Rising China, anxious Asia? A Bayesian New Keynesian view

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\textit{THIS DRAFT: DECEMBER 2012}

Abstract

Should Asia be anxious about China’s expansion? We look for the answer by constructing and estimating a two-country New Keynesian model of production fragmentation on ten Asian economies including China. The estimates show that vis-à-vis China the developed Asia has fragmented production structure to greater extent with higher domestic value added embodied in intermediates traded with China, whereas the developing Asian production chains are less fragmented with more foreign value added. We also find that China’s expansion made possible by favorable demand and price shocks benefit all Asian neighbors. Expansion driven by total factor productivity improvement, however, lifts aggregate value added in developed but not developing Asia, unless the shocks are symmetrically originated in both China and developing Asia. Fixing regional currencies irrevocably to the U.S dollar makes China’s productivity improvement beneficial to all regardless of the nature of shocks, though it is almost irrelevant in the responses to other type of shocks. So, our answer is simply no for developed Asia and conditional no for developing Asia.

\textit{Keywords:} Production fragmentation; Value-added trade; China; New Keynesian model; Bayesian estimation

\textit{JEL classification:} F41, F44
1. **Introduction**

The rise of China as the manufacturing powerhouse and exporting platform has been frequently penned in recent years. It deserves limelight from its Asian neighbors, wherein production and trade have been integrated the most into the world (Amador and Cabral, 2009). To Asian economies, China’s rise means both opportunity and threat. On one spectrum, rapid expansion of China’s processing exports implies greater demand for parts and components from its Asian neighbors. Ianchovichina and Walmsley (2005), for instance, by calibrating and simulating on a computable general equilibrium model, show that China’s WTO accession has crowded in Japan and the East Asian newly industrialized economies that supply materials to China (see Greenaway et al. 2008). On another spectrum, as the main source of labor-intensive value added for United States and the Euro Area, Chinese expansion also triggers displacement effect on the export of developing Asian economies with approximate endowment structure. Eichengreen et al. (2007), for instance, find that while China’s growth is beneficial to advanced East Asian economies exporting capital-intensive goods, the pain is felt by the developing Southeast Asian countries that export labor-intensive goods (see also Wood and Mayer, 2011; Roland-Holst and Weiss, 2004; Haltmaier et al. 2007. Ahearne et al. 2003 show contradictory findings).

Figure 1 neatly visualizes this comrade-or-competitor conjecture. Fast expanding East and Southeast Asian trade with China particularly following China’s accession into World Trade Organization (WTO) in the end of 2001 is obviously accompanied by declining export and import with the United States. Take an example. In the first quarter of year 1990, of total Malaysian exports to the world, China only accounted for 2.3 percent whereas the U.S has digested 18 percent. Just prior to China’s WTO accession, the relative importance of China
steadily climbed to 8 percent although U.S. share still firmly stood at 20 percent. However, within the subsequent eight years China turns out to be the one that has digested 18 percent of Malaysian exports in conjunction with a nose-diving fall in the share of exports to U.S. to a historical low level of 11 percent.

-- [INSERT FIGURE 1 HERE]--

Of question is has China really displaced other Asian countries’ exports to the United States? Or the great trade reshuffling can actually be attributed to the reorganization of values chains in such a way that other Asian countries now export to China for final goods assembly before being exported to the rest of the world (Athukorala, 2007)? Not to forget too that the pattern of exports can be endogenous to other shocks. Shift in U.S consumers’ taste toward Chinese goods, for instance, may cause this great reshuffling in the direction of trade. Permanent favorable China’s productivity shock, for instance, while enhancing its export competitiveness that may have displaced other Asian exports, actually improves regional terms of trade and welfare. In either case, “friend or foe” is an irrelevant narrative.

Instead of examining the export competition, this paper has a larger purpose. We ask two questions: first, what is the bilateral production and trade linkage between China and the rest of Asia? Second, how bilateral fragmentation in production and trade has shaped the responses of Asian neighbors to macroeconomic disturbances on China? To search for the answers, we lay out a medium scale, two-country dynamic New Keynesian model of production fragmentation in Section 2 and take the model in Section 3 to the data on ten Asian countries including China by using Bayesian approach.

Previewing the results in Sections 4 and 5, we show that the value chains of production in advanced Asian economies have been sliced up to greater extent than that in China. This is
perhaps unsurprising as compared to another finding that China has more vertically fragmented production structure vis-à-vis the developing Southeast Asia. As a result, China trades intermediates with the advanced Asia but not with the developing Southeast Asia. While this varied bilateral relationship in production and trade barely has any implications on the impulse responses of Asia to China’s demand and price shocks, it matters for the international transmission of total factor productivity (TFP) shock: the favorable China’s TFP shock lifts aggregate value added in the advanced Asia but not the developing Southeast Asia.

More interestingly, the role of production fragmentation in the pattern and magnitude of responses to shock is influenced by the nature of shock and choice of exchange rate regime. Irrevocable peg of Chinese renminbi to the dollar makes China’s expansion due to whatever reasons beneficial to all countries in the region. Symmetric shock ties the responses of all countries within the value chains, in which the advanced Asia that fragments the most responds to China’s shocks at greater magnitude than the developing Southeast Asia.

2. Setting up a New Keynesian model of production fragmentation and trade

Grounded on the two-country, three-production value chains model first developed in Wong and Eng (in press), in this section we formalize the interaction between China and the rest of Asia. In this model, final goods produced at downstream stage use domestic and imported intermediates manufactured in midstream stage, which in turn, uses domestic and imported intermediates produced in the most upstream stage of production as input of production. As such, a simple global input-output structure is established with outputs of all stages are tradable. Shocks to any value chains will be transmitted across stages and borders. Besides, by reinvesting part of the final goods as capital stock for upstream production, a simple “intermediate loop” is
also established. This parsimonious model is sufficient to account for the most comprehensive breakdown of value added in gross export as advanced in Koopman et al. (2012) and Johnson and Noguera (2012).

The model also incorporates external habit persistence, investment adjustment cost, partial price and nominal wage indexation, and time-dependent price and nominal wage setting mechanism. The model is thus rich enough, as compared to dynamic Ricardian model of Yi (2003), for instance, to investigate dynamic macroeconomic interactions between China and the others. Because decisions made by China’s and the rest of Asian countries are analogous in a two-country model, discussion is thus mainly devoted to China as home economy.

