International Price System, Intermediate Inputs and Regional Trade *

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Abstract

International trade is mostly priced in a few key vehicle currencies. We model the effects of this pricing system on the macroeconomic dynamics of regional trade. We find key differences between the dynamic response of regional trade in final goods and intermediate materials to internal and external shocks. We use a granular decomposition of bilateral exports at the sector level to test the main predictions of the model and find reasonable evidence for the muted impact of US monetary policy stance on intermediate goods and global value chain oriented trade on the one hand, and final goods and regionally oriented trade on the other.

Keywords: Dollar invoicing, regional trade, monetary policy, global value chains.

JEL: E2, E5, E6

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1. Introduction

Over the last 20 years, the United States' role in global trade has declined. During the period 1991-1995, the US averaged about 15% of global imports and about 12% of global exports. During the period 2011-2015, these same figures had declined to less than 13% and about 8% respectively. Though the US might have limited direct participation as a trading party, the US dollar plays a more significant role. Despite the rise of competitive currencies, the US dollar still acts as the vehicle currency for the foreign exchange market (as shown in the recent BIS triennial surveys) participation in close to 90% of currency trades. It is understood that the dollar plays an outsized role in international finance as borrowers in emerging markets issue debt in foreign currency and currency reserves are held in US dollars (see Chinn, 2015).

In addition to the dominant role of the US dollar in international finance, the dollar also acts as a unit of account for international trade, with invoicing in international trade denominated primarily in US dollars (see Goldberg and Tille, 2008; and Gopinath, 2016). In this setting, pricing frictions in the invoicing currency could potentially alter the competitiveness effects of exchange rates impacting macroeconomic dynamics. In particular, the structure of pricing can intuitively affect how economies respond to external shocks or monetary policy (see Betts and Devereux, 1996). If an exporter to the US is already pricing their goods in US dollars, then a devaluation of domestic currency relative to the US may not improve the competitiveness of exports by much in the presence of reasonable price stickiness. Conversely, passthrough into import prices may be more significant and the adjustment will occur primarily through imports (see Cook and Devereux, 2006; Goldberg and Tille, 2006,Casas, Díez, Gopinath, and Gourinchas, 2016). However, a growing share of trade occurs amongst emerging

markets without directly involving the United States. South-South trade, defined as trade that does not directly involve developed economies as either the importer or the exporter, has constituted a rising share of international economic activity. According to UNCTAD (2015) the South-South part of emerging market imports has risen from below 40% in 1990 to almost 60% by 2013. Boz,Gopinath, and Plagborg-Moller (2017) show that trade between countries that invoice in major global currencies are more dependent on the value of these global currencies.

Much of the growth of trade in recent years has been in intermediate goods shipments traded as part of a global value chains (see Hummels, Ishii and Yi, 2001). As noted by Koopman, Wang and Wei (2014), the imported value component of emerging markets are significantly larger than large developed economies. As much of this processing may be to satisfy ultimate final demand in developed economies, it may be important to distinguish between the different effects of shocks on intra and inter-regional trade. Exchange rate fluctuations against the US dollar, for example, might affect the competitiveness of intra-regional trade. However, the factors driving exchange rate fluctuations could also drive ultimate demand for the value chain. This will impact the competitiveness effects of exchange rates on all preceding stages of production including processing trade, as firms importing foreign materials in subsequent stages of the value chain may make a trade-off between importing imported value and producing in house. If the factors driving exchange rate fluctuations affect internal production costs without necessarily affecting demand because of sticky prices, the competitiveness changes of exchange rate devaluations might be attenuated. In general, considering the equilibrium effects of the factors driving exchange rate devaluations may be important for thinking about potential control variables in empirical work identifying the effects on trade.

In this paper, we examine the equilibrium effects of external and internal interest rate shocks in a dynamic general equilibrium, New Keynesian model of two regional small open economies that interact with each other and with a large third "global" economy through trade. There are two categories of regional trade. The regional economies trade in goods meant for final consumption. In addition, we model a simple international value chain operating within the region. Each economy operates an export sector producing goods to satisfy final demand from the broader global economy outside the region. Each export platform uses both domestic value added and imported materials from the region. Regional currencies are used only in domestic transactions. In the benchmark model, trade with the the rest of the world as well as trade within the region is denominated in the hard currency of the global market. Due to sticky prices in the global currency, fluctuations in the exchange rate relative to the external currency affect the price competitiveness of imports even if domestic fundamentals in the two small open economies remain unchanged.

In this scenario, the implication for exports of final goods is fairly straightforward. Regional trade in final goods depends on aggregate spending in the importing country and the exchange rate of the importing country with the international currency. However, the determinants of trade materials to the global value chain is more complicated. Intraregional trade in materials may be less dependent on final demand within the importing economy and more dependent on global demand which may be endogenously related to the value of the international currency. We examine the equilibrium effects of internal and external shocks that causes shifts in exchange rates, focusing on a contractionary external interest rate shock that affects both economies and a monetary expansion in one of the regional trading partners. Each shock leads to an exchange rate depreciation relative to international currency and each leads to a decline

in intraregional trade. However, the industry level intensity of the contraction depends on the type of shock, with final goods contracting less in the face of local monetary expansions, while final goods exports contract less severely in the face of external interest rate shocks.

Given our primary motivation to understand the implications of pricing frictions on the response of different types of international trade flows to shocks, we use a detailed decomposition of bilateral trade data based on Wang, Wei and Zhu (2013, 2017). It goes beyond the usual two-category classification of trade flows into final and intermediate goods and further decomposes intermediate goods trade flows into 8 separate components based on their subsequent journey through the global value chain and the number of international border crossings involved until they are finally consumed as part of final goods. We study the response of these components to changes in the US monetary policy stance. This is accomplished using dynamic panel regressions estimated with local projection methods.

We find the patterns in the data to be broadly supportive of the model. In particular, the components of trade that are akin to final goods trade decline more in response to a rise in US interest rates, as opposed to components that are more supply chain oriented and cross international borders more than once.

The remainder of this paper is organized as follows. After a brief literature review to conclude this introductory section, we lay out the benchmark model in section 2. Section 3 discusses the calibration and illustrates the main dynamics of the model in response to shocks. Section A considers some variations of the benchmark model to assess the robustness of the results as well as explore how the implied dynamics differ under alternate modeling scenarios. Section 4 . discusses the data and presents empirical results motivated by the model. Section 5 concludes with a summary of the main messages and policy implications that

arise from the analysis.

Literature Review. A number of papers have identified factors determining the currency of denomination including nominal and real volatility (see Devereux et al. 2004 and Engel, 2006), price elasticities (Friberg, 1998), currency hedging (Golberg and Tille, 2008) and imported inputs (Novy, 2006). Bacchetta and van Wincoop (2004) emphasize the role of country market size as a determinant of currency of invoicing. Portes and Rey (1998) and Devereux and Shi (2013) identify externalities and transactions costs

Mckinnon and Schnabel (2004) identified the importance of the US dollar in trade invoicing for the stability of trade in East Asia. Goldberg and Tille (2008) and Kamps (2006) constructed data on invoicing currencies for a broad set of countries finding a heavy role for the US and Europe. This data is extended in Ito and Chinn (2013) and Gopinath (2016). Ito et al examine the history of the yen in the pricing of US dollars. Ito and Kawai (2015) compare the historical development of the Euro and the Yen as an invoicing currency. Devereux, Hinton, and Dong (2016) identify the currency invoicing choice of Canadian importers.

Cook and Devereux (2006) shows that during an emerging markets crisis may be exacerbated by the effect of a region wide devaluation against the dollar on intra-regional trade. If emerging markets in a region all price their exports in US dollars, then he exchange rates passthrough into the prices of all of the exports to regional trading partners. Imports from regional trading partner become less competitive reducing trade region-wide. Goldberg and Tille (2008) show that trade between countries is sensitive to the monetary policy of the currency of invoice even when neither country issues that currency. Casas, Díez, Gopinath, and Gourinchas (2017) identify the optimal monetary policy in a small open economy facing exports priced in external currencies.

2. Model

The model consists of two regional economies, $j = A$ and B, each with their own currency; along with a global economy, W, that uses global dollars as a currency. All cross-country transactions are priced in global dollars. Local currencies are only used within the domestic economy. Each of these countries import goods for final use. In addition, each operates a platform export sector which combines an array of value added from regional producers for ultimate export to the global economy. The exchange rate between regional currencies and international dollars is S_t^j.

2.1 Household

The preferences of the household are:

$$\sum_{t=0}^{\infty} \beta^t u(C_t^j, L_t^j) = \sum_{t=0}^{\infty} \beta^t \left\{ \frac{\zeta}{\zeta - 1} {C_t^j}^{\frac{\zeta-1}{\zeta}} - \frac{\theta \cdot \Gamma}{1+\theta} {L_t^j}^{\frac{\theta+1}{\theta}} \right\}$$

where L_t^j is aggregate labor; and C_t^j is the consumption basket which is a CES aggregate of regional goods, CR_t^j, and imported global goods, CW_t^j:

$$C_t^j = \left(a^{\frac{1}{\varsigma}} \cdot \left\{ CR_t^j \right\}^{\frac{\varsigma-1}{\varsigma}} + (1-a)^{\frac{1}{\varsigma}} \cdot \left\{ CW_t^j \right\}^{\frac{\varsigma-1}{\varsigma}} \right)^{\frac{\varsigma}{\varsigma-1}} \tag{2.1}$$

Regional goods are a combination of goods produced domestically and goods imported from the regional trading partner.

$$CR_t^j = \left(b^{\frac{1}{\psi}} \cdot \left\{ CH_t^j \right\}^{\frac{\psi-1}{\psi}} + (1-b)^{\frac{1}{\psi}} \cdot \left\{ CM_t^j \right\}^{\frac{\psi-1}{\psi}} \right)^{\frac{\psi}{\psi-1}} \tag{2.2}$$

where CH_t^j is domestically produced goods and CM_t^j is imported regionally produced goods.

Relative demand for global goods are based on the relative price of importing at global prices.

$$CW_t^j = (1-a) \cdot \left(\frac{S_t^j P_t^W}{CPI_t^j} \right)^{-\xi} \cdot C_t^j \tag{2.3}$$

where CPI_t^j is the domestic country consumer price index and, P_t^W, is the price of goods from the global economy denominated in international dollars.

The demand for regional goods is given by

$$CR_t^j = a \cdot \left(\frac{RPI_t^j}{CPI_t^j} \right)^{-\xi} \cdot C_t^j \tag{2.4}$$

where RPI_t^j is the cost-minimizing marginal cost of consuming regional goods. Domestic producer prices are priced at PPI_t^j in domestic currency. Goods can be imported from the regional trading partner at price $IPI_t^{\neq j}$ invoiced in global dollars. The cost minimizing combination of regional goods is characterized.

$$\begin{aligned} \frac{CM_t^j}{CR_t^j} &= (1-b) \cdot \left(\frac{S_t^j IPI_t^{\neq j}}{RPI_t^j} \right)^{-\psi} \quad \frac{CH_t^j}{CR_t^j} = b \cdot \left(\frac{PPI_t^j}{RPI_t^j} \right)^{-\psi} \rightarrow \\ RPI_t^j &= \left(b \cdot \left\{ PPI_t^j \right\}^{1-\psi} + (1-b) \cdot \left\{ IPI_t^{\neq j} \right\}^{1-\psi} \right)^{\frac{1}{1-\psi}} \end{aligned} \tag{2.5}$$

The demand for regional goods can be written[1]

$$\begin{aligned} CM_t^j &= (1-b)\cdot a\cdot\left(\frac{S_t^j IPI_t^{\neq j}}{RPI_t^j}\right)^{-\psi}\cdot\left(\frac{RPI_t^j}{CPI_t^j}\right)^{-\xi}\cdot C_t^j \\ CH_t^j &= a\cdot b\cdot\left(\frac{PPI_t^j}{RPI_t^j}\right)^{-\psi}\cdot\left(\frac{RPI_t^j}{CPI_t^j}\right)^{-\xi}\cdot C_t^j \end{aligned}$$

The household will save by holding international bonds, B_t^j:

$$S_t^j B_{t+1}^j = (1+r_t^j)S_t^j B_t^j + W_t^j H_t^j - CPI_t^j C_t^j + \Pi_t^j \tag{2.6}$$

where W_t^j are nominal wages and interest rate, $1+r_t$. is an external interest rate in international dollars. The first order conditions are.

$$\Omega_t^j W_t^j = -MU_t^H = \Gamma {L_t^j}^{\frac{1}{\theta}} \tag{2.7}$$

$$\Omega_t^j CPI_t^j = MU_t^C = {C_t^j}^{\frac{-1}{\zeta}} \tag{2.8}$$

$$1 = E_t[\beta\frac{\Omega_{t+1}^j}{\Omega_t^j}(1+r_t^j)\frac{S_{t+1}^j}{S_t^j}] = E_t[\beta\frac{\Omega_{t+1}^j}{\Omega_t^j}(1+i_t^j)]$$

where Ω_t^j is the shadow value of domestic currency and i_t^j is the implicitly defined domestic currency nominal interest rate.

2.2 Production Firms

[1] Implicitly, the consumer price index is $CPI_t^j = \left(a\cdot\left\{RPI_t^j\right\}^{1-\xi} + (1-a)\cdot\left\{S_t^j P_t^W\right\}^{1-\xi}\right)^{\frac{1}{1-\xi}}$.

2.2.1 Domestic Value Added

Production firms hire labor and sell goods in competitive wholesale markets

$$Y_t^j = Z_t^j L_t^j \rightarrow MCY_t^j = \frac{W_t^j}{Z_t^j} \tag{2.9}$$

where Y_t^j is output and Z_t^j is technology. The competitive price of production goods is MCY_t^j.

2.2.2 Export Platforms

Each country also hosts a platform that generates value for export to the global economy, V_t^j.

$$V_t^j = \left(d^{\frac{1}{\nu}} \cdot \left\{ VH_t^j \right\}^{\frac{\nu-1}{\nu}} + (1-d)^{\frac{1}{\nu}} \cdot \left\{ VM_t^j \right\}^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}} \tag{2.10}$$

where VH_t^j is domestically produced value and VM_t^j are semi-processed materials imported from the regional trading partner. The cost minimizing marginal cost MCV_t^j of the export platform is characterized by

$$\begin{aligned} \frac{VM_t^j}{V_t^j} &= (1-d) \cdot \left(\frac{S_t^j IPI_t^{\neq j}}{MCV_t^j} \right)^{-\nu} \qquad \frac{VH_t^j}{V_t^j} = d \cdot \left(\frac{PPI_t^j}{MCV_t^j} \right)^{-\nu} \\ MCV_t^j &= \left(d \cdot \left\{ PPI_t^j \right\}^{1-\nu} + (1-b) \cdot \left\{ S_t^j IPI_t^{\neq j} \right\}^{1-\nu} \right)^{\frac{1}{1-\nu}} \end{aligned} \tag{2.11}$$

2.3 Distribution Firms

There is an industry that distributes domestic value added for domestic processing. Each distribution sector is made up of a unit range of monopolistically com-

petitive firms.

$$CH_t^j + VH_t^j = H_t^j = \left[\int h_{l,t}^{\frac{\phi-1}{\phi}} dl\right]^{\frac{1}{1-\phi}} \tag{2.12}$$

Define the price of each domestic good as ppi_t^l where the price index is defined $PPI_t^j \cdot H_t^j \equiv \int \left\{ppi_{l,t} h_{l,t}\right\} dl$.

Another sector produces for regional export purposes.

$$CM_t^{\neq j} + VM_t^{\neq j} = EX_t^j = \left[\int ex_{l,t}^{\frac{\phi-1}{\phi}} dl\right]^{\frac{1}{1-\phi}} \tag{2.13}$$

Define the price of each regional export as $ipi_{l,t}$ where the price index is defined $IPI_t^{\neq j} \cdot EX_t^j \equiv \int \left\{ipi_{l,t} ex_{l,t}\right\} dl$. Note that this price is denominated in global dollars.

Finally, exports to the global economy are also constructed by distribution.

$$WM_t^j = \left[\int wim_{l,t}^{\frac{\phi-1}{\phi}} dl\right]^{\frac{1}{1-\phi}} \tag{2.14}$$

The price of exports to the global economy, $xpi_{l,t}$, is also priced in global dollars where the price index is defined $XPI_t^j \cdot WM_t^j \equiv \int \left\{xpi_{l,t} wim_{l,t}\right\} dl$.

