anchored by costs, adjustment of an external deficit must be driven by changes of nominal rates of exchange and domestic demand, and the resulting change in exports and imports, respectively. Either required change can be quite sizable; in other words, the output contraction required for external adjustment under a fixed nominal exchange rate regime is large. Similarly, the nominal devaluation required to force external balance with endogenous incomes can be large.

This paper investigates both issues in combination. In a demand-driven model, correction of imbalances must involve an increase in expenditures in the surplus country and a decrease in expenditures in the deficit country. Suppose that these expenditure changes are of equal size in both countries. Will then the bilateral imbalance be reduced by the same amount? With a fixed nominal

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[1] We will not review the literature on causes of global imbalances. See, for example, Eichengreen (2006), Ocampo (2007) and Vasudevan (2010).

exchange rate and an import propensity less than unity, the answer must be no.[2] Hence, the questions this paper asks are

(1) *what real exchange depreciation is necessary for expenditure decrease in US and increase in China to lead to adjustment of the bilateral external imbalance by the same amount*, and,
(2) *how large the accompanying output changes are*.

Three different sets of factors are likely to determine the answer: (1) size, structure, and trade relations of the economies under consideration, which we address by using a two country Social Accounting Matrix (SAM); (2) income and price elasticities of imports in the two countries, which we estimate for US and China; and (3) the distribution of the expenditure changes across different autonomous sources of demand, which we address with Monte Carlo simulation methods. More detail on each follows, but let us begin here with a brief exposition of the model.

A two country model

Kalecki's writings provide fertile ground for international economics, even if he often focused on closed economies. Recent decades have seen a number of important contributions to Neo-Kaleckian literature, both on closed and open economies. Early on, and in extension of the work of both Kalecki (1971) and Steindl (1952), Rowthorn (1982), Dutt (1984) and Taylor (1985) made the case for *stagnationism*—the possibility that increases in mark-ups and the concomitantly suppressed labor share of income lead to decreases in output. In other words, demand was wage-led. Bhaduri and Marglin (1990) emphasized that a modified investment demand function could, and indeed would be likely to, imply profit-led demand or *exhilarationism*.

Similarly, Blecker (1989) suggested that a wage-led demand regime would be less likely in an open economy, due to the negative impact of real unit labor costs on external demand. Blecker (1999) presents an overview of open economy modeling from a Kaleckian perspective; the following section substantially owes to that chapter. Recently, Stockhammer *et.al.* (2011) have investigated a similar model empirically.[3]

The condensed version of the model discussed in this section abstracts from the rest of the world, with which of course both US and China have important trade relations. For now, we consider only the

[2] The question can be seen through the lens of transfer theory. Assume the expenditure changes in the two countries implies a financial transfer from deficit (transferor) to surplus (transferee) country. The question then is whether the transfer will be *effected*; that is, whether the trade balance improves by exactly the amount of the expenditure change. If output is demand-determined and the exchange rate is fixed, it will always be undereffected unless it directly and sufficiently impacts autonomous expenditures on imports. A fully effected transfer implies that the transferor country finances the expenditure change with increased net export earnings. Since import propensities are much smaller than unity, the endogenous import changes following income changes can not be sufficient to that end. If, however, the transfer to a significant part directly affects autonomous import demands—which add to the endogenous trade changes—the transfer can be effected, and can even be overeffected. See Johnson (1956) for a relevant discussion.

[3] Other papers have focussed on cyclical as well as financial issues. Here, we will do neither—the model is presented purely in terms of (real) flows. Moreover, the model is not scaled by the capital stock, and concerns only the medium run. It follows that the rate of utilization is endogenous, but does not have to be in the long period. For an early contribution to that debate, see Auerbach and Skott (1988).

home country, and variables of the foreign country are primed.[4] The price of supply P is an index of import and domestic factor costs. The index of domestic factor costs P_y is a mark-up on domestic nominal unit labor costs,

$$P_y = (1+\tau)w/\xi, \tag{1}$$

where the mark-up rate is $\tau = \pi/(1-\pi)$ and $\pi = 1-\psi = 1-wL/P_yY = 1-\omega/\xi$ the profit share (and ψ the wage share); $\omega = w/P_y$ the real (product) wage and $\xi = Y/L$ average labor productivity. Throughout the paper, it will be assumed that the nominal wage w as well as labor productivity ξ are exogenous. Further, the mark-up rate τ is constant, so that prices P, P_y are fixed, but change with shocks to τ, w, ξ and of course the nominal exchange rate e; $\rho = eP'/P$ is the real exchange rate. The nominal exchange rate e is quoted as the domestic currency price of one unit of foreign currency.

Output is demand-determined. Labor markets do not clear, and with constant productivity and a linear technology, labor demand follows. The components of aggregate demand are consumption C, exogenous government expenditure G, investment I and net exports. Domestic sources of demand can be written as

$$C = (1-s[\psi]-t)Y \tag{2}$$

$$I = I[Y,\psi] \tag{3}$$

where $s[\psi]$ represents the savings function with $\partial s/\partial\psi < 0$, and $I[Y,\psi]$ the investment function with the distributive and output variable as independent arguments.

Imports of the home country are of course exports of the foreign country, and vice versa. Net exports of the home country can then be written as

$$NX = M'[Y',\rho] - \rho M[Y,\rho], \tag{4}$$

where $\partial M/\partial\rho < 0$ but $\partial M'/\partial\rho > 0$—meaning a rise in ρ, which is equivalent to a real depreciation (appreciation) at home (abroad), decreases (increases) real imports. The standard Neo-Kaleckian result applies: redistribution towards workers increases demand through the consumption channel, but decreases demand both through investment and net export channels. Which effects dominate determines the demand regime to be wage-led or profit-led.

However, the focus here shall be on the two country demand interactions with a given mark-up (and, hence, a given functional distribution of income).[5] In order to highlight the interdependence of demands, a two country model can be represented in *income-income* space. The graph is much the same as in Blecker (1999), just that the discussion there centers on home versus foreign *profits*. To focus

[4] An appendix details the equations of the full model, with the US, China and the rest of the world indexed country 1, 2 and 3, respectively. Table 5 shows a symbolic Social Accounting Matrix (discussed as well further below), which might be helpful to quickly illustrate the accounting of the model.

[5] The model is fairly straightforward, and to save space we leave a brief discussion of stability for the appendix. Here, it might suffice to say that the model is dynamically stable if both countries have positive multipliers in isolation; this result is unaffected when output prices are taken into account, since mark-up, nominal wage and labor productivity are constant.

on what matters, prices and distributive variables are assumed fixed.

Panel (a) of Figure 1 is drawn with two identical countries initially in trade balance. The foreign country's real income Y' is denoted on the horizontal axis, the home country's real income Y on the vertical axis. The home income schedule has a positive intercept—effective demand autonomous of the foreign country's income. The slope is the product of the foreign import propensity and the home multiplier. The foreign income schedule's slope is the inverse of the analogous product. The dashed line $B = 0$ shows the combinations of home and foreign demands that correspond with balanced trade, given relative prices. For two identical countries in trade balance, $B = 0$ begins at the origin and has a slope of unity. Given Y' and the real exchange rate, any point above $B = 0$ coincides with a home deficit, any point below with a home surplus: the points above $B = 0$ imply higher home imports.

Figures 1 & 2 about here

Panel (b) of Figure 1 shows a real depreciation of home currency, which of course could emanate from a wage, price or distributive shock. The home income schedule shifts up, the foreign income schedule shifts left. The *net* demand effect of the real depreciation on home income is positive; in other words, the external demand response to the relative price change and the internal investment response to the implied distributive change are larger than the internal consumption demand response. The same story applies to the foreign country, with the inverse sign. Further, as drawn, upward shift of home and leftward shift of foreign are large enough in combination to render the depreciation conflictual.

The balanced trade line completes the picture. It shifts up and rotates clockwise, since at the new relative prices only substantially higher home income, and the implied higher imports, can balance trade. As drawn, the upward shift moves $B = 0$ beyond the new intersection of Y and Y', so that the home country now generates an external surplus.

Connecting the initial and new equilibrium signifies the often conflictual nature of international competition. Price and distributive changes benefit one country, and cost the other. In contrast, connecting the initial equilibrium and the potential new balanced trade equilibrium exemplifies how international policy coordination can buffer such conflict: A domestic demand expansion at home would shift the home income schedule up further, increase import demand, and lessen the trade off between home and foreign income and employment.

