Dissecting the Dynamics of the US Trade Balance in an Estimated Equilibrium Model*

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Abstract

This paper presents empirical evidence on the stochastic driving forces of the US trade balance. In an estimated two-country DSGE model, we find that investment-specific technology shocks have the strongest impact on the volatility of cyclical trade balance fluctuations, especially when the shocks are domestic and considered over longer forecast-horizons. At shorter horizons, US and foreign inter-temporal shocks that generate co-movement between consumption and investment, have an impact comparable to that of the investment-specific technology shocks. In contrast, shocks to US public spending and neutral technology - both forces traditionally used to explain trade balance fluctuations - hardly explain the volatility.

JEL Classification C11, F41

Keywords US Trade Balance, New Open Economy Macroeconomics, Bayesian Inference, DSGE Estimation.

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1 Introduction

The recent experience of the United States on the external sector has spawned a vast literature in international macroeconomics dwelling on its consequences for the global economy. The US current account deficit, both in absolute terms and as a proportion of output, has reached unprecedented levels in the nation's financial history. This paper disentangles the stochastic influences on the trade balance, the dominant component of the current account.[1]

Extant macroeconometric work centered on the US trade balance has focussed solely on the influence of domestic shocks. Bems, Dedola and Smets (2007) find that fiscal shocks and investment-specific technological change have had a negative influence on the trade balance. Corsetti and Konstantinou (2004, 2005) attribute the persistence of the deficit to a permanent shock that raises output, consumption and net foreign liabilities. This shock, interpreted by the authors as a technology shock, dominates the volatility of US net foreign liabilities over very long horizons. In the short run, transient shocks which decrease net foreign liabilities play a non-negligible role in explaining the volatility of the variables.

A truism inspires our analysis. Specifically, it takes two parties to make a trade balance. The US trade deficit absorbs three-fourth of the trade surpluses in the world[2] thereby rendering any analysis of the US deficit that ignores influences from its trade partners inadequate. The contribution of this paper is that we explicitly account for disturbances of foreign origin to influence the external position of the US by placing the trade balance in an estimated two country New Keynesian dynamic stochastic general equilibrium (DSGE) model.

Several authors have examined cyclical fluctuations in the US trade balance in calibrated two-country DSGE models. The classic contribution of Backus, Kydland and Kehoe (1994) assesses the link between the terms of trade and the trade balance as well as the responses of these variables to total factor productivity (TFP) and public spending shocks in an In-

[1] The US deficits on the current account and the trade balance equalled (at an annualized rate) 5.74 and 5.12 per cent of GDP respectively in 2007. The figures we use are computed from time series obtained from the FRED II database.

[2] See Obstfeld and Rogoff (2005).

ternational Real Business Cycle model. Similarly, Kollmann (1998) examines the influence of TFP and fiscal shocks. On the other hand, Erceg, Guerrieri and Gust (2005) focus on the impact of tax and public spending shocks on the external balance in a calibrated New Keynesian model. Just as the aforementioned authors, we focus on cyclical fluctuations in the trade balance, while abstracting from the trend.[3] However, in contrast to them, we confront our model with the data in a formal full-information likelihood-based estimation exercise in order to evaluate the response of the trade balance to a wider array of structural shocks.

Since we utilize the Bayesian framework to estimate the model, our approach is similar to other estimated small-scale two-country models in the recent literature like Lubik and Schorfheide (2005) and Rabanal and Tuesta (2006). Our model though stylized is also much richer than our precedents as we include capital accumulation and allow imports to enter the investment basket. The incorporation of the 'Rest of the World' (RoW) in an estimated micro-founded model makes this study the first of its type in the empirical literature on the US trade balance.[4]

Such a viewpoint, *i.e.* that of the influence of the RoW on the 'US' imbalance, has gained ground in policy-circles in recent times. Ferguson (2005) states that slumps in aggregate demand and depressed growth in major trade partners such as Japan and the Eurozone lead to the emergence of the US as a favourable location for investment. Bernanke (2005) attributes the deficit to excess saving in the global economy. He suggests that the strong savings motive of rich countries with aging populations and high capital-labor ratios coupled

[3] Our methodology only allows detrended data to speak within a stationary environment imposed by a log-linearized DSGE model. The US has been in a trade deficit since the early 1980s and this paper attempts to understand the stochastic influences that have had positive or negative influences on the trade balance at business cycle frequencies. Other authors, e.g. Engel and Rogers (2006) have examined the long-run path of the US trade balance.

[4] Bergin (2006) uses maximum likelihood to estimate a New Keynesian model of the US and the remaining of the G-7 countries. He estimates the model in country differences and hence can only identify *relative* shocks. Corsetti, Dedola and Leduc (2005) study the impact of relative productivity shocks on the exchange rate and net exports in impulse response analysis in an SVAR framework. Our DSGE model is asymmetric in the parameters estimated across countries and we intend to identify the structural shocks specific to both regions.

with the apparent lack of domestic investment opportunities led them to lend to the US, hence running external surpluses. Bernanke's views are echoed by Clarida (2005) who notes the higher rates of national saving in East Asia and describes the US deficit as a general equilibrium phenomenon that is in part caused by a global excess of saving over profitable investment opportunities.

Long quarterly series are unavailable for the developing countries whose shares in the US trade balance have increased in recent times. This undermines the credibility of the use of the actual time series on the US trade balance in an estimation exercise as ours. We circumvent this difficulty by constructing the aggregated trade balance between the US and sixteen OECD trade partners with whom the US has experienced deficits for a reasonably long span of time. As can be seen in Figure 1, the proxy contributes a sizable proportion of the actual trade deficit and mimics it remarkably well especially upto the late 1990s. As we take our two-country model to the data, we utilize trade-weighted time series from the sixteen OECD economies for the second 'country' in the model. As a consequence, this paper does not take a stand on the *actual* US trade balance, but restricts attention to the intra-OECD imbalance.

Insert Figure 1

The estimated model contributes to our understanding of the external position of the US in a number of ways. The US investment-specific technology shock has a very strong impact on the volatility of cyclical fluctuations in the trade balance to output ratio and is the predominant influence when considered over longer forecast-horizons. At shorter forecast-horizons, we find that inter-temporal disturbances that act as interest rate 'wedges' and affect both the opportunity cost of private consumption as well as the value of physical capital- and hence raise aggregate demand- have a considerable impact. Both foreign and US wedge shocks are important and account for about 40 per cent of the volatility in the short and medium run, decreasing over longer horizons. Further, historical decompositions show that the US investment-specific technology shocks and the interest rate wedge shocks from the Rest of the World contributed strongly and negatively to fluctuations in the trade balance in the late 1990s.

On the other hand, our results de-emphasize the role of two factors mentioned earlier in this section as cited in related strands of the literature as explanations of the behaviour of the US trade balance: those of neutral TFP movements and rises in public expenditure. For instance, Kollmann (1998) finds that differentials in TFP between the US and the G-6 economies were the main source of fluctuations in the trade balance over 1975-1991. The rise in output that follows a domestic TFP shock is dominated by rises in consumption and investment causing a surge in the demand for imports, resulting in current account deficits. We find that while the US TFP shock worsens the external position in impulse responses, it has had a negligible impact on the volatility. Furthermore, others have emphasized the role of the US Federal government and the consequent 'Twin Deficits' on the domestic and external sectors.[5] This paper does not provide an empirical evaluation of the Twin Deficits hypothesis and reduces the role of public expenditure to a residual in aggregate demand. However, we find that the US public spending shock - just as the US TFP shock- deteriorates the trade balance in impulse responses but hardly matters for the volatility.

The remainder of the paper is organized as follows. The next section details the theoretical model we set up. Section 3 describes the methodology and construction of the key open economy data series. Section 4 and 5 present estimation results and our exposition of the stochastic influences that drive fluctuations in the US trade balance over the business cycle. Section 6 summarizes our main conclusions.

[5]Proponents of the 'Twin Deficits' view posit that a lack of public saving deteriorates the nation's external position via the national income accounting identity while others have argued that the two deficits have not been twins and have moved even in opposite directions as in the late 1990s. See Erceg *et al.* (2005), Corsetti and Müller (2006) and the references therein.

2 A Two Country Two Sector Model

Our framework has much in common with the work of Smets and Wouters (2007) and Rabanal and Tuesta (2006). The model is quite standard in the literature and we do not present a complete description.[6] Our world comprises two regions, each inhabited by infinitely lived consumers, producers and the fiscal and monetary authorities. We present equilibrium conditions for the Home economy that are log-linearized around a simple symmetric non-stochastic steady-state with no inflation, exchange rate depreciation or foreign asset accumulation. The Foreign region is isomorphic. Foreign region parameters and variables are denoted by a supercript $*$ and are presented, when essential, in parentheses next to their Home analogs. Variables that represent a deviation from steady-state are denoted by $\widehat{\cdot}$.

2.1 Private Agents

2.1.1 Firms

There exists a continuum of intermediate monopolistic firms each of which produces a unique variety that can be both consumed and invested. C_H (C_F^*) and X_H (X_F^*) are Dixit-Stiglitz aggregates of individual domestic varieties to be consumed and invested respectively. C_F (C_H^*) and X_F (X_H^*) are similar aggregates of imported varieties. A distribution sector costlessly produces Armington aggregates of the composite Home and imported bundles for consumption and investment.

$$C_t = \left[(1-\xi)^{\frac{1}{\mu}} C_{Ht}^{\frac{\mu-1}{\mu}} + \xi^{\frac{1}{\mu}} C_{Ft}^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{\mu-1}},\ X_t = \left[(1-\xi)^{\frac{1}{\mu}} X_{Ht}^{\frac{\mu-1}{\mu}} + \xi^{\frac{1}{\mu}} X_{Ft}^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{\mu-1}},\ \mu > 0$$

ξ denotes the share of imports in the consumption and investment baskets. Note however that to keep matters simple, we assume that the consumption and investment baskets are

[6] All our derivations are available on request.

equally open to imports. Further, we assume that the Foreign region is as open to Home region exports. μ is the elasticity of substitution between home and foreign goods in both regions. The price-indices of the domestic and imported bundles are denoted by P_H (P_F^*) and P_F (P_H^*) respectively.

The firm rents capital K and labor N from the household at (real) prices r^k and w in perfectly competitive factor markets. Factor payments in the Home country accrue only to domestic residents.[7] It combines the two factors of production using a Cobb-Douglas technology, so that real marginal cost is a weighted average of factor prices.

$$\widehat{RMC}_t = (1-\alpha)\,\hat{w}_t + \alpha \hat{r}_t^k - \hat{A}_t \tag{1}$$

where exogenous TFP follows $\hat{A}_t = \rho_{\,TFP}\ \hat{A}_{t-1} + \eta_t^{TFP}$.

Imperfect Passthrough We follow Benigno (2004) in assuming that the firm prices in the currency of the market of destination. This 'local-currency pricing' strategy yields two empirically appealing features in the model. On the one hand, the law of price is broken at the level of the intermediate varieties and on the other, price stickiness delays the transmission of exchange rate changes into the aggregate price level in the market of destination. The firm, indexed by i, chooses its prices, *i.e.* $\ddot{p}_{Ht}^{\,i}$ for domestic sales and $\ddot{p}_{Ht}^{*\,i}$ for exports to maximize the value of expected profits.

$$\max_{\ddot{p}_{Ht}^{\,i},\,\ddot{p}_{Ht}^{*\,i}} \mathbf{E}_t \sum_{\tau=0}^{\infty} \beta^{\tau} \frac{\lambda_{t+\tau}}{\lambda_t} \frac{P_t}{P_{t+\tau}} \left[\theta_H^{\,\tau} \left(\ddot{p}_{Ht}^{\,i} Z_{Ht,\tau} - RMC_{t+\tau} P_{t+\tau} y_{Ht+\tau}^{i} \right) + \theta_H^{*\,\tau} \left(S_{t+l} \ddot{p}_{Ht}^{*\,i} - RMC_{t+\tau} P_{t+\tau} y_{H^*t+\tau}^{i} \right) \right]$$

subject to its demand constraint and indexation rule.

$$y_{Ht+\tau}^{i} = \left(\frac{p_{Ht+\tau}^{\,i}}{P_{Ht+\tau}} \right)^{-\chi} \left(C_{Ht+\tau} + G_{t+\tau} + X_{Ht+\tau} \right),\ y_{H^*t+\tau}^{i} = \left(\frac{p_{Ht+\tau}^{*\,i}}{P_{Ht+\tau}^{*}} \right)^{-\chi} \left(C_{Ht+\tau}^{*} + X_{Ht+\tau}^{*} \right)$$

[7] Similarly, factor payments in the Foreign region accrue only to its residents.

$$Z_{Ht,\tau} = \prod_{l=0}^{\tau-1} \pi_{Ht+l}^{\iota_p} \text{ iff } \tau > 0 \text{ and } 1 \text{ iff } \tau = 0,\ \chi > 1,\ \iota_p \in (0,1)$$

λ is the marginal utility of wealth, β is the agent's subjective discount factor and P denotes the aggregate price level in the economy. S is the nominal exchange rate, defined as the Home currency price of a unit of foreign currency: a rise in the exchange rate means a depreciation of the Home currency. The superscript '¨' indicates that the optimal price set, cannot be reoptimized in the τ periods that follow the decision. As the marginal cost is independent of output, we can allow the degree of price stickiness to differ between domestic and export sales. However since we do not use data for export prices for the estimation of the model, we keep the export pricing equations simple by abstracting from indexation.

