Value-added Trade, Exchange Rate Pass-Through and Trade Elasticity: Revisiting the Trade Competitiveness *

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Abstract

How is exchange rate pass-through (ERPT) measure affected by increasing participation in global value chains? This paper measures ERPT for value-added trade, where production of exportable intermediate inputs requires sharing among countries in a back-and-forth manner for producing a single final product. Estimation of pass-through was done using World Input-Output Database (WIOD), World Economic Outlook (WEO), and OECD statistics. Empirically estimated findings suggest that ignoring the value-added trade will cause a systematic upward bias in the estimation of ERPT. From empirical investigation, it is also evident that there exists substantial heterogeneity in pass-through rates across sectors: sectors with high-integration into global market functions with a lower rate of exchange in comparison to sectors with less integration.

JEL Code: F14, F23, F41, L16

Key Words: Value-added trade, Pass-Through, Trade Competitiveness, Intermediate inputs, Production Sharing

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1 Introduction

In international economics, prices and exchange rates lie at the heart of classic academic and policy analysis (Burstein and Gopinath, 2014).[1] The exchange rate affects domestic price levels directly through imported final goods and indirectly through imported inputs used in the production of domestic goods. Conventional trade theory predicts that exchange rate increases (in other words, devaluation) will increase exports. On the other hand, imports become more expensive. When the exports of a country are produced using imported intermediary inputs, then the effectiveness of exchange rate policy becomes complex.

Empirical studies have paid little attention toward this indirect channel, maybe due to required data limitation. Under the liberalized trade era, freer factor (capital and labor) movements, technological improvements, lower transaction and communication costs, and information availability expedited cross-border production sharing. The recent availability of input-output tables across countries and over time revealed the supply-side information about the production stages of a single product compared to the traditional demand-side information.[2] This supply-side information raised some questions regarding the effectiveness of exchange rates as an automatic stabilizer in open economy macroeconomics. Therefore, the central question in international finance remains whether exchange rate pass-through is complete or incomplete, and is it heterogeneous across sectors or not?

This paper considers a back-and-forth trade structure as follows: assume there are four countries in the world, namely Bangladesh (B), India (I), China (C), and the USA (U), engaged in a global value chain of trade.[3] In this hypothetical trade structure, countries are producing apparel and textile products. Figure 1 presents the illustrated view of the proposed production structure. In *stage one*, countries C and I produce raw materials (cottons) for the production of textiles. In *stage two*, countries C and I

[1] Literature explains the relationship between prices and exchange rates using the relative purchasing power parity (PPP) which states that changes in price of a product should be same across markets after converting it into a common currency (Burstein and Gopinath, 2014).

[2] Using input-output information across countries, Johnson (2014) found that the value-added exports share are lower than the gross exports share in total trade.

[3] In this paper back-and-forth trade considers the case when exported products are produced with imported raw materials and imported products are produced with the exported items. See Chungy (2012); Timmer et al. (2014b); and Hummels et al. (2001) for more on global value chain or production fragmentation, which is the basic idea of back-and-forth trade structure.

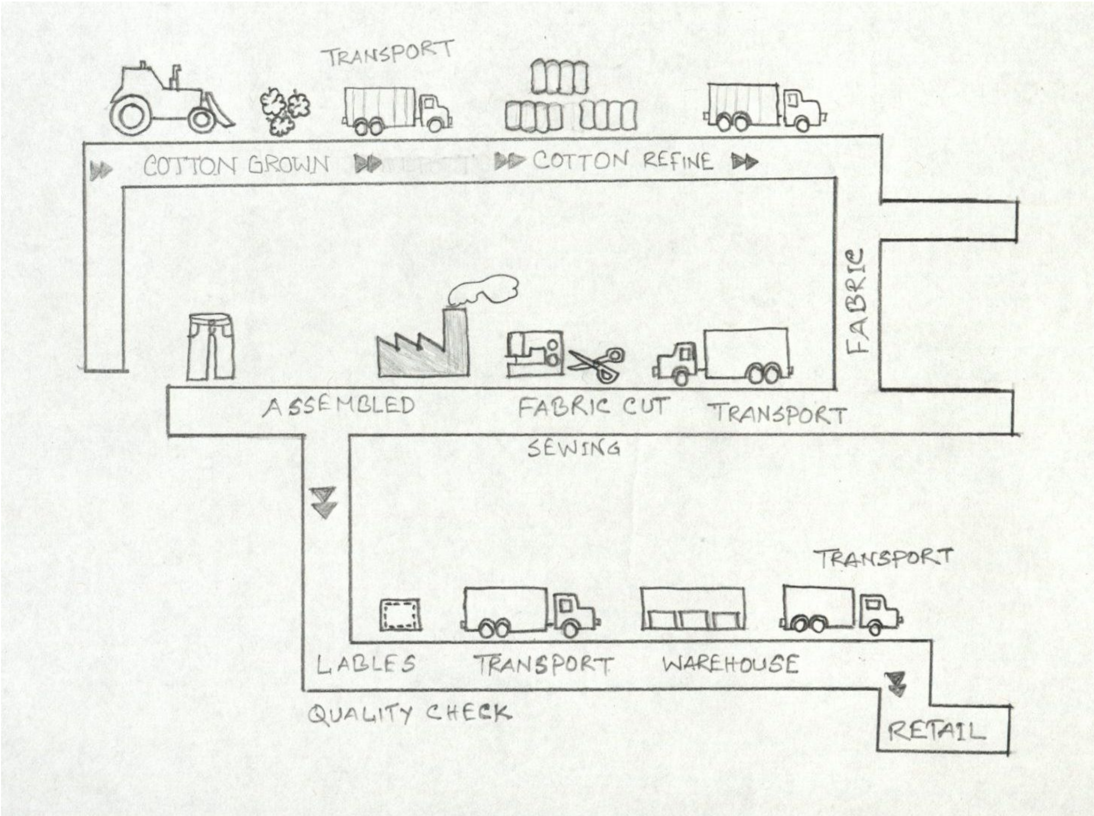
ship the cotton to country B, and where it is refined to make threads. In *stage three,* country B uses some of the threads to produce fabrics in their own country and the rest is exported to country C to produce different quality fabrics. In *stage four,* country C exports their fabrics to country B for cutting, stitching and finalizing the product for retailers. In *stage five,* country B produces the final product and then exports it to country U, whereas U had sent the design in the first place. It may appear from the label of the product that it is made in country B, even though country B has a small fraction of the value-added share in the total production process.

Traditional trade theory predicts that a depreciation of country B's currency makes that country's goods cheaper to foreigners, which implies that their export to country U increases. On the other hand, exports from country C and/or country I to country U decrease. The global value chain assails this conventional prediction and reveals that, in general, this does not hold across sectors. The demand for raw materials from country C and country I increases due to the higher demand for country B's exportables. Empirical studies in international finance overlook this secondary channel. This paper examines how exchange rate change passes-through to relative prices of exports and imports with increasing participation in back-and-forth trade. Does this pass-through change the conventional notion of the relationship between exchange rates and trade?

There have been several studies on different branches of production fragmentation, global value chain trade, and their welfare effects: both in theoretical and empirical settings.[4] However, there have been a limited number of studies, compared to other subbranches, on exchange rate pass-through under production sharing or global value chain trade. We found few studies that examined the relationship between production sharing and exchange rate pass-through. Ghosh (2009) theoretically studied the impact of exchange rate movement on cross-border production, while Ghosh (2013) empirically tested the responsiveness of trade between Mexico and the USA, focusing on production sharing exports. Powers and Riker (2013) studied exchange rate pass-through behavior under value-added trade. However, none has studied the back-and-forth nature of production and value-added export to analyze the effectiveness of

[4] Arndt and Kierzkowski (2001); Arndt (2008); Baldwin and Venables (2013) and Arndt et al. (2014). Arndt and Kierzkowski (2001) and Arndt et al. (2014) discussing different aspects of cross-border production sharing. Arndt (2008) discusses the cross-border production sharing for the east Asian countries, but he did not mention about back-and-forth production structure.

