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Productivity and Global Imbalances: The Role of Nontradable Total Factor Productivity in Advanced Economies

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This paper investigates the role played by total factor productivity (TFP) in the tradable and nontradable sectors of the United States, the euro area, and Japan in the emergence and evolution of today's global trade imbalances. Simulation results based on a dynamic general equilibrium model of the world economy, and using the new EU KLEMS database, indicate that TFP developments in these economies can account for a significant fraction of the deterioration in the U.S. trade balance since 1998, as well as for some of the surpluses in the euro area and Japan. Differences in TFP developments across sectors can also partially explain the evolution of the real effective value of the U.S. dollar during this period. These results highlight the importance of focusing on productivity developments in the nontradable sector of these large, relatively closed economies to understand the evolution of their trade balance and real exchange rate. [JEL E0, F3, F4, G1]
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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 three-quarters of the world's current account surpluses, and net U.S. liabilities are at record-high, representing over one-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 an equilibrium phenomenon, generated by the interaction of growth and financial development differentials among countries, that will resolve themselves slowly over time.[1] Many, however, trust that these imbalances originate in economic distortions, and that they should be resolved primarily through policy adjustment, including significant changes in effective exchange rates and fiscal policies or both.[2]

One issue that, by contrast, is relatively undisputed is that differences in relative productivity across world regions have likely played a nonnegligible role in the emergence and evolution of today's trade imbalances. This general perception is supported by empirical evidence. Glick and Rogoff (1995), for example, estimate that a 1 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 potential role of total factor productivity (TFP) differences across countries in explaining the global imbalances, based on multicountry dynamic general equilibrium (DGE) models with calibrated TFP processes. Erceg, Guerrieri, and Gust (2002) and Hunt and Rebucci (2005), for instance, find that a permanent shock to the level of TFP in the United States, combined with uncertainty or learning about its persistence, can explain at least in part the behavior of the U.S. trade deficit in the late 1990s.

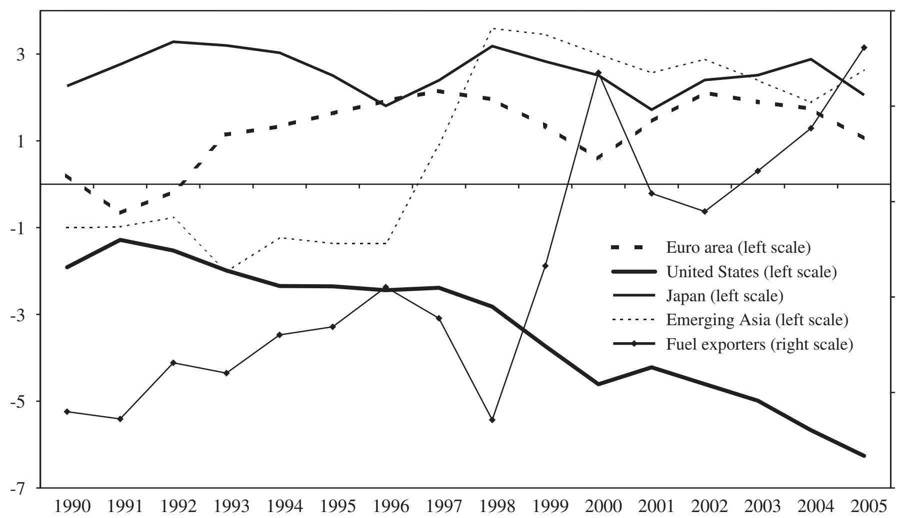
As Obstfeld and Rogoff (2007) note, however, productivity could only help to reduce the large U.S. trade deficit if it were concentrated either in the tradable sector of the United States (as foreign goods become less attractive to both U.S. and non-U.S. residents) or in the nontradable sector in the euro area and Japan (as this boosts their wage and capital income and hence their demand for U.S. goods).[3] Reasoning along these lines, they infer that much

[1]See, for example, Engel and Rogers (2006); Blanchard (2007); Caballero, Fahri, and Gourinchas (2006); Mendoza, Rios-Rull, and Quadrini (2007); Fogli and Perri (2006); and McGrattan and Prescott (2007).

