Global Sourcing and Domestic Value-added in Gross Exports*

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Preliminary Only.

Abstract

This paper employs data from the World Input-Output Database (WIOD) to document the evolution of the domestic content in exports, as measured by the domestic value added to gross exports ratio (DVAR), across countries and sectors over the period 1995-2008. We develop a multiple-sector general equilibrium model of Eaton and Kortum (2002) with domestic and global input-output linkages (a la Caliendo and Parro (2015)) to provide structural interpretations of individual countries' DVAR. We use the calibrated version of the model to fully decompose the time-series changes of the global DVAR and selected countries' DVAR into separate parts that are due to changes in technology, bilateral trade frictions, unilateral export fixed costs, and other exogenous factors such as changes in factor endowments and trade balances. We find that while the partial effects of both technology and trade costs are negative, there is a positive and significant interactive effect from the two. Taking into account the interactive effects, we find that the total effect of technology, which has been either overlooked or misinterpreted in the existing analyses of the evolution of global value chains, is significantly positive, while the total effect of trade frictions is far from capable of explaining the changes in DVAR over the sample period. The contributions of other determinants are quantitatively very small.

JEL Classification codes: F10, F11, F14, F17

Keyword: fragmentation, gravity, global value chain, domestic value-added ratio

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1 Introduction

Advances in information and communication technologies and declining trade barriers have encouraged firms to source inputs more globally. Global fragmentation of production tasks implies that a country's exports may contain a significant amount of foreign content, making gross trade flow statistics increasingly less accurate for describing the actual value-added of a country in its exports. Take consumer electronics, such as iPhones, as an example. According to Kee and Tang (2016), only 53% of the exports of electronics from China in 2007 was value-added attributed to China. As documented by Koopman, Wang, and Wei (2014) and Johnson and Noguera (2017), the share of domestic value-added in gross exports is significantly lower than 1 for most countries and sectors, and has been decreasing for decades.

Analyzing the determinants of the DVAR of a country's exports can help us understand the drivers of global production fragmentation. In this paper, we employ data from the World Input-Output Database (WIOD) to document the evolution of the domestic content in exports, as measured by the domestic value added to gross exports ratio (DVAR), across countries and sectors over the period 1995-2008. To guide our quantitative analysis of the evolution of the DVAR in exports across countries and years, we develop a multi-country, multi-sector, quantitative trade model with inter-sectoral input-output linkages, based on Eaton and Kortum (2002) and Caliendo and Parro (2015). The model offers structural interpretations of the DVAR at the country-sector level for each year.

We use the calibrated version of the model to fully decompose the time-series changes of the global and selected countries' DVAR into separate parts that are due to (exogenous) changes in three sets of factors, namely (i) technology, (ii) trade frictions, and (iii) other exogenous factors such as factor endowments and trade balances. We find that while the stand-alone effects of both technology and trade costs are negative, there is a positive and significant interactive effect from the two. Taking into account the interactive effect the interactive effect, we find that the total effect of technology, which has been either overlooked or misinterpreted in the existing analyses of the evolution of global value chains, is significantly positive, while the total effect of trade frictions is only marginally negative. The contributions of other determinants are quantitatively very small.

Tables 1 and 2 report the calibrated decomposition of the 4.9 percentage-point decline in the global DVAR during the sample period. Table 1 reports the pure (i.e. stand-alone) effects of each set of factor(s) and their interactive effects. Table 2 reports the total effect (pure effect plus interactive effects) of each set of factor(s). The stand-alone effects of technology and trade costs are -4.8 and -9.1, respectively, while the stand-alone effect of other factors (i.e., changes in trade balances and factor endowments) is only 0.3. The three stand-alone effects add up to a number that is much more negative than the data, because there are positive interactive effects, in particular,

the one that involves the interaction between changes in technology and change in trade costs. It contributes about 8.7 percentage-point *increase* in the global DVAR. The large positive interactive term is an outcome of the non-linearity in the structural gravity equations derived from a large class of quantitative trade models, to which Eaton and Kortum (2002) belongs, together with a negative correlation between changes in technology and changes in import barriers across country-sector pairs (e.g., China's estimated sectoral TFP was rising faster in sectors that experienced larger declines in import barriers). In section 2, we will develop a two-country one-sector version of our model to analytically highlight the insights.

Table 1: Percentage-point Changes in DVAR (1995-2008)			
	Global	Developed	Developing
Total	-4.36	-4.20	-4.58
due to changes in			
Technology (stand-alone)	-2.78	-3.25	-2.28
Trade Costs (stand-alone)	-8.03	-5.84	-10.62
Other Factors (stand-alone)	0.94	-0.69	2.75
Tech * Trade Costs	5.79	4.82	6.99
Tech * Other Factors	-0.72	0.42	-1.98
Trade Costs * Other Factors	-0.86	0.41	-2.27
All Three Forces	1.05	-0.14	2.38
Residual	0.25	0.07	0.45

Table 2: Percentage-point Changes in DVAR (1995-2008)			
	Global	Developed	Developing
Total	-4.36	-4.20	-4.58
total effect of			
Technology	3.34	1.84	5.11
Trade Costs	-2.05	-0.74	-3.52
Other Factors	0.40	0.01	0.88

Adding the stand-alone effect and the interactive effects together, we find that for the world (and also for most countries), technological changes have a significant and positive impact on its DVAR, while trade liberalization has a slightly negative effect. The small negative effect of trade costs contrasts the previous finding in the literature (e.g., Johnson and Noguera, 2017). In fact, certain fast-growing countries like China, have their DVAR increasing over time, despite falling trade frictions. Our calibrated model will be able to explain that as a result of significant technological growth.

In sum, the total effect of the changes in technology on a country's DVAR cannot be isolated from that of the trade frictions, or vice versa. The total effects of each factor depend on the underlying empirical distribution of the changes in technology and trade frictions across time and sectors within a country. Since trade friction act in conjunction with technology to shape trade patterns, ignoring such interactive effect may result in a biased estimate of the contribution of a single determinant to the DVAR and other global value chains (GVC) indices.

An important contribution of our paper is to bridge two literatures in international trade, namely the one that documents the facts about GVC (e.g. Hummels, Ishii and Yi, 2001 and Koopman, Wang, and Wei, 2014, among others) and the one that develops quantitative trade models to answer the "welfare gains from trade" and other macroeconomic questions (e.g., Arkolakis, Costinot, and Rodriguez-clare, 2012).

1.1 Related Literature

1. Models of fragmentation
    - Baldwin (2006), Baldwin and Venables (2013); EK (2002); Alvarez and Lucas (2007); Yi (2003; 2010); Antras and Chor (2017)
2. The measurement of global value chains.
    - Koopman, Wang and Wei (JDE 2008; AER 2014), Johnson and Noguera (2012), Johnson (2014); Timmer et al. (2014), KWW (2012), Ma, Wang and Zhu (2015), Kee and Tang (2016).
3. Bridging the two literatures
    - Antras and Chor (2017); Antras and de Gortari (2017); Johnson and Noguera (2017); Fally and Hillberry (2018); de Gortari (2018)

2 A Model of Fragmentation

2.1 Setup

Our model is built on Eaton and Kortum (2002) and thus adopts the same set of model assumptions: (1) All countries have the capability to produce all intermediates and final goods; (2) international trade (but not domestic trade) is costly; and markets are perfectly competitive.

There are N countries in the world, indexed by $n = 1, ..., N$. Each country has (time-varying) labor (L) and capital (K) endowments. Labor and capital are fully mobile across sectors within

a country, but not mobile across countries. There are J final goods available for consumption, indexed by $i = 1, ..., J$.

In each country there is a representative household, who uses labor and capital income to purchase an optimal consumption bundle of final goods to maximize utility, as described as

$$U = \prod_{i=1}^{J} \left\{ \left[\int_0^1 \left(q^i(\omega) \right)^{\frac{\sigma^i - 1}{\sigma^i}} d\omega \right]^{\frac{\sigma^i}{\sigma^i - 1}} \right\}^{\alpha^i}, \text{ with } \sum_{i=1}^{J} \alpha^i = 1. \tag{1}$$

where $q^i(\omega)$ is the consumption of a variety ω in sector i; $\sigma^i > 1$ is the elasticity of substitution between any pair of varieties within sector i; α^i is the expenditure share of the final good i.

The production function of a variety is given by

$$y^i(\omega) = z^i(\omega) \left(M^i(\omega) \right)^{1-\beta^i} \left(l(\omega) \right)^{\beta^i \mu^i} \left(k(\omega) \right)^{\beta^i \left(1-\mu^i\right)} \tag{2}$$

where $y^i(\omega)$ is the quantity produced by firm ω in sector i; $z^i(\omega)$ is the total factor productivity (TFP) of the firm; M^i is the sector-i specific intermediate composite (to be defined later); $l(\omega)$ and $k(\omega)$ are labor and capital inputs, respectively.