Figure 1: Back-and-forth trade structure for apparel and textile products



exchange rate pass-through.

This paper contributes to the literature on international trade and finance by examining a new production structure, where inputs are shared among countries in several stages. The empirical estimation for bilateral trade by sectors uses data from the World Input-Output Database (WIOD). The database contains time series data on the international sourcing of intermediate inputs and final goods in 35 sectors among 40 countries (27 EU and 13 other major countries) during the period of 1995-2011. The WIOD database contains data on sectoral trade, domestic expenditure, and final expenditure and sectoral value-added (labor and capital) in production. From the input-output table, we estimate the sources of value added in final goods traded and consumed in the world.

This paper follows a similar empirical estimation technique as Powers and Riker (2013). However, in contrast to value-added trade as used by the former paper, we used a back-and-forth production structure to determine the value-added trade that crossed the border multiple times for the production of a single product. To construct the variable of interest (i.e., back-and-forth export), this paper uses Wang et al. (2013)'s technique to separate domestic value-added that is absorbed abroad and returned to home after some value addition.[5] From the empirical estimation, we found that the average pass-through rate ranges from 0.002 to 0.028 for different types of value-added measure, while the pass-through rate for the manufacturing sector ranges from 0.016 to 0.204 and the pass-through rate for the service sector ranges from -0.048 to 0.185. Our estimated pass-through is higher than Powers and Riker (2013), but similar to the value of Campa and Mínguez (2006) and Marazzi et al. (2005).[6]

A significant amount of literature has studied the macroeconomic implications of invoicing currency choice and associated trade effects. The real effective exchange rate (REER) is one of the most important indices to policy makers and academia for welfare analysis, as well as to explaining exports' competitiveness.[7] The REER also measures the change in competitiveness due to the change in the demand for goods produced by a country as a function of changes in relative price (Patel et al. (2014); Saito et al. (2013); Powers and Riker (2013)). Competitiveness arises as changes (falls) in the cost structure of a producer make their product more competitive by enabling it to capture demand from other producers (Patel et al., 2014); therefore, it is important to decompose the role of competitiveness, which arises from the change in REER. Global value chain trade provides new weights that depend on both the global input-output structure and relative elasticities in production versus demand (Bems and Johnson, 2015).

According to the above-described trade structure, an increase in prices for textile raw materials in country C or country I could very well lead to a decline in demand for country B's products, even though in country B everything remains the same; hence there is a decline in competitiveness. This paper decomposes trade elasticity into two parts: own price and price index effect. Own price effects capture the cost increase

[5]This paper also has some similarity with Gaulier et al. (2008) and Campa and Mínguez (2006) in terms of the empirical estimation procedure. Gaulier et al. (2008) studied exchange rate pass-through (ERPT) at the product level for Canadian goods exported to the united states, while Campa and Mínguez (2006) studied ERPT for EURO countries. This paper combines both sectors and countries over time. We did our estimation by sectors and also by countries.

[6]Using the WIOD database, and excluding 12 smaller countries and service sectors from their empirical estimation, Powers and Riker (2013) found the median pass-through rate for manufacturing sector is 0.44. They also restricted their analysis only for the period of 2000-2009.

[7]The standard REER indices measured by BIS and IMF used in their surveillance are based on gross trade rather than trade in intermediate goods. The most widely-used indices published by the IMF and the Bank of England uses bilateral export shares or import shares or trade (exports plus imports) shares as their weights Bayoumi et al. (2006).

due to increase in raw materials' price from an exchange rate shock. We found that there is a substantial heterogeneity both in own price and cross-price elasticities across sectors and across countries. For example, we found that a 10% increase in the nominal exchange rate of the Renminbi to the USD (10% depreciation of the Renminbi relative to the USD) will increase China's agriculture, forestry, and fisheries exports by 2.3%. Further, we found that due to the negative effect of own price effect, exports decrease by 0.19%, while for positive cross-price effect exports increase by 2.5%.

This paper is organized as follows: section 2 describes some recent literature on global value chain trade, real exchange rate measurement, and competitiveness issues. Section 3 describes the methodology and data for examining the difference between other approaches and this approach. Section 4 discusses the empirical findings from the data. Finally, section 5 concludes.

2 Literature Review

Since the early 1980s, there has been a considerable amount of research on exchange rate pass-through (ERPT), mainly in advanced countries. Although previous research explained the ERPT as the changes in consumer prices due to changes in exchange rate, recent studies included both the change of producer prices or consumer prices due to a change in import prices. The effect of exchange rate pass-through depends on both time dimension and pricing strategy. Under the producer currency pricing (PCP), prices are determined in the exporter's currency, then import price passes completely. On the other hand, under local currency pricing (LCP), exporters' prices vary with the exchange rate changes but the destination (importer) prices are stable. However, a complete pass-through may occur if the production process takes place under perfect competition, while incomplete pass-through may occur in an imperfectly competitive environment.

Nowadays, the production process becomes more complicated, with several stages of imported intermediate inputs. In consequence of the multi-stage production process, traditional trade statistics become increasingly less reliable for defining the margin of a contribution made by each single country. Hummels et al. (2001), in their seminal paper, came up with the idea of vertical specialization (VS) in production processes. They defined vertical specialization under some assumptions, such as a good is produced in at least two sequential stages, at least two countries provided value-added during the production of the good, at least one country must use imported inputs in the production process, and part of the output must be exported. Using input-output table information from 14 countries (10 OECD and 4 emerging economies) for the period of 1960-1990, they found that the VS share of merchandise exports for the 10 OECD countries was 0.20 and smaller countries have VS shares as high as 0.4, on average. Moreover, for the entire sample they found the VS share grew by about 30% during the time period, and growth in VS exports accounted for 30% of the growth in the overall export/GDP ratio.

However, when a country exports processing goods, then vertical specialization with multi-stage processes will give a biased result. Koopman et al. (2012) mentioned that when more than one country is exporting intermediate goods, then the VS trade, as Hummels et al. (2001) mentioned, will not hold. Recent literature on REER using global input-output structure uses the Global Trade Analysis Project (GTAP) database (Johnson and Noguera (2012); Koopman et al. (2014); and Daudin et al. (2011)), the World Input-Output database (WIOD) (Koopman et al. (2012, 2014); Wang et al. (2013)), and the OECD-WTO TiVA Database to explore this issue.

As the production process became more fragmented, standard official gross trade statistics account the total value of goods at each border crossing, rather than the net value added at each crossing point. Johnson and Noguera (2012) computed the value-added content of trade, combining global input-output tables with bilateral trade data for several countries. They separated gross output of a country by destination where it is absorbed in their final demand then they used value-added to output ratios for the country of origin to compute the value added output transfer to each destination. They mapped where the value added was produced and where it was absorbed.