[2]See, for example, IMF (2005 and 2006a); Blanchard, Giavazzi, and Sa (2005); Mussa (2004); Obstfeld and Rogoff (2007); Roubini and Setser (2004); and Yoshitomi (2007).

[3]Guerrieri, Henderson, and Kim (2005) also point out that the transmission of a TFP shock in the tradable sector may differ significantly from that of a shock in the nontradable sector of the U.S. economy, in terms of the responses of the exchange rate and the trade balance.

Figure 1. Global Merchandise Trade Balances
(In percent of GDP)



of the widening of the U.S. trade deficit over the past 10 years or so must have originated from the boom in relative productivity in the U.S. nontradable sector.

This paper investigates the role played by TFP in the tradable and nontradable sectors of the United States, the euro area, and Japan in the emergence and evolution of today's global trade imbalances. Specifically, we feed sector-specific TFP data from 1995 to 2004 for these countries, from a new and homogenous data set, to a flexible-price version of the (DGE) model of the world economy developed by Cova and Pisani (2007) at the Bank of Italy.

This model is a five-region DGE. It comprises an emerging Asia and a rest-of-the-world bloc, in addition to the United States, the euro area, and Japan, and shares many features with the IMF's Global Economy Model (GEM).[4] The model does not treat oil-exporting economies separately. It does not incorporate realistic financial frictions, possibly inducing precautionary demands for official reserves or constraining the supply of marketable financial assets, as well as other policy distortions, such as sustained sterilized foreign exchange intervention.[5]

Subject to the caveat that the analysis in this paper focuses only on one among several factors likely to drive the current constellation of global

[4]See Laxton and Pesenti (2003); Hunt and Rebucci (2005); Batini, N'Diaye, and Rebucci (2005); and Faruqee, Muir, and Pesenti (2007).

[5]See IMF (2006b and 2007) on the role of oil prices and exchange rate changes for global imbalances.

imbalances, we find that TFP developments in advanced economies, and especially in the nontradable sector of the United States, can account for a significant fraction of the deterioration in the U.S. trade balance after 1998, as well as for some of the surplus periods in the euro area and Japan. Sector-specific productivity differentials in the United States also do well at capturing the direction, persistence, and turning point of the U.S. dollar effective exchange rate since the mid-1990s, although the volatility of the simulated exchange rate path is much smaller, and the turning point earlier, than in the data.

I. Methodology

We feed to our model historically realized TFP paths for the United States, the euro area, and Japan. We then compare actual and simulated paths for the trade balance, as well as the real effective exchange rate and the national accounts. This section briefly describes the model, its calibration and solution, and the data that we use in the analysis.

Model, Calibration, and Solution

The analysis uses a flexible price version of the model of the world economy developed by Cova and Pisani (2007) at the Bank of Italy.[6] This is a five-region and two-sector (tradable and nontradable) DGE model 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 nonzero net foreign asset positions in steady state. The five regions are the United States, Japan, euro area, emerging Asia, and the rest of the world. The calibration of the model draws on previous GEM work at the IMF and on the international real business cycle and trade literature. 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.[7]

We run perfect foresight simulations recursively to allow for a revision of the agents' expectations about the future evolution of TFP.[8] Specifically, we run a sequence of perfect foresight simulations based on a sequence of country- and sector-specific TFP forecasts. At each period, as a new realization of the historical TFP path is added, agents update their forecast for the remaining part of the TFP path. These forecasts are based on country- and sector-specific AR(1) processes for the rate of growth of TFP,

[6]Specific features of the model, and the details of its calibration, are reported and discussed in the working paper version of this paper.

[7]The "simul" instruction uses a Newton method to solve simultaneously all the equations for every period (see Julliard, 1996). Simulations with up to 6,000 periods give similar results.

[8]For more details, see the working paper version of the paper, which also reports results without recursive evolution of expectations. We thank the editors, Bob Flood and Doug Laxton, for the suggestion to solve the model in this more realistic manner.

estimated on the first difference of the historical TFP paths (detrended as described below).[9] Departing from a perfect foresight simulation in this manner introduces time-varying expectations about future TFP evolution that slows the response of the economy to actual TFP changes.[10]

In the simulations, we assume the world economy is in steady state in 1994:Q4 and that, after 2004:Q4, historical TFP paths for the United States, the euro area, and Japan revert to trend at the rate of 0.001 per quarter (that is, with an autoregressive coefficient of 0.999). The TFP paths of emerging Asia and the rest of the world are assumed to remain in steady state throughout the simulation period. Given that the spillover from other countries' TFP evolution to the United States are very small (see below), we start the simulations in 1995. Thus, the simulations attach no weight to the 1990–95 productivity slowdown in Japan and the euro area.