The production function of an intermediate composite M^i in the same country takes the same functional form:

$$M^i = \prod_{k=1}^{J} \left\{ \left[\int_0^1 \left(q^k(\omega) \right)^{\frac{\sigma^k - 1}{\sigma^k}} d\omega \right]^{\frac{\sigma^k}{\sigma^k - 1}} \right\}^{\gamma^{ik}}, with \sum_{k=1}^{J} \gamma^{ik} = 1. \tag{3}$$

where $q^k(\omega)$ is the quantity of input variety ω in sector k; $\sigma^k > 1$ is the elasticity of substitution between any pair of varieties within sector k; γ^{ik} is the sector-pair specific cost share of (upstream) input k in the total cost of producing (downstream) input composite i.

International trade is costly. Whenever an intermediate or final good variety from sector i is shipped from country n to country m to be used as input in sector j, an iceberg trade cost τ_{mn}^{ji} is incurred ($j = F$ if it is used as final good). That is, $\tau_{mn}^{ji} > 1$ units of good are shipped from the origin for one unit to arrive at the destination. As usual, we normalize $\tau_{nn}^{ji} = 1$ for all n, j and i, implying frictionless domestic trade. We also assume that the triangle inequality $\tau_{mn}^{ji} \tau_{nl}^{ji} \geq \tau_{ml}^{ji}$ holds for $\forall l, m, n, i$ and j.

As such, the competitive price of a variety in sector i shipped from country l to country n to be used as input in sector j takes the following form.

$$p_{nl}^{ji}(\omega) = \frac{\tau_{nl}^{ji} c_l^i}{z_l^i(\omega)} \qquad \text{for all } \omega \in [0, 1],$$

where

$$c_l^i = \left(\frac{P_l^i}{1 - \beta_l^i} \right)^{1-\beta_l^i} \left(\frac{w_l}{\beta_l^i \mu_l^i} \right)^{\beta_l^i \mu_l^i} \left(\frac{r_l}{\beta_l^i \left(1 - \mu_l^i\right)} \right)^{\beta_l^i \left(1-\mu_l^i\right)}$$

where P_l^i is the price index of the intermediate composite used in sector i and (source) country l, while w_l and r_l are the equilibrium wage rate and rental cost of capital in country l, respectively.

The final remark about the supply side is about firm-specific productivity. We assume that country l possesses a technology stock of T_l^i in producing sector-i varieties. The technology stock T_l^i reflects country l's absolute advantage in producing sector-i goods. Following Eaton and Kortum (2002), we assume that firms in country l draw efficiency z_l^i for each variety $\omega \in [0,1]$ from the Fréchet distribution:

$$F\left(z_l^i < z\right) = e^{-T_l^i z^{-\theta}}.$$

2.2 Price Indices and Trade Shares

Perfect competition implies that firms of each variety of sector j in country n will purchase the intermediates from the firm that offers the lowest cost across all possible source countries. Thanks to Fréchet distribution of z, the price index of intermediates in country n and sector j is given by

$$P_n^j = \Upsilon_n^j \prod\nolimits_{i=1}^{J} \left(p_n^{ji}\right)^{\gamma_n^{ji}} = \Upsilon_n^j \prod\nolimits_{i=1}^{J} \left(\Phi_n^{ji}\right)^{-\frac{\gamma_n^{ji}}{\theta}},$$

where $\Upsilon_n^j = \prod_{i=1}^{J} \left(\gamma_n^{ii}\right)^{-\gamma_n^{ii}}$ is a constant and

$$\Phi_n^{ji} = \sum\nolimits_l T_l^i \left(c_l^i \tau_{nl}^{ji}\right)^{-\theta}.$$

For sector-j in country n, the cost share of intermediates i from country l in total costs spent on intermediates i:

$$\pi_{nl}^{ji} = \frac{T_l^i \left(c_l^i \tau_{nl}^{ji}\right)^{-\theta}}{\Phi_n^{ji}}$$

2.3 Expressions of DVAR

Domestic value added (DVA) in sales (domestic or exports) includes: (1) DVA from foreign countries embodied in imported intermediates; (2) DVA embodied in domestically-produced intermediates; (3) Primary factors (i.e. capital and labor) directly employed (direct DVA).

Let r_{mn}^i = VAR (value-added ratio) of country n embodied in country m's production of sector-i goods:

$$\begin{aligned} r_{nn}^i &= \beta_n^i + (1-\beta_n^i) \sum_{h=1}^{N} \sum_{k=1}^{J} \pi_{nh}^{ik} \gamma_n^{ik} r_{hn}^k \\ \text{and } r_{mn}^i &= (1-\beta_m^i) \sum_{h=1}^{N} \sum_{k=1}^{J} \pi_{mh}^{ik} \gamma_m^{ik} r_{hn}^k \text{ for } m \neq n \end{aligned}$$

We can express the DVAR in matrix $\mathbf{r}$ for all country-sector pairs as its element as

$$\mathbf{r} = \left[r_{mn}^{i}\right] = \beta + (\mathbf{I} - \mathbf{B})\,\mathbf{G}\mathbf{r}$$

where $\mathbf{r}$ is a $NJ \times N$ matrix of VAR of country n.

The recursive nature of the global IO linkages can be solved in matrix form by collecting all terms that contain $\mathbf{r}$ on the left hand side, which yields

$$\mathbf{r} = \left[\mathbf{I} - (\mathbf{I} - \mathbf{B})\,\mathbf{G}\right]^{-1}\beta, \tag{4}$$

where $\mathbf{B}$ is the $NJ \times NJ$ value-added share matrix with the diagonal element being β_n^i ($n = 1, ..., N$; $i = 1, ..., J$) and other elements being zero. $\mathbf{G} = \left[\pi_{nm}^{ik}\gamma_n^{ik}\right]$ is the $NJ \times NJ$ global intermediate goods cost share matrix. $\beta = \left[\beta_n^i I_{mn}\right]$ is a $NJ \times N$ matrix formed by stacking up J number of $N \times N$ matrixes each with element β_n^i when $m = n$ and 0 otherwise (i.e., I_{mn} is an indicator function such that $I_{mn} = 1$ when $m = n$ and 0 otherwise).

Totally differentiating $\mathbf{r}$ gives us the following expression

$$\begin{aligned} d\mathbf{r} &= d\beta - (d\mathbf{B})\,\mathbf{G}\mathbf{r} + (\mathbf{I} - \mathbf{B})\,(d\mathbf{G})\,\mathbf{r} + (\mathbf{I} - \mathbf{B})\,\mathbf{G}\,(\mathbf{dr}) \\ \Rightarrow d\mathbf{r} &= \left[\mathbf{I} - (\mathbf{I} - \mathbf{B})\,\mathbf{G}\right]^{-1}\left[d\beta - (d\mathbf{B})\,\mathbf{G}\mathbf{r}\right] \\ &\quad + \left[\mathbf{I} - (\mathbf{I} - \mathbf{B})\,\mathbf{G}\right]^{-1}(\mathbf{I} - \mathbf{B})\,(d\mathbf{G})\,\mathbf{r} \end{aligned}$$

The first term of the right hand side captures the pure effect of changing β_n^i. The second term captures the effect of the changes in intermediate goods shares π_{nm}^{ik} and input-output coefficients γ_n^{ik}. In the structural estimation exercises below, we will quantify the magnitude of each of the channels.

2.4 A $2 \times 1 \times 1$ Toy Model

Let us build a two-country, one-factor, one-sector model to obtain some insights about the stand-alone and interactive effects of changes in technology and trade frictions on country's DVAR.

Suppose there are two countries, indexed by $i = 1, 2$, with technology level T_i and wage w_i for country i, and $t = T_1/T_2$; $c = c_1/c_2$. Define $\tau_1 \equiv \tau_{12}$ and $\tau_2 \equiv \tau_{21}$.

There is only one primary factor of production, labor, and one sector with IO linkages.

Thus, the trade shares from country country l in country n (π_{nl}) is given by:

$$\begin{aligned} \pi_{11} &= \frac{tc^{-\theta}}{tc^{-\theta} + \tau_1^{-\theta}}, \pi_{12} = \frac{\tau_1^{-\theta}}{tc^{-\theta} + \tau_1^{-\theta}}, \\ \pi_{22} &= \frac{1}{1 + tc^{-\theta}\tau_2^{-\theta}}, \pi_{21} = \frac{tc^{-\theta}\tau_2^{-\theta}}{1 + tc^{-\theta}\tau_2^{-\theta}}. \end{aligned}$$

The value-added ratio of country 1's firms in country 1's exports and country 2's exports, respectively, are

$$\begin{aligned} r_{11} &= \beta + (1-\beta)(\pi_{11} r_{11} + \pi_{12} r_{21}) \\ r_{21} &= (1-\beta)(\pi_{21} r_{11} + \pi_{22} r_{21}) \end{aligned}$$

Totally differentiating this system of VAR yields

$$\begin{aligned} dr_{11} &= (1-\beta)(\pi_{11} dr_{11} + \pi_{12} dr_{21}) + (1-\beta)(r_{11} - r_{21})\, d\pi_{11} \\ dr_{21} &= (1-\beta)(\pi_{21} dr_{11} + \pi_{22} dr_{21}) - (1-\beta)(r_{11} - r_{21})\, d\pi_{22} \end{aligned}$$

which leads to

$$dr_{11} = A d\pi_{11} - B d\pi_{22}$$

where A and B are some constants, with $A > B > 0$.