Measuring competitiveness when trade is happening in a back-and-forth setting can be defined by REER. Intermediate inputs sharing in the production process change the relative price of goods, but are less sensitive to the domestic factor price movement. Bayoumi et al. (2013) formulated a new index of REER and named it *REER-goods*, where goods are produced using both domestic production inputs and foreign production inputs. They incorporated the price of goods as a function of the price of production factors, which were embedded in goods. They concluded that their result captured a depletion in competitiveness due to a rise in relative factor costs or an appreciation of nominal exchange rate. In determining the price index, they used the two-level constant elasticity of substitution (CES) functional form as the production technology, which separated domestic value-added and foreign value-added used in the domestic production instead of using one CES price aggregator, as Armington (1969) did. For empirical estimation of their model, they used both the OECD bilateral trade database and the Input-Output database, with the UN-Comtrade database to define intermediate inputs sharing among countries, and for price measure, they used GDP deflator from the World Economic Outlook (WEO) from the International Monetary Fund (IMF).

For a tractable and empirically replicable formulation, Koopman et al. (2014) provided a unified accounting framework, which can fully account for a country's gross exports by its various value-added (domestic value-added that returns home and foreign value-added) and double counting components. Their framework considered the measure of vertical specialization and value-added trade, which solved the problem of back-and-forth trade of intermediates across the border multiple times. They proposed an accounting framework for avoiding the double counted problem in the existing official trade statistics. For the empirical estimation for their theoretical framework, they used the GTAP database 7 along with the UN-Comtrade database and a quadratic mathematical programming model to construct a unique dataset. The new database covers 26 countries and 41 sectors.

However, with the availability of a more structured database, it was found that the value-added export (VAX) ratio has two limitations. Wang et al. (2013) identified that the VAX ratio cannot consistently explain sectoral, bilateral or bilateral-sectoral level fluctuations. They also pointed out that even after reformulation, some of the important features such as the back-and-forth nature of value addition by sectors cannot be explained by the VAX ratio, as proposed by Johnson and Noguera (2012). Koopman et al. (2014), revealed that the total gross exports of a country can be decomposed into domestic value addition, foreign value addition and also detect the double-counted value added portion for the countries. However, this method cannot differentiate sectoral, bilateral or bilateral-sector level value addition. The exports in a given sector from a country use value-added from other sectors in the same country, and value-added from both the same sectors and other sectors in other countries (Wang et al., 2013). Augmenting Koopman et al. (2014)'s framework and incorporating the above limitations, Wang et al. (2013) applied the gross exports decomposition formula to bilateral-sector level data. Their decomposition framework can explain any level of dis-aggregation from gross trade flows into domestic value-added engrossed abroad; domestic value added that is initially exported but eventually returned home; only foreign value-added; and pure double counting terms.

The advancement of global supply chains and intermediate inputs sharing present an ultimatum for the traditional multi-sector macro models. Recent literature documented the importance of re-defining the measurement of exchange rate fluctuation, as well as the effectiveness (Thorbecke and Smith (2010); Purfield and Rosenberg (2010); and Cheung et al. (2012)). In a multi-country, multi-sector production, both foreign and domestic inputs play an important role in external sector adjustment. Mismeasured preference weights and price elasticity parameters from the traditional value-added model give a biased result in relative price response. Bems (2014) decomposed the deviation due to price fluctuation into "imported input" and "domestic input" categories based on preference weights. Imported input lowers barriers to economic openness, and thereby increases the responsiveness of relative price to a given external adjustment, i.e., the traditional value-added model understated price adjustment. Domestic input increases service embedded manufacturing trade or lowers net manufacturing trade; therefore, the traditional value-added model overstates the price adjustment. He also showed that mismeasurement overstates CES price elasticity and interaction of both preference and weight effects and price elasticity understate the price response effects.

Recent research also showed that exchange rate has experienced a freat deal of variation over recent decades, whereas the price has changed relatively little. Amiti et al. (2014) found that larger exporters were also larger importers. They showed that the value of a country's currency is associated with its trade partners through the imports of intermediate inputs, which reduces the need for exporters to adjust their export market prices. To check their theoretical framework, they used firm-level data for Belgium and found that exporters with larger imported input share pass lower exchange rate variation into export prices. They investigated their results further, decomposed them into several channels, and found that higher import-intensive firms have the higher export market shares. They concluded that a small exporter with no imported inputs has a nearly complete pass-through, while a large import-intensive exporter has a pass-through of just above 50%, at an annual horizon.

Economic models for accounting exchange rate pass-through rely on the assumption that exports are denominated in exporters' currency fully and the exported items are fully produced with exporters' own value addition (Powers and Riker (2013, 2015)). However, as global value chain estimation becomes forthright, calculating the share of the cost structure for exports becomes easier. Using the input-output tables, Powers and Riker (2015) calculated the exchange rate pass-through coefficient for 28 countries for 13 manufacturing sectors. They found that exchange rate pass-through denominated in the costs of the exporters' currency are inclined to understate the pass-through rates and to overstate the adjustment of the exporters' markups to movements in exchange rates. They also found that without incorporating value-added trade, trade elasticity estimates are systematically overstated.

3 Methodology and Data

3.1 Model

This structural model is derived from Bems and Johnson (2015) and Powers and Riker (2013) to estimate exchange rate pass-through, which accommodate value-added trade. This section is divided into two parts. In the first part, we derived the estimable equation of exchange rate pass-through using value-added trade, prices, and exchange rates. In the second part, we derived the trade elasticity based on the parameters driven in part one and value-added trade information.

3.1.1 Exchange Rate Pass-Through

Let's assume that the world economy consists of many countries (i, j, and $k \in \{1,2,...,N\}$). Each country follows Armington type production function to produce a tradable good in sector s using both intermediate and final goods. Country i's total output, Q_i, is produced combining both domestic value-added, X_i, and the composite intermediate inputs, V_i. The composite intermediate inputs are the aggregate of domestic and foreign imported inputs, where inputs are imported from country j to country i. The production process follows constant elasticity of substitution (CES) form:

$$V_i = \left(\sum_j (\alpha_{ij})^{1/\sigma} q_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{3.1}$$

where the α's are aggregation weights, and σ is the elasticity of substitution among composite inputs.

Solving the maximization problem in (3.1), yields the demand function as follows:

$$q_{ij} = (\alpha_{ij})\,(P_{ij})^{-\sigma} P_i^{\sigma-1} V_i \tag{3.2}$$

The value of total value-added trade (V_{ij}) is simply equal to the price times quantity, i.e., $V_{ij} = P_{ij} q_{ij}$. Then we have:

$$V_{ij} = (\alpha_{ij})\,(P_{ij})^{1-\sigma} P_i^{\sigma-1} V_i \tag{3.3}$$

With CES demand preferences for a product in sector s, intermediate inputs from distinct countries are imperfect substitutes to each other with an elasticity of substitution of σ. Relative expenditures on different products is a constant elasticity of the relative prices in the consumer's currency.

$$\frac{V_{ij}}{V_{jj}} = \left(\frac{\alpha_{ij}}{\alpha_{jj}}\right) \left(\frac{P_{ij}}{P_{jj}}\right)^{1-\sigma} \tag{3.4}$$

Here $V_{ij,t}$ value of exports from country i to country j in the currency of j; $V_{jj,t}$ value of export in the destination country j in the currency of j; $P_{ij,t}$ price of exports from country i in the currency of country j; $P_{jj,t}$ price of domestic export in currency j. As this equation is sector specific, therefore, any subscription for sector is avoided.