TFP Paths

We construct the historical path for TFP in the United States (US), the euro area (EA, defined here as EU-15), and Japan (JA), for the tradable and nontradable sector, from the new EU KLEMS database "Growth and Productivity Accounts" (euklems.net).

We identify the tradable sector with "Manufacturing" and the nontradable with the weighted average of "Wholesale and retail trade," "Electricity, gas and water supply," and "Transportation, storage, and communication," with weights given by the relative value added within the sector. We include only a subset of all the sectors available because these are the most accurately measured (Basu and Fernald, 2006). The results reported in the next section, however, are robust to using a narrower definition of the nontradable sector or a broader definition of the tradable sector.

The data are in line with the conventional wisdom about the evolution of productivity growth in these areas.[11] Table 1 reports five-year averages of annual TFP growth, together with their average over the whole sample period available, and from 1981 to 2004 for ease of comparison across countries. U.S. tradable TFP growth accelerated temporarily in late 1990s, while nontradable TFP growth lagged behind for most of the 1990s,

[9]We find similar results (not reported but available on request from the authors) estimating these processes on the detrended level of the historical TFP paths, imposing autoregressive coefficients of 0.99 in the cases in which the estimated process has a unit root or it is explosive (like for instance in the case of the U.S. nontradable TFP path).

[10]Running perfect foresight simulations recursively as we described here is akin to positing a simple learning process on the evolution of TFP. Erceg, Guerrieri, and Gust (2002); and Hunt and Rebucci (2005), for instance, calibrate a learning process about future TFP growth to the time evolution of actual medium-term growth forecasts for the United States and show this can help improve the model's ability to match the data, especially consumption and the exchange rate. Introducing "news shocks," along the line of Jaimovich and Rebelo (2007), is an alternative way to address the same issue.

[11]See, for example, Jorgenson (2003); Jorgenson and Motohashi (2005); Gordon (2004); and Oliner, Sichel, and Stiroh (2007).

Table 1. Annual Average Total Factor Productivity Growth by Sector and Country
(Percent per year)

	United States		Japan		EU-15	
	Tradables	Nontradables	Tradables	Nontradables	Tradables	Nontradables
1971–74	3.3	2.8	NA	NA	NA	NA
1975–79	1.3	1.9	7.6	2.0	NA	NA
1980–84	0.2	−0.1	1.3	4.3	2.1	0.9
1985–89	3.3	0.8	4.0	3.3	2.0	2.0
1990–94	1.7	1.1	−0.8	3.7	1.7	1.3
1995–99	4.0	0.2	1.3	0.2	0.7	1.9
2000–04	1.7	3.9	2.5	0.4	1.3	1.1
Average full sample	2.2	1.5	2.8	2.4	1.5	1.5
Average 1981–2004	2.4	1.3	1.8	1.7	1.5	1.5

Source: EU KLEMS.

Note: Tradable sector identified with "Manufacturing." Nontradable sector identified with the weighted average of "Wholesale and retail trade," "Electricity, gas and water supply," and "Transportation, storage, and communication," with weights given by the relative value added within the sector. NA = not available.

accelerating sharply only in the last five-year period. In Japan, tradable TFP growth was below average during the 1990s, falling sharply in the first half of the 1990s. The fall in TFP growth in the nontradable sector lagged by about five years, but was deeper and more persistent than that experienced in the tradable sector. In the euro area, tradable and nontradable TFP growth slowed down markedly in the 1990s. In the first half of the 2000s, tradable productivity recovered partially, while nontradable productivity continued to decline.[12]

Interestingly, although the differences in TFP growth across sectors and countries are large and persistent over the past 15 years or so, longer-term averages are remarkably similar. The TFP growth acceleration in the tradable sector of the United States, in particular, appears to be temporary, consistent with the estimates of Ireland and Schuh (2007) for the degree of persistence of investment-specific technological progress.

