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Abstract

This paper investigates the role played by emerging Asia in the emergence and evolution of the global trade imbalances. Based on simulations in a general equilibrium model of the world economy, we find that a productivity slowdown in the non-tradable sector of these economies in the second half of the 1990s fits regional macroeconomic developments relatively well, but has limited spillover effect to the United States trade balance. In contrast, an increase in the desired level of emerging Asia net foreign assets starting in 2001 not only fits regional developments relatively well, but also has a significant spillover effect to the United States.

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I. INTRODUCTION

During the 1990s, large trade imbalances developed in different regions of the world, with the United States running persistent deficits, and Japan and the euro area first, and later emerging Asia and oil-exporting countries, running surpluses (Figure 1). Today, the United States absorbs an overwhelming share of the world's current account surpluses, and net U.S. liabilities remain close to record-highs, representing about a fifth of U.S. GDP.

The debate about the sources and hence possible resolutions of these external imbalances is polarized. Some argue that global imbalances should not be resisted. This is because they largely manifest as an "equilibrium" phenomenon, generated by the interaction of growth and financial development differentials among countries, that will resolve themselves slowly over time—see, for example, Engel and Rogers (2006), Blanchard (2006), Caballero, Fahri, and Gourinchas (2008), Mendoza, Rull, and Quadrini (2007), Fogli and Perri (2006), and McGrattan and Prescott (2007). Many, however, trust that these imbalances originate in economic distortions, and they should be resolved primarily through policy adjustment, including significant changes in effective exchange rates and fiscal policies or both—for instance, IMF (2005 and 2006), Blanchard, Giavazzi and Sa (2005), Mussa (2004), Obstfeld and Rogoff (2007), Roubini and Setser (2004), and Yoshitomi (2007).

By contrast, one relatively undisputed issue is that differences in relative productivity across world regions have likely played a non-negligible role in the emergence and evolution of the today's trade imbalances. This general perception is supported by empirical evidence. Glick and Rogoff (1995), for example, estimate that a one percent increase in country-specific productivity decreases the current account balance by 0.15 percent of GDP. Estimates by Bems, Dedola and Smets (2007), Edwards (2007), and Corsetti, Dedola, and Leduc (2006) detect even larger elasticities between shocks to productivity and imbalances. A few recent studies also examined the role of total factor productivity (TFP) differences across countries in explaining the global imbalances, based on multi-country dynamic general equilibrium models, with mixed results.[2]

As Obstfeld and Rogoff (2007) noted, however, productivity differences across countries can only help to explain the large U.S. trade deficit if they were concentrated either in the non-tradable sector of the United States or the tradable sector of the rest of the world. Faster TFP growth in the U.S. non-tradable sector boosts the U.S. wage and capital income, and hence U.S. demand for

[2] Early contributions that highlighted the importance of productivity differences among world regions are Erceg, Guerrieri and Gust (2002) and Hunt and Rebucci (2005). Chakraborty and Dekle (in this volume), however, shows that some of the findings of those early analyses are not robust to alternative specifications of the model or the productivity shocks considered.

foreign goods. Relatively faster TFP growth in the tradable sector of the rest of the world makes U.S. goods become less attractive to both U.S. and foreign residents. Indeed, Cova et al (2008) find that a TFP growth acceleration in the non-tradable sector of United States after 1999 accounts relatively well for the total deterioration of the U.S. trade balance, as well as some of the surpluses in Japan and Euro Area.

Many other aspects of the global imbalances, however, remain unaccounted for by TFP differences among advanced economies. Chiefly among them is the sharp shift into surplus of the emerging Asia trade balance during the 1997-98 financial crisis (Figure 1). While some have attributed this change to an increase in saving rates in the region—the so-called "saving glut" hypothesis of Bernanke (2005)—others have pointed to a persistent fall in investments as the main driver of the swing—the so-called "investment draught" hypothesis of Rajan (2006). In the first half of the 2000s, there has also been strong monetary liquidity creation on a global scale that has weakened the link between short and long-term interest rates, including particularly in the United States.

This paper investigates the role of emerging Asia in the emergence and evolution of the global trade imbalances. We focus particularly on two potential explanatory factors: a regional productivity slowdown in the non-tradable sector of these economies in the second half of the 1990s, and a desired net foreign asset (NFA) increase in the first half of the 2000s. Taking these two factors as given, and hence without attempting to explain them, we asses their ability to explain the U.S. and the emerging Asia trade balance evolution from 1995 to 2007, as well as the broader macroeconomic dynamics of these two regions.

Both the productivity deceleration and the NFA increase we consider are broadly consistent with the available evidence. Focusing on productivity slowdown in the non-tradable sector of emerging Asian economies as a source of global imbalance is novel in the literature. And, indeed, the new productivity data that we use to calibrate our simulations show a marked slowdown in the second half of the 1990s in the service sector of the economies at the center-stage of the 1997-98 financial crisis. Tracing the consequences of the spectacular increase in official reserves in emerging Asia in the first half of the 2000s is quantitatively important in order to asses the role of this region in the global imbalances. Asian official reserve accumulation may have contributed to the evolution of the global imbalances both directly, through the trade surpluses necessary to accumulate foreign reserves, and indirectly, through the pressure exerted on global capital markets by the Asian demand of foreign asset and associated monetary liquidity creation.

To implement the analysis, we feed a non-tradable productivity growth decline and a desired NFA increase to the model used by Cova et al (2008). We then look at the trade balance response and the broader macroeconomic dynamics associated with such autonomous changes, comparing the model simulations with the data for the United States and an aggregate of emerging Asian countries. The model is a five-region dynamic general equilibrium (DGE) model of the world economy. In addition to an emerging Asia block, it comprises the United States, Japan, the euro area, and a rest-of-the-world block. These five world regions are interconnected through trade and financial linkages, calibrated consistently with the data. The model does not incorporate realistic financial features, such as the reserve-currency status of the U.S. dollar, or policy distortions, such as the sustained sterilized foreign exchange intervention that has taken place in some of the countries in the region.[3] The model also does not treat oil-exporting exporting economies separately.[4] Despite these limitations, the model permits to trace and quantify the impact of autonomous changes in productivity and official reserves in the emerging Asian block onto the other world regions, and particularly the United States, and hence to assess quantitatively the role of emerging Asia in the global imbalances.

The simulation results indicate that a non-tradable productivity slowdown in the second half of the 1990s and an increase in the desired level of NFA in the first half of the 2000s, can partially account for the regional macroeconomic dynamics in emerging Asia, and some of the U.S. trade balance deficits during this period. The productivity slowdown, in particular, fits quite well Asain regional macroeconomic developments around the time of the 1997-98 financial crisis, but has a limited spillover effect onto the United States. In contrast, the desired NFA increase after 2001, which may be interpreted as a policy response the 1997-98 crisis, not only can partially fit regional macroeconomic developments, but also has significant spillover effects onto the United States. Neither of these two factors, however, are capable of generating strong downward pressure on U.S. interest rates in the first half of the 2000s in the model.

These findings suggest that financial linkages between emerging Asia and the United States are more important than real linkages. They also suggest that while emerging Asia may have had an important role in the evolution of the global imbalances, its role in their emergence in the mid-late 1990s is much more limited than often assumed. Moreover, our analysis suggests that both an investment "drought" and a saving "glut" characterize emerging Asia's contribution to the global imbalances, depending on the specific time-period considered. More generally, the results we report cast doubt on the notion that "home grown" growth in emerging Asia can have significant effects on the rest of the world, and particularly the United States.

II. METHODOLOGY

We feed to our model exogenous paths for productivity and desired NFA in emerging Asia. We then compare actual and simulated paths for the trade balance, the real effective exchange rate, the terms of trade, the real interest rate, and the national accounts. This section briefly describes the model that we use and the two scenarios that we construct, including the calibration of the productivity and NFA paths.

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[3] See IMF (2007) on the role of exchange rate changes for global imbalances.

[4] Kilian, Spatafora, and Rebucci (2008) show that oil shocks, historically, have not had persistent effects on external balances, as the non-oil trade balance has tended to adjust rather quickly to both supply and demand shocks, offsetting their impact on the oil trade balance. In addition, they show that sizeable valuation effects have helped containing the impact of oil shocks on countries' NFA positions. In the case of the United States, for instance, the NFA position has not deteriorated significantly historically in response to oil shocks.

A. The Model

The analysis uses a flexible price version of the model of the world economy developed at the Bank of Italy by Cova and Pisani and used by Cova et al. (2008).[5] This is a multi-country, two-sector (tradable and non-tradable) DGE model of the world economy with incomplete international asset markets, home bias in consumption and investment, international price discrimination (due to the presence of a distribution sector), capital accumulation, and non-zero net foreign asset positions in steady state, which we call desired NFA. As we noted already, the five regions are emerging Asia (AS), the United States (US), Japan (JA), the euro area (EA, defined here as EU-15), and the rest of the world (ROW). Emerging Asia, in turn, is comprised of China, India, Hong Kong, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand.

B. The Scenarios

The first scenario is a non-tradable productivity slowdown in emerging Asia. Table 1 reports 5-year averages of annual TFP and labor productivity growth for the aggregate of emerging Asian countries that we consider, as well as for China, India, and all countries in our group excluding China and India, separately. Country groups are constructed by taking a simple average of the annual rate of growth across countries. TFP data are economy-wide. Labor productivity data are by sector, with "Industry" identifying the tradable sector and "Service" the non-tradable sector.[6]

The evidence in Table 1 points to a marked productivity slowdown in the non-tradable sector of these economies during the 1995–99 period, compared to historical average annual growth, with a strong rebound during 2000-04. Jaumotte and Spatafora (2006) report similar evidence and interpret it in terms of convergence and catch up to the income level of more advanced economies such as the United States, Japan, and the euro Area. In fact, they also note that productivity has tended to decline over time after growth take-offs in many countries of the region, especially in the service sector, including particularly in China. The fact that, region-wide, non-tradable productivity started to decelerate in 1995-1996, before the 1997-98 financial crisis, is consistent with this interpretation. The strong rebound across the region during 2000-04, however, suggests that the slowdown during the preceding five-year period was a temporary deceleration rather than a manifestation of long-run convergence. Interestingly, in addition, the fact that also economy-wide TFP decelerated over the same period, suggests that the slowdown in non-tradable labor productivity was not simply driven by the investment boom-bust cycle around the time of the financial crisis. In contrast, region-wide productivity growth in the tradable sector of these economies remained very close to historical average throughout the 1990s, to accelerate slightly in first half of the 2000s.[7]

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[5] The model, its calibration, and the perfect foresight solution technique we use are described in details in the appendix of the working paper version of the article avaiable at www.imf.org.

[6] Note that, in the case of India, many services, including particularly financial and IT services, are tradable. As we shall argue below, this classification is therefore problematic in the case of India.

[7] On an annual basis, tradable productivity growth is much more volatile than non-tradable productivity. It increased sharply in 1995-1996, it slowed in 1997-1998 (albeit much less

The non-tradable productivity slowdown is driven by the countries directly affected by the 1997-98 f nancial crises. In the case of China, in particular, both tradable and non-tradable labor productivity are slightly above average during the whole 1995-2004 period, with tradable productivity slowing somewhat in the second half of the 1990s, and aggregate TFP staying very close to the historical 1980-1994 average.[8] In the case of India, during the whole 1995-2004, non-tradable (i.e., service) labor productivity accelerates strongly, while tradable (i.e., industry) productivity falls sharply, and aggregate TFP hovers around the 1980-1994 historical average.

In light of this evidence, in the simulations of our productivity slowdown scenario, we feed to the model the simple average of labor productivity growth only in the non-tradable sector—i.e., the second column of Table 1.[9] The simple average of all countries excluding China and India (reported in the last column of Table 1) would give too much weight to the non-tradable slowdown in the smaller "crisis" countries. At the same time, a weighted average of all countries would give too little weight to the slowdown in the smaller "crisis" countries. In addition, we know that a signif cant part of the service sector in India should be more properly classif ed as tradable. We would therefore have to exclude India from such weighted average, leaving us with China having a disproportionate weight on the exercise.

To construct the non-tradable productivity level path that we feed to the model, we follow the same approach used by Cova et al (2008). We assume that the world economy is in steady state in 1994:Q4 and that, after 2004:Q4, non-tradable productivity reverts to trend at the rate of 0.001 per quarter (i.e., with an autoregressive coeff cient of 0.999). Further, for simplicity and without affecting the results signif cantly, we also assume that productivity in all other regions of the world, remains at its steady state level throughout the period considered.[10] A detrended productivity level path is computed by taking a sector-specif c gross percent deviation from a linear trend. This sector-specif c linear trend is computed by cumulating the average annual rate of growth from 1980:Q1 to 1994:Q4. The data are annual, so a quarterly path is obtained by taking a moving average of the annual observations. The resulting quarterly productivity path, from 1995 to 2004, is plotted in the Figure 2, Panel A for both the non-tradable and tradable sector, for completness.