Taking total differentiating and using "hat" algebra, we can write (3.4) as follows:

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = (1-\sigma)(\hat{p}_{ij,t} - \hat{p}_{jj,t}) \tag{3.5}$$

$\hat{P}_{ij,t}$ is the weighted average of the imported inputs prices for the exports at source country currency, $p_{kk,t}$ divided by the exchange rate of source country to country j, $E_{kj,t}$ with an additional markup λ. This λ captures the exchange rate pass-through coefficient.

$$\hat{p}_{ij,t} = \lambda \Sigma_k \theta_{ki,t}(\hat{p}_{kk,t} - \hat{E}_{kj,t}) \tag{3.6}$$

$\theta_{ki,t}$ captures the cost share of country k's exports in the sector s in country i at year t. Using equation (3.5) and (3.6)

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = -(1-\sigma)\hat{p}_{jj,t} - \lambda(1-\sigma)\Sigma_k \theta_{ki,t}(\hat{p}_{kk,t} - \hat{E}_{kj,t}) \tag{3.7}$$

3.1.2 Trade Elasticity

In order to calculate the trade elasticity, we used the same CES preferences structure, however, instead of relative demand, we used relative expenditures on exports from country i to country j as follows:

$$V_{ij,t} = Y_{j,t}(P_{j,t})^{\sigma}(P_{ij,t})^{-\sigma} \tag{3.8}$$

Y_{jt} total consumer expenditure in each sector in the country j; P_{jt} is the CES price index in the country j for each sector.

Taking total differentiating and using hat algebra,

$$\hat{v}_{ij,t} = \hat{y}_{j,t} + \sigma(\hat{p}_{j,t} - \hat{p}_{ij,t}) \tag{3.9}$$

where, $\hat{p}_{j,t}$ is the expenditure weighted average of percentage changes in the prices of imports from all source countries.

$$\hat{p}_{jt} = \Sigma_k \gamma_{kj,t} \hat{p}_{kj,t} \tag{3.10}$$

where, $\gamma_{kj,t}$ is the share of exports from country k to country j in the total expenditures of the country k in year t. Substituting equation (3.5) and (3.9) into (3.8) and setting $\hat{y}_{j,t} = 0$, yields as follows:

$$\hat{v}_{ij,t} = \sigma\left(\Sigma_k \gamma_{kj,t}\hat{p}_{kj,t} - \lambda\Sigma_k \theta_{ki,t}(\hat{p}_{kk,t} - \hat{E}_{kj,t})\right) \tag{3.11}$$

$$\hat{v}_{ij,t} = \sigma\lambda\Sigma_k \theta_{ki,t}\hat{E}_{kj,t} + \sigma\left(\Sigma_k \gamma_{kj,t}\hat{p}_{kj,t} - \lambda\Sigma_k \theta_{ki,t}\hat{p}_{kk,t}\right) \tag{3.12}$$

Now setting $\hat{P_{ij,t}} = 0$ for all i and j, and using exchange rate as the relative currency prices between country i and country j, we can write (3.10) as follows:

$$\hat{v}_{ij,t} = -\sigma(-\lambda\theta_{iit}\hat{E}_{ijt} + \lambda\Sigma_k \theta_{ikt}\gamma_{kjt}\hat{E}_{ijt}) \tag{3.13}$$

From equation (3.12), we derived trade elasticity as the percentage change in the value of exports from country i to country j in response to a one percent increase in E_{ijt} $\left(i.e., \frac{d\hat{v}_{ij,t}}{d\hat{E}_{ijt}}\right)$. Then we decomposed the trade elasticity into two parts: own price effect and price index effect.

$$TE_{ij,t} = \underbrace{-\sigma\lambda(-\theta_{ii,t})}_{\text{own price effect}} + \underbrace{(-\sigma\lambda)\Sigma_k \theta_{ik,t}\gamma_{kj,t}}_{\text{prices index effect}} \tag{3.14}$$

From equation (3.13), we expect that the trade elasticity is positive. The own price effect is always positive, and it is increasing in the country i's share of the value added in its own production in the sector. The price index effect is always negative, and it is declining in the country j expenditure-weighted average of country i's share of the value added in the production of each country that exports to country j (Powers and Riker, 2013).

3.2 Data

The world's export-to-output ratio grew from 20 to 25 % during 1995-2009; the increase is even more for Southeast Asian countries (especially China with 23 to 39 %) and northern European areas (Saito et al., 2013). This variation in output and gross exports might be due to the production of the same amount of output using more imported intermediate inputs, which cross borders multiple times. In this section, we describe the available data sources, their advantages, and disadvantages.

Figure 2: Bilateral trade among countries with top importing and exporting pairs'

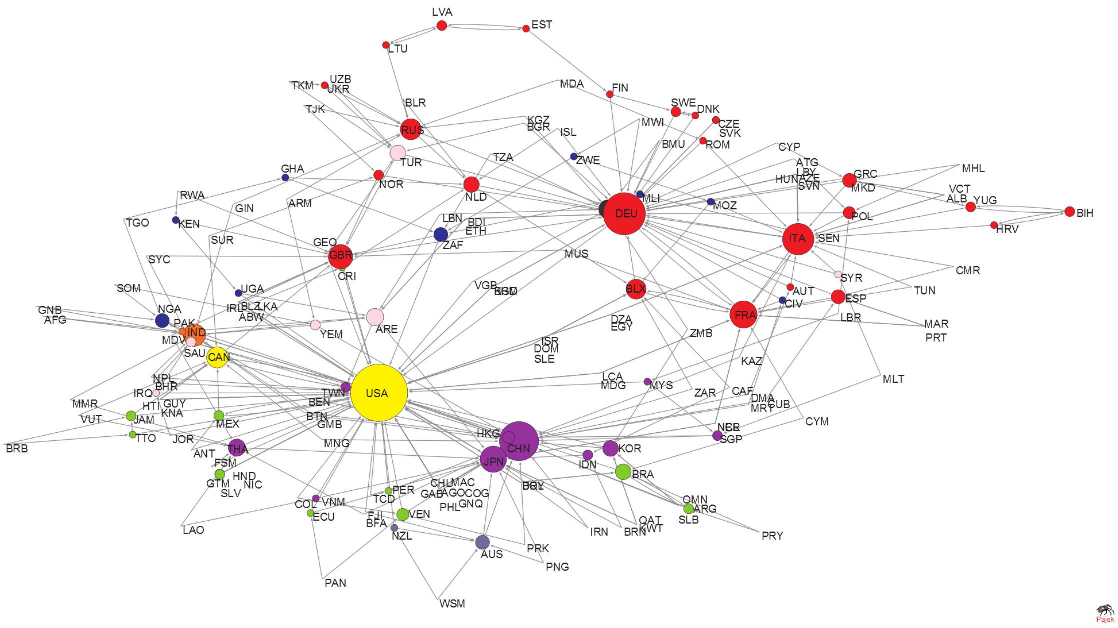


Figure 2 shows the bilateral trade between countries with the top two exporting partners.[8] Each country is represented by the nodes in the network and labeled by the three-digit country code. Each color represents a geographical region where countries are situated. The circle size represents the degree of openness in global production, i.e., the larger the circle size, the higher the connection in the global production system. This figure also depicts that when countries are trading more, they remain closer (not in the geographical position, but in the trade arms). For example, European countries have a higher trade among themselves, so they are placed a short distance from each other, and the United States, Japan, and China are placed close together as they trade more among themselves. From this figure, it is evident that for analyzing cross-country production sharing by sectors, we need international input-output table (IIOT) data. The following section sheds more light on the IIOT database.

Figure 3 summarizes the available global input-output database. The WIOD database

[8] This figure is reproduced following De Benedictis et al. (2014)'s network trade visualization methods. For details on Pajak and Stata module see De Benedictis et al. (2014).