The two panels of Figure 2 are drawn with US-China imbalances in mind. In panel (a), the dotted balanced-trade line $B = 0$ has a negative intercept and slope less than unity—the former due to the US deficit vis-a-vis China, and the latter due to the larger US import propensity. The initial equilibrium is to the left of $B = 0$, signifying the US deficit, and the fact that a rightward shift of Y' and the associated higher imports could balance trade, given the real exchange rate.

Now suppose the US dollar depreciates. As in Figure 1, the US's income schedule shifts up, and China's shifts left. The depreciation shifts the dotted balanced trade line up, and rotates it clockwise. As drawn, and not unlikely, the new intersection of the two income schedules remains left of the new dotted line $B = 0$: the net export response to the depreciation improves, but does not overcome the sizable bilateral deficit.

An oft-discussed solution is to increase savings in the US. One way to do that is to decrease the budget deficit. The small dotted line suggests how that might play out. A decrease in US government expenditures leads to a downward shift of the US's along China's income schedule, possibly down to the new balanced trade line. Adjustment then has been brought about by a global recession.

Finally, panel (b) of Figure 2 considers expenditure shifts. Let us distinguish between the solid initial income schedules, the dotted intermediate and the final thicker schedules. As in panel (a), the US is initially in deficit. Suppose now that expenditures are shifted from the US to China; in other words, US overall expenditures fall, and Chinese expenditures rise. As drawn, the US is still in deficit at the new intersection of the dotted lines. As mentioned before, unless significant parts of the expenditure shift directly affect autonomous expenditures on foreign products, this is the only possible outcome in a demand-driven world; and the size of the remaining deficit would be especially pronounced between the US and China, given their relatively small import propensities.

What depreciation is necessary for the expenditure change to lead to a reduction of the bilateral imbalance by the same amount? Below, simulations are employed to give a rough answer to this question. Here, panel (b) shows the direction of required changes. After the depreciation, a new balanced trade equilibrium could exist at the intersection of the thick income lines, and the shifted line $B = 0$. As drawn, the contraction of income in the US is not avoided, but it could be buffered; and the appreciation-induced downturn in China might be avoided.

Bilateral trade elasticities

This section presents empirical estimates for bilateral trade elasticities. The following three equations are estimated:

$$\ln(tb_t) = \gamma_0 + \gamma_1 \ln(y_t) + \gamma_2 \ln(y_t^*) + \gamma_3 \ln(\rho_t) + \varepsilon_{1t} \quad (5)$$

$$\ln(im_t) = \beta_0 + \beta_1 \ln(y_t) + \beta_2 \ln(\rho_t) + \varepsilon_{2t} \quad (6)$$

$$\ln(ex_t) = \alpha_0 + \alpha_1 \ln(y_t^*) + \alpha_2 \ln(\rho_t) + \varepsilon_{3t} \quad (7)$$

In equation (5), tb is the ratio of US real exports to China over imports of the US from China; y is real income of US, y^* is real income of China and ρ is the real exchange rate. Similarly, in equation (6) and (7), im, ex denote real imports of US from China and real exports of US to China, respectively. All variables are expressed in logarithmic form. Higher domestic income leads to higher demand for imports and hence lower the trade balance and therefore we expect that that $\gamma_1 < 0, \beta_1 > 0$. However, with higher foreign income the trade balance improves due to high demand for domestic exports; hence $\gamma_2 > 0, \alpha_1 > 0$ are expected. In addition, an increase of the real exchange rate (real depreciation of US currency) is expected to increase the demand for exports and decrease the demand for imports. Quarterly data over the period 1986:01 to 2011:01 were used to estimate the above equation.[6] In the

[6] US goods exports and imports to and from China are from US Census Bureau. Unit value index of exports and imports of US (Base: 2005=100) is used to deflate export and import series. Seasonally adjusted quarterly GDP (Base: 2005=100) is used

following paragraphs, we describe both ARDL bound testing and Johansen cointegration test to estimate the above equations.

The ARDL bound testing approach to cointegration

We use Auto Regressive Distributed Lag (ARDL) cointegration procedure developed by Pesaran and Shin (1999) and Pesaran *et.al.* (2001). The main advantage of this method is that this test can be applied irrespective of whether variables in the model are purely I(0) or purely I(1).[7] The error correction model of the ARDL model pertaining to the trade balance is

$$\Delta \ln(tb_t) = \alpha_0 + \lambda_1 \ln(tb_{t-1}) + \lambda_2 \ln(y_{t-1}) + \lambda_3 \ln(y^*_{t-1}) + \lambda_4 \ln(\rho_{t-1}) + \sum_{i=1}^{p} \beta_i \Delta \ln(tb_{t-i}) + \sum_{i=1}^{p} \delta_i \Delta \ln(y_{t-i}) + \sum_{i=1}^{p} \phi_i \Delta \ln(y^*_{t-i}) + \sum_{i=1}^{p} \gamma_i \Delta \ln(\rho_{t-i}) + u_t. \quad (8)$$

Pesaran et al. (2001) propose an F-test for the joint significance of all lagged level variables. If they are all jointly significant, then there is cointegration. That is the null hypothesis $H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ is tested against an alternative of$H_0: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$. Pesaran et al. (2001) propose lower and upper critical values for the F-statistic assuming all variables are I(0) for lower bound and all variables are I(1) for upper bound. If the computed F-statistic exceeds the upper critical value, then the null of no cointegration can be rejected irrespective of the order of integration of the variables. Conversely, if the test statistic falls below the lower critical bound, then the null of no cointegration cannot be rejected. However, if the test statistic falls between the lower and upper critical values, then the result is inconclusive.

Tables 1 & 2 about here

Table 1 reports the results from F-test. Bahmani-Oskooee and Brooks (1999) showed that the results of *F*-test are sensitive to the number of lags imposed on each first difference variable and hence we carry the F-test for different lag orders, i.e. from 1 to 4, on each first differenced variable in the above three equations.[8] The results show that calculated F-statistics are greater than the upper bound critical value in all the three equations i.e. rejecting the null of no cointegration.

Having established the cointegration relationship, the next step is to estimate the long-run and short-run coefficients of the equation by using the ARDL specification. After imposing maximum of 4 lags on each first differenced variable, Schwarz lag selection criteria (SBC) choose the optimum lag as three while Akaike information criterion (AIC) chooses as four for trade balance equation. However, both criteria select optimum lag as one for imports and exports equations. The long-run and short-run estimates of three equations are given in the Table 2.

The results show that all variables exhibit the theoretically expected sign in the long-run, except

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to proxy US income (Source: Bureau of Economic Analysis). Similarly for China, GDP series is drawn from National Bureau of Statistics of China. Since quarterly GDP of China is available only from 1992 onwards, earlier data points are constructed using the GDP growth rate by Abeysinghe and Rajaguru (2004). GDP is deflated by the Consumer Price Index (Base: 2005=100) and seasonally adjusted. The real exchange rate is measured with CPI of China and CPI of USA respectively; price indexes are from International Financial Statistics (IFS).

[7] The results from ADF unit root test suggest that all variables are non-stationary, i.e. I (1), except the trade balance, which is found to be stationary.

[8] A trend term is included in import and import equations, since we find a strong trend in these series.

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for the exchange rate in the export equation. The estimated income elasticity of the US obtained from trade balance and imports equations is in the range from -2.49 to -2.99. These estimates are statistically significant. Similarly, the income elasticity for China obtained from trade balance and export equations is in the range from 0.47 to 1.4 and are statistically significant—except in the trade balance equation with lag 4. Similarly, the exchange rate elasticities obtained from trade balance equations are 1.36 to 1.55 and are as well statistically significant. Likewise the exchange rate elasticity of US imports is found to be -1.11 and statistically significant. Though the exchange rate elasticity obtained from export equation exhibits theoretically unexpected sign, it is not statistically significant. The second part of the table shows the short-run dynamics of the equation and the error correction term for all the equations are found to be statistically significant at the 1% level and has the expected sign. Based on the diagnostics statistics, it can be concluded that in the most cases the models pass all diagnostic tests, and CUSUM and CUSUMQ indicate the stability of the estimated coefficients across the same period.

Johansen's cointegration approach

If the variables in the model are non-stationary and integrated with same order then the systems method of cointegration proposed by Johansen and Juselius (1992) helps to check for long-run relationship between variables. We employ this method to estimate export and import equations since we found that the variables in these two equations are non-stationary and integrated at order one I(1). Since this technique is widely known in the literature, the methodology is not repeated here due to space limitation.[9] The trace and maximum eigen statistics for testing the rank of cointegration are shown in Table 3. The results of both test statistic provide evidence that the null of 'None' cointegrating vector can be rejected. However, both statistics could not reject the null of 'At most 1' cointegrating vector, implying that a unique cointegrating vector among three variables considered in export equation as well as import equation. Table 4 reports the implied long-run elasticities as obtained by normalizing cointegrating vector associated with exports and imports.