Detrended historical TFP paths are computed taking country- and sector-specific gross percent deviations from linear trends. The country- and sector-specific linear trends are calculated as time averages from 1980 up to the beginning of the shock periods. The beginning of the shock periods, in

[12]We also looked at the TFP evolution in emerging Asia, with data from Jaumotte and Spatafora (2006). These data point to a possible deceleration of TFP growth in the region, consistent with the notion of a catch up and convergence with more advanced economies. This slowdown, however, is modest and it is thus unclear to what extent it may have had impact on this region's large trade surplus after the mid-1990s crisis.

turn, is identified maximizing the model-based simulation's ability to fit the U.S. trade balance path. The identified beginning of the shock periods are 1995 and 2000 for the U.S. tradable and nontradable sector, respectively; and 1990 and 1995 for the euro area and Japan tradable and nontradable sector, respectively. The resulting historical TFP paths, from 1995 to 2004, are plotted in Figure 2.

II. Results

The results compare actual and simulated paths. We simulated the model under four different scenarios: (1) U.S. nontradable TFP only; (2) U.S. tradable TFP only; (3) both U.S. tradable and nontradable TFP; and (4) tradable and nontradable TFP in all three economies. Figure 3 plots the U.S. trade balance of goods and services as a share of GDP, in deviation from the model steady state, normalized so that the steady state is equal to the data in 1994:Q4 in all four scenarios. Figure 4 compares actual and simulated paths for the trade balance of the United States, Japan, the euro area, and emerging Asia, in the fourth scenario (measured as in Figure 3). Figure 5 plots the U.S. real effective exchange rate in the fourth scenario (in deviation from the model steady state, normalized so that the steady state is equal to the data value in 1994:Q4).

The simulation with only U.S. nontradable TFP tracks the U.S. trade balance evolution reasonably well (Figure 3). U.S. nontradable TFP declines mildly between 1995 and 1999, with a sharper fall in 1999, and then increases strongly through 2004 (Figure 2). The associated trade balance dynamics results from the net effect of three different forces.[13] First, there is a "composition" effect associated with the complementarity between tradables and nontradables and the strong substitutability among tradables. Driven by TFP changes, the relative price of nontradable goods first rises and then falls (not reported). Correspondingly, U.S. demand of nontradables first decreases and then increases. Because of the complementarity between tradables and nontradables, U.S. consumption of tradable goods also decreases first and then increases. The U.S. terms of trade first deteriorates and then improves, and, with high substitutability, foreign demand of U.S. tradables (U.S. imports of foreign tradables) first increases and then decreases (first decrease and then increase). Therefore, these composition effects tend to push the U.S. trade balance into surplus initially, and then into deficit. Second, there is consumption smoothing. Households initially decrease and then increase consumption, but less than the labor and capital income changes associated with actual TFP changes. This second force tends to offset the composition effect, initially increasing and then reducing the trade balance deficit. Third, firms postpone investment, which is relatively intensive in tradables and less biased toward U.S. goods than the consumption basket, toward relatively more

[13]More details on the transmission mechanism are discussed in the forthcoming IMF Working Paper version of this article.

Figure 2. Total Factor Productivity Paths
(Percent deviation from trend)