Taylor series expansion of $d\pi_{11}$ and $d\pi_{22}$ to the second order derivative gives the decomposition of effects on DVAR due to different forces

Rearranging the terms and ignoring the second order effects on c, the effect can be decomposed into

(i) The pure effect of technology

$$(C+D)\frac{dt}{t} - [C\pi_{11} + D\pi_{21}]\left(\frac{dt}{t}\right)^2$$

(ii) The pure effect of trade frictions

$$-C\left[\frac{d\tau_1^{-\theta}}{\tau_1^{-\theta}} - \pi_{12}\left(\frac{d\tau_1^{-\theta}}{\tau_1^{-\theta}}\right)^2\right] + D\left[\frac{d\tau_2^{-\theta}}{\tau_2^{-\theta}} - \pi_{21}\left(\frac{d\tau_2^{-\theta}}{\tau_2^{-\theta}}\right)^2\right]$$

(iii) The interactive effect from technology and trade frictions

$$C(\pi_{11} - \pi_{12})\left(\frac{dt}{t}\right)\left(\frac{d\tau_1^{-\theta}}{\tau_1^{-\theta}}\right) + D(\pi_{22} - \pi_{21})\left(\frac{dt}{t}\right)\left(\frac{d\tau_2^{-\theta}}{\tau_2^{-\theta}}\right)$$

where $C = A\pi_{11}(1-\pi_{11})$ and $D = B\pi_{22}(1-\pi_{22})$

2.5 Major Source of Data

We use the 2013 edition of the World Input-Output (WIOD) Database which contains data for

- $J = 40$ countries + ROW

- $S = 35$ industries/sectors
- $T = 14$ years: 1995-2008

We provide a model to map the yearly changes in the $NJ \times NJ$ (2,059,225) global intermediate goods cost share matrix $\mathbf{G}$ due to changes in intermediate goods shares π_{nm}^{ik}

2.6 Taking the Model to Data

We estimate the change in competitiveness (relative to the US) using the following gravity equation,(which is derived from the model):

$$\begin{aligned}\ln\left(\frac{\pi_{nlt}^{ji}}{\pi_{nnt}^{ji}}\right) &= \ln\left(T_{lt}^{i}\left(c_{lt}^{i}\right)^{-\theta}\right) - \theta ex_{lt}^{i} - \ln\left(T_{nt}^{i}\left(c_{nt}^{i}\right)^{-\theta}\right) \\ &\quad -\theta v_{nlt}^{ji}\end{aligned}$$

The estimated asymmetric bilateral trade costs $\{\tau_{nl}^{ji}\}$ is obtained from the gravity estimation based on the estimated values of ex_{lt}^{i} and v_{nlt}^{ji}:

$$\ln \tau_{nlt}^{ji} = ex_{lt}^{i} + v_{nlt}^{ji}$$

The data are directly obtained from the WIOD table and PWT9.0 (Penn World Table 9.0).

2.7 Solving for the Equilibrium

Following Dekle, Eaton, and Kortum (2008), we use hat algebra to characterize the equilibrium changes. $\widehat{x} = x'/x$. For each year, use the estimated $\{\widehat{T}_l^i \left(\widehat{c}_l^i\right)^{-\theta}\}$ and $\{\widehat{\tau}_{nl}^{ji}\}$ as initial values. Start with a guess of $\{\widehat{w}_l\}$ and $\{\widehat{r}_l\}$, solve for:

$$\widehat{c}_l^i = \left(\widehat{P}_l^i\right)^{1-\beta_l^i} \left(\widehat{w}_l\right)^{\beta_l^i \mu_l^i} \left(\widehat{r}_l\right)^{\beta_l^i\left(1-\mu_l^i\right)}$$

$$\widehat{P}_n^j = \prod_{i=1}^{J} \left(\widehat{p}_n^{ji}\right)^{\gamma_n^{ji}}$$

$$\widehat{p}_n^{ji} = \left[\sum_{l=1}^{N} \pi_{nl}^{ji} \widehat{T}_l^i \left(\widehat{c}_l^i \widehat{\tau}_{nl}^{ji}\right)^{-\theta}\right]^{-\frac{1}{\theta}}$$

We can thus get the changes in trade shares $\{\widehat{\pi}_{nl}^{ji}\}$, and therefore the new trade shares $\pi_{nl}^{jii'} = \pi_{nl}^{ji} * \widehat{\pi}_{nl}^{ji}$

$$\widehat{\pi}_{nl}^{ji} = \widehat{T}_l^i \left(\frac{\widehat{c}_l^i \widehat{\tau}_{nl}^{ji}}{\widehat{p}_n^{ji}}\right)^{-\theta}$$

2.8 Constraints

The endogeneous variables and parameters we obtained from the data must satisfy the followign constrants:

The total expenditure on final goods mut be equal to payments to factors of production and trade deficit (D'_n)

$$E'_n = w'_n L'_n + r'_n K'_n + D'_n$$

Total production of each sector in each country $\{X_n^{i\prime}\}$ through

$$X_n^{i\prime} = \sum_{k=1}^{J} \sum_{m=1}^{N} \left(1 - \beta_m^k\right) \gamma_m^{ki} \pi_{mn}^{ki\prime} X_m^{k\prime} + \sum_{m=1}^{N} \pi_{mn}^{Fi\prime} \alpha_m^i E'_m$$

Capital and labor market clearing conditions

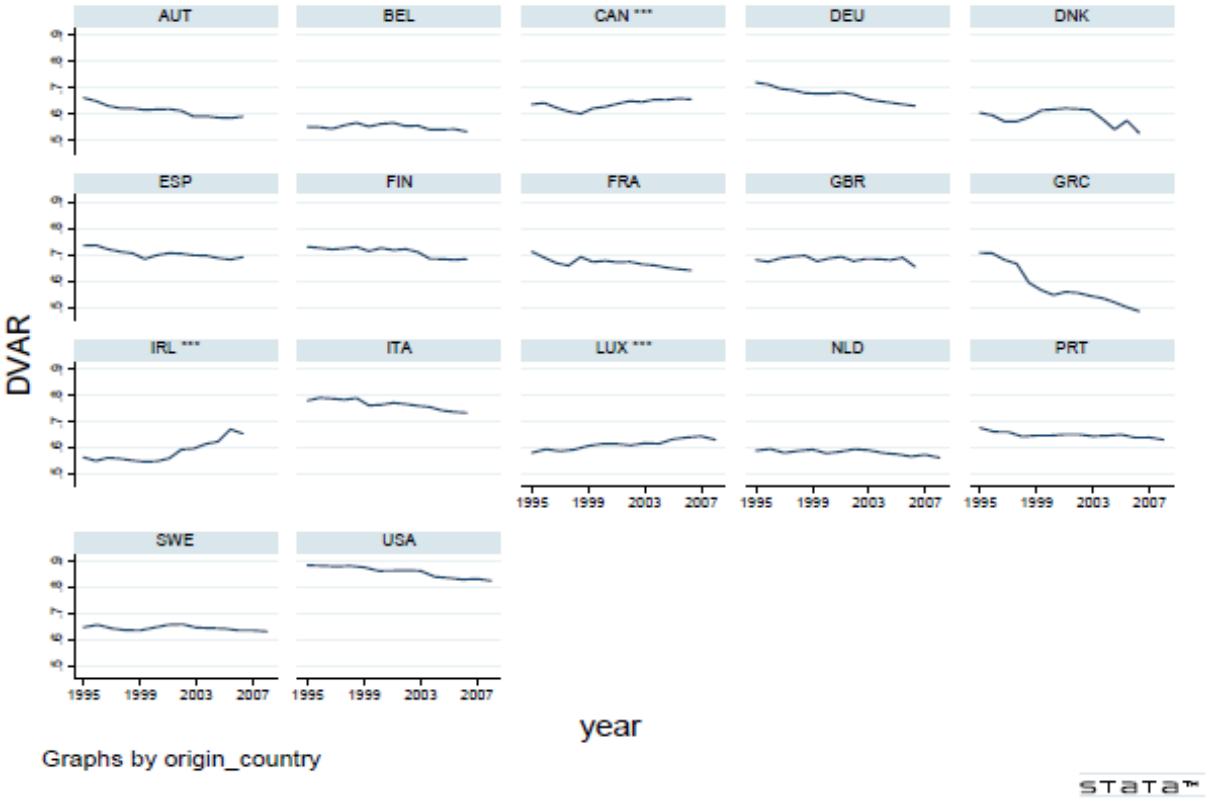
$$\begin{aligned} r'_n K'_n &= \sum_{i=1}^{J} \beta_n^i \left(1 - \mu_n^i\right) X_n^{i\prime} \\ w'_n L'_n &= \sum_{i=1}^{J} \beta_n^i \mu_n^i X_n^{i\prime} \end{aligned}$$

2.9 Calibration Results

The following two diagrams show the individual countries' DVAR for the fast-growing countries and the developed (OECD) countries respectively. We can see that some countries had their DVAR increasing over time, though the general trend is decreasing.



Fast-Growing Countries' DVAR



Developed Countries' (OECD) DVAR

The following graph shows the actual cumulative change in the DVAR of exports from developed and developing countries, respectively, using data from WIOD from 1995 to 2008 and equation (4). As the figure shows, the DVAR of exports from both samples of countries have been declining continuously, with the cumulative decline for deveoping countries equal to 5%, compared to 4% for developed countries.