Any of the firms in the distribution sector faces cost minimizing demand for $x_{l,t} \in \{h_{l,t}, ex_{l,t}, wim_{l,t}\}$ relative to total demand $X_t^j \in \{H_{l,t}, EX_{l,t}, WM_{l,t}\}$

$$x_{l,t} = \left(\frac{p_{l,t}}{P_t^j}\right)^{-\phi} \cdot X_t^j \rightarrow \tag{2.15}$$

where $p_{l,t} \in \{ppi_{l,t}, ipi_{l,t}^{\neq j}, xpi_{l,t}\}$ and $P_t^j \in \{PPI_t^j, IPI_t^{\neq j}, XPI_t^j\}$.

2.3.1 Sticky price firms

Distribution firms are given a chance to change prices with exogenous probability, $1-\kappa$. Distribution firms set an optimal price as a markup over a weighted average of future prices. Consider the distribution firms targeting the domestic sector.

$$\overline{ppi}_t^j = \tau \frac{\phi}{\phi-1} \frac{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j H_{t+n}^j PPI_{t+n}^{j\phi}\right] \cdot MCY_{t+n}}{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j H_{t+n}^j PPI_{t+n}^{j\phi}\right]} \tag{2.16}$$

where τ is defined as a subsidy on production provided to potentially offset monopoly power. The dynamics of producer prices follows

$$PPI_t^{j(1-\phi)} = (1-\kappa)\overline{ppi}_t^{j(1-\phi)} + \kappa PPI_{t-1}^{j(1-\phi)} \tag{2.17}$$

The regional export distribution sector prices in international dollars. The optimal price is

$$\overline{ipi}_t^j = \tau \frac{\phi}{\phi-1} \frac{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j EX_{t+n}^j IPI_{t+n}^{j\phi}\right] \cdot \frac{MCY_{t+n}^j}{S_{t+n}^j}}{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j EX_{t+n}^j IPI_{t+n}^{j\phi}\right]} \tag{2.18}$$

$$IPI_t^{j(1-\phi)} = (1-\kappa)\overline{ipi}_t^{j(1-\phi)} + \kappa IPI_{t-1}^{j(1-\phi)} \tag{2.19}$$

The global export distribution sector also prices in international dollars. The optimal price is

$$\overline{xpi}_t^j = \tau \frac{\phi}{\phi-1} \frac{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j WM_{t+n}^j XPI_{t+n}^{j\phi}\right] \cdot \frac{MCV_{t+n}^j}{S_{t+n}^j}}{\sum_{n=0}^{\infty}(\beta\kappa)^n \left[\Omega_{t+n}^j WM_{t+n}^j XPI_{t+n}^{j\phi}\right]} \tag{2.20}$$

$$XPI_t^{j(1-\phi)} = (1-\kappa)\overline{xpi}_t^{j(1-\phi)} + \kappa XPI_{t-1}^{j(1-\phi)} \tag{2.21}$$

2.4 Global Demand

The global demand for country j exports is an isoelastic function of relative costs:

$$WM_t^j = f \cdot \left(\frac{XPI_t^j}{P_t^W} \right)^{-\varsigma} \cdot Y_t^W \tag{2.22}$$

2.5 Market Equilibrium

Goods market equilibrium implies

$$\begin{aligned} \int \left\{ h_{l,t} + ex_{l,t} \right\} dl &= Y_t^j \\ DH_t^j \cdot H_t^j + DX_t^j \cdot EX_t^j &= Y_t^j \end{aligned} \tag{2.23}$$

$$DH_t^j \equiv \left[\int \left(\frac{ppi_{l,t}}{PPI_t^j} \right)^{-\phi} dl \right] \quad DX_t^j \equiv \left[\int \left(\frac{ipi_{l,t}}{IPI_t^{\neq j}} \right)^{-\phi} dl \right] \tag{2.24}$$

and

$$\begin{aligned} \int \left\{ wim_{l,t} \right\} dl &= V_t^j \\ DW_t^j \cdot WM_t^j &= V_t^j \end{aligned} \tag{2.25}$$

$$DW_t^j \equiv \left[\int \left(\frac{xpi_{l,t}}{XPI_t^j} \right)^{-\phi} dl \right] \tag{2.26}$$

External interest rates are set at a risk premium over the exogenous interest rate r_t. The risk premium is a decreasing function of wealth, B_t^j .

$$1 + r_t^j = \Lambda_t^R \cdot \{ 1 + (r \cdot e^{-\eta B_t^j}) \}$$

where Λ_t^R is an external interest rate. Domestic interest rates follow a modified Taylor Rule with persistence.

$$1+i_t^j = (1+i)^{1-\chi_i}\left(1+i_{t-1}^j\right)^{\chi_i}\left(\frac{P_t^j}{P_{t-1}^j}\right)^{\chi_\pi(1-\chi_i)}\left\{\frac{S_t^j}{S_t^{\neq j}}\right\}^{\chi_S(1-\chi_i)}\lambda_t^j \tag{2.27}$$

where λ_t^j, is a monetary policy shock. The focus price for monetary policy $P_t^j \in \{CPI_t^j, PPI_t^{\neq j}, S_t^j\}$ depends on the policy experiment. We also allow a competitive devaluations component, in which monetary policy adjusts according to the gap versus the regional trading partner, $\frac{S_t^j}{S_t^{\neq j}}$.

3. Calibration and shocks

To the extent possible, we calibrate the model with parameters within the range of standard business cycle studies. The inter temporal elasticity of substitution, $\zeta = 1$, consistent with log preferences. The Frisch elasticity of labor supply, θ, is set equal to 1. The parameter Γ is normalized so steady state employment is $L = 1$. The subjective discount factor is set, $\beta = .99$, consistent with an annualized interest rate near 4%. We follow Backus , Kydland and Kehoe (1992) in setting the Armington elasticity including: the elasticity of substitution between regional and global goods, $\xi = 1.5$; the substitutability between domestic and imported goods in regional consumption, $\psi = 1.5$; and the substitutability of domestic and regional goods in the export platform's production is $\nu = 1.5$. The elasticity of substitution between differentiated goods, $\phi = 11$, consistent with an markup of 10% gross of subsidy. We assume a subsidy, $\tau\frac{\phi}{\phi-1} = 1$, so net steady state markup is zero. We set price stickiness so that prices adjust on an annual average basis, $\kappa = .75$. We calibrate around a zero inflation, zero current account steady state with the risk premium parameter set just large enough to

ensure long-term convergence, $\eta = -.0001$. We calibrate the shares of the model so that total exports are 50% of GDP and exports to the regional trading partner are 50% of exports. This implies $a = b = d = .75$. We normalize the foreign price level to unity, $P^W = 1$; the size of demand from the global economy, $f \cdot Y^W$ is set so that the bilateral trade balance is zero at a real exchange rate of 1.

The policy parameter $\{\chi_i, \chi_\pi, \chi_S\}$ will be set according to the policy experiment. Our benchmark interest rate smoothing parameter is $\chi_i = .75$ corresponding to the degree of price stickiness.

3.1 Global Interest Rate Shocks

We consider the response of the economy to an external interest rate shock that affects both economies. The external shock follows an AR(1) process:

$$\ln \Lambda_t^R = \rho^R \cdot \ln \Lambda_{t-1}^R + \varepsilon_t^R$$

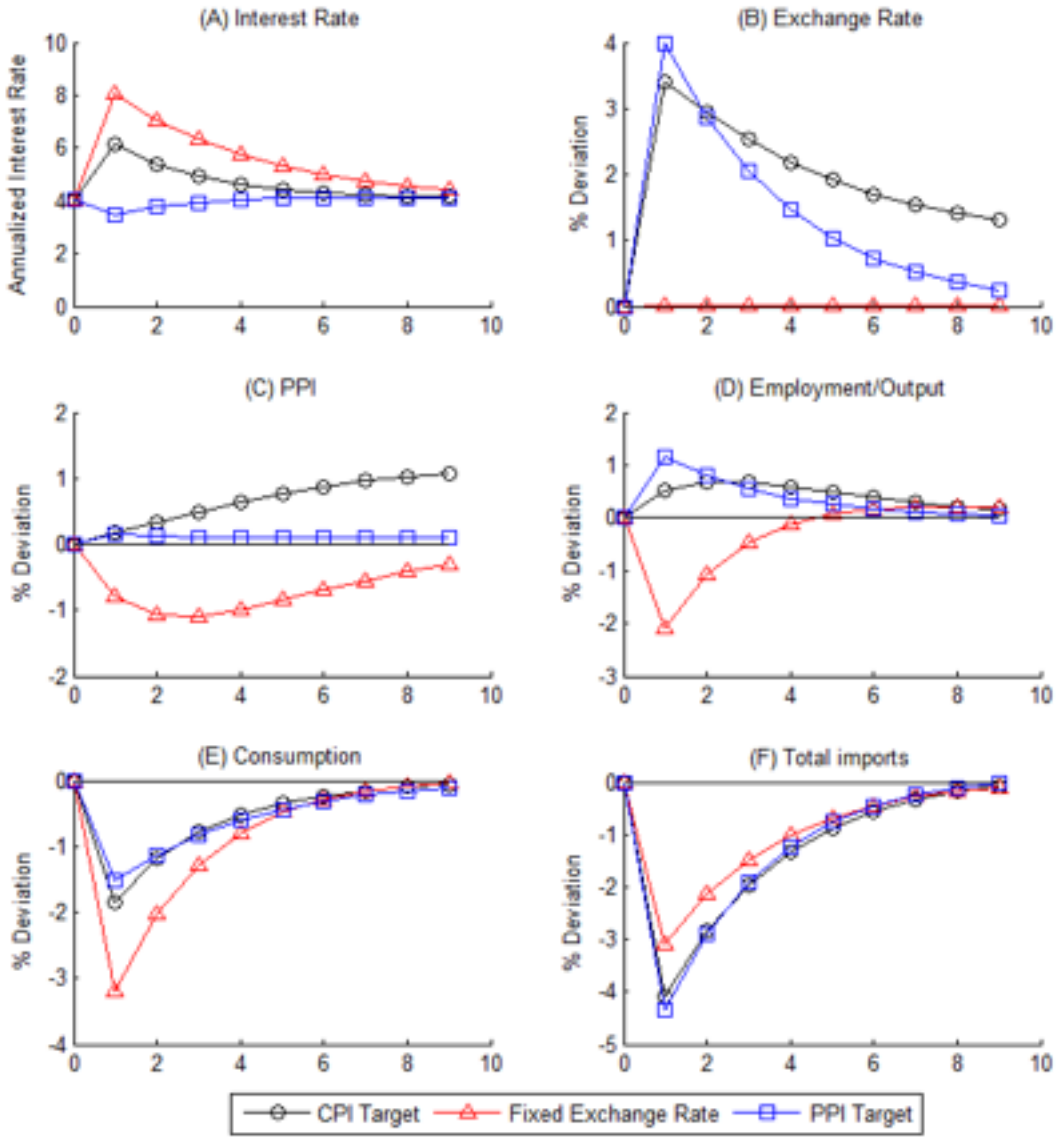
We calibrate the auto-correlation, $\rho^R = .75$, to the degree of domestic interest rate persistence and examine the case of a shock, $\varepsilon_t^R = .01$, that raises the real interest rate (ceteris parabis) by 100 basis points or annualized 4%. We consider three possible policy responses. The Inflation Target case assumes a Taylor rule type focus on the CPI inflation rate, $P_t^j = CPI_t^j$, and $\chi_\pi = 1.5$. In a second case, we model a fixed exchange rate with $P_t^j = S_t^j$, and $\chi_\pi = 5000$. In a third case, we model a Producer Price target which sets $P_t^j = PPI_t^j$, and $\chi_\pi = 5000$ which focuses directly on the sticky price. We set $\chi_S = .00001$ to allow for long-term stationarity in the relative exchange rate between regional trading partners. Note that we model the shock as affecting both countries symmetrically and each country responding with identical policy rules. Therefore, each economy will have identical responses to the external shock.

A persistent increase in the external interest rate will require a real depreciation for both small economies. The real depreciation can occur through some combination of exchange rate depreciation or nominal deflation. Figure 3.1, Panel A shows the adjustment of the nominal interest rate (reported in annualized terms). The required policy response under a Fixed Exchange Rate will be to match the rise in external interest rates on a one-for-one basis. Maintaining a soft CPI Inflation Target will allow for a milder increase in interest rates. To maintain a level for the Producer Price Index, the central bank must cut interest rates.

As shown in Figure 3.1, Panel B, the spot exchange rate depreciates in the absence of central bank commitment to an exchange rate peg. Either type of domestic inflation target will allow for an exchange rate depreciation. The CPI Inflation Target somewhat smoothes the exchange rate in the short-run but allows for a long run nominal expansion so the exchange rate adjusts more persistently. Panel C shows the response of the producer price index, PPI. Under a fixed exchange rate, real depreciation requires a persistent fall in the price level. Under the CPI Inflation Target, the smoothing of the CPI allows the PPI to remain stable initially, though over time there is some inflation.

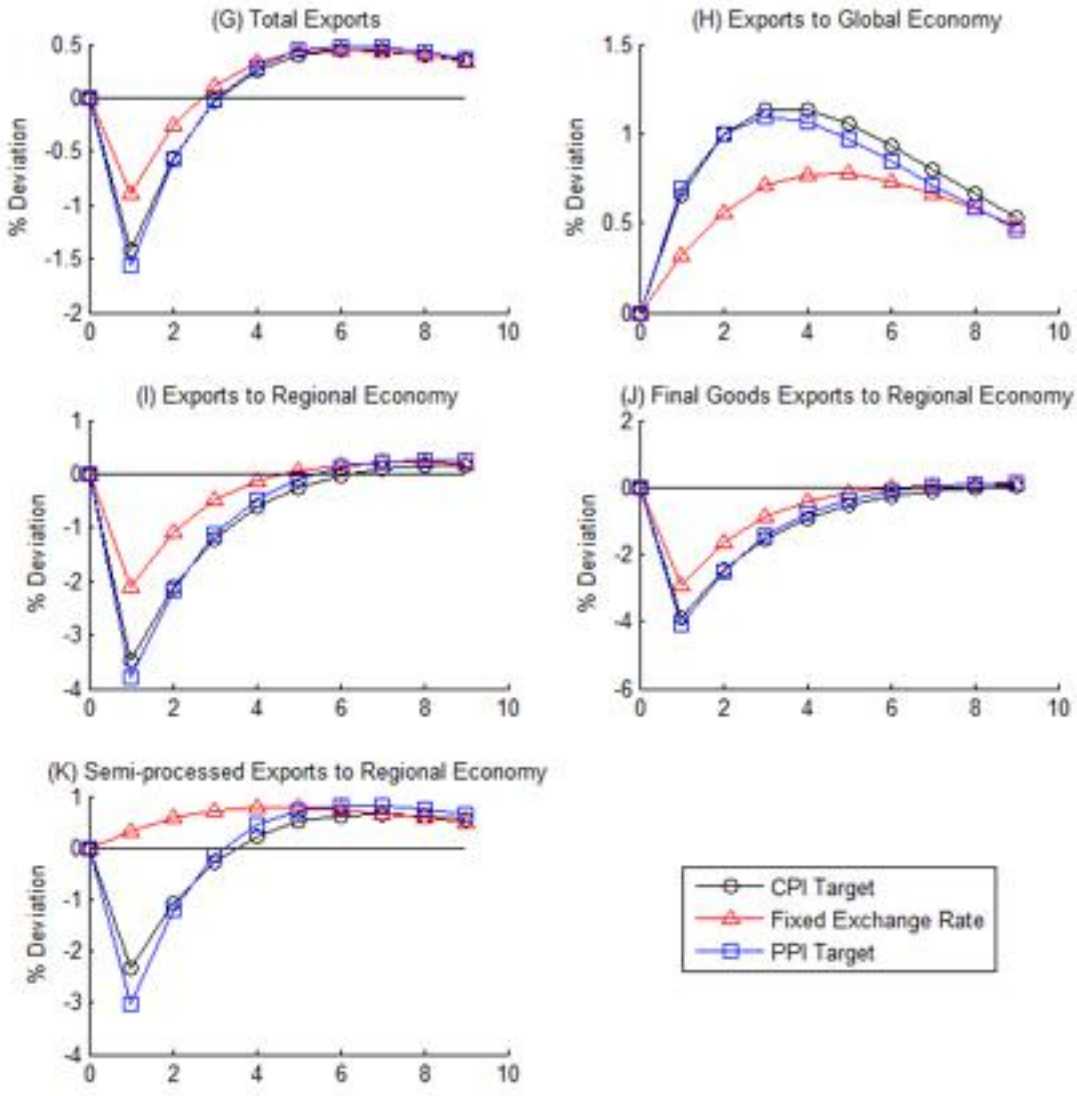
The implications for the real side of the economy can be seen in Panel D, which shows the response of employment, L_t, or equivalently output, Y_t. Flexible exchange rates avoids deflation entirely. As a result, the effect of the shock is expansionary on domestic output (partially due to the income effect on labor supply). By contrast, the Fixed Exchange rate regime requires the contraction to occur entirely through internal deflation. The deflationary environment leads to a persistent contraction in output. The soft CPI Inflation Target allows for a smoother nominal expansion and, therefore, a smoother real expansion. Panel E shows the response of aggregate consumption. The nominal contraction and

Figure 3.1



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three monetary policy rules: a) a standard CPI targeting interest rate rule; b) a fixed exchange rate with the global currency; c) a rule that stabilizes the domestic PPI. This part shows the response of domestic interest rates and exchange rate, producer prices, domestic output, consumption and imports.