Tables 3 & 4 about here

The long-run estimates of imports equation show theoretically expected sign and statistically significant at 1 percent level. The estimated income elasticity and exchange rate elasticity of imports are found to be 3.09 and -1.75 which are higher than those obtained from ARDL estimation. Similarly in the case of exports, the income elasticity of China is found to be 1.21 and which is statistically significant at 1 percent level. The exchange rate elasticity is found to be -0.15 and statistically insignificant. These results are consistent with the ARDL results.

[9] This method applies the maximum likelihood procedure to determine the presence of cointegrating vectors in non-stationary time series. If cointegration is detected, then normalized cointegrating vectors provide estimates of long-run relationship. Johansen's cointegrating analysis involves estimating a Vector Error Correction Model in reduced form. Johansen has proposed two likelihood ratio statistics, the trace static and the maximum eigenvalue statistic, both of which determine the number of cointegrating vectors based on significant eigenvalues of the matrix of parameters. The trace statistic tests the null of r cointegrating vectors against the alternative of more than r cointegrating vectors, while the maximum eigen statistic tests the null of r against the alternative of exactly r + 1 cointegrating vectors. If the variables under consideration are cointegrated, i.e. the long-run relationship is established, then cointegrating vector is normalized with respect to the relevant variables.

The overall empirical results from ARDL and Johansen's cointegration tests suggest that the income elasticities of the US obtained from trade and import equations and of China from export equation are greater than unity. The implication is that US trade balance, imports and exports are income elastic. Similarly, the exchange rate elasticities of US obtained from trade balance and import equations are greater than unity, which imply that the US trade balance and imports are price elastic, whereas demand for US exports is price inelastic, since exchange rate elasticity of exports is less than unity (and the coefficient insignificant). These estimations already suggest that adjustment of US China imbalances would have to fall on US imports—either through price or income changes. Simulation results further below will add to this insight. Further, the sum of import demand and export demand price elasticities (in absolute terms) exceeds unity—Indicating that the Marshall-Lerner condition is met and devaluation of US dollar can be expected to improve the trade balance.

Data, multipliers, and repercussions

In a multi-country model with demand-determined output, demand shocks and policies in one country have an impact on aggregate demand in the other country, and vice versa. The relevant multipliers need to take repercussions between the two countries into account. How large are own-country and repercussion multipliers; or, in other words, what output changes are necessary to aid adjustment of imbalances? Quantifying multipliers of the simple two country model with fixed mark-ups sketched above will provide some rough results to this question. The data underlying the analysis in this and the following section is presented in Tables 6 and 7. To start with, Table 5 shows a one country symbolic Social Accounting Matrix (SAM), included here to collect symbols and demonstrate standard SAM features: Row and column sums are equal; rows 1 through 5 record incomes, columns A through E expenditures; row 6 reports savings of private, public and foreign sector, which is offset by capital formation in column F. See Pyatt (1988), Robinson (2003) and Taylor (2004) for standard discussions of the methodology.

Tables 5 & 6 about here

Table 6 is the corresponding two country SAM, with the rest of the world appended with its own foreign column.[10] The columns for US and China show the firm's cost decomposition, household and government expenditures, and foreign and investment account. Above the first dotted line, rows show firm revenue, and labor, capital and government income. Below, three rows in the three cost columns combine to the bilateral trade matrix. The last row, below the second dotted line, shows the flows of funds. Row-column consistency is satisfied; in order to save space, the household's column corresponds to wage and profit income, and the foreign account's column total equals the sum of imports across origins.

Table 7 gives more detail. The upper part shows bilateral trade flows and balances between US, China and the rest of the world (ROW) in 2008bn USD. The US's deficit with China amounts to 268bn

[10] The SAM underlying the model is an aggregated version of the SAM used in von Arnim (2010). The raw data stems from a number of sources, including UN SNA, BEA, IMF Direction of Trade Statistics (DOTS) and IMF International Financial Statistics, (IFS). Functional distribution of income for China is taken from Rada (2010).

USD, which is equivalent to about 1.9 per cent of US GDP; the overall US external deficit in 2008 was about five per cent of GDP. The matrix of import propensities are recorded in percentage points on the bottom left—and are, with 2.4 (US imports from China relative to US GDP) and 1.5 (China's imports from US relative to China's GDP), not very large.

Next, public, private and foreign macroeconomic balances relative to GDP show the typical characteristics. The external deficit country has to run a corresponding domestic deficit, either in the public or private sector. The numbers here mask important differences between US corporate and household sectors, since the former has been in surplus for a while, and the latter accumulating large amounts of debt. In that sense, the *twin* that matches the foreign world's surplus has been the private deficit in the US.

Tables 7 & 8 about here

Lastly, on the bottom right, Table 7 shows the multiplier matrix. The appendix briefly details derivation. The US's own multiplier is 2.74, and China's 2.02. A unit increase of autonomous demand in the US leads to an increase of 2.74 units of US GDP, but furthermore 0.13 units of China's GDP. Analogously, a unit increase of autonomous demand in China increases US GDP by 0.08 units. These *small* repercussions suggest that expenditure changes will not only be undereffected, but can not contribute hugely to rebalancing.

Simulations

How then can rebalancing occur? This section presents simulation results. Before delving into things, we should briefly comment on the calibration. First, since the price-distributive system is "passive" with a fixed mark-up and fixed nominal wage, the set of behavioral parameters is limited to investment, savings and trade function. The domestic demand regime is calibrated to be wage-led. It seems appropriate to presume wage-led demand in current conditions. Demand will tend to be profit-led, if "costs weigh heavily on firm's minds"—i.e., when the *positive* impact of reduced real unit labor costs on investment is sizable, relative to the *negative* impact of lower consumption demand on investment. High unemployment and stagnating wages suggests that cost factors are less important; slow growth suggests, on the other hand, that investment is demand constrained. Further, available cash flow and government policies have supported corporate and especially financial sector balance sheets, but households are still and will be for a while in the process of deleveraging—higher real wages would ease the pressure, and provide stimulus to demand. (That such increases in real wages are quite unlikely is certainly part of the dire predicament the US finds herself in.) Second, for a 'baseline' configuration (shown in Table 8) the trade functions are calibrated to the estimated elasticities discussed previously.[11] We do, however, vary trade elasticities to conduct sensitivity analysis. More on

[11] The focus of the simulations is on the trade linkages and trade elasticities. As can be seen in Table 8, the distributive-demand calibration is chosen with equal parameters in both countries. That is not to argue that this must be the case, but in order to choose parameter values that are plausible, and broadly supported by empirical estimates. Importantly, while the savings differential is assumed to be the same, the aggregate private savings propensity differs drastically. The (gross) aggregate savings propensity is 14% in the US, but 50% in China; see the flows of funds row (FOF) in Table 6.

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that in a moment.

A first illustrative set of simulations

Table 9 presents a few selected simulations, mainly to illustrate the model and simulation strategy. To motivate these, we have to consider two different *closures* for international accounts.

The first *standard closure* implies three endogenous trade balances and three exogenous exchange rates, i.e. $e_{12} = 1, e_{13} = 1$ and $e_{23} = e_{13}/e_{12}$. Simulations 1-6 are subject to this closure, and are included to provide some insight on how the model works. The second closure takes the bilateral trade balance between US and China as *exogenous*, and the bilateral US-China exchange rate as endogenous. For this *adjustment closure* we can exogenously reduce the trade balance and solve for the exchange rate change necessary to bring that about. We discuss each in more detail:

Simulations 1 through 4 demonstrate, first, the character of economic links between the US and China. An investment shock in the US has a very small impact in China. Second, real US dollar depreciation does little for rebalancing by itself. Comparing simulation 2 and 4, it becomes clear that a US wage increase is expansionary, but so is the depreciation. This result depends, as so many things in these numerical results, on the strength of the links between the US and China. Since exports and imports to and from the rest of the worlds are not price responsive, the overall effect of the wage increase on external competitiveness is limited. Similarly, a nominal wage increase in China (simulation 3) is expansionary in the US, and contractionary in China due to the real appreciation and induced net export changes.

Simulation 5 demonstrates that an expenditure increase in the US and an expenditure decrease in China—as expected—does not trigger a reduction of the bilateral imbalance by the same amount. A reduction of government expenditures in the US by the full amount of the bilateral trade deficit and a simultaneous increase of government expenditures in China by that same amount leads to sharp contraction in the US and expansion in China. The size of the shock represents about 1.8 per cent of GDP in the US, and about 5 per cent in China. Next, simulation 6 shows a trade shift of the amount of B_{12}, equivalent to $134bn—trade shift meaning that the full amount of the expenditure change falls on autonomous imports. As would be expected, this type of expenditure change leads to a US surplus vis-a-vis China.