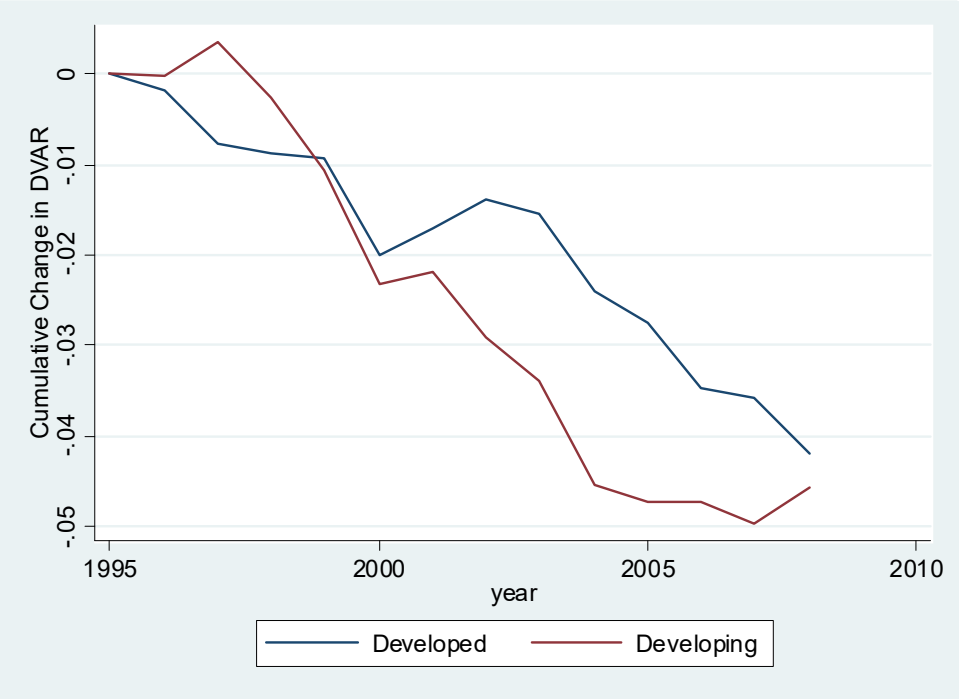


Figure 1: Developed and Developing Countries' DVAR

The following sets of diagrams show the results of our calibration.

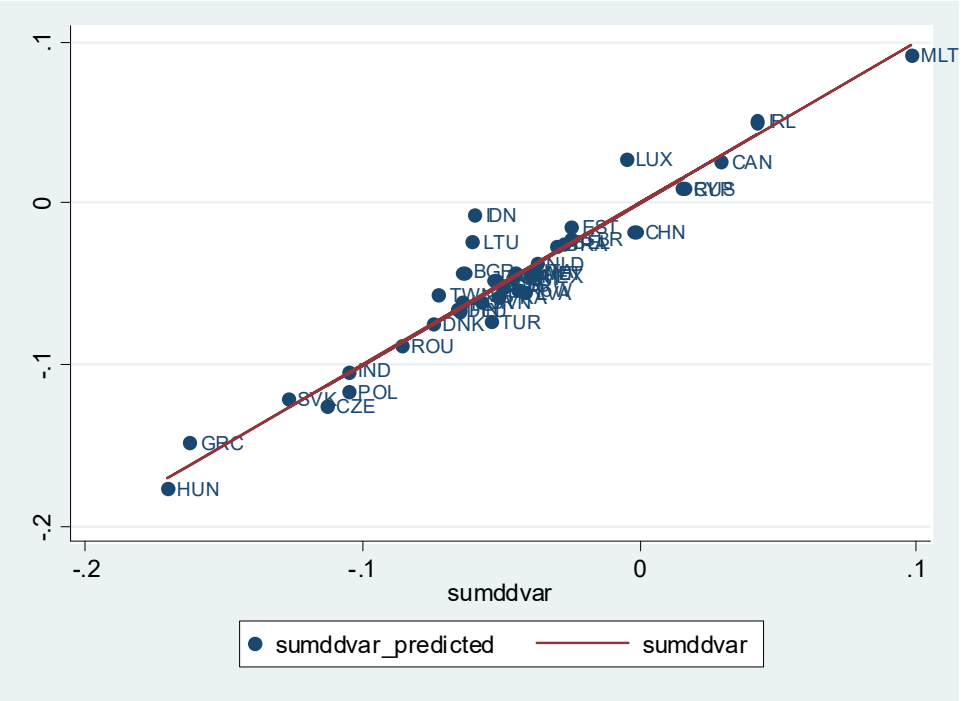


Figure 2: Fit of the Calibration.

The vertical axis is our prediction and the horizontal axis is the data. The fit is very good.

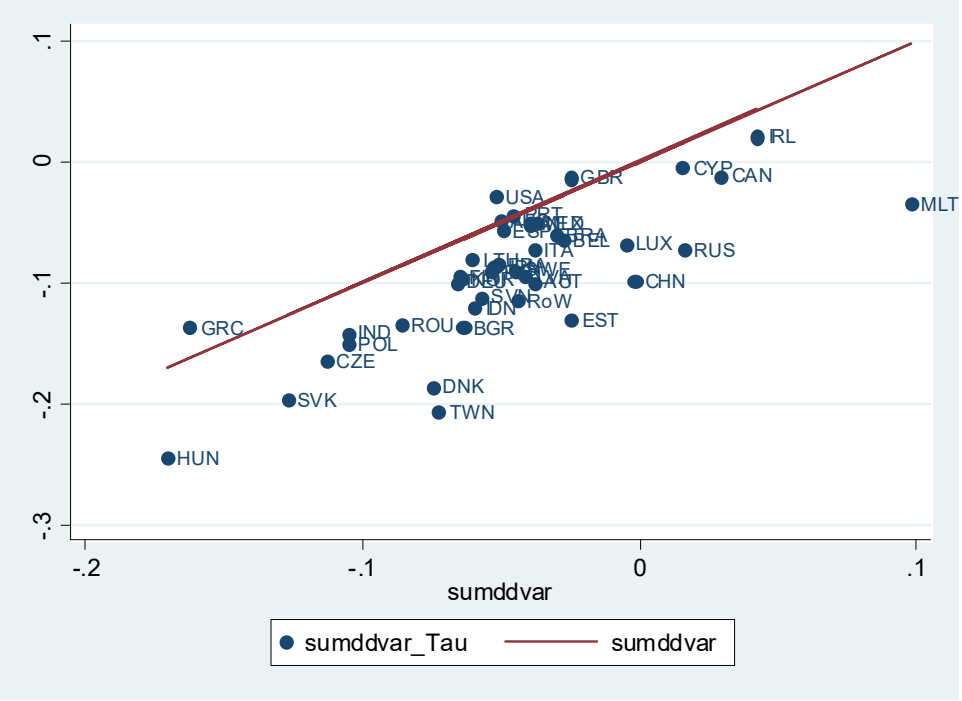


Figure 3: The Pure (Stand-alone) Effect of Changes in τ.

The pure (stand-alone) effect of changes in trade costs does not fit the data very well.

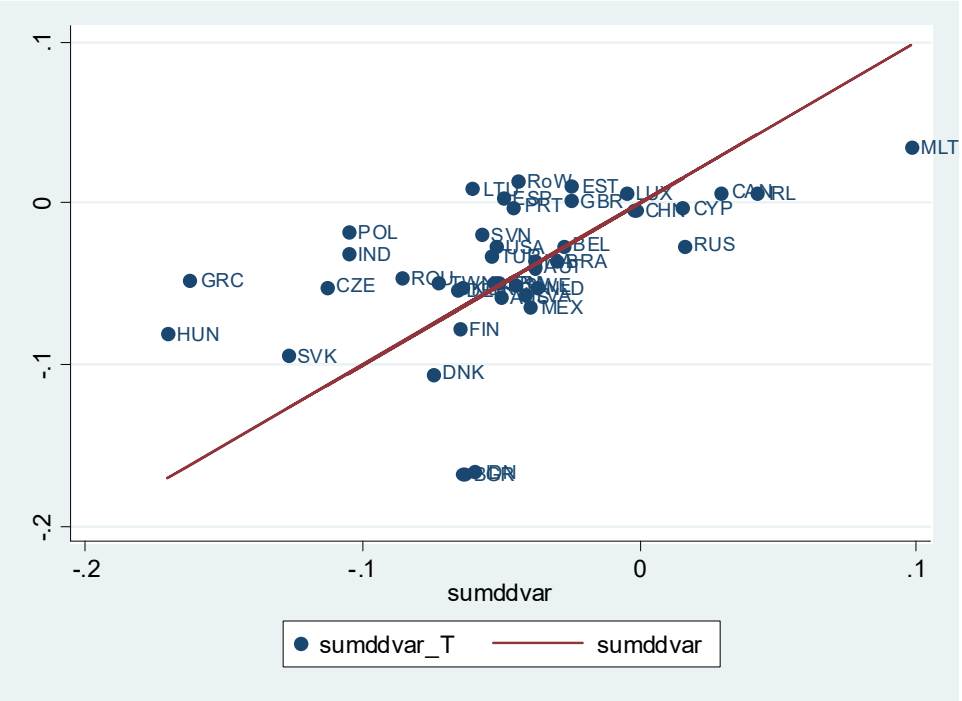


Figure 4: Pure Effect of Changes in T.