Figure 3.1: cont.



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three monetary policy rules: a) a standard CPI targeting interest rate rule; b) a fixed exchange rate with the global currency; c) a rule that stabilizes the domestic PPI. This part shows the response of aggregate exports, exports to the global and regional economies, and exports by use

sharper rise in real interest rates required under the Fixed exchange rate leads to the largest contraction in domestic consumption expenditure. CPI inflation targeting and the Producer Price target lead to roughly similar contractions in consumption.

As shown in Panel F, there is a large decline in imports under all monetary policies for two potential reasons. First, aggregate consumption demand falls due to the contraction. Second, all imports are priced in international dollars; a depreciation against the global economy will pass through into import prices immediately inducing a switch away from imports. Note that the second factor seems more important. The decline in imports is less severe under fixed exchange rates, though domestic demand contracts more sharply under that policy response. The exchange rate depreciation under the flexible exchange rate regimes such as the CPI Inflation and PPI Target tilt the consumption basket away from imports.

More surprisingly, exchange rate depreciation also leads to a contraction in exports. Figure 3.1, Panel G shows the response of exports. Note that under all the policy regimes there is a temporary decline in exports for three periods followed by a mild expansion. An explanation for this surprising result can be seen by examining the response of different types of exports. Panel H shows the response of exports to the global economy and Panel I shows the response of exports to the regional trading partner (which are also, symmetrically, imports from the regional trading partner). Under each monetary policy, exports to the global economy, WM, expand persistently. The real exchange rate depreciation reduces the relative price of domestic goods increasing demand for domestic exports. Because exports are priced in global dollars, reduced costs pass through into prices only slowly. Under flexible exchange rates, the rapid exchange rate depreciation passes through very quickly into export prices and the exports to

the global economy respond more sharply. Deflation of domestic prices under fixed exchange rates is slower due to sticky domestic prices, so the increase in exports to the global economy are milder under the Fixed Exchange Rate rule.

At the same time, exports to the regional economy decline under all monetary policies for two reasons. First, there is a decline in aggregate demand for all final goods in the region. Second, the exchange rate depreciation perversely makes importing goods within the regional economy more expensive as they are priced in international dollars. This causes demand to shift away from regional goods. Note that the latter substitution effect appears to be more important. Regional exports decline most sharply under the flexible exchange rate rule which features a smaller decline in demand but a significantly more dramatic exchange rate depreciation. A stable exchange rate response also stabilizes intraregional trade.

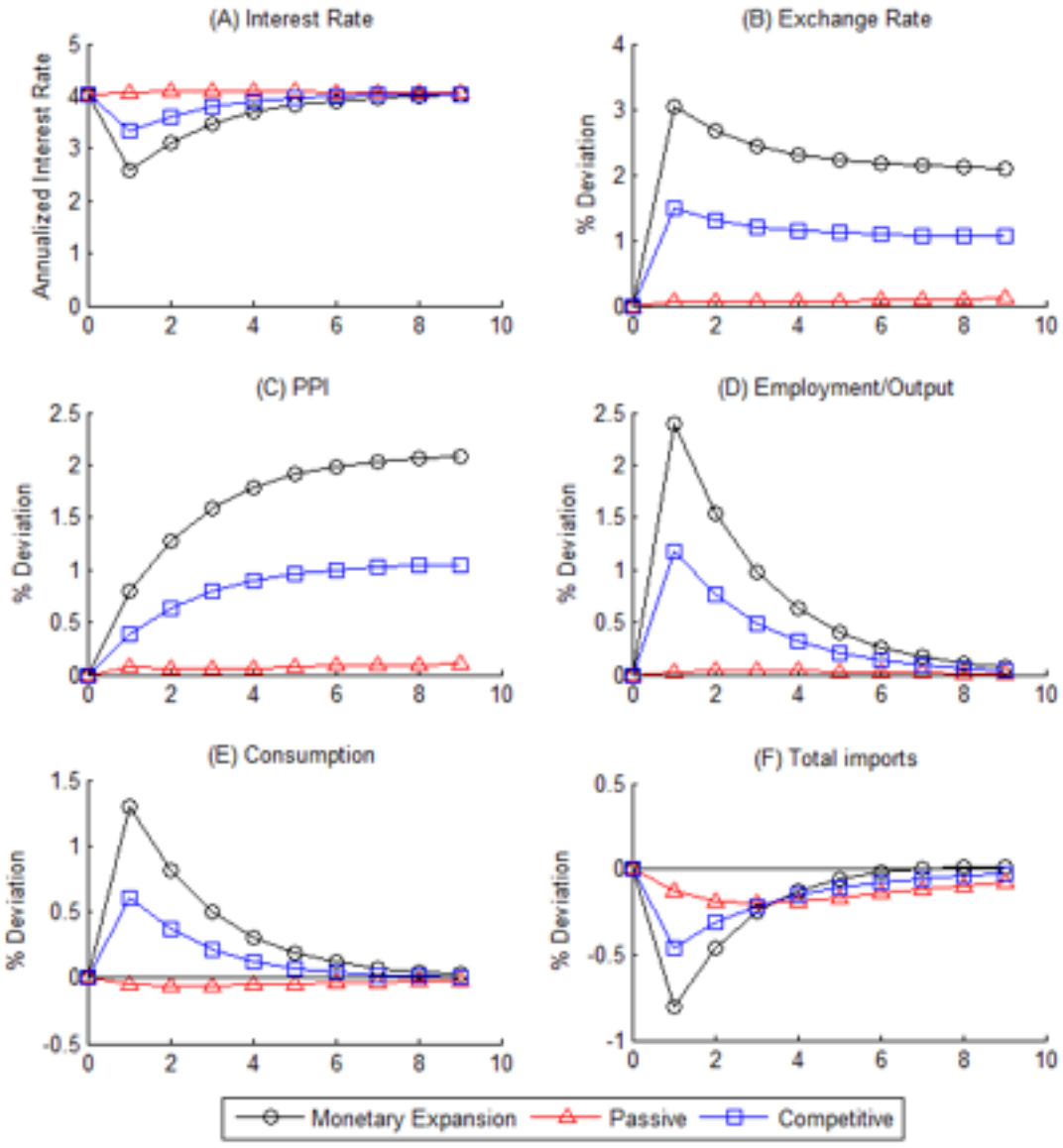
Regional exports are either used as final goods or for materials for the export platform. Regional exports for final use unambiguously contract following the rise in external rates (see Panel J). This occurs due to a combination of the decline in consumption, exacerbated by potential exchange rate depreciation. The response of regional exports for processing is more policy dependent (see Panel K). There are two different effects. First, the overall level of final products exported to the global economy increases which, in turn, increases demand for inputs from the regional trading partner. However, an exchange rate depreciation instantly makes imports priced in global dollars more expensive. Under fixed exchange rates, the first channel alone applies and the exports for regional processing increase. Under the flexible exchange rate regimes, the sharp exchange rate depreciation leads to the second channel dominating and exports for regional processing decrease.

3.2 Asymmetric Monetary Policy Shocks

In this section, we estimate the effect of an exogenous monetary policy expansion in Country A. We examine the effect of a one time shock to the interest rate rule at period 1, such that $\lambda^A_{t=1} = .99$, equivalent to a (ceteris parabis) 4% decline in annualized interest rates. Due to persistence in the interest rate rule, this leads to a persistent decline in the nominal interest rate in Country A. Figure 3.2 shows the response of the economy to a monetary policy shock in one country under two possible assumptions about the monetary policy rule of country B. First, we assume country B implements a policy following a CPI inflation target with $P_t = CPI_t$, $\chi_i = .75$, $\chi_\pi = 1.5$, and $\chi_S = .00001$. Beyond responding to any changes in the domestic CPI, the *Passive* central bank will not respond to monetary expansion from its trading partner. We also examine the case when the country B engages in a competitive devaluation with $\chi_S = 50000$. This implies that the interest rates of country B tracks the interest rates of country A exactly. When country B acts according to a *Competitive* rule, both countries have identical responses to the shock because both countries implement identical monetary policies.

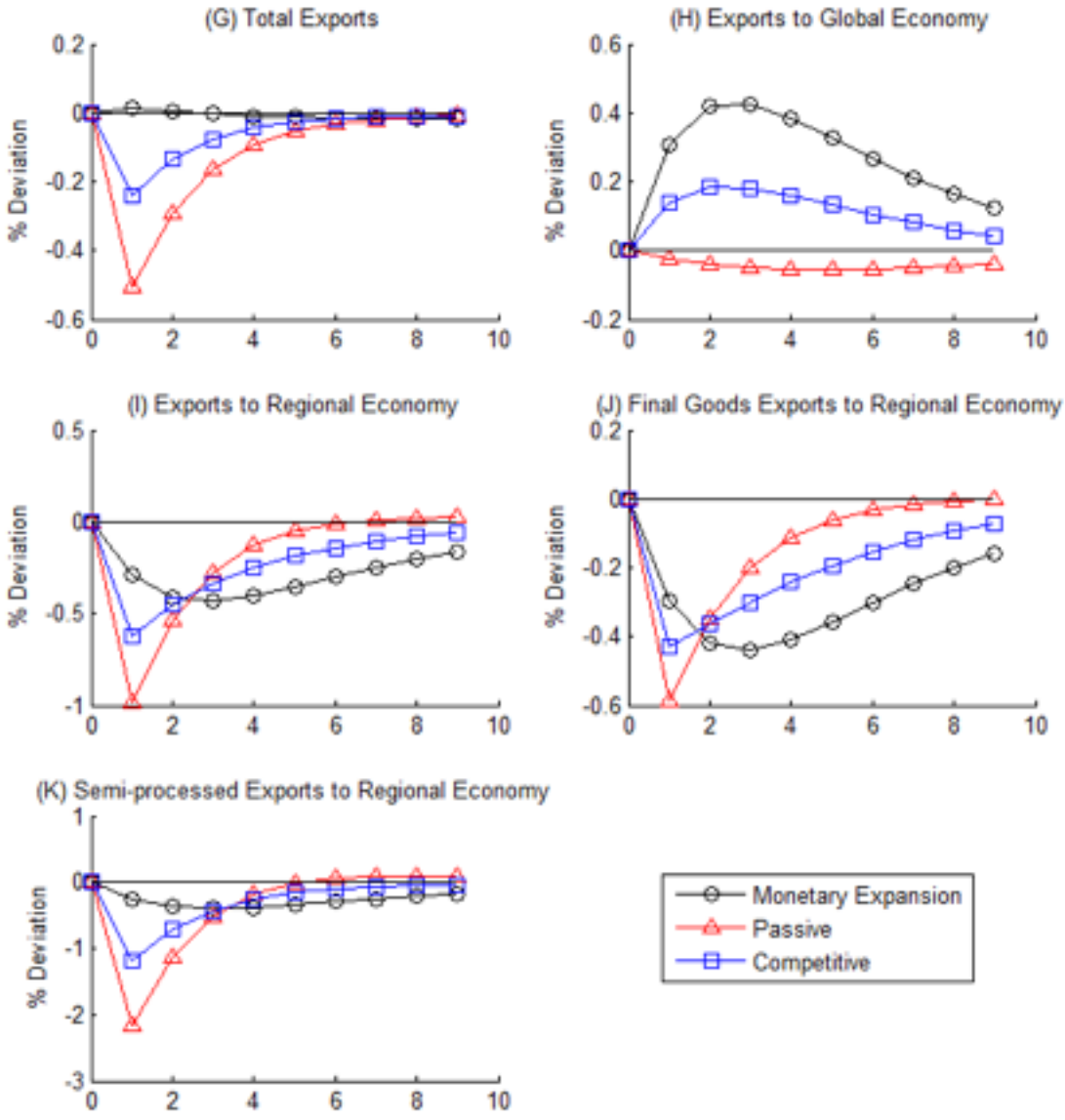
Figure 3.2 shows the response of Country A and Country B when Country B has a passive policy; Country A is labeled *Monetary Expansion* and Country B is labeled *Passive*. For comparison, we show the symmetrical response of either Country A or Country B when Country B follows a competitive devaluation policy. Figure 3.2, Panel A shows the the extent of the interest rate cut for Country A. Because of the inflationary effects of the shock, the inflation targeting central bank will not fully implement the interest cut implied by the shock. This interest rate cut is persistent due to the interest smoothing parameter. The Passive trading partner's central banks interest rate remains essentially unchanged. Figure 3.2, Panel B shows that Country A experiences a persistent nominal exchange

Figure 3.2



Notes: Asymmetric impulse responses of both regional economies to an expansionary interest rate cut in one economy. The response is shown under two policy responses by the regional trading partner. The Monetary Expansion and Passive impulse responses show the response of the economy undertaking monetary expansion along with a passive regional trading partner operating a CPI targeting interest rate rule. The Competitive impulse response shows the outcome when the trading partner pegs its exchange rate to the regional trading partner. Under the Competitive scenario, both economies have the same monetary policy so the outcome is symmetric. This part shows the response of domestic interest rates and exchange rate, producer prices, domestic output, consumption and imports.

Figure 3.2: cont.



Notes: Asymmetric impulse responses of both regional economies to an expansionary interest rate cut in one economy. The response is shown under two policy responses by the regional trading partner. The Monetary Expansion and Passive impulse responses show the response of the economy undertaking monetary expansion along with a passive regional trading partner operating a CPI targeting interest rate rule. The Competitive impulse response shows the outcome when the trading partner pegs its exchange rate to the regional trading partner. Under the Competitive scenario, both economies have the same monetary policy so the outcome is symmetric. This part shows the response of aggregate exports, exports to the global and regional economies, and exports by use.

rate depreciation versus the global economy and its passive trading partner; depreciation generates nominal expansion in the PPI as shown in Panel C.

The nominal expansion leads to a real expansion in output and consumption in Country A (see Panel D and E). Note the expansion in output is proportionally stronger than the expansion in consumption. As a result, Country A experiences a sharp decline in imports. The exchange rate devaluation versus the global economy increases the cost of imports which are priced in global dollars, so exchange rate pass through is immediate. The rising cost of imports causes the economy to shift to domestic value added. Panel F shows the Passive Country B also experiences a slow contraction in imports from regional trade. Country A experiences an increase in PPI which ultimately passes through to its export prices which reduces its exports to country B.

Panel G shows that the exchange rate depreciation in Country A results in very little net export response. The exchange rate depreciation versus the global dollar only slowly passes through to the price of exports. Thus, exports to the global economy increase only slowly. Likewise, the increased price of goods in Country A will slowly pass through into the price of exports to passive country B. These two effects offset. However, the exchange rate depreciation of country A immediately passes through into the price of imports from country B which are priced in global dollars; this reduces country B's exports relatively sharply despite the absence of a depreciation in its own exchange rate vs the global economy. Country B's exports of final goods fall by proportionally smaller amount than the exports for use in ultimate export as country A's overall final goods spending is expanding while their global exports adjust to only a small degree.

We compare the response of an asymmetric devaluation to one in which the trading partner matches the exchange rate devaluation. As shown, if both countries engage in nominal expansion, the exchange rate depreciation and domestic

price expansion will pass through into import prices in both countries heightening the inflation response at any given interest rate path. As a result, the interest rate response is muted relative to the case when the trading partner is passive. Likewise, the exchange rate in each country depreciates, but the depreciation is milder than that seen in country A when the monetary policy is asymmetric. The nominal expansion leads to an increase in employment and output in both countries. Again, this is milder than the expansion observed in country A under asymmetric monetary policy. In both countries, the exchange rate depreciation leads to a contraction in both imports and exports. Each country experiences a mild expansion in exports to the global economy. However, this is dominated by the decline in regional trade.