Last but not least, simulations 7 and 8—emphasized in bold—show the real US dollar depreciation necessary to reduce the bilateral trade deficit by the same amount as the expenditure changes. B_{12} is halved (so that column 4 varies slightly depending on what the denominator does). For 7, only B_{12} is shocked. Simulation 8 includes a public expenditure change by the same amount. Several results stand out. Due to the relatively weak linkages between the two economies, US dollar real depreciation against China's currency is sizable. Correspondingly, the overall improvement in the US's trade balance is limited, and so is the overall real depreciation of the US dollar. Lastly, and importantly, bilateral depreciation in combination with the expenditure shift does reduce the bilateral trade balance, and *does not necessarily require a recession in either country*; see simulation 8.

Further simulations: Monte Carlo

The key weakness of the calculations made in the previous section is that nobody knows where the expenditure shift might originate—presuming, of course, that it does in the first place. This section attempts to alleviate this problem through the application of *Monte Carlo* simulation methods. For a Monte Carlo simulation, a model is repeatedly solved—but each time with a changed parameter, initial condition or otherwise relevant exogenous input.

Here, we randomly distribute the expenditure shock of half the bilateral US-China imbalance, or $134bn, across government expenditures and the autonomous components of investment and import demand. (Table 10 gives an indication of the involved magnitudes.) Across these three demand components, shares of the total shock must add to one. Hence, we (1) randomly pick two of the three autonomous demands, (2) assign random share values between 1/5 and 1/2, and (3) calculate the remainder to one for the last item. The procedure is repeated 500 times; and the model then solved 500 times with these varying distributions of the expenditure shock. Panel (a) of Figure 3 shows the resulting probability distributions.[12]

Figures 3 & 4 about here

First, the top left distributions of Panel 3 (a) show that about a 15% to 20% real deprecation of USD is necessary to reduce the US trade deficit. The higher the US income elasticity of import demand, the higher is the required depreciation—since increased income from exports would then lead to a surge of imports. Overall, however, the magnitude of the US income elasticity of import demand has limited effect on the location of the distribution of required exchange rate changes.

Second, the top right panel shows that the US price elasticity of import demand has a significant impact on required depreciation. This appears to be the case especially when the price elasticity is relatively weak. In contrast, the bottom left panel of Figure 3 shows that China's price elasticity of import demand has no significant impact on required depreciation. Similarly—and for the sake of brevity the graph is not included—China's income elasticity of import demand does not have a strong impact on mean or variance of the resulting distribution.

Lastly, the bottom right shows probability distributions for growth in both countries. As can be seen, the US has on average positive growth (and some inflation), whereas China has on average negative growth (and some deflation).[13] What drives this growth pattern? The reason must be seen in the relative size of the two economies and the particular trade links they have. In the simulation, the forcibly reduced bilateral balance requires a net export increase for the US and a net export decrease for China. The average net trade shock implies, however, a much larger negative (positive) change relative to base year levels of demand for China (than for the US). This negative (positive) change outweighs the domestic demand changes in China (US).

[12] The probability distribution functions are estimated with a (normal) Kernel Density Estimation (KDE) procedure. The bandwidth is chosen *ad hoc*, such that tails of the distributions are not "too far" from the lower and upper limits of the sample data.

[13] The inflation statistics are probably of less concern. The key issue is that inflation in both countries is "imported," since all other items in the cost decomposition are held constant.

This result depends on the simulation structure, which assigns a significant amount of the expenditure change to fall on trade. Panel (b) of Figure 3 summarizes an additional set of simulations. The only difference to those presented in Figure 3 is that *the shock to autonomous import demand in both countries is limited to not more than ten per cent of the total expenditure change*. As can be seen, the required depreciation is on average larger. Correspondingly, growth in China (as in the US) is on average positive.

To further illustrate the structure of adjustment, Figure 4 considers two more cases. Panel (a) of Figure 4 considers an "incomplete adjustment." Specifically, the shock applied includes the reduction of the bilateral trade balance by ½, and the increase of expenditures in China by the same amount—but not reduction of US expenditures. Panel (b) of Figure 4 applies the reduction of the bilateral trade balance by ½, and the decrease of expenditures in the US by the same amount—but not increase of China's expenditures. (In both cases, the trade shock is limited to 10% of the total expenditure change.) The results complement those of Figure 3: In all cases, the US benefits through the assumed increase in net exports, but the structural relationship of the two countries can easily generate adverse affects in China.

Discussion

In summary:

- *First*, the particular required depreciation in any simulation is driven overwhelmingly by the share of the expenditure change that falls on autonomous imports: the higher this share, the lower the required real depreciation. This is not surprising, but indeed expected.
- *Second*, however, if a relatively large (small) share falls on trade, China will tend to experience contraction (expansion), while the US experiences an expansion with large and small trade shifts. This result appears to depend on the structural trade relationship between the two countries.
- *Third*, particular trade elasticities have overall limited effect on required depreciation, with the exception of the US price elasticity of import demand. A relatively low US price elasticity of import demand significantly increases required US real depreciation—the reason is simply that the vast majority of endogenous trade changes must fall on US imports.
- *Fourth,* in these scenarios, expenditure increase in China is vastly more important to buffer contraction than expenditure decrease in the US.

One can consider the question whether this last (fourth) change is in fact being enacted; simply through faster growth in China, and relative contraction in the US. As China's economy matures and moves away from the heavily export-led growth model, the bilateral trade elasticity might rise, and the exchange rate would 'naturally' appreciate. Further, why would anyone assume the simulated shifts in demand patterns to occur? In fact, such occurrence could be considered unlikely, if only because the US and China are intertwined in a complex transnational global production network. The analysis here thus brushes over all sectoral issues, which are arguably of great importance. Indeed, China's low bilateral price elasticity of import demand suggests that imports are largely intermediate capital goods.

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Moreover, past investments in manufacturing capacity might necessitate a relatively stable exchange rate to protect profit margins of both national and foreign investors for some time to come. In summary, the particular structural economic relationship between the two countries and its impact on trade, the bilateral trade elasticities and exchange rates consistent with profitability of existing capacity *necessitates a gradual and slow adjustment*. Adjustment, in fact, requires structural change in both countries, and thus cannot play out in the short run. (Randomly distributing these structural demand shifts across sources of demand tries to capture this issue.) Still, relevant policy changes include a shift towards tradeable production in the US, and a shift towards non-tradeable production in China. The former could come with a shrinking FIRE-sector in the US and renewed attention to manufacturing,[14] the latter with development of a social safety net in China—for example.

The analysis brushes as well over all issues monetary. The US issues reserve currency and assets to the global economy, which necessitates US deficits for credit and demand creation globally. The implications, most simplified, appear to be two-fold: Suppose, for the sake of the argument, that the US-China imbalance were to be slowly reduced due to the expenditure, price and structural changes as discussed above; but that the international financial architecture remains unchanged. Then global growth would necessitate a US deficit with a different country (or region). Second, though, assume that the international financial architecture is reformed, in such a way as to change global supply of and demand for reserves, as well as their patterns of "recycling." Then, possibly, US-China adjustment could come about without pressure for a new US deficit to emerge.[15] Only a different—stock-flow consistent, financial—model can deal with such questions, and we believe that they should be addressed. But for our purposes here, we argue in favor of a sharp *Occam's Razor*. The model used here treats the US just like "any other country"—not to suggest that that is what it is, but as an abstraction. Since, in the end, whatever monetary matters materialize, they cannot possibly obviate the fact that adjustment of imbalances in a demand-driven world would require expenditure and relative price changes.

Broadly, our results are in line with other studies—while using a quite different approach. First, empirical studies indicate that the Chinese currency is undervalued between 30% and 50% against the US Dollar (Groenewold and He (2007), Wren-Lewis (2004)). Presumably, these estimates suggest that a 50% of depreciation of US Dollar is required for reducing imbalances. However, depreciation of US currency leads to expansion in the deficit country (US) and contraction in the surplus country (China). Chinn (2004) also argued that the depreciation of US Dollar would have limited scope to increase US net exports. Hence it is necessary to have a realignment of growth trends, i.e., lower US income growth or accelerated foreign income growth—a point previously emphasized by Obstfeld and Rogoff (2005). They argued that reduction of the current account imbalance to a sustainable magnitude would require not just US Dollar depreciation but also a change in the level of expenditures. Unlike any of these studies, we propose a policy mix with expenditure changing and switching policies, *based on a full*

[14] FIRE: Finance, Insurance, Real Estate.