The Phillips curves for domestic sales are given by

$$\hat{\pi}_{Ht} = \frac{\iota_p}{1+\beta\iota_p}\hat{\pi}_{Ht-1} + \frac{\beta}{1+\beta\iota_p}\mathbf{E}_t\hat{\pi}_{Ht+1} + \frac{(1-\beta\theta_H)(1-\theta_H)}{\theta_H(1+\beta\iota_p)}\left(\widehat{RMC}_t + \xi\widehat{ToT}_t\right) \quad (2)$$

$$\hat{\pi}^*_{Ft} = \frac{\iota_p^*}{1+\beta\iota_p^*}\hat{\pi}^*_{Ft-1} + \frac{\beta}{1+\beta\iota_p^*}\mathbf{E}_t\hat{\pi}^*_{Ft+1} + \frac{(1-\beta\theta_F^*)(1-\theta_F^*)}{\theta_F^*\left(1+\beta\iota_p^*\right)}\left(\widehat{RMC}_t^* + \xi\widehat{ToT}_t^*\right) \quad (3)$$

$\widehat{ToT}$ and $\widehat{ToT}^*$ are the Home and Foreign terms of trade that determine the rate at which consumers substitute the imported good for the domestically produced good. They are defined as follows.[8]

$$\widehat{ToT}_t \equiv \hat{P}_{Ft} - \hat{P}_{Ht},\ \widehat{ToT}_t^* \equiv \hat{P}^*_{Ht} - \hat{P}^*_{Ft}$$

The Phillips curves for export prices are detailed in the section on inter-regional linkages.

[8] When the law of one price holds $\widehat{ToT}_t^* = -\widehat{ToT}_t$. Note further that the real exchange rate Q can be expressed in terms of the nominal exchange rate S and the Home and Foreign terms of trade in the following way.

$$\hat{Q}_t = \left(\hat{S}_t + \hat{P}^*_{Ft} - \hat{P}_{Ht}\right) - \xi\left(\widehat{ToT}_t - \widehat{ToT}_t^*\right)$$

2.1.2 Consumers

The factor payments $WN^h + r^k K^h$ and profits Π^h that consumers receive from the firms are used to consume the final good, purchase financial assets and to invest in the stock of capital. International financial markets are incomplete: the consumers can trade in two kinds of single period risk-free private nominal bonds. In particular, agents acquire domestic bonds denominated in the home currency and they also have access to bonds NFA that are denominated in the foreign currency. The home and foreign bonds yield gross interest rates R and R^* respectively. On the expenditure side, the consumer also incurs quadratic adjustment costs Ψ^{NFA} to acquire foreign bonds and pays lumpsum taxes T^h that are paid to finance public expenditure.[9] As in Smets and Wouters (2007), the transformation of investment X into physical capital involves adjustment costs while physical capital depreciates at a constant rate δ per period. Capital accumulation is affected by a random element ϵ_X that is modelled as an AR(1) process.

The consumer has a period utility function separable over consumption and leisure. $\vartheta \in (0,1)$ governs (external) habit persistence in consumption behavior. The optimization program that faces the generic household h is given as

$$\max_{C_t^h,\, N_t^h\,,\, K_{t+1}^h,\, X_t^h,\, B_{t+1}^h,\, NFA_{t+1}^h} \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t^h - \vartheta C_{t-1}\right)^{1-\sigma_C}}{1-\sigma_C} + \frac{\left(1-N_t^h\,\right)^{1-\sigma_N}}{1-\sigma_N} \right]$$

subject to

$$C_t^h + X_t^h + \frac{B_{t+1}^h}{P_t} + \frac{S_t NFA_{t+1}^h}{P_t} + T_t^h + \Psi_t^{NFA} = w_t N_t^h + r_t^k K_t^h + \frac{R_{t-1} B_t^h}{P_t} + \frac{R_{t-1}^* S_t NFA_t^h}{P_t} + \Pi_t^h \quad (4)$$

$$\epsilon_{Xt}\, X_t^h \left[1 - \Phi\left(\frac{X_t^h}{X_{t-1}^h}\right)\right] + (1-\delta)\, K_t^h = K_{t+1}^h \quad (5)$$

[9] Without the adjustment costs, the policy function for foreign bond holdings exhibits a unit root that will in turn be transmitted to consumption and output. This prevents a local analysis around a deterministic steady state. See among others Rabanal and Tuesta (2006).

$$\Psi_t^{NFA} = \frac{\kappa}{2}\frac{S_t}{P_t Y_t}\left(NFA_{t+1}^h - NFA\right)^2, \text{ where } \kappa > 0,\ \sigma_C,\ \sigma_N \geqslant 0,\ \beta \in (0,1)$$

Intra-temporal optimality implies that labor supply is determined by the utility gain from the real wage.

$$\hat{N}_t = \frac{1}{\sigma_N}\hat{w}_t - \frac{\sigma_C}{\sigma_N}\frac{1}{(1-\vartheta)}\hat{C}_t + \frac{\sigma_C}{\sigma_N}\frac{\vartheta}{(1-\vartheta)}\hat{C}_{t-1} \tag{6}$$

The inter-temporal flow of aggregate consumption is decided by the following Euler equation.[10]

$$\hat{C}_t = \frac{1}{(1+\vartheta)}\mathbf{E}_t\hat{C}_{t+1} + \frac{\vartheta}{(1+\vartheta)}\hat{C}_{t-1} - \frac{1}{\sigma_C}\frac{(1-\vartheta)}{(1+\vartheta)}\left(\hat{R}_t - \mathbf{E}_t\hat{\pi}_{t+1} - \hat{\varepsilon}_{Wt}\right) \tag{7}$$

As in Smets and Wouters (2007) ε_W is a wedge between the interest rate controlled by the monetary authority and the return on domestic financial assets faced by the consumer and evolves as an AR(1) process. A positive wedge shock decreases the effective rate of return on assets and stimulates current consumption.[11] The wedge also affects the dynamics of Tobin's Q and hence investment in physical capital. A positive shock raises the value of capital and boosts investment. It is this additional effect of the wedge shock that prevents it from being observationally equivalent to the traditional time impatience shock to the agent's subjective discount factor as in Rabanal and Tuesta (2006).

$$\widehat{TQ}_t = (1-\beta(1-\delta))\,\mathbf{E}_t\hat{r}_{t+1}^k + \beta(1-\delta)\,\mathbf{E}_t\widehat{TQ}_{t+1} - \left(\hat{R}_t - \mathbf{E}_t\hat{\pi}_{t+1} - \hat{\varepsilon}_{Wt}\right) \tag{8}$$

The presence of the convex investment adjustment costs implies that investment reacts optimally to its own lagged and expected values as well as Tobin's Q.[12]

$$\hat{X}_t = \frac{1}{\varphi(1+\beta)}\widehat{TQ}_t + \frac{\beta}{(1+\beta)}\mathbf{E}_t\hat{X}_{t+1} + \frac{1}{(1+\beta)}\hat{X}_{t-1} + \tilde{\varepsilon}_{Xt} \tag{9}$$

[10] π is the inflation rate in the aggregate price level.

[11] Following Smets and Wouters (2007), we redefine the interest rate wedge as $\tilde{\varepsilon}_W \equiv \frac{1}{\sigma_C}\frac{(1-\vartheta)}{(1+\vartheta)}\hat{\varepsilon}_W$ such that $\tilde{\varepsilon}_{Wt} = \rho_{WED}\,\tilde{\varepsilon}_{Wt-1} + \eta_t^{WED}$ in our estimation.

[12] The properties of the investment adjustment cost function in the steady state are such that $\varphi = \Phi''(1) > 0, \Phi'(1) = \Phi(1) = 0$

The inter-temporal flow of the physical capital stock is given by

$$\hat{K}_{t+1} = \delta \hat{X}_t + (1-\delta)\,\hat{K}_t + \delta\varphi\,(1+\beta)\,\tilde{\varepsilon}_{Xt} \tag{10}$$

ε_X is an investment-specific technology shifter in the spirit of Greenwood *et al.* (1997) and evolves as $\tilde{\varepsilon}_{Xt} = \rho_{INV}\ \tilde{\varepsilon}_{Xt-1} + \eta_t^{INV}$.[13] The technology shifter increases the rate of conversion of investment into capital by reducing adjustment costs. Alternatively, one can interpret the shock as a fall in the relative price of investment goods.

2.1.3 Government

The government operates under a simple fiscal rule with its expenditure G equalling aggregate revenue from lumpsum taxes T. Public expenditure that is modelled as an AR(1) process, falls entirely on the domestic good, *i.e.* the government's consumption basket is closed.[14]

$$\hat{T}_t = \hat{G}_t \tag{11}$$

As in much of the literature on estimated DSGE models, we keep matters simple by decreeing that public expenditure is a purely residual shock on aggregate demand. For simplicity, we have also abstracted from public debt and hence the Twin Deficits phenomenon.[15]

[13] $\tilde{\varepsilon}_X$ is a rescaled version of the shock that affects the investment adjustment cost function. In particular, $\tilde{\varepsilon}_X \equiv \frac{1}{\varphi(1+\beta)}\hat{\varepsilon}_X$

[14] We rescale the public expenditure shock by Ξ_G , the steady state share of public expenditure in output. That is, $\tilde{G}_t = \rho_{GOV}\ \tilde{G}_{t-1} + \eta_t^{GOV}$ such that $\tilde{G} = \Xi_G \hat{G}$.

[15] In previous estimations, we modelled government debt and included the Federal budget balance as an observable in the estimation. However the posterior distributions of the structural parameters failed to achieve convergence even after millions of simulations. The volatility decompositions showed that the public spending shock had virtually no impact on the trade balance. In standard New Keynesian DSGE models with consumption-smoothing agents, the public spending shock that is modelled as being neither useful nor productive, crowds out private expenditures by raising real interest rates. Hence any worsening of the trade balance via a rise in private expenditures is negated. Hence, our decision to abstract from the 'Twin Deficits' phenomenon: adding public debt in both regions will add two additional state variables and complicate estimation. See Corsetti and Müller (2006) for a discussion of the influence of public expenditure and budget deficits on the external balance.

2.1.4 Monetary Authority

The monetary authority follows a simple empirical Taylor-type rule to set the nominal interest rate. As in Walsh (2003), allowing the interest rate to respond to changes in inflation and output in addition to their levels, controls for discretionary 'speed-limit' reactions from the monetary authority.

$$\hat{R}_t = \rho_{MON}\, \hat{R}_{t-1} + (1-\rho_{MON})\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{Y}_t\right) + \phi_{\Delta\pi}\left(\hat{\pi}_t - \hat{\pi}_{t-1}\right) + \phi_{\Delta y}\left(\hat{Y}_t - \hat{Y}_{t-1}\right) + \eta_t^{MON} \tag{12}$$

2.2 Inter-Regional Linkages

2.2.1 Exchange Rate

The expected nominal depreciation of the Home currency is linked to the interest rate and inflation differentials via the arbitrage condition for Home and Foreign bonds.

$$\mathbf{E}_t\left(\hat{S}_{t+1} - \hat{S}_t\right) = \hat{R}_t - \left(\hat{R}_t^* - \kappa \widehat{NFA}_{t+1} + \hat{\zeta}_t\right) \tag{13}$$

Uncovered interest parity does not hold due to the presence of the net foreign asset position in the arbitrage condition. The additional cost of acquiring foreign assets κNFA serves as an endogenous risk premium. As is common in the empirical literature, we add to the arbitrage condition a stochastic risk-premium ζ whose evolution is given as $\hat{\zeta}_t = \rho_{UIP}\, \hat{\zeta}_{t-1} + \eta_t^{UIP}$. Hunt and Rebucci (2005) interpret the exogenous risk-premium as a proxy for foreign investors' preference for Home financial assets.

