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A SIMPLE GLOBAL PERSPECTIVE ON THE US SLOWDOWN, BOOM-BUST CYCLES AND THE RISE OF PROTECTIONISM

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A SIMPLE GLOBAL PERSPECTIVE ON THE US SLOWDOWN, BOOM-BUST CYCLES AND THE RISE OF PROTECTIONISM

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Resumen

La economía internacional ha vivido significativos acontecimientos durante los últimos años: la creciente importancia de los países asiáticos en el comercio global; la crisis financiera de 2007-08, la gran recesión en EE.UU. y su propagación al resto del mundo; el agudo aumento y posterior caída del precio de las materias primas en el período 2006-2009. En este trabajo desarrollamos un modelo dinámico y estocástico de equilibrio general para la economía global descompuesta en varias regiones. Este modelo constituye un marco conceptual simple para entender los sucesos recientes de la economía global y su propagación al resto del mundo, dado que está equipado para ofrecer una determinación conjunta de los tipos de cambio, las balanzas comerciales y los precios de las materias primas básicas (petróleo y cobre). Realizamos varias simulaciones con el modelo. Primero, consideramos la desaceleración de EE.UU. y su transmisión internacional. Segundo, exploramos un ciclo de auge-caída a nivel global generado por perspectivas excesivamente optimistas de la productividad y su relación con los desbalances globales. Finalmente, analizamos las consecuencias económicas globales de políticas proteccionistas. Encontramos que los efectos en los precios de las materias primas, la actividad y la demanda global derivados de estas simulaciones tienden a amplificarse si los tipos de cambio reales y los salarios reales tienen un ajuste más lento en algunas de las regiones.

Abstract

The global economy has experienced several significant developments during the recent years: the rising role of giant Asian economies in international trade; the 2008 financial crisis and the ensuing Great Recession in the US, with its propagation to the rest of the world; the sharp rise and subsequent burst of commodity prices over 2006-2009. In this paper we use a multi-region DSGE model for the global economy as a simple framework to understand the global response to these shocks and the importance of the propagation to different regions. The model is equipped to jointly determine exchange rates, trade balances and commodity prices across the world. We carry out several simulations with the model. First, we consider the US slowdown and its international propagation. Second, we explore a global boom-bust cycle driven by overoptimistic forecasts for productivity and their relationship with current account rebalancing. Finally, we analyze the global economic consequences of protectionism. We find that the effects in commodity prices, global output and demand tend to be amplified if the real exchange rates and real wages are more sluggish to adjust in some regions.

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1 Introduction

The past few years have witnessed both the emergence of significant tensions as well as the continuation of trends in the global economy. On the one hand, the financial systems in the most advanced economies have been severely shaken, due to the bursting of the housing bubble at the end of 2007 and its aftershocks most notably in the United States and other Anglo-Saxon economies, leading to the most severe global slowdown in economic activity since the Great Depression. On the other hand, these very negative developments have occurred against the backdrop of sustained globalization and some resilience in growth in large emerging economies. Some other areas, historically prone to financial contagion, such as Latin America, also have shown a less damaging impact than in previous moments of large economic crisis in the world. Hence, some economies have been able to keep growing, while others have faced the global financial turbulence from a more robust economic standpoint. Although this global picture dissipated over the last part of 2008, as most economies suffered a coordinated bust in demand and output, the recent performance of big emerging economies and the recovery of commodity prices seems to have given a new twist to the decoupling hypothesis.

On the other hand, the recent behavior in housing market in the US and elsewhere have renewed the interest on how changes in the expectation about the future can explain business cycles and asset prices bubbles. Although this situation was originated in the US, globalization in good and financial markets has helped propagated this US boom-bust cycle to the rest of world. Thus, commodity prices experienced a significant surge during the period 2006-2008, but a sharp bust at the end of 2008 that apparently can not only be attributed to fluctuations in their supply. Beaudry and Portier (2004, 2007) have argued that stock market fluctuations and business cycles can be explained significantly by expected anticipated changes in productivity. Christiano et al. (2007) have adapted this mechanism to generate cycles that are triggered by expected changes in future productivity that do not materialize ex-post in the context of a closed economy as a way to explain the recent episode in US.

The recent boom and bust of the global economy have also affected the support for globalization and free-trade policies. Many countries have enacted measures that seem against free-trade principles. For example, France launched a state fund to protect French companies from foreign takeovers. The funds provided by the US government to General Motors and Chrysler could be considered as trade-distorting policies.

Thus, several stylized facts and open questions of the global economy suggest the need for a multi-country model of the world. First, the trade and economic inter-linkages between economic zones give rise naturally to feedback effects of shocks to specific zones of the world. Second, the existence of independent monetary policies gives rise to financial inter-linkages

across economic zones, thanks to the impact of different monetary policy paths on exchange rates and hence one the short-run dynamics of demand and production. Third, and coupled with the second point, the geographically concentrated supply of non-renewable commodities, such as oil and metals, implies that the external accounts of these economic areas will be an important channel of transmission of international shocks.

This paper presents a simple DSGE model of the global economy that can tackle these very different questions from a coherent perspective. Our model is build in line with the recent literature on New Open Macroeconomics and closely related to Elekdag et al. (2008), Erceg et al. (2006), Faruqee et al. (2005). As in these works, we consider a multi-region setting for modelling the global economy and we assume the presence of nominal rigidity, so that monetary policy in each region has a non-trivial role. In particular, we consider four economic regions: The US, the euro area plus Japan (EU), emerging Asia (AS) and the rest of the world (RW). Each region produces a distinctive tradable good. The multi-region context considers explicitly the trade flows and relative prices among regions, including the exchange rate. The model introduces nominal rigidities in prices and wages, implying Phillips curves for nominal prices and wages in each region. We include commodities as inputs in the production function available in each region. This allows us to have an endogenous behavior for commodity prices. A distinctive ingredient of our model is that explicitly considers oil and copper as two different commodity goods needed in the gross production of each regions. Consistent with the data, we assume that commodity endowments are mainly concentrated in the rest of the world (RW).

We use our global model to analyze (i) the international transmission of the US slowdown; (ii) a boom-bust cycle driven by overoptimistic perspectives for productivity; and (iii) the economic consequences of protectionism.

When the US slowdown is driven by a contraction in aggregate demand, we would observe a decline in global inflation and commodity prices combined with a GDP reduction of the other regions. However, when the US slowdown is originated by a fall in its productivity, the global economy can decouple from the US downturn phase in the short-run because the global demand is maintained with a increase in the share in global production of emerging Asia and the rest of the world. Moreover, this case implies a rise in inflation and commodity prices across the world since emerging Asia production is relative more intensive in commodity than US. Also, when emerging Asia and net commodity exporters peg to the US dollar we can observe higher commodity prices and an initial decoupling of these economies even in the case of a fall in US demand. This is due to the fact that the real appreciation required in emerging Asia and net commodity exporters is limited, which allows them to sustain its foreign demand and implies that commodity prices helps to make the adjustment in relative prices.

Overoptimistic expectations about future productivity increased productivity in the future that turns out to be false ex-post can generate a boom-bust cycle in world output and commodity prices. An amplification of this boom-bust cycle results if AS and RW stabilize their currencies or US and EU have more rigid real wages since a limitation in the adjustment of relative prices (e.g., real exchange rates, real wages) would generate more effects in the real quantities.

When US and EU apply protectionist policies that imply subsidies to domestic production, we observe a rise in output of these regions without affecting much the other regions' outputs and global trade flows among regions. In this case, we would observe a rise in commodity prices. However, this type of policy generates a fiscal deficit. On the other hand, if US and EU were to impose import tariffs to keep their fiscal accounts balanced, the reduction in trade flows would be significant, reducing mainly the output in AS. Moreover, in this last case, output in US and EU would be reduced as well due to the fall in foreign demand generated through increases in their domestic prices.

The rest of the paper is organized as follows. In the next section, we present the structure of the model. Section 3 discusses the parameter choices for the base calibration of the model. Section 4 shows the results of simulating a US slowdown. Section 5 analyzes a global boom-bust cycle focused in US while section 6 explores the consequences of protectionist policies in US and EU. Section 7 concludes.

2 A Model for the Global Economy

The structure of the model is based on the literature in New Open Economy Macroeconomics, which analyzes international variables based on microeconomics foundations combined with real and nominal rigidities. As mention previously, our model is closely related to Elekdag et al. (2008), Erceg et al. (2006), and Faruqee et al. (2005). An innovation of our model is the explicit inclusion of not only oil, but also copper as inputs in production. In this section, we provide a synthetic overview of the model.[1]

The global economy consists of four regions: United States (US), Euro Area (EU), emerging Asia (AS), and the rest of world (RW). In each region there are firms, households and a monetary authority. Firms produce intermediate goods and final tradable goods. In order to obtain an endogenous behavior for commodity prices, we include them (e.g. oil and copper) as inputs in the production function of firms. The supply of commodities is assumed to be fixed and concentrated in the rest of the world (RW). Households in each region take decisions

[1] A detailed version of the model is available in Medina (2009).

on consumption, savings and labor supply. We assume the presence of nominal rigidities in prices and wages in each region, which implies that the dynamics of price and wage inflation are captured by New Keynesian Phillips curves. Monetary policy in each region is modelled as a Taylor type rule.

Firms producing intermediate goods use labor, capital, oil and copper as inputs. For simplicity, we assume that the capital stock in each region is constant. Thus, a log-linear approximation for the production function of this type of firms in region i is:

$$\widehat{y}_{i,t} = \widehat{a}_{i,t} + \alpha_{i,l}\widehat{l}_{i,t} + \alpha_{i,o}\widehat{y}_{O,i,t} + \alpha_{i,s}\widehat{y}_{s,i,t}$$

where $\widehat{a}_{i,t}$, $\widehat{l}_{i,t}$, $\widehat{y}_{O,i,t}$, and $\widehat{y}_{S,i,t}$ are the level of productivity, labor, the amount of oil and copper used for the production of goods $\widehat{y}_{i,t}$ in region i. Parameters $\alpha_{i,l}$, $\alpha_{i,o}$ and $\alpha_{i,s}$ are the production shares of each input. We will assume that both oil and copper are complements of labor in production. Hence, the elasticity of substitution among commodities and labor is lower than one.