[15] The global supply of reserves could be affected through emergence of new currencies, including the Euro and a (fully convertible) Yuan; the global demand for reserves could be affected through reduced necessity for emerging market countries to "self-insure" against balance of payments crises and resulting IMF conditionality. Discussion of these proposals goes beyond this paper. Ocampo (2007) provides an overview.

macroeconomic (Neo-Kaleckian) model of the real side. Importantly, adjustment of imbalances does not have to place the burden on the US, the deficit country—indeed, might rather place it on China, and overall does not have to be a burden on either.

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Appendix

This appendix briefly presents the equations of the model in more detail. Here, attention is paid as well to the rest of the world (ROW), which throughout the paper has largely been ignored. Further below, we briefly comment on stability. Price and distributive equations of the US can be summarized as follows. China's equations are analogous, with the appropriate adjustments in exchange rates. The US is indexed as country 1, China as country 2, and ROW as 3. Specifically, e_{12} is the US dollar price of one unit of China's currency, e_{13} the dollar price of ROW currency. $P_3 = 1$ for simplicity. e_{23}, the Yuan price of one unit of ROW currency, follows from the ratio e_{13}/e_{12}.

$$P_1 X_1 = P_{y1} Y_1 + e_{12} P_2 M_{12} + e_{13} M_{13} \quad (5)$$

$$P_1 = (1 - m_{12}^x - m_{13}^x) P_{y1} + m_{12}^x e_{12} P_2 + m_{13}^x e_{13} \quad (6)$$

$$P_{y1} Y_1 = w_1 L_1 + r_1 P_1 K_1 \quad (7)$$

$$P_{y1} = (1 + \tau_1) w_1 / \xi_1 \quad (8)$$

$$\pi_1 = 1 - \psi_1 = r_1 P_1 K_1 / P_{y1} Y_1 = 1 - w_1 L_1 / P_{y1} Y_1 = 1 - \omega_1 / \xi_1 \quad (9)$$

$$\rho_1 = ((M_{12} + M_{21})\rho_{12} + (M_{13} + M_{31})\rho_{13}) / Trade \quad (10)$$

The domestic price P_1 of the single homogenous good is a mark—up on variable costs, and can be derived from the cost decomposition, where X_1 is real supply valued at P_1, Y_1 is real GDP valued at P_{y1}, $w_1 L_1$ is the wage bill, $r_1 P_1 K_1$ profit income, and $m_{12}^x e_{12} P_2$ are imported intermediates from China, valued at the foreign price P_2 converted into domestic currency units. Setting $m_{12}^x = M_{12}/X_1$,the price of supply is a weighted average of domestic factor and import costs. P_{y1} follows in standard fashion from the domestic factor cost decomposition, where $(1 + \tau_1) = 1/(1 - \pi_1)$ and π_1 is the capital share of gross (pre—tax) income. $\omega_1 = w_1 / P_{y1}$ is the real wage and $\xi_1 = Y_1 / L_1$ labor productivity. Lastly, the US real exchange rate is a trade—weighted index of the bilateral exchange rates with China and the rest of the world.

Demand equations can be summarized as follows. For brevity, these domestic demand equations are not indexed by country.

$$I = \alpha + \beta\pi + \gamma Y \quad (11)$$

$$S = s(P_y/P)Y = \big(s_\pi - (s_\pi - s_\psi)\psi\big)(P_y/P)Y \quad (12)$$

$$C = (1 - s_\pi - t_\pi)\pi(P_y/P)Y + (1 - s_\psi - t_\psi)\psi(P_y/P)Y \quad (13)$$

$$T = t(P_y/P)Y = \big(t_\pi - (t_\pi - t_\psi)\psi\big)(P_y/P)Y \quad (14)$$

The flow of investment is a positive function of profits and real income, where α represents autonomous investment driven by *animal spirits*, and all other notation is as in the main text. Distribution enters as well on the side of private leakage; where s_π and s_ψ are the savings propensities of profit and wage earning households. In a one—sector model, real consumption follows from the income constraint of both wage earning and profit earning households, where nominal income

P_yY is deflated by the supply (or consumption) price P. The public (primary) balance is the difference between receipts and expenditures. Expenditures are exogenous policy variable, and with only income taxes included in the model, real tax receipts can be written analogously to the savings function. Assuming that both profit receiving households have a higher propensity to save and are taxed at a higher rate, savings and taxes responds negatively to redistribution towards workers, increasing the multiplier.

Exports and imports are functions of relative prices $\rho = eP'/P$ and demand Y, Y'. The home country's exports are of course the foreign country's imports, and vice versa. For brevity, only US's and China's bilateral import functions are listed. Imports from ROW are functions of US and Chinese demand, and exports from these countries to ROW are exogenous.

$$M_{12} = m_{12}^0 - \delta_{12}\rho + m_{12}Y_1 \qquad (15)$$

$$M_{21} = m_{21}^0 + \delta_{21}\rho + m_{21}Y_2 \qquad (16)$$

The income—expenditure identities for the US and China give two implicit functions,

$$Y_i - \left(C_i + I_i + G_i + \sum_{j,j\neq i}^{3} M_{ji} - \rho_{ij}M_{ij}\right) = 0. \qquad (21)$$

The partial derivative of these with respect to the incomes Y_i gives a matrix J. J's main diagonal contains the inverse of the own-country multipliers; the off-diagonal items the negative of the product of bilateral import propensities and real exchange rates. Since J is non-singular, the inverse exists, and

$$dY = J^{-1}dD, \qquad (22)$$

collects all multipliers, with dY a vector of incomes and dD a vector of autonomous demand changes. The bottom right of Table 3 is J^{-1} in equation (22). Further, letting the time derivative of incomes Y_i respond to excess demands, the fixed-price model will be dynamically stable if the leading principal minors of the matrix $-J$ alternate in sign, beginning with minus. In the $2x2$ case, this is equivalent to the negative of the denominator of the US own-country multiplier, and the determinant of $-J$. Put more simply, the model is stable if both countries have positive multipliers in isolation. For a detailed discussion, see, for example, Gandolfo (2010), chapter 18.

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Tables and Figures

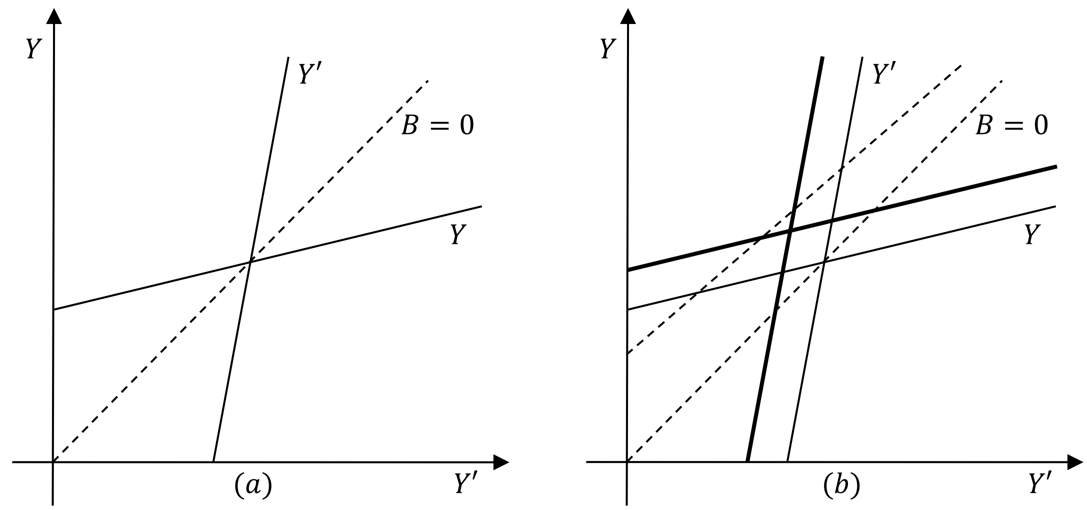

Figure 1: Panel (a) shows interdependent home and foreign income of two identical countries initially in trade balance. Panel (b) shows income changes after a depreciation of home currency. Home income schedule shifts up, foreign income schedule shifts left, and the balanced trade line shifts up and rotates right. As drawn, the home country now has a trade surplus, and trade is conflictual. (Note that the slope of the income lines change as well with a change in the real exchange rate.)