As inflation differentials between the US and RoW are not that pronounced, real exchange rate volatility is likely to be driven by changes in the nominal exchange rate. To help our model match the data[16] better, we follow Lubik and Schorfheide (2005) and allow

[16] The nominal depreciation of the US dollar is an observed variable in our estimation.

an idiosyncratic disturbance to affect changes in the exchange rate. This shock captures deviations from purchasing power parity not accounted for by endogenous frictions such as local currency pricing and home-bias in trade.

$$\hat{Q}_t - \hat{Q}_{t-1} = \left(\hat{S}_t - \hat{S}_{t-1}\right) - \left(\hat{\pi}_t - \hat{\pi}_t^*\right) + \eta_t^{PPP} \tag{14}$$

The innovations η_t^x are independently and identically distributed $\mathcal{N}(0, \sigma_x)$ and $\rho_x \in (0,1)$ $\forall x$.

2.2.2 Export Prices

The Phillips curves for exports sales prices are purely forward looking. The degree of stickiness in price adjustment will determine the passthrough of exchange rate changes into the aggregate price level.[17]

$$\hat{\pi}^*_{Ht} = \beta \mathbf{E}_t \hat{\pi}^*_{Ht+1} + \frac{(1-\beta\theta^*_H)(1-\theta^*_H)}{\theta^*_H} \left\{ \widehat{RMC}_t - \hat{Q}_t - (1-\xi)\widehat{ToT}_t^* \right\} \tag{15}$$

$$\hat{\pi}_{Ft} = \beta \mathbf{E}_t \hat{\pi}_{Ft+1} + \frac{(1-\beta\theta_F)(1-\theta_F)}{\theta_F} \left\{ \widehat{RMC}_t^* + \hat{Q}_t - (1-\xi)\widehat{ToT}_t \right\} \tag{16}$$

2.2.3 Goods Market Clearing

Domestic output in each region is absorbed by fixed proportions of consumption and investment at home and abroad as well as exogenous domestic government spending.

$$\hat{Y}_t = \Xi_C \left((1-\xi)\hat{C}_t + \xi \hat{C}_t^*\right) + \Xi_X \left((1-\xi)\hat{X}_t + \xi \hat{X}_t^*\right) + \mu\xi(1-\xi)\left(\Xi_C + \Xi_X\right)\left(\widehat{ToT}_t - \widehat{ToT}_t^*\right) + \tilde{G}_t \tag{17}$$

$$\hat{Y}_t^* = \Xi_C \left((1-\xi)\hat{C}_t^* + \xi \hat{C}_t\right) + \Xi_X \left((1-\xi)\hat{X}_t^* + \xi \hat{X}_t\right) + \mu\xi(1-\xi)\left(\Xi_C + \Xi_X\right)\left(\widehat{ToT}_t^* - \widehat{ToT}_t\right) + \tilde{G}_t^* \tag{18}$$

[17] Note that the aggregate inflation is a convex combination of inflation in domestic sales prices and import price inflation, *i.e.* $\hat{\pi}_t = (1-\xi)\hat{\pi}_{Ht} + \xi\hat{\pi}_{Ft}$

Ξ_C and Ξ_X are the steady-state shares of consumption and investment in output.

2.2.4 Balance of Payments

The balance of payments between the two regions is determined by the inter-temporal flow of net foreign assets (as a proportion of output).

$$\begin{aligned}\widehat{NFA}_{t+1} - \frac{1}{\beta}\widehat{NFA}_t &= \xi\Xi_C\left(\hat{C}_t^* - \hat{C}_t\right) + \xi\Xi_X\left(\hat{X}_t^* - \hat{X}_t\right) + \xi\left(\Xi_C + \Xi_X\right)\hat{Q}_t \\ &\quad + \xi\left(1-\xi\right)\left(\Xi_C + \Xi_X\right)\left(\mu - 1\right)\left(\widehat{ToT}_t - \widehat{ToT}_t^*\right) \qquad (19)\end{aligned}$$

The trade balance (net exports) to output ratio of the Home economy, expressed in terms of the consumption and investment baskets, the terms of trade and the real exchange rate is given by the right hand side of the above equation.[18] Note how adjustments in savings and investment via the trade balance are facilitated by a concurrent movement in the net foreign asset position, *i.e.* the capital account.

3 The Case for a Proxied Trade Balance

The acquisition of dollar-denominated assets by economies as China, the oil-producing economies and to a lesser extent Brazil, Russia and India have received the recent attention of pundits, policy-makers and the media alike in the context of the US deficit. However, quarterly data series spanning reasonably long time-spans are unavailable for these economies. This undermines the credibility of using the actual time series on the US trade balance, *i.e.* *vis-á-vis* all countries including the emerging markets, in an estimation exercise as ours.

Given the sometimes conflicting objectives of considering a long enough sample period while also maintaining consistency over the selection of countries that run surpluses with

[18] If one removes investment from the model, *i.e.* set $\Xi_X = 0$, the structural equations reduce to those of the model featuring incomplete-markets with local currency pricing posited in Rabanal and Tuesta (2006).

the US, we restrict ourselves to the OECD and choose economies that have mostly been net lenders to the US. In particular, we choose Canada, Japan, South Korea, the United Kingdom and twelve economies in the Eurozone to form our aggregate of the RoW. We then construct the aggregated bilateral trade balance of the US *vis-á-vis* the sixteen economies, thereby circumventing the difficulty of controlling for the economies omitted from our sample. A weighted aggregate of these sixteen OECD economies now constitutes our measure of the RoW and the 'proxy' trade balance that channels savings and investment flows between the US and the aggregate of economies is the centerpiece of our empirical analysis.

Interestingly, despite not including in our RoW aggregate the high-saving economies of Asia that have drawn the specific attention of policy makers, the long-run imbalance between savings and investment prevails even in our synthetic two-country world. Figure 2 depicts crude measures of savings ratios and investment ratios in our aggregate of economies and the US over 1980-2005. It is clear that while the RoW has always met its investment needs with sufficient rates of savings, the opposite has been the case with the US. The savings and investments ratios in both regions were roughly in balance in the early 1980s, diverged as the years progressed and returned to approximate balance by the end of the decade. In 1991-92, the US savings-investment gap was close to zero. Strikingly, at this *very* point in time, the RoW also bridged its savings-investment gap. From this point of balance, the ensuing decade and a half saw drastic changes. The high savings-lower investment gap in the RoW became quite persistent towards the late 1990s. The US experience was exactly the opposite, with private saving- having trended downward throughout the sample period- turning very low by the turn of the millenium.

Insert Figure 2

Equipped with the intuition about the long-run differentials in savings-investment behavior in the two regions, we attempt a business cycle analysis of the fluctuations of the US trade balance around its trend as we estimate our two country model and analyze the impact of the various shocks on the trade balance. Without doubt, leaving out the non-OECD economies handicaps our analysis and imperils inference. Note further that our two-country framework also restricts us to view all the economies that constitute the RoW as a unified economic region, thereby abstracting from all heterogeneity in economic behavior across the sixteen economies. The structural parameters for the RoW including those pertaining to the monetary policy rule have to be seen as a weighted average. However, despite the many limitations of our RoW aggregate and the stylized two-country approach, we demonstrate in our estimation of the theoretical model how our artificial equilibrium environment can be used as a laboratory to understand the forces that influence the actual disequilibrium.

3.1 Construction of Key Open Economy Series

We use the Direction of Trade Statistics (DOTS) database of the IMF to construct the aggregated bilateral trade balance (net exports in US dollars). Panel (i) of Figure 1 compares the sample aggregated trade balance to output ratio as a proportion of US GDP with the actual series over the time period we consider. Omitting many of the non-OECD economies in our aggregate implies that there is some disparity in size between the two series. However, until the late 1990s the proxy tracks the actual series rather well. The two series have high correlation coefficients of 0.85 in levels and 0.77 after linear detrending. The gap between the two series increases by the turn of the millenium, understandably due to the emergence of the Asian economies as major trade partners of the US.

Unlike other studies that use multi-country aggregates, we avoid using real GDP weights to aggregate the series for the individual economies which constitute the RoW.[19] We use trade-share weights instead that may better emphasize the role of each country in the inter-regional transmission of shocks. Shares of each individual economy are computed by dividing

[19]See Bussière *et al.* (2005) and Bergin (2006) among others.

the sum of imports and exports with the individual economy by aggregate trade. They are exhibited in Panel (i) of Figure 3. We use the trade-share weights to aggregate individual nominal exchange rates of the dollar *vis-á-vis* the trade parters.[20] We display a comparison of the depreciation of the constructed exchange rate and the Nominal Effective Exchange Rate of the IMF in Panel (ii) of Figure 3. The correlation is high between the actual series and the constructed series at 0.81. The trade shares are then used to aggregate the time series obtained for the individual economies. All particulars are detailed in the Appendix.

Insert Figure 3

3.2 Bridging the Theory and the Data

We use 12 quarterly series over the period 1980.I to 2005.IV to identify the structural parameters in the model. In addition to the trade balance and the nominal exchange rate, we use series on real GDP, real consumption, real investment, nominal interest rate and the GDP deflator for both the US and the RoW. We multiply the natural logarithms of consumption, output, investment, the price level and the nominal exchange rate by 100. These series are fed into the model in demeaned first differences. The demeaned nominal interest rates are divided by 4 to translate them into quarterly terms. The nominal interest rates and the linearly detrended trade balance to US GDP ratio enter the estimation in levels.

4 Estimation Methodology

We follow the Bayesian estimation methodology of Smets and Wouters (2007). A brief description is presented in the Appendix.

[20]Individual country nominal exchange rates were obtained from the IMF-IFS database. The pre-EMU Euro-Dollar exchange rate was constructed using the methodology of Lubik and Schorfheide (2005) harnessing country-weights from the Area Wide Model.

4.1 Prior Distributions

Estimated Parameters An overview of all priors that we set are presented in Table 1. As we have virtually no information on structural parameters in the constructed aggregate of economies, we use the priors identical to those used for the US. As in Lubik and Schorfheide (2005), we set Gamma priors of mean 2 and standard deviation 0.5 for the risk-aversion coefficients ($\sigma_C,\ \sigma_{C^*}$). The external habit parameters ($\vartheta,\ \vartheta^*$) are given Beta priors of mean 0.50 and standard deviation 0.15. Similar to Smets and Wouters (2007), we use a loose Normal prior of mean 4 and unit variance for the investment adjustment cost parameters ($\varphi,\ \varphi^*$). We set Normal priors of mean 2 and unit variance for the duration of pricing contracts ($\Gamma,\ \Gamma^*$) which is interpretable as a price change every three quarters.[21] For the indexation parameters, $\left(\iota_p,\ \iota_p^*\right)$ we set Beta priors on mean 0.50 and standard deviation 0.15. We use loose priors on the monetary policy rule: the inflation coefficients ($\phi_\pi,\ \phi_{\pi^*}$) are given Normal priors of mean 1.5 and unit variance. All other coefficients $\left(\phi_y,\ \phi_{y^*},\ \phi_{\Delta y},\ \phi_{\Delta y^*},\ \phi_{\Delta\pi},\ \phi_{\Delta\pi^*}\right)$ are given Gamma priors of mean 0.50 and standard deviation 0.25. The interest rate smoothing parameters in the policy rules are given Beta priors of mean 0.50 and standard deviation 0.15.

The intratemporal elasticity of substitution between Home and Foreign goods, a subject of much discussion and debate in international macroeconomics, is given a loose Uniform prior between 0.001 and 7. Estimates of this parameter obtained in similar structural models are in the vicinity of unity.[22] All shock persistence parameters are given Beta priors of mean 0.50 and standard deviation 0.15. We use Inverse Gamma priors with mean 0.10 and standard deviation 2 for the standard deviations of the shocks.

Calibrated Parameters As we do not use data on wages or hours worked, we calibrate the frisch elasticities of labor $\left(\frac{1}{\sigma_N},\ \frac{1}{\sigma_{N^*}}\right)$. As in Smets and Wouters (2007), they are fixed

[21] As in Rabanal and Tuesta (2006), we define $\Gamma = \frac{1}{1-\theta_H} - 1$ so that the average duration of pricing contracts exceeds one quarter.

[22] See Bergin (2006) and Rabanal and Tuesta (2006).

at 0.5. Similarly, due to non-availability of data for exports and imports prices *vis-á-vis* the economies in our sample, we fix the degree of price-stickiness in the export sales sector. We set the mean duration of price changes in export sales at two quarters. The subjective discount factor (β), the share of capital in the production function (α) and the quarterly depreciation rate of capital (δ) are set at 0.99, 1/3 and 0.025 respectively. This implies a steady-state share of investment in output (Ξ_X) of about 0.24. The steady-state consumption to output ratio (Ξ_C) is set to 0.60. The cost of acquiring foreign assets (κ) is given a value of 0.001. We impose considerable home bias in consumption and investment expenditures by setting the openness parameter (ξ) at 0.15. This value is in the range obtained in the literature : Backus *et al.* (1994) set the parameter at 0.15, Rabanal and Tuesta (2006) obtain posterior estimates varying between 0.05 and 0.16 while Bergin (2006) uses a value of 0.20.