Households consume a composite basket that consists of tradable goods produced in each region. Since we exclude government consumption and investment, total household consumption represents the aggregate demand of each region. A log-linear approximation of the consumption basket of region i can be expressed as:

$$\widehat{c}_{i,t} = \gamma_{i,us}\widehat{c}_{i,t}(us) + \gamma_{i,eu}\widehat{c}_{i,t}(eu) + \gamma_{i,as}\widehat{c}_{i,t}(as) + \gamma_{i,rw}\widehat{c}_{i,t}(rw)$$

where $\widehat{c}_{i,t}(j)$ is the consumption of region i of goods produced in region j. $\gamma_{i,j}$ is the share of goods of region j in the consumption basket of region i. Households in region i will minimize the cost of their consumption basket, which delivers the demand for each type of goods (in a log-linear form):

$$\widehat{c}_{i,t}(j) = \widehat{c}_{i,t} - \eta_{i,j}\left(\widehat{p}_{i,t}(j) - \widehat{p}_{c,i,t}\right)$$

where $\widehat{p}_{i,t}(j)$ is the price of goods produced in region j and consumed in region i (and in the currency of region i) and $\widehat{p}_{c,i,t}$ is the price level of the consumption basket in region i. Also, $\eta_{i,j}$ is the elasticity of substitution of goods produced in region j in the consumption basket of region i. These elasticities determine the degree of sensitivity of the demand for each type of goods to changes in relative prices and, therefore, they are key to the adjustment of net exports to fluctuations in exchange rates. The price level of the consumption basket of region i can be written as:

$$\widehat{p}_{c,i,t} = \gamma_{i,us}\widehat{p}_{i,t}(us) + \gamma_{i,eu}\widehat{p}_{i,t}(eu) + \gamma_{i,as}\widehat{p}_{i,t}(as) + \gamma_{i,rw}\widehat{p}_{i,t}(rw)\ .$$

In price setting, we allow for the possibility of a complete or incomplete exchange rate pass-through to import prices in the short run. In the simple framework adopted here, the

exchange rate pass-through depends on the currency of denomination of the prices of goods produced and exported from one region to another. For example, if producers of region j sell their goods in region i in US dollars, we will have that $\widehat{p}_{i,t}(j) = \widehat{p}_{j,t}^{us\$} + \widehat{e}_{i,t}$, where $\widehat{p}_{j,t}^{us\$}$ is the US dollar price set by the producers of goods in region j and $\widehat{e}_{i,t}$ is the value of the currency of region i in terms of the US dollar.[2]

In each region, there are two types of households. One type of household is forward-looking and optimizing. The other households are financially constrained and do not hold any assets. The latter type of households represents a fraction λ_i of the total households in region i and their consumption ($\widehat{c}_i^R$) is equal to their disposable labor income:

$$\widehat{c}_{i,t}^R = \widehat{w}_{i,t}^R - p_{c,i,t} + \widehat{l}_{i,t}^R$$

where $\widehat{w}_{i,t}^R$ and $\widehat{l}_{i,t}^R$ are the wages and the labor supply of constrained households.

In contrast, forward-looking and optimizing households maximize their utility function subject to their intertemporal budget constraint. This type of households owns the firms and holds two types of bonds. One of these bonds is traded domestically in each region and is denominated in local currency. The other type of bonds is denominated in US dollars and is traded internationally with a zero net supply worldwide. As usual, the optimal path of consumption of this type of households is characterized by a Euler equation, which can be log-linearized as:

$$\widehat{c}_{i,t}^O = -\frac{1-h_i}{1+h_i}\sigma_i E_t\left[\widehat{Rn}_{i,t} - \widehat{\pi}_{c,i,t+1}\right] + \frac{1}{1+h_i}E_t\left[\widehat{c}_{i,t+1}^O\right] + \frac{h_i}{1+h_i}\left[\widehat{c}_{i,t-1}^O\right] + \frac{1-h_i}{1+h_i}\sigma_i E_t\left[\zeta_{C,i,t} - \zeta_{C,i,t+1}\right]$$

where $\widehat{c}_{i,t}^O$ is the consumption of forward-looking households in region i, $\widehat{Rn}_{i,t}$ is the nominal interest rate in region i, $\widehat{\pi}_{c,i,t}$ is the price level inflation of the consumption basket in region i, and $\zeta_{C,i,t}$ is a demand shock that shifts the consumption of forward looking households. As usual, $E_t[\cdot]$ denotes the expectation conditional on the information at period t. Parameters σ_i and h_i are the intertemporal elasticity of substitution and the degree of habit formation in consumption. This last element induces a more sluggish behavior of private demand, which is coherent with observed dynamics at the aggregate level. Portfolio decisions by forward looking households for domestic and international bonds give rise to a no-arbitrage condition between foreign and domestic interest rates. In other words, the *uncovered interest parity* (UIP) condition is satisfied:

$$\widehat{Rn}_{i,t} = \widehat{R}_t^* + E_t\left[\Delta e_{i,t+1}\right] + \rho_{i,t}$$

[2]See Table 6 in appendix B for the calibration used to the share of exports of each region denominated in different currencies.

where $\widehat{R}_t^*$ is the US interest rate, $\Delta e_{i,t}$ is the nominal depreciation of region i relative to the US dollar, and $\rho_{i,t}$ is a risk premium.[3]

Firms producing tradable goods in region i face nominal rigidities when setting their prices. In each period only a fraction of these firms are able to adjust optimally their prices. The optimal rule implies that prices are based on the expected path of marginal costs. Those firms that are unable to adjust optimally their prices set them based on a weighted average of past inflation and inflation target, adjusting their level of production to satisfy their demand. Aggregating price decisions across firms, we are able to obtain a hybrid New Phillips curve that relates the path of inflation to marginal costs, expected inflation and past inflation:

$$\widehat{\pi}_{i,t} = \upsilon_{1,i} E_t[\widehat{\pi}_{i,t+1}] + \upsilon_{2,i}\widehat{\pi}_{i,t-1} + \kappa_i \left(\widehat{mc}_{i,t} - \widehat{p}_{i,t} + \zeta_{i,p,t}\right)$$

where $\widehat{\pi}_{i,t}$ is the rate of domestic inflation, $\widehat{mc}_{i,t}$ are the marginal costs, $\widehat{p}_{i,t}$ is the price level of tradable goods produced in region i and $\zeta_{i,p,t}$ is an exogenous cost-push shock. $\upsilon_{1,i}$, $\upsilon_{2,i}$ and κ_i are constants that depend on parameters that determine the degree of nominal rigidities and price indexation.

Analogously, the wage setting process also faces nominal rigidities. In each period only a fraction of optimizing forward-looking households are able to set optimally their wages. Those households that cannot adjust their wages optimally set them based on past inflation, the inflation target and the labor productivity trend. Constrained households set their wages equal to the average wage of optimizing households. Aggregating across optimizing forward-looking households, a log-linear expression for labor supply decision is:

$$\Delta\widehat{w}_{i,t} = \varphi_{w,i}\left(\widehat{mrs}_{i,t}^{O} - \widehat{w}_{i,t} + \widehat{p}_{c,i,t}\right) + \delta_{i,1} E_t\left[\Delta\widehat{w}_{i,t+1}\right] + \delta_{i,2}\left[\widehat{\pi}_{c,i,t-1} - \beta\widehat{\pi}_{c,i,t}\right] \ .$$

Constants $\varphi_{w,i}$, $\delta_{i,1}$, $\delta_{i,2}$ are parameters that depend on the degree of nominal rigidity and indexation of wages and the elasticity of the labor supply. $\widehat{mrs}_{i,t}^{O}$ is the marginal rate of substitution between leisure and consumption for the optimizing forward-looking households in region i.

Finally, monetary policy in region i is modelled through a Taylor type rule that reacts to aggregate GDP, CPI inflation and (potentially) to the depreciation of the nominal domestic currency vis-à-vis the US dollar:

$$\widehat{Rn}_{i,t} = \psi_{i,Rn}\widehat{Rn}_{i,t-1} + (1 - \psi_{i,Rn})\left(\psi_{i,y}\widehat{va}_{i,t} + \psi_{i,\pi}\widehat{\pi}_{c,i,t} + \psi_{i,\Delta e}\Delta\widehat{e}_{i,t}\right) \ .$$

[3]This premium depends on the total net asset position of each region in a very elastic manner. This device is introduced in the model to obtain well defined dynamics around steady state. See Schmitt-Grohé and Uribe (2003) for different ways to get steady state independent of initial conditions for small open economy models.

$\widehat{va}_{i,t}$ is GDP of region i as a deviation of its balanced growth path. Parameter $\psi_{i,Rn}$ is the degree of smoothing of the monetary policy rule, while $\psi_{i,y}$, $\psi_{i,\pi}$, and $\psi_{i,\Delta e}$ determine the intensity with which monetary policy reacts to GDP, inflation, and exchange rate depreciation, respectively.

3 Model Parametrization

In this section we describe our choices for the parameters used to solve the model numerically. In general, we use values for the parameters that are consistent with relevant statistics in the data and line with those chosen in other works that develop multi-country general equilibrium models (see, among others, Faruqee *et al.* (2005), Elekdag *et al.* (2008), Batini *et al.* (2007), Erceg *et al.* (2006))). In table 1 in appendix A, we present statistics for the four regions: United States (US), Europe (EU), Asia (AS), and Rest of World (RW). [4]

Tables 2, 3, 4 and 5 in appendix B show values for the parameters used for the base calibration. In the production function of each region we assume that the oil share is 3% for US, EU and RW, and 6.0% for AS. These figures are coherent with other studies. For example, Blanchard and Gali (2007) estimates an oil share between 1 and 3% for US data. Sanchez (2008) obtain an oil share close to 3% for euro area countries for the year 2000. Our calibration is also coherent with the notion that emerging Asia uses oil in production more intensively. Labor share is the most relevant variable factor of production in each region, assuming that its use is relatively more intensive in AS. The parameter governing the degree of substitution between oil and the other factors of production in region i is denoted by $\theta_{i,o}$, while the one for the substitution between copper and the other factors is $\theta_{i,s}$. These parameters are set to remark the low degree of substitution between commodities and the rest of factors in production. Regarding household preferences, we consider that the intertemporal elasticity of substitution is equal to 1.0 and set the coefficient of habit formation in consumption at 0.8 for all regions. Consistently with the degree of openness of each region, we assume that the shares of domestic goods in the total consumption basket are high, in a range between 90% (for US) and 81% (for RW).