Before detailing the model, it is noteworthy to point out a well-known caveat of two-country model: it can easily overlook the influence of the third country, particularly the role of the U.S. and Euro Area absorption for both China’s and the rest of Asian exports. We take three measures to overcome this limitation. First, we allow the U.S. monetary policy shock to spillover to both regions through uncovered interest rate parity condition. Second, we use observable series on aggregate exports and imports, rather than bilateral trade series, in estimation to accommodate for the potential third-country influence on respective economies through trade. Third, on principle, third-country shock may land on China and the rest of Asia either through the door gate exclusively in China, only rippled upward to other countries via input-output linkage, or concurrently through various stages of production. Hence, we supplement the baseline analysis in a model of vertical production linkage facing asymmetric shocks originated in China with symmetric shocks that resemble the latter channel.

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1 See Liao et al. (2012) for an interesting treatment of three-country interaction within two-country setting.
2.1. Household

Consider a continuum of infinitely-lived households, represented and indexed by \( i \in [0,1] \), that possess the utility function of

\[
U = E_t \left\{ \sum_{t=0}^\infty \beta^t u^C_t \left[ \frac{(C^i_t - bC^i_{t-1})^{1-\sigma}}{1-\sigma} - u^N_t \right] \right\} 
\]

where

\[
C^i_t = \left[ (\gamma)^{\frac{1}{\varphi}} \left( \frac{C^i_{C,t}}{(\varphi-1)})^\varphi + (1 - \gamma)^{\frac{1}{\varphi}} \left( \frac{C^i_{AC,t}}{(\varphi-1)})^\varphi \right) \right]^{\varphi/(\varphi-1)}
\]

and

\[
u^C_t \text{ and } u^N_t \text{ refer to i.i.d preference and labor supply shock, respectively.}
\]

\[
C^i_{C,t} \left\{ = \left( \int_{i \in I} C^i_{C,t}(i) \rho \, di \right)^{\frac{1}{\rho}} \right\}
\]

and

\[
C^i_{AC,t} \left\{ = \left( \int_{i \in I} C^i_{AC,t}(i) \rho \, di \right)^{\frac{1}{\rho}} \right\}
\]

are the composite varieties of home and imported consumer goods from the rest of Asia\(^2\). The parameter \( \frac{1}{1-\rho} \) denotes the elasticity of substitution between varieties. \( b \) is the parameter that governs the extent of habit persistence. \( 0 < \beta < 1 \) refers to subjective discount factor, \( \sigma \) measures the coefficient of relative risk aversion, and the reciprocal of \( \chi \) indicates the wage elasticity of labor supply. The parameter \( \varphi > 1 \) denotes the elasticity of substitution between home and imported consumer goods, and \( \gamma \) measures home bias. Household \( i \) maximizes Eq. (1) subject to Eq. (2) and the following flow budget constraint

\[
C^i_t + \left( \frac{S_{CD,t}}{P_t \omega_t} \right) \left( \frac{B^i_t}{R^i_t} \right) + \frac{B_t}{P_t R_t} + K_t = W^i_t N^i_t + \Pi_t + (1 + r_{K,t}) K_{t-1} + \left( \frac{S_{CD,t} B^i_{t-1} + B_t}{P_t} \right)
\]

where

\[
W^i_t \left( = \left[ \int_{i \in I} (W^i_t)^{\rho n} \, di \right]^{\frac{1}{\rho n}} \right), r_{K,t}, \text{ and } \Pi_t, \text{ respectively, denote real wage compensation for labors of variety } i, \text{ return on capital stock, and profit as firm’s owner.}
\]

Household holds domestic

\[\text{For variable } x_{ij}, \text{ where } i \neq j, \text{ } i \text{ denotes the source country or origin of production, while } j \text{ denotes destination of export. When } i = j, \text{ we simplify the notation to } x_i.\]
There is an i.i.d exchange-rate risk $\omega_t$ in foreign asset market for fluctuation between home currency and the U.S. dollar $S_{CD}$. Solving for the utility maximization problem gives us the optimal demand schedules for varieties and composite varieties from Eqs. (4) to (7), marginal rate of substitution between work and consumption (8), consumption Euler equation (9), and uncovered interest rate parity (UIPC) (10).

\begin{equation}
C^i_{c,t}(i) = \left( \frac{p_{cd}(i)}{p_{ct}} \right)^{\frac{1}{1-\rho_t}} C^i_{c,t}
\end{equation}

\begin{equation}
C^i_{AC,t}(i) = \left( \frac{p_{ac}(i)}{p_{ac,t}} \right)^{\frac{1}{1-\rho_t}} C^i_{AC,t}
\end{equation}

\begin{equation}
C^i_{c,t} = \gamma \left( \frac{p_{ct}}{p_t} \right)^{-\psi} C^i_t
\end{equation}

\begin{equation}
C^i_{AC,t} = \gamma \left( \frac{p_{ac,t}}{p_t} \right)^{-\psi} C^i_t
\end{equation}

\begin{equation}
(N_t^i)^x (C^i_t - bC^i_{t-1})^\sigma u^N_t = W^M_{t^R}
\end{equation}

\begin{equation}
\frac{(c^i_t - bC^i_{t-1})^{-\sigma}}{p_t} u^c_t = \beta (1 + r_t) \frac{(E_tC^i_{t+1} - bC^i_t)^{-\sigma}}{E_tP_{t+1}} E_t u^c_{t+1}
\end{equation}

\begin{equation}
S_{CD,t} = E_t S_{CD,t+1} \left( \frac{1 + r_t^d}{1 + r_t} \right) \omega_t
\end{equation}

where $\omega_t$ can also be interpreted as i.i.d UIPC shock. $P_t$ is the utility-based consumer price index (CPI) that features the price of domestic and Asian-exported final goods, weighted with the degree of home biasness.

\begin{equation}
P_t = \left[ \gamma P^1_{c,t} - \phi + (1 - \gamma) P^1_{AC,t} \right]^{1/(1-\psi)}
\end{equation}

Households are differentiated in types, $i \in I$, and are thus monopolistic supplier of labor effort sought in upstream production. In each period, a fraction of household, $1 - \theta_w$, can reset their posted nominal wage to approximate welfare-maximizing wage level compatible with the marginal rate of substitution between labor supply and consumption (8), whereas another
fraction of household $\theta_w y_w$ readjust the wage for last-period inflation. Hence, nominal wage inflation equation can be derived as
\[
\pi_{w,t} = \left\{ \frac{y_w}{1 + \beta y_w \theta_w} \right\} \pi_{w,t-1} + \left\{ \frac{\beta}{1 + \beta y_w \theta_w} \right\} E_t \pi_{w,t+1} + \left\{ \frac{(1-\theta_w)(1-\theta_w \beta)}{\theta_w (1 + \beta y_w \theta_w)} \right\} (\omega_t + u_{w,t})
\] (12)
where $\omega_t = \tilde{\omega}_{t}^{MRS} - \tilde{\omega}_t$. $u_{w,t}$ is i.i.d wage markup shock. $\hat{x}_t (\equiv \ln x_t - \ln \bar{x})$ is defined as a variable log-linearized around the steady state value.