4.2 Posterior Distributions and Impulse Responses

We report the results of the posterior optimization and monte carlo simulation in Table 1 and the marginal posterior distributions are displayed in Figure 4. We comment on the median values of the marginal distributions of selected parameters. The elasticity of substitution between home and foreign goods, a critical parameter in open economy models, is found to be in the range obtained in other studies. The posterior median is seen to be at 0.9, slightly lower than estimates found by Rabanal and Tuesta (2006) and Bergin (2006) but higher than the estimates of Lubik and Schorfheide (2005). The distribution of this parameter is fairly tightly spread around the traditional benchmark of unity used in the open economy literature: despite the loose and flat prior, the posterior spans from about 0.8 to 1.1.

Insert Table 1

Parameters governing inter-temporal substitution in consumption appear to be quite dissimilar between the two regions. For the risk aversion coefficients, we find a value of about 1.7 for the US and 2.6 for the RoW. The habit coefficient for the US is found to be low at 0.2. The RoW analog is even lower at about 0.1. The estimates of the investment adjustment cost parameter in the US is slightly lower than Smets and Wouters (2007) at about 4.75. The RoW analog is almost identical. The estimates for the average length of pricing contracts is between 2 and 3 quarters for both the US and the RoW. The US price indexation parameter is very similar to that of Smets and Wouters (2007) at about 0.26. The RoW analog is lower at about 0.14. All shocks show high persistence, with the AR(1) coefficients of both TFP shocks nearly hitting the boundary of unity. However, notably the UIP risk premium shock is relatively less persistent than in other studies, at about 0.84. Bergin (2006) finds a point estimate of 0.97 while Rabanal and Tuesta (2006) find posterior means ranging between 0.91 and 0.94 in various specifications.

Insert Figure 4

We present the impulse responses to some key variables in Figure 5. The 5^{th} and 95^{th} percentiles and the median of the posterior distribution are displayed for each of the twelve shocks in the model. To save on space, we present only the responses of the main components of the trade balance: relative consumption $\left(\hat{C} - \hat{C}^*\right)$, relative investment $\left(\hat{X} - \hat{X}^*\right)$, and the real exchange rate $\left(\hat{Q}\right)$. The responses of the country-specific variables behave in a standard way and are similar to other closed economy estimations such as Smets and Wouters (2007) and are not displayed in the figure.[23] In our discussion, we focus on the impact of US shocks on the trade balance, the exchange rate and the domestic US variables as the responses induced by the RoW analogs are similar.

Insert Figure 5

[23]Impulse responses for other variables are available upon request.

Investment-specific Technology Shocks In the short run the investment-specific technology shock, that increases the efficiency of conversion of the good into the capital stock, resembles a demand-type shock. Investment spending rises in the US, leading to a persistent rise in output. The monetary authority raises the interest rate to stabilize output and inflation, which has a negative impact on US consumption. However in the medium and long run, the shock acts more like a supply-type shock when wealth effects raise consumption. The rise in relative investment is the single most important factor in explaining the short- and medium term decline in the trade balance in this case. The immediate impact on the dollar is a strong real appreciation, before it starts to rise after about eight quarters. The depreciation of the currency leads to an improvement in the trade balance in the long run before it returns to steady-state.

Interest Rate Wedge Shocks The inter-temporal shock appears as a wedge between the policy interest rate and the rate that faces the economic agent. On impact, consumption and investment spending rise in the US, inducing positive responses from output, inflation and the nominal interest rate. Notably relative investment rises more sharply and persistently than relative consumption. This demand-type shock causes a real appreciation of the US dollar and the terms of trade. The result is a strong deterioration in the US external position. Note that a negative wedge shock, that increases savings and lowers investment in the RoW mimics the US shock as far as the responses from the external variables are concerned.

TFP Shocks Despite the extreme persistence of the US TFP shock, its quantitative impact on the trade balance is mild in comparison to the investment-specific technology shock and the interest rate wedge shock. A rise in US TFP invokes positive responses from consumption and investment as the permanent income of the agents rise. It decreases US inflation and the interest rate leading to a strong real depreciation of the dollar and a concurrent deterioration of the US terms of trade. On impact, the strong expenditure switching effect of the dollar depreciation improves the trade balance by increasing exports, but in the medium-term the negative impact of rising relative consumption and investment dominates the expenditure switching effect and the trade balance deteriorates.

Public Spending Shocks In response to a US public spending shock, the US nominal interest rate rises strongly due to the central bank response to the rise in inflation following the surge in aggregate demand. This crowds out US consumption and investment while appreciating the US dollar. The appreciated dollar also raises inflation and the interest rate in the RoW decreasing consumption and investment. In effect, relative consumption shows a decline while the impact on the relative investment is insignificant. These two effects are dominated by the real appreciation of the dollar that causes US exports to fall due to a strong negative expenditure switching effect, causing the trade balance to decline. While the quantitative impact of public spending shocks on the trade balance is stronger than the response induced by neutral productivity, it is still considerably milder than the impact of the interest-rate wedge shocks and investment-specific technological shocks.

Risk Premium Shock to the Exchange Rate A rise in the risk premium on foreign borrowing depreciates the US dollar, raises the US interest rate and lowers the RoW interest rate. This reduces US consumption and investment while increases the RoW analogs.The impact of the falling relative consumption and investment are reinforced by positive movements in the exchange rate and the terms of trade. In effect, the US external position improves.

Monetary Policy Shocks Contractionary monetary policy leads to a decrease in US investment, consumption, output and inflation. The dollar appreciates via the interest parity condition making imports cheaper and improving the US terms of trade. Similar to the case of the public spending shock, the trade balance deteriorates as the impact of the dollar appreciation dominates the fall in relative consumption and investment.

Purchasing Power Parity Shock The impact of the purchasing power parity shock that disturbs the deterministic relationship between the nominal and the real exchange rates is statistically insignificant for all variables except for the US dollar that experiences a strong nominal appreciation. The shock, the most difficult to interpret among all the stochastic influences in the model, seems to be the driving force of the nominal exchange rate. Just as in Lubik and Schorfheide (2005), the dynamics of the exchange rate exhibit considerable disconnect from the fundamentals formally modelled.[24]

5 Determinants of Fluctuations in the Trade Balance

5.1 Volatility Decomposition

The influence of the twelve shocks that we embedded in the theoretical construct are reflected in the conditional variances of the forecast errors given by the estimated model. We dissect the volatility of the forecast error of the trade balance to output ratio to reveal the contributions of the shocks on an individual basis. Note that we do not implement the decomposition at a particular point in the parameter space, e.g. at the posterior mode or median. Instead, we use 250 random draws from the posterior to generate a distribution of forecast error volatility decompositions. We report the 5^{th} and 95^{th} percentiles and the median value of the contributions of the individual shocks to the trade balance to output ratio in Table 2.[25]

Both US and RoW monetary policy shocks appear to have little impact on the trade balance. Public spending shocks also play a negligible role: the median contribution of the

[24] The PPP disturbance accounts for almost 80% of the conditional forecast volatility of the nominal depreciation of the US dollar. The variance decomposition of the nominal depreciation of the US dollar is available on request.

[25] Our strategy of relying on random draws of parameters instead of a particular point in the parameter space implies that the median percentage contributions of the shocks do not add up to 100. The decomposition at the mode, that is invariant to the results of posterior simulation, is very similar and is presented in Table 3.

US shock barely comes to 2 per cent at all horizons. In our world of forward-looking agents that smooth consumption inter-temporally, exogenous increases in (unproductive) public spending crowds out private consumption due to the rise in real interest rates. Thus any worsening of the external position by a stimulation of private expenditures is precluded. However, simulation results in Erceg *et al.* (2005) confirm the negligible influence of public spending shocks on the external position, even in models with non-ricardian features as liquidity-constrained consumers who cannot smooth their consumption inter-temporally and hence are insensitive to changes in the interest rate.[26]

Unlike Bergin (2006), who finds that the risk premium shock to the exchange rate, determines about two-thirds of the variation in the external balance (current account), we find that this shock plays a muted role. The median contribution comes to about 17 per cent on impact and its role decreases over time to a minimal 8 per cent over the very long run. The lower contribution of the risk premium shock is possibly due to our lower estimate of the persistence parameter.

5.1.1 Neutral versus Investment-Specific Technology Shocks

Neutral technology shocks to TFP, with the US shock being the most persistent of all shocks in the model, do not cause much variability in the trade balance. The combined median effect of the TFP shocks at home and abroad never exceeds 2 per cent. The weak influence of TFP on the trade balance is in contrast to Kollmann (1998) who finds that TFP differentials betwen the US and the G-6 economies were the main source of fluctuations in the trade balance over 1975-1991. In contrast, our results suggest that the rise in consumption and investment that TFP induces are insufficient to generate much variability in the external position, as the strong depreciation of the currency offsets these negative effects. We find

[26]In an empirical test of the two competing traditional explanations of the US external position, *i.e.* neutral productivity *vis-á-vis* the fiscal balance, Bussière *et al.* (2005) find a statistically significant effect of TFP on the US trade balance while the fiscal position appears to matter very little. Both Bussiere *et al.* (2005) and Erceg *et al.* (2005) allow for rule-of-thumb consumers who are liquidity constrained, in order to allow for a rise in private consumption following a public spending shock.

that the technological shocks specific to investment, however have a very strong impact. The contribution of the US investment-specific shock increases over time and contributes in excess of 40 per cent the long horizon of 10 years. At all horizons, this shock strongly dominates its RoW analog whose contribution remains stable over time at about 10 per cent. In the long run, the combined effect of these investment shocks dominate that of all other shocks.

The strong influence of the investment-specific shock *vis-á-vis* the neutral TFP shock, is mainly due to the different responses the two shocks evoke from the real exchange rate. In the short run following impact of the investment-specific shock, the sharp rise in private investment crowds out private US consumption due to the hike in the real interest rate. The consequent dollar appreciation induces expenditure-switching effect in favor of imports from the RoW. In the long run, even though the dollar depreciates and stimulates US exports, consumption rises due to the wealth-effect that a technology shock typically induces. The combined negative impact of rising consumption and investment in the long run, dominates the positive impact of the depreciating dollar. This is in contrast to the neutral TFP shock that depreciates the dollar so strongly that the consequent expenditure switching in favor of US exports smothers the negative impact of rising consumption and investment.[27] The considerable impact of investment-specific technological shocks on the trade balance is consistent with the structural VAR results in Bems *et al.* (2007) who only check the impact of US shocks.

Upto the first year following impact, the trade balance is mainly driven by the interest rate wedge shocks that generate comovement between consumption and investment. In unison, the median contributions of the shocks range between 30 and 40 per cent at all horizons. As in the case of investment-specific shocks, the US wedge shock dominates the RoW analog. While the role of the US shock remains stable over time at about 22 per cent,

[27]For a comparison between the two types of technological shocks in a closed-economy context, see Justiniano *et al.* (2008).

the contribution of the RoW shock decreases slightly from 15 per cent to 10 per cent.

Evidence of the considerable influence of the wedge shocks from outside the US that have negative impacts on RoW consumption and investment supports the arguments of policymakers that factors boosting saving in the RoW have considerable impact on the US position. The strong contributions of these interest-rate wedges to the volatility of the trade balance in the short and medium run, suggest that the determination of the US external position stretches beyond purely technological differences between the US and the Rest of the World.

Insert Table 2

5.1.2 Beyond Technology: Net Worth Shocks?

Recent theoretical papers by Mendonza, Quadrini and Rios-Rull (2007) and Caballero, Farhi, and Gourinchas (2008) relate the US current account position to progress in the sophistication of financial intermediation in the US *vis-á-vis* the rest of the world. The key point that these authors raise is that in a world of well integrated but heterogenous financial markets, the more financially developed economy experiences a decline in the external balance by attracting savings from the other. In our model, a positive interest rate wedge shock in conjunction with the real interest rate acts as a lowering of the *effective* opportunity cost of current expenditure, boosting aggregate demand by affecting the inter-temporal marginal conditions in much the same way as for e.g. highly liquid capital markets or rising asset prices would. These effects are similar to the 'net-worth' mechanism posited in Bernanke, Gertler and Gilchrist (1999). A wealth-transfer as a net-worth shock that increases the agent's wealth typically raises the value of capital by driving up the demand for physical capital for investment purposes and hence output as well. In our case, these wealth effects appear strong enough to affect the external balance.

If this shock was specified in the model as affecting private consumption alone as in the earlier generation of estimated DSGE models, it would capture merely a time impatience effect to the economy's discount factor. However, the fact that the wedge shock affects the value of capital as well and the empirical observation that investment appears to react much more robustly than consumption to the realization of the shock, makes it a likely candidate for a 'financial' disturbance rather than a pure preference shock. A sophisticated formulation of a financial intermediation sector or asset prices, their role in boosting aggregate demand and the consequent impact on a nation's external position is beyond the scope of our empirical two country model. However, the predominant role of the inter-temporal 'opportunity cost' wedges in driving fluctuations in the US trade balance makes a compelling case for the validity of this channel. In the long run, the combined effect of these shocks reduces and the the investment-specific technology shocks dominate.