We do not consider important differences in the degree of nominal rigidities among regions. We assume the Calvo probabilities of optimally setting prices and wages are equal to 0.33 and 0.25, for all regions. These values imply that nominal prices in average adjust optimally every

[4] These regions do not coincide directly with our classification of regions used in the model. Hence, these figures are considered as information for our calibration in a broad sense and are not used strictly. For instance, Asia in this data includes not only emerging economies but also Japan.

two quarters, while wages do so every four quarters. The degree of smoothing of the monetary policy rules is calibrated at 0.8 for all regions. The reaction coefficient of monetary policy to CPI inflation is slightly different across regions, with a value of 2.0 for US and EU, and a value of 1.2 for AS and RW.[5]

Finally, we assume that relative sizes in terms of GDP are 30% for US and EU, 25% for RW and 15% for AS. The steady-state trade statistics assume that net exports represent 0.6% of GDP in US, and between -0.2% and -0.4% in the other regions. These figures are coherent with the notion that US is a net debtor in the steady state while the other regions are net lenders.[6] Regarding the trade flows of final goods, we consider that in steady-state the US exports as percentage of its GDP is 13.2%, which is divided into 5.7% to RW, 5.0% to EU and 2.5% to AS. In the case of EU, exports of final goods as a percentage of its GDP is 13.1%, of which 4.0% goes to US, 4.1% to AS and 5.0% to RW. AS is relatively more open in the trade of final goods, with exports of final goods explaining 25.1% of its GDP. This figure is divided into 9.9% to US, 10.8% to EU and 4.4% to RW. Final goods of RW exported to US, EU and AS represent, respectively, 1.2%, 3.0% and 3.2% of its GDP. The net exports of oil as a percentage of each region's GDP are -2.5% for US and EU, and -6.4% for AS. For RW this ratio is equal to 10%. The net export of copper represents a 0.5% of its GDP in RW, while this ratio is -0.1% for US and EU, and -0.4% for AS. Consistent with trade flows in steady-state, the net foreign asset position as a percentage of the GDP of each region are -60% for US, 20% for EU, 40% for AS, and 24% for RW.

In the next sections we use the global model as a laboratory to explore the effects and mechanisms behind several types of economics shocks that have been part of the recent international discussion.

4 U.S. Slowdown and its International Propagation

In this section we analyze the response of the international economy –represented in the four regions of the model– to a United States (US) slowdown. We also explore its effects in commodity prices. First, using the base calibration of the model, we consider two sources for the US slowdown. One is caused by a reduction in private demand in US and the other by a fall in the productivity of the US. Second, we consider the impact of this US slowdown with an alter-

[5] Alternative calibrations for the monetary policy rules are considered to analyze how different monetary reactions can affect the international transmission of shocks. In particular, we will consider a case where AS and RW aim at stabilizing their exchange rate fluctuations. This would generate more expansionary monetary policies in AS and RW in response to shocks that tend to appreciate their currencies.

[6] See Elekdag et al. (2008).

native calibration where Emerging Asia (AS) and the Rest of World (RW) follow a monetary regime that tends to stabilize their exchange rates.

4.1 U.S. Slowdown: Demand vs. Supply Factors

Reduction in U.S. Demand

A US slowdown generated by a fall in the private demand is shown in figure 1. The size of the shock is calibrated in order to obtain a maximum decline in US GDP about 1.5%. This shock reduces the demand in US for goods produced domestically and for imports. As results, the CPI inflation in US declines, reaching a maximum decline slightly larger than 2.5% after one year and a half (6 quarters). The US nominal interest rate falls smoothly until reaching about 400 basis points below the baseline. The fall of US imports favors an improvement of close to 2% of GDP in its trade balance.

The cuts in the US nominal interest rate depreciates the US dollar about 4% against the currencies of the other regions. Thus, the improvement in the US trade balance has as a counterpart a fall in the next exports as percentage of GDP in regions AS, EU and RW, within a range between 0.5% and 1.0%.

The decline in US demand is transmitted to the other regions, reducing their total outputs. The propagating dynamics are heterogenous among regions and depend crucially on the degree of trade integration of each region with US. Also, this transmission hinges on the currency of denomination of export prices of each region to US and to the other regions as well. For instance, given that EU sets the price of its exports in its own currency, the impact of the appreciation of its currency with respect to the US dollar is passed instantaneously into a contraction in the exported volumes of this region to US. This implies an initial fall of 0.5% in EU output. The appreciation in region EU together with the fall in external demand induces a fall in CPI inflation of 0.8% after four quarters.

Despite that exports of AS to US are greater than those of EU to US, we observe a fall in AS output similar to the one observed in EU. This occurs because we have assumed that the prices of exports of region AS to US are denominated in US dollars, such that the appreciation of its currency in AS is absorbed initially by the margins of producers in AS. Over time, producers in AS pass part of the appreciation currency to the US dollar price of goods exported to US and the other regions. This explains a fall in AS output that is larger than in EU after some quarters. During the first year after the shock, we observe a reduction of CPI inflation in AS that is close to 2% while the nominal interest rate falls about 200 basis points. The rest of the World (RW) —that is a net commodities exporter— shows similar declines in inflation and

nominal interest rates, but the fall in its output is smaller than in AS since its final goods exported to US represent a low fraction of its total production.

As expected, the fall in the output of each region contributes to a decline in the demand for commodities, which shifts down the price of oil and copper by about 5% and 10%, respectively. This fall in commodity prices also favors an improvement in the net exports of US vis-à-vis those of RW, that is a net exporter of commodities.

Reduction in U.S. Productivity

When the slowdown in US is originate in a reduction in productivity, the effects on the global economy are subtly different. In figure 2 we show the responses of the international variables after a fall in US productivity that reduces its total output about 1.5%, the same amount as in the latter case. The decline in US productivity pushes the marginal cost up and, therefore, inflation in US accelerates until reaching an increase of 1.5% about one year after the shock. This, in turn, implies an increase in the US interest rate of a similar magnitude. Since the US demand adjusts slowly to a lower income, we do not observe an initial improvement in the trade balance. Later, the trade balance increases, but in a more limited way and in a more sluggish manner than in the case of a demand contraction. Net exports as percentage of GDP rise about 0.2% after almost two years.

The decline in US productivity generates a depreciation on impact of 0.5% of the currencies of the other regions with respect to the US dollar. Thus, we observe a more muted fall in the trade balance of the other regions than in the case of a demand contraction. However, more inflation in US is transmitted to the other regions, generating a rise in the CPI inflation of the other regions in a range between 0.2% and 1% after one year. Given the rise in CPI inflation in the other regions, monetary policy in each region modelled as a Taylor type rule dictates a rise in the interest rate.

It is worth noting that this type of contraction in US generates an increase in the price of commodities, oil and copper. These responses of commodity prices contribute to the rise of inflation in all regions and partly reduces the adjustment in net exports in US vis-à-vis the net exporters of commodities (RW).

The explanation for these commodity price dynamics lie in the fact that the fall in US productivity generates incentives to move factors and resources from US to the rest of the global economy and, in particular, to AS. Since AS production of final goods is relatively more intensive in commodities than US production, in equilibrium, the rise in AS production relative to the US production requires an increase in commodity prices. This rise in commodity prices

generates a slight expansion in output in the region that is a net exporter of commodities (RW).

In summary, a US slowdown caused by a reduction in productivity is able to generate an international decoupling of RW, with relatively muted reductions in the output of EU and AS. Moreover, this case reflects a more limited adjustment in the global imbalances with additional increases in commodity prices and a rise in international inflation. Therefore, this type of shock was better equipped to explain the international economic outlook during most of 2008 where the United States was decelerating with smaller consequences in the global economy and new increases in commodity prices together with higher prospects for inflation across the world.

4.2 Exchange rate stabilization in AS and RW

During the 2000s many emerging economies have applied policies aimed to sustain export competitiveness. In many cases, this has been translated into stabilizing the value of the exchange rate, which has required low interest rates in emerging economies when there are forces to drive up the value of their currencies up. China and oil exporters are clear examples of this behavior. As we observe in the last subsection, a US slowdown requires an appreciation of the currencies in AS and RW. Thus, if AS and RW try to avoid the appreciation of their currencies, monetary policy would be forced to lower interest rates. To explore the consequences of this, we analyze the responses of the international economy to the same shocks, but with an alternative specification for the monetary policies in AS and RW that tend to remove the variations in the US dollar of their currencies in a systematic way.[7]

Figure 3 shows the impact of a US slowdown driven by a fall in demand in the base calibration and the alternative specification where AS and RW stabilize their exchange rates against the US dollar. Interestingly, the behavior of monetary policy in AS and RW allows them to decouple in the short run from the US slowdown. However, the US suffers a bigger downturn than in the baseline case. The increase in the US trade balance is smaller than in the base calibration while the fall in the trade balance is slower in AS and RW. EU absorbs more intensively the reduction in US demand and the contraction in output and trade balance is higher than in the base case.

Similarly, figure 4 presents the US slowdown driven by a fall in productivity when AS and RW stabilize their exchange rates against the US dollar. The contraction in US GDP is bigger than in the base calibration. Emerging Asia and the rest of the world experience a slightly higher real depreciation of their currencies with a significant increase in domestic inflation. Commodity prices rise more than in the base case and US also faces higher inflation.

[7]Formally, we set monetary policy in these two regions such that $\psi_{AS,\Delta\hat{e}} = \psi_{RW,\Delta\hat{e}} = 10$.

5 The Global Boom-Bust Cycle and Current Account Imbalances

The boom-bust cycle experienced recently by the U.S. has renewed several questions regarding how changes in expectations may be an important ingredient of economic fluctuations.[8] In addition, particular attention has been given to the factors that can amplify these episodes as structural elements and monetary policy. Moreover, the boom-bust cycle in the US seems to translate to the rest of the global economy and to the behavior of the commodity prices. In this section, we use the perspective suggested by Beaudry and Portier (2004, 2007), adapted by Jaimovich and Rebelo (2006, 2007), and Christiano *et al.* (2007) to analyze this kind of economic fluctuations. The mechanism is that the boom phase is driven by a signal about an improvement in productivity in the future. Eventually this signal turns out to be false and the bust phase of the cycle begins.

To implement this possibility in our model, we assume that productivity in block i is governed by the following stationary process:

$$\widehat{a}_{i,t} = \rho_{a_i} a_{i,t-1} + \zeta_{a_i,t-p} + \varepsilon_{a_i,t} \qquad i = US, EU, AS, RW$$

where $\varepsilon_{a_i,t} \sim N\left(0, \sigma_{a_i}^2\right)$ are $i.i.d.$ innovations. The variable $\zeta_{a_i,t-p}$ is a shock to the expected future productivity level p periods ahead and is uncorrelated with $\varepsilon_{a_i,t}$. This shock captures the idea that signals to the future level of productivity are received over time. An observation of this shock in t makes private agents expect that productivity p periods ahead will be given by

$$E_t\left[a_{i,t+p}\right] = \rho_{a_i}^p a_{i,t} + \zeta_{a_i,t}$$

where $\zeta_{a_i,t} > 0$. At time $t+p$ agents learn that the productivity level did change by less than expected. For that, we introduce a shock $\varepsilon_{a_i,t+p} < 0$ on productivity at $t+p$.