4. Empirics

In this section we evaluate the predictions of the model for explaining dynamics in international trade flows in the data. Given the different predictions of the model for final goods vs intermediate goods trade, we draw on data from the world output database[2] which provides a decomposition of trade flows into intermediate and final goods at the bilateral level. After reviewing broad patterns based on this two category decomposition at the country level, we delve deeper into studying the role of supply chain vs final goods trade by using the bilateral decomposition of international trade flows based on the framework in Wang, Wei and zhu (2013), which isolates different components of international trade flows depending on the extent of their participation in global value chains and number of border crossings involved to provide the most granular decomposition of international trade flows by end use pattern available in the literature.

[2]The documentation and data is publicly available at: http://www.wiod.org/home

4.1 A first look at country-level bilateral trade data

We start with the following empirical specification to study the impact of an external (US) interest rate shocks on trade flows.

$$\triangle Y_{i,j,t} = \alpha_{i,j} + \triangle Y_{i,j,t-1} + \beta i_{us,t} + \triangle E_{i,j,t} + \delta X_t \tag{4.1}$$

Here, i denotes the exporting country and j denotes the destination (importing) country. Y denotes the dependent variable which is intermediate exports, final goods exports or the share of intermediate to final exports. $\triangle E_{i,j,t}$ is the bilateral exchange rate and X_t is a vector of additional controls including current and lagged values of GDP growth and inflation (both country and partner), growth in world trade, a dummy for financial crisis (set equal to 1 for 2008 and 2009) and the financial crisis dummy interacted with partner GDP growth. The sample runs from 1995-2009 (annual) and includes bilateral trade flows between 39 (non-US) countries.[3] Impulse responses are computed from the above specification using the local projection method in Jorda (2005). Since our sample period overlaps with the period in which the federal funds rate was at its effective lower bound, we use the shadow rate in Lombardi and Zhu (2014) to proxy for the stance of monetary policy.[4]

In response to an increase in the US policy rate, both intermediate and final goods exports by non US countries to non US destinations rise moderately on impact, but subsequently fall, as predicted by the model (figure 4.1). The initial rise may be indicative of residual endogeneity in the model, a conjecture confirmed by the absence of this rise if the main independent variable is lagged by one period. More importantly, in line with the predictions of the model, the

[3] The list of countries is available in appendix C

[4] As shown by the authors, the shadow rate closely tracks the effective federal funds rate outside of the zero lower bound episodes.

share of intermediate to final goods exports to regional (non-US) economies rises, which is a common finding across multiple versions of the model. Interestingly, we do not find significant differences in these patterns across EU and non EU countries, suggesting that dollar pricing is a global phenomenon which is prevalent even within the EU. A[5]

4.2 Sector Level Analysis

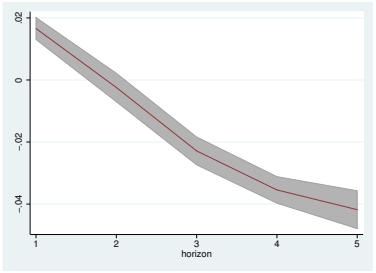
There are a few limitations when using country level data with a two way split between intermediate and final goods. Firstly, as shown by Wang, Wei and Zhu (2013), a significant fraction of intermediate imports are eventually embodied in final goods that are consumed within the immediate importing country. From a global perspective, these trade flows, although classified as intermediate in the data, are more akin to final goods and do not fit the global value chain definition that is typically accorded to them in modeling frameworks. For instance, these trade flows are closer to final goods exports rather than platform exports in our model, since the latter flows are destined to cross international borders further and be consumed in a different country. Secondly, our limited sample at the country level which is only available at annual frequency not only prevents robust statistical inference as seen by the high standard errors, but also prevents an investigation of heterogeneity across sectors in the response of exports to shocks.

To address these concerns and further investigate the role of multiple border crossings and global value chains in explaining the impact of US interest rates on observed patterns in international trade between non-US countries, we now turn to a more granular decomposition of international trade flows based

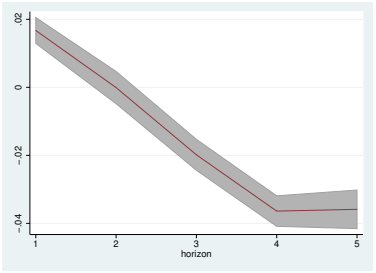
[5]This may also reflect the fact that EU economies are more open that the rest of the countries in our sample, so even a lower share of dollar invoiced exports may represent a higher absolute volume of trade.

Figure 4.1: Response of regional bilateral exports (exports to destinations other than the US) to US interest rate increase

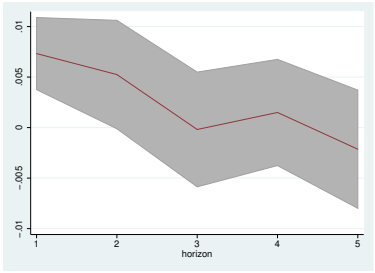
(a) Intermediate regional exports: Full sample



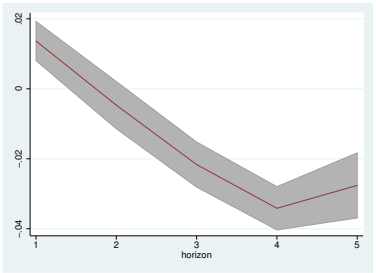
(b) Final regional exports: Full sample



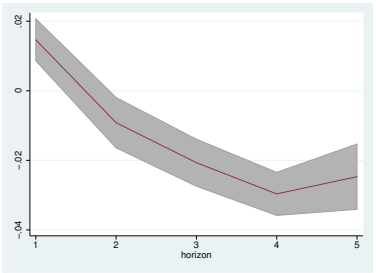
(c) Ratio of intermediate to final exports



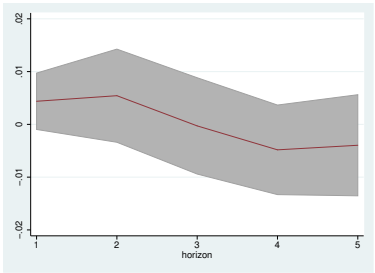
(d) Intermediate regional exports: Sample of non EU countries



(e) Final regional exports: Sample of non eEU countries



(f) Ratio of intermediate to final exports: Non EU countries



Notes: The figure plots impulse responses to US interest rate based on Lombardi and Zhu (2014) local projection method using equation 4.1. X axis measures time since the shock (in years) and y axis denotes the deviation of export growth in percentage points. Shaded area denotes 95 percent confidence internals.

on Wang, Wei and Zhu (2013, 2017). Starting with an initial shipment of a good from particular sector in the exporting country to a particular importing country, this framework tracks and classifies the flow according to its subsequent journey all the way to the final destination until it is consumed as part of a final good somewhere in the world-which could be either in the importing country, the exporting country itself (back and forth trade) or a third country which is different from both the initial exporter or importer (global value chain trade). For instance, it can separately identify and track the fraction of the initial shipment which remains in the importing country and is used to produce final goods which are either exported or consumed domestically, and the part which is exported by the importing country as further (second-round) intermediate inputs for further processing, either to a third country or back to the source country. Table 1 provides a summary of the different components of international trade flows that are tracked by this framework.

Similar to the country level analysis, the empirical model is specified as follows:

$$Y_t^{i,j}(s) = \alpha^{i,j}(s) + \eta Y_{t-1}^{i,j}(s) + \beta i_{us,t} + \delta X_t + \epsilon_t^{i,j}(s) \tag{4.2}$$

$Y_t^{i,j}(s)$ denotes a component of bilateral exports from sector s in country i to country j, measured typically as a share of total gross exports. $i_{us,t}$ is the US policy rate.[6] X_t is a vector of controls and includes contemporaneous and lagged values of changes in the bilateral exchange rate between the importer and the exporter, change in real GDP and inflation of the importer and exporter, change in total imports by the importer, and change in total imports and exports by the importing country with the US, as well as the change in unit labor cost in the exporting country. A quadratic time trend is also included in the re-

[6]Which as above is proxied by the shadow rate in Lombardi and Zhu (2014)

Table 1: Decomposition of intermediate goods trade flows

1. Used by direct importer to produce final goods directly , and then used as:(Figure 4.3)
   (a) domestic final goods consumed by the direct importer
   (b) exported final goods consumed by third countries
   (c) exported final goods consumed by the source (exporting) country
2. Used by the direct importer to produce intermediate exports, and then:
   (a) first used by direct importer to produce intermediate goods exports, then used by third countries to produce final goods which are subsequently used as:(Figure 4.4)
      i. domestic final goods consumed in the third country
      ii. exported final goods consumed by countries other than the source country(exporting country)
      iii. exported final goods consumed by the source (exporting) country
   (b) first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods (Figure4.5)
      i. domestic final goods consumed by the source (exporting) country
      ii. exported final goods consumed by other countries

Source: Wang, Wei and Zhu (2013)

gressions. The impulse responses are once again computed using the local projection method developed in Jorda (2005).[7] The sample runs from 1995-2011 (annual) and covers 35 sectors in 40 countries (See Appendix C for the full list of countries and sectors). To streamline the discussion, we classify the 35 sectors into three broad categories corresponding to "primary" (agriculture, food and mining), secondary (primarily manufacturing) and tertiary (services) sectors and present results for these categories separately in addition to the pooled results. The full list of sectors and the classification is available in appendix C.

In interpreting these results, we consider each bilateral pair to represent the regional economy (which we match to the model by fcontrolling for the the biltareal exchaneg rate in the regressions), with the rest of the world implicitly capturing the global economy in the background. Figure 4.2 displays the response of total (left panel) and intermediate (center panel) bilateral exports between non-US countries in response to a monetary contraction in the US. The graphs confirm the patterns observed in the country-level data, as both measures of exports decline persistently after a small contemporaneous increase. The decline is sharpest for tertiary sectors, and least for primary sector exports. The right hand panel shows the decline in ratio of value added to gross exports, which is consistent with the overall message from different versions of the model to the extent that it implies an increase in the share of value chain related trade (analogous to platform exports in the model) as opposed to final goods trade that are absorbed in the importing country.

To further uncover these mechanisms, we next examine the response of different components of intermediate exports (scaled by gross exports). These are the eight components summarized in Table 1. Figure 4.3 considers the response of the components of intermediate exports that are used to produce final goods

[7]The large dimension of the dataset (where we have close to a million data points) makes the typical alternative of using vector autoregression less attractive.

in the direct importing country. Within this category, the left panel shows that the share of the component which is consumed as final goods in the direct importing country itself declines on average. This is consistent with the predictions of the model, since in this case the intermediate goods in effect act like final goods insofar as they are consumed by the direct importer, and these trade flows decline unambiguously across all versions of the model, as they become more expensive compared to domestically produced goods from the perspective of consumers in the importing country. On the other hand, the middle panel shows that the share of intermediate goods that are eventually exported to third countries after converting to final goods rises, which is consistent with the model as this part of the exports is akin to the platform export component in the model. It is interesting to note that this positive response is the sharpest for primary sectors. One explanation for this based on the robustness results of the model could be that producer currency pricing is more prevalent in this sector. The right panel in figure 4.3 shows that the share of the component that is re-exported back to the original exporting country also declines persistently, a pattern that is again supportive of the mechanism in the model highlighting the fact that back and forth trade becomes more expensive as regional currencies depreciate against the dollar.

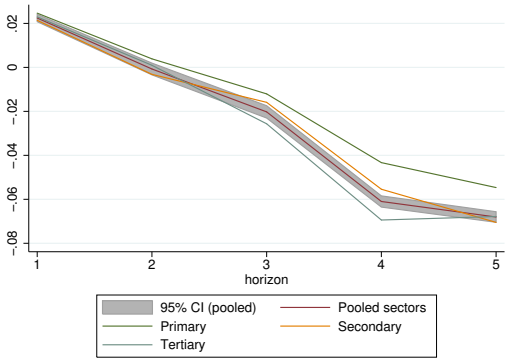
Figure 4.4 shows the response of the share of intermediate exports that is used by the direct importer to further produce intermediate goods exports, which is then exported and used by the third countries to produce final goods. The left and middle panels display the same pattern of an initial rise, which turns to a decline after 2-3 years. Commenting on these results in the context of the model is a bit harder since the stylized nature of the model does not allow for more than two border crossings. However it is interesting to note the the right hand panel which shows that the component that can be traced and eventually returns to

the home country (i.e the original exporting country) falls (albeit after a moderate contemporaneous rise), in line with the prediction of the model both in terms of a higher dollar making back and fort trade more expensive, as well as the overall decline in imports by the home country. The relatively muted decline in the primary sector in the right hand side panel of 4.4 is consistent with the patterns in figure 4.3, further contributing to the evidence in favor of PCP in this sector.

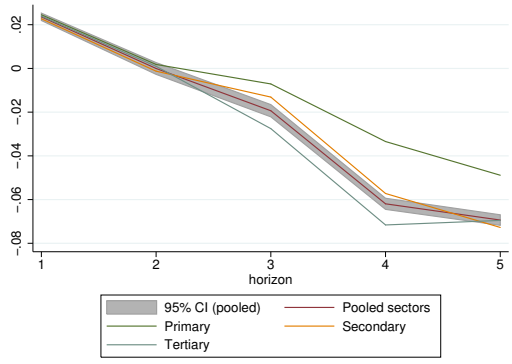
Figure 4.5 shows the response of the share of intermediate exports first used by direct importer to produce intermediate exports, which are subsequently shipped back to the source (exporting) country as intermediate imports to produce final goods. Within this, the share of the component that is ultimately absorbed in the original source country experiences a persistent decline (left panel in figure 4.5). This is in line with the with the patterns above as well as with the insights obtained form the model, as the higher dollar makes bilateral back and forth trade more expensive than domestic goods, causing consumers to switch towards the latter, with the primary sector once again showing a significantly different patters which points towards the larger role of PCP in this sector. The share of the component that is eventually exported and consumed by other countries on the other hand rises initially (right panel in figure 4.5), but then experiences a persistent decline.

Figure 4.2: Response of total and intermediate bilateral exports from non US exporters to non-US importers in response to a shock

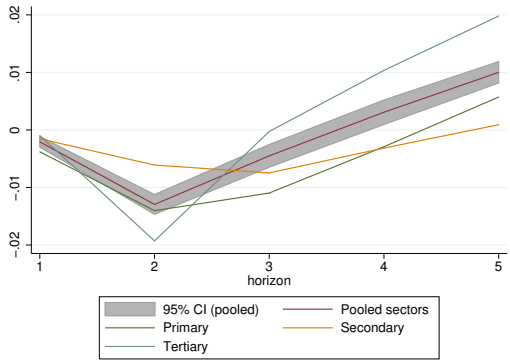
(a) Total bilateral exports (real)



(b) Total bilateral intermediate goods exports (real)



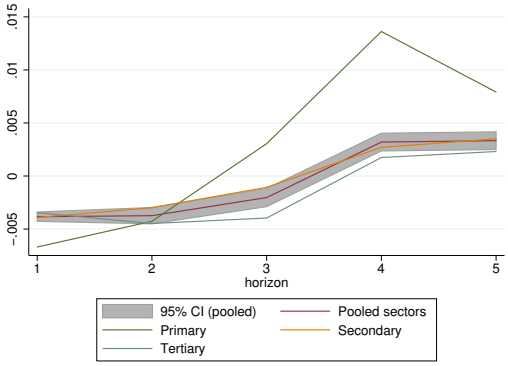
(c) Ratio of value added to gross exports



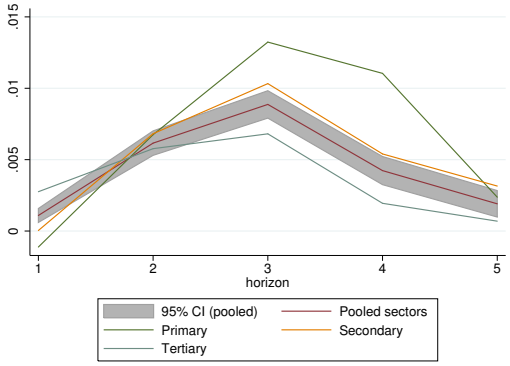
Notes: Percentage deviations from steady state. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure 4.3: Response of intermediate exports used by direct importer to produce final goods..