2.2. Input-output linkage: From downstream to midstream and upstream firms

Final goods consumed by households are manufactured by a continuum of monopolistically competitive downstream producers $j$ of measure $J$ that combines a variety of home $Y_{2C,t}^j \left( = \left[ \int_{j \in J} Y_{2C,t}(j)^\rho d_j \right]^{\frac{1}{\rho}} \right)$ and Asian-exported intermediate goods $M_{2AC,t}^j \left( = \left[ \int_{j \in J} M_{2AC,t}(j)^\rho d_j \right]^{\frac{1}{\rho}} \right)$ inconstant-elasticity-of-substitution (CES) technology.

\[
Y_{3t}^j = \left[ (1 - \kappa_3)^{\frac{1}{\theta}} (Y_{2C,t}^j)^{\frac{\theta-1}{\theta}} + \kappa_3^{\frac{1}{\theta}} (M_{2AC,t}^j)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}
\] (13)

The parameter $\kappa_3$ denotes the share of imported intermediate inputs in downstream production, and $\theta > 0$ indicates the elasticity of substitution between domestic and imported intermediate inputs. In addition to domestic and foreign consumption, the downstream output is also purchased and reinvested by upstream producers as capital stock for productions, $Y_{3t}^l \equiv C_{3t}^l + Y_{3CA,t}^l + I_{t}^j$.

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3 One can associate this Calvo-type staggered wage setting with an analogy of performance-linked wage setting. In every period, “outperforming” fraction of households $1 - \theta_w$ is rewarded with compensation that matches welfare-maximizing wage level. For another fraction of households that achieves “meeting expectation” performance $\theta_w y_w$, they receive compensation adjusted only for cost of living. The remaining “underperforming” fraction of households $\theta_w (1 - y_w)$ will receive no wage adjustment in whatsoever form. As the performance assessment normally takes place when certain time interval has elapsed, it is thus not inappropriate to assume time-dependent wage setting mechanism.
The use of domestic intermediates in both local and foreign downstream productions constitutes the demand for home midstream output, \( Y_{2t}^j \equiv Y_{2c,t}^j + Y_{2C,t}^j \). To comply with the demand, a mass continuum of midstream monopolistically competitive firms \( j \in J \) processing a variety of domestic \( Y_{1c,t}^j \left( = \left[ \int_{j \in J} Y_{1c,t}^j (j)^{\frac{1}{\rho}} \right] \right) \) and imported intermediates at c.i.f \( M_{1AC,t}^j \left( = \left[ \int_{j \in J} M_{1AC,t}^j (j)^{\frac{1}{\rho}} \right] \right) \) manufactured at earlier stage of production in CES technology into midstream output

\[
Y_{2t}^j = \left( 1 - \kappa_2 \right)^{\frac{1}{\theta}} \left( Y_{1c,t}^j \right)^{\frac{\theta - 1}{\theta}} + \kappa_2 \left( M_{1AC,t}^j \right)^{\frac{\theta - 1}{\theta}}
\]  
(14)

Formally speaking, firms at both downstream and midstream stage first choose \( Y_{sC,t}^j (j) \) and \( M_{sAC,t}^j (j) \), \( s = 2,3 \), to minimize the cost of each variety. Next, given the Lagrange multiplier \( \mathcal{R}_{st} \) that denotes real marginal cost, firms choose \( Y_{sC,t}^j \) and \( M_{sAC,t}^j \) to minimize overall cost of production subject to production function (13) and (14) in downstream and midstream stage, respectively. The optimal demand schedules for varieties, and for home and imported intermediate goods at \( s = 2,3 \) can be easily obtained as what follows:

\[
Y_{sC,t}^j (j) = \left( \frac{p_{sC,t}^j (j)}{p_{sC,t}^j} \right)^{-\frac{1}{1-\rho}} Y_{sC,t}^j
\]  
(15)

\[
M_{sAC,t}^j (j) = \left( \frac{p_{sAC,t}^j (j)}{p_{sAC,t}^j} \right)^{-\frac{1}{1-\rho}} M_{sAC,t}^j
\]  
(16)

\[
Y_{s-1,ct}^j = \left( 1 - \kappa_s \right) \left( \frac{p_{s-1,c,t}^j}{p_{s-1,t}^j} \right)^{-\theta} Y_{s,t}^j
\]  
(17)

\[
M_{s-1,AC,t}^j = \kappa_s \left( \frac{p_{s-1,AC,t}^j}{p_{s-1,t}^j} \right)^{-\theta} Y_{s,t}^j
\]  
(18)
$P_{s-1,t}^{j}$ is the producer price index for producers at stage $s$, derived as the weighted average price of domestic $P_{s-1,c,t}^{j}$ and imported foreign intermediates $P_{s-1,AC,t}^{j}$ manufactured at the earlier stage $s-1$.

$$P_{s-1,t}^{j} = R_{st} = \left[ (1 - \kappa) \left( P_{s-1,c,t}^{j} \right)^{1-\theta} + \kappa \left( P_{s-1,AC,t}^{j} \right)^{1-\theta} \right]^{\frac{1}{1-\theta}}$$  \hspace{1cm} (19)

This input-output linkage can be traced further backward as the intermediates used in midstream production are churned out by a unit mass of competitive firms at upstream production. The upstream firms adopt Cobb-Douglas production technology (20) that blends plant-specific capital $K_{t-1}^{j}$, $j \in J$, with differentiated labor $N_{t}^{i}$, $i \in I$, to produce plant-specific intermediates $Y_{1t}^{j}$.

$$Y_{1t}^{j} = e^{A_{t}} \left( K_{t-1}^{j} \right)^{\alpha} \left( N_{t}^{i} \right)^{1-\alpha}$$  \hspace{1cm} (20)