Figure 5 shows this exercise under the base calibration. We simulate a case where the most favorable prospects for productivity are more intense in US, followed by the EU and finally in AS and RW ($\zeta_{a_{US}} > \zeta_{a_{EU}} > \zeta_{a_{AS}} = \zeta_{a_{RW}}$) when the signal is received eight quarters in advance ($p = 8$).[9] Although the economies do not increase their productivity level during the first two years, the signal about a future increase in it is generating a boom phase in all regions with peaks in outputs within a range between 2 and 4%. Aggregate demand rises more than current income in US, EU and AS, implying a reduction in the trade balance in these regions

[8] See Beaudry and Portier, 2004, 2007; Christiano et al., 2007; Schmitt-Grohe and Uribe, 2008, among recent studies

[9] We also assume that $\rho_{a_i} = 0.99$ for all i.

between 1 and 3%. The rest of the world, being a net exporter of commodities, runs a positive trade balance as commodity prices rise in response to the boom in global demand. Since the optimistic perspectives for productivity are higher in the US than in the other regions, their currencies depreciate in real terms against the dollar in the boom phase.

Christiano *et al.* (2007) argue that this type of news shocks pull inflation down in the boom phase as the Phillips Curve of domestic prices is determined by the expected path of the marginal cost. Thus, an expected future increase in productivity reduces the marginal cost in the future, and through that channel inflation falls. In a small open economy version of that type of model, Marfán *et al.* (2008) obtain similarly a fall in inflation not only due to the expected reduction in marginal cost but also due to the appreciation of the currency. In the present simulation, however, we observe a rise in CPI inflation in US and EU in the boom phase. The increase in commodity prices helps to explain the initial increase in inflation in the boom phase in US and EU. The other factor that explains the behavior of inflation in US and EU is the fact that exports to US and EU are denominated in US dollars and EU currency. Thus, any appreciation in US and EU against a bilateral trade partner is transmitted slowly to CPI inflation. For that reason, we observe a reduction in CPI inflation in AS and RW.

When private agents realize that the signal about productivity increase turned out to be false, the global economy experiences a sharp downturn, pushing for a reversal in the trade balances in each region. The commodity prices burst and inflation in all regions is reduced. Later, as the marginal cost turns to be higher than expected, CPI inflation rises even in the presence of a protracted fall in commodity prices.

As the previous section showed, the exchange rate policy in AS and RW can be critical to the international adjustment. Figure 6 presents the same exercise under the case where AS and RW peg to the US dollar. Interestingly, this type of policies changes significantly the response of inflation in AS and RW. Under exchange rate stabilization in AS and RW, their inflation paths are higher in the boom phase. We also see a marginal amplification in the boom-bust cycle of commodity prices and trade balance adjustments. The peaks in output expansion of AS and RW are also higher. It is worth noting that there is no important change in the dynamics in output and inflation in US and EU. Thus, the exchange rate inflexibility in the emerging economies (AS and RW) can amplify a boom-bust cycle in commodity prices and in output and inflation in the emerging economies.

Christiano *et al.* (2007) have noted that a boom-bust cycle can be potentially exacerbated if the nominal wages are rigid in the short run and monetary policy follows a stricter inflation targeting regime. The combination of these two features, when nominal wages are not indexed automatically to past inflation, induces a significant real wage rigidity which, in turn, amplifies

the boom-bust cycle. To explore this possibility of more wage rigidity in US and EU, we consider an alternative calibration where the weight of inflation in the Taylor-type rule increases and the indexation to past inflation of wages is fixed at zero in both US and EU.[10] Figure 7 shows the responses to the same boom-bust cycle in the case where AS and RW peg to the US dollar and with more rigidity in real wages in US and EU. This feature amplifies the boom-bust cycle in commodity prices and in the output of US and EU. Also, the inflation path of AS and RW is higher in the boom phase. As expected, inflation increases in US and EU are smaller in the boom phase when real wages are more rigid in these regions.

As we have seen, a boom-bust cycle can partly explain current account imbalances, but it is unable to predict a trade surplus in emerging Asia. In figure 8 we show a simulation where we add an appetite for saving in AS and loose monetary policy in AS and RW to complement the boom-bust cycle pattern in the base calibration. This last element helps to generate a surplus in the trade balance of emerging Asia. It is worth noting that the reversal in the US trade balance does not need a sizeable depreciation of the US dollar against EU and AS. The real depreciation of US against the net exporter of commodities is bigger. The reduction in commodity prices helps to attenuate the need for an important adjustment in the real exchange rate of US.

6 The Effects of Protectionism

During the economic expansion of the period 2003-2007, there was widespread support for globalization and cross-border trade. However, since the downturn hit, the faith in free-trade policies seems to be under test. This situation is not particular to this recent period. After the great depression of the 1930s, several countries implemented policies that limited trade in goods. Although leaders of industrialized economies have issued a pledge to refrain from protectionist policies, many countries have enacted measures that seem to go against free-trade principles. Moreover, some observers have warned that these anti-trade measures could grow into a broader wave of protectionism. In this section, we use our model to analyze the consequences of protectionist policies in US and EU.

In figure 9 we show the responses of placing subsidies in US and EU as a protectionist policy. These subsidies are assumed to be transitory but very persistent and cause on impact a 2% reduction in the cost of domestic production. Both US and EU experience an increase in output of about 1% while their trade surplus does not adjust much. AS and RW reduce their outputs marginally. We observe a rise in commodity prices that helps explain the positive trade

[10] For the Taylor-type rule, we increase ψ_π in US and EU from 2.0 to 4.0.

surplus in RW and the reduction in net exports of AS. Although commodity prices increase, CPI inflation falls across the globe, and not only in the US and EU. Imposing a subsidy generates an income effect that increases the demand for all goods, including imports. For that reason, the trade balance in each region does not change much and a measure of global imports –a weighted average of the imports of all regions– does not fall.

The application of only subsidies generates a financing problem in the fiscal side. A more realistic case would complement subsidies with import tariffs in order to keep the fiscal accounts balanced in the medium term. Figure 10 presents the dynamics when the subsidies in US and EU are complemented with import tariffs after two quarters in order to keep the fiscal accounts balanced. The presence of import tariffs in US and EU induces a reduction of 10% in global imports. Emerging Asia, being very open in its trade linkages with US and EU, is the region that suffers the most from the import tariffs in terms of output, reducing its GDP in a range between 2 and 3%. Output in US and EU falls about 1% as a consequences of the import tariffs imposed. The initial fall in inflation in US and EU derived from the subsidies is followed by an increase despite the fall in commodity prices. Although tariffs in US and EU reduce their imports, the trade balance in these two regions does not increase as the increase in the prices of their domestic production disincentives foreign demand for their exports.

7 Final Comments

The model presented here offers a conceptual framework to understand the interaction among regions in the international economy and the behavior of the prices of commodities from a general equilibrium perspective. Simulations of the models are used to explore the global consequences of a U.S. slowdown, a global boom-bust cycle and protectionist policies in the industrialized economies.

When the US slowdown is driven by a contraction in aggregate demand, we observe a decline in global inflation and commodity prices combined with a reduction in the GDP of the other regions. However, when the US slowdown is originated by a fall in its productivity, the global economy can decouple from the US downturn cycle in the short run. Moreover, this case implies a rise in inflation and commodity prices across the world. Also, when emerging Asia and net commodity exporters peg to the US dollar we can observe higher commodity prices and an initial decoupling of these economies even in the case of a fall in US demand.

An overoptimistic expectation of increase in productivity in the future that turns to be false ex post can generate a boom-bust cycle in outputs and commodity prices. An amplification of this boom-bust cycle can be derived if AS and RW stabilize their currencies or US and EU

have more rigid real wages.

When US and EU apply protectionist policies that imply subsidies in domestic production, we observe a rise in output of these regions without affecting the other regions' outputs and the trade flows among regions much. In this case, we would observe a rise in commodity prices. However, this type of policy generates a deficit on the fiscal side. To remove this problem, if US and EU impose an import tariff that keeps their fiscal account balanced, the reduction in trade flows would be significant, reducing mainly output in AS. Moreover, in this last case, output in US and EU would fall as well due to the reduction in foreign demand that generated the increases in domestic prices of US and EU.

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Figure 1: US Slowdown Driven by a Fall in Demand