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than in the non-tradable sector), and recovered quickly in 1999, to fall again in 2000. It then grows steadily thereafter.

8 A marked non-tradable productivity growth deceleration is evident during the preceding 1990-94 period. However, this is not ref ected in the economy-wide TFP growth data.

9 When we feed both tradable and non-tradable paths to the model as a robustness check, we obtain similar results to those reported below for only non-tradable productivity. This is both because of the larger share of the non-tradable sector in the economy (see Table A2 in appendix of the working paper version of the article), as well as because of the more volatile nature of the tradable productivity path.

10 Cova et al (2008) f nd that spillover effects from TFP differences among advanced economies to emerging Asia are very small in the multi-region model of the world economy that we use. This is in part because rest of the world block has the largest trade shares in the model (see Table A5 in appendix of the working paper version of the article), and in part also because sector TFP moves in offsetting manners in the euro area and Japan during this period.

The second scenario is a desired NFA increase in emerging Asia. This scenario is meant to represent, albeit roughly, the startling increase in off cial reserve in the region, after 2000 (Figure 2, Panel B).[11] To feed this off cial reserve increase to the model, we note f rst that net and gross foreign assets are the same in the model, because the model has only one asset traded internationally—the U.S. dollar-denominated nominal bond. Second, from Figure 2, we can also see that the regional NFA position tracks the evolution of the off cial reserve position closely during the period we consider.[12] Thus, we assume that the regional steady-state NFA position in the model, which we call desired NFA position, grows in percent of GDP, between 2001:Q1 and 2006:Q4 (the last year for which we have off cial reserve data for all countries in the region), at a constant quarterly rate such that the cumulative desired NFA change equates the cumulative change in off cial reserves over the same period. Although this change in the steady-state NFA position of the model should be assumed to be permanent, for simplicity, we specify it to be persistent, but ultimately temporary. Thus we let this change revet to zero with autoregressive coeff cient of 0.99.[13] The resulting exogenous path for desired NFA is also reported in Figure 2, Panel B.

III. RESULTS

The results compare actual and simulated paths for the trade balance, the real effective exchange rate, the terms of trade, the real interest rate, and the national accounts, under the two scenarios discussed above. Figure 3a and 3b trace the effects of the non-tradable productivity slowdown scenario. Figure 4a and 4b traces the effects of the desired NFA increase scenario.[14]

Actual and simulated paths of the variables reported are as follows. The trade balance and the net foreign asset position are expressed as a share of GDP, in deviation from the steady state, normalized so that the steady state is equal to the data in 1994:Q4. The terms of trade and the real effective exchange rate are in deviation from the model steady state, normalized so that this is equal to 100 in 1994:Q1. The real interest rate is in deviation from steady state, normalized so that this is equal to the actual short rate in 1994:Q4. Real GDP is the annual rate of growth, normalized so that the steady state is equal to the data in 1994:Q4. Actual real GDP growth is in deviation from its sample mean over the 1994-2005 period. Consumption and investment are reported both in terms of annual rate of growth and as a share of GDP. GDP shares are in deviation from steady state, normalized like the trade balance. Annual real consumption and investment growth are normalized like GDP growth.

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[11] See Aizenman (2008) and the other papers in this volume for an extensive discussion of the possible determinants of this reserve accumulation process.

[12] The correlation between the two series over the 2000-2006 interval is 0.96. The NFA data are from Lane and Milesi-ferretti (2007), and the off cial reserve data are from the IFS database of the IMF.

[13] Simulating a permanent shock is more diff cult because it involves f nding a solution satisfying both an initial and a terminal steady state condition.

[14] The results of a combined productivity slowdown and increased desired NFA scenario are available from the authors on request.

All data used are from the World Economic Outlook database of the IMF, except the series for the real effective exchange rate that are from the BIS, and the data on net foreign assets that are from an updated version of the Lane and Milesi-Ferretti (2007) dataset.[15] Emerging Asia-wide aggregates have been constructed as weighted average of individual country variables. We use current dollar GDP weights for exchange rates and interest rates (available for only a small subset of the countries we considered), and constant dollar (PPP-valued) GDP weights for the other variables. All quarterly f ow variables are annualized in the model by multiplying the fourth-quarter value of the respective variable by four.

A. Productivity Slowdown

To interpret our perfect foresight simulation results it is useful to keep in mind the transmission mechanism of a more conventional negative, temporary but persistent, productivity shock to non-tradable TFP in the emerging Asia block of the model. Such a shock tends to generate a trade balance surplus and an effective exchange rate appreciation.[16] The real effective exchange rate response to this shock is driven by the relative price of non-tradable goods. A decline in non-tradable productivity, with a high weight of nontradables in the consumption baskets, generate a persistent increase in the relative price of non-tradable goods. Because of foreign bias in consumption and investment (see more below), the terms of trade also appreciate in response this shock. As a result, the real exchange rate depreciates even more than the terms of trade in response to this shock.

The trade balance surplus results from the net effect of three different forces. First, there is a set of "substitution" effects associated with the complementarity between tradeables and non-tradables and the composition of the consumption and investment baskets. Driven by the productivity decline, the relative price of non-tradable goods rises. Correspondingly, demand of nontradables declines. Because of the complementarity between tradables and nontradables, domestic demand of tradable goods also decreases initially (i.e., the demand of both home and foreign tradable goods falls). With foreign bias in the emerging Asian consumption and investment baskets, however, the demand of foreign tradeables falls more than the demand of domestic tradeables, and hence the terms of trade improve.[17] Substitution effects thus tend to push the trade balance into surplus by generating lower imports of foreign tradables. Second, there is consumption smoothing. Households decrease consumption, but less than the labor and capital income decline associated with falling productivity. This second force tends to reduce the trade balance surplus.

[15] End-2006 is the last year for which these data are available. We extend the NFA data to 2007 using the average annual growth rates of the preceding three years.

[16] Impulse responses not reported, but available on request from the authors.

[17] In emerging Asia, the weight of tradable goods in aggregate investment and consumption is 0.82 and 0.37, respectively. The bias towards domestic goods in the traded good basket of the investment and consumption composite good is 0.06 and 0.05, respectively. By comparison, in the United States, the share of tradable goods in aggregate investment and consumption is 0.74 and 0.35, respectively. The bias towards domestic goods in the traded good basket of both the investment and consumption composite good is 0.87. See Table A2 in the appendix of the working paper version of the article.

Third, f rms postpone investment to relatively more productive times. This third force pushes the trade balance into surplus. With our calibration, the f rst and the third set of effects combine to dominate the consumption smoothing effect. As a result, when non-tradable productivity declines, the trade balance goes into surplus.[18]

Now recall that, in our scenario in Figure 2, nontradable productivity declines persistently from 1995 to 1999, to rebound gradually in the subsequent years. The simulation reported in Figure 3a for emerging Asia tracks very well actual GDP growth from 1996 to 2002, broadly mirroring the productivity path. The simulation also f ts the composition of growth from 1997 to 2002, capturing the sharp increase in foreign demand associated with the trade balance adjustment during the 1997-98 crises, as well as the investment collapse and the consumption decline during that period. Investment and consumption, however, are too volatile and too smooth, respectively, compared to the data without signif cant adjustment costs or f nancial frictions. As a result, for instance, investment recovers faster than in the data from the crisis, and reduces the trade surplus in a counterfactual manner.

The simulation misses the large and persistent terms of trade deterioration in the data, predicting an improvement rather than a decline in the second half of the 1990s. The model predicts correctly the behavior of the real exchange rate from 1994 to 1997 and from 1998 to 2004, but misses the sharp devaluation during the f nancial crisis. The model also predicts a small and counterfactual f uctuation in the real interest rate, which initially falls and then increases while the opposite occurs in the data, consistent with a transmission of technology shocks in the model mostly going through relative price changes.

Looking at the spillover effect of the productivity slowdown in emerging Asia onto the United States, it is interesting to note that the simulation reproduces almost exactly the 1998 deterioration of the U.S. trade balance (Figure 3b). More generally, however, the productivity slowdown in emerging Asia has a very limited impact of the broader macroeconomic dynamics of the United States, including particularly on the interest rates. This is may be due in part to the absence from the model of f nancial features, such as the reserve currency status of the U.S. dollar, and policy distortions, such as sterilized foreign exchange intervention. But more fundamentally the spillover effects from emerging Asia to the United States are small in the model because of the relatively small share of U.S. exports absorbed by Asia's imports.[19]

B. Desired NFA Increase

A temporary but persistent increase in the desired level of NFA (the long-run, steady state level of NFA) requires a sustained trade balance surplus to take actual NFA to its new, higher desired

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[18] The trasmission is fairly robust to the assumptions on the elasticity of substitution between home and foreign tradable goods, and between imports from different countries.

[19] As of end-2002, in fact, the rest of the world (which in the model calibration includes Canda and Mexico—the U.S. largest trading partners) was still the most important export destination for the United States, given relative size of the different world regions and their international trade linkages (See Table A2 and A5 in the appendix of the working paper version of the article).

level. To understand the effects of this shock in the model, notice that actual NFA needs not be the same as desired NFA in all periods, and that the adjustment is gradual.[20] An actual NFA position that is smaller than the desired NFA position induces an interest rate increase, via an international intermediation premium that is increasing in the size of this difference and a no-arbitrage condition between domestic and international interest rates. Higher domestic interest rates give firms and households the incentive to postpone investment and consumption expenditure. On the supply side of the economy, lower investment and consumption lead to lower relative prices of both tradable and non-tradable goods, and hence a terms of trade deterioration and real exchange rate depreciation. These in turn help to switch home and foreign demand toward domestic tradables and to generate the necessary surpluses to move the actual NFA position toward its higher, desired level.

As actual NFA tends to approach desired NFA, the trade balance must turn around, and move toward smaller surpluses or larger deficits for two reasons. The first is that a higher level of NFA generates higher capital income, and hence requires a correspondingly smaller trade surplus. The second is that, as the shock to desired NFA ultimately unwinds, the trade balance must shift more markedly into deficit before reverting to its initial steady state level.

Recall now that the NFA scenario we constructed involves a constant increase in desired NFA from 2001 to 2006 which then unwinds gradually.[21] The simulation matches relatively well the NFA path in the data by construction (Figure 4a). The simulation also fits the trade balance path relatively well, between 2000 and 2004, when the reversion to the initial steady state starts, although it generates smaller surpluses than in the data. Unlike the productivity slowdown scenario, the simulation captures the smooth and persistent terms of trade decline and the trend-depreciation in the real exchange rate, from 1999 to 2004. However, the model generates a counterfactual, excessively smooth real interest rate response, consistent with a transmission going mostly through relative price changes as in the productivity scenario.

Looking at the national accounts, the higher desired NFA scenario can generate an investment growth decline that is even more persistent than in the data (the so-called “investment drought”). The simulation, however, misses real consumption and GDP growth, which are essentially constant in the model, and the falling real interest rates. In the model, domestic absorption falls driven by the protracted fall in investment, while net exports increase sharply to generate the desired NFA accumulation, both driven by relative price changes. In the data, however, consumption growth accelerates in 2004 after declining for several years, and both as short- and long-term real interest rates decline throughout the period considered.

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[20] We calibrate the two parameters that control the speed with which actual NFA converges to desired NFA, consistent with previous work with the IMF’s GEM model, so as to have minimal impact on the model second moments. This is an additional reason why the interest rate moves very little in the simulation scenarios we consider.

[21] Given that we solve the model under perfect foresight, agents see this desired NFA change from the beginning of the simulation period, and start to accumulate NFA even before the change actually takes place. As a result, actual NFA at the beginning of our simulation is above the still unchanged desired NFA. By the same token, in the terminal part of the simulation, actual NFA is below its desired level with a temporary change.

Looking at the impact of this scenario on the United States, we can see that the spillover are much more sizable than in the productivity slowdown scenario (Figure 4b). In particular, this scenario generates simulated paths for the trade balance, the NFA position, the terms of trade, investment, and to a lesser extent the real exchange rate, that are qualitatively consistent and quantitatively comparable to the data, although the simulated dynamic tends to lead those in the data. For instance, the trade balance worsens as the terms of trade improve, and the real effective exchange rate appreciates, but these effects occur even before the desired NFA position starts to change because of the perfect foresight nature of the simulation. Successive trade def cits cumulate to generate a NFA position that reaches almost 20 percent of GDP by 2004. These changes in the external position of the U.S. ref ect in turn a shift in the composition of expenditure, with the negative contribution of net exports matched by the positive contribution of investment. As in the case of emerging Asia, however, there are no effects on the real interest rate as well as on consumption and GDP growth.