The output is used for midstream production at home and foreign, $Y_{1t}^{j} \equiv Y_{1ct}^{j} + Y_{1c,at}^{j}$. $A_{t}$ is the first-order autoregressive Hicks-neutral total factor productivity (TFP) shock. The upstream firms vary the purchase of investment goods from downstream firms $l_{t}^{j}$ at a cost to accumulate capital stock for production. Specifically, capital stock accumulation with quadratic investment adjustment cost evolves as

$$K_{t}^{j} = (1 - \delta)K_{t-1}^{j} + u_{t}^{j}I_{t}^{j} \left\{ 1 - \frac{\psi}{2} \left( \frac{u_{t-1}^{j}l_{t-1}^{j}}{u_{t}^{j}l_{t}^{j}} \right) \left( \frac{u_{t}^{j}l_{t}^{j}}{u_{t-1}^{j}l_{t-1}^{j}} - 3 \right) \right\}$$  \hspace{1cm} (21)

where $u_{t}^{j}$ is investment-specific technology (IST) shock, and follows first-order autoregressive process. The parameter $\Psi$ governs investment adjustment cost, and $\Sigma$ determines to what extent investment decision is forward-looking. The upstream firm optimally chooses the path of $K_{t}^{j}$ and $N_{t}^{i}$ to minimize the cost of production $\left( r_{K,t} + \delta \right)K_{t-1}^{j} + W_{t}^{i}N_{t}^{i}$ subject to the production net of investment adjustment cost.
\[ R_{1t} \left\{ e^{A_t(K_{t-1})^\alpha (N_t^i)^{1-\alpha}} - \frac{\Psi}{2} \left( \frac{u_{t-1}^i l_{t-1}^j}{u_t^i l_t^j} \right) \left( \frac{u_t^i l_t^j}{u_{t-1}^i l_{t-1}^j} - 3 \right)^2 = 0 \right\} \]

where \( R_{1t} \) is Lagrange multiplier which proxies upstream real marginal cost. As for optimal demand for labor of varieties \( i \), marginal productivity of capital and labor, and dynamic investment decision, we can get

\[
N_t^i(i) = \left( \frac{w_t^i(j)}{w_t^i} \right)^{\frac{1}{1-\rho_n}} N_t^i
\]

\( r_{K,t} = \alpha R_{1t} \left( \frac{y_t^j}{K_t^j} \right) - \delta \)  \hspace{2cm} (23)

\[
W_t^i = (1 - \alpha) R_{1t} \left( \frac{y_t^j}{N_t^i} \right)
\]

\[
R_{1t} \left( \frac{u_t^i l_t^j}{u_{t-1}^i l_{t-1}^j} - 3 \right) = R_{1t+1} \left\{ \left( \frac{u_{t+1}^i l_{t+1}^j}{u_{t}^i l_{t}^j} - 3 \right) \left( \frac{u_t^i l_t^j}{u_{t}^i l_{t}^j} \right) - \frac{1}{2} \left( \frac{u_{t+1}^i l_{t+1}^j}{u_{t}^i l_{t}^j} - 3 \right)^2 \right\}
\]  \hspace{2cm} (25)

Inserting marginal product of capital (23) and of labor (24) into the Cobb-Douglas production function (20) gives us the real marginal cost of upstream firm.

\[
R_{1t} = \frac{(r_{K,t} + \delta)^{\alpha} (w_t^i)^{1-\alpha}}{e^{\alpha t} \alpha^{(1-\alpha)^{1-\alpha}}}
\]  \hspace{2cm} (26)

For the sake of simplicity, we assume a perfectly market for upstream goods. The elasticity of substitution between varieties is thus close to infinity, and as a consequence, output price approximates real marginal cost, \( P_{1,t}^j = R_{1t} \), and is symmetry across manufacturing plants.

2.3. Optimal pricing decision with U.S dollar pricing in export

Pricing decision is assumed to be time dependent. The ability of domestic firms in midstream and downstream production to re-optimize the price is subject to the signal received at probability \( 1 - \theta_p s \), for \( s = 2,3 \). Firm \( j \) that receives the signal chooses \( P_{sC,t}^j \) and \( P_{sC,A,t}^D \) to
maximize the expected discounted profits $E_t \Pi_t$ for sales in home and export market, respectively. As for home market, the pricing decision is formulated as

$$E_t \Pi_t = E_t \sum_{i=0}^{\infty} (\theta p_s \beta) i \Lambda_{t+i} \left[ \frac{p_{sC,t+i}(j) - R^n_{s,t+i}}{p_s^{i,t+i}} \right] \left[ \frac{p_{sC,t+i}(j)}{p_s^{i,t+i}} \right]^{-\frac{1}{1-\rho}} Y_{sC,t+i}(j)$$

(27)

Another important feature of the model is the assumption of U.S dollar pricing in export and import motivated by the fact that international trade is mostly priced in U.S dollar (Goldberg and Tille, 2008). In fact, at least for the case of Japanese firms, the formation of regional production network with the United States as final destination has contributed to the pervasive trade invoicing in dollar (Ito et al., 2012).

Dollar pricing mechanism interestingly resembles the close movement between nominal exchange rates and relative price of import and export, while giving incomplete exchange rate pass-through into output price. Nominal depreciation, as the argument goes, raises unit import price in local currency. Nonetheless, local-currency denominated export revenue has expanded too, helping firms to absorb the negative impact of depreciation on markup without the need to raise output price for home and export market proportionally. As a result, nominal depreciation is associated with less than proportional deterioration in terms of trade and incomplete exchange rate pass-through.

Firm’s expected export profit in home currency under dollar pricing strategy is formulated as

$$E_t \Pi_t^{\text{export}} = E_t \sum_{i=0}^{\infty} (\theta p_{sC,A} \beta) i \Lambda_{t+i} \left[ \frac{S_{ADV} p_{sC,AD,t+i}(j) - R^n_{s,t+i}}{p_s^{i,t+i}} \right] \left[ \frac{S_{ADV} p_{sC,AD,t+i}(j)}{p_s^{i,t+i}} \right]^{-\frac{1}{1-\rho}} Y_{sC,A,t+i}(j)$$

(28)

In what follows we assume that all firms are symmetric in price setting. Solving for optimal reset price gives us
\[
\mathbb{P}_{scl,t+i} = \left( \frac{1}{\rho_t} \right) \sum_{i=0}^{\infty} \left( \theta_{ps}\beta \right)^i \Lambda_{t+i} R_{s,t+i}^{n}\]