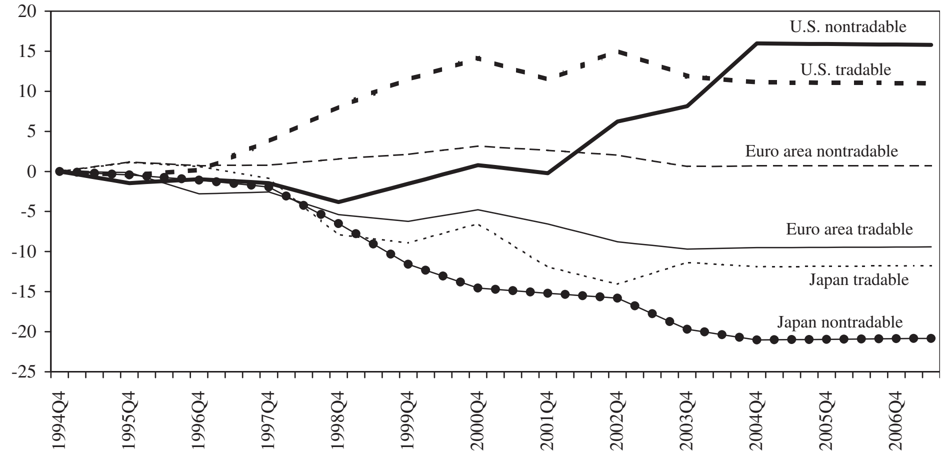
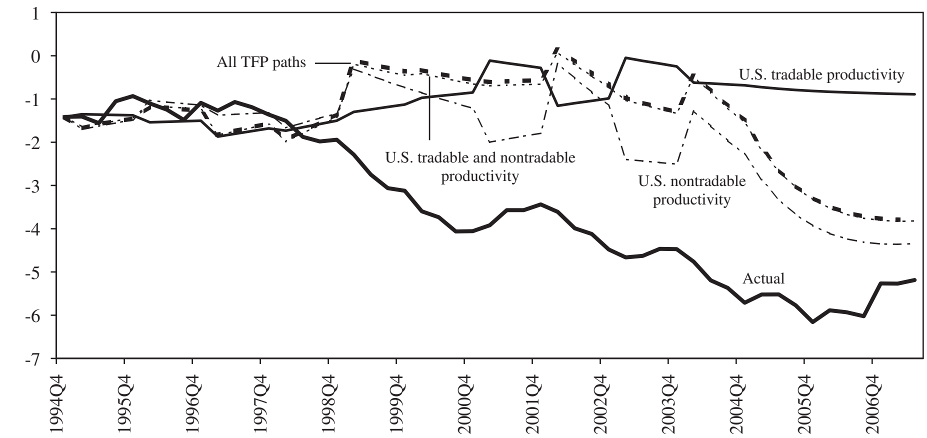


Figure 3. Actual and Simulated U.S. Trade Balance



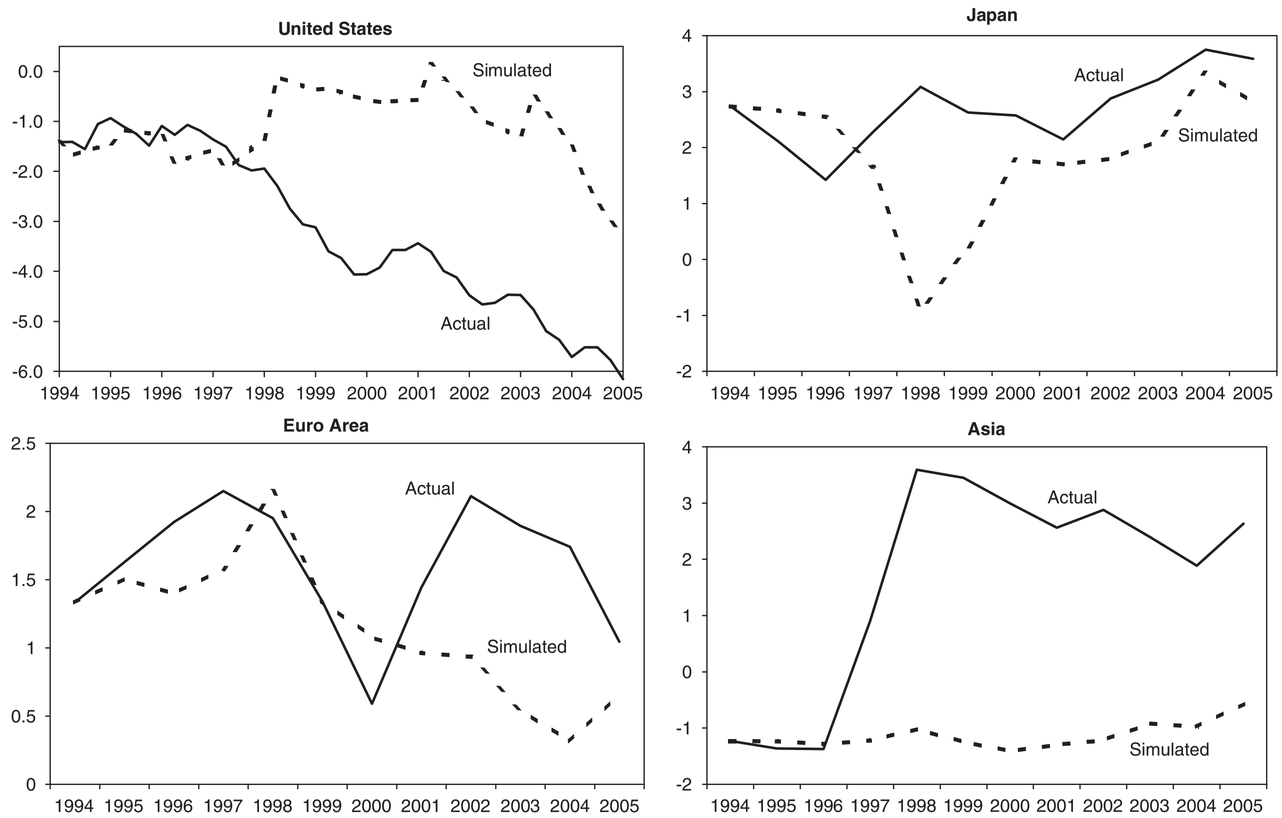
Note: Actual trade balance in percent of GDP; simulated trade balance in percentage points of GDP deviation from steady state. TFP = total factor productivity.