This latter f nding suggests that the reserve accumulation that we see in the data involves more that the relative price and demand composition changes that are in our model, in which there are no f nancial frictions and policy distortions. This scenario thus suggests that it may be useful to take into account the specif c policies with which reserve accumulation has been brought about to better understand the consumption and growth dynamics of both emerging Asia and the United States during the f rst half of the 2000s.

IV. Conclusions

This paper examines the role of emerging Asia for the emergence and evolution of the global trade imbalances. We considered two factors, both broadly calibrated to the data: f rst, a productivity slowdown in the non-tradable sector of these economies in the second half of the 1990s; and second, an increase in the desired level of the NFA position of these economies in the f rst half of the 2000s.

Feeding these two autonomous changes to a seemingly frictionless DGE model of the world economy yields model dynamics that are partially consistent with those observed in the data for both emerging Asia and the United States. A non-tradable productivity slowdown f ts well internal and to a lesser extent external macroeconomic developments in emerging Asia in the second half of the 1990s, but has limited spillover effects to the United States. This is arguably because of the still small share of U.S. export absorbed by emerging Asia. A desired NFA increase in emerging Asia can explain reasonably well some of the external developments in the region, and has more sizable spillover effects to the US. This scenario, however, does not provide a good description of the consumption dynamics in either emerging Asia or the United States. Finally, neither of the two scenarios considered is capable of generating the movements in real interest rates that we see in the data.

One implication of the analysis is that emerging Asia is unlikely to have been a key contributor to the emergence of the global imbalances, although it has certainly had a role in its evolution since 1997-1998. A second implication is that, in order to understand emerging Asia's role in the evolution of the global imbalances both an "investment drought" and a "saving glut" hypothesis are necessary to match data. More generally, the findings of this paper suggest that financial linkages between emerging Asia and the United States are more important than real linkages, and thus casting doubt on the notion that "home grown" growth in emerging Asia can have significant effects on the rest of the world, and particularly the United States.

Extending the analysis by introducing in the model realistic financial frictions and policy distortions, such as for instance the reserve currency role of the dollar or sterilized foreign exchange intervention seems a promising area of future research to better understand the consequences of the spectacular increase in the level of official reserve in emerging Asia.

Table 1. Annual Average Productivity Growth

(Percent per year)

Panel A. Aggregate Total Factor Productivity

	Emerging Asia [a]	China	India	Other Emerging Asia [a]
1975–79	0.52	1.39	-0.7	0.65
1980–84	0.35	3.73	1.6	-0.3
1985–89	1.49	2.84	2.3	1.4
1990–94	1.71	4.75	0.9	1.6
1995–99	-0.08	3.21	2.0	-0.9
2000–04	1.33	3.50	1.3	1.2
Average full sample	0.89	3.24	1.23	0.63
Average 1981–04	0.96	3.61	1.62	0.63

Panel B. Sector Labor Productivity [b]

	Emerging Asia [c]		China		India		Other Emerging Asia [c]	
	Tradables	Nontradables	Tradables	Nontradables	Tradables	Nontradables	Tradables	Nontradables
1975–79	5.00	1.25	4.88	1.81	3.11	1.71	7.26	1.72
1980–84	2.20	1.09	4.11	3.93	0.35	1.00	2.91	0.54
1985–89	3.96	3.17	7.51	6.48	3.67	3.43	4.13	2.80
1990–94	3.30	1.89	9.58	0.34	-0.84	1.30	3.54	2.69
1995–99	3.36	0.51	9.06	4.81	-1.75	4.92	3.91	-1.13
2000–04	4.07	2.99	10.42	5.88	-1.44	4.11	4.72	2.79
Average full sample	3.65	1.82	7.59	3.87	0.52	2.74	4.41	1.57
Average 1980–04	3.38	1.93	8.14	4.29	0.00	2.95	3.84	1.54

Source: TFP and labor productivity from Spatafora and Jaumotte (2007) and APO Productivity Databook, 2008, respectively.

[a] Average of China, India, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand.

[b] Tradable sector identified with "Industry". Nontradable sector identified with "Services".

[c] Average of China, India, Indonesia, Malaysia, the Philippines, South Korea, and Thailand.

Figure 1. Global Merchandise Trade Balances

(In percent of GDP)

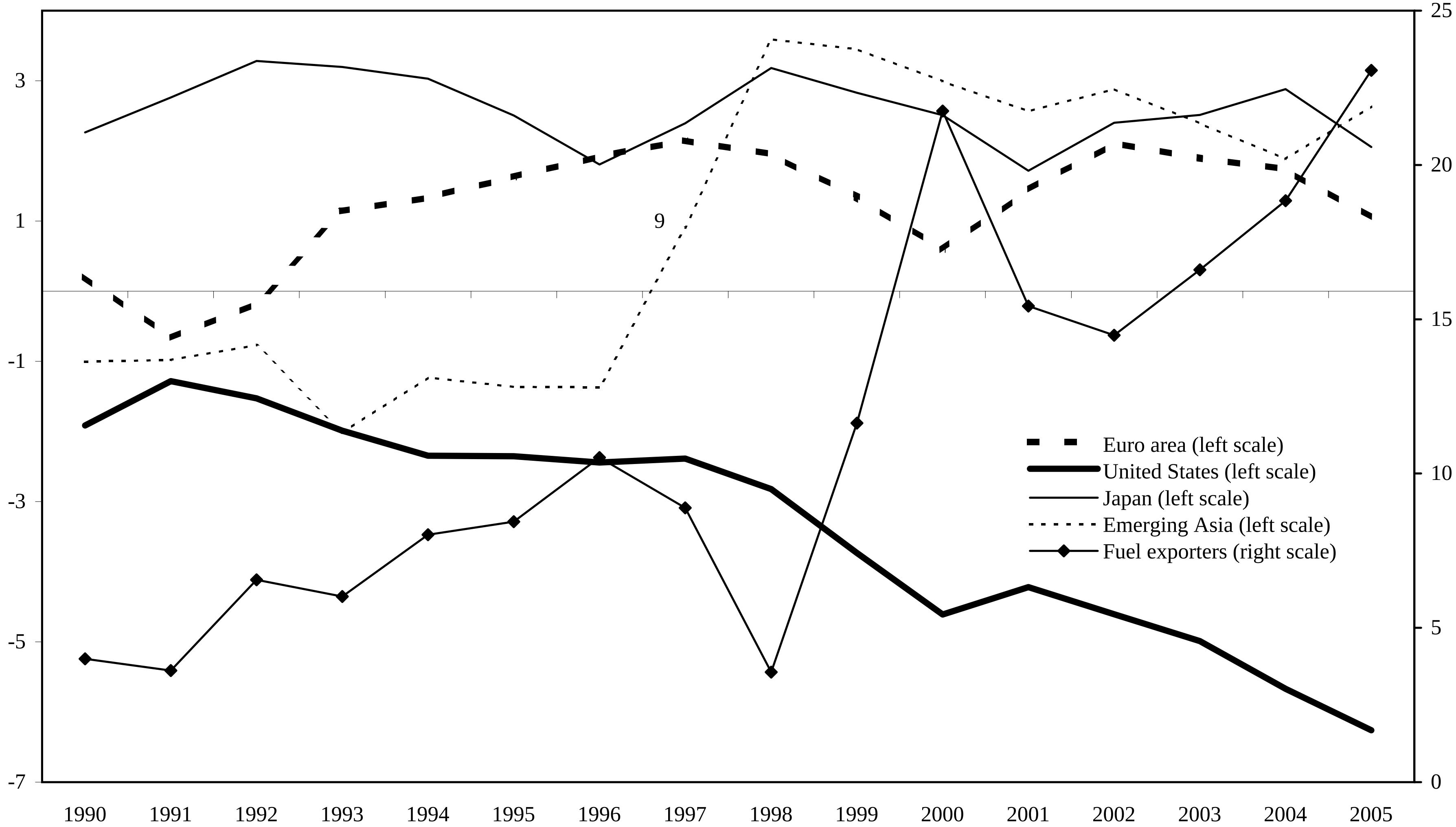
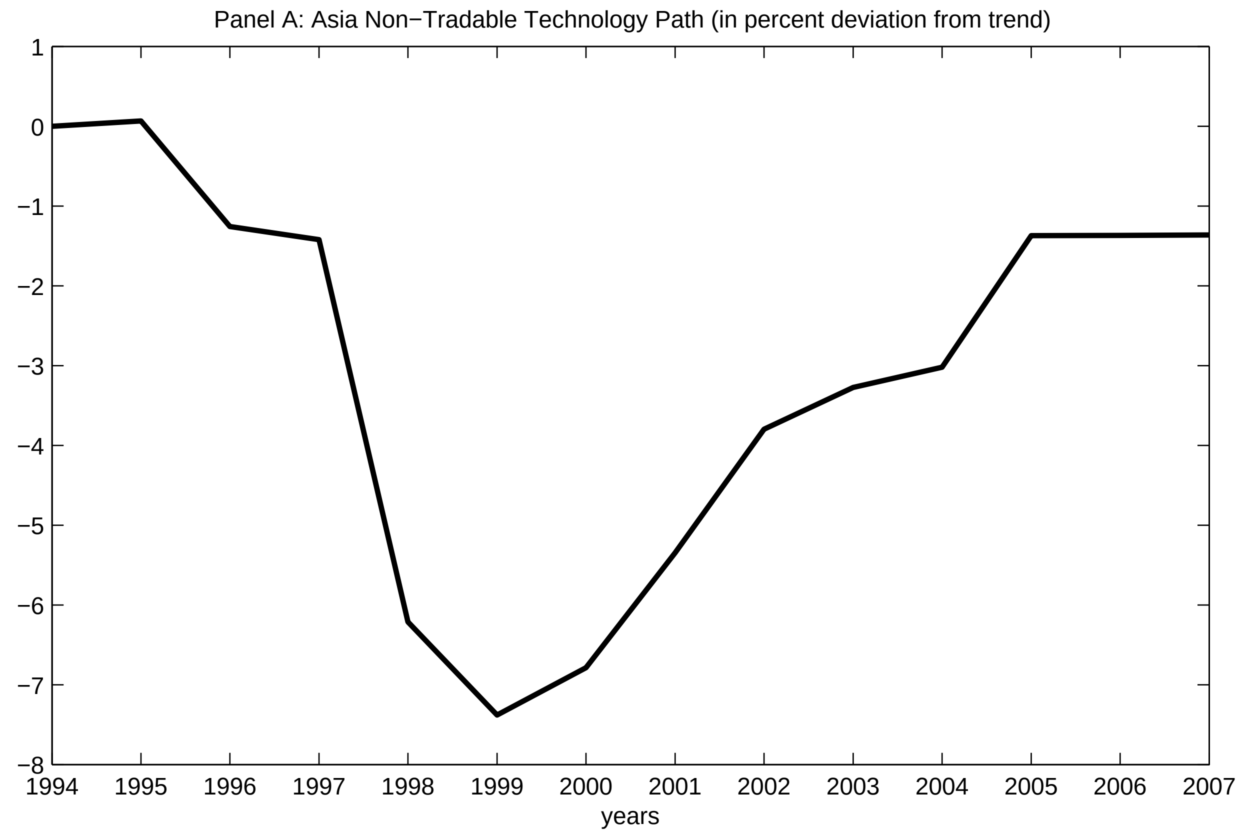