5.2 The Experience of the 1990s through the Lens of the Model

An oft-repeated theme in the literature is the real appreciation of the dollar and the simultaneous plummeting of the trade balance in the later years of the 1990s. Hunt and Rebucci (2005) state that labor productivity in the tradable goods sector played a major role in these events. They find that augmenting a version of the IMF-GEM model with a TFP shock, a risk premium shock proxying foreign investor's preferences for US assets and learning in expectations formation can help it to match the data satisfactorily. The productivity view has also been examined by Corsetti, Dedola and Leduc (2007) in VAR estimations. The thesis is that the rise in labour productivity appreciated the dollar and the terms of trade via classic Harrod-Balassa-Samuelson effects and concurrently eroded the trade balance.

We contribute to the above literature by examining the explanatory power of each shock in the estimated model to the evolution of the proxy trade balance in the 1990s. The 1990s are of interest in our empirics for a number of reasons. The proxy trade balance matches the actual series in this time-span and the correlation between the two increases to 0.92 in levels.

Furthermore, from the long-run savings-investment differential depicted in Figure 2, we can see that it was during the early 1990s, that savings and investment in our two country world, were last noted to be in approximate balance in both regions: the origin of contemporary global financial imbalances can be traced to the beginning of that decade.

Note from Panel (ii) of Figure 1 that for both the proxy and the actual trade balance, fluctuations from their respective trends were positive in this decade.[28] We now attempt to understand the factors that contributed negatively and positively to the US external position in the 1990s by implementing a historical decomposition of the proxy trade balance using the best estimates of the structural parameters and the residuals.[29] To examine the contribution of each of the twelve shocks in the model to the evolution of fluctuations in the proxy trade balance in the 1990s, we start from a benchmark of zero for the first observation in our sample and then simulate the model forward. The contribution of a shock to the trade balance must be understood as how the trade balance would have evolved in a world where the only influence on the trade balance was the shock itself. The results are presented in Figure 6.

Not surprisingly, the main actors in our volatility decomposition exercise, namely the investment-specific shocks, the UIP risk premium shock and the interest rate wedge shocks, also play dominant roles in the historical evolution of the series. This is even as shocks to TFP, public spending and monetary policy have barely any explanatory power. In our discussion below, we focus on the shocks that had a substantial impact.

Insert Figure 6

We observe distinct patterns in the influence of various shocks for the early 1990s and the later years of the decade. In the first half of the decade, US investment-specific technology

[28] We remind the reader that a positive deviation from the trend should not be interpreted as a US trade surplus. In our exercise, we study which shocks help track the evolution of the detrended series.

[29] We implement the historical decomposition at parameter values set at the mode of the posterior distribution.

shocks made a positive contribution to the observed series as did the RoW interest rate wedge shocks. The positive impact of these shocks appear to have been smothered by the strong negative contribution of UIP risk-premium shocks and US interest rate wedge shocks. The net effect on the trade balance, however, was positive. The roles of the shocks reversed towards the end of the decade. The mid- and the late 1990s saw the influence of UIP shocks and US interest rate wedge shocks turn positive. The downward pressure seems to have been exerted by an extremely strong negative impact of US investment-specific shocks and RoW interest rate wedge shocks.

The strong negative influences of US investment-specific technology shocks and (negative) RoW interest rate wedge shocks towards the late 1990s are intuitive. This was a period when the US entered an era of prosperity heralded by the arrival of the 'New Economy'. The surge in investment - and the rise in consumption that gradually follows in the aftermath of an investment specific shock- had a negative impact on the trade balance. Concurrently, the influence of the RoW interest rate wedge shock, that dislocated savings from the Rest of the World to the US had a similar negative impact.on the US position. The 1990s were financially turbulent times for two major US trade partners in our sample. Monetary uncertainty prevailed in Western Europe in the period preceding the institution of the Euro and Japan was already experiencing vapid economic growth throughout the 1990s. We conjecture that these external factors could have made the RoW a less favourable location for investment and contributed to the relocation of savings into the US, that was experiencing prosperous times during the same period. However the net effect of these shocks was positive as far as fluctuations in the trade balance from the trend are concerned.

6 Conclusion

The primary contribution of this paper is the examination of the US trade balance in an empirical two country DSGE model. We investigate the degree to which a variety of stochastic influences, both of US and foreign origin, matter for fluctuations in the US trade balance. US investment-specific technology shocks have a very strong and persistent influence on the trade balance and dominate the impact of all other shocks embedded in the model in the long run. In the short and medium run, we find that inter-temporal disturbances that create wedges between the interest rate set by the monetary authority and the one that faces the economic agent, have a strong influence. The considerable influence of (negative) inter-temporal disturbances from the RoW in the volatility decomposition indicates that factors that boost saving and lower investment abroad appear to have a negative impact on the external position of the US. Since these shocks have similar dynamic effects as the 'net-worth' mechanism posited in the literature, we conjecture that- in addition to technological changes - relative advancement in financial intermediation has had a strong negative impact on the external position of the US over the sample period.

We also find that two factors previously cited in the literature as important determinants of the US external position, namely public spending shocks and TFP, have had relatively little influence on the trade balance, as compared to the shocks to consumption and investment. While the US public spending shock can worsen the external position by inducing a strong appreciation of the currency, its impact on the volatility of the trade balance is negligible. Similarly, shocks to TFP, despite exhibiting extreme persistence, have had very little influence on the volatility. Domestic technology shocks if neutral as in the case of TFP movements, tend to depreciate the currency strongly and the consequent expenditure switching effect in favour of US exports compensates the negative impact of rising US consumption and investment.

Note however that a few caveats are in order. The results regarding the negligible influence of the US public spending shock should be taken with a grain of salt. Given the historical observation that the 'Twin Deficits' prevailed in the mid-1980s and the post-millennial years while moving in opposite directions in the late 1990s, it is likely that the effect of changes in the fiscal position on the external balance has changed over time. We cannot observe these effects in our theoretical model as the role of public expenditure in the determination of aggregate demand is restricted to being merely residual. It may be instructive to consider a more elaborate role of public spending in the economy by allowing it to either affect private utility or the production function. Further, our approach, both in the construction of the theoretical model and in its statistical implementation, is insufficient to study the persistent downward trend in the US trade balance over the sample period. A negatively trending trade-balance would be a useful facility in a structural model of the US trade balance and in our analysis using detrended data, we are constrained in examining sustainability of the external position or exploring the consequences of an unwinding of the imbalance. These avenues, undoubtedly challenging, could be explored in future empirical research.

The above caveats notwithstanding, we are optimistic that empirical insights that have emerged from the use of our proxy trade balance in the model environment are useful to visualize the *actual* imbalance as a global phenomenon instead of one that is necessarily 'made-in-the-USA', in the absence of concurrent influences from the Rest of the World. Afterall it takes two parties to make a trade balance.

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Appendix

1 Construction of Data Series

All raw series are seasonally adjusted by the Census X12 method.

Rest of the World The series for Japan, South Korea, the United Kingdom and Canada are obtained from the International Financial Statistics Database (IFS) of the International Monetary Fund (IMF). For the Eurozone series, we use data from the Area Wide Model from the European Central Bank (Fagan *et al.* 2001). We use data on GDP, private consumption, gross capital formation, nominal interest rate and the GDP deflator for each economy. We use the best available substitutes for the nominal interest rate for each economy.[1] For Canada and the United Kingdom, we use the Treasury Bill rate and for Japan we use the government bond yield. For want of a better alternative over the entire sample period, we use the discount rate for Korea. For the Eurozone, we use the effective nominal interest rate series (STN) from the Area Wide Model. Data on population was not available on a quarterly basis for most countries in the sample. Hence we do not control for growth in population. All series except the nominal interest rate are now expressed as an index based on the value for the first quarter of the year 2000. Individual economy series are aggregated using the trade-share weights.

US For the US, we use IFS-IMF for series on GDP, private consumption, gross capital formation, the Federal Funds rate and GDP deflator. We also use data from the FRED II database of the Federal Reserve Board of St.Louis on the federal governmental expenditure (FGEXPND) and receipts (FGRECPT). We use these two series to construct the real primary budget deficit to output ratio. All series except the nominal interest rate and primary deficit are expressed as indices.

2 Bayesian Estimation of the Model

The log-linearized equations are solved to obtain a linear rational expectations system.

$$X_t = \Gamma_x(\Theta)\; X_{t-1} + \Gamma_\epsilon(\Theta)\; \epsilon_t$$

X and ϵ denote vectors of endogenous variables and exogenous processes. $\Gamma_x(\Theta)$ and $\Gamma_\epsilon(\Theta)$ are the coefficient matrices, whose elements are functions of the model's deep parameters Θ. The endogenous variables are linked to a vector of variables that are statistically observable.

$$\mathcal{O}_t = \Psi_x\, X_t$$

[1] For Canada and the United Kingdom, we use the Treasury Bill rate. For Japan we use the government bond yield. For want of a better alternative over the entire sample period, we use the discount rate for South Korea. For the Eurozone, we use the effective nominal interest rate series (STN) from the Area Wide Model.

Invoking Bayes theorem, we know that if $p\left(\right)$ indicates the prior information available on the vector of structural parameters Θ and $\mathcal{L}\left(\mathcal{O} \mid \Theta\right)$ is the conditional likelihood function of the data, the posterior density is given by

$$\mathcal{P}\left(\Theta \mid \mathcal{O}\right) \propto p\left(\Theta\right)\ \mathcal{L}\left(\mathcal{O} \mid \Theta\right)$$

The estimation is implemented in the following steps.

1. The Kalman filter is used to evaluate the logarithm of the posterior density

2. The Sims optimizer is used to find the mode $\tilde{\Theta}$ of the posterior density. The inverse of the Hessian $\tilde{\Sigma}_{\Theta}$ is evaluated at the mode.

3. The posterior density is simulated using the Random Walk Metropolis Algorithm that is initiated at the mode of the posterior. For $\mathrm{n} = 1..\mathrm{n}_{sim}$, draw $\Theta^{(n)}$ from a multivariate normal jumping distribution $\mathcal{N}\left(\Theta^{(n-1)}, c^2\,\tilde{\Sigma}_{\Theta}^{-1}\right)$. $\Theta^{(n)}$ is accepted with a probability $min\left(1,\ \Delta\ \left(\Theta^{(n)}, \Theta^{(n-1)} \mid \mathcal{O}\right)\right)$ or rejected $\left(\Theta^{(n)} = \Theta^{(n-1)}\right)$ otherwise.

$$\Delta\ \left(\Theta^{(n)}, \Theta^{(n-1)} \mid \mathcal{O}\right) = \frac{p\left(\Theta^{(n)}\right)\ \mathcal{L}\left(\mathcal{O} \mid \Theta^{(n)}\right)}{p\left(\Theta^{(n-1)}\right)\ \mathcal{L}\left(\mathcal{O} \mid \Theta^{(n-1)}\right)}$$

   c^2 is adjusted to obtain an acceptance rate of about 34 %. We use 1 long chain of $\mathrm{n}_{sim} = 1{,}000{,}000$.

4. The initial 10,000 draws are discarded. The expected values of $h\left(\Theta\right)$ are approximated using the draws

$$h\left(\Theta\right) = \sum_{n=10{,}001}^{n_{sim}} h\left(\Theta^{(n)}\right)$$

   Chain convergence is monitored using CUSUM statistics as in Bauwens *et al.* (1999). Impulse responses and the decomposition of the volatility of the trade balance are computed using 250 random draws from the posterior density.