(29)

\[
\mathbb{P}_{scd,t+i}^D = \left( \frac{1}{\rho_t} \right) \sum_{i=0}^{\infty} \left[ \frac{\left( \theta_{pscl}\beta \right)^i \Lambda_{t+i} R_{sc,t+i}^{n}}{S_{cd,t+i}} \right]
\]

(30)

Firms allowed for price re-optimization will reset their log-linearized price to approximate the optimal reset price (29) and (30), resulting respectively in

\[
\hat{p}_{scl,t} = \theta_{ps} \beta E_t \hat{p}_{scl,t+1} + (1 - \theta_{ps} \beta) \mathbb{P}_{scl,t}
\]

(31)

\[
\hat{p}_{scd,t} = \theta_{pscl} \beta E_t \hat{p}_{scd,t+1} + (1 - \theta_{pscl} \beta) \mathbb{P}_{scd,t}^D
\]

(32)

The remaining firms that do not receive signal for reoptimization will maintain last-period price, out of which a fraction of them (\(\gamma_p\)) adjust the price for inflation. Hence, the log-linearized aggregate price level at each date can be written as probability-weighted average of non-optimized and reoptimized price:

\[
\hat{p}_{sc,t} = \theta_{ps} \left( \hat{p}_{scl,t-1} + \gamma_p \pi_{sc,t-1} \right) + (1 - \theta_{ps}) \hat{p}_{scl,t}
\]

(33)

\[
\hat{p}_{scd,t} = \theta_{pscl} \left( \hat{p}_{scd,t-1} + \gamma_{pscl} \pi_{scd,t-1} \right) + (1 - \theta_{pscl}) \hat{p}_{scd,t}
\]

(34)

By inserting, respectively, aggregate price level (33) and (34), and its forward iteration, together with the log-linearized optimal reset price (29) and (30) into reoptimized price level (31) and (32), we can obtain four New Keynesian Phillip curves: producer price inflation, GDP deflator inflation, and export price inflation for intermediates and final goods.

\[
\pi_{sc,t} = \left( \frac{\gamma_p}{1+\theta_{ps}\beta \gamma_p} \right) \pi_{sc,t-1} + \left( \frac{\beta}{1+\theta_{ps}\beta \gamma_p} \right) E_t \pi_{sc,t+1} + \lambda_c (\bar{R}_{s,t} + \pi_{sc,t})
\]

(35)

\[
\pi_{scd,t} = \left( \frac{\gamma_{pscl}}{1+\theta_{pscl} \beta \gamma_{pscl}} \right) \pi_{scd,t-1} + \left( \frac{\beta}{1+\theta_{pscl} \beta \gamma_{pscl}} \right) E_t \pi_{scd,t+1} + \lambda_{ca} (\bar{R}_{s,t} - s_{cd,t} + \pi_{scd,t})
\]

(36)

where
\[ \lambda_c = (1 - \theta_{PS})(1 - \theta_{PS}\beta)/(\theta_{PS}(1 + \theta_{PS}\beta \gamma_{PS})), \]

\[ \lambda^* = (1 - \theta_{P,SC,\beta})(1 - \theta_{P,SC,\beta}\beta)/(\theta_{P,SC,\beta}(1 + \theta_{P,SC,\beta}\beta \gamma_{P,SC,\beta})). \]

The aggregate value added of the economy \( \mathcal{Y} \), which corresponds to gross domestic product (GDP) in national account, is summed up as

\[ \mathcal{Y}_t = C_t + I_t + \Pi_t \]  \hspace{1cm} (37)

where trade balance \( \Pi \) is defined as the balance between aggregate f.o.b exports and aggregate c.i.f imports.

\[ \Pi_t \equiv \]

\[ Y_{1C,\lambda,t} + \int_{j \in J} Y_{2C,\lambda,t}(j) dj + \int_{j \in J} Y_{3C,\lambda,t}(j) dj - M_{1AC,t} - \int_{j \in J} M_{2AC,t}(j) dj - \int_{i \in I} C_{AC,t}(i) di \]  \hspace{1cm} (38)

The model is closed by considering a general form of monetary policy reaction as below:

\[ r_t = \rho_R r_{t-1} + (1 - \rho_R)(r^*_t + V_\pi \pi_{CPI,t} + V_\psi \psi_t + V_{\Delta S} \Delta s_{CD,t}) + u^R_t \]  \hspace{1cm} (39)

where \( r^*_t \) is the natural rate of interest determined by efficient shocks, and \( \rho_R \) measures the interest rate persistence. Central bank’s willingness to stabilize CPI inflation, aggregate demand variability, and rate of change in nominal exchange rates between home currency and U.S. dollar is captured by \( V_\pi \), \( V_\psi \), and \( V_{\Delta S} \), respectively. \( u^R_t \) refers to i.i.d white noise to the conduct of monetary policy.

3. **Bayesian estimation**

3.1. **Implementation**
The model is confronted with the data using Bayesian method. As the literature on Bayesian estimation and evaluation has been growing tremendously, its estimation procedure is only briefly sketched here. The intuition is attractively simple. The model parameters is stacked in a vector of $\mathbf{x}$, and is drawn a priori probability density $p(\mathbf{x}, \mathcal{M})$. Along with a set of observed data, $\mathbf{y}^T = \{\mathbb{R}^1, ..., \mathbb{R}^T\}$, where $T$ denotes the number of periods, the log-linearized model can be estimated by Kalman filter to yield log likelihood function, $\mathcal{L}(\mathbf{y}|\mathbf{x}, \mathcal{M})$, that describes the density of the data. Likelihood function is thus identical to $p(\mathbf{y}|\mathbf{x}, \mathcal{M})$. Given the prior density $p(\mathbf{x}, \mathcal{M})$ on the one hand, and likelihood function $p(\mathbf{y}|\mathbf{x}, \mathcal{M})$ on the other hand, we are able to infer the posterior density according to Bayes’s theorem:

$$p(\mathbf{x}|\mathbf{y}, \mathcal{M}) = \frac{p(\mathbf{y}|\mathbf{x}, \mathcal{M}) p(\mathbf{x}, \mathcal{M})}{p(\mathbf{y}, \mathcal{M})} \tag{40}$$

where $p(\mathbf{y}, \mathcal{M}) = \int \mathcal{L}(\mathbf{y}|\mathbf{x}, \mathcal{M}) \mathcal{P}(\mathbf{x}, \mathcal{M}) \, d\mathbf{x}$ is the marginal density of the data given a specific model $\mathcal{M}$.