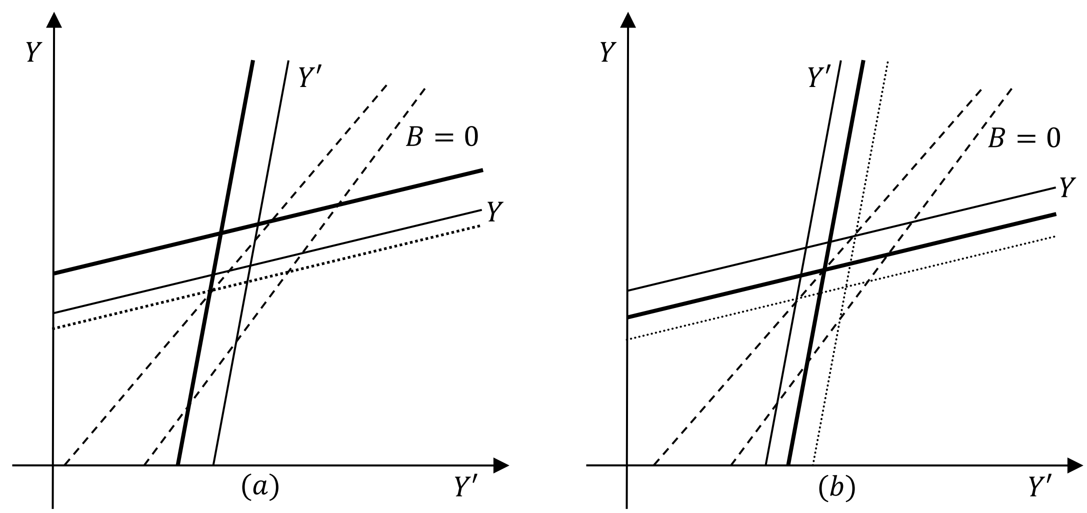

Figure 2: Here, home and foreign country differ. The home country has initially a trade deficit. Panel (a) shows the effects of a depreciation: upward shift of home, leftward shift of foreign, and upward shift (and rotation) of $B = 0$. The depreciation is, however, insufficient to produce balanced trade. A home domestic demand contraction, shown by the dotted bold line, could do that, but at the cost of a recession at home and abroad. Panel (b) shows the result of an expenditure change in combination with depreciation: expenditures decrease at home and increase abroad, but the home country remains in deficit.

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Lag length	1	2	3	4
Trade balance equation	6.81**	7.82**	7.71**	7.32**
Import equation	7.11**	7.23**	8.28**	8.72**
Export equation	16.85**	19.72**	21.23**	19.7**

Table 1: The results of the F-test for cointegration among variables. Note: For trade balance equation, the critical bounds of the F statistic with constant are 3.23-4.35 at 5% level, whereas for imports and exports equation, the F statistic with constant and trend are 4.87-5.85; and ** denotes statistically significant at 5 percent level.

	Trade balance		Imports	Exports
	Long-run equation			
	Lag3	**Lag4**	**Lag1**	**Lag1**
	SBC-ARDL [1,0,3,0]	AIC-ARDL [4,0,3,0]	SBC-ARDL [1,0,0]	SBC-ARDL [1,1,0]
Constant	35.78 [4.98]*	35.59 [2.02]**	-30.11[-2.04]**	-12.9[-2.89]*
$Ln(y)$	-2.83 [-4.04]*	-2.99 [-2.79]*	2.49 [2.40]**	
$Ln(y^*)$	0.47 [2.37]**	0.62 [1.26]		1.44[4.60]*
$Ln(rer)$	1.36 [4.64]*	1.55 [2.13]**	-1.11[-3.66]*	-0.13[-0.75]
Trend			0.020 [2.78]*	-0.005[-1.71]***
	Error correction representation			
Constant	22.81[3.97]*	7.69 [1.35]	-12.85[-1.90]****	-9.98 [-2.69]*
Δtb_{t-1}		-0.53 [-4.5]*		
Δtb_{t-2}		-0.65 [-6.21]*		
Δtb_{t-3}		-0.47 [-5.61]*		
$\Delta Ln(y_t)$	-1.80 [-3.44]*	-0.64 [-1.89]***	1.06 [2.17]**	3.5 [4.27]*
$\Delta Ln(y_t^*)$	2.56 [2.05]**	2.33[2.25]**		
$\Delta Ln(y_{t-1})$	1.49 [1.15]	1.57 [1.44]		
$\Delta Ln(y_{t-1}^*)$	4.05 [3.11]*	4.15 [3.79]*		
$\Delta Ln(rer_t)$	0.87 [3.89]*	0.33 [2.55]*	-0.47 [-3.03]*	-0.10[-0.75]
Trend			0.02 [2.78]*	-0.004[-0.70]
ecm_{t-1}	-0.63 [-6.79]*	-0.21[-2.86]*	-0.42 [-4.95]*	-0.77[-8.04]*
Adjusted R^2	0.33	0.54	0.18	0.45
χ^2_{AC}	3.54(0.31)	5.71(0.22)	1.1(0.75)	2.35(0.06)
χ^2_{Arch}	1.00(0.80)	2.81(0.58)	0.06(.96)	5.79(0.05)
χ^2_{Norm}	1.68(0.43)	3.7(0.15)	0.58(0.74)	0.55(0.69)
CUSUM	Stable	Stable	Stable	Stable
CUSUMQ	Stable	Stable	Stable	Stable

Table 2: Long-run and short-run estimates from ARDL model. χ^2_{AC} and χ^2_{Arch} are LM statistics for serial correlation, for ARCH effect at lag 4, and χ^2_{Norm} is LM statistic for normality in residual at lag 2. *, ** and *** are statistically significantly different from zero at 1, 5 and 10 percent levels respectively. Figures in square brackets and parenthesis show t- statistics and level of significance, respectively.

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Hypothesized number of CV(s)	Trace Statistic	5 % critical Value	Max-Eigen Statistic	5% critical value
		Import equation		
None*	51.34	42.91	29.26	25.82
At most 1	22.08	25.87	17.13	19.38
At most 2	4.94	12.51	4.94	12.51
		Export equation		
None*	37.32	29.79	23.14	21.13
At most 1	14.18	15.49	14.14	14.26
At most 2	0.04	3.38	0.04	3.84

Table 3. Johansen's cointegration test. Notes: CV denotes cointegrating vector and * denotes rejection of the hypothesis at 5 percent significance level

Variable	Imports	Exports
Constant	-51.96 [-11.1]*	-9.85[-3.01]*
$Ln(y)$	3.09 [8.99]*	
$Ln(y^*)$		1.21 [4.22]*
$Ln(rer)$	-1.75 [-3.38]*	-0.15 [0.84]
Trend	-0.028 [-4.08]*	-0.03 [-2.41]*
Constant	0.02 [1.15]	0.01[0.37]
$\Delta Ln(im_{t-1})$	0.15 [1.55]	
$\Delta Ln(ex^*_{t-1})$		-0.20 [-1.93]
$\Delta Ln(y_{t-1})$	1.50 [0.69]	
$\Delta Ln(y^*_{t-1})$		1.09 [1.15]
$\Delta Ln(rer_t)$	0.11[0.40]	0.14 [0.52]
ecm_{t-1}	-0.45[-4.75]*	-0.61[-4.16]
Adjusted R^2	0.36	0.48
χ^2_{AC}	13.2 (0.15)	5.64 (0.77)
χ^2_{Arch}	54.91(0.22)	187.9 (0.04)
χ^2_{Norm}	5.45 (0.06)	2557.45 (0.00)

Table 4: Long-run and short-run estimates. Note: χ^2_{AC}, χ^2_{Hetro} and χ^2_{Norm} are LM statistics for serial correlation, for heteroscedasticity and normality in residuals at lag 1, respectively. *, ** and *** are statistically significantly different from zero at 1, 5 and 10 percent levels respectively. Figures in square brackets and parenthesis show t- statistics and level of significance, respectively.

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	(A) Costs	(B) Wage-rec. households	(C) Profit-rec. households	(D) Govern-ment	(E) Foreign	(F) Invest-ment	(G) SUM
(1) Output		PC_ψ	PC_π	PG	PM'	PI	PX
(2) Wage	wL						$\psi P_y Y$
(3) Profit	rPK						$\pi P_y Y$
(4)Government		$t_\psi P_y Y$	$t_\pi P_y Y$				PT
(5) Foreign	$eP'M$						$eP'M$
(6) FOF		$s_\psi P_y Y$	$s_\pi P_y Y$	$P(T-G)$	$-CA$	$-PI$	0
(7) SUM	PX	$\psi P_y Y$	$\pi P_y Y$	PT	$eP^* M$	0	

Table 5: A symbolic Social Accounting Matrix (SAM).