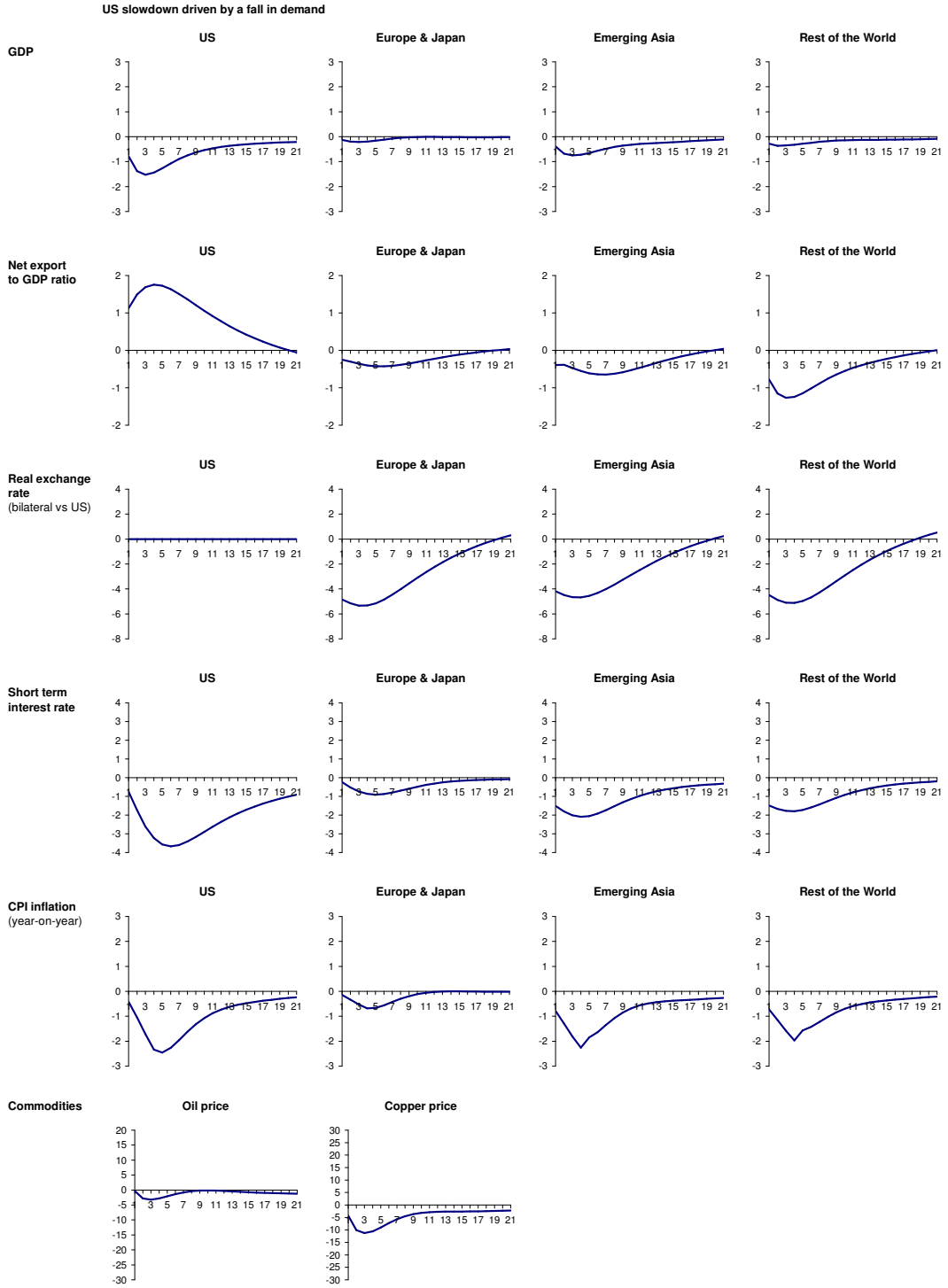


Figure 2: US Slowdown Driven by a Fall in Productivity

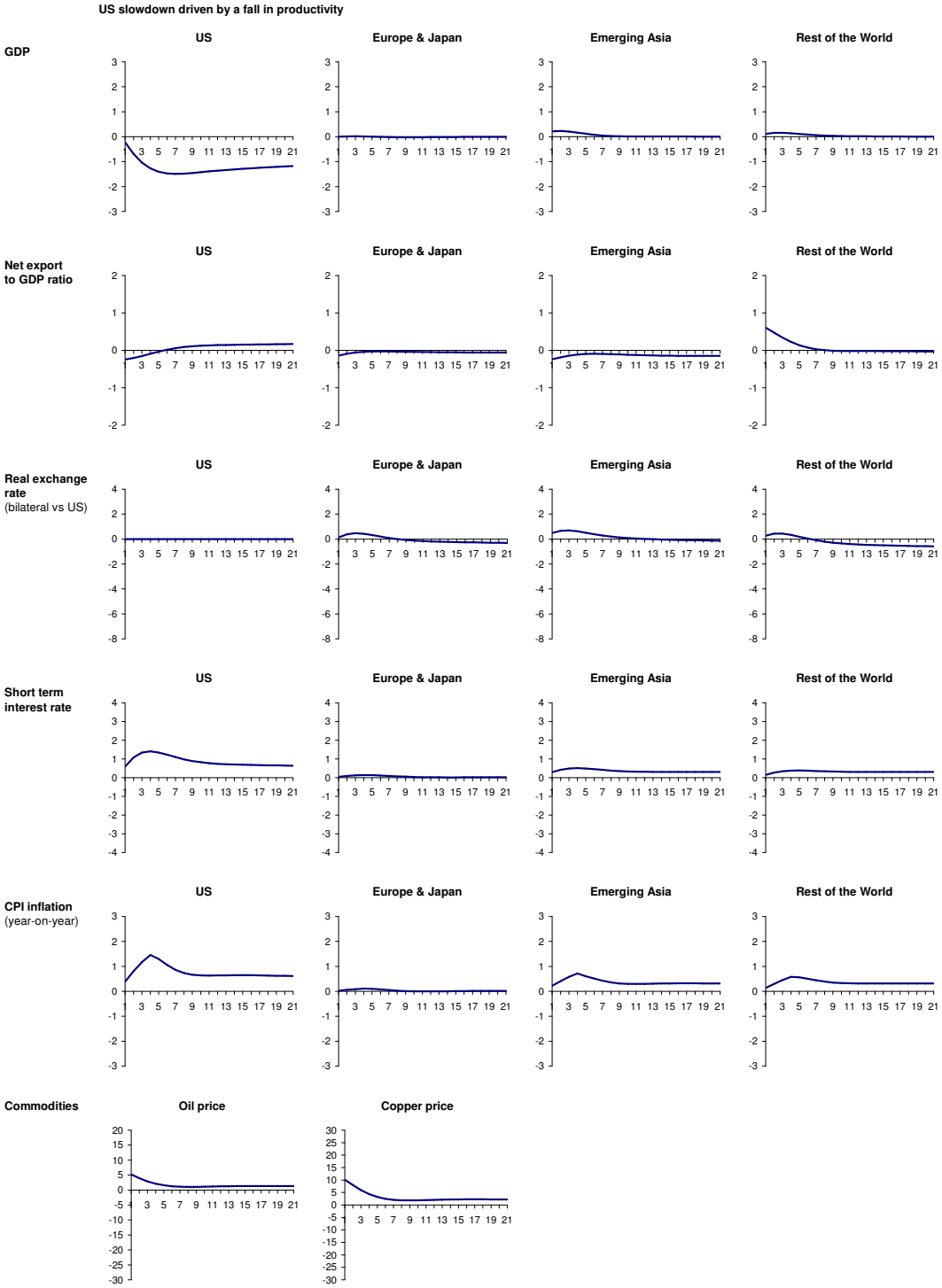


Figure 3: US Slowdown Driven by a Fall in Demand with AS and RW Pegging to the US Dollar

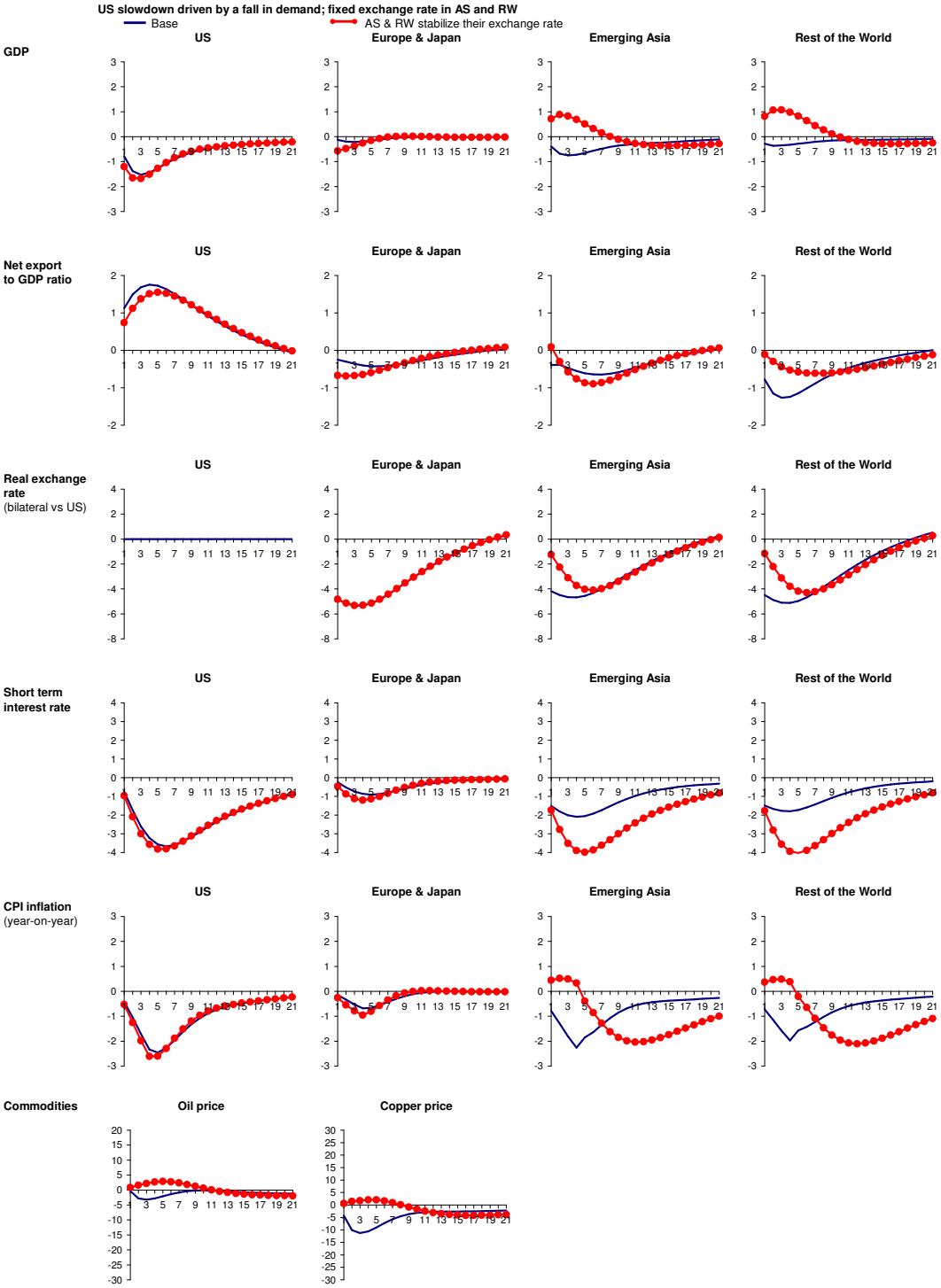


Figure 4: US Slowdown Driven by a Fall in Productivity with AS and RW Pegging to the US Dollar