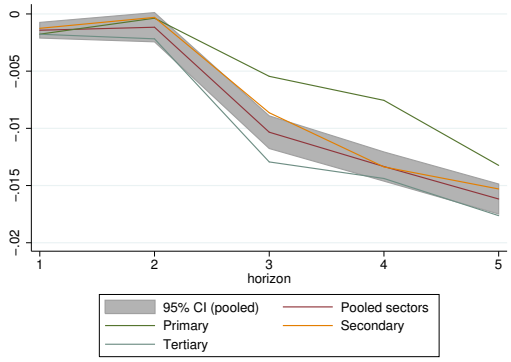
(a) ..consumed domestically (i.e by the direct importer)



(b) ..exported to third countries



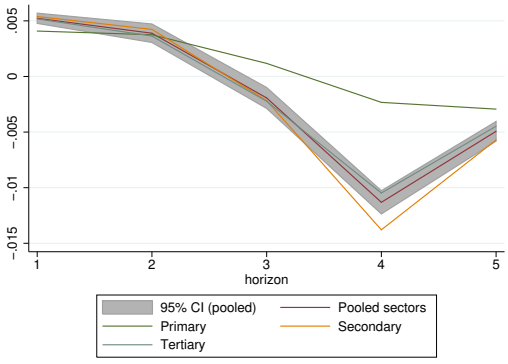
(c) ..exported back to the source country



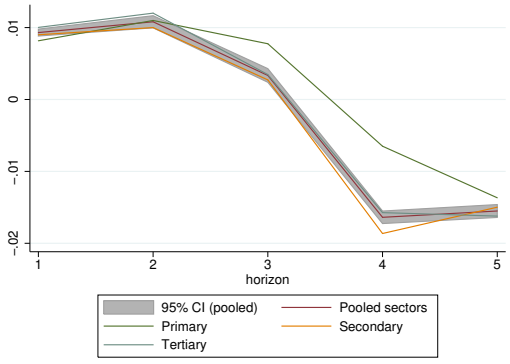
Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure 4.4: Response of intermediate exports first used by direct importer to produce intermediate goods exports then used by third countries to produce final goods..

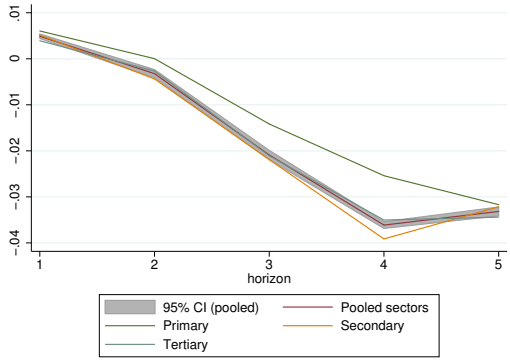
(a) ..consumed domestically (by third country)



(b) ..exported final goods consumed by countries other than the source country(exporting country)



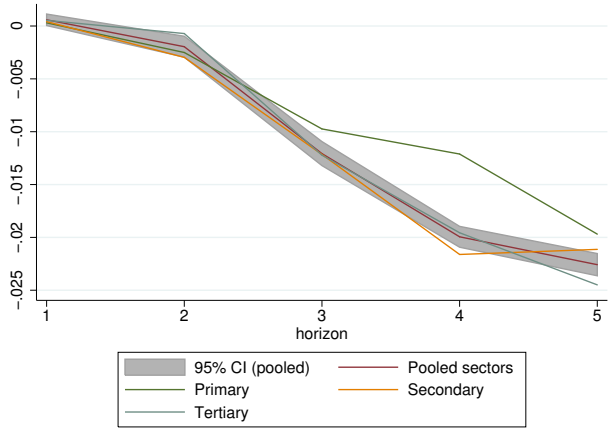
(c) ..exported final goods consumed by the source (exporting) country



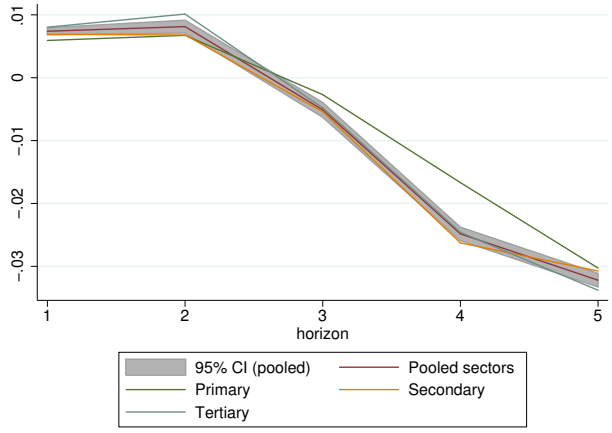
Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure 4.5: Response of intermediate exports first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods

(a) ...domestic final goods consumed by the source (exporting) country



(b) ..exported final goods consumed by other countries



Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

In summary, while not all of the above patterns that are perfectly in line with the predications of the model, on the whole, these results can be categorized as being broadly supportive of the predictions of the model vis-a-vis the distinction between the response of final goods trade and supply chain oriented trade to external shocks.[8]

[8]Appendix B discusses how these patterns differ quantitatively across European and non European countries in the sample, but are qualitatively similar in most cases.

5. Conclusion

Contrary to most mainstream open economy models that build on the Mundel-Flemming framework, international trade is primarily invoiced in a handful of global currencies, primarily the US dollar. In this paper we explore the implications of such pricing frictions for the business cycle dynamics of different types of international trade flows in a general equilibrium setting. To this end, we set up a three-country model which comprises of two small open ("regional") economies which interact with each other and with a large "global" economy through international trade. All economies export final goods to each other which are consumed directly by consumers in the importing country. In addition, recognizing the rising role of trade in intermediate inputs and global value chains in international trade, we also allow the two small open economies to export intermediate goods to one another. These intermediate imports are used by the importer for subsequent processing, and the final product is exported to the global economy, thereby representing a stylized global value chain within the model.

The key insight that emerges across different versions of the model is that in response to both internal and external shocks, the model has notably different implications for final goods trade on the one hand, and global value chain oriented trade on the other. For example, a monetary contraction in the global economy leads to a depreciation of the currencies of both small open economies. Since in the benchmark model, all exports, irrespective of their country of origin, are priced in dollars, they become more expensive for the regional economies. Final consumers in these economies therefore substitute away from imports and towards the respective domestically produced goods, leading to a drop in final goods exports between the two small open economies. However, exports tied to global value chains are also affected by the implications of the shock on demand coming from the global economy, which rises in this case due to the appreciation

of the global currency in real terms. These trade flows therefore decline by less, and under alternate monetary frameworks (for instance under fixed exchange rates) can even rise.

To test the implications of the model in the data, we exploit the most granular classification framework available to decompose bilateral trade at the sector level for 35 sectors in 39 countries into different components based on the degree of involvement in supply chains and international border crossings involved in the production process. Specifically, focussing on trade flows between two foreign countries in response to changes in US interest rates, we use the decomposition of gross bilateral exports in Wang, Wei and Zhu (2013) to show that components of international trade flows that are global value chain oriented and cross international borders multiple times are less affected than final goods, or trade flows that are more regional in nature. These patterns are particularly stark for goods in the primary sector (agriculture, food production and mining).

These results highlight several interesting points with regard to policy implications. For instance, the cushioning role played by global value chain trade in response to external interest rate shocks could be a phenomenon than can be exploited by policymakers seeking to stabilize fluctuations. This in turn can be an important rationale for countries to promote participation in global value chains through different policy levers like industrial policy and easing restrictions on foreign direct investment which is typically of the "vertical" type in emerging markets.

With regard to monetary policy, these results re-enforce the message that flexible exchange rates (either through a PPI or CPI target) continue to remain a superior alternative to fixed exchange rates, even with the dominance of global currencies in trade invoicing. While fixed exchange rates do help cushion the burden on sectors involved in global value chains, this comes at a much higher

cost for the rest of the economy which manifests itself in sharper declines in output, consumption and employment.

In addition to the nature of price setting and monetary policy frameworks, these results also highlight the importance of considering the general equilibrium implications of shocks that lead to exchange rate changes, and caution against the use of the exchange rate as the sole metric for analyzing the impact of external disturbances on an economy.

The analysis conducted in this paper highlights several interesting avenues for future exploration. Firstly, while we zero in and focus on the role of dollar invoicing in international trade, the dollar also happens to be the currency in which most international financial transactions, including debt contracts, are denominated. Understanding this role of the dollar, particularly dollar denominated debt, in affecting ordinary and global value chain trades and how this interacts with the mechanisms in the paper that arise through currency invoicing would be a topic of interest for future investigation. Secondly, while the paper focusses exclusively on positive aspects to highlight key mechanisms, the results naturally inspire an exploration of optimal monetary policy in a world with global value chains and currency invoicing frictions.

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Appendix

A. Robustness Checks

In this section we compare the response of the benchmark economy to an asymmetric monetary policy shock under a couple of alternate scenarios with regard to price setting and platform export specification.

A.1 Pricing Model

First, we assume the regional distribution firms price in the customer's country currency; only global exporters continue to price in global dollars. For exports to the global economy, prices are sticky in global dollars; for exports to the regional

trading partner, the price is in the regional trading partners currency. Relative to the benchmark model, we re-write the price for domestic materials. This model replaces (2.5) and (2.11) with:

$$\frac{CM_t^j}{CR_t^j} = (1-b)\cdot\left(\frac{IPI_t^{\neq j}}{RPI_t^j}\right)^{-\psi} \qquad \frac{VM_t^j}{V_t^j} = (1-d)\cdot\left(\frac{IPI_t^{\neq j}}{MCV_t^j}\right)^{-\nu} \tag{A.1}$$

Replace pricing equation (2.18)

$$\overline{ipi}_t^j = \tau\frac{\phi}{\phi-1}\frac{\sum_{n=0}^{\infty}(\beta\kappa)^n\left[\Omega_{t+n}^j EX_{t+n}^j IPI_{t+n}^{j\phi}\right]\cdot MCY_{t+n}^j\cdot\frac{S_{t+n}^{\neq j}}{S_{t+n}^j}}{\sum_{n=0}^{\infty}(\beta\kappa)^n\left[\Omega_{t+n}^j EX_{t+n}^j IPI_{t+n}^{j\phi}\right]} \tag{A.2}$$

Optimal pricing is a weighted average of domestic marginal cost converted to the trading partner's currency. The principal difference in the pricing is the exchange rates in global dollars do not immediately pass through into inter-regional trade. We refer to this as the *Local Currency Pricing (LCP)* model.

An alternative pricing mechanism would be when every distribution firm prices in their own currency. This changes the demand curves, equilibrium and pricing. Replace the demand for imports (2.5) and (2.11) and import demand (2.22) with :

$$\begin{aligned}
\frac{CM_t^j}{CR_t^j} &= (1-b)\cdot\left(\frac{S_t PPI_t^{\neq j}}{S_t^{\neq j} RPI_t^j}\right)^{-\psi} \\
\frac{VM_t^j}{V_t^j} &= (1-d)\cdot\left(\frac{S_t PPI_t^{\neq j}}{S_t^{\neq j} MCV_t^j}\right)^{-\nu} \\
WM_t^j &= f\cdot\left(\frac{XPI_t^j}{S_t^j P_t^W}\right)^{-\varsigma}\cdot Y_t^W
\end{aligned}$$

Replace equilibrium (2.23) with:

$$CH_t^j + VH_t^j + CM_t^{\neq j} + VM_t^{\neq j} = H_t^j = \left[\int h_{l,t}^{\frac{\phi-1}{\phi}} dl\right]^{\frac{1}{1-\phi}} = \frac{Y_t^j}{DH_t^j}$$

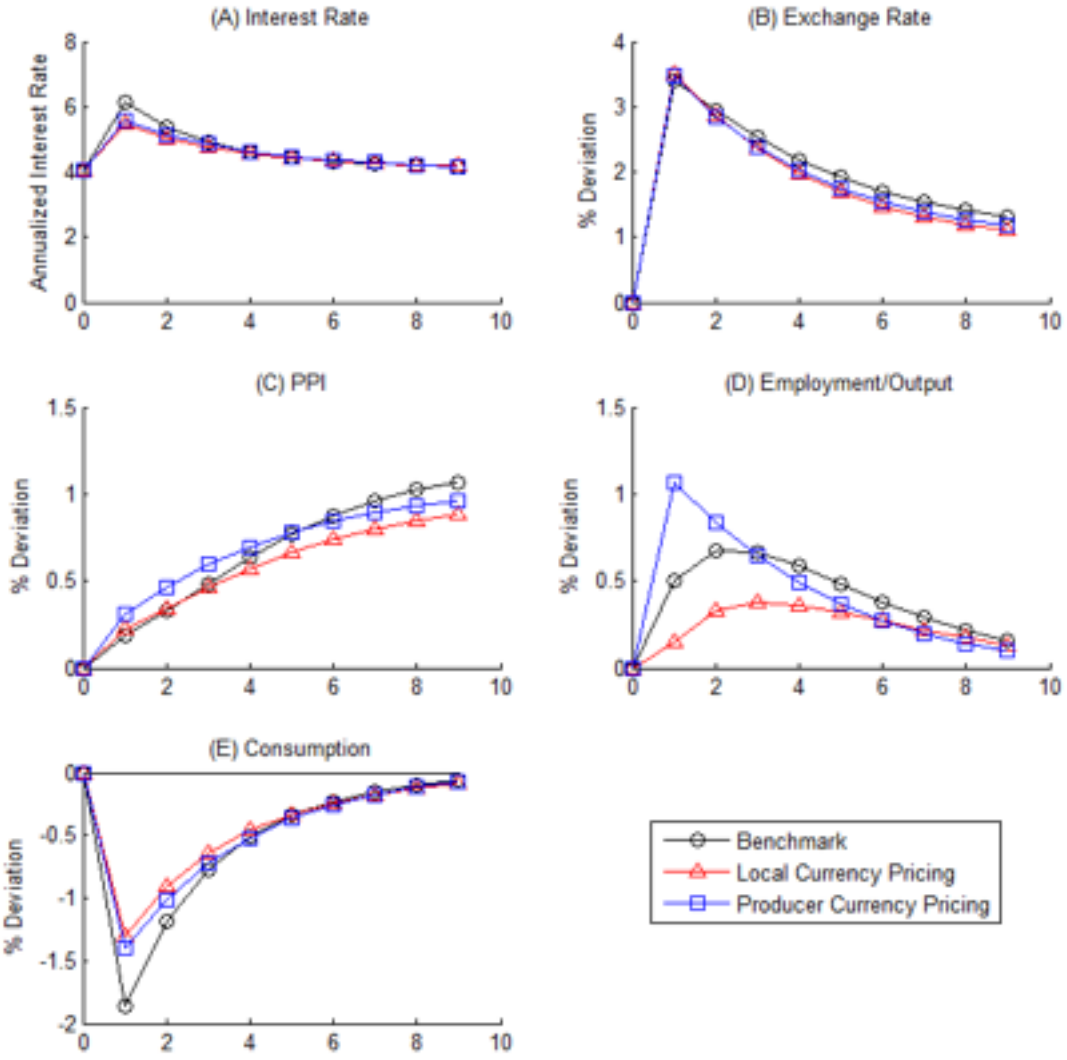
and replace pricing (2.20)

$$\overline{xpi}_t^j = \tau \frac{\phi}{\phi-1} \frac{\sum_{n=0}^{\infty} (\beta\kappa)^n \left[\Omega_{t+n}^j WIM_{t+n}^j XPI_{t+n}^{j\phi}\right] \cdot MCV_{t+n}^j}{\sum_{n=0}^{\infty} (\beta\kappa)^n \left[\Omega_{t+n}^j WIM_{t+n}^j XPI_{t+n}^{j\phi}\right]}$$

Optimal pricing of global exports are a weighted average of domestic currency marginal cost. All exchange rates passthrough into import prices immediately. We refer to this as the *Producer Currency Pricing (PCP)* model.