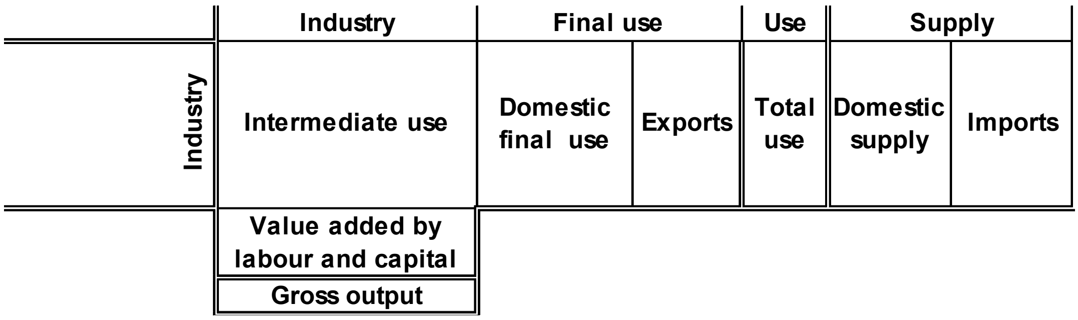
Figure 3: Sources of International Input-Output Tables (IIOTs)

Database	Data Source	Data Coverage		
		Countries	Sectors	Years
World Input-Output tables	National supply-use tables	40	35	1995-2011
OECD-WTO TiVA database	National Input-output tables	61	34	1995, 2000, 2005, 2008-2011
UNCTAD-EORA GVC database	National and regional supply-use and I-O tables	187	25	1990-2010
Global Trade Analysis Project (GTAP)	I-O tables submitted by GTAP members	140	57	1997, 2001, 2004, 2007, 2011

is developed and managed by the European Commission. The WIOD covered 40 countries and 35 sectors during the period from 1995-2011. The OECD and the WTO mutually developed an International Input-Output database to understand international trade. Although the OECD-WTO database has information on trade in a value-added measure (TiVA), the database is not continuous in terms of a time dimension. The initial version of the OECD-WTO TiVA database had 58 economies and 37 sectors for the years 1995, 2000, 2005, 2008 and 2009, while the recent release has 61 economies with two more years, and 34 sectors instead of 37. The global trade analysis project (GTAP) has the most extensive and routinely updated database for this type of trade analysis. The current version of the GTAP database has 140 countries and 57 commodities. However, the information for this database is comes from unofficial sources, mostly submitted by the GTAP members. The Eora multi-region IO database provides a time series of high-resolution input-output (IO) tables with matching environmental and social satellite accounts for 187 countries.

In this paper, we use the WIOD database over other global input-output tables. This database has several advantages compared to others. *Firstly*, WIOD is constructed from world input-output tables (WIOT) and is designed to capture value added trade and consumption over time using national account statistics from respective countries. *Secondly,* the WIOTs are constructed from national supply and use tables (SUTs), which

Figure 4: Single country input-output table structure



source: Timmer et al. (2014a)

are constructed from official statistical sources.[9] *Thirdly,* apart from WIOTs, WIOD also provides socio-economic accounts (SEA) data on quantity and prices of input factors, workers, and wages by level of educational attainment and capital inputs. *Finally,* WIOD is completely free, whereas the OECD-WTO has limited accessibility, the GTAP database needs purchasing, and the IDE-JETRO has only one regional perspective rather than the world as a whole.

Figure 4 shows a single country input-output table, where rows indicate supply of and columns indicate demand for an input. The industry-by-industry matrix represents the demand for and supply of intermediate inputs across industries for a country. The domestic final use section shows how much of the intermediate inputs they are using domestically and how much they are exporting, with a check-sum of total use. The last section of figure 4 shows the input linkages for the production process. However, this import does not have any information about where it came from. For the construction of WIOTs, cross-country detailed import and export information is required.

Figure 5 shows the structure of the WIOD with only three countries in the trading system, while in the WIOD database there are 40 countries plus the rest of world by 35 sectors during the period 1995-2011. Figure 5 decomposes the imports from the source country by HS 6 digit level, then aggregating in 2 digit industries level. Intermediate use block shows the input requirements for the output production. It is possible to look for sectors sharing inputs among themselves in a specific country; for example, it is possible to trace down the source of an intermediate input used in the production

[9] In contrast to WIOD, IDE-JETRO, and GTAP has different benchmark year for the different version of their dataset. The IDE-JETRO has limited number of countries only for Asian countries, while the EORA dataset has almost all the countries in the world.

Figure 5: WIOD: 3 country Input-Output table structure

		Country A Industry	Country B Industry	Country C Industry	Country A	Country B	Country C	Total
Country A	Industry	**Intermediate use by A of domestic output**	**Intermediate use by B of exports from A**	**Intermediate use by C of exports from A**	**Final use by A of domestic output**	**Final use by B of exports from A**	**Final use by C of exports from A**	**Output in A**
Country B	Industry	**Intermediate use by A of exports from B**	Intermediate use by B of domestic output	Intermediate use by C of exports from B	**Final use by A of exports from B**	Final use by B of domestic output	Final use by C of exports from B	Output in B
Country C	Industry	**Intermediate use by A of exports from C**	Intermediate use by B of exports from C	Intermediate use by C of domestic output	**Final use by A of exports from C**	Final use by B of exports from C	Final use by C of domestic output	Output in C
		Value added by labour and capital in A	Value added by labour and capital in B	Value added by labour and capital in C				
		Output in A	Output in B	Output in C				

source: Timmer et al. (2014a)

by industry 1 in country A, by looking at the associated column for country A. Final-use columns are divided into several parts for each country, such as final consumption expenditure by household, final consumption expenditure by NGOs to household and government, gross capital formation, change in inventory and total output. WIOTs also have some additional rows, as follows: total intermediate consumption, taxes less subsidies on products, CIF/FOB adjustments on exports, direct purchases abroad by residents, non-resident purchases in domestic territory, international transport margin, and output at basic prices.

Figure 8 - 16 presents bilateral exports, imports and exchange rate growth during 1995-2011. Here, positive growth of exchange rate implies exchange rate depreciation and negative growth rate implies appreciation relative to foreign currency. For example, figure (8) shows that export, import, and exchange rate change during 1995-2011 between USA and China. From the figure, it is also evident that during 1995-2000, the United States dollar appreciates against the Chinese Renminbi (first quadrant), the USA import increases from China (second quadrant, clockwise), and interestingly the United States exports also increases to China (third quadrant). In the fourth quadrant, we have shown the scatter plot of growth rate of exchange rate with the growth rate of trade, and it shows a positive association between them.[10]

[10]Figures 8 – 16 shows some contradiction with the traditional theoretical prediction that when ex-

4 Empirical Estimation

This section describes the construction of the variables from the WIOD database and following the methodology described in section 2. Following the description of the estimation procedure, we discuss the empirical findings.

4.1 Estimation Strategy

This paper uses the WIOTs to calculate value-added trade shares, consumer price index from the World Economic Outlook (WEO) database as a measure of prices in local currency, and we also use the OECD producer price index instead of GDP deflator or inflation index as a proxy for price measures.[11] We took nominal bilateral exchange rates across countries during the sample period from UNCTAD Stats.