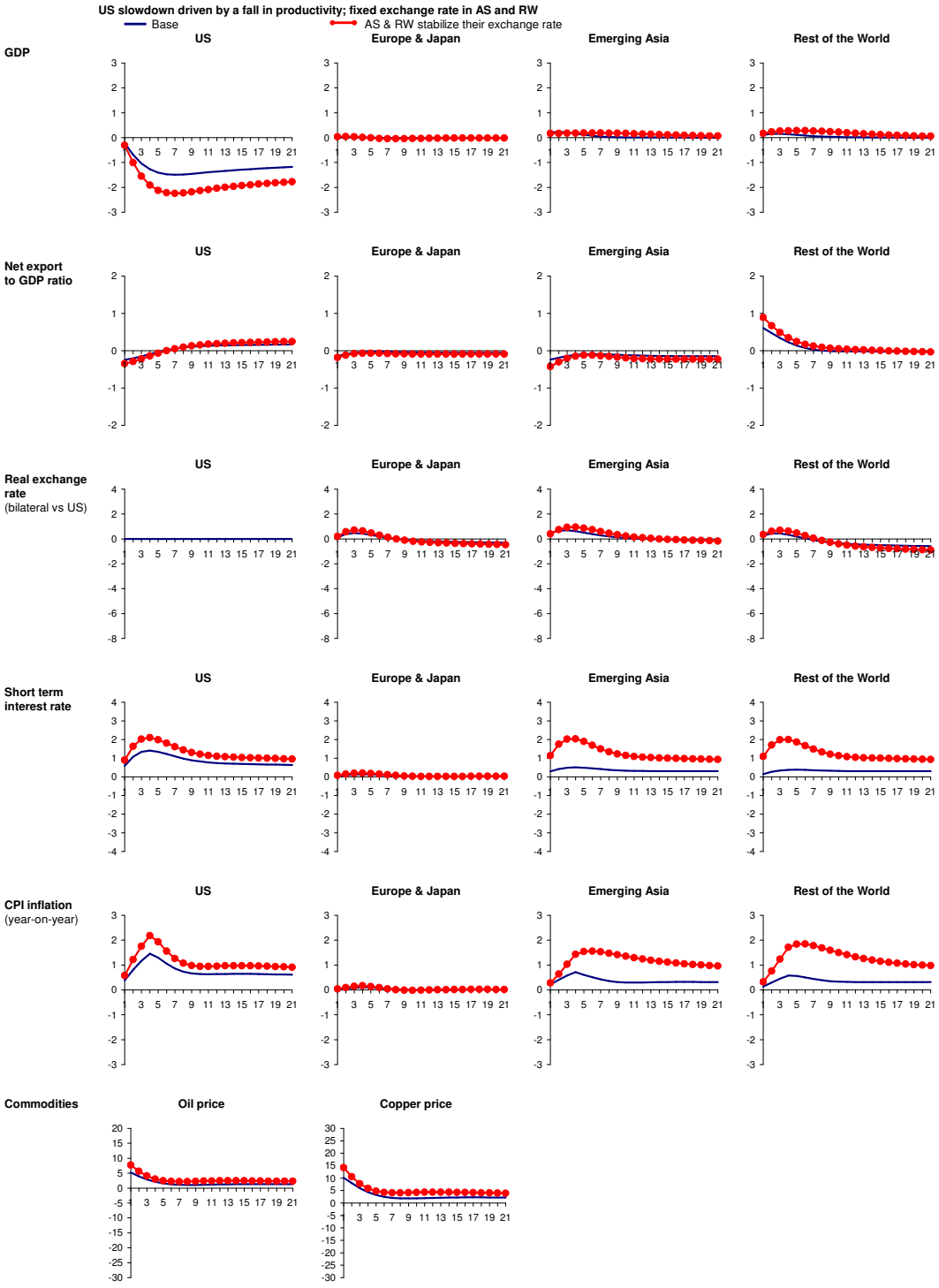


Figure 5: Global Boom-Bust Cycle

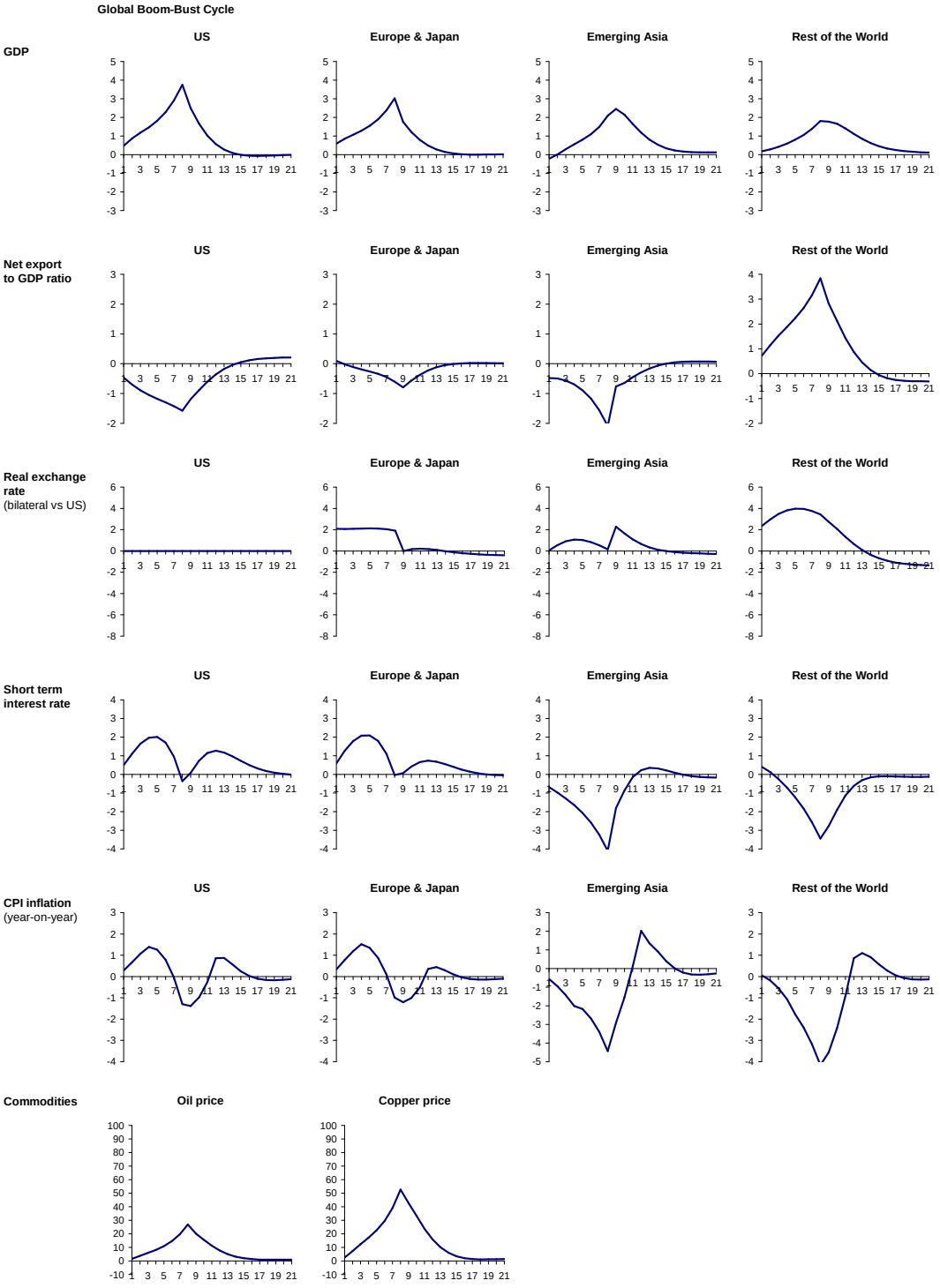


Figure 6: Global Boom-Bust Cycle with AS and RW Pegging to the US Dollar

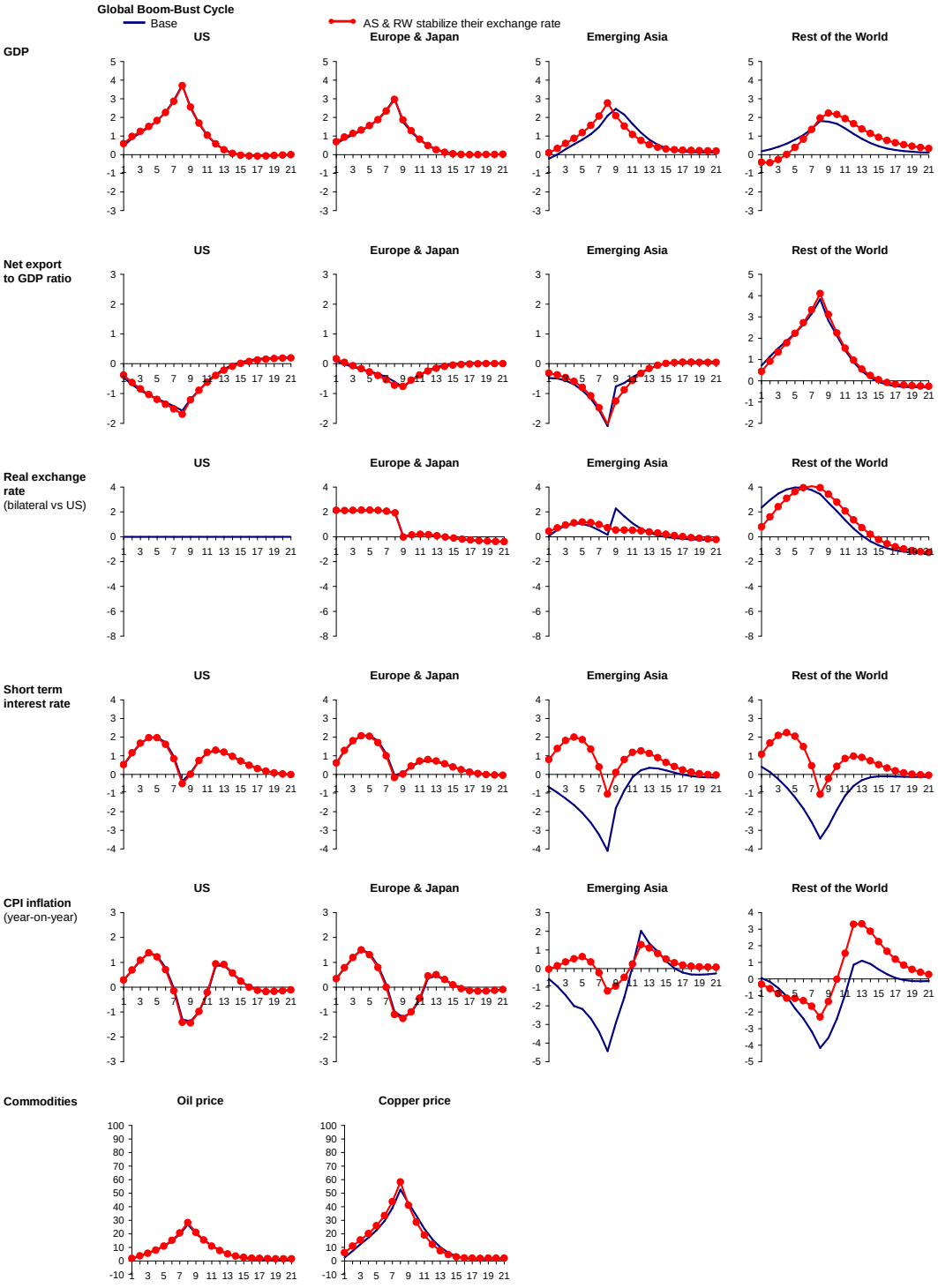


Figure 7: Global Boom-Bust Cycle with AS and RW Pegging to the US Dollar and More Wage Rigidity in US and EU