productive times.[14] This third force pushes the trade balance in the same direction as the composition effect, initially into surplus and then into deficit.

The simulation with only U.S. tradable TFP results in a persistent and counterfactual trade balance improvement in the United States between 1998

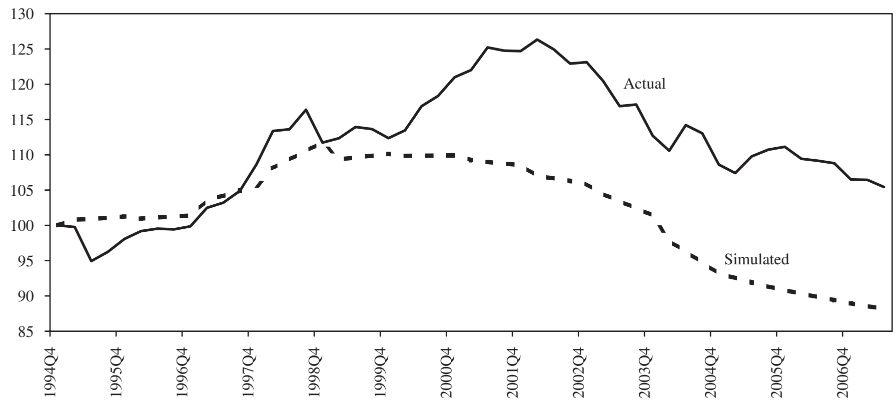
[14]The share of tradable goods in aggregate investment and consumption is 0.75 and 0.35, respectively. The bias toward domestic goods in the traded good basket of both the investment and consumption composite goods is 0.87.

Figure 4. Actual vs. Simulated Trade Balances[1]
(Percentage points of GDP deviation from steady state)



[1]All total factor productivity paths.

Figure 5. Actual and Simulated U.S. Real Effective Exchange Rate
(Increase=Appreciation; 1994 Q4=100)



and 2002 (Figure 3). U.S. tradable TFP declines slightly in 1995 and then increases sharply until 2001, when it starts to revert toward its trend. The transmission mechanism is similar to the one for nontradable TFP. Consumption and investment gradually rise over time as labor and capital income increase. However, the composition effect depresses the U.S. terms of trade sharply and persistently, in this case, after a short-lived improvement.[15] World demand, therefore, shifts strongly in favor of U.S. tradable goods after 1996, driving the trade balance into persistent surplus. Not surprisingly, the simulation with both tradable and nontradable U.S. TFP tracks the evolution of the U.S. trade balance less well than in the case of only nontradable TFP, with the deficit deteriorating persistently only after 2003 in the latter case.