SAM	**US**						**China**						**ROW**
	Costs	HH	Gov	For	Inv	**Sum**	Costs	HH	Gov	For	Inv	**Sum**	For
Output		10130	3243	1316	1776	**16465**		1613	762	1206	1959	**5540**	2431
Wages	9463					**9463**	2938					**2938**	
Profits	4940					**4940**	1824					**1824**	
Government		2300				**2300**		743				**743**	
US	0					**0**	71					**71**	1245
China	339					**339**	0					**0**	867
ROW	1723					**1723**	708					**708**	0
FOF		1973	-943	747	-1776	**0**		2405	-19	-427	-1959	**0**	-319
Sum	16465	14403	2300	2062	0		5540	4761	743	779	0		

Table 6: Numerical SAM. Summary of data on national income, bilateral trade data, functional distribution of income and the macroeconomic flows of funds in 2008 bn USD. The columns for US and China show the firm's cost decomposition, household and government expenditures, and foreign and investment account. Above the first dotted line, rows show firm revenue, and labor, capital and government income. Below, three rows in the three cost columns combine to the bilateral trade matrix. The last row, below the second dotted line, shows the flows of funds. Row-column consistency is satisfied; in order to save space, the household's column corresponds to wage and profit income, and the foreign account's column total equals the sum of imports across origins. Sources: UN SNA, BEA, IMF Direction of Trade Statistics (DOTS), IMF International Financial Statistics, (IFS) and author's calculations. Functional distribution of income for China: Rada (2010).

Selected statistics

	Bilateral trade matrix				*Bilateral trade balances*				*Bilateral trade balances rel. to row-county GDP*			
	US	China	ROW	Sum	US	China	ROW	Sum	US	China	ROW	Sum
US		71	1245	1316		-268	-479	-747		-1.9	-3.3	-5.2
China	339		867	1206	268		159	427	5.6		3.3	9.0
ROW	1723	708		2431	479	-159		319	1.2	-0.4		0.8
	2062	779	2112									

Import propensities			
US		1.5	3.0
China	2.4		2.1
ROW	12.0	14.9	
Sum	14.3	16.4	5.1

Macroeconomic balances rel. to GDP	*S-I*	*T-G*	*E-M*	
US	1.4	-6.5	-5.2	0.0
China	9.4	-0.4	9.0	0.0

Multiplier matrix	US	China
US	2.74	0.08
China	0.13	2.02

Table 7: Selected trade and macroeconomic statistics. The upper part shows bilateral trade flows between US, China and the rest of the world (ROW) in 2008bn USD and bilateral trade balances. Within-region trade of ROW is suppressed. The lower left reports import propensities, i.e. trade flows relative to column country GDP, and macroeconomic balances relative to row country GDP. Bottom right shows the multiplier matrix. Sources: UN SNA, BEA, IMF Direction of Trade Statistics (DOTS), IMF International Financial Statistics, (IFS) and author's calculations.

Baseline calibration

	US	China
Domestic demand		
Distributive elasticity of investment	0.2	0.2
Demand elasticity of investment	0.4	0.4
Savings differential	0.3	0.3
External demand		
Price elasticity of import demand	-1.5	0.0
Income elasticity of import demand	2.0	1.0

Table 8: Baseline calibration. The table summarizes key behavioral parameters used for simulations.

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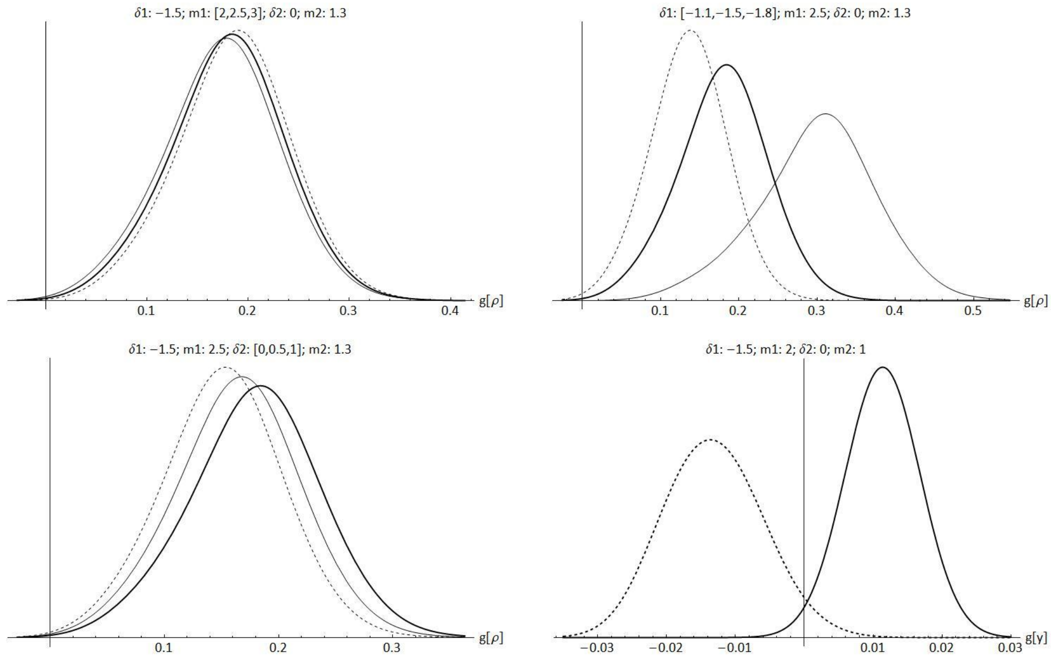
	Simulation results	1	2	3	4	5	6	7	8	9	10	11	12
		US					**Bilat.**	**China**					
		S-I	T-G	B	GDP	RR	RR12	B12	S-I	T-G	B	GDP	RR
	(Base year shares)	1.36	-6.55	-5.18				-1.86	9.36	-0.39	8.97		
	Examples												
1	US investment shock	-0.80	0.53	-0.27	2.4	0.0	0.00	-0.06	0.13	0.08	0.21	0.5	0.0
2	US 10% nom. wage shock	0.24	0.56	0.80	1.4	-8.0	-7.9	-0.27	0.32	0.22	0.54	1.5	1.9
3	CH 10% nom. wage shock	0.01	0.06	0.08	0.4	0.8	8.4	0.10	0.38	0.11	0.48	-0.6	-7.9
4	10% nom. depr. (USD/CYN)	0.01	0.06	0.08	0.4	0.8	8.4	0.10	0.38	0.11	0.48	-0.6	-7.9
	Expenditure changes												
5	Public (B12)	-0.34	0.91	0.57	-4.4	0.0	0.00	0.17	1.74	-4.10	-2.37	7.6	0.0
6	Trade (B12)	0.60	1.82	2.42	8.8	0.0	0.00	3.12	-4.41	-2.86	-7.26	-15.1	0.0
7	**Reduction of B12 (by 1/2)**	**0.17**	**0.57**	**0.74**	**3.0**	**2.4**	**42.8**	**0.96**	**1.00**	**0.14**	**1.14**	**-3.8**	**-30.2**
8	**… & public (by 1/2)**	**-0.01**	**0.94**	**0.93**	**0.4**	**2.3**	**38.0**	**0.93**	**1.92**	**-1.90**	**0.02**	**0.5**	**-27.8**

Table 9: Simulation results. The columns list the variables, beginning with macroeconomic balances. B12 is the US-China bilateral trade balance in US currency relative to US GDP. All balances are reported as the change in percentage points to GDP; i.e. -0.8 in simulation 1 for US (S-I) means that the private balance worsened by four-fifth of a percentage point relative to GDP. The following columns report growth rates of GDP and real exchange rates (RR). RR12 refers to the bilateral real exchange rates of the US vis-a-vis China. Simulations 7 and 8 are highlighted in bold face since these employ a different closure. See text for further details.