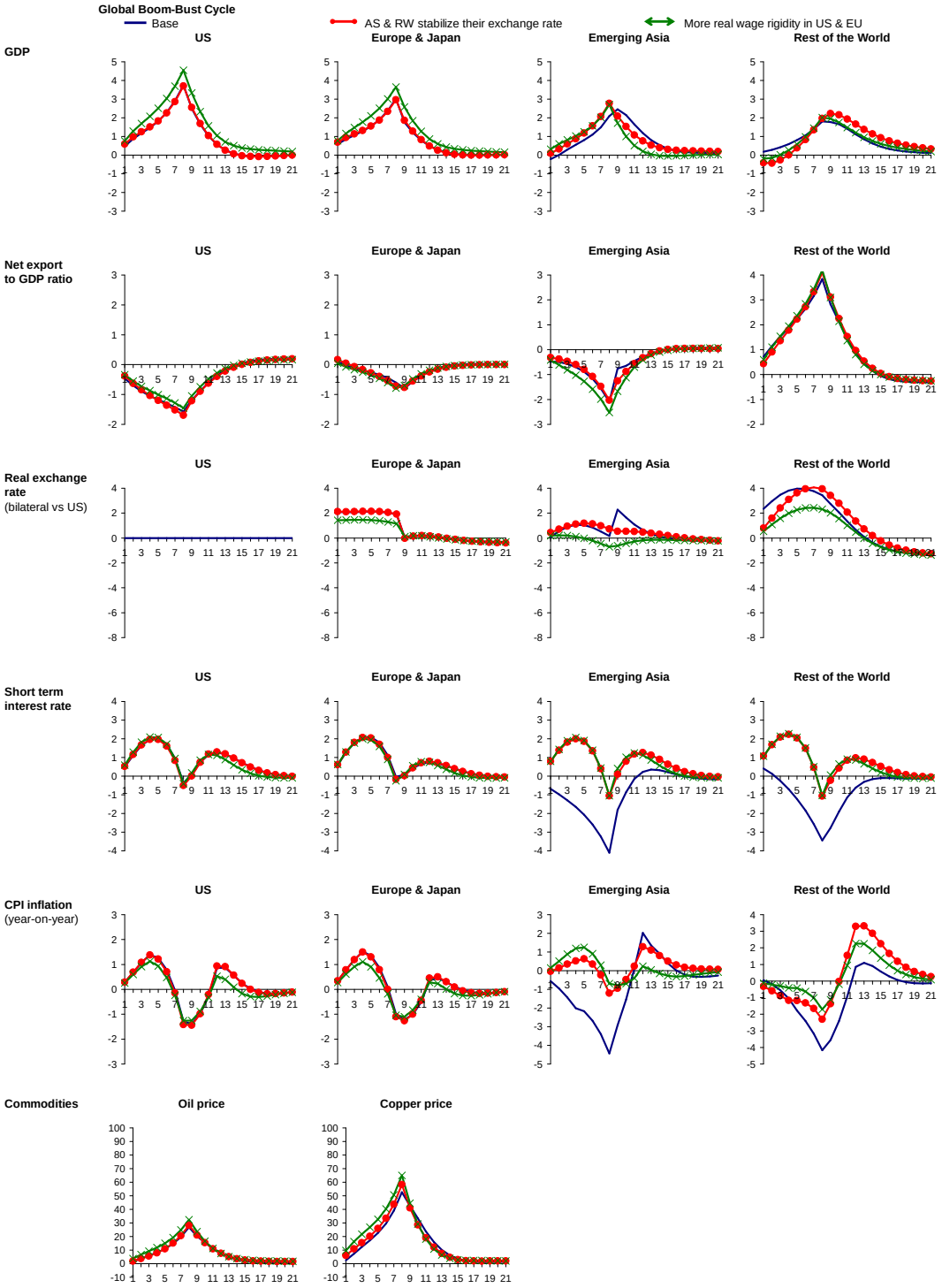


Figure 8: Global Boom-Bust Cycle and Current Account Imbalances

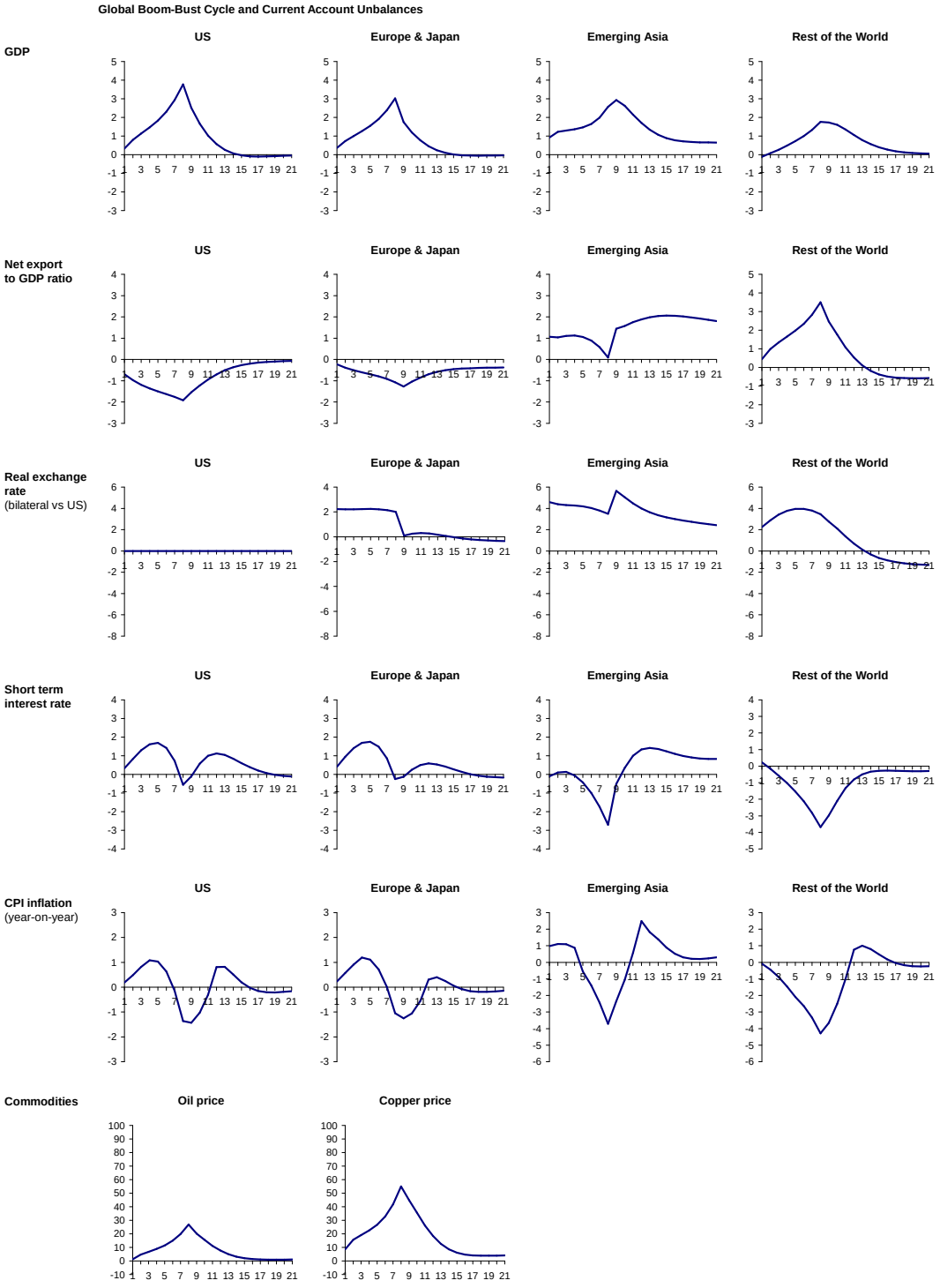


Figure 9: Protectionism in US and EU through Subsidies

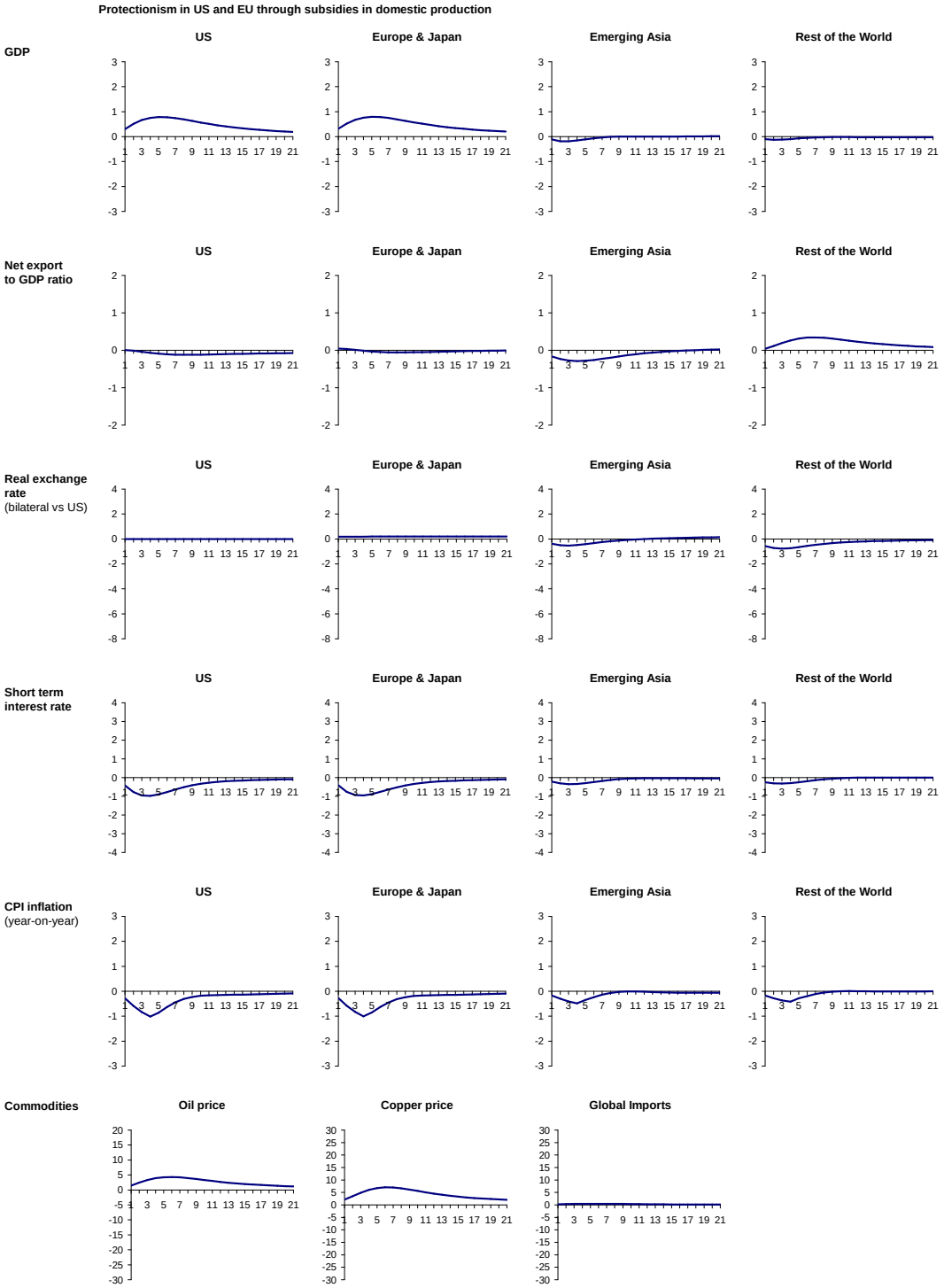
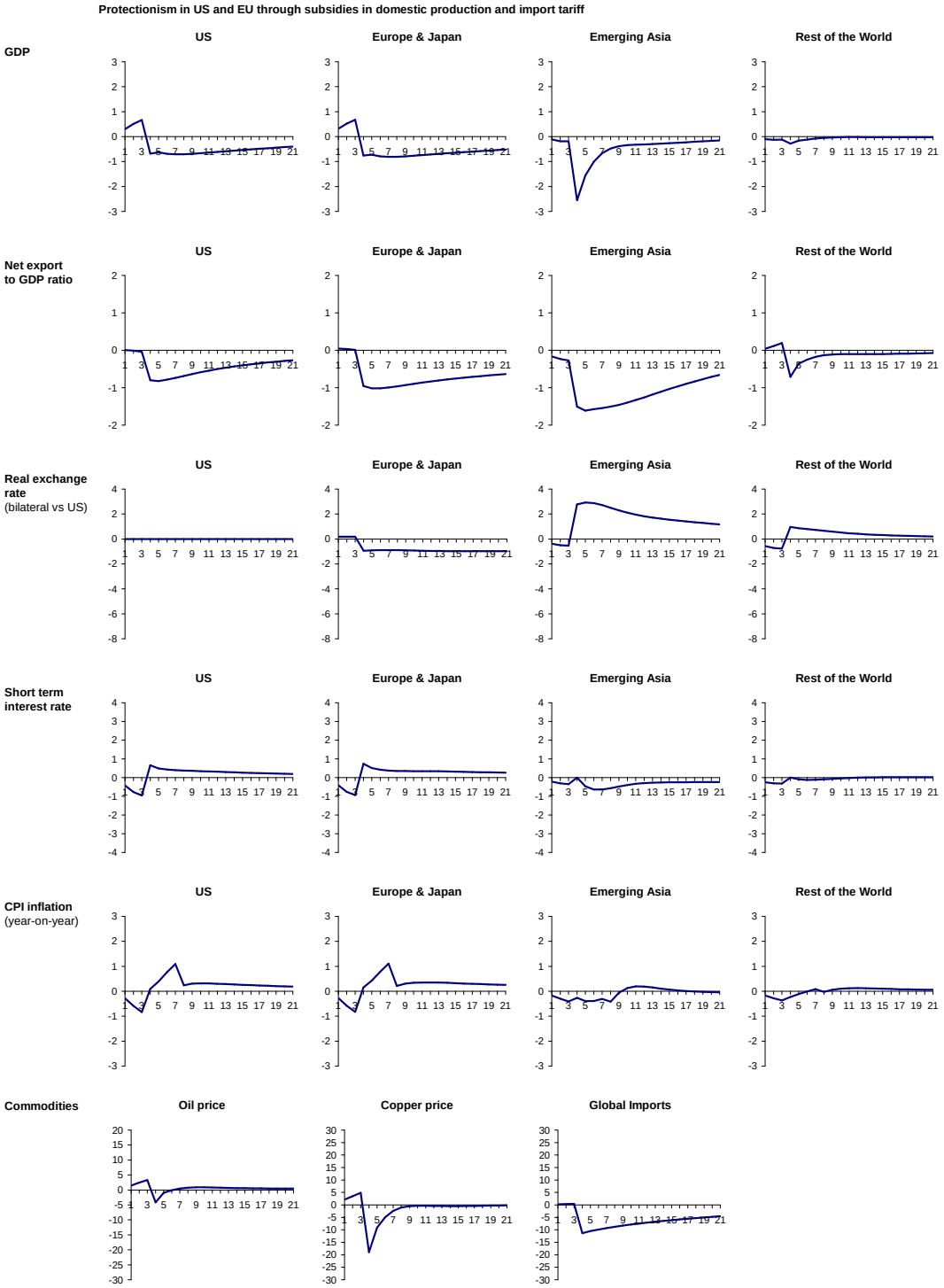