Figure 2. Scenarios



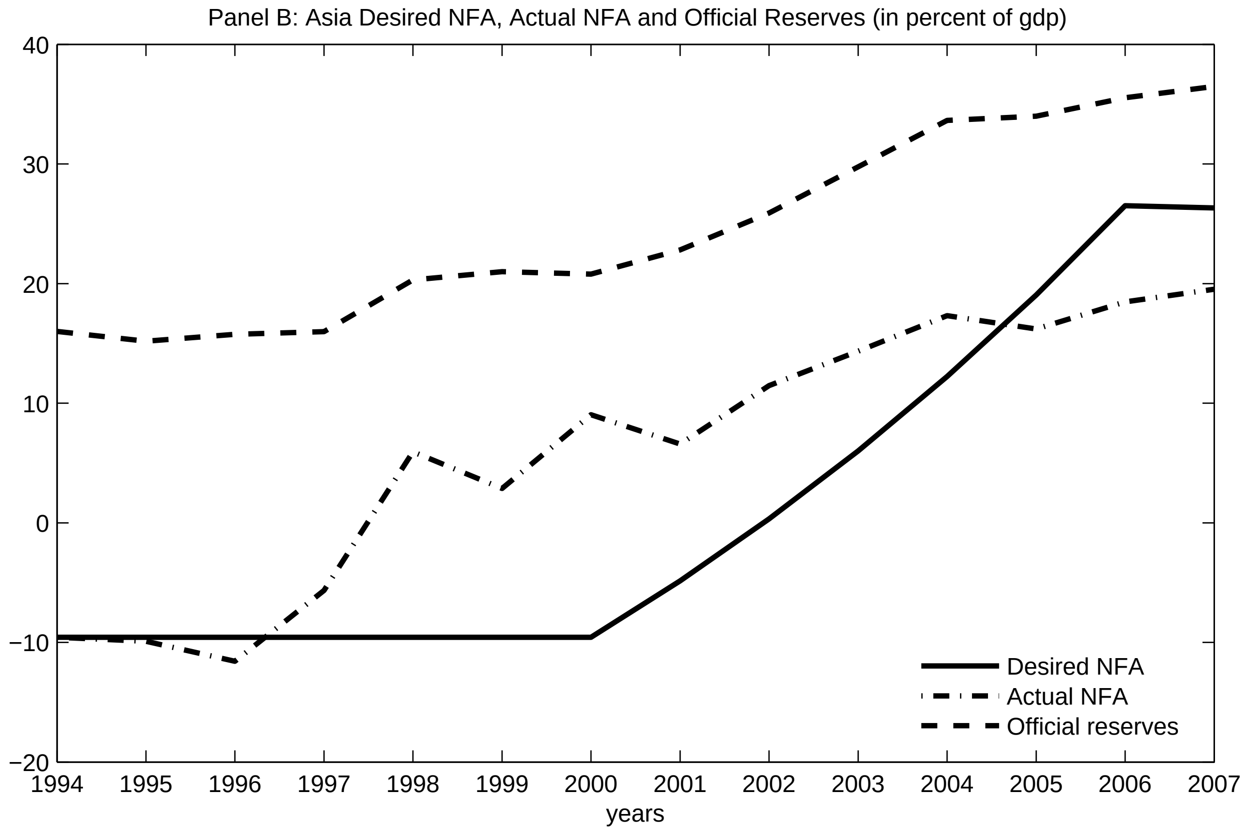


Figure 3a. Asia Non−Tradable Technology Shocks: Domestic Effects (in percent)

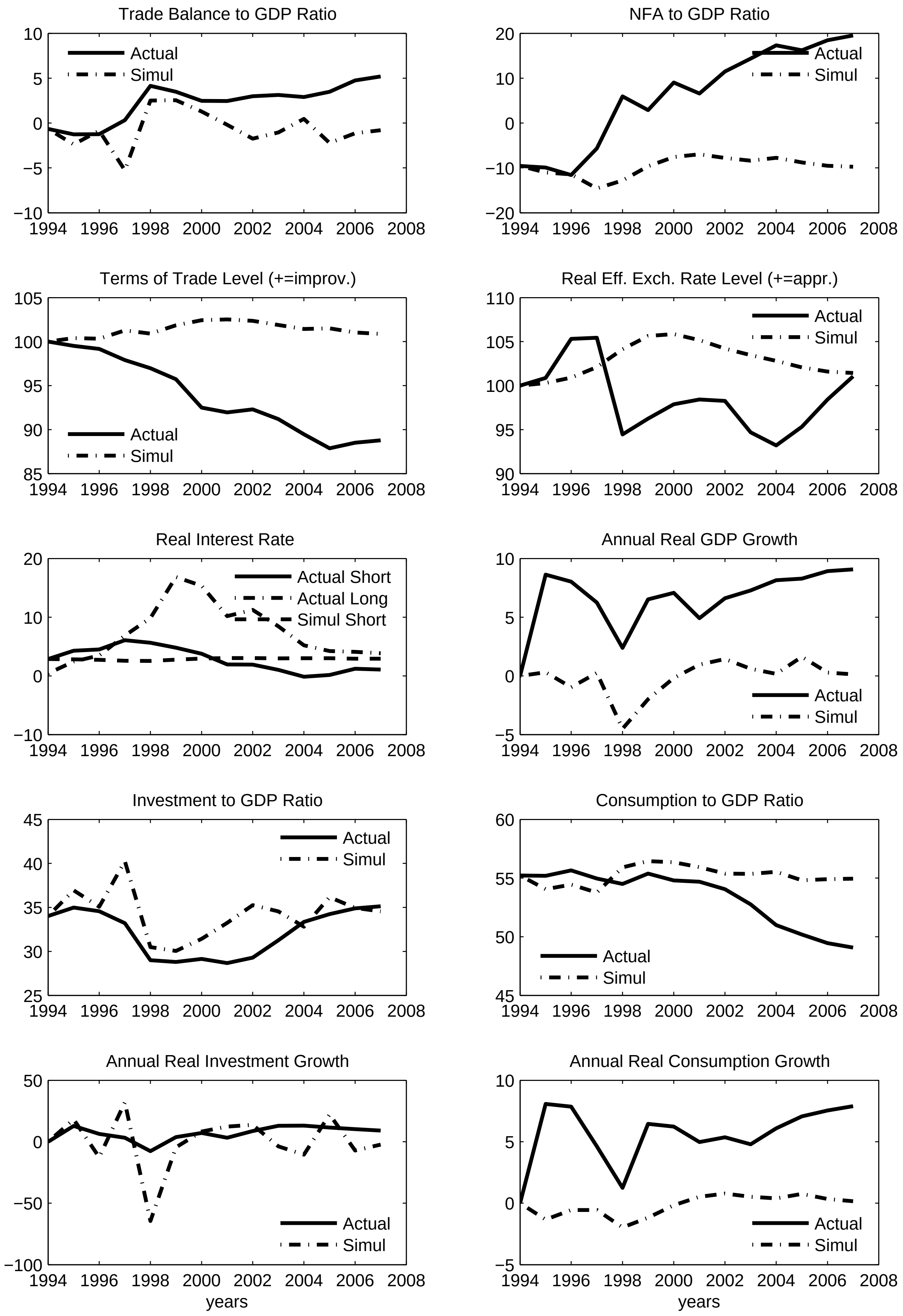


Figure 3b. Asia Non−Tradable Technology Shocks: Spillovers to the United States (in percent)

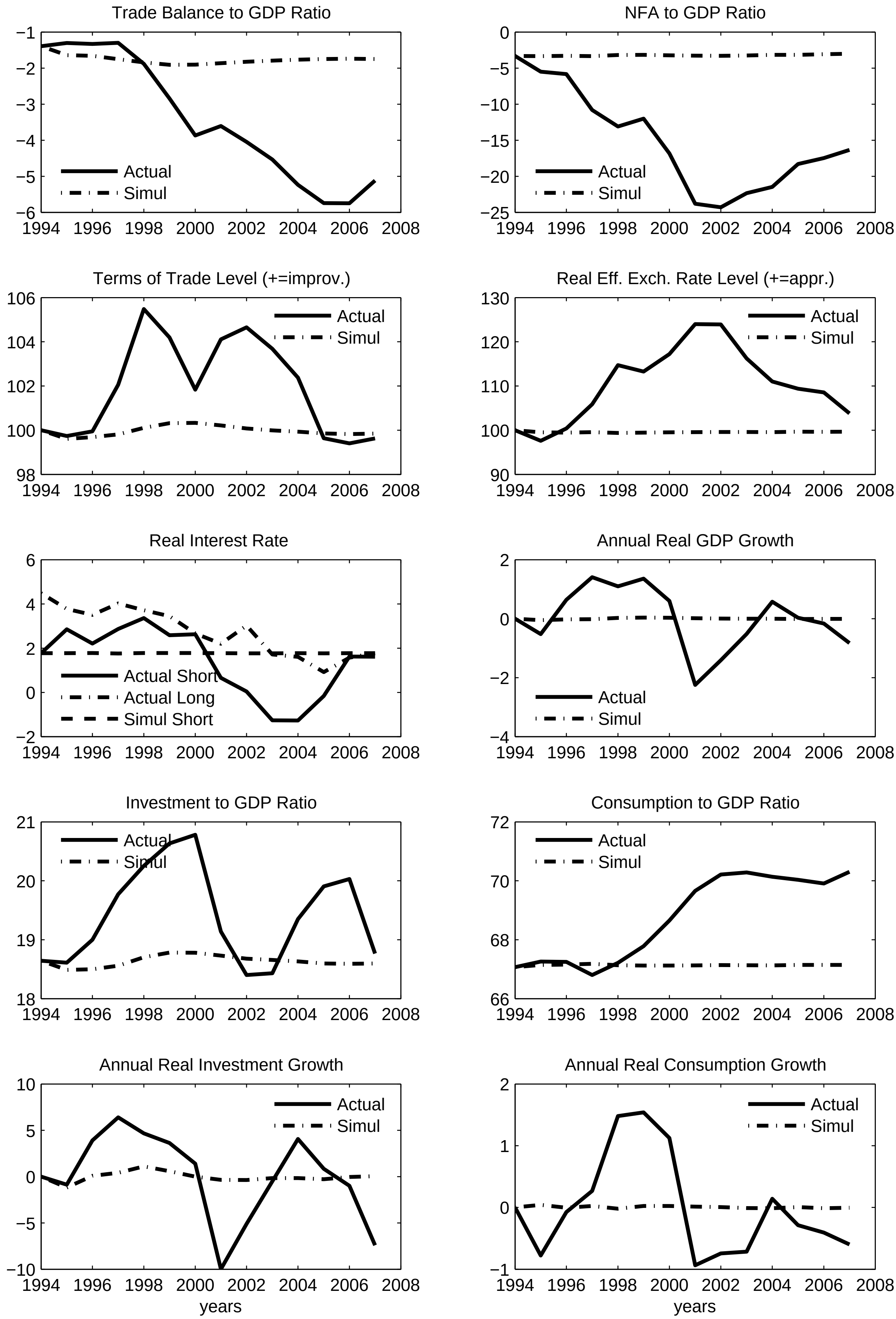


Figure 4a. Asia Desired NFA shock: Domestic Effects (in percent)