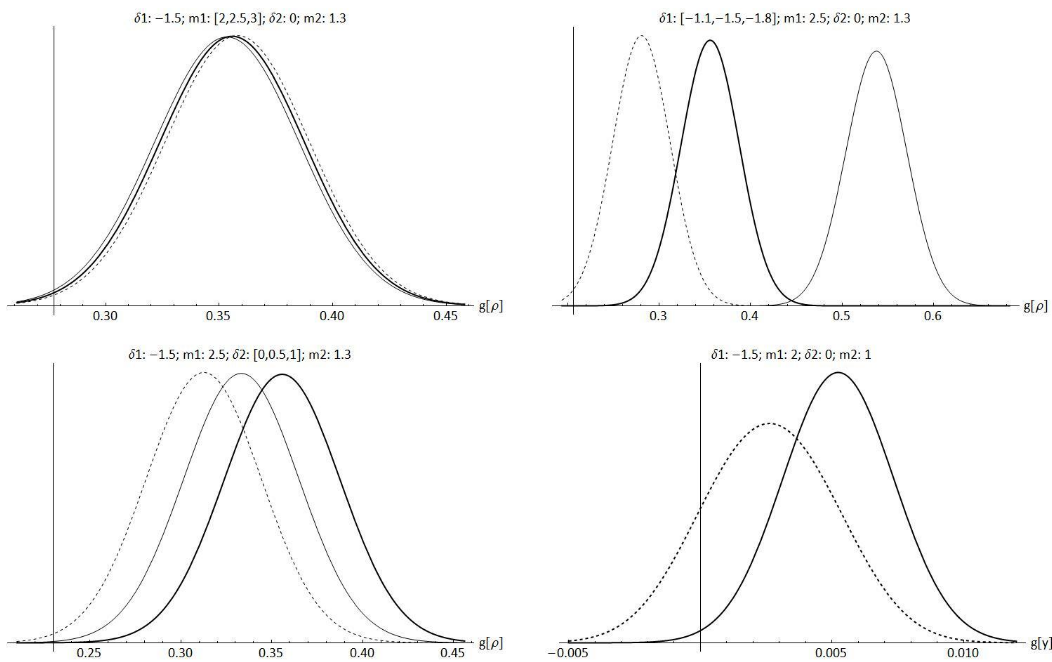
Selected statistics on expenditure changes

US				China			
Y	I	G	M12	Y	I	G	M21
14403	1776	3243	339	4761	1959	762	71
-0.9	-2.5	-1.4	-13.2	2.8	2.3	5.9	62.9

Table 10: Expenditure changes. This table presents selected statistics of the expenditure changes; the left part for the US, the right for China. The first row shows base year (real) values for GDP (Y), investment (I), government expenditures (G) and bilateral imports (M12 and M21). The second row shows ratios of the expenditure change (134bn, half the base year bilateral imbalance) to GDP for each country, followed by an even distribution of the shock across the components of demand. I.e., -2.5 for US investment means that 1/3 of 134 represents a 2.5 per cent reduction of base year US investment.

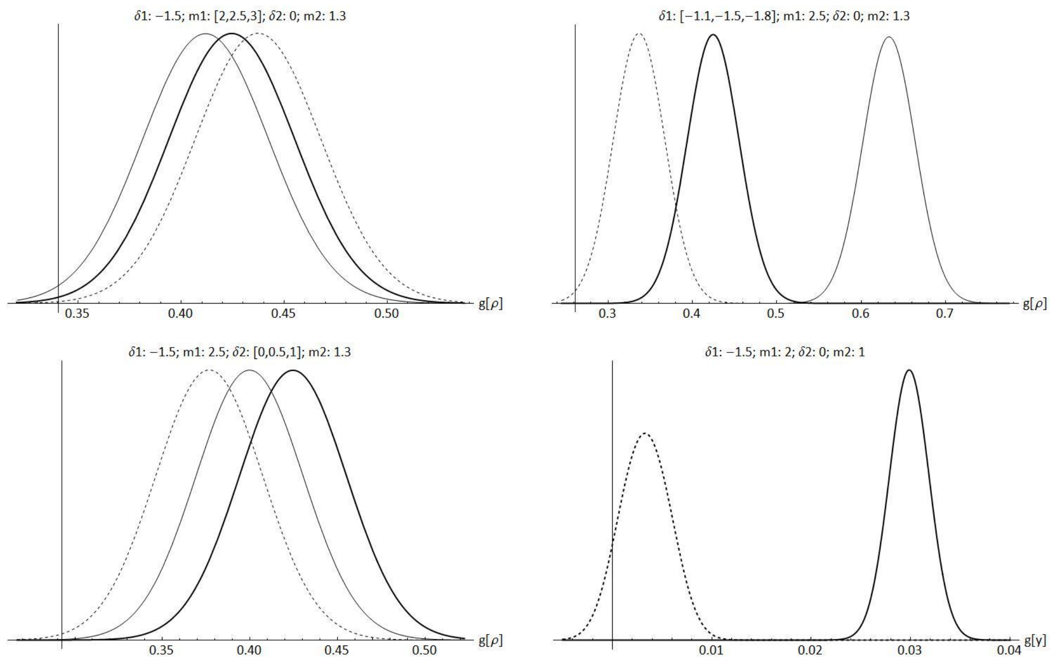


(a)

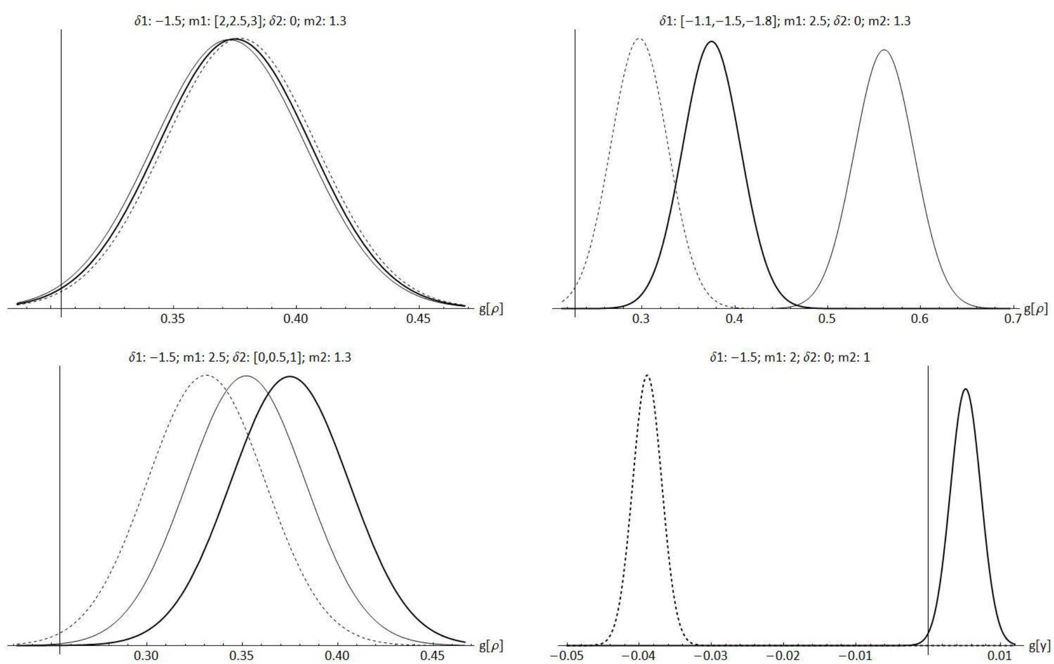


(b)

Figure 3: Simulation results: Real exchange rate depreciation required to effect a change of expenditures of half the bilateral US-China imbalance and GDP growth rates. The distribution of the shock is randomized across autonomous government, import and investment demand in US and China. **Panel (a): All three shares can maximally represent 60% of the total expenditure change; Panel (b): The shock to autonomous import demand in both countries is limited to at most 10%.** In the three exchange rate charts, the thick black distribution represents the baseline calibration. **Top left:** The black (dashed) pdf shows the same shock distribution with a lower (higher) US income elasticity of import demand. **Top right:** The black (dashed) pdf shows the same shock distribution with a lower (higher) US price elasticity of import demand. **Bottom left:** The black (dashed) pdf shows the same shock distribution with a higher (the highest) China price elasticity of import demand. **Bottom right:** Growth of GDP in US (black) and China (dashed).



(a)



(b)

Figure 4: Simulation results: Real exchange rate depreciation required to effect a change of expenditures of half the bilateral US-China imbalance and GDP growth rates. The distribution of the shock is randomized across autonomous government, import and investment demand in US and China. **In both panel (a) and (b), the shock to autonomous import demand in both countries is limited to at most 10%. In Panel (a), the US does not reduce expenditure; in Panel (b), China does not increase expenditures.** In the three exchange rate charts, the thick black distribution represents the baseline calibration. **Top left:** The black (dashed) pdf shows the same shock distribution with a lower (higher) US income elasticity of import demand. **Top right:** The black (dashed) pdf shows the same shock distribution with a lower (higher) US price elasticity of import demand. **Bottom left:** The black (dashed) pdf shows the same shock distribution with a higher (the highest) China price elasticity of import demand. **Bottom right:** Growth of GDP in US (black) and China (dashed).

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