Figure 10: Protectionism in US and EU through Subsidies and Import Tariffs



A Some Statistics used for the Parameterization

Table 1: Production and Trade Data

Description	United States	Europe	Asia	Rest of the World
GDP share in total World				
Average 2000-2007, PPP adjusted	20.2	15.5	25.2	39.1
Net Exports				
Average 2000-2006, as percentage of GDP	-5.5	-0.1	3.1	-1.4
Average 1980-2006, as percentage of GDP	-3.3	-0.4	0.3	-0.8
Average 1960-2006, as percentage of GDP	-1.3	-	-	-
Net Exports of Oil				
Average 2000-2006, as percentage of GDP	-1.4	-1.5	-5.0	4.5
Net Exports of Copper				
Average 2000-2006, as percentage of GDP	-0.1	-0.1	-0.6	0.5
Total Oil Consumption				
Average 1980-2006, as percentage of GDP	2.4	3.6	8.3	2.5

Source: Authors' calculation, based on data from World Economic Outlook, IFS, Direction of Trade Statistics, British Petroleum and Cochilco

B Parameters for Calibration

Table 2: Production Function Parameters

Parameter	Meaning	US	EU	AS	RW
$\theta_{i,s}$	Elasticity of Substitution of copper and the other factors in gross production	0.0500	0.0500	0.0500	0.0500
$\theta_{i,o}$	Elasticity of Substitution of oil and the other factors in gross production	0.1000	0.1000	0.1000	0.1000
$\alpha_{i,s}$	Share of copper in gross production	0.0010	0.0010	0.0040	0.0001
$\alpha_{i,o}$	Share of oil in gross production	0.0300	0.0300	0.0600	0.0300
$\alpha_{i,l}$	Share of labor in gross production	0.9000	0.9000	0.9300	0.9000

Table 3: Household Preference Parameters

Parameter	Meaning	US	EU	AS	RW
h_i	Habit formation coefficient	0.8000	0.8000	0.8000	0.8000
σ_i	Inverse of intertemporal substitution elasticity	1.0000	1.0000	1.0000	1.0000
$\sigma_{L,i}$	Inverse of labor supply elasticity	2.0000	2.0000	2.0000	2.0000
$\gamma_{us,i}$	Share of produced goods in US aggregate demand	0.8990	0.0400	0.0490	0.0101
$\gamma_{eu,i}$	Share of produced goods in EU aggregate demand	0.0490	0.8930	0.0530	0.0025
$\gamma_{as,i}$	Share of produced goods in AS aggregate demand	0.0490	0.0810	0.8130	0.0547
$\gamma_{rw,i}$	Share of produced goods in RW aggregate demand	0.0680	0.0590	0.0260	0.8456
λ_i	Fraction of Non-Ricardian households	0.2000	0.2000	0.4000	0.4000

Table 4: Parameters Governing Nominal Rigidities and Monetary Policy

Parameter	Meaning	US	EU	AS	RW
$\phi_{p,i}$	Calvo parameter of price rigidity	0.6600	0.6600	0.6600	0.6600
$\xi_{p,i}$	Weight of price indexation to past inflation	0.5000	0.5000	0.5000	0.5000
$\phi_{L,i}$	Calvo parameter of wage rigidity	0.7500	0.7500	0.7500	0.7500
$\xi_{L,i}$	Weight of wage indexation to past inflation	0.7000	0.7000	0.7000	0.7000
$\psi_{rn,i}$	Smoothing coefficient in the Taylor-type rule 0.8000	0.8000	0.8000	0.8000	
$\psi_{\pi,i}$	Reaction coefficient to inflation in the Taylor-type rule	2.0000	2.0000	1.2000	1.2000
$\psi_{y,i}$	Reaction coefficient to output in the Taylor-type rule	0.1250	0.1250	0.1250	0.1250
$\psi_{\Delta e,i}$	Reaction coefficient to exchange devaluation in the Taylor-type rule	0.0000	0.0000	0.2000	0.2000

Table 5: Trade Parameters

Parameter	Meaning	US	EU	AS	RW
$X_{us,i}/VA_{us}$	Exports from US to each region as percentage of GDP	-	0.0500	0.0250	0.0570
$X_{eu,i}/VA_{eu}$	Exports from EU to each region as percentage of GDP	0.0400	-	0.0410	0.0500
$X_{as,i}/VA_{as}$	Exports from AS to each region as percentage of GDP	0.0990	0.1080	-	0.0440
$X_{rw,i}/VA_{rw}$	Exports from RW to each region as percentage of GDP	0.0120	0.0030	0.0320	-
$\eta_{us,i}$	Elasticity of substitution among goods in US aggregate demand	1.5000	1.5000	1.5000	1.5000
$\eta_{eu,i}$	Elasticity of substitution among goods in EU aggregate demand	1.5000	1.5000	1.5000	1.5000
$\eta_{as,i}$	Elasticity of substitution among goods in AS aggregate demand	1.5000	1.5000	1.5000	1.5000
$\eta_{rw,i}$	Elasticity of substitution among goods in RW aggregate demand	1.5000	1.5000	1.5000	1.5000
$(\zeta_{S,i} - Y_{S,i})/VA_i$	Net exports of copper as percentage of GDP	-0.0010	-0.0010	-0.0040	0.0049
$(\zeta_{O,i} - Y_{O,i})/VA_i$	Net exports of oil as percentage of GDP	-0.0250	-0.0250	-0.0640	0.0996
NX_i/VA_i	Total net exports as percentage of GDP	0.0060	-0.0020	-0.0040	-0.0024
$\mathcal{B}_i^*$	Net foreign asset position as percentage of GDP	-0.6058	0.2020	0.4038	0.2424
VA_i/VA	Output share in the global GDP	0.3000	0.3000	0.1500	0.2500

Table 6: Currency of denomination of the exports from each region

Parameter	Meaning	US	EU	AS	RW
Share of exports in US dollars					
$\nu_{1,us,j}$	Share of export from each region to US	-	1.00	1.00	1.00
$\nu_{1,eu,j}$	Share of export from each region to EU	0.00	-	0.00	0.00
$\nu_{1,as,j}$	Share of export from each region to AS	0.00	0.00	-	1.00
$\nu_{1,rw,j}$	Share of export from each region to RW	0.00	0.00	1.00	-
Share of exports in currency of EU (euros)					
$\nu_{2,us,j}$	Share of export from each region to US	-	0.00	0.00	0.00
$\nu_{2,eu,j}$	Share of export from each region to EU	1.00	-	1.00	1.00
$\nu_{2,as,j}$	Share of export from each region to AS	0.00	0.00	-	0.00
$\nu_{2,rw,j}$	Share of export from each region to RW	0.00	0.00	0.00	-
Share of exports in currency of the producer					
$1-\nu_{1,us,j}-\nu_{2,us,j}$	Share of export from each region to US	-	0.00	0.00	0.00
$1-\nu_{1,eu,j}-\nu_{2,eu,j}$	Share of export from each region to EU	0.00	-	0.00	0.00
$1-\nu_{1,as,j}-\nu_{2,as,j}$	Share of export from each region to AS	1.00	1.00	-	0.00
$1-\nu_{1,rw,j}-\nu_{2,rw,j}$	Share of export from each region to RW	1.00	1.00	0.00	-

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