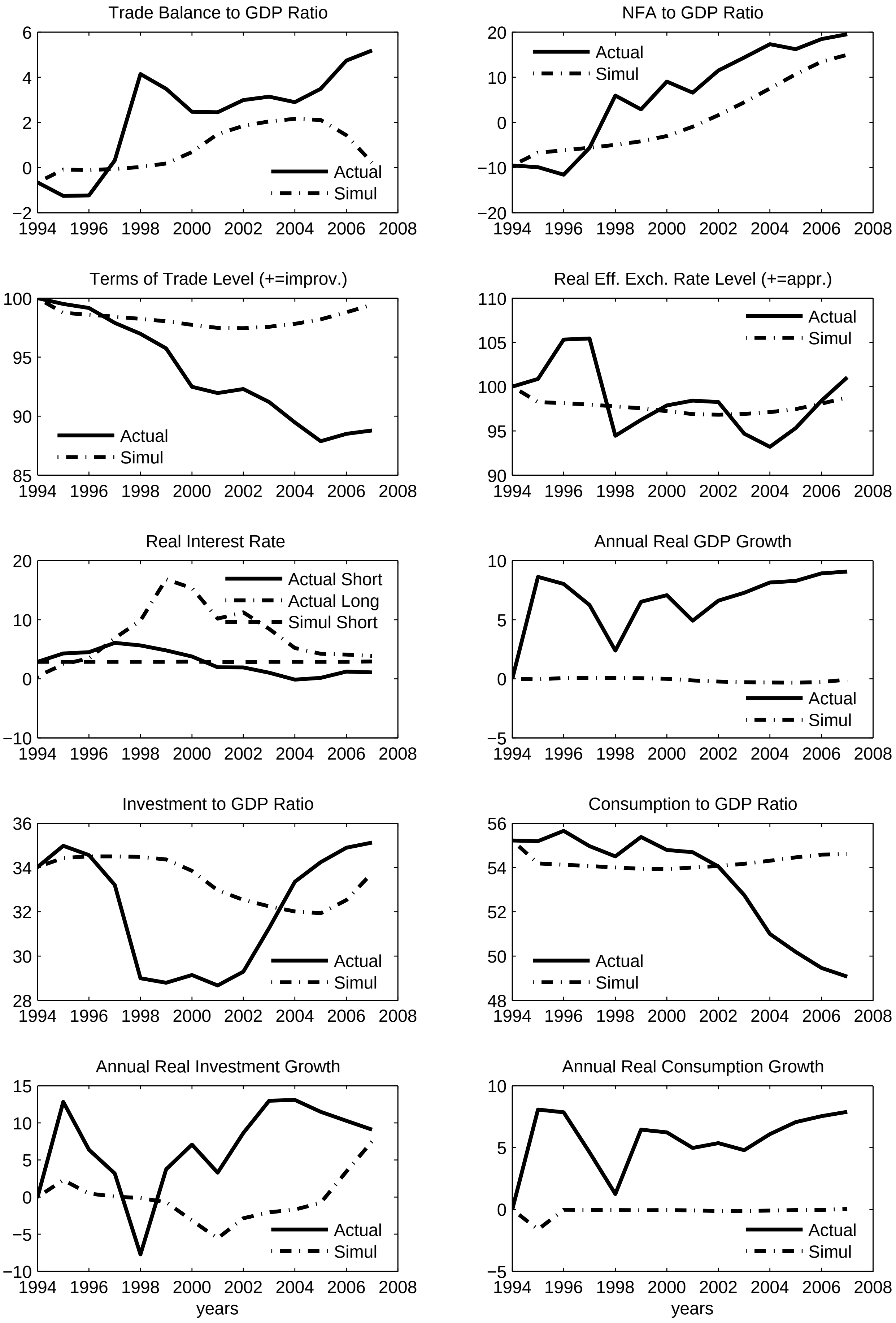
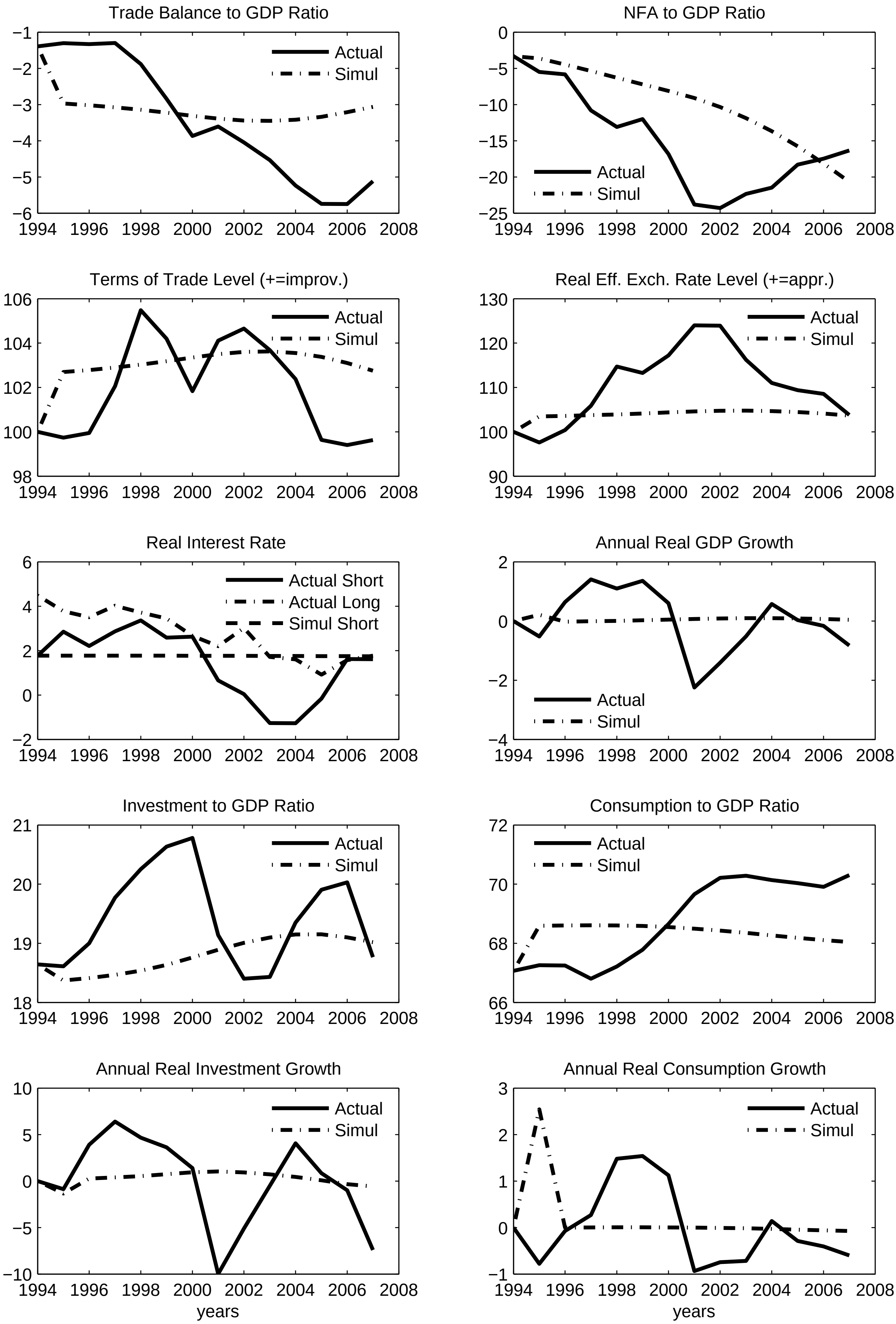


Figure 4b. Asia Desired NFA Shock: Spillovers to the United States (in percent)



I. THE MODEL

In this appendix we describe the model, its calibration, and the solution technique that we use. The world economy consists of five regional blocs ('countries'): United States (US), Japan (JAP), EA (Euro area), Emerging Asia (AS), and Rest of the World (ROW). In each country there are households, firms, and a government. World population is normalized to unity. Country sizes are denotes s^{CO}, with $\sum s^{CO} = 1$. We denote $TREND_t$ the common stochastic trend for the world economy and $g_{t,\tau}$ its (gross) rate of growth, with $TREND_\tau = g_{t,\tau} TREND_t$. All quantity variables in the model are expressed in detrended terms, i.e. as ratios of $TREND$.

Each household is infinitely-lived, consumes a non-tradable final good (C), and is the monopolistic supplier of a differentiated labor input (ℓ) to all domestic firms.[22]

In each country there are two types of households: forward-looking or Ricardian ones (with subscript FL) and liquidity-constrained or non Ricardian ones (with subscript LC). Liquidity-constrained agents do not have access to capital markets and finance their consumption exclusively through income from labor. Forward-looking households own domestic firms and the domestic capital stock (K), which they rent to domestic firms. The market for capital is competitive. Capital accumulation is subject to standard adjustment costs. Labor and capital are immobile internationally, but fully mobile across sectors.

Forward-looking households in each country also hold two short-term nominal bonds, one denominated in domestic currency and issued by the country's government, and another issued by the United States and denominated in US dollars and with a zero net supply worldwide. There are intermediation costs for national households entering the international bond market to induce stationarity. No other asset is traded internationally.

In each country, perfectly competitive firms produce two final nontradable goods, a consumption good (A) and an investment good (E) using all types of intermediate goods as inputs (nontradables N, domestic tradables Q, and imports M). Intermediate goods come in different brands, each produced by a single firm under conditions of monopolistic competition with domestic labor inputs and domestic capital. Firms also provide intermediation services, without use of human or physical resources. All prices and wages are fully flexible (the correspondent adjustment cost is set to zero). Therefore, there is no role for monetary policy in the model (in each country the interest rate rule imposes that the gross consumer price inflation rate equal to 1 in all period).

The government in each country consumes the two final goods and finances its expenditures by issuing debt. The government's intertemporal solvency condition is guaranteed by a simple feedback rule according to which lump-sum taxes vary as the debt-to-GDP ratio deviates from some exogenous target ratio.

[22] Interpreting $TREND_t$ as labor-augmenting technical change, ℓ_t in the model is time devoted to work, assumed to be bounded by endowment, while effective labor is $TREND_t \ell_t$. It follows that the nominal wage (the monetary remuneration for one unit of labor services ℓ) can be trending both because of nominal inflation and because of real (labor-augmenting) growth.

As a general convention in the model, when we state that variable X follows an autoregressive process, we mean that:

$$X_t = X_{t-1}^{\rho_X} e_{X,t} \tag{A-1}$$

where $0 < \rho_X < 1$ and $e_{X,t}$ is a noise term.

A. Firms

Supply of intermediate goods

In each country there are two kinds of intermediate goods, tradables and nontradables. Each kind is def ned over a continuum of brands of mass s. Without loss of generality, we assume that each nontradable brand is produced by a single domestic f rm indexed by $n \in [0, s]$, and each tradable brand is produced by a f rm $h \in [0, s]$.

The nontradable brand n is produced with the following CES technology:

$$N_t(n) = Z_{N,t} \left[(1-\alpha_N)^{\frac{1}{\xi_N}} \ell_t(n)^{1-\frac{1}{\xi_N}} + \alpha_N^{\frac{1}{\xi_N}} K_t(n)^{1-\frac{1}{\xi_N}} \right]^{\frac{\xi_N}{\xi_N - 1}} \tag{A-2}$$

Firm n uses labor $\ell(n)$ and capital $K(n)$ to produce $N(n)$ units of its brand. $\xi_N > 0$ is the elasticity of input substitution, and Z_N is a productivity shock common to all producers of nontradables.

Def ning as w_t and r_t the relative prices of labor and capital (in units of domestic consumption), the marginal cost to produce nontradables is:

$$mc_t(n) = \frac{\left\{ (1-\alpha_N)\, w_t^{1-\xi_N} + \alpha_N r_t^{1-\xi_N} \right\}^{\frac{1}{1-\xi_N}}}{Z_{N,t}} \tag{A-3}$$

and the capital-labor ratio is:

$$\frac{K_t(n)}{\ell_t(n)} = \frac{\alpha_N}{1-\alpha_N} \left(\frac{r_t}{w_t} \right)^{-\xi_N} \tag{A-4}$$

Labor inputs are differentiated by skills. They are def ned over a continuum of mass equal to the country size and indexed by $j \in [0, s]$. Each f rm n uses a CES combination of labor inputs:

$$\ell_t(n) = \left[\left(\frac{1}{s} \right)^{\frac{1}{\psi_t}} \int_0^s \ell(n,j)^{1-\frac{1}{\psi_t}} dj \right]^{\frac{\psi_t}{\psi_t - 1}} \tag{A-5}$$

where $\ell(n, j)$ is the demand of labor input of type j by the producer of good n, and $\psi > 1$ is the elasticity of substitution among different labor skills. Cost minimization implies that $\ell(n, j)$ is a function of the relative wage:

$$\ell_t(n,j) = \left(\frac{1}{s}\right)\left(\frac{w_t(j)}{w_t}\right)^{-\psi_t}\ell_t(n) \tag{A-6}$$

where $w(j)$ is the wage paid to Home labor input j and the wage index w is defined as:

$$w_t = \left[\left(\frac{1}{s}\right)\int_0^s w_t(j)^{1-\psi_t}dj\right]^{\frac{1}{1-\psi_t}} \tag{A-7}$$

Similar considerations hold for the production of tradables. We denote by $T(h)$ the supply of each intermediate tradable h. Using self-explanatory notation, we have:

$$T_t(h) = Z_{T,t}\left[(1-\alpha_T)^{\frac{1}{\xi_T}}\ell_t(h)^{1-\frac{1}{\xi_T}} + \alpha_T^{\frac{1}{\xi_T}}K_t(h)^{1-\frac{1}{\xi_T}}\right]^{\frac{\xi_T}{\xi_T-1}} \tag{A-8}$$

where Z_T is an autoregressive process (in logarithm). Aggregating across firms, we obtain the total demand for labor input j as:

$$\int_0^s \ell_t(n,j)dn + \int_0^s \ell_t(h,j)dh$$
$$= \left(\frac{w_t(j)}{w_t}\right)^{-\psi_t}\left(\frac{1}{s}\right)\left(\int_0^s \ell_t(n)\,dn + \int_0^s \ell_t(h)\,dh\right) \equiv \left(\frac{w_t(j)}{w_t}\right)^{-\psi_t}\ell_t \tag{9}$$

where ℓ is per-capita total labor in the economy.

Price setting in the nontradable sector

Consider now profit maximization in the intermediate nontradable sector. Each firm n takes into account the demand (A-18) for its product and sets its price to maximize the real profits in each period.

The price-setting problem is then characterized as:

$$\max_{p_t(n)} \; (p_t(n) - mc_t(n))\left(\frac{p_t(n)}{p_{N,t}}\right)^{-\theta_N}(N_{A,t} + N_{E,t} + G_{N,t}) \tag{profits}$$

where N_A, N_E, and G_N represent the final demands by households and the government and $\theta_N > 1$ is the elasticity of subsitution between nontradable brands. The optimization problem yields the standard constant mark-up pricing rule:

$$p(n) = \frac{\theta_N}{\theta_N - 1}mc_t(n) \tag{A-10}$$

Since the firms n are symmetric they all charge the same equilibrium price $p(n) = p_N$.

The distribution sector and price setting in the tradable sector

As we want to focus on export markets, our notation needs to account explicitly for country indexes. In what follows we use the index CO to denote a generic country, and denote H the country where the exporting firm h^H is located.

Following Corsetti et al. (2004), we assume that tradeable-producing firms need distribution services intensive in local nontradeables to deliver their products to final consumers. This implies that the elasticity of demand for any tradable brand is not necessarily the same across markets, reflecting asymmetries in the marginal costs and prices across the country-specific distribution sectors. As a consequence, it is optimal to price discriminate across markets.