Suppose that the marginal density of the data is a constant or equals certain parameter, the posterior kernel can be derived from the numerator of the posterior density

$$\mathcal{K}(\mathbf{x}|\mathbf{y}, \mathcal{M}) \equiv \mathcal{P}(\mathbf{x}|\mathbf{y}, \mathcal{M}) \propto \mathcal{P}(\mathbf{y}|\mathbf{x}, \mathcal{M}) \mathcal{P}(\mathbf{x}, \mathcal{M}) \tag{41}$$

where $\propto$ denotes proportionality. Posterior kernel is simulated to generate draws using Markov Chain Monte Carlo (MCMC) method. Specifically, we use Metropolis-Hastings algorithm in Dynare 4.3.1 to generate twenty thousand draws, of which half is discarded to attain convergence. The number of Markov chains are adjusted to make sure that draws of the posterior sampling for means, variances, and third moments for the model parameters within and across sequences finally converge. We also fine tune variance of the jumps in $\mathbf{x}$ in MCMC chain (mh_jscale) to

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4 See, for instance, the influential Smets and Wouters (2003) and Fernandez-Villaverde (2010) for in-depth discussion on implementation.
ensure that the acceptance ratio is approximately 24%. The resultant findings provide the point estimates, standard deviations and confidence interval.

3.2. Data

We categorize nine Asian economies comprising Japan, Republic of Korea, Hong Kong, Taiwan, Singapore, Malaysia, Indonesia, the Philippines, and Thailand into two groups: the first five constitute the developed Asian economies (DA5) and the next four as developing Southeast Asian economies (DESA4). By interpreting China (CHN) as home country, DA5 and DESA4, respectively, become foreign country. Hence, there are two models for estimation: CHN-DA5 and CHN-DESA4.

Sourced from International Financial Statistics with supplementary data from Economist Intelligence Unit (EIU) database particularly for the case of Taiwan, nineteen macroeconomic time series are used in the estimation of each two-country model. This includes gross domestic product, consumption, investment, labor force, nominal interest rate, nominal exchange rates vis-à-vis the U.S. dollar, year-to-year PPI inflation, GDP deflator inflation and CPI inflation for home and foreign economy, and the U.S. federal funds rate. All the quantity variables are in PPP-adjusted constant price, and all data, except for inflation and interest rates, are logged and detrended using Hodrick-Prescott Filter with smoothing parameter $\lambda = 1600^5$. Detrended series are then weighted based on the time-varying fraction of national total trades over aggregate regional trades to construct regional series for DA5 and DESA4. The data starts at 2001 first quarter, the year wherein China joined WTO, and ends at 2008 fourth quarter.

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5 Wong and Eng (in press) show that the choice of detrending is not critical to the empirical relevancy of the estimated model.
3.3. Prior and posterior distribution

Due to the limitation of data points relatively to the number of model parameters for estimation, a satisfactory implementation needs restriction on the number of parameters for measurement. Hence, after numerous trials and errors in getting the highest log marginal data density, we restrict prior and posterior distribution for habit persistence, risk aversion coefficient, wage elasticity, parameter governing the degree of forward looking in investment, elasticity of substitution between home and imported intermediate goods, and the U.S. monetary policy shock to be identical for home and foreign economy.

Note that both efficient labor supply shock and inefficient wage markup shock enter nominal wage inflation (12). Of problem is monetary policy responds differently towards inefficient and efficient shocks (see Smets and Wouters, 2003). Plus, observable time series for the sample countries are largely incomplete at best and unavailable at worst. To minimize the potential identification problem, we choose not to estimate but to preset the nominal wage indexation at 0.5 and Calvo wage stickiness at 0.75. Turning to prior distribution, as risk aversion coefficient, wage elasticity, and monetary policy reaction function shall presume only positive value, we assume Gamma distribution for them. Persistence, which by definition shall be within the range of (0,1), is assumed to be beta distributed. The remaining parameters and shocks are assumed to be in uniform distribution to allow equal probability for all potential values within the theoretically reasonable range. Table 1 summarizes the prior distribution.

--[INSERT TABLE 1 HERE]--

Table 1 also reports the posterior mode, mean, and the 5th and 95th percentiles of the posterior distribution of the parameters and shocks for China-East Asia (CHN-DA5) and China-Southeast Asia (CHN-DESA4) models. The parameters are generally identified as the values of
mean and mode largely coincide. Overall, the estimates corroborate the theoretical intuitions, and are generally identical over the two models. That said, two interesting observations deserve more ink.

Firstly, the posterior risk aversion coefficient in CHN-DA5 model is less than one, including the higher end of the probability distribution, whereas the value is approximately unity for CHN-DESA4. When $\sigma < 1$, the substitution effect of higher real wage made possible by favorable productivity shock dominates the negative wealth effect following smaller marginal utility of consumption on labor supply, causing employment to rise (see Eq. (8)). The substitution and wealth effects are counterbalanced, however, when $\sigma = 1$. Lower $\sigma$ also implies larger intertemporal elasticity of substitution between current and future consumptions in response to changes in real interest rate (see Eq. (9)). As a consequence, DA5 will be more responsive as compared to DESA4 to symmetric TFP, monetary policy and UIPC shocks originated in China.

Secondly, of all the price setting mechanisms estimated in both models across all countries, final output price has been the least reoptimized. Comparatively, producer prices are more frequently reoptimized. These estimates fit the intuition that output prices further down the chains of production tend to be more persistent (Huang and Liu, 2004). Turning to export price, the frequency of price reoptimization in China’s midstream and downstream export prices is consistently less than 4 quarters across models. Export prices of DESA4 are even more flexible. Export prices of DA5, however, are consistently more rigid across value chains. For instance, DA5 exporters reoptimize export price for final output in every 4.6 quarters $\left( \frac{1}{1-0.781}\right)$ whereas DESA4 exporters reoptimize within an interval of 2 quarters $\left( \frac{1}{1-0.522}\right)$. We offer our intuition in next section.
4. Assessing bilateral fragmentation in production and trade between China and Asia