The value-added trade shares are calculated from the WIOT, where each row shows the global use of respective sector's output in each country by sector, i.e., whether that product is used as an intermediate input by the industry or is used as a final good by consumers in each country. The columns indicate the total inputs from each country, plus the value added (value-added by labor and capital) in each country-sector, that are supplied to produce the total output of a product in each country. Next, the value-added is calculated using equation 4.1

$$V = F(I - A)^{-1}C \tag{4.1}$$

where A is the matrix of intermediate inputs needed to produce one unit of output, and $(I - A)^{-1}$ is known as Leontief inverse, which represents the gross output values that are generated in all stages of the production process of one unit of consumption. F represents a diagonal matrix of value added to gross output ratios in all industries in all countries. The value-added exports of a country, C, counts the consumption to other countries in consideration. Although this method can retrieve a value-added trade structure, it failed to define back-and-forth trade exclusively.

This paper follows the methodology of Wang et al. (2013) (see in equation 37) to

change rate appreciate, export falls; on the other hand, import rises.

[11] Estimation results for the producer price index are not presented in this paper, however, an interested person can send me an email for that tables.

measure the back-and-forth nature of trade.[12] They decomposed gross exports into domestic value-added absorbed abroad (DVA), value-added first exported but eventually returned home (RDV), foreign value-added (FVA), and pure double counted terms (PDC). They further decomposed the DVA, FVA, and PDC into intermediate goods, intermediate goods re-exported to third countries as intermediate goods, and final goods.

The econometric estimation is based on equation 4.2. For the regression purpose, we considered log change of value-added exports for a country. This study used domestic intermediate inputs, those which are exported abroad and then returned back to the home country as intermediate goods, as of our dependent variable. Similarly, price index and exchange-rate variables are also transformed into first-difference of logarithms of the variable.[13]

Moreover, as a robustness check, we also estimated other models where dependent variables are intermediate goods returned home as final goods and value-added trade, and for sub-sample only for the manufacturing sectors. Apart from those, we also estimated the above-mentioned models with 100% value-added share to compare with our results.

4.2 Estimation Results

This section presents the empirical estimation results following the above-mentioned methodology. Section 4.2.1 presents the aggregated (pooled over sector and country) exchange rate pass-through along with sector-level estimations, while section 4.2.2 presents the trade elasticity calculated using equation 3.14.

4.2.1 Exchange Rate Pass-Through

For the empirical econometric estimation, we used equation (3.6) in the following equation (4.2):

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = \beta_0 + \beta_1 \hat{p}_{jj,t} + \beta_2 \Sigma_k \theta_{ki,t} (\hat{p}_{kk,t} - \hat{E}_{kj,t}) + \eta_{ij,t} \tag{4.2}$$

[12]Koopman et al. (2014) first provided an accounting framework to decompose total gross exports of a country into nine value-added and double counted components. Although, their accounting framework can define the back-and-forth nature of trade, this framework is suitable for country level rather country-sector studies. In the appendix, I also summarized the decomposition of Wang et al. (2013).

[13]Similar exercises were also undertaken by Powers and Riker (2013); they did it only for 13 Non-Petroleum sectors and for the period of 2000-2009 for selected countries.

Table 1: Exchange Rate Pass-Through (ERPT) and Elasticity of Substitution

Variables	Value-added export (texp)	VA export Intermediate	Domestic VA intermediate	Return Value added (RDV)	RDV Intermediate	RDV Final	Foreign Value -added (FVA)	FVA Intermediate
Elasticity of Substitution (σ)	1.175	1.174	1.169	1.328	1.134	1.160	1.141	1.032
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
ERPT (λ)	0.028	0.022	0.021	0.002	0.009	0.006	0.028	0.006
	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
Constant	0.146	0.115	0.109	0.101	0.081	0.099	0.133	0.049
	(0.038)	(0.031)	(0.030)	(0.019)	(0.020)	(0.018)	(0.033)	(0.018)
Observations	828,567	828,567	827,872	333,866	828,449	828,567	828,434	332,924
R-squared	0.005	0.006	0.006	0.050	0.011	0.009	0.006	0.056
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Here, the error term ($\eta_{ij,t}$) is independently and identically distributed. From the econometric regression, we can retrieve the exchange rate pass-through, λ, as $(-\beta_2/\beta_1)$ and the elasticity of substitution as σ can be retrieved as $(1+\beta_1)$.

Table 1 shows the estimation results for exchange rate pass-through and elasticity of substitution for different specifications of value-added exports. In table 1, all the models presented have a common set of independent variables: domestic price index, value-added share adjusted bilateral nominal exchange rates, and fixed effects as a control measure. From the first column of table 1, it is evident that the ERPT estimator for total value-added exports is 0.028; a one percent increase in the exchange rate (in other terms, 1% depreciation of local currency) increases value-added exports by 0.028 percent. Similarly, the second and third columns show the ERPT estimator for value-added exports of intermediate goods and domestic value-added exports as intermediate goods are 0.022 and 0.021, respectively. The elasticity of substitution is 1.175, which is statistically significant and different from one. We found that the ERPT is higher for total value-added exports compared to intermediate exports or domestic value-added exports of intermediate goods. Therefore, it becomes important to study the effect of ERPT in more sectoral level.

In this paper, we are more interested to see the effect of exchange rate change on domestic value-added exports that returned home. In table 1, columns 4- 7 show different specifications of value-added exports that returned home as final or intermediate products. For example, in column 4, the dependent variable is domestic value-added that returned home (RDV) and independent variables are value added adjusted bilateral nominal exchange rate and price index. The ERPT estimate is 0.002, which shows that a 1% increase in exchange rate (depreciation) passes through into the exports by 0.002 percent. In columns 5 and 6, we see that for domestic value added returned home as intermediate goods (RDV intermediate), the ERPT estimate is 0.009 and ERPT estimate is 0.006 for the value added returned home as final goods (RDV Final). Similarly, columns 8 and 9 examine the impact of exchange rate fluctuation on gross foreign value-added in domestic exports and foreign value-added in domestic exports as intermediate products, respectively. The ERPT estimates are 0.028 and 0.006, respectively. From table 1, it is also evident that the elasticity of substitution for RDV, RDV intermediate, and RDV final are also significantly different from one and mostly greater than one. From these estimation results, it is evident that the ERPT is lower for value-added exports that return home compared to gross value-added exports and foreign value-added in domestic exports. This table (table 1) shows a significant variation in ERPT across different specifications of value-added exports, which invites us to examine the sector level analysis of exchange rate variations. This heterogeneity of ERPT estimates supports our hypothesis that under the back-and-forth production structure, exchange rate becomes less effective as an automatic stabilizer.

Table 2 presents exchange rate pass-through and elasticity of substitution for manufacturing and services sectors using different measures of value-added exports. For example, columns 10 and 12 in table **??** show the ERPT estimate for gross value-added export and value-added export of intermediate goods. The average pass-through is 0.090 and 0.155 for gross value-added exports (TEXP) and value-added exports of intermediate goods (TEXP Intermediate), respectively. We found that the average pass-through for the manufacturing sector is 0.016 and 0.204, and for the services sector it is −0.007 and 0.128 for *TEXP* and *TEXP Intermediate*, respectively. Our estimated exchange rate passes-through are significantly lower compared to Powers and Riker (2013), Brun-Aguerre et al. (2012), and Campa and Goldberg (2005).