The pure effect of changes in technology stocks also does not fit the data well.

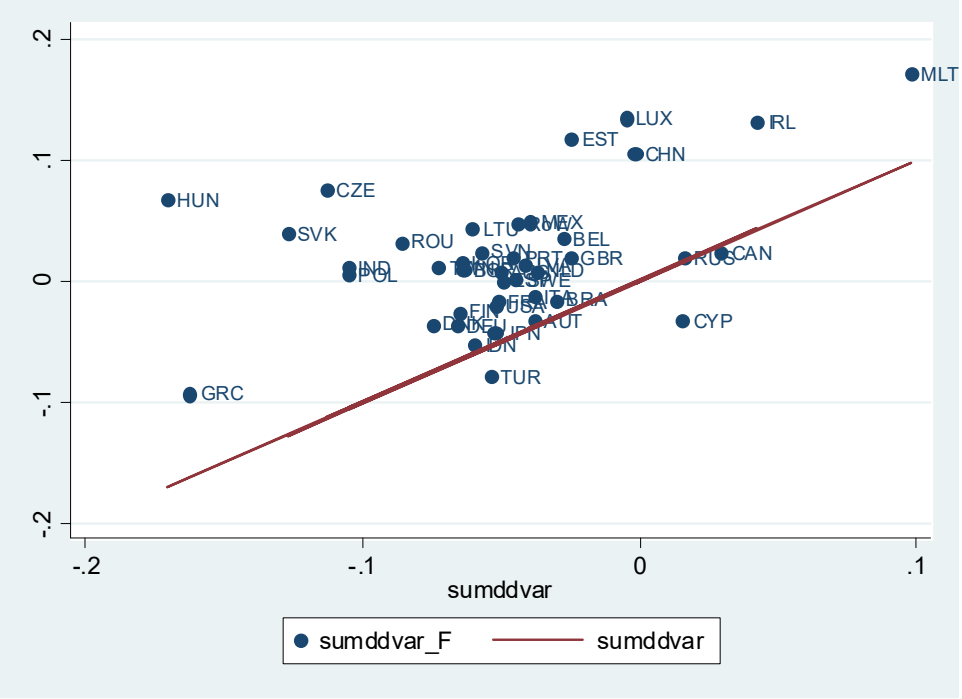


Figure 5: Pure Effects of Changes in Other Factors (i.e. K, L and trade balance).

The pure effect of "other factors" provides the poorest fit among the three sets of factors.