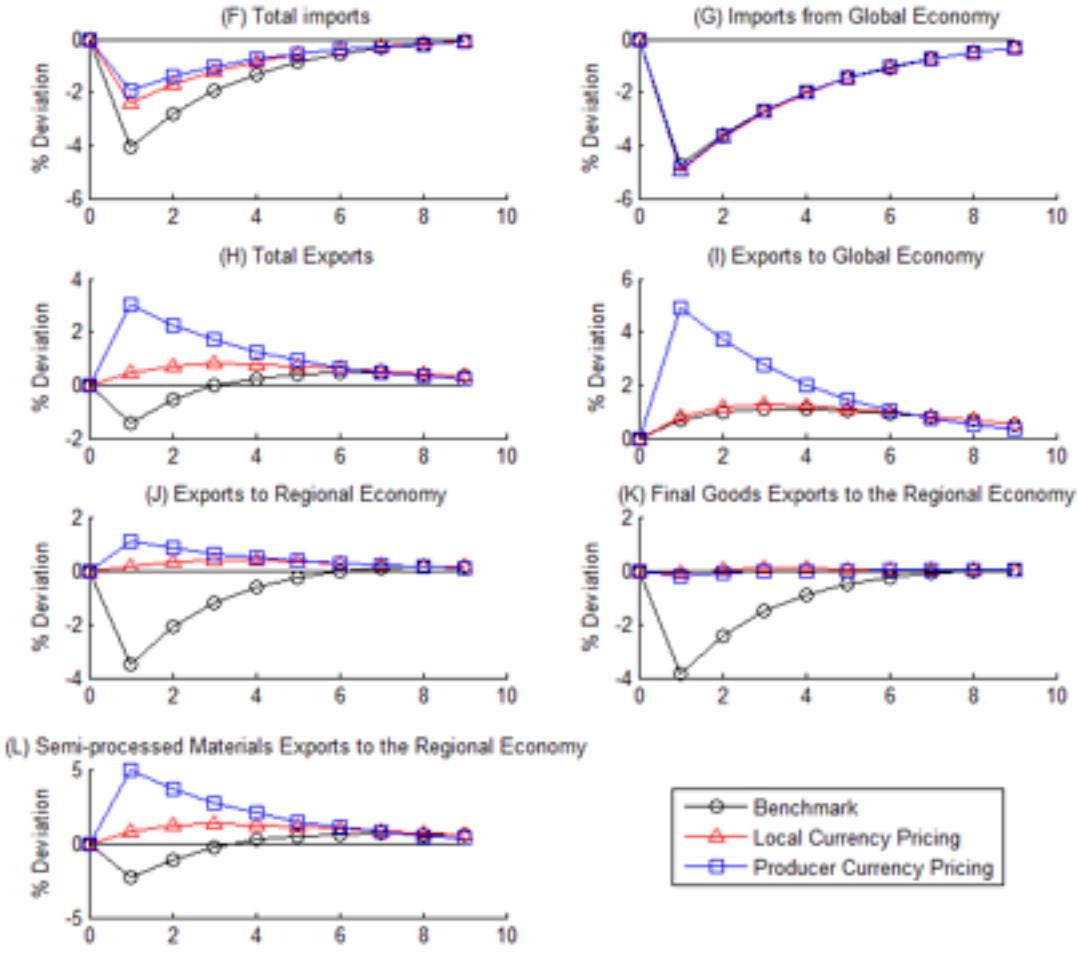
Figure A.1 shows the response of each regional economy to an external interest rate shock under the different pricing models. The figure compares the response under the Local Currency Pricing and Producer Currency Pricing models with the response under the benchmark global Dollar Currency Pricing model. The rise in the external interest rate leads to an exchange rate depreciation under all pricing models as in the benchmark. The depreciation passes through into import prices from the global economy and therefore into the CPI. The policy rate rises temporarily with CPI inflation. The nominal expansion under all specifications leads to a persistent increase in producer prices. This leads to an expansion in employment and output under all pricing models though there is some difference among the pricing models. Consumption declines under all specifications due to the increase in real interest rates. Under Local Currency Pricing, there is little incentive to switch toward domestic value added in final goods consumption, so the impact on domestic output is mitigated relative to

Figure A.1



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three specifications of the pricing of regional trade: a) the Benchmark dollar currency pricing; b) Local Currency Pricing in the currency of the importer; c) Producer Currency Pricing in the currency of the exporter. This part shows the response of domestic interest rates and exchange rates with the global currency, producer prices, domestic output, and consumption.

Figure A.1: cont.



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three specifications of the pricing of regional trade: a) the Benchmark dollar currency pricing; b) Local Currency Pricing in the currency of the importer; c) Producer Currency Pricing in the currency of the exporter. This part shows the response of aggregate imports, imports from the global economy, aggregate exports, exports to the global and regional economies, and regional exports by use.

the Benchmark model. As shown in the next figure, there is a sharp export expansion under Producer Currency Pricing which leads to a sharp increase in domestic output.

There are sharper differences in the dynamic response of international trade patterns. In Figure A.1, Panel F we see the decline of aggregate imports is stronger in the benchmark model than in the other specifications. Panel G shows that the response of imports from the Global economy are nearly identical suggesting differences in imports are due to differences in the response of regional trade. The response of aggregate exports is contractionary in the benchmark model, but expansionary in the other specifications (see Panel G). The much larger expansion in exports (see Panel H) that occurs under Producer Currency Pricing is due to the expansion in exports to the global economy (see Panel I). The exchange rate depreciation makes exports to the global economy immediately more competitive. Under the Benchmark and Local Currency Pricing specifications, exports to the global economy expand only mildly.

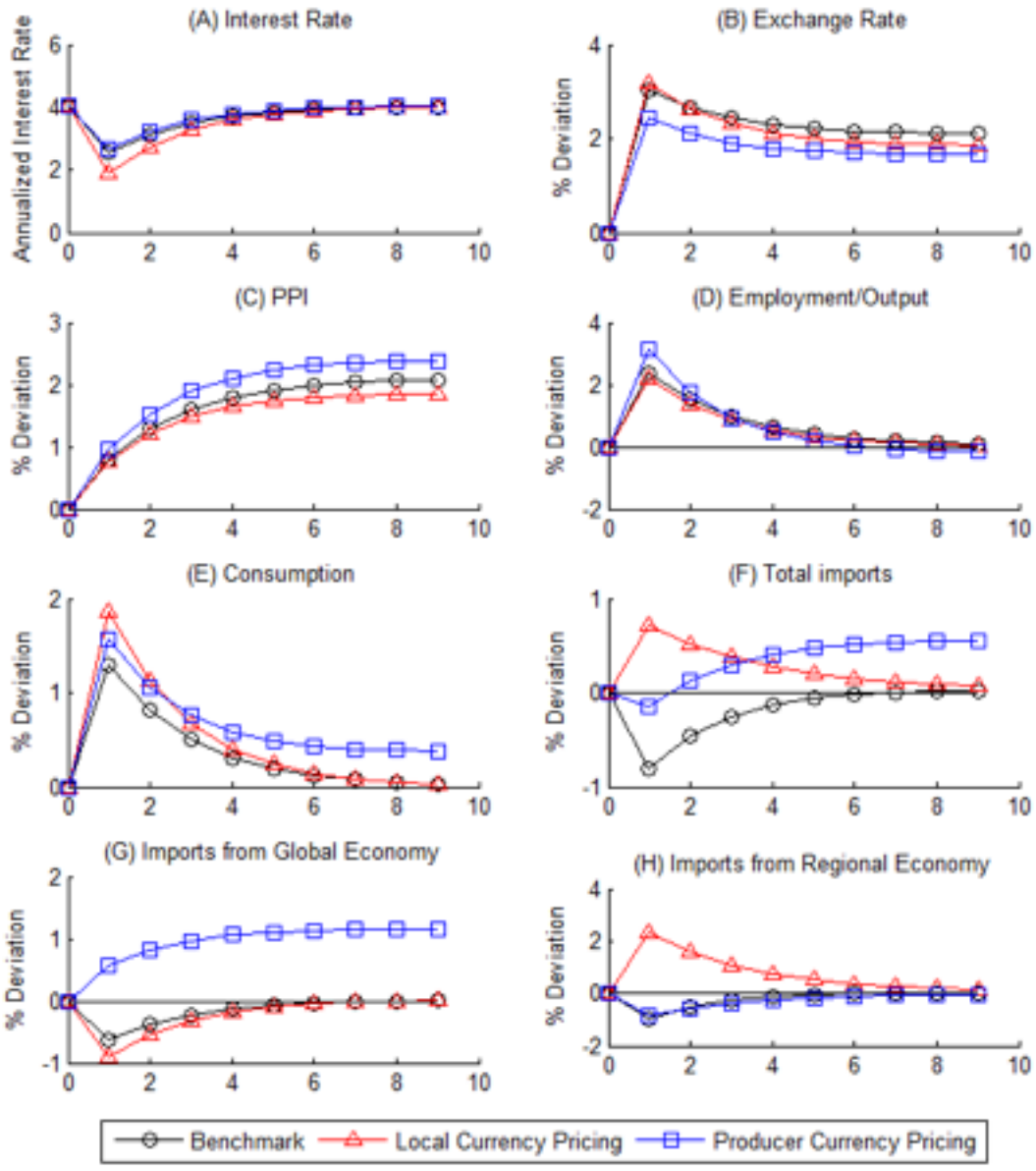
There are stark differences in the response of exports to (and imports from) the regional trading partner (see Panel J). Under the Benchmark, regional exports decline because of the immediate pass-through of the importing partner's economy against the global currency which makes regional exports priced in global currency more expensive. By contrast, under PCP and LCP regional exports mildly expand. This is not true for final goods; since the two regional trading partners do not depreciate or appreciate against each other, the effects on regional final goods exports are small (see Panel K). However, exports of materials expand under PCP due to their use in exports to the global economy which are expanding. Under LCP, exports of materials to the regional value chain expand mildly to suit the mild expansion of global imports (See Panel L).

We also consider the effect of a 1% ceteris parabis monetary shock to Coun-

try A's CPI targeting rule with partner Country B engaging in a passive CPI target. Figure A.2 shows the response of Country A to the monetary shock under the different pricing models. The figure compares the response under the Local Currency Pricing and Producer Currency Pricing models with the response under the benchmark global dollar currency pricing model. Though there are minor differences in the aggregate response under the different pricing models, the principal difference is in the response of the pattern of international trade (see Figure A.2 Panel A-E).

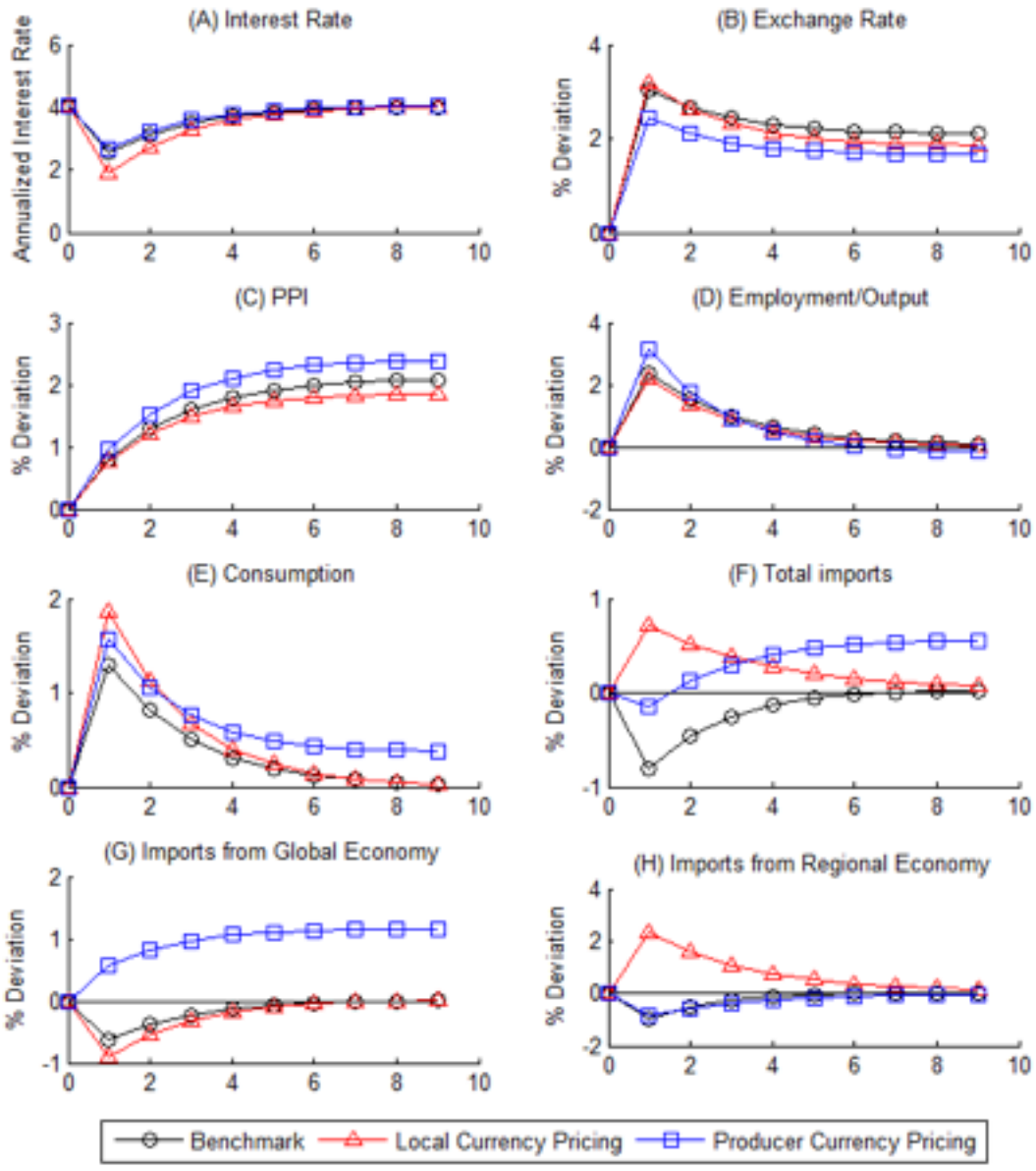
In Figure A.2, Panel F we see the response of imports is qualitatively different under the different pricing models. Under the Benchmark, imports contract; under Local Currency Pricing, imports expand; while under Producer Currency Pricing, there is a mild initial contraction coupled with a longer term expansion. There are two channels impacting imports. First, aggregate consumption demand expands in Country A (see panel E). Second, the exchange rate relative to the international economy (and the passive regional trading partner, Country B) depreciates more than producer price index inflates (see panel B and C). This potentially leads to a change in relative prices. Panel G and H show the response from imports from the global and regional economy. We see that under LCP as under the Benchmark, imports from the global economy decrease as under the Benchmark but imports from the regional economy expand. The exchange rate depreciation passes through directly into the price of imports from the global economy but not into prices from the regional economy under LCP. As a result of this pricing model, imports from the regional economy expands approximately proportionately with aggregate demand. Conversely, the pass through of depreciation causes global imports to experience some decline. Under PCP, depreciation passes through into all export and import prices immediately. Since imports from the regional economy decline are a direct substitute for domestic

Figure A.2



Notes Impulse responses of a regional economy to an expansionary interest rate cut. The response of the small open economy engaging in expansionary monetary policy is examined under three specifications of the pricing of regional trade: a) the Benchmark dollar currency pricing; b) Local Currency Pricing in the currency of the importer; c) Producer Currency Pricing in the currency of the exporter. These figures assume a passive CPI target by the other trading partner. This part shows the response of domestic interest rates and exchange rates with the global currency, producer prices, domestic output, and consumption. In addition, this figure shows total imports, imports from the global economy and imports from the regional economy.

Figure A.2: cont.



Notes: Impulse responses of a regional economy to an expansionary interest rate cut. The response of the small open economy engaging in expansionary monetary policy is examined under three specifications of the pricing of regional trade: a) the Benchmark dollar currency pricing; b) Local Currency Pricing in the currency of the importer; c) Producer Currency Pricing in the currency of the exporter. These figures assume a passive CPI target by the other trading partner. This part shows the response of regional imports by use, aggregate exports, exports to the global and regional economies, and regional exports by use.

production which is expanding, global imports mildly increase but regional imports decline. This pattern is reflected in final goods imports from the regional economy (see Figure A.2 Part ii, Panel I).

Semi-processed materials imports decline sharply in the Benchmark economy but only mildly under PCP. Under both pricing models, regional imports become immediately more expensive due to exchange rate depreciation. However, under producer currency pricing, the exchange rate pass through also passes through into export prices. As a result, exports expand across the board in all categories as they become more competitive, while there is minimal impact on exports under Local Currency Pricing or benchmark global dollar currency pricing (see Panel K-O). The expansionary response of exports to the global economy under PCP buoys imports of semi-processed materials (see Panel O).

A.2 Platform Exports Specifications

We also compare the Benchmark model with models with different structures for inter-regional trade of semi-processed materials for the global market. First, we drop the assumption that domestic value added industries and export platforms are separate industries that interact through sticky price domestic firms. Instead we assume that competitive firms jointly produce value for domestic final goods firms, regional exports and semi-processed materials for export to the global economy. Optimal choice of semi-processed materials replaces (2.11) with:

$$\frac{VH_t^j}{V_t^j} = d \cdot \left(\frac{MCY_t^j}{MCV_t^j} \right)^{-\nu} \tag{A.3}$$

so that domestic materials are sourced at marginal cost. Equilibrium is given by

$$CH_t^j = H_t^j \qquad DH_t^j \cdot H_t^j + DX_t^j \cdot EX_t^j + VH_t^j = Y_t^j \tag{A.4}$$

We refer to this as the *Unified Industry* model.