We also found that there is substantial heterogeneity across sectors in terms of pass-through rates (see table **??** for details). Interestingly, we found that some of the sectors have a negative coefficient for ERPT and are significantly different from zero. This may happen when domestic currency depreciation raises costs of import for intermediate

Table 2: ERPT and Elasticity of Substitution by sectors

VARIABLES	Returned Domestic Value-added (RDV)		Returned VA Intermediate		Returned VA Final		Domestic VA Intermediate		Total Value Added Export		TEXP Intermediate	
	σ	λ	σ	λ	σ	λ	σ	λ	σ	λ	σ	λ
Median	1.318	0.004	1.142	0.003	1.098	-0.001	1.144	0.001	1.142	0.008	1.154	0.004
Average	1.412	0.026	1.133	0.233	1.159	0.033	1.167	0.165	1.173	0.090	1.173	0.155
Manufacturing	1.365	0.137	1.146	0.056	1.227	0.064	1.188	0.156	1.250	0.016	1.197	0.204
Services	1.404	-0.048	1.122	0.056	1.140	-0.004	1.151	0.185	1.114	-0.007	1.153	0.128

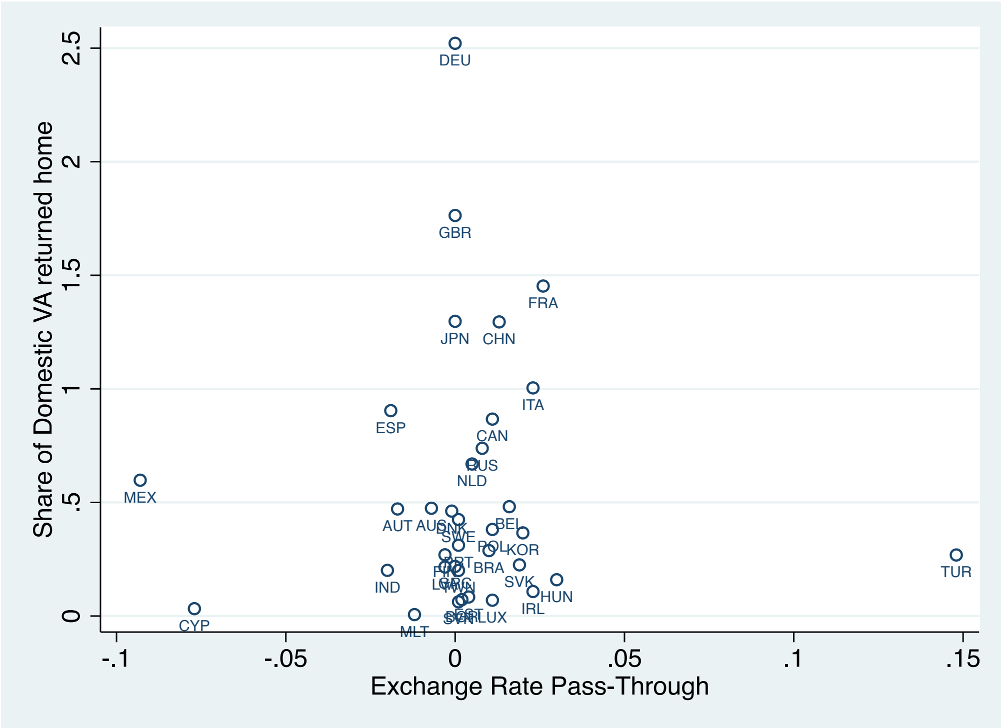
inputs, which leads to a decrease in exports of goods. Therefore, the service sector's negative ERPT can be a result of the increasing embodiment of services into manufacturing exports.

Figure 6 shows the relationship between exchange rate pass-through coefficients and share of domestic value-added that returned home (RDV) by country. In this figure, the horizontal axis represents exchange rate pass-through and the vertical axis represents domestic value-added share that returned home. It is evident that there is significant heterogeneity across countries in terms of ERPT coefficients and RDVs. Although most of the countries have smaller ERPT corresponding to RDV, countries with higher integration with the global market in the production chain have a higher share of RDV and lower value of ERPT. For example, with the exception of China, developed countries have the higher share in the global production chain and lower value of ERPT coefficient. From the figure, it is evident that Germany (DEU) has the highest share of domestic value-added that returned home and ERPT close to zero, which demonstrates that higher integration in back-and-forth production, and thereby exports, minimizes the effectiveness of ERPT. Similarly, developing countries, such as China, India and Mexico, have a smaller share of RDV and ERPT with close to zero (Mexico has a negative ERPT coefficient). This relationship supports our hypothesis that countries with higher integration in back-and-forth trade structure have a lower pass-through effect. We found that our estimated coefficients vary between -0.1 and 0.18, which is significantly lower than Campa and Mínguez (2006) and Gaulier et al. (2008).[14].

Figure 7 shows the relationship between exchange rate pass-through coefficients and share of domestic value-added that returned home (RDV) by sector. From figure 7, it is evident that there is a lot of heterogeneity in ERPT across sectors. The first seg-

[14] Campa and Mínguez (2006) found a ERPT coefficient of 0.317 for EURO countries, while Gaulier et al. (2008) found that weighted average of median pass-through is 0.128 across countries.

Figure 6: ERPT and share of DVA returned home by countries

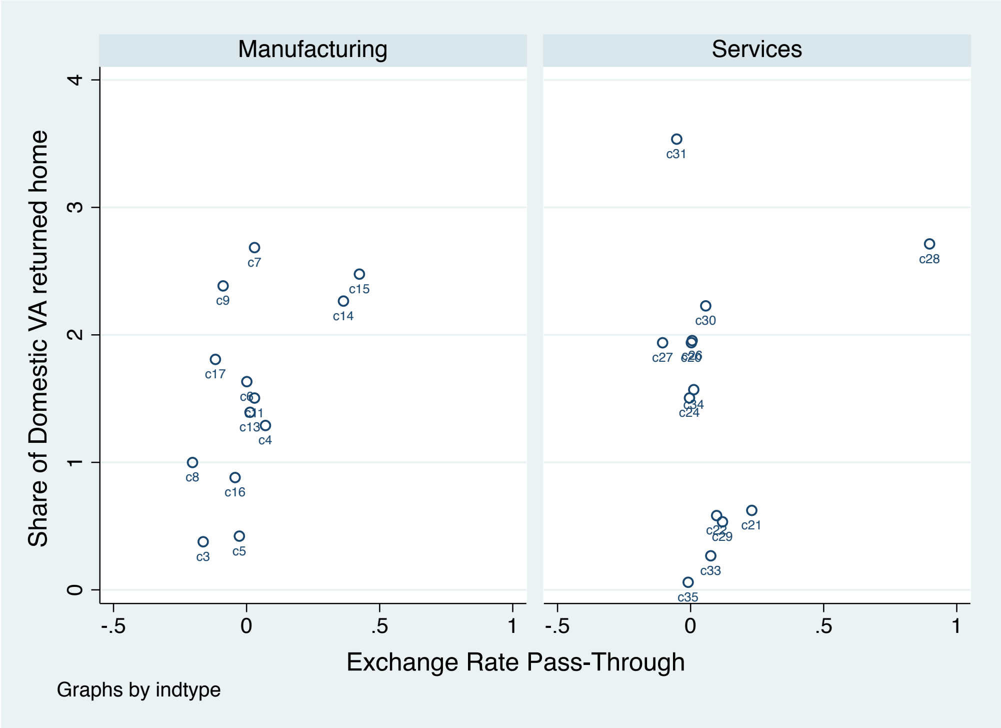


ment shows the ERPT estimate and share of domestic value-added returned home for manufacturing sectors. ERPT varies significantly; the apparel and textile (c4), manufacturing (c16), and electronics sectors (c13) have lower ERPT. The second segment shows the ERPT estimate and share of domestic value-added returned home for service sectors; ERPT varies less than manufacturing. It is evident that service sectors have higher value-added share compared to manufacturing sectors. For example, financial intermediation (c28) has the highest exchange rate pass-through as well as the highest returned value-added share compared to other sectors. This result also supports the fact that the manufacturing sector's production is embodied with services.