Firms in the distribution sector are perfectly competitive. They purchase home and foreign tradeable goods and distribute them domestically using a Leontief technology through which they combine one unit of the tradeable with $\eta \geq 0$ units of the basket of nontradeable brands n:

$$\eta \equiv \left[\int_0^1 \eta \left(n \right)^{\frac{\theta_N - 1}{\theta_N}} dn \right]^{\frac{\theta_N}{\theta_N - 1}} \quad \theta_N > 1 \tag{A-11}$$

The distribution sector introduces a wedge η between wholesale and consumer prices. Denoting with $\bar{p}_{\tau}^{CO}(h^H)$ and $p_{\tau}^{CO}(h^H)$ the wholesale and consumer prices of the home brand in country CO, and $\bar{p}_{\tau}^{H}(h^H)$ and $p_{\tau}^{H}(h^H)$ their domestic counterparts, respectively, consumer prices are given by:

$$p_t^H(h) = \bar{p}_t^H(h) + \eta P_{N,t}^H \ , \quad p_t^{CO}(h) = \bar{p}_t^{CO}(h) + \eta P_{N,t}^{CO} \tag{A-12}$$

where P_N^H (P_N^{CO}) is the price of the home (generic importing country) composite basket η.[23]

Consider now the price-setting problem in the tradables sector. As the distribution sector induces segmentation among five national markets in the world economy, each firm h has to set five prices, one in the domestic market and four in the export markets.

Taking equation (A-27) below into account, the four price-setting problems of firm h in country H can then characterized as follows:

$$\max_{\sum_{CO} \bar{p}_t^{CO}(h^H)} \sum_{CO} \tag{A-14}$$

$$\left\{ [\varepsilon_t^{H,CO} \bar{p}_t^{CO}(h^H) - mc_t^H(h^H)] * \frac{s^{CO}}{s^H} \left(\frac{p_t^{CO}(h^H)}{p_{M,t}^{CO,H}} \right)^{-\theta_T^H} \left(M_{A,t}^{CO,H} + M_{E,t}^{CO,H} + G_{H,t}^{CO,H} \right) \right\}$$

[23]The price index P_N^{CO} is:

$$P_N^{CO} = \left[\int_0^1 p^{CO} \left(n \right)^{1-\theta_N} dn \right]^{\frac{1}{\theta_N - 1}} \tag{A-13}$$

This is the minimum expenditure necessary to buy one unit of the basket η.

When $H \neq CO$, recall that $\bar{p}^{CO}(h^H)$ is the wholesale price of good h^H in country CO, $\bar{p}_M^{CO,H}$ is the wholesale price of country CO's imports from country H, and $M_A^{CO,H} + M_E^{CO,H}$ are country CO's imports from country H. The term $\varepsilon^{H,CO}$ is the bilateral real exchange rate between country H and country CO (an increase in $\varepsilon^{H,CO}$ represents a real depreciation of country H's currency against country CO).[24] $\theta_T^H > 1$ is the elasticity of substitution between tradable brands produced in country H.

For the domestic prices of tradables $\bar{p}^H(h^H)$ we use (A-14) with $CO = H$, adopting the notational conventions $\bar{p}_M^{H,H} = \bar{p}_Q^H$, $M_A^{H,H} = Q_A^H$ and $M_E^{H,H} = Q_E^H$ as described in (A-19) below.

Demand for domestic intermediate goods

As we just saw in the last section, intermediate inputs come in different brands and are produced under conditions of monopolistic competition. They are then bundled by a continuum of symmetric firms indexed by $x \in [0, s]$, where $0 < s < 1$ is the country size, into two baskets of intermediate goods (tradable and nontradable) under perfect competition. Consider now the composition of the baskets of intermediate goods.

Focusing first on the basket N_A, this is a CES index of all domestic brands of nontradables. Denoting as $N_A(n, x)$ the demand by firm x of an intermediate good produced by firm n, the basket $N_A(x)$ is:

$$N_{A,t}(x) = \left[\left(\frac{1}{s} \right)^{\frac{1}{\theta_{N,t}}} \int_0^s N_{A,t}(n, x)^{1-\frac{1}{\theta_{N,t}}} dn \right]^{\frac{\theta_N}{\theta_N - 1}} \quad \text{(A-15)}$$

Firm x takes as given the prices of the nontradable goods $p(n)$ and minimizes its costs subject to its production technology (A-15). Cost minimization implies:

$$N_{A,t}(n, x) = \frac{1}{s} \left(\frac{p_t(n)}{p_{N,t}} \right)^{-\theta_N} N_{A,t}(x) \quad \text{(A-16)}$$

where p_N is the price of one unit of the non-tradable basket, or:

$$p_{N,t} = \left[\left(\frac{1}{s} \right) \int_0^s p_t(n)^{1-\theta_N} dn \right]^{\frac{1}{1-\theta_N}} \quad \text{(A-17)}$$

The basket N_E is similarly characterized. Aggregating across firms, and accounting for public demand of nontradables — here assumed to have the same composition of private demand — we

[24] All exchange rates are quoted in real terms, that is, in relative consumption units. Of course, $\varepsilon^{H,CO} = 1/\varepsilon^{CO,H}$ and $\varepsilon^{H,H} = 1$.

obtain the total demand for good n as:[25]

$$\int_0^s N_{A,t}(n,x)dx + \int_0^s N_{E,t}(n,e)de + G_{N,t}(n) = \left(\frac{p_t(n)}{p_{N,t}}\right)^{-\theta_N} (N_{A,t} + N_{E,t} + G_{N,t}) \quad \text{(A-18)}$$

Following the same steps we can derive the domestic demand schedules for the intermediate goods h:

$$\int_0^s Q_{A,t}(h,x)dx + \int_0^s Q_{E,t}(h,e)de + G_{A,t}(h) = \left(\frac{p_t(h)}{p_{Q,t}}\right)^{-\theta_T^H} (Q_{A,t} + Q_{E,t} + G_{A,t}) . \quad \text{(A-19)}$$

Demand for imports

The derivation of the foreign demand schedule for good h shares the same functional form as (A-18) and (A-19) above and can be written as a function of the relative price of good h (with elasticity $\theta_{T,t}$) and total foreign demand for imports.

Let us focus first on import demand in the consumption good sector. Since we deal with goods produced in different countries, the notation needs to rely on specific country indexes. Thus, we refer again to a generic country as CO, to the importing country as H, and to the representative firm in the consumption sector as $x^H \in [0, s^H]$. Its imports $M_A^H(x^H)$ are a CES function of baskets of goods imported from the other countries, or:

$$M_{A,t}^H(x^H)^{1-\frac{1}{\rho_A^H}} = \sum_{CO \neq H} \left(b_A^{H,CO}\right)^{\frac{1}{\rho_A^H}} \left(M_{A,t}^{H,CO}(x^H)\right)^{1-\frac{1}{\rho_A^H}} \quad \text{(A-20)}$$

where:

$$0 \leq b^{H,CO} \leq 1, \quad \sum_{CO \neq H} b^{H,CO} = 1 \quad \text{(A-21)}$$

In (A-20) above, $M_A^{H,CO}(x^H)$ denotes imports of country H's firm x^H from country CO, while ρ_A^H is the elasticity of import substitution across countries: the higher ρ_A^H, the easier it is for firm x^H to substitute imports from one country with imports from another. The parameters $b_A^{H,CO}$ determine the composition of the import basket across countries.

Denoting $p_M^{H,CO}$ the relative price in country H of a basket of intermediate inputs imported from CO, cost minimization implies:

$$M_{A,t}^{H,CO}(x^H) = b_A^{H,CO} \left(\frac{p_{M,t}^{H.CO}}{p_{MA,t}^H(x^H)}\right)^{-\rho_A^H} M_{A,t}^H(x^H) \quad \text{(A-22)}$$

[25] Variables which are not explicitly indexed (to firms or households) are expressed in per-capita (average) terms. For instance $A_t \equiv (1/s)\int_0^s A_t(x)dx$.

The import price in the consumption sector, p^H_{MA}, is defned as:

$$p^H_{MA,t}(x^H) = \left[\sum_{CO \neq H} b^{H,CO} \left(p^{H,CO}_{M,t} \right)^{1-\rho^H_A} \right]^{\frac{1}{1-\rho^H_A}} \tag{A-23}$$

In principle, the cost-minimizing import price $p^H_{MA}(x^H)$ is frm-specifc, as it depends on frm x^H's import share. To the extent that all frms x^H are symmetric within the consumption sector, however, there will be a unique import price p^H_{MA}.[26]

Let us now consider the basket $M^{H,CO}_A(x^H)$ in some detail. In analogy with (A-15) above, it is a CES index of all brands of tradable intermediate goods produced by frms h^{CO} operating in country CO and exported to country H. Denoting as $M^{H,CO}_A\left(h^{CO}, x^H\right)$ the demand by frm x^H of an intermediate good produced by frm h^{CO}, the basket $M^{H,CO}_A\left(x^H\right)$ is:

$$M^{H,CO}_{A,t}(x^H) = \left[\left(\frac{1}{s^{CO}} \right)^{\frac{1}{\theta^{CO}_{T,t}}} \int_0^{s^{CO}} M^{H,CO}_{A,t}\left(h^{CO}, x^H\right)^{1-\frac{1}{\theta^{CO}_T}} dh^{CO} \right]^{\frac{\theta^{CO}_T}{\theta^{CO}_T - 1}} \tag{A-24}$$

where $\theta^{CO}_T > 1$ is the elasticity of substitution among intermediate brands, the same elasticity entering (A-19) in country CO.

The cost-minimizing frm x^H takes as given the prices of the imported goods $p^H(h^{CO})$ and determines its demand of good h^{CO} according to:

$$M^{H,CO}_{A,t}(h^{CO}, x^H) = \frac{1}{s^{CO}} \left(\frac{p^H_t(h^{CO})}{p^{H,CO}_{M,t}} \right)^{-\theta^{CO}_T} M^{H,CO}_{A,t}(x^H) \tag{A-25}$$

where $M^{H,CO}_{A,t}(x^H)$ has been defned in (A-22) and $p^{H,CO}_M$ is:

$$p^{H,CO}_{M,t} = \left[\left(\frac{1}{s^{CO}} \right) \int_0^{s^{CO}} p^H_t\left(h^{CO}\right)^{1-\theta^{CO}_T} dh^{CO} \right]^{\frac{1}{1-\theta^{CO}_T}} \tag{A-26}$$

The import demand schedules in the investment good sector can be derived in the same way. Finally, we can derive country CO's demand schedule for country H's intermediate good h^H, that is, the foreign equivalent of (A-19). Aggregating across frms (and paying attention to the order of the country indexes) we obtain:

$$\begin{aligned} &\int_0^{s^{CO}} M^{CO,H}_{A,t}(h^H, x^{CO}) dx^{CO} + \int_0^{s^{CO}} M^{CO,H}_{E,t}(h^H, e^{CO}) de^{CO} + G^{CO,H}_{A,t}(h) \\ &= \frac{s^{CO}}{s^H} \left(\frac{p^{CO}_t(h^H)}{p^{CO,H}_{M,t}} \right)^{-\theta^H_{T,t}} \left(M^{CO,H}_{A,t} + M^{CO,H}_{E,t} \right) + \left(\frac{p^{CO}_t(h^H)}{p^{CO,H}_{M,t}} \right)^{-\theta^H_T} G^{CO,H}_{A,t}(h) \end{aligned} \tag{27}$$

[26]It follows that $p^H_{MA} M^H_A = \sum_{CO \neq H} p^{H,CO}_M M^{H,CO}$

Final goods

The baskets of intermediate goods are used in each country by a continuum of symmetric f rms to produce two f nal goods, the consumption good (A) and the investment good (E) under perfect competition.[27]

Consider f rst the consumption sector. Each f rm is indexed by $x \in [0, s]$, where $0 < s < 1$ is the country size. Indicating f rm x's output at time (quarter) t with $A_t(x)$, the consumption good is produced with the following nested constant elasticity of substitution (CES) technology:

$$A_t(x)^{1-\frac{1}{\varepsilon_A}} = \left(1-\gamma_{A,t}\right)^{\frac{1}{\varepsilon_A}} N_{A,t}(x)^{1-\frac{1}{\varepsilon_A}} \\ +\gamma_{A,t}^{\frac{1}{\varepsilon_A}}[\nu_A^{\frac{1}{\mu_A}} Q_{A,t}(x)^{1-\frac{1}{\mu_A}} + (1-\nu_A)^{\frac{1}{\mu_A}} M_{A,t}(x)^{1-\frac{1}{\mu_A}}]^{\frac{\mu_A}{\mu_A-1}\left(1-\frac{1}{\varepsilon_A}\right)} \quad \text{(A-28)}$$

Three intermediate inputs are used in the production of the consumption good A: a basket N_A of nontradable goods, a basket Q_A of domestic tradable goods, and a basket M_A of imported goods. The elasticity of substitution between tradables and nontradables is $\varepsilon_A > 0$, and the elasticity of substitution between domestic and imported tradables is $\mu_A > 0$. The weights of the three inputs are, respectively, $1-\gamma_A$, $\gamma_A\nu_A$ and $\gamma_A(1-\nu_A)$ with $0 < \gamma_A, \nu_A < 1$.