We also construct a model in which there is no cross-regional trade in semi-processed goods. Instead, export demand (2.22) is replaced by

$$WM_t^j = f \cdot \left(\frac{IPI_t^j}{P_t^W} \right)^{-\varsigma} \cdot Y_t^W \tag{A.5}$$

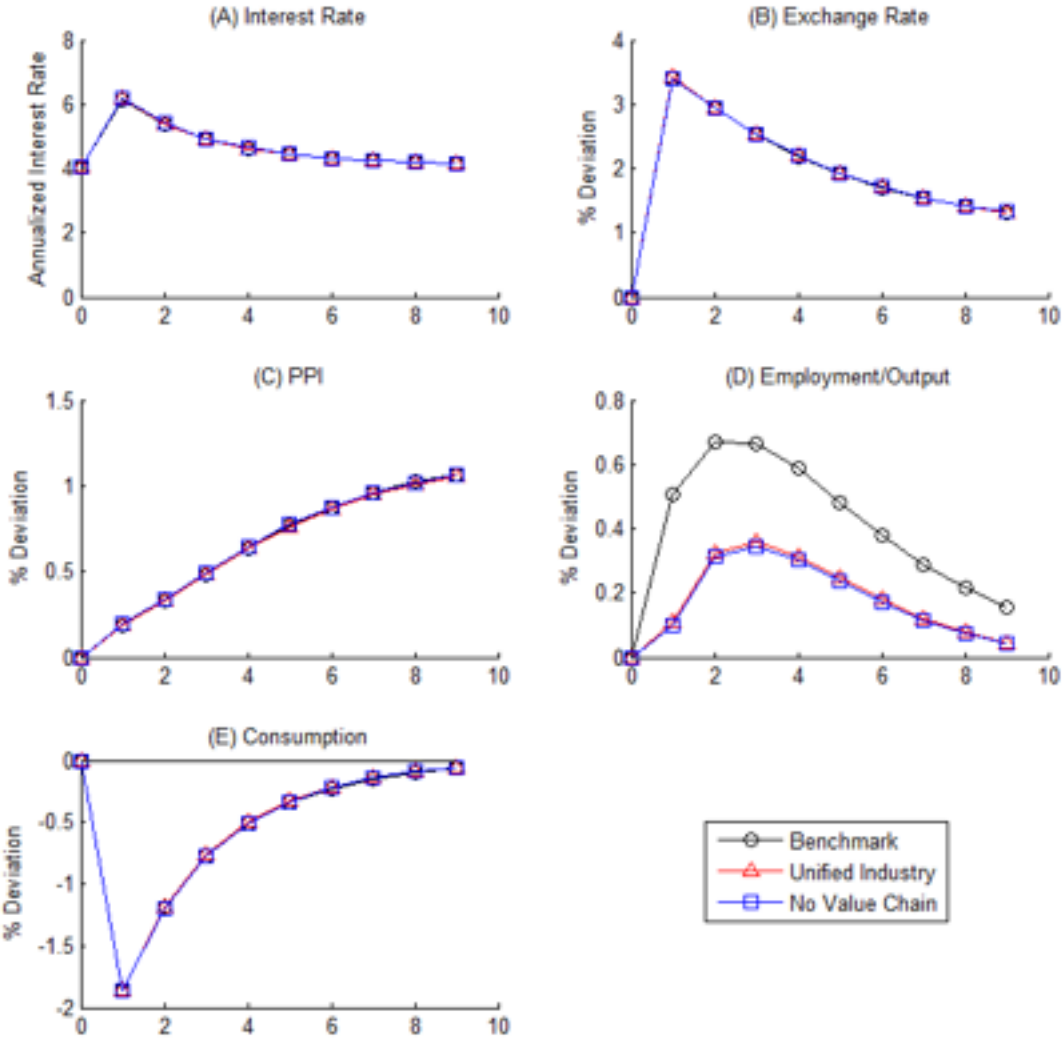
and equilibrium exports (2.13) is

$$CH_t^j = H_t^j \qquad CM_t^{\neq j} + WM_t^j = EX_t^j \tag{A.6}$$

We refer to this as the *No Value Chain* model.

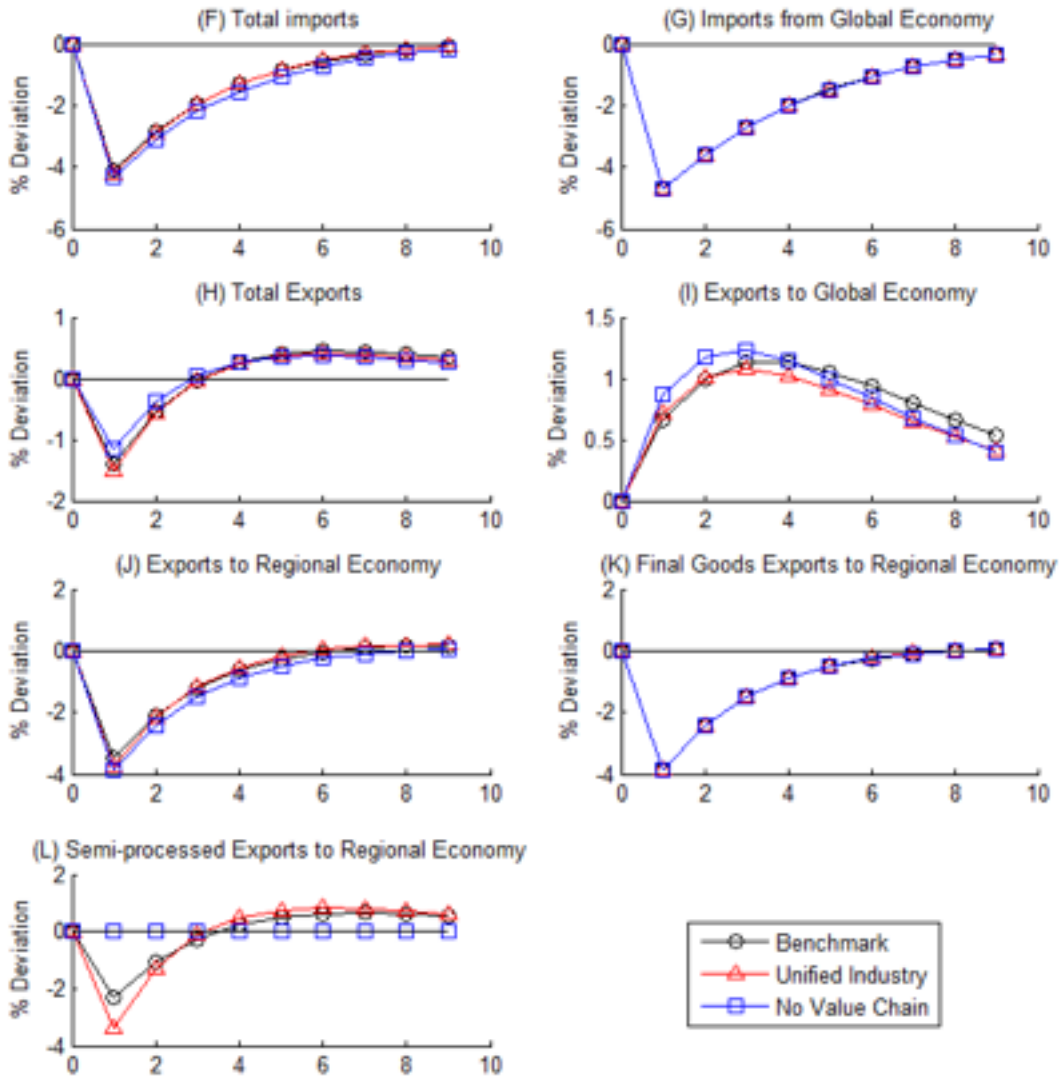
Figure A.3 shows the symmetric response of each regional economy to an external interest rate shock under the different export models. The nature of the export industry has little impact on the dynamic response of the exchange rate, CPI inflation or the response of the policy interest rate (see Panel A-C). Given the rise in the real interest rate, there is a persistent contraction in consumption (see Panel E). However, domestic output increases as the passthrough of exchange rates into final goods imports cause domestic consumers to substitute domestic value added (see Panel D). This occurs more strongly in the Benchmark model as the export platform sector in this specification shifts toward domestic value added when the exchange rate depreciation versus global currency makes regional materials imports less competitive. In the Unified Industry model, the nominal expansion flows directly into the cost of domestic value added leading

Figure A.3



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three specifications of the structure of the export platform: a) the Benchmark in which a distinct export industry purchases regional and domestic value added subject to pricing friction; b) Unified Industry in which the export platform imports regional materials but produces its own value added not subject to pricing frictions; and c) No Value Chain where global exports use only domestic value added. This part shows the response of domestic interest rates and exchange rates with the global currency, producer prices, domestic output, and consumption.

Figure A.3: cont.



Notes: Symmetric impulse response of either small regional economy to a persistent rise in the external interest rate in the global economy. The response is examined under three specifications of the structure of the export platform: a) the Benchmark in which a distinct export industry purchases regional and domestic value added subject to pricing friction; b) Unified Industry in which the export platform imports regional materials but produces its own value added not subject to pricing frictions; and c) No Value Chain where global exports use only domestic value added. This part shows the response of aggregate imports, imports from the global economy, aggregate exports, exports to the global and regional economies, and regional exports by use.

the platform export sector to shift very little toward domestic value added. In the No Value Chain specification, there is no option of shifting away from imported materials in the platform sector.

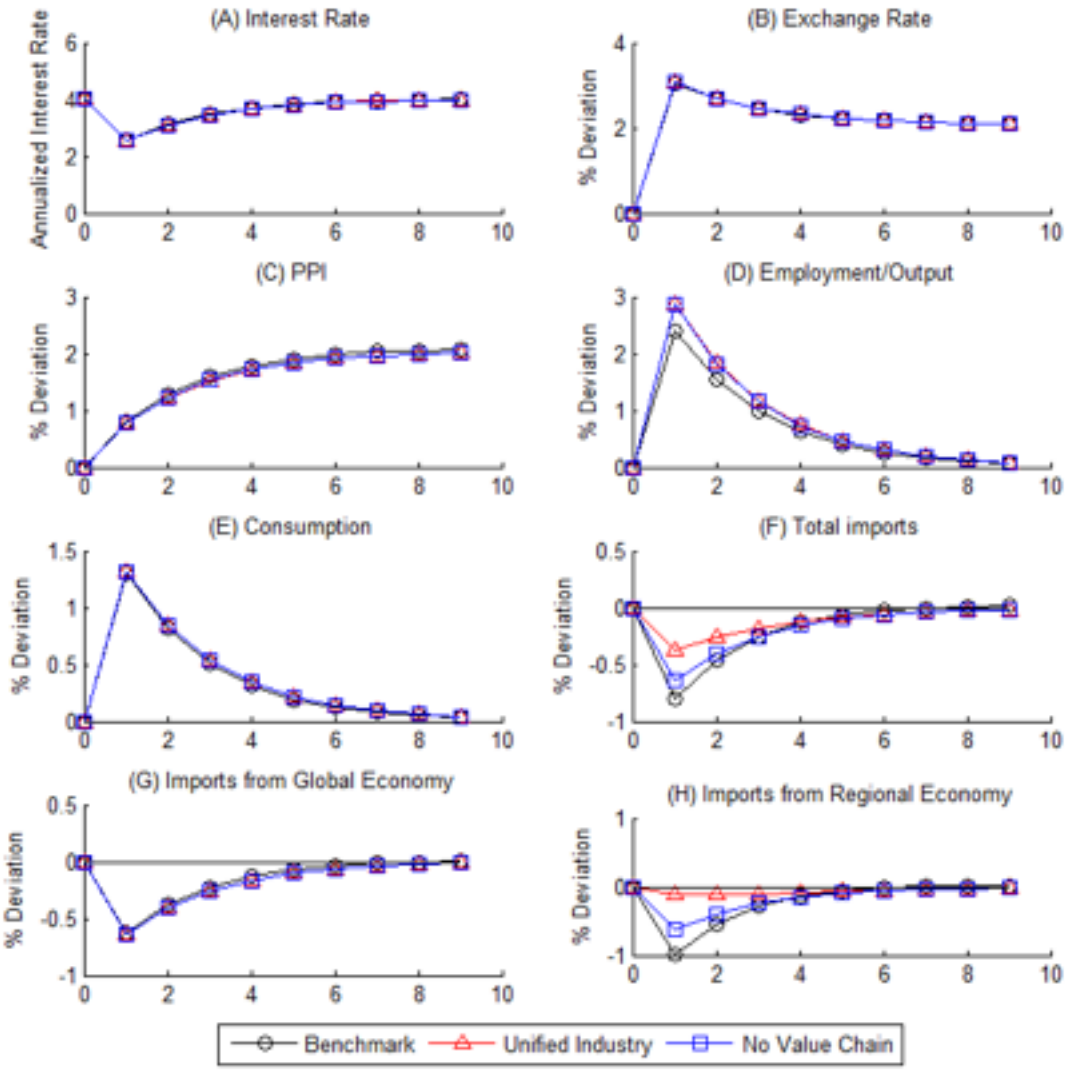
Figure A.3 also shows the impact on international trade. Panel F shows there is little difference in the response of imports. The response of imports from the global economy are essentially identical (see Panel G). In all of the models, the dynamic response of exports is contractionary though this is somewhat weaker in the model in the No Value Chain model and sharpest in the Unified Industry model (see Panel H). Exports of final goods either to the global economy (see Panel I) or the regional trading partner (see Panel K) are fairly similar. In the Benchmark model, the exchange rate depreciation versus the global currency reduces the competitiveness of materials trade in the value chain. The increase in interest rates and decline in consumption increases labor supply; the resulting decline in wages passes directly into the costs of domestic value added in the Unified Industry model. In the Unified Industry specification, this exacerbates the shift in the export platform toward domestic value added in the Unified Industry model relative to the Benchmark (see Panel O).

Figure A.4 shows the response to an asymmetric monetary policy shock to the CPI targeting rule in Country A (as in Figure 3.2 and A.2) under the Benchmark economy along with the response to an identical shock in the Unified Industry model and the No Value Chain. Again, all of the model show a similar domestic economy response to the monetary policy shock as the Benchmark (see Panels A-E). Figure 6, Panel F shows the contraction of imports are somewhat milder under the alternative models relative to the Benchmark. Panel G and Panel I show that final goods imports from the global economy and the regional trading partner respond similarly to the Benchmark model. However, there is some change in the response of materials imports as shown in Panel J. In

the Benchmark model, imports of semi-processed materials sharply decline in the Benchmark model. Obviously, this response does not occur in the No Value Chain model. Conversely, materials imports sharply expand in the Unified Industry model. Though materials imports are priced in global dollars and Country A's depreciation makes these more expensive. However, the combination of nominal expansion and real expansion increases the marginal cost of producing goods in country A, MCY_t^A, increase even more. Imported materials are substituted for domestic value added. his means that regional imports decline least under the Unified Industry model than in the other models (see Panel H).