Figures

Figure 1: The Tale of Two US Trade Deficits

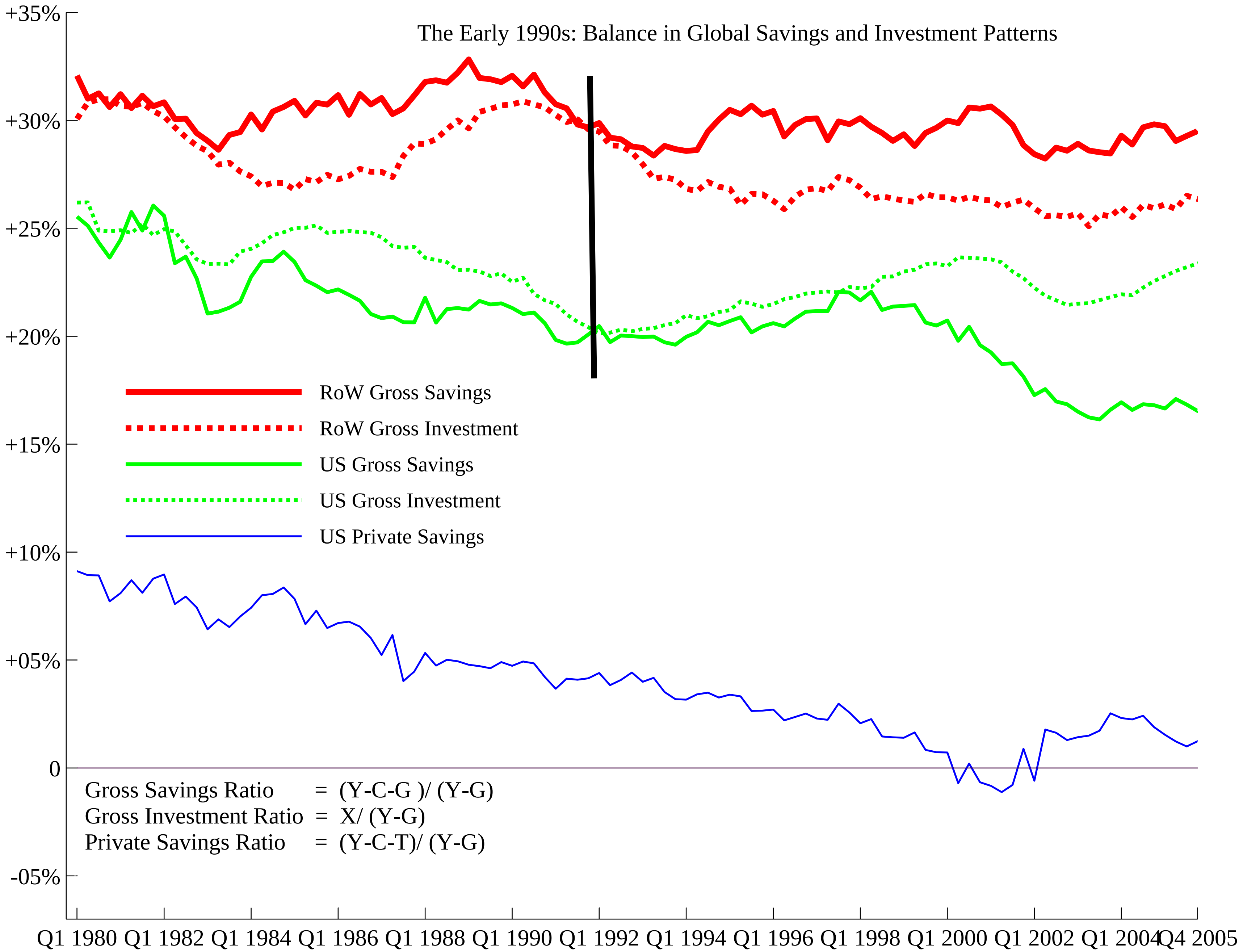

Figure 2: The History of Savings and Investment in Our Two Country World

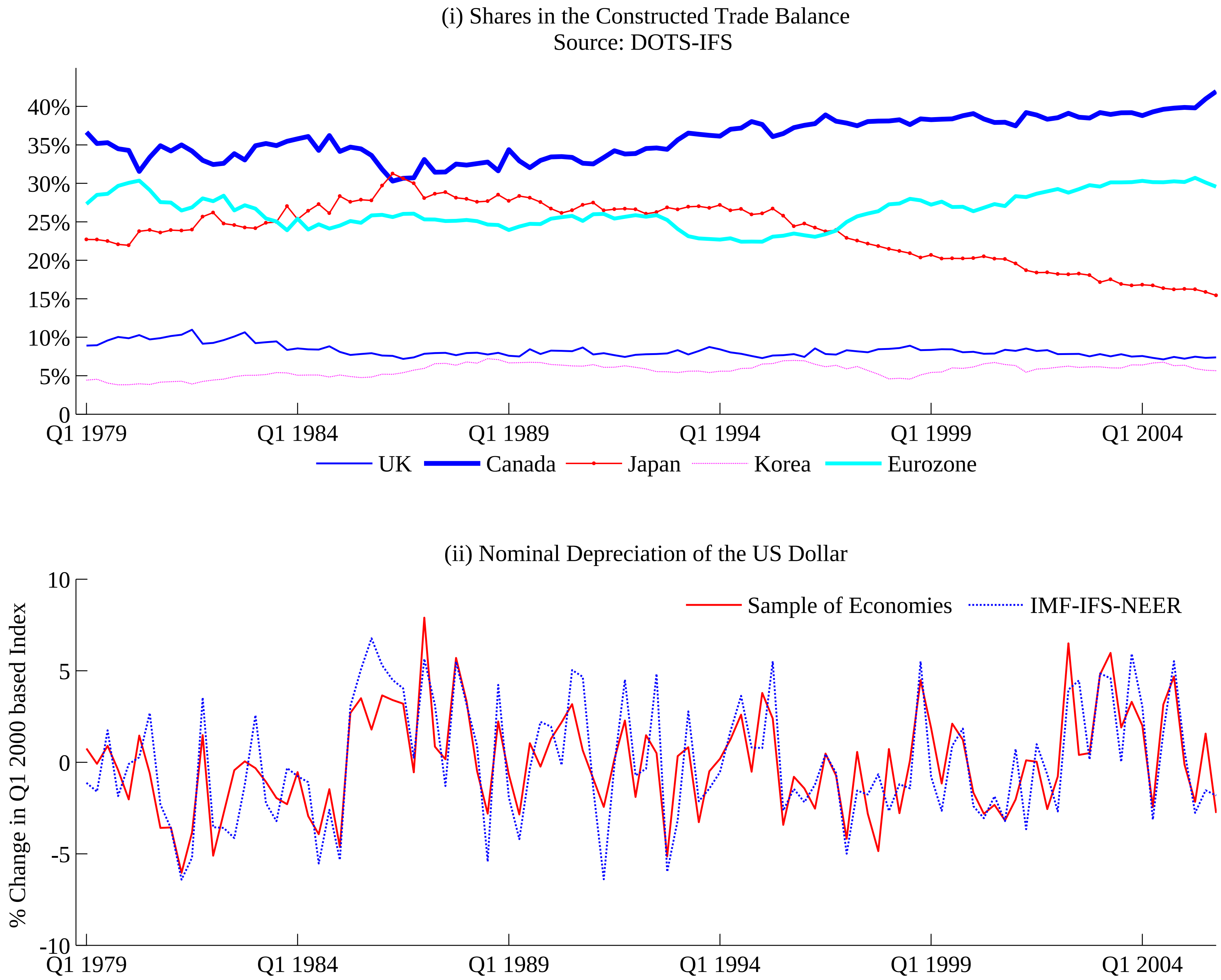

Figure 3: Trade Shares and Constructed Nominal Depreciation of the US dollar

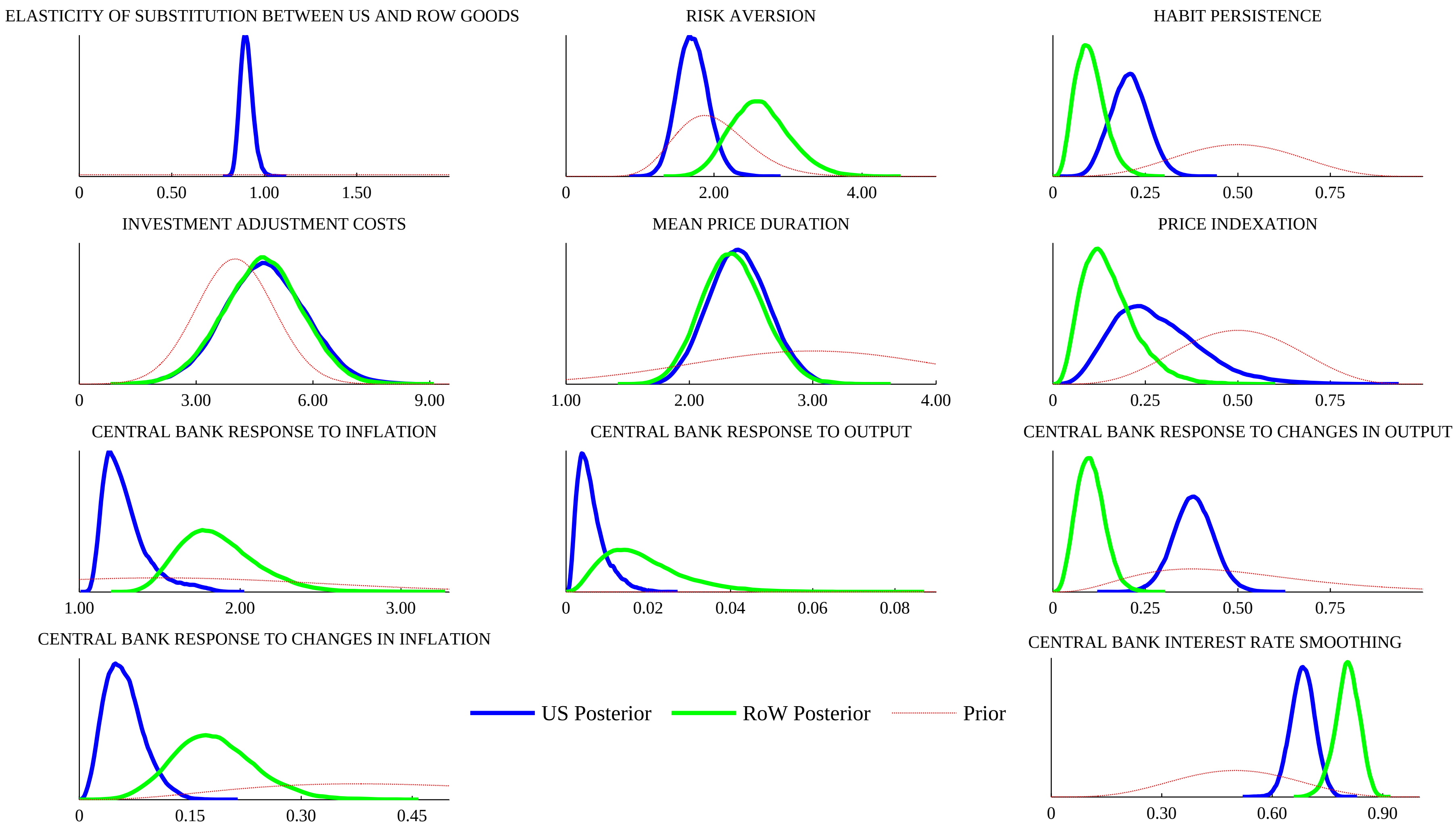

Figure 4: Priors and Posteriors of Structural Parameters

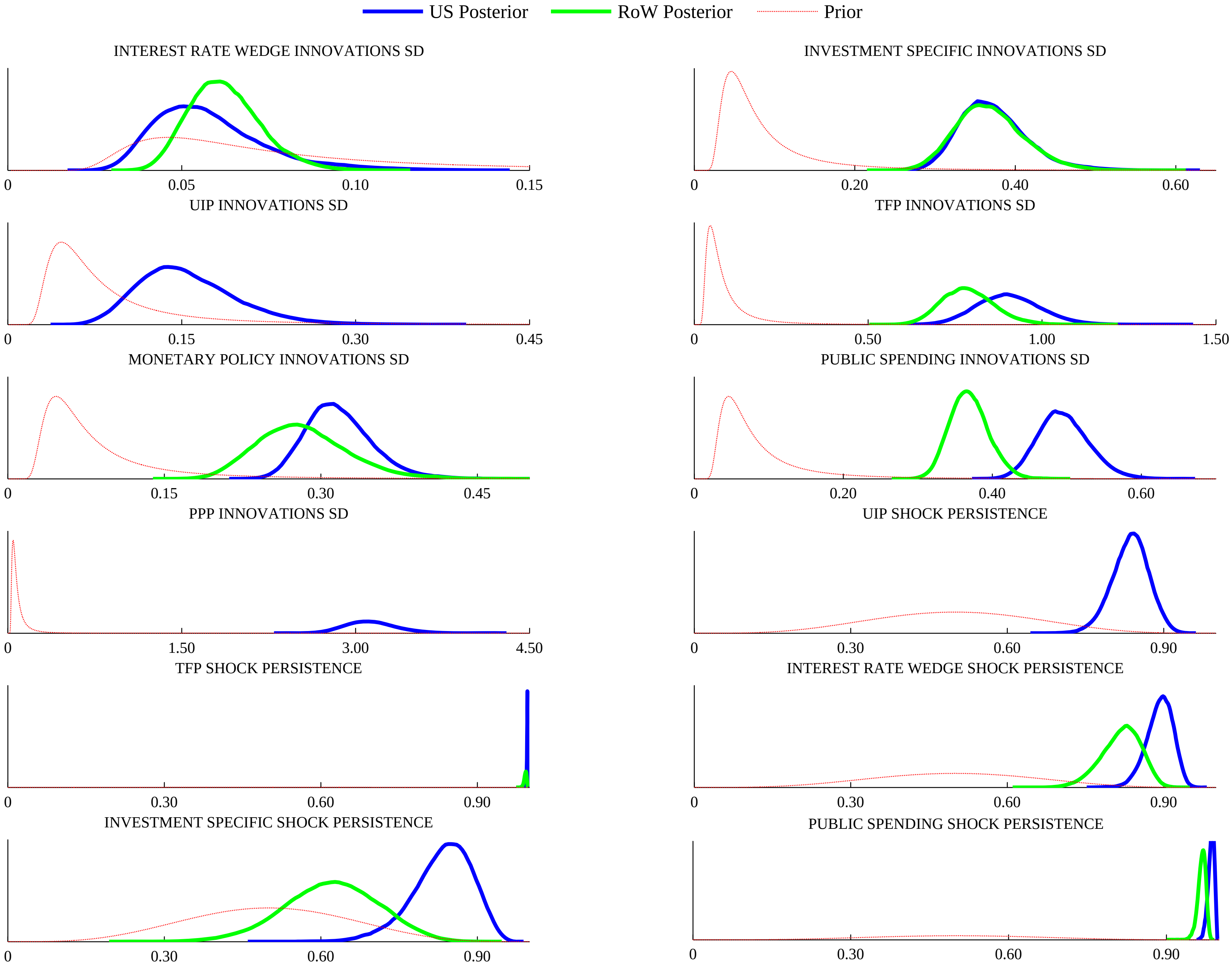

Figure 4 (Contd) : Priors and Posteriors of Parameters Governing Shock Variance and Persistence