Firm x takes as given the prices of the three inputs and minimizes its costs subject to the technological constraint (A-28). Cost minimization implies that f rm x's demands for intermediate inputs are:

$$N_{A,t}(x) = \left(1-\gamma_{A,t}\right) p_{N,t}^{-\varepsilon_A} A_t(x) \quad \text{(A-29)}$$

$$Q_{A,t}(x) = \gamma_{A,t}\nu_A p_{Q,t}^{-\mu_A} p_{XA,t}^{\mu_A-\varepsilon_A} A_t(x) \quad \text{(A-30)}$$

$$M_{A,t}(x) = \gamma_{A,t}\left(1-\nu_A\right) p_{MA,t}^{-\mu_A} p_{XA,t}^{\mu_A-\varepsilon_A} A_t(x) \quad \text{(A-31)}$$

where p_N, p_Q and p_{MA} are the relative prices of the inputs in terms of consumption baskets and p_{XA} is the price of the composite basket of domestic and foreign tradables, or:

$$p_{XA,t} \equiv \left[\nu_A p_{Q,t}^{1-\mu_A} + (1-\nu_A)\, p_{MA,t}^{1-\mu_A}\right]^{\frac{1}{1-\mu_A}} \quad \text{(A-32)}$$

The technologies for the production of consumption and investment goods can be parametrized differently but their functional forms are the same, with self-explanatory changes in notation. For instance, a f rm $e \in [0, s]$ produces the investment good demands nontradable goods according to:

$$N_{E,t}(e) = \left(1-\gamma_{E,t}\right)\left(p_{N,t}/p_{E,t}\right)^{-\varepsilon_E} E_t \quad \text{(A-33)}$$

Note that p_{MA} and p_{ME} are sector-specif c as they ref ect the different composition of imports - described below - in the two sectors, while p_N and p_Q are identical across sectors.

[27] A is the *numeraire* of the economy and all national prices are expressed in terms of domestic consumption units, that is relative to the consumer price index (CPI).

B. Households

Consumer preferences

In each country there is a continuum of households indexed by $j \in [0, s]$, the same index of labor inputs. Some households have access to capital markets, while others do not. The latter, indexed by $j \in [0, s(1 - s_{LC})]$, finance their consumption by relying exclusively on their income from labor and are a share $(1 - s_{LC})$ of total domestic households. The former are a share s_{LC} of total domestic households and are indexed by $j \in (s(1 - s_{LC}), s]$.

The specification of households' preferences adopts the Greenwood, Hercowitz and Huffman (1988) (GHH) utility function, adjusted for habit formation and preference shocks. Denoting with $\mathcal{W}_t(j)$ the lifetime expected utility of household j, we have:

$$\mathcal{W}_t(j) \equiv \mathsf{E}_t \sum_{\tau=t}^{\infty} \beta^{\tau} g_{t,\tau}^{1-\sigma} u_{\tau}(\, C_{\tau}(j), \ell_{\tau}(j)\,) \tag{A-34}$$

where the instantaneous felicity is a function of detrended consumption C and labor effort ℓ:

$$\begin{aligned} u_t\,(\, C_t(j), \ell_t(j)\,) &= Z_U(1 - \frac{b_c}{g_{t-1,t}})(\frac{1-b_\ell}{1-\sigma}) \\ *[\frac{C_t(j) - b_c C_{j,t-1}/g_{t-1,t}}{1 - b_c/g_{t-1,t}} &- \frac{Z_V}{1+\zeta}(\frac{\ell_t(j) - b_\ell \ell_{j,\tau-1}}{1-b_\ell})^{1+\zeta}]^{1-\sigma} \end{aligned} \tag{A-35}$$

In the expressions above β^{τ} is the discount rate between time t and time τ, possibly different across countries. The term $g_{t,\tau}^{1-\sigma}$ in (A-34) implies that the disutility of labor effort increases with the common trend. As customary, this feature can be interpreted as technological progress associated with home production activities, here related to the global trend. The parameter σ in (A-34) and (A-35) is the reciprocal of the elasticity of intertemporal substitution. The parameter ζ which affects the curvature of labor disutility is the reciprocal of the Frish elasticity.

There is habit persistence in consumption with coefficient $0 < b_c < 1$. The term $C_{j,t-1}$ in (A-35) is past per-capita consumption of household j's peers. Similarly, there is habit persistence in leisure with coefficient $0 < b_\ell < 1$.[28] The terms Z_U and Z_V are constants.

[28]The instantaneous felicity is normalized such that in a steady state U , U_C and U_ℓ can all be written as $constant * f(C, \ell)$, where f is some function of steady-state consumption and labor effort, independent of the habit persistence coefficients.

Budget constraint (Ricardian households)

The individual f ow budget constraint for Ricardian agent $j \in [0, (1 - s_{LC})\, s]$ is:

$$B_t(j) + \varepsilon_t B_t^*(j) \leq (1 + i_{t-1}) \frac{B_{t-1}(j)}{g_{t-1,t}} + (1 + i_{t-1}^*) \left[1 - \Gamma_{B,t-1}\right] \frac{\varepsilon_t B_{t-1}^*(j)}{g_{t-1,t}}$$
$$+ r_t K_t(j) + w_t(j)\ell_t(j) - C_t(j) - p_{E,t} I_t(j) + \Phi_t(j) - TT_t(j) \quad (36)$$

where $TT_t < 0$ is a positive transfer to households.

Households hold two real bonds: $B_t(j)$ represents (detrended) holdings of domestic bond by household j, expressed in terms of domestic consumption units, while $B_t^*(j)$ indicates (detrended) holdings of the international bond, expressed in terms of US consumption units, and ε_t is the CPI-based, bilateral real exchange rate, expressed as the price of one unit of US consumption basket in terms of domestic consumption.[29]

The short-term real rates i_t and i_t^* are paid at the beginning of period $t + 1$ and are known at time t. Only the US bond is traded internationally and is in zero net supply worldwide, while the domestic bond is issued by the local government.[30] It follows that the net f nancial wealth of Ricardian household j at time t is:

$$F_t(j) \equiv (1 + i_{t-1}^*) \left[1 - \Gamma_{B,t-1}\right] \frac{\varepsilon_t B_{t-1}^*(j)}{g_{t-1,t}} \quad \text{(A-37)}$$

A f nancial friction Γ_B is introduced to guarantee that international net asset positions follow a stationary process and that economies converge asymptotically to a well-def ned steady state. Agents who take a position in the international bond market must deal with f nancial intermediaries who charge a transaction fee Γ_B on sales/purchases of the international bond.[31] This transaction cost is a function of the aggregate net foreign asset position of the whole economy. Specif cally, we adopt the following functional form:

$$1 - \Gamma_{B,t} = \left(1 - \phi_{B1} \frac{\exp\left(\phi_{B2}\left[\varepsilon_t B_t^* - b_F^* GDP_t\right]\right) - 1}{\exp\left(\phi_{B2}\left[\varepsilon_t B_t^* - b_F^* GDP_t\right]\right) + 1}\right) \quad \text{(A-38)}$$

where $0 \leq \phi_{B1} \leq 1$, $\phi_{B2} > 0$, and $\varepsilon_t B^* \equiv (1/s)\, \varepsilon_t \int_0^{s(1-s_{LC})} B^*(j)dj$ represents the per-capita net asset position of the country in consumption units. The term b_F^* is the desired, steady state net asset position of the country expressed as a ratio of GDP.[32]

[29]Note that ε is shorthand for $\varepsilon^{H,US}$, where H denotes the country under consideration.
[30]If the country under consideration is the United States, $\varepsilon = 1$ and $i = i^*$.
[31]In our model it is assumed that all intermediation f rms are owned by the country's residents, and that their revenue is rebated to domestic households in a lump-sum form. A simple variant of the model in which intermediation f rms are owned by foreign residents leaves the basic results virtually unchanged. There are no intermediation costs for US residents entering the international bond market, that is, there is no difference between onshore and offshore US interest rates.
[32]The concept of GDP in our model will be discussed below with reference to (A-52).

To understand the role played by Γ_B, suppose first that $b_F^* = 0$. In this case, when the net asset position of the country is equal to its steady state level of zero, it must be the case that $\Gamma_B = 0$ and the return on the international bond is equal to $1 + i^*$. If the country is a net creditor Γ_B rises above zero, implying that domestic residents lose an increasing fraction of their international bond returns to financial intermediaries. When holdings of the international bond go to infinity, the return on the international bond approaches $(1 + i^*)(1 - \phi_{B1})$. By the same token, if the country is a net debtor worldwide Γ_B falls from zero to $-\phi_{B1}$, implying that households pay an increasing intermediation premium on their international debt. When net borrowing goes to infinity, the cost of borrowing approaches $(1 + i^*)(1 + \phi_{B1})$. The parameter ϕ_{B2} controls the flatness of the Γ_B function: if $\phi_{B2} = 0$ then $\Gamma_B = 0$ regardless of the net asset position; if ϕ_{B2} tends to infinity then $1 - \Gamma_B = (1 - \phi_{B1})$ for any arbitrarily small net lending position, and $1 - \Gamma_B = (1 + \phi_{B1})$ for any arbitrarily small net borrowing position. An appropriate parameterization allows the model to generate realistic dynamics for net asset positions and current account.

Households accumulate physical capital which they rent to domestic firms at rate r. The law of motion of capital is:

$$K_{t+1}(j) g_{t,t+1} = (1 - \delta) K_t(j) + \Gamma_{I,t} K_t(j) \qquad 0 < \delta \leq 1 \tag{A-39}$$

where δ is the country-specific depreciation rate of capital. To simulate realistic investment flows, capital accumulation is subject to adjustment costs. Capital accumulation is denoted by $\Gamma_{I,t} K_t(j)$, where $\Gamma_I(.)$ is an increasing, concave, and twice-continuously differentiable function of the investment/capital ratio $I_t(j)/K_t(j)$ with two properties entailing no adjustment costs in steady state: $\Gamma_I(\delta + g - 1) = \delta + g - 1$ and $\Gamma_I'(\delta + g - 1) = 1$. The specific functional form we adopt is quadratic and encompasses inertia in investment:

$$\Gamma_{I,t}(j) \equiv \frac{I_t(j)}{K_t(j)} - \frac{\phi_{I1}}{2} \left(\frac{I_t(j)}{K_t(j)} - (\delta + g - 1) \right)^2$$

where $\phi_{I1} \geq 0$, and g is the steady-state growth rate.

Each household j is the monopolistic supplier of a specific labor input and sets the nominal wage for its labor variety j accounting for (A-9).

Ricardian households own all domestic firms and there is no international trade in claims on firms' profits. Finally, the variable Φ in the budget constraint includes all dividends accruing to shareholders, plus revenue from financial intermediation which is assumed to be provided by domestic firms exclusively.

Liquidity-constrained households

A fraction of the population is composed by liquidity-constrained households, that do not borrow or save because of lack of access to financial markets. Hence, they cannot smooth their consumption intertemporally. Each household is subject to the following budget constraint:

$$C_t(j) = w_t(j) L_t(j) - TT_t(j)$$

For simplicity we assume that the amount of hours worked, L_t, the real wage and the per capita amounts of net transfers from the fiscal authority are the same as the correspondent counterparts received by the forward-looking agents.

C. Government

Given that all prices and wages are fully flexible, we impose that there is no role for monetary policy. For calibration purposes, we assume there is a fiscal authority in each country which consumes final goods and collects lump-sum taxes following a simple feedback rule such that deviations of the government debt-to-GDP ratio from its target are temporary.

Specifically, public spending falls exclusively on intermediate nontradable goods. The Home government budget constraint is:

$$\frac{B_{G,t}}{R_t} - B_{G,t-1} = p_{N,t} G_t - TT_{X,t}$$

B_G is the negative of a riskless one-period real bond domestically sold (government debt). TT_X are total lump-sum taxes (in consumption units) paid by the households. R_t is the gross real interest rate. We assume that Ricardian and non-Ricardian agents are equally taxed. Taxes are set so as to stabilize the public debt:

$$\left(\frac{TT_{Xt}}{TT_X}\right) = \left(\frac{B_{G,t}}{B_G}\right)^{\phi_B}$$

where $\phi_B > 0$ and TT_X and B_G are the steady state values of tax and public debt.