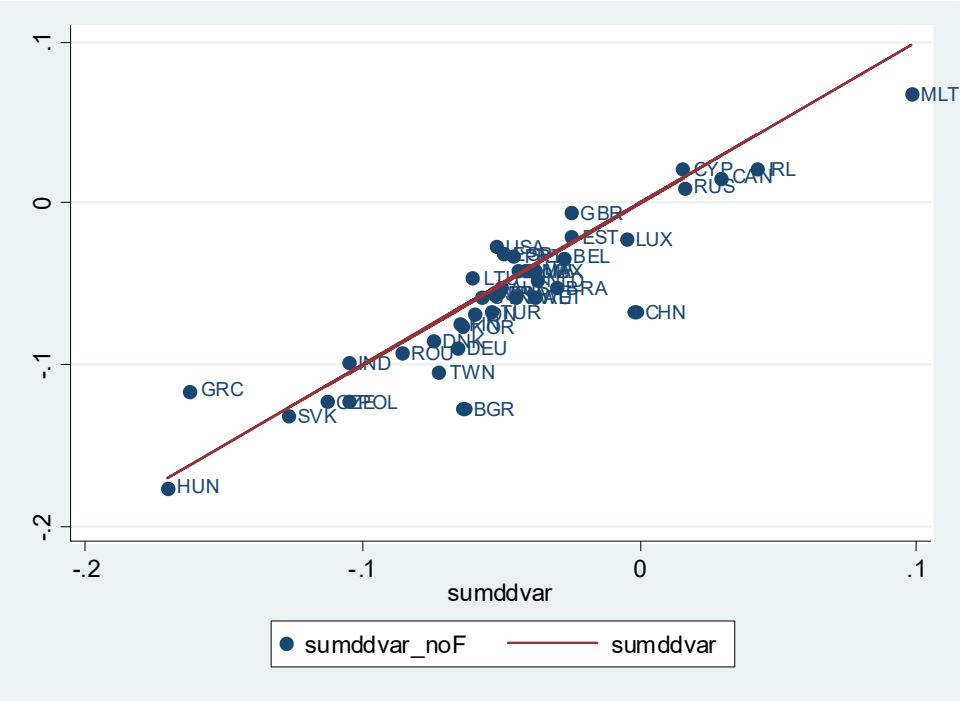


Figure 6: Counterfactuals of No Change in Other Factors

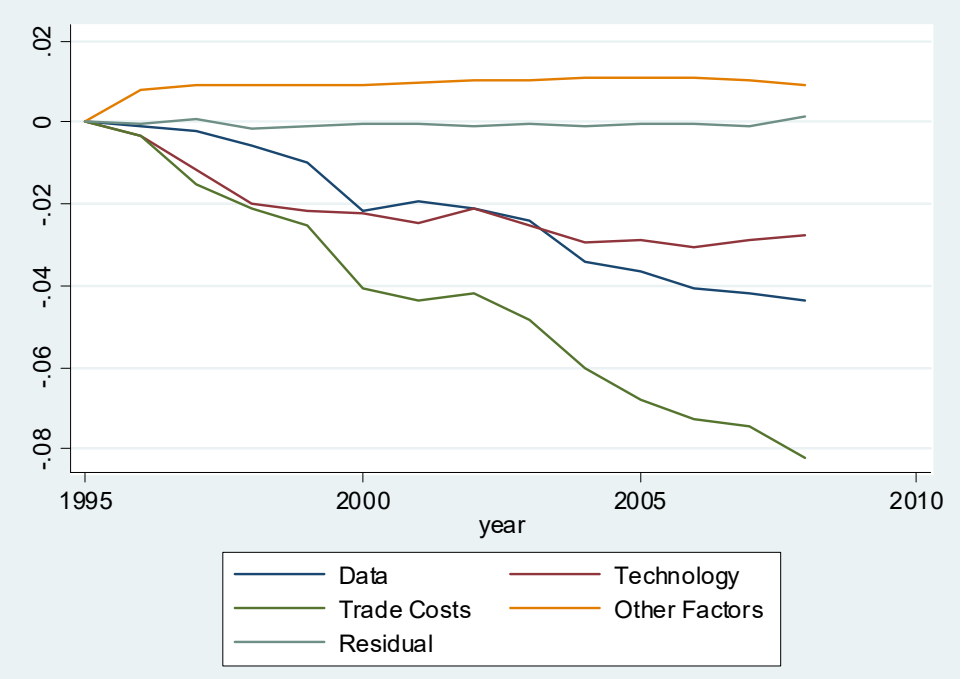


Figure 7: Different Pure Effects on Global DVAR

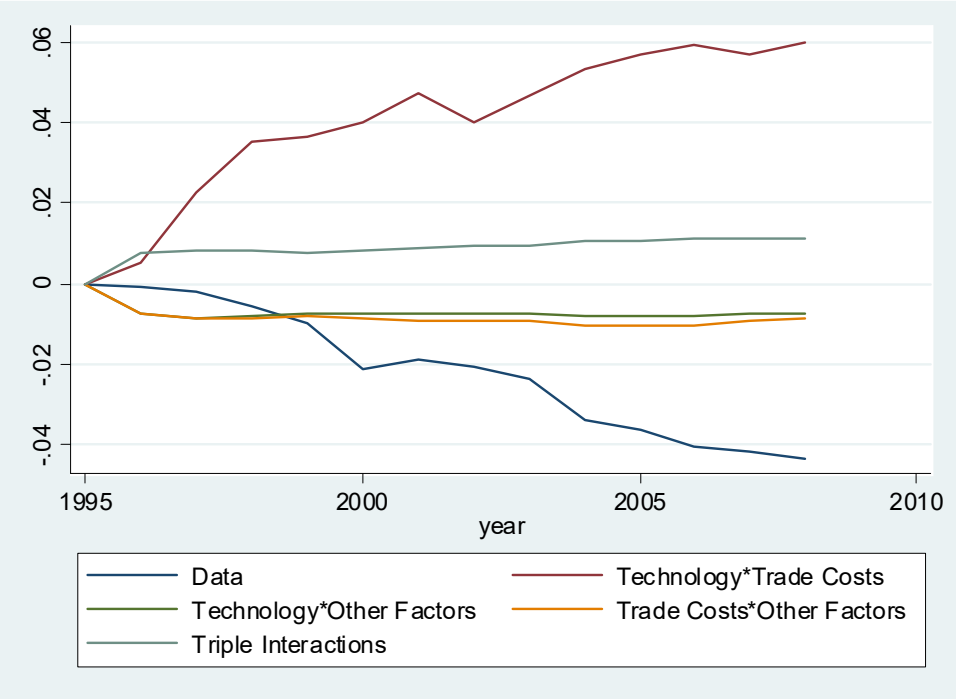


Figure 8: Effects of Interaction Terms on Global DVAR

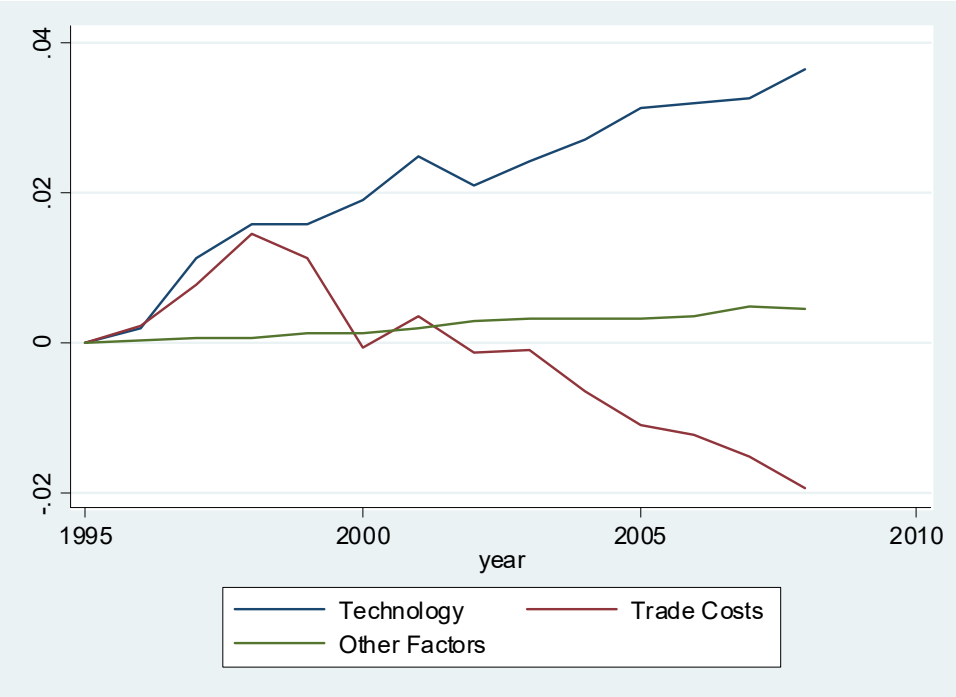


Figure 9: Total Effects of T, τ, and Other Factors on Global DVAR

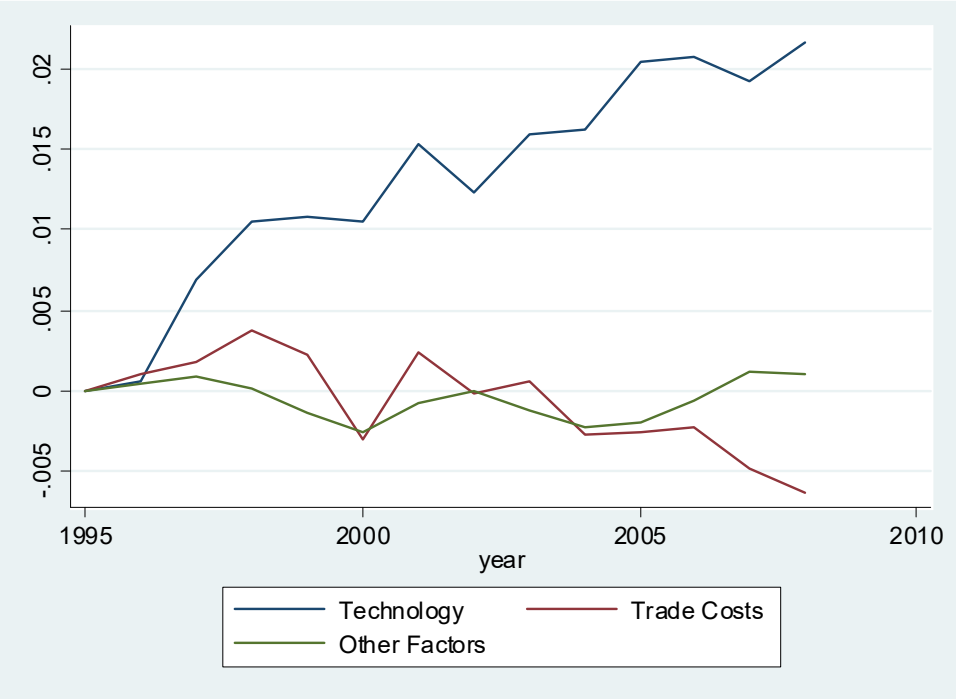


Figure 10: Total effects of T, τ and other factors for Developed Countries

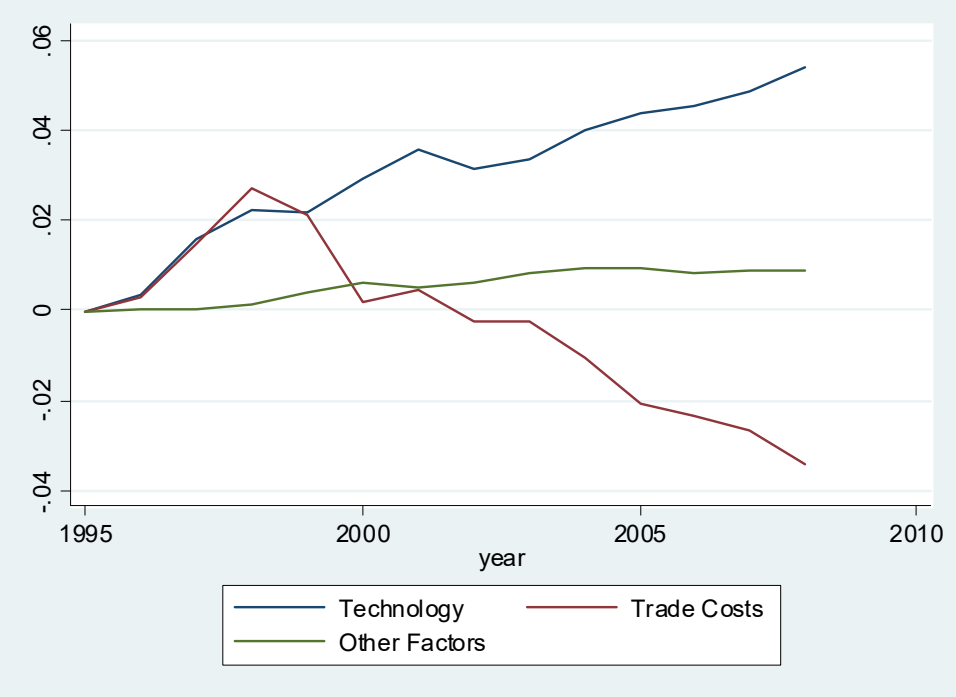


Figure 11: Total effects of T, τ and other factors for Developing Countries

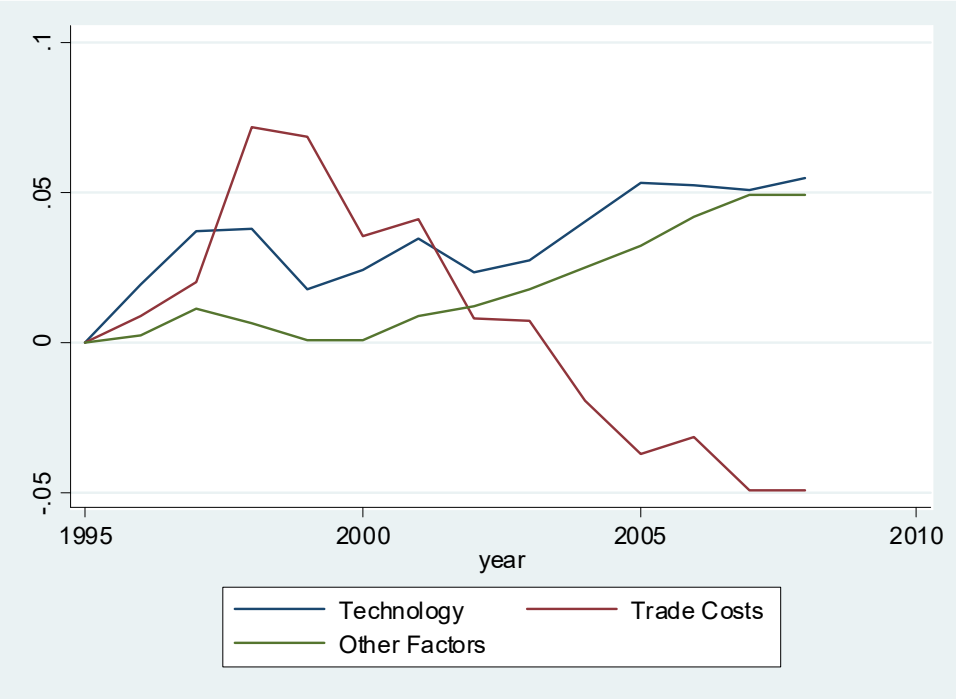


Figure 12: Total effects of T, τ and other factors for China

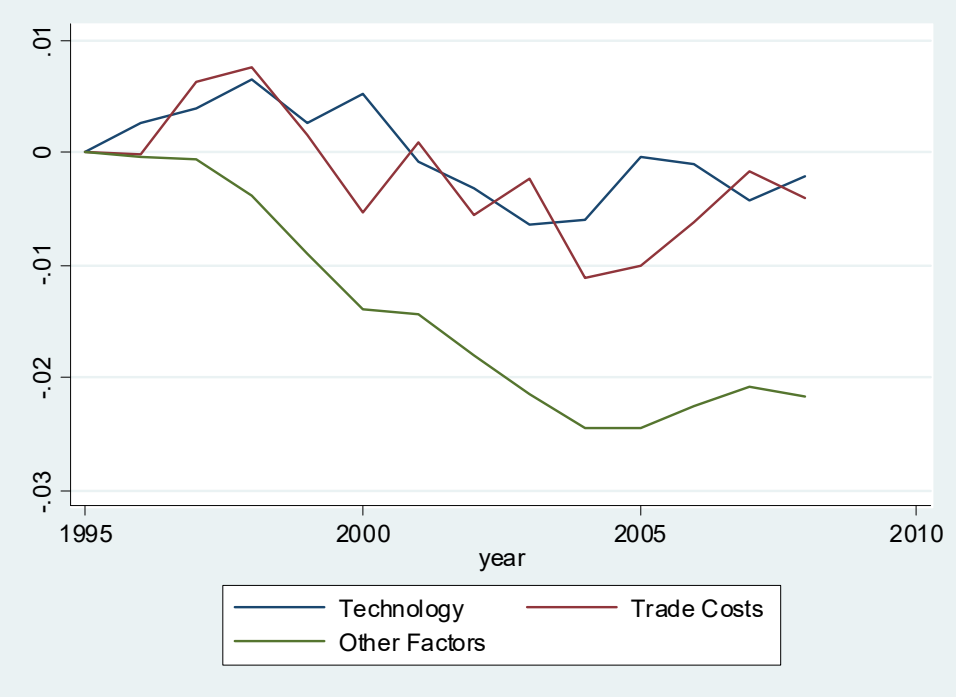