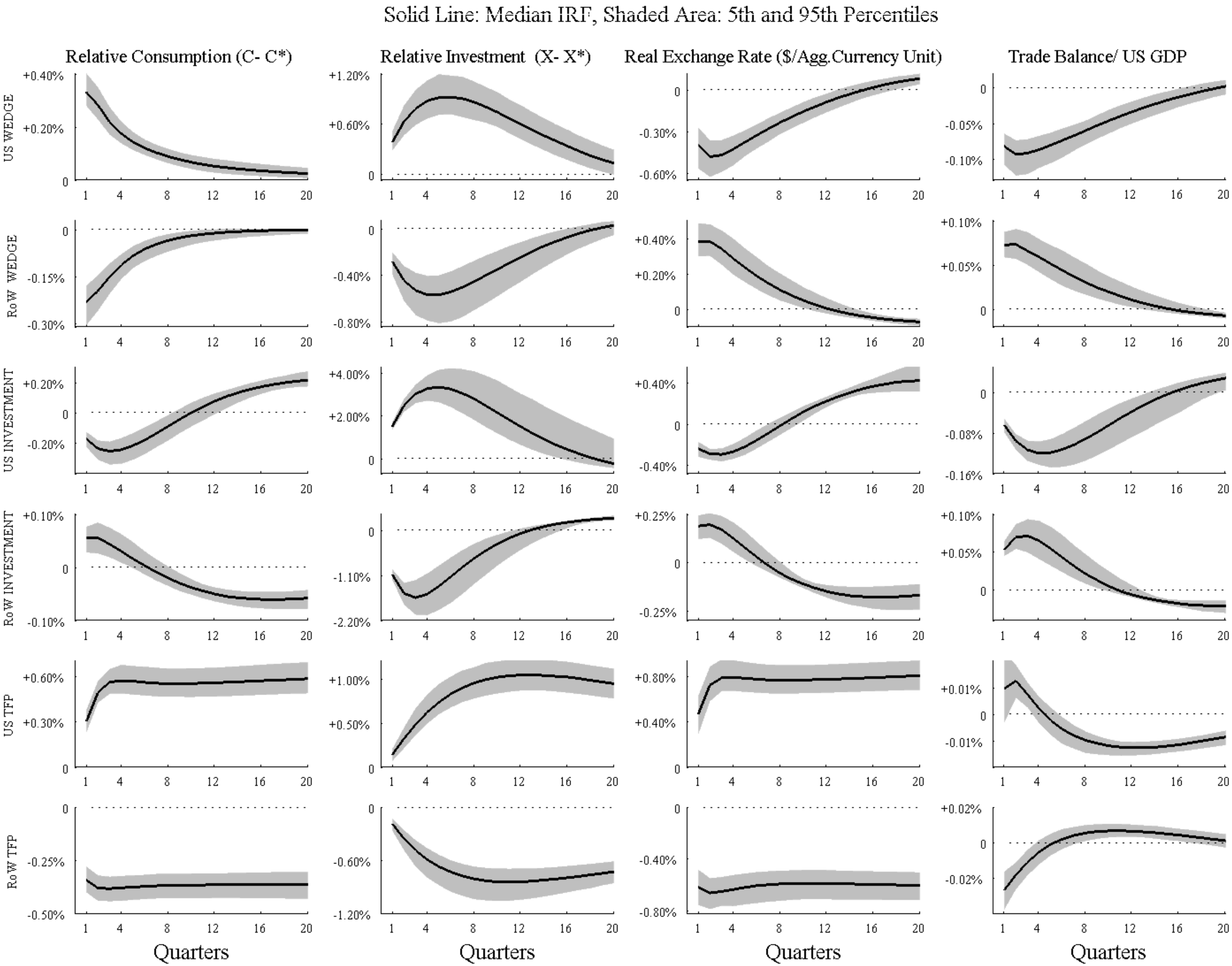

Figure 5: Impulse Responses to a Unit Standard Deviation Shock

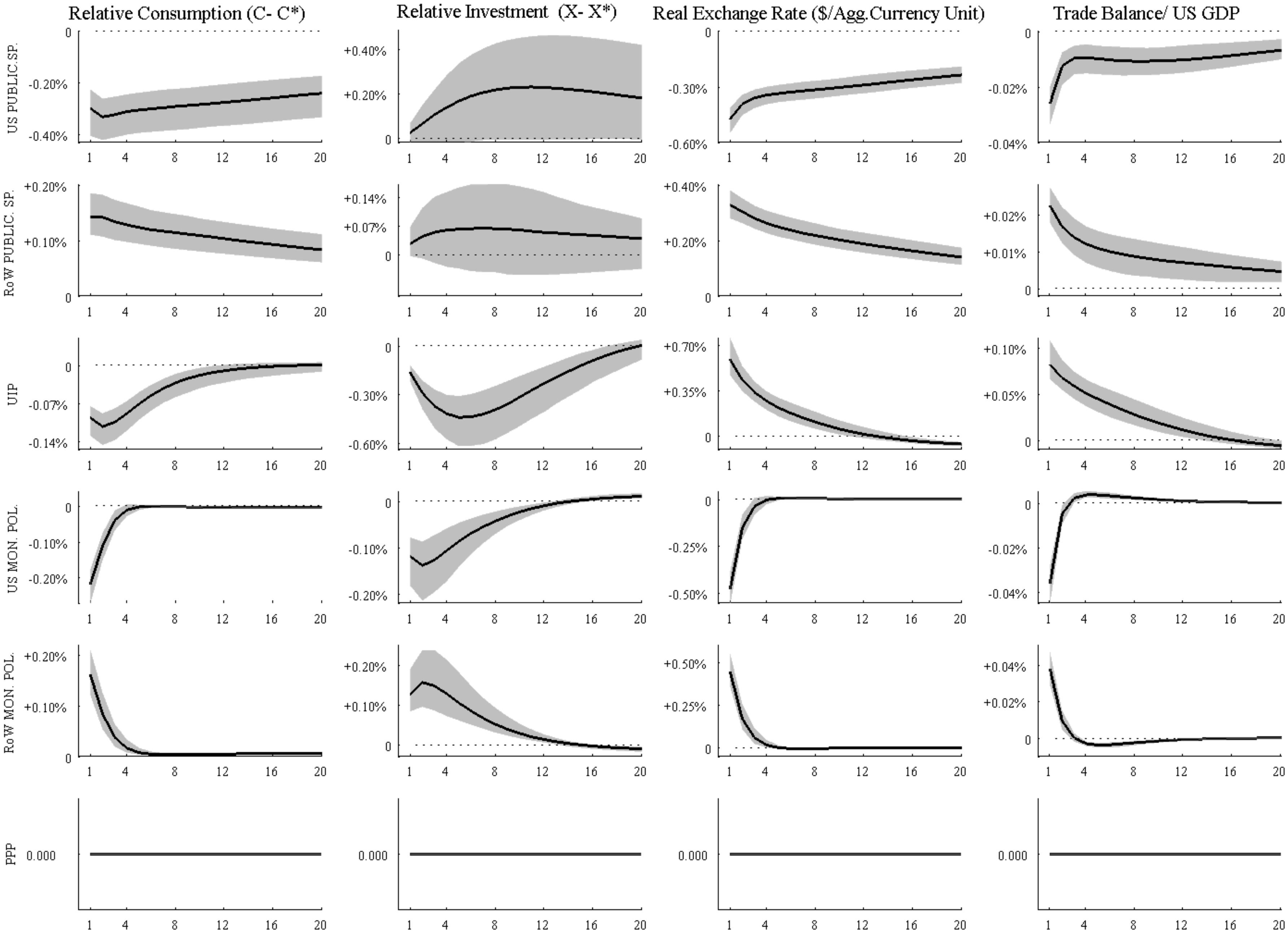

Figure 5 (Contd)

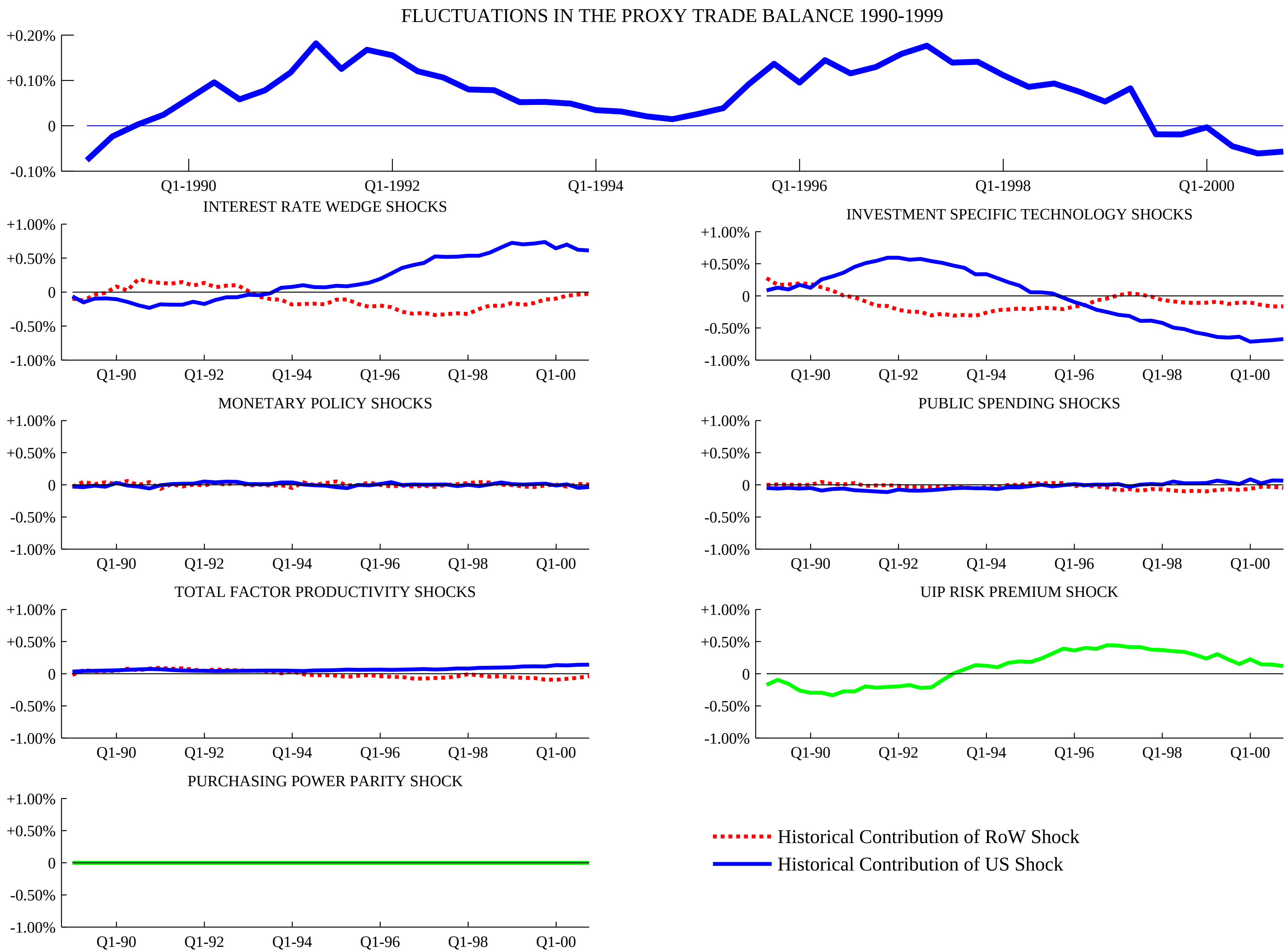

Figure 6: Historical Contributions of the Shocks to Fluctuations in the Proxy Trade Balance to Output Ratio