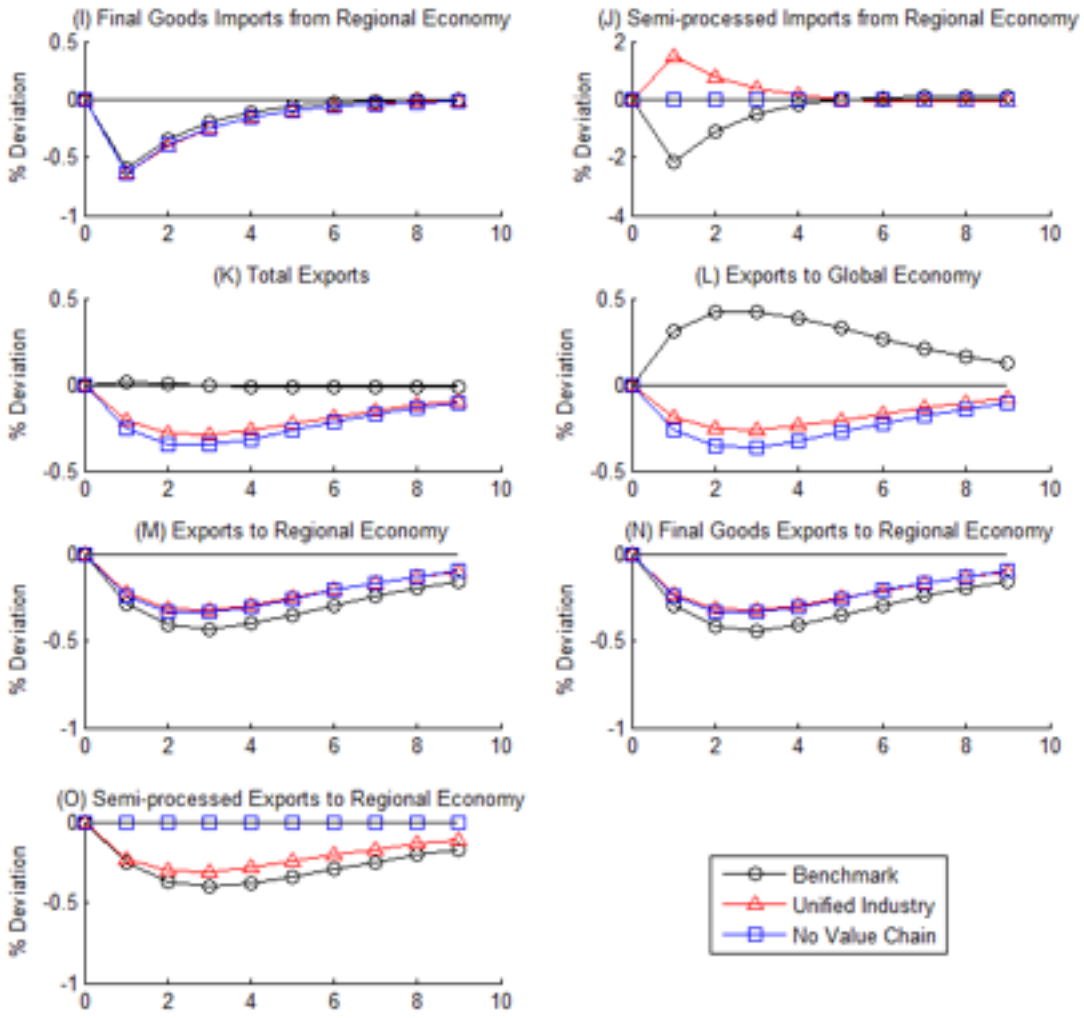
The alternative models also imply differences for the response of exports. In the Benchmark model, exports to the global economy persistently expand (see Panel L) . In the alternative models, exports to the global economy contract. In the Benchmark model, the price of domestic value added in the platform is sticky; combined with the exchange rate depreciation, the price of exports to the global economy becomes more competitive. In the Unified Industry model, the marginal cost of this value added increases faster than the exchange rate depreciates. This cost increase passes through into export prices and global exports decline. Similarly, in the No Value Chain model, the increase in value added marginal cost, slowly passes through into export prices making exports less competitive. Exports to the regional economy (see Panel M-O) are not much impacted by the shock since the importing country does not depreciate relative to the global dollar currency.

Figure A.4



Notes: Impulse responses of a regional economy to an expansionary interest rate cut. The response of the small open economy engaging in expansionary monetary policy is examined under three specifications specifications of the structure of the export platform: a) the Benchmark in which a distinct export industry purchases regional and domestic value added subject to pricing friction; b) Unified Industry in which the export platform imports regional materials but produces its own value added not subject to pricing frictions; and c) No Value Chain where global exports use only domestic value added. These figures assume a passive CPI target by the other trading partner. This part shows the response of domestic interest rates and exchange rates with the global currency, producer prices, domestic output, and consumption. In addition, this figure shows total imports, imports from the global economy and imports from the regional economy.

Figure A.4: cont.



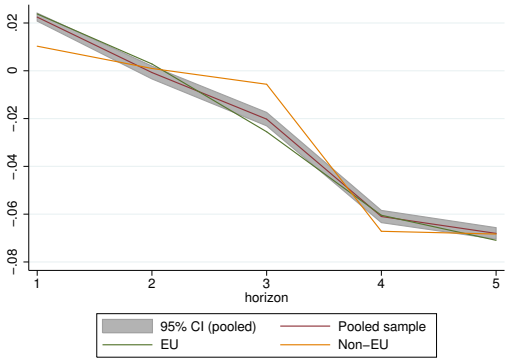
Notes: Impulse responses of a regional economy to an expansionary interest rate cut. The response of the small open economy engaging in expansionary monetary policy is examined under three specifications specifications of the structure of the export platform: a) the Benchmark in which a distinct export industry purchases regional and domestic value added subject to pricing friction; b) Unified Industry in which the export platform imports regional materials but produces its own value added not subject to pricing frictions; and c) No Value Chain where global exports use only domestic value added. These figures assume a passive CPI target by the other trading partner.

B. Additional empirical results: Exploring heterogeneity across European and non European countries

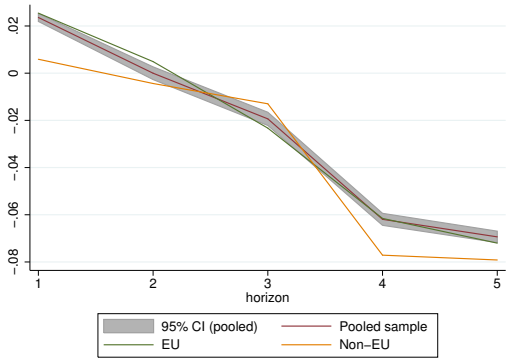
With the goal of checking the robustness of the results as well as understanding the differences in patterns across countries, we replicate the impulse responses in figures 4.2-4.5 for the pooled sample and augment it with a sample that includes only European countries (12 non European countries and 27 European countries in the sample (see Appendix C for the full list). Figures B.1-B.4 show the results. The key messages from this exercise can be summarized as follows. Firstly, reflecting the dominance of European countries in our sample, full sample (pooled) results are driven to the larger extent by this group, as is evident in most figures in this section. Secondly, although they differ quantitatively, the results for the two sets of countries are qualitatively in agreement in most cases. There are only two notable exceptions to this pattern, namely the value added to gross exports ratio and the intermediate goods that are used by the importer to produce final goods that are exported to third countries.

Figure B.1: Response of total and intermediate bilateral exports from non US exporters to non-US importers in response to a shock

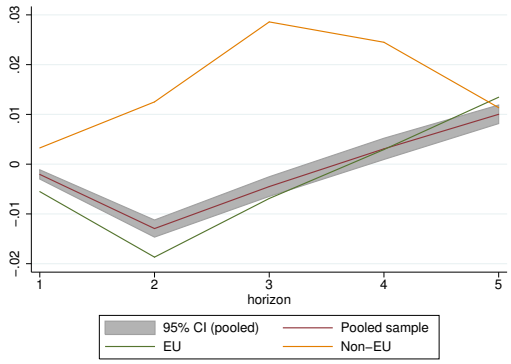
(a) Total bilateral exports (real)



(b) Total bilateral intermediate goods exports (real)



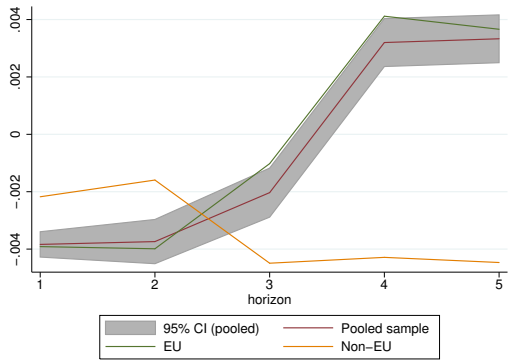
(c) Ratio of value added to gross exports



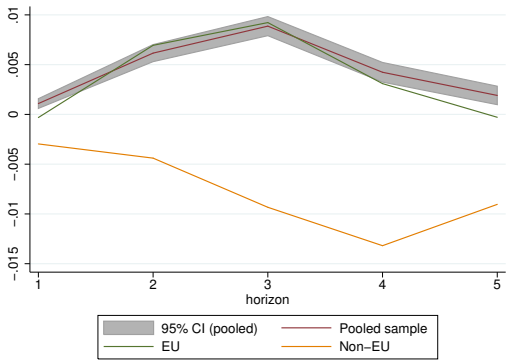
Notes: Percentage deviations from steady state. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure B.2: Response of intermediate exports used by direct importer to produce final goods..

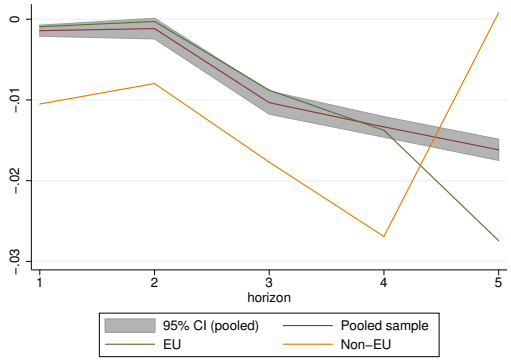
(a) ..consumed domestically (i.e by the direct importer)



(b) ..exported to third countries



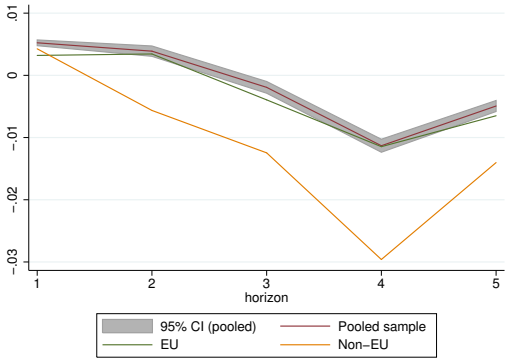
(c) ..exported back to the source country



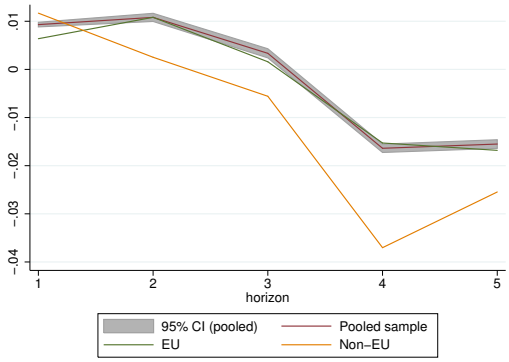
Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure B.3: Response of intermediate exports first used by direct importer to produce intermediate goods exports then used by third countries to produce final goods..

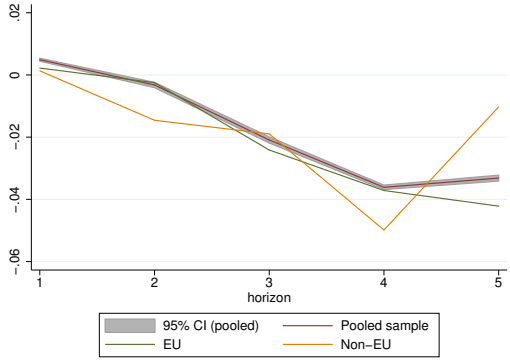
(a) ..consumed domestically (by third country)



(b) ..exported final goods consumed by countries other than the source country(exporting country)



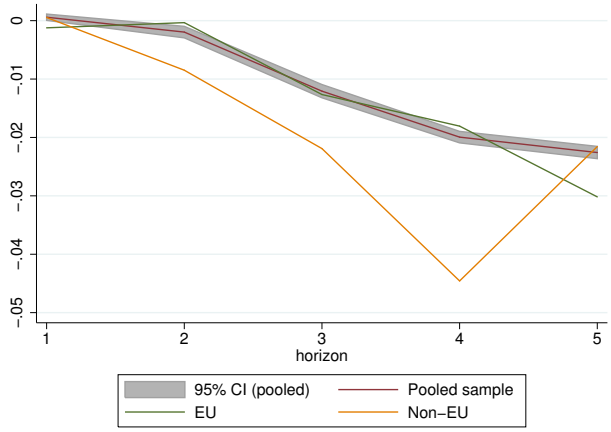
(c) ..exported final goods consumed by the source (exporting) country



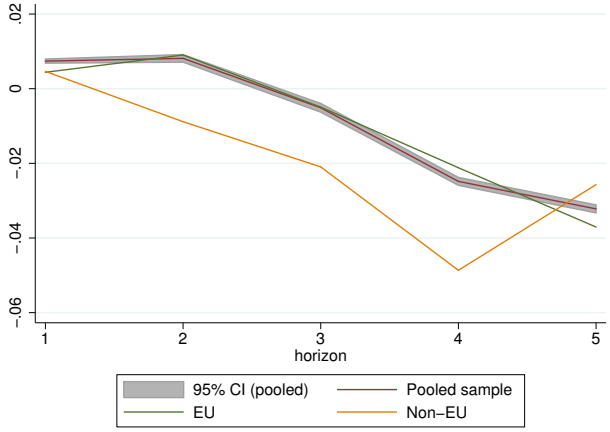
Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

Figure B.4: Response of intermediate exports first used by direct importer to produce intermediate exports shipped back to the source (exporting) country as intermediate imports to produce final goods

(a) ...domestic final goods consumed by the source (exporting) country



(b) ..exported final goods consumed by other countries



Notes: Percentage deviations from steady state. All variables are standardized by total bilateral exports. Lines marked “Primary”, “Secondary” and “tertiary” correspond to a restricted sample with only the indicated sectors included. “Pooled” corresponds to the pooled sample with all sectors. The shaded error band is the 95% confidence interval for the pooled sample.

C. List of countries and sectors

List of countries: Australia (non EU) Austria Belgium Bulgaria, Brazil(non EU) Canada (non EU) China (non EU) Cyprus Czech Republic Germany Denmark Spain Estonia Finland France United Kingdom Greece Hungary Indonesia (non EU) India (non EU) Ireland Italy Japan (non EU) Korea (non EU) Lithuania Luxembourg Latvia Mexico (non EU) Malta Netherlands Poland Portugal Romania Russia (non EU) Slovak Republic Slovenia Sweden Turkey(non EU) Taiwan(non EU) United States (non EU)

Table 2: Sectoral classification and description

WIOD sector	Sector description	NACE code	Broad 3 sector Classification (Primary, secondary and tertiary)
c01	AGRICULTURE, HUNTING, FORESTRY AND FISHING	AtB	Primary
c02	MINING AND QUARRYING	C	Primary
c03	FOOD , BEVERAGES AND TOBACCO	15t16	Primary
c04	Textiles and textile	17t18	Secondary
c05	Leather, leather and footwear	19	Secondary
c06	WOOD AND OF WOOD AND CORK	20	Secondary
c07	PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22	Secondary
c08	Coke, refined petroleum and nuclear fuel	23	Secondary
c09	Chemicals and chemical	24	Secondary
c10	Rubber and plastics	25	Secondary
c11	OTHER NON-METALLIC MINERAL	26	Secondary
c12	BASIC METALS AND FABRICATED METAL	27t28	Secondary
c13	MACHINERY, NEC	29	Secondary
c14	ELECTRICAL AND OPTICAL EQUIPMENT	30t33	Secondary
c15	TRANSPORT EQUIPMENT	34t35	Secondary
c16	MANUFACTURING NEC; RECYCLING	36t37	Secondary
c17	ELECTRICITY, GAS AND WATER SUPPLY	E	Secondary
c18	CONSTRUCTION	F	Secondary
c19	Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel	50	Tertiary
c20	Wholesale trade and commission trade, except of motor vehicles and motorcycles	51	Tertiary

Table 2: Sectoral classification and description cont.

WIOD sector	Sector description	NACE code	Broad 3 sector Classification (Primary, secondary and tertiary)
c21	Retail trade, except of motor vehicles and motorcycles; repair of household goods	52	Tertiary
c22	HOTELS AND RESTAURANTS	H	Tertiary
c23	Other Inland transport	60	Tertiary
c24	Other Water transport	61	Tertiary
c25	Other Air transport	62	Tertiary
c26	Other Supporting and auxiliary transport activities; activities of travel agencies	63	Tertiary
c27	POST AND TELECOMMUNICATIONS	64	Tertiary
c28	FINANCIAL INTERMEDIATION	J	Tertiary
c29	Real estate activities	70	Tertiary
c30	Renting of m&eq and other business activities	71t74	Tertiary
c31	PUBLIC ADMIN AND DEFENSE; COMPULSORY SOCIAL SECURITY	L	Tertiary
c32	EDUCATION	M	Tertiary
c33	HEALTH AND SOCIAL WORK	N	Tertiary
c34	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	O	Tertiary
c35	PRIVATE HOUSEHOLDS WITH EMPLOYED PERSONS	P	Tertiary