Figure 13: Total effects of T, τ and other factors for the US

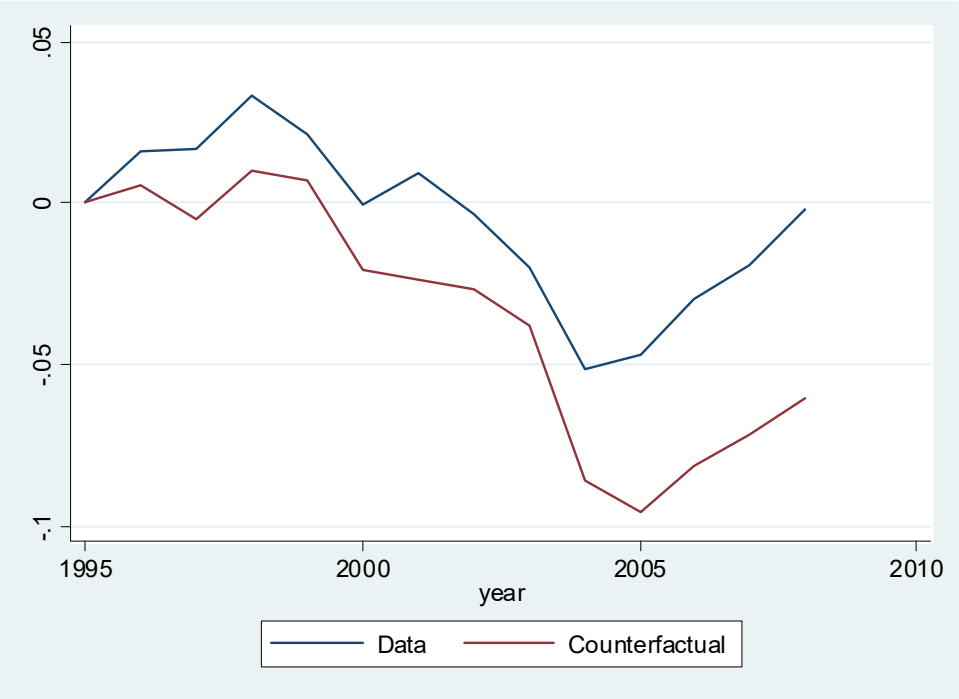


Figure 14: Effects of Shutting Down Changes in China's T on China's DVAR

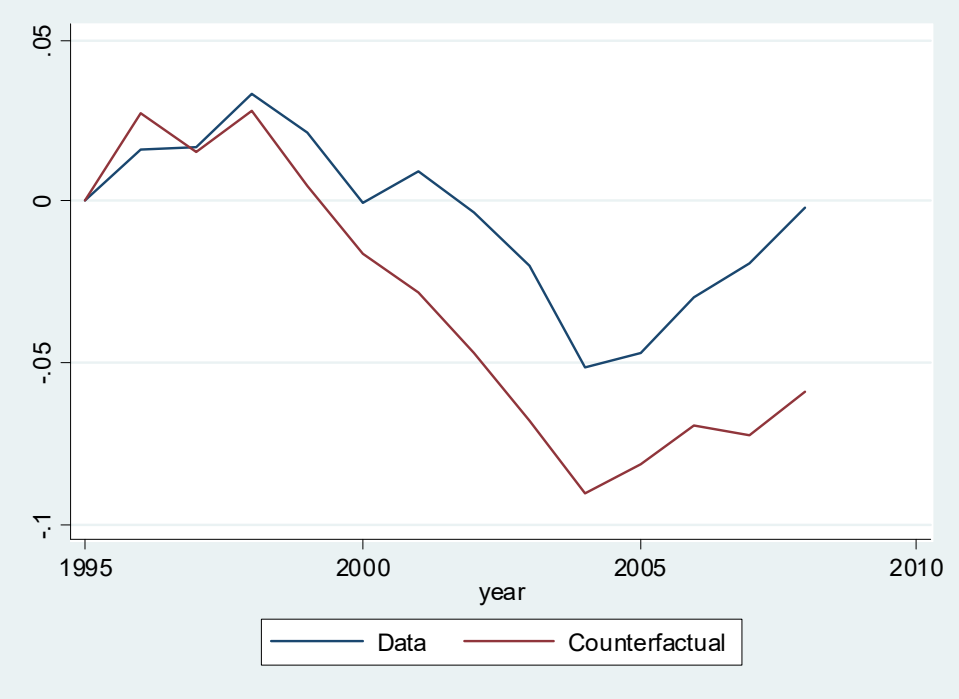


Figure 15: Effects of Shutting Down Changes in China's τ on China's DVAR

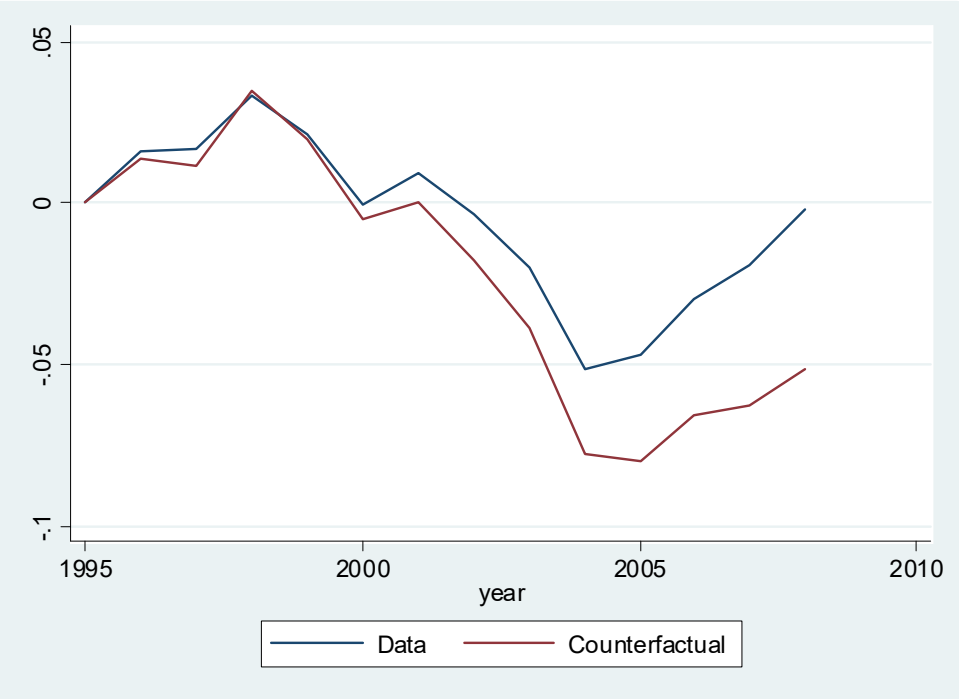


Figure 16: Effects of Shutting Down Changes in China's Capital on China's DVAR

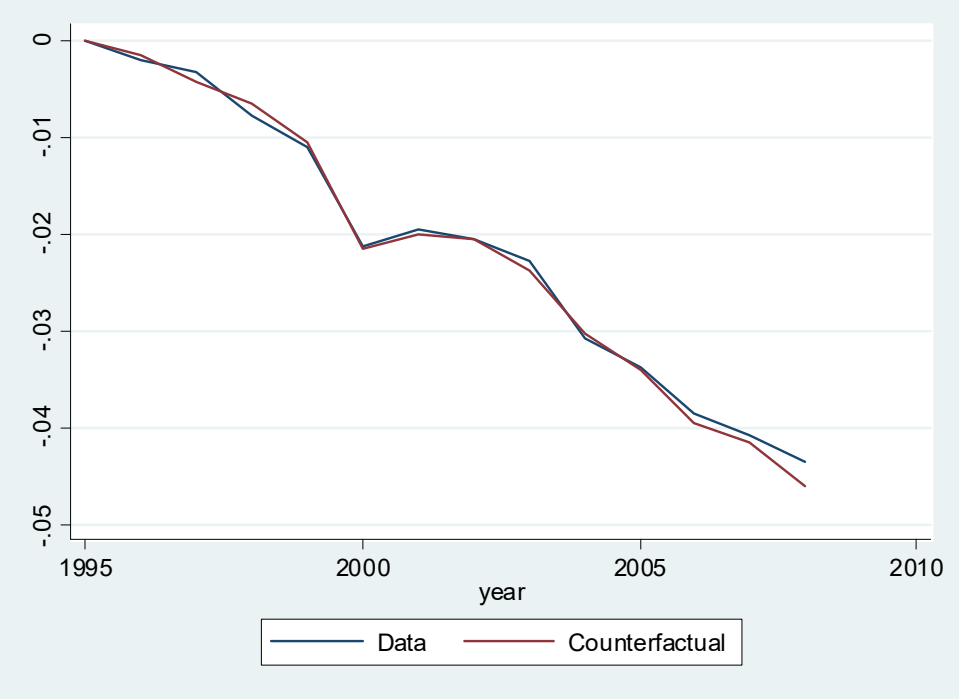


Figure 17: Effects of Shutting Down Changes in China's Technology on ROW's DVAR

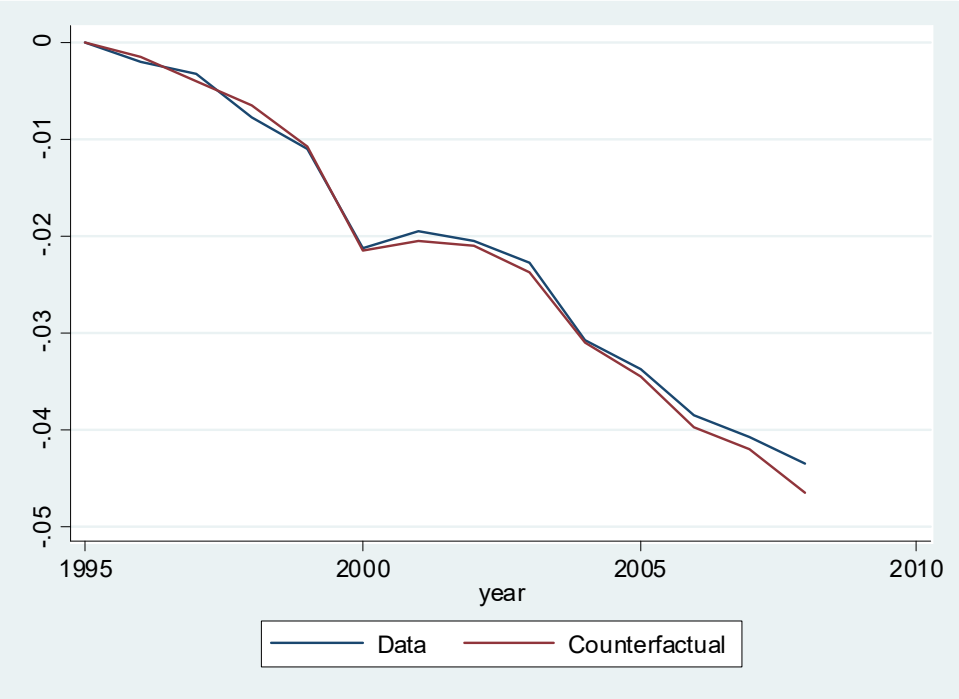


Figure 18: Effects of Shutting Down Changes in China's τ on ROW's DVAR

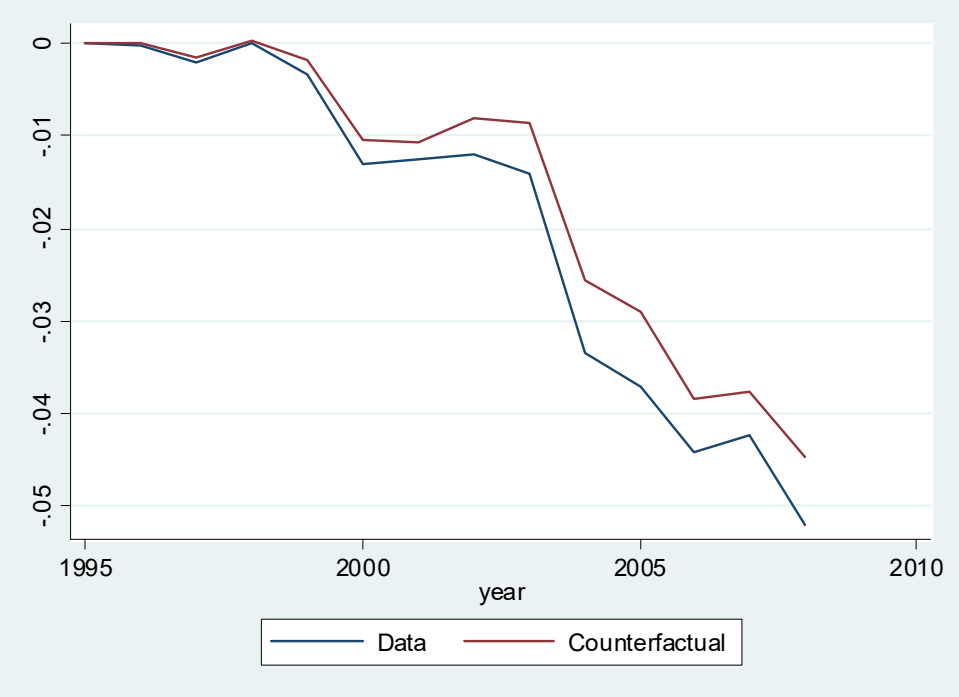


Figure 19: Effects of Shutting Down Changes in China's T on US's DVAR

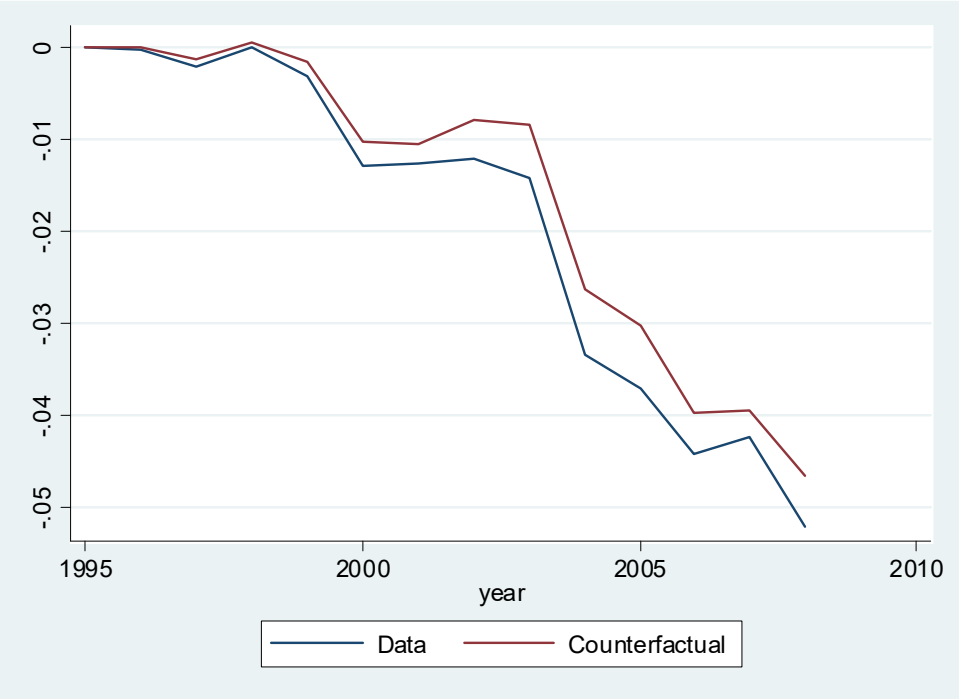


Figure 20: Effects of Shutting Down Changes in China's τ on US's DVAR

3 Conclusion

Based on a multi-sector Eaton-Kortum (2002) model with domestic and global input-output linkages, we quantify the contributions of different sets of factors to the changes in individual countries' DVARs and global DVAR during 1995-2008. In addition to trade frictions, we emphasize the importance of the positive effect of technology on individual countries' DVARs and global DVAR. The contribution of other exogenous factors (factor endowment, trade imbalance) are small. Last but not least, fast-growing countries, like China, which experienced a substantial improvement in technology, despite falling trade frictions, could have DVAR increasing over time.

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