Tables

Parameter Index	
μ	Elasticity of substitution between US and RoW Goods
$\sigma_C,\ \sigma_{C^*}$	Risk aversion coefficients
$\vartheta,\ \vartheta^*$	External habit parameters
$\varphi,\ \varphi^*$	Investment adjustment costs
$\Gamma,\ \Gamma^*$	Average duration of pricing contracts
$\iota_p,\ \iota_p^*$	Price indexation
$\phi_\pi,\ \phi_{\pi^*}$	Interest rate response to inflation
$\phi_y,\ \phi_{y^*}$	Interest rate response to output
$\phi_{\Delta\pi},\ \phi_{\Delta\pi^*}$	Interest rate response to changes in inflation
$\phi_{\Delta y},\ \phi_{\Delta y^*}$	Interest rate response to changes in output
$\rho_{MON},\ \rho_{MON^*}$	Interest rate smoothing

Table 1: Estimated Structural Parameters											
Prior Distributions[1]				Posterior Distributions							
				Optimization		Simulation by Metropolis-Hastings					
Parameter	Type	Para 1	Para 2	Mode	SE	Median	SD	Min	Max	5^{th} $\%^{ile}$	95^{th} $\%^{ile}$
μ	Uniform	0.00	7.00	0.901	0.034	0.902	0.034	0.783	1.112	0.853	0.965
σ_C	Gamma	2.00	0.50	1.735	0.374	1.707	0.213	0.893	2.858	1.381	2.075
σ_{C^*}	Gamma	2.00	0.50	2.541	0.360	2.600	0.399	1.397	4.442	2.012	3.321
ϑ	Beta	0.50	0.15	0.198	0.072	0.206	0.050	0.024	0.433	0.126	0.290
ϑ^*	Beta	0.50	0.15	0.085	0.038	0.097	0.040	0.005	0.294	0.043	0.173
φ	Normal	4.00	1.00	4.743	1.531	4.758	1.044	1.164	8.760	3.068	6.509
φ^*	Normal	4.00	1.00	4.692	1.074	4.722	1.016	1.005	8.904	3.016	6.368
Γ	Normal	2.00	1.00	1.379	0.241	1.397	0.243	0.550	2.423	1.010	1.813
Γ^*	Normal	2.00	1.00	1.338	0.237	1.347	0.254	0.471	2.581	0.952	1.789
ι_p	Beta	0.50	0.15	0.255	0.159	0.265	0.120	0.013	0.912	0.117	0.502
ι_p^*	Beta	0.50	0.15	0.124	0.063	0.142	0.073	0.007	0.587	0.058	0.292
ϕ_π	Normal	1.50	1.00	1.206	0.330	1.254	0.141	1.030	2.003	1.124	1.582
ϕ_{π^*}	Normal	1.50	1.00	1.758	0.503	1.835	0.247	1.245	3.227	1.519	2.310
ϕ_y	Gamma	0.50	0.25	0.004	0.003	0.005	0.003	0.001	0.027	0.002	0.013
ϕ_{y^*}	Gamma	0.50	0.25	0.013	0.011	0.017	0.010	0.001	0.085	0.006	0.038
$\phi_{\Delta y}$	Gamma	0.50	0.25	0.390	0.102	0.380	0.055	0.131	0.617	0.290	0.470
$\phi_{\Delta y^*}$	Gamma	0.50	0.25	0.098	0.048	0.100	0.038	0.003	0.296	0.045	0.168
$\phi_{\Delta\pi}$	Gamma	0.50	0.25	0.049	0.033	0.058	0.026	0.001	0.209	0.024	0.110
$\phi_{\Delta\pi^*}$	Gamma	0.50	0.25	0.179	0.076	0.179	0.056	0.010	0.447	0.097	0.281
ρ_{MON}	Beta	0.50	0.15	0.676	0.080	0.684	0.033	0.526	0.824	0.628	0.737
ρ_{MON^*}	Beta	0.50	0.15	0.807	0.085	0.805	0.033	0.665	0.915	0.746	0.855

[1] If Uniform, Para 1= Lower Bound, Para 2= Upper Bound. Otherwise, Para 1= Mean, Para 2= SD

Table 1 (Contd): Estimated Structural Shocks

Prior Distributions				Posterior Distributions							
				Optimization		Simulation by Metropolis-Hastings					
Parameter	Type[2]	Mean	SD	Mode	SE	Median	SD	Min	Max	5^{th} $\%^{ile}$	95^{th} $\%^{ile}$
σ_{WED}	IG	0.10	2.00	0.047	0.025	0.056	0.016	0.020	0.141	0.037	0.090
σ_{WED^*}	IG	0.10	2.00	0.057	0.011	0.062	0.010	0.032	0.114	0.047	0.081
σ_{INV}	IG	0.10	2.00	0.364	0.072	0.368	0.042	0.240	0.622	0.312	0.449
σ_{INV^*}	IG	0.10	2.00	0.362	0.044	0.366	0.043	0.224	0.604	0.304	0.444
σ_{UIP}	IG	0.10	2.00	0.139	0.136	0.150	0.043	0.045	0.387	0.095	0.234
σ_{TFP}	IG	0.10	2.00	0.885	0.101	0.902	0.092	0.599	1.416	0.759	1.061
σ_{TFP^*}	IG	0.10	2.00	0.780	0.072	0.784	0.076	0.518	1.203	0.671	0.920
σ_{MON}	IG	0.10	2.00	0.309	0.033	0.314	0.032	0.218	0.560	0.270	0.375
σ_{MON^*}	IG	0.10	2.00	0.271	0.063	0.279	0.043	0.148	0.507	0.217	0.359
σ_{GOV}	IG	0.10	2.00	0.485	0.034	0.494	0.034	0.379	0.665	0.442	0.555
σ_{GOV^*}	IG	0.10	2.00	0.370	0.027	0.368	0.026	0.270	0.499	0.329	0.415
σ_{PPP}	IG	0.10	2.00	3.103	0.214	3.120	0.220	2.340	4.258	2.797	3.519
ρ_{WED}	Beta	0.50	0.15	0.904	0.050	0.894	0.026	0.757	0.977	0.847	0.930
ρ_{WED^*}	Beta	0.50	0.15	0.829	0.075	0.822	0.038	0.618	0.942	0.750	0.875
ρ_{INV}	Beta	0.50	0.15	0.854	0.158	0.839	0.058	0.471	0.977	0.727	0.916
ρ_{INV^*}	Beta	0.50	0.15	0.635	0.091	0.622	0.091	0.212	0.928	0.465	0.767
ρ_{UIP}	Beta	0.50	0.15	0.841	0.088	0.838	0.035	0.651	0.955	0.775	0.892
ρ_{TFP}	Beta	0.50	0.15	0.996	0.005	0.995	0.001	0.983	0.996	0.993	0.996
ρ_{TFP^*}	Beta	0.50	0.15	0.993	0.004	0.992	0.002	0.975	0.996	0.987	0.995
ρ_{GOV}	Beta	0.50	0.15	0.993	0.003	0.986	0.006	0.958	0.996	0.974	0.993
ρ_{GOV^*}	Beta	0.50	0.15	0.971	0.007	0.968	0.008	0.902	0.990	0.953	0.978

[2] IG=Inverse Gamma

Table 2: The Fundamental Forces that Influence the US Trade Balance

Quarter	η^{WED}	η^{WED^*}	η^{UIP}	η^{INV}	η^{INV^*}	η^{TFP}	η^{TFP^*}
1	24.46	15.52	16.82	20.38	11.86	0.36	1.59
	(18.29, 31.86)	(11.13, 21.24)	(12.66, 23.00)	(14.63, 26.66)	(6.65, 18.09)	(0.08, 1.25)	(0.63, 3.28)
2	24.49	14.62	14.24	26.10	12.65	0.30	1.16
	(18.20, 32.16)	(10.02, 20.06)	(10.38, 19.57)	(18.38, 34.45)	(7.10, 19.72)	(0.09, 0.93)	(0.48, 2.47)
4	23.71	12.89	11.59	33.48	12.20	0.20	0.74
	(17.12, 31.37)	(7.92, 18.65)	(7.80, 16.53)	(23.87, 44.16)	(6.16, 20.73)	(0.06, 0.62)	(0.31, 1.65)
8	23.57	10.80	9.79	39.72	10.05	0.31	0.57
	(16.37, 32.24)	(6.16, 17.86)	(5.86, 15.30)	(25.36, 53.69)	(4.64, 18.94)	(0.14, 0.68)	(0.27, 1.13)
20	23.78	9.93	9.15	39.66	10.15	0.85	0.62
	(15.99, 33.05)	(5.25, 17.43)	(5.12, 14.99)	(25.52, 55.25)	(4.61, 19.16)	(0.46, 1.51)	(0.34, 1.16)
40	22.13	9.21	8.43	43.00	10.26	0.82	0.76
	(14.74, 31.26)	(4.77, 16.62)	(4.67, 14.04)	(27.58, 59.31)	(4.61, 20.33)	(0.47, 1.50)	(0.43, 1.36)

The numbers in bigger case in each column indicate the median contribution of each shock in the distribution of volatility decompositions at each horizon. The parentheses present the $5^{th}$and the 95^{th} percentiles.

Table 2 (Contd)

Quarter	η^{MON}	η^{MON*}	η^{GOV}	η^{GOV*}	η^{PPP*}
1	2.06	2.31	1.31	1.16	0.00
	(1.30, 3.23)	(1.19, 4.20)	(0.83, 2.03)	(0.65, 1.81)	(0.00, 0.00)
2	1.32	1.50	0.96	0.93	0.00
	(0.86, 2.07)	(0.78, 2.66)	(0.58, 1.50)	(0.51, 1.50)	(0.00, 0.00)
4	0.83	0.92	0.72	0.73	0.00
	(0.53, 1.26)	(0.49, 1.64)	(0.41, 1.16)	(0.39, 1.22)	(0.00, 0.00)
8	0.59	0.66	0.69	0.65	0.00
	(0.37, 0.90)	(0.36, 1.15)	(0.38, 1.17)	(0.32, 1.14)	(0.00, 0.00)
20	0.53	0.59	0.95	0.74	0.00
	(0.31, 0.79)	(0.31, 1.03)	(0.47, 1.64)	(0.32, 1.42)	(0.00, 0.00)
40	0.45	0.50	0.87	0.67	0.00
	(0.26, 0.67)	(0.27, 0.89)	(0.43, 1.50)	(0.28, 1.28)	(0.00, 0.00)

Table 3: Volatility Decomposition at the Posterior Mode

Quarter	η^{GOV^*}	η^{GOV}	η^{INV^*}	η^{INV}	η^{PPP}	η^{MON^*}	η^{MON}	η^{UIP}	η^{WED^*}	η^{WED}	η^{TFP^*}	η^{TFP}
Trade Balance/US GDP												
1	1.21	1.19	12.79	24.86	0.00	2.52	2.30	16.79	14.47	21.96	1.60	0.31
2	0.97	0.83	13.48	31.74	0.00	1.60	1.46	13.73	13.05	21.76	1.12	0.25
4	0.75	0.62	12.56	40.80	0.00	0.97	0.88	10.61	11.01	20.97	0.68	0.15
8	0.66	0.68	9.93	48.14	0.00	0.66	0.60	8.53	9.17	20.89	0.50	0.23
20	0.78	1.18	9.89	48.44	0.00	0.58	0.53	7.76	8.37	21.21	0.56	0.71
40	0.69	1.12	9.74	52.22	0.00	0.49	0.44	7.04	7.65	19.31	0.64	0.66
Real Exchange Rate												
1	5.17	9.36	1.78	4.08	0.00	6.15	6.57	12.55	6.53	8.27	21.47	18.09
2	4.96	8.50	1.72	4.69	0.00	4.29	4.53	10.41	6.24	9.11	22.34	23.20
4	4.77	7.96	1.36	4.81	0.00	2.77	2.93	7.97	5.43	9.32	23.60	29.07
8	4.62	8.02	0.96	3.46	0.00	1.77	1.87	5.56	3.99	8.03	25.82	35.89
20	3.49	6.89	1.60	7.28	0.00	0.84	0.88	2.70	1.98	4.07	27.47	42.79
40	2.21	4.97	1.25	9.50	0.00	0.44	0.46	1.56	1.22	2.72	27.98	47.69