Following the methodology outlined in Wong and Eng (2012), we decompose the gross exports into domestic value added embodied in exports that stay in foreign economy for local use (DVA) and in exports that are shipped back to the source (VS1*), and the foreign value added used in exports (VS):

\[ x_t = \sum_s DVA_{s,t} + VS1*_{s,t} + VS_{s,t} \]

where

\[ \sum_s DVA_{s,t} = \]

\[ \left( 1 - \frac{M_{0,s}^{I}}{y_{1,t}} \right) \left( 1 - \frac{M_{1,s}^{I}}{y_{2,t}} \right) Y_{3,s}^{I,\alpha,t} + \right. \]

\[ \left( 1 - \frac{M_{0,s}^{I}}{y_{1,t}} \right) \left( \frac{M_{1,s}^{I}}{y_{2,t}} \right) Y_{2,s}^{\alpha,t} + \left( 1 - \frac{M_{1,s}^{I}}{y_{2,t}} \right) \left( \frac{M_{2,s}^{I}}{y_{3,t}} \right) (C_{s,t} + I_{t}^{\alpha}) \quad (42) \]

\[ \sum_s VS1*_{s,t} = \left( 1 - \frac{M_{0,s}^{I}}{y_{1,t}} \right) \left( \frac{M_{1,s}^{I}}{y_{2,t}} \right) Y_{2,s}^{\alpha,t} + \left( 1 - \frac{M_{1,s}^{I}}{y_{2,t}} \right) \left( \frac{M_{2,s}^{I}}{y_{3,t}} \right) Y_{3,s}^{\alpha,t} \quad (43) \]

\[ \sum_s VS_{s,t} = \left( 1 - \frac{M_{0,s}^{I}}{y_{1,t}} \right) \left( \frac{M_{1,s}^{I}}{y_{2,t}} \right) Y_{2,s}^{\alpha,t} + \left( 1 - \frac{M_{1,s}^{I}}{y_{2,t}} \right) \left( \frac{M_{2,s}^{I}}{y_{3,t}} \right) Y_{3,s}^{\alpha,t} \quad (44) \]

The decomposition is indeed compatible with the most comprehensive value added break down as empirically searched in Koopman et al. (2010). Taking as a share of gross exports, Eq. (42) corresponds to VAX ratio of Johnson and Noguera (2012), Eq. (43) is VS1* in Daudin et al. (2011), which also corresponds partly to VS1 in Hummels et al. (2001), and Eq. (44) matches the Hummels et al. (2001)’s VS definition.
VAX ratio contains domestic value added embodied in the export of final goods (item (i)) and in the export of intermediates for foreign local use in midstream and downstream production (item (ii) & (iii)). As the imported foreign materials used in final goods production may contain domestic value added embodied in earlier stage of foreign production, we count those domestic value added in to avoid underestimation. On the flip side, we deduct the foreign value added embodied in the production of upstream and midstream output exported for foreign local use.

VS1* comprises domestic value added embodied in the intermediates exported for foreign production that are reexported back to the source as intermediates (item (iv)) or final goods (item (v)). Likewise, foreign value added may have been embodied in earlier stage of domestic production of intermediates. To avoid double counting we also eliminate those foreign value added. Finally, VS considers all foreign value added of domestic exports.

Figure 2 illustrates the evolution of VAX, VS1*, and VS as a share of gross exports simulated from the estimated CHN-DA5 and CHN-DESA4 models over the periods of 2001Q1 to 2008Q4. VAX ratio declines when production value chains are unbundled and fragmented across borders. It is obvious then that production value chains of DA5 are more fragmented, and are increasingly so, vis-à-vis China’s production. To the contrary, China’s productions are more fragmented than that of DESA4. Different extents of bilateral production fragmentation have resulted in different patterns of trade. When a firm splits and relocates part of the value chains abroad, it improves its position in the value chains network by climbing up the ladder of production streams to produce more intermediates. This is reflected in higher domestic value added embodied in the intermediates exported for foreign production that will be shipped back to the source for further processing. That explains lower (higher) VS1* ratio for China than that for DA5 (DESA4) in their bilateral trade. Furthermore, when a firm has higher position in the value
chains network, the probability that export contains foreign value added is lower. VS ratio for China is thus higher than that for DA5, though not so as compared to DESA4.

--[INSERT FIGURE 2 HERE]--

The bilateral production fragmentation is expected to leave mark on the export price stickiness in DA5 and DESA4 vis-à-vis China. Here is our intuition. When the advanced DA5 supplies intermediates to China for further processing, most of the trade occurs between a parent and its affiliates within a multinational firm’s boundary (WTO and IDE-JETRO, 2011; Dean and Lovely, 2009). This is not necessarily the case, however, for trade between China and the developing DESA4 that compete at the downstream value chain: arm’s length trade is the norm. Neiman (2008) finds that when products are complementary ($\theta < 1$), price is stickier for arm’s length trade. As goods become more substitutable ($\theta > 1$), median price duration for arm’s length trade decreases from about 5.3 quarters to 2 quarter, whereas the median price duration for intra-firm trade remains about 4 quarters. Put in out context, given the posterior average elasticity substitution between domestic and imported intermediates at 1.49 for CHN-DA5 and 1.56 for CHN-DESA4, which means homogenous and substitutable intermediates, the findings that DESA4 has more flexible export prices than DA5 are coherent with the existing empirical results.

5. **Evaluating China’s macroeconomic influence on Asia**

In this section, we analyze the dynamic responses of DA5 and DESA4 to China’s macroeconomic disturbances. In addition to the baseline analysis, we also consider two hypothetical cases. The first is we assume China rigidly pegs its renminbi to the U.S dollar. We set $\rho_R = V_\pi = V_\psi = 0$. Solving simultaneously UIPC (10) and policy rule (39) yields
\[
\begin{bmatrix}
\tau_t \\
S_{CD,t}
\end{bmatrix} = \frac{1}{1+V_{\Delta S}} \begin{bmatrix}
-V_{\Delta S} & V_{\Delta S} & 1 & 1 & V_{\Delta S} \\
1 & 1 & -1 & -1 & 1
\end{bmatrix} \psi'
\]

where \( \psi' = [S_{CD,t-1} S_{CD,t+1} \tau_t^D \tau_t^R u_t^R \omega_t]' \). By setting \( V_{\Delta S} = 1000 \), \( S_{CD,t} = S_{CD,t-1} \) all the time, and \( \tau_t \) only responds to eliminate exchange rate changes and risk. The second case is we assume all Asian countries fix the currency to the dollar. The Asian dollar standard requires \( \rho_R^d = \rho_R = V_{\pi}^d = V_{\pi} = V_{\psi}^d = V_{\psi} = 0 \) and \( V_{\Delta S}^d = V_{\Delta S} = 1000 \). Figure 3 illustrates the impulse responses of GDP and gross exports in DA5 (the first two horizontal panels) and in DESA4 (the last two horizontal panels) to 1% asymmetric shocks originated in China.