D. Market clearing and the current account

The model is closed by imposing the following resource constraints and market clearing conditions, adopting explicit country indexes.

For every country H, the domestic resource constraints for capital and labor are, respectively:

$$\int_0^{s^H\left(1-s^H_{LC}\right)} K^H_t(j^H)dj^H \geq \int_0^{s^H} K^H_t(n^H)dn^H + \int_0^{s^H} K^H_t(h^H)dh^H \tag{A-40}$$

and:

$$\ell^H_t(j^H) \geq \int_0^{s^H} \ell^H_t(n^H, j^H)dn^H + \int_0^{s^H} \ell^H_t(h^H, j^H)dh^H \tag{A-41}$$

The resource constraint for the nontradable good n^H is:

$$N^H_t(n^H) \geq \int_0^{s^H} N^H_{A,t}(n^H, x^H)dx^H + \int_0^{s^H} N^H_{E,t}(n^H, e^H)de^H + \eta\left(n\right)\int_0^{s^H} T_t\left(h^H\right)dh^H + G_t \tag{A-42}$$

while the tradable h^H can be used by domestic firms or imported by foreign firms:

$$T_t\left(h^H\right) \geq \int_0^{s^H} Q_{A,t}(h^H, x^H)dx^H + \int_0^{s^H} Q_{E,t}(h^H, e^H)de^H$$
$$+ \sum_{CO \neq H} \left(\int_0^{s^{CO}} M_{A,t}^{CO,H}(h^H, x^{CO})dx^{CO} + \int_0^{s^{CO}} M_{E,t}^{CO,H}(h^H, e^{CO})de^{CO} \right) \quad \text{(A-43)}$$

The final good A can be used for private consumption (by both liquidity-constrained and forward-looking households):

$$\int_0^{s^H} A_t^H(x^H)dx^H \geq \int_0^{s^H(1-s_{LC}^H)} C^H(j^H)dj^H + \int_{s^H(1-s_{LC}^H)}^{s^H} C^H(j^H)dj^H \quad \text{(A-44)}$$

and similarly for the investment good E:

$$\int_0^{s^H} E_t^H(e^H)de^H \geq \int_0^{\left(1-s_{LC}^H\right)s^H} I_t^H(j^H)dj^H \quad \text{(A-45)}$$

Market clearing in the asset market requires:

$$\int_0^{s^H(1-s_{LC}^H)} B_t^H(j^H)dj^H = s^H B_t^H \quad \text{(A-46)}$$

for the five government bond markets, and:

$$\sum_{CO} \int_0^{s^{CO}(1-s_{LC}^{CO})} B_t^{*CO}(j^{CO})dj^{CO} = 0. \quad \text{(A-47)}$$

E. Measuring output and current account

The current account balance of country H can be written as:

$$CURBAL_t^H = \varepsilon_t^{H,US}\left(B_t^{*H} - \frac{B_{t-1}^{*H}}{g_{t-1,t}}\right) = \frac{i_{t-1}^{*}\varepsilon_t^{H,US}B_{t-1}^{*H}}{g_{t-1,t}} + TBAL_t^H \quad \text{(A-48)}$$

The left hand side of (A-48) represents algebraically country H's current account, the first term on the right hand side indicates net factor payments from the rest of the world to country H and $TBAL$ is the trade balance. The latter can be expressed in symbols as:

$$TBAL_t^H = EX_t^H - IM_t^H \quad \text{(A-49)}$$

where total exports EX are:

$$EX_t^H = p_{T,t}^H T_t^H - p_{Q,t}^H\left(Q_{A,t}^H + Q_{E,t}^H\right) \quad \text{(A-50)}$$

and total imports IM are:

$$IM_t^H = p_{MA,t}M_{A,t}^H + p_{ME,t}M_{E,t}^H = \sum_{CO \neq H} p_{M,t}^{H,CO}\left(M_{A,t}^{H,CO} + M_{E,t}^{H,CO}\right) \tag{A-51}$$

Finally, we define the model-based Gross Domestic Product (in consumption units) as:

$$GDP_t^H = A_t^H + p_{E,t}^H E_t^H + EX_t^H - IM_t^H = p_{N,t}^H N_t^H + p_{T,t}^H T_t^H \tag{A-52}$$

so that:

$$CURBAL_t^H = TBAL_t^H + \frac{i_{t-1}^* \varepsilon_t^{H,US} B_{t-1}^{*H}}{g_{t-1,t}} = GDP_t^H - \left(C_t^H + p_{E,t}^H I_t^H\right) + \frac{i_{t-1}^* \varepsilon_t^{H,US} B_{t-1}^{*H}}{g_{t-1,t}} \tag{A-53}$$

Note that, while theoretically consistent with the model, this measure of output is not consistent with standard, fixed-weight, constant-dollar measures of real GDP constructed by national accounts. The problem is particularly severe for relatively open economies facing large swings in real exchange rates and relative prices. In the simulations, we therefore adopt 'national accounts' concepts for GDP, $TBAL$ and their components, evaluating constant-dollar expenditures at any time t by using fixed steady-state prices instead of the corresponding relative prices at time t.

F. The equilibrium

We find a symmetric equilibrium of the model. In each country there are two representative agents (Ricardian and non-Ricardian) and four representative firms (belonging to the intermediate tradable sector, the intermediate nontradable sector, the consumption production sector and the investment production sector). The equilibrium is a sequence of allocations and prices such that, given initial and transversality conditions and the sequence of exogenous shocks, each private agent and firm satisfy the correspondent first order conditions such that market clearing conditions hold.

G. Calibration

To calibrate the model we rely on previous GEM work at the IMF (e.g., Hunt and Rebucci (2005), Batini, N'Diaye, Rebucci (2005), Faruquee et al. (2007)) and on the real business cycle and trade literature. This is the same calibration used by Cova et al (2008). Table A1 provides a data benchmark for the steady state of the model. Tables A2 through A5 document the parameterization adopted, including in particular the regional composition of imports.

Table A2 reports the parameter governing the optimization problem of households and firms. The share of non Ricardian households is 10 percent, in all five regional blocs. Although households differ with respect to their access to financing, the preferences of the liquidity-constrained and forward-looking households are identical. We set identical discount factors, at 0.997, which implies a steady state quarterly real interest rate of 0.53 percent, and unitary elasticities of intertemporal substitution in consumption (i.e., logarithmic period utility). For labor, we assume a common value for the Frish elasticity of 0.67. The elasticity of substitution between labor and capital is set at 0.75 in both the tradable and non-tradable sectors. This is slightly lower than the conventional (Cobb-Douglas) unitary assumption to help reduce the sensitivity of capital to changes in its relative price. The bias towards the use of capital, sector-specif c but common across countries, yields a slightly higher investment share of GDP for emerging Asia (close to 18 percent) relative to the other blocks, whose investment shares are very similar (between 15 and 16 percent). In all regions, the non-tradable sector (e.g., services) is assumed to be less capital-intensive than the tradable sector (e.g., manufacturing). The depreciation rate is assumed to be 2 percent per quarter across all regions (8 percent per year). Following the trade literature we set the elasticity of substitution between imported goods and that between (domestic and imported) tradeable to a relatively high level, equal to 4, thus typically higher than in the GEM. The substitution between tradable and non-tradable is set to a more conventional level of 0.5, consistent with the GEM.

The only real rigidities that we keep are described in Table A3. The distribution cost parameter is set at 0.3, a value very close to that used in the GEM. Following the RBC literature, the capital adjustment cost parameter is set very low, at 0.01, and habit persistence on consumption and labor, as well as adjustment costs on investment, are set to 0 (not reported in Table A3).

There are separate mark-ups on tradable and non-tradable goods since f rms have pricing power under monopolistic competition (Table A4). We use estimates for the price mark-ups from Martins, Scarpetta, and Pilat (1996) and take the simple average of their sector-specif c values for the United States, Japan, the euro area, and the rest of the world. This yields average mark-ups of 18 and 35 percent for the traded and non traded sectors, respectively. In the labor market, we assume agents have the same pricing power, yielding a 20 percent wage mark-up in all regions.

The calibration of each international linkages is reported in Table A5. The regional composition of imports in Table A5, as well as the weight coeff cients in the demand function for imports in Table A2, are consistent with the matrix of trade shares (at end-2002) used to calibrate the IMF GEM. The elasticity of substitution among baskets of imports from different countries is slightly higher than the elasticity between home and foreign tradable goods, at 5. The maximum and the steepness of the f nancial intermediation cost on net foreign asset holdings are set as in the GEM at 0.05 and 0.1, respectively. Finally, the common gross rate of growth, $g_{t\tau}$, is set to one. This corresponds to assuming that the model is stationary and there is no underlying trend growth.

H. Solution

The model is coded in DYNARE and is solved using the deterministic (perfect foresight) simulation command “simul”, with a simulation length of 500 periods or quarters. The “simul” instruction uses a Newton method to solve simultaneously all the equations for every period (see Juillard, 1996). Simulations with up to 6000 periods give similar results.

Table A1: Steady-state National Accounts (In percent of GDP)

	US	JA	AS	EA	ROW
Private Consumption	68.96	59.64	69.33	58.99	67.83
Forward-looking consumers	62.64	52.56	54.71	54.73	62.00
Liquidity-constrained consumers	6.31	7.08	14.60	4.25	5.83
Private Investment	15.94	21.08	19.34	15.32	15.73
Public Expenditure	14.51	19.78	12.1	25.5	16.8
Trade balance	0.60	-0.41	-0.64	0.18	-0.37
Imports	11.46	11.49	26.73	17.41	22.98
Consumption Goods	7.33	8.06	11.32	15.01	12.13
Investment Goods	4.13	3.43	15.40	2.40	10.85
Government Debt	61.5	80.0	55.0	60.0	60.0
Net Foreign Assets	-51.08	55.03	49.02	-11.3	26.4
Share of World GDP (percent)	30.05	11.48	9.83	22.80	25.84

Source: Batini, N'Diaye, Rebucci (2005).

Table A2: Households and Firms Behavior

	US	JA	AS	EA	ROW
Rate of time preference	.997	.997	.997	.997	.997
Depreciation rate	0.02	0.02	0.02	0.02	0.02
Intertemporal elasticity of substitution	1.00	1.00	1.00	1.00	1.00
Inverse of the Frisch elasticity of labor	1.50	1.50	1.50	1.50	1.50
Share of liquidity-constrained consumers	0.10	0.10	0.10	0.10	0.10
Tradable Intermediate Goods					
Substitution between factors of production	0.75	0.75	0.75	0.75	0.75
Bias towards capital	0.60	.60	0.60	0.60	0.60
Nontradable Intermediate Goods					
Substitution between factors of production	0.75	0.75	0.75	0.75	0.75
Bias towards capital	0.50	.50	0.50	0.50	0.50
Final consumption goods					
Substitution between domestic and imported goods	4	4	4	4	4
Bias towards domestic goods	0.87	0.49	0.15	0.04	0.20
Substitution between tradables and nontradables	0.50	0.50	0.50	0.50	0.50
Bias towards tradable goods	0.35	0.36	0.37	0.36	0.30
Final investment goods					
Substitution between domestic and imported goods	4	4	4	4	4
Bias towards domestic goods	0.87	0.63	0.06	0.92	0.14
Substitution between tradables and nontradables	0.50	0.50	0.50	0.50	0.50
Bias towards tradable goods	0.75	0.77	0.82	0.75	0.73

Table A3: Real rigidities

	US	JA	AS	EA	ROW
Capital accumulation	0.01	0.01	0.01	0.01	0.01
Distribution costs	0.30	0.30	0.30	0.30	0.30

Table A4: Price and Wage Markups

	US	JA	AS	EA	ROW
Tradables Price Markups	1.18	1.18	1.18	1.18	1.18
Nontradables Price Markups	1.35	1.35	1.35	1.35	1.35
Wage Markup	1.20	1.20	1.20	1.20	1.20

Table A5: International Linkages

	US	JA	AS	EA	ROW
Substitution between consumption imports	5	5	5	5	5
Bias towards imported consumption goods from					
US	...	0.45	0.23	0.04	0.39
JA	0.06	...	0.12	0.03	0.01
AS	0.17	0.38	...	0.14	0.02
EA	0.16	0.10	0.25	...	0.58
ROW	0.61	0.07	0.40	0.79	...
Substitution between investment imports from	5	5	5	5	5
Bias towards imported investment goods from					
US	...	0.53	0.26	0.26	0.37
JA	0.06	...	0.13	0.05	0.04
AS	0.28	0.25	...	0.14	0.16
EA	0.16	0.13	0.12	...	0.43
ROW	0.50	0.09	0.49	0.55	...
Net Foreign Liabilities					
Maximum of f nancial intermediation cost function	0.05	0.05	0.05	0.05	0.05
Steepness of f nancial intermediation cost function	0.1	0.1	0.1	0.1	0.1

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