The simulation with tradable and nontradable TFP in all three economies tracks the trade balance of the euro area and Japan relatively well. In the case of emerging Asia, however, the model cannot account for the very large trade balance reversal associated with the crisis in 1997 and 1998 (Figure 4). For the euro area, the model fit is better in the first part of the simulation period, while for Japan the fit is better in the second part.[16] Note, however, that the relatively large TFP swings that we feed to the model have small spillover effects to other countries. For instance, adding the TFP evolution of the euro area and Japan to the model (as in the fourth scenario reported) has essentially no impact on the U.S. trade balance evolution (Figure 3).

[15]The relative price of nontradable goods initially falls, but by less than the increase in the tradable good price (because of the complementarity between tradables and nontradables), and then increases over time.

[16]We do not report model-based results for the rest of the world because we do not have a data benchmark for this aggregate owing to the well-known global trade discrepancy.

The simulation with tradable and nontradable TFP in all three economies also tracks the evolution of the U.S. real effective exchange rate relatively well. The simulation tracks well the direction, persistence, and turning point of the exchange rate response, although the volatility is less, and the turning point is earlier, than in the data (Figure 5). For example, the dollar stops appreciating in 1998:Q4, when nontradable productivity starts to increase, and starts to fall in 2000:Q4. However, in the data, the dollar reversal in 1999 is followed by a renewed sustained appreciation through end-2001. As for the transmission mechanism, the simulated exchange rate dynamics is driven by a Harrod-Balassa-Samuelson effect. The relative price of nontradable goods first raises and then declines sharply, in the simulation, dominating movements in the terms of trade. This is because of both the timing differences in TFP changes across tradable and nontradable sectors and the large share of the nontradable sector in the U.S. consumption basket.

These results are robust to the assumptions on the elasticity of substitution between home and foreign tradable goods and between imports from different countries (see the working paper version of this article for more details on the latter). The results, however, are sensitive to two other model features. First, reducing the value of the financial intermediation cost that determine model stationarity alters agents' intertemporal consumption smoothing possibilities, strengthening the consumption response, and hence resulting in larger trade deficits, at the beginning of the simulation period.[17] Second, as we mentioned in the previous section, the results are also sensitive to the implicit assumptions on agent's expectations about future productivity, which would effectively alter actual TFP paths fed to the model.

Our results are partly consistent with the existing empirical literature. We find that a 1 percent increase in U.S. productivity in the nontradable sector decreases the U.S. trade account by 0.16 percent of GDP,[18] a value at the lower end of the 0.15–0.5 range of elasticities in the empirical work of Glick and Rogoff (1995); Bems, Dedola, and Smets (2007); and Edwards (2007). On the other hand, given our calibration of the model, the U.S. trade balance moves into surplus, and the U.S. terms of trade depreciate, in response to a 1 percent increase in tradable TFP,[19] which runs counter the recent empirical evidence of Corsetti, Dedola, and Leduc (2006).

III. Conclusions

This paper examined the role of TFP differences in the tradable and nontradable sector of the United States, the euro area, and Japan on the

[17]In our simulations it would be possible to eliminate the adjustment costs on net foreign asset, provided we specify the end value of the net foreign asset position, and solve the model with a two-point boundary algorithm (for example, Mendoza and Tesar, 1998).

[18]See Figure A2 in the working paper version of this article.

[19]See Figure A2 in the working paper version of this article.

emergence and evolution of today's constellation of global trade imbalances. Feeding these differences to a global, flexible price DGE model yields dynamics that are partially consistent with those observed in the data. The simulations can explain a significant fraction of the overall deterioration in the U.S. trade balance since 1998, some of the surpluses in Japan and the euro area, and the persistent U.S. exchange rate swings observed in the data. The basic mechanisms at work in the model, however, result in an exchange rate that is too little volatile compared with the data.

One important implication of the analysis is that, as past TFP accelerations seem persistent but ultimately temporary, and spillovers from TFP changes in individual countries appear small, rebalancing of the U.S., and hence global, trade imbalance should happen, at least in part, naturally, as the acceleration in U.S. nontradable TFP slowly unwinds. More generally, the analysis highlights the importance of focusing on productivity developments in the nontradable sector to understand the evolution of the trade balance and the exchange rate of large, relatively closed economies such as the United States, the euro area, and Japan.

We see the analysis of TFP differences across sectors and countries in the presence of financial frictions and policy distortions (such as for instance sustained sterilized foreign exchange intervention) as a natural complement of the work reported in this paper and a promising area of future research.

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