Irrespective of the pattern of fragmentation, DA5 and DESA4 respond almost identically to a variety of China-specific shocks. Favorable IST and preference shock stimulates exports and GDP of DA5 and DESA4; positive shock to producer price markup and transportation cost raises the cost of exporting, pulling down Asian gross exports to China and GDP; and Chinese renminbi depreciation is also contractionary to Asian export and GDP. Put another way, demand and price shocks that benefit China also prosper-thy its Asian neighboring countries. Moreover, these responses are robust to the choice of exchange rate regime. The benign effect of China’s IST shock on DA5, however, turns short-lived when currency is irrevocably fixed to the dollar by China or all.

There are two important exceptions. So far as China’s TFP shock is concerned, the responses of DA5 and SDA5 are different. While DA5 gross export and GDP (to lesser extent) respond positively to the shock, DESA4 gross export and GDP react negatively. In other words, China’s expansion made possible by total factor productivity improvement can crowd out the developing DESA4 in terms of GDP that competes at final goods export with China while crowding in the advanced DA5 that supplies intermediates to China. Although these responses
corroborate the empirical findings discussed earlier in the introduction, Figure 3 shows that the choice of exchange rate regime critically influences the responses to China’s TFP shock. By adopting a dollar standard, even DESA4 is crowded in by China’s expansion, and the benign effect of China’s TFP improvement felt by Asia is more sustainable.

Another notable exception is that the magnitude of DA5 responses is systematically smaller than that of DESA4. Intuitively, smaller quantity responses can be attributed to smaller changes in prices made possible by stickier price and lower exchange rate pass-through. Neiman (2010) and Ando and Iriyama (2009), for instance, find that exchange rate pass-through is smaller when trade occurs within the same firm’s boundaries. Putting together with the empirical evidence on price stickiness discussed earlier, it is unsurprising then that the magnitude of quantity responses will tend to be smaller for DA5 with larger share of intra-firm trade as price is less frequently adjusted and exchange rate pass-through is smaller.

5.1. Does the nature of shock matter?

The results we have found so far are cemented on the assumption of asymmetric shock originated in China. Will the responses be different when shocks are symmetric? We seek the answer by contemplating the impulse responses of DA5 and DESA4 to 1% shock symmetrically originated in China and DA5 and DESA4, respectively, as illustrated in Figure 4.

Overall, two results survive: the responses of DA5 and DESA4 to China’s shocks ranging from the efficient IST and preference shock to the inefficient producer price markup, UIPC and transportation cost shock remain synchronized, and currency peg to the dollar is still the mechanism that magnifies the beneficial effect of China’s TFP shock to DESA4. But other two
results have been overturned. Gross exports and GDP of both DA5 and DESA4 facing the symmetric TFP shock have been lifted up. China’s expansion driven by symmetric productivity shock is now comrade to both DA5 and DESA4. Equally fascinating is the finding that the magnitude of DA5 responses to all shocks is larger than DESA4. This is compatible with the argument that countries positioned at upstream value chains will be affected more severely by negative external demand shocks (see Wong and Eng (2012) and reference cited therein).

6. Discussion and concluding remarks

Motivated by the inconclusive empirical findings on the influence of China’s trade expansion on its neighboring countries, this paper delves two important and interrelated questions: what is the bilateral production and trade relationship between China and the rest of Asia since China’s accession into World Trade Organization? And how macroeconomic disturbances on China influence its Asian neighbors? We provide a general equilibrium view by laying out a two-country medium-scale New Keynesian model expanded to feature three stages of production. We take the model to data on ten East and Southeast Asia, including China, by using Bayesian approach. With two estimated models on hand, we construct bilateral production fragmentation and vertical specialization ratio for China-developed Asia model and China-developing Southeast Asia model, and inspect the dynamic responses of developed and developing Asia to a variety of China’s shocks. Here are our answers to some interesting questions.

Does fragmentation in production and trade matter for China’s influence on its Asian neighbors? In fact, it does in two dimensions. First, while China-specific positive TFP shock, which lifts its own exports and economy, stimulates gross exports and total economic activity of
developed Asia that has more fragmented production and positions itself as source of intermediates, it did not equally lift the gross domestic product of developing Southeast Asia that are mainly the consumer of intermediates in downstream production. Second, in the face of asymmetric shock, the magnitude of responses of developed Asia is much smaller than that of developing Southeast Asia. We infer that the magnitude is influenced by the way firms organize value chains across border. To what quantitative extent the firm’s organizational form is associated with the position of firm in the value chains network deserves more ink in the future.

Has the nature of shock shaped the responses? Yes, very much indeed. China’s expansion benefits all in the region when shocks are symmetric. Of questionis what causes symmetric shock? It is not unreasonable to associate symmetric shock to preference and relative prices with third-country effect. Expenditure-raising shock in the United States, for example, can boost demand for Chinese and Asian goods simultaneously, whereas U.S monetary contraction depreciates all Asian currencies vis-à-vis dollar. However, what knots all Asian total factor productivity? We apparently need a theory of TFP in the presence of production fragmentation.

Is the choice of exchange rate regime important? Yes and no. A hard currency peg amplifies and sustains the beneficial effect of China’s favorable TFP shock on the whole Asia regardless of the nature of shocks. However, the choice of exchange rate regime matters neither in the pattern nor magnitude of responses to other disturbances on China. Quantifying the welfare effect of the choice of exchange rate regimes in the presence of production fragmentation and vertical specialization is a promising venue for future research.

References


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Notes: The posterior distribution is obtained based on 4 parallel Markov chains of 50,000 draws each in Metropolis-Hastings sampling algorithm. The first half was discarded as burn-in. The average acceptance rate for each estimated model is 0.235 for CHN-DA5 and 0.251 for CHN-DESA4. DESA4 comprises Indonesia, Malaysia, the Philippines, and Thailand weighted by total trades, where DA5 comprises Japan, Hong Kong, Korea, Singapore, and Taiwan weighted by total trades.
Fig. 1. Has Asian trade with the United States been diverted to or displaced by China?
Fig. 2. Fragmentation in production and trade, 2001Q1-2008Q4
Notes: The first two rows are East Asian responses, followed by Southeast Asian responses.

Fig. 3. Dynamic responses of Asia to idiosyncratic China’s shocks.
Notes: The first two rows are East Asian responses, followed by Southeast Asian responses.

Fig. 4. Dynamic responses of Asia toward symmetric shocks