4.2.2 Trade Elasticity

Following equation 3.14, we calculated trade elasticity and decomposed it into own price effect and price index effect. Table 3 presents the estimates of the elasticity of substitution for the USA in 2011 for some selected countries and sectors. We calculated the trade elasticity using equation (3.14), and the σ and λ coefficients are obtained from regression estimation. The first panel of table 3 shows the elasticity of substitution

Figure 7: ERPT and share of DVA returned home by sectors



for agriculture, hunting, forestry and fisheries for Brazil, Canada, China, India, Japan, and Mexico. For example, a 10% increase in the nominal exchange rate of Renminbi or the price of the Renminbi (10% depreciation of the Renminbi relative to the USD) will increase the value of China's agricultural, forestry and fisheries exports by 2.3%, which we decomposed into own price effect and price index effect. The own price effect is negative and it shows that 0.19% decreases the exports from China to the USA, and this negative effect is eliminated by the positive price index effect, which increases exports by 2.5%. Similarly, for Brazil, a 10% depreciation of the Brazilian Real will increase the export from Brazil to the USA by about 0.203%, where own price effect is (0.01%) insignificant, but relatively strong positive price index effect (0.23%). The first row of panel one in table 3 also confirmes that there is substantial heterogeneity across countries in trade elasticity.

In the second panel of table 3, we can see that a 10% depreciation of the Renminbi will increase exports from China to the USA by 0.51%; on the other hand, a 10% depreciation of the Canadian dollar to the USD will increase export of food and beverages from Canada to the USA by 7.64%. A similar depreciation of the Japanese Yen will increase exports from Japan to the United States by 0.078%, and for India it will increase

Table 3: Trade Elasticity for the selected sectors and countries to USA in 2011

	BRA	CAN	CHN	IND	JPN	MEX
Panel One: Trade Elasticity for Agriculture, Hunting, Forestry and Fishing for 2011 for USA						
Trade Elasticity with Value added data	0.0203	0.1409	0.2309	0.0153	0.0069	0.1598
Own price Effect	-0.0019	-0.0191	-0.0191	-0.0007	-0.0008	-0.0091
Price Index Effect	0.0222	0.1600	0.2500	0.0160	0.0077	0.1690
Ratio of Price Index Effect to Own price effect	-0.0863	-0.1195	-0.0765	-0.0423	-0.1061	-0.0540
Panel Two: Trade Elasticity for Food, Beverages and Tobacco for 2011 for USA						
Trade Elasticity with Value added data	0.0203	0.7637	0.0510	0.0510	0.0077	0.3277
Own price Effect	-0.0019	-0.0309	-0.0028	-0.0017	-0.0003	-0.0099
Price Index Effect	0.0222	0.7946	0.0538	0.0527	0.0080	0.3375
Ratio of Price Index Effect to Own price effect	-0.0863	-0.0389	-0.0521	-0.0322	-0.0397	-0.0292
Panel Three: Trade Elasticity for Textiles and Textile Products for 2011 for USA						
Trade Elasticity with Value added data	0.0182	0.9338	0.2655	0.3173	0.0101	1.7287
Own price Effect	-0.0008	-0.0441	-0.0209	-0.0120	-0.0014	-0.0732
Price Index Effect	0.0189	0.9779	0.2864	0.3292	0.0115	1.8018
Ratio of Price Index Effect to Own price effect	-0.0398	-0.0451	-0.0731	-0.0364	-0.1253	-0.0406
Panel Four: Trade Elasticity for Machinery for 2011 for USA						
Trade Elasticity with Value added data	0.0082	0.0494	0.2016	0.0053	0.0143	0.1436
Own price Effect	-0.0003	-0.0032	-0.0006	-0.0002	-0.0006	-0.0057
Price Index Effect	0.0085	0.0526	0.2022	0.0055	0.0149	0.1493
Ratio of Price Index Effect to Own price effect	-0.0326	-0.0605	-0.0030	-0.0425	-0.0419	-0.0384

exports from India to the United States by 0.051%. These results confirm that for a particular sector, higher trade elasticity value associated with a country implies a higher domestic value-added content in their exports.

Panel three in table 3 shows that a 10% depreciation of the Mexican peso to the USD will increase exports of textile and textile products to the United States by 17.2%, and most of this positive export change is driven by the larger positive price index effect compared to very small negative own price index effect. With a 10% depreciation of the Indian rupee, exports of textile and textile products from India to the United States will increase by 3.17%.

Likewise, panel four in table 3 presents trade elasticity for the sector of machinery and related equipment. Column 4 shows that a 10% depreciation of the Renminbi to the USD will increase exports of machinery from China to the USA by 2.01%, while a similar depreciation of the Mexican peso will increase machinery exports from Mexico to the United States by 1.4%.

5 Conclusion

In open economy macroeconomics, exchange rate policy plays an important role in stabilizing the economy against adverse economic shocks. Although, literature in international trade/finance found mixed evidence of exchange rate changes on international trade (Rodríguez-López, 2011). This paper studies exchange rate pass-through and trade elasticity using a new framework and dataset.

This paper contributes to the literature of international finance and trade by examining a new production structure, where inputs are shared among countries in several stages to produce a single product. We have contributed by setting up a theoretical model, where we accounted the weight share across trade partners through value-added exports and imports. Furthermore, we also disentangled the trade elasticity into two section: own price effect and price index effect.

This paper estimates the effect of nominal exchange rate fluctuations on the value of exports of manufacturing and services sectors in the OECD and some developing countries using a structural model of back-and-forth production and value-added trade decomposed from gross trade flows. The empirical estimation for bilateral trade by sectors uses data from the World Input-Output Database (WIOD). The database contains time series data on the international sourcing of intermediate inputs and final goods in 35 sectors across 40 countries (27 EU and 13 other major countries) for the period of 1995-2011. The WIOD database also contains data on sectoral trade, domestic expenditure, and final expenditure and sectoral value added (labor and capital) in production. From the input-output table, we estimate the sources of value added in final goods traded and consumed in the world.

From the empirical estimation, we found that the average pass-through rate ranges from 0.002 to 0.028 for different types of value-added measure, while the pass-through rate for the manufacturing sector ranges from 0.016 to 0.204 and the pass-through rate for the service sector ranges from -0.048 to 0.185. We found that there is substantial heterogeneity in exchange rate pass-through measures across sectors and also across different specifications of value-added measure. However, our result is consistent across all the value-added measures and also for all the sectors in which exchange rate plays a minimum role in a trade policy settings.

This paper decomposes trade elasticity into two parts: own price and price index effect. Own price effects capture the cost increase due to increases in the price of raw materials from an exchange rate shock. We found that there is a substantial heterogeneity both in own price and cross-price elasticities across sectors and across countries. For example, we found that a 10% increase in the nominal exchange rate of the Renminbi to the USD (10% depreciation of the Renminbi relative to the USD) will increase China's export of agricultural, forestry and fisheries by 2.3%. Further, we found that due to the negative effect of own price effect, exports decreased by 0.19%, while for positive price effect, exports increased by 2.5%.

This paper contributes to the literature in several ways. We proposed an alternative theoretical model incorporating a back-and-forth production structure to estimate ERPT. Additionally, we empirically tested our structured model, which incorporates back-and-forth production structure and value-added trade. From our estimation result, it is evident that trade elasticity estimates that do not consider the intermediate inputs sharing across borders are systematically overstated. The estimates also validated the importance of price index effect in exports from most of the countries to their destination markets.

Figure 8: Bilateral exports, imports, and exchange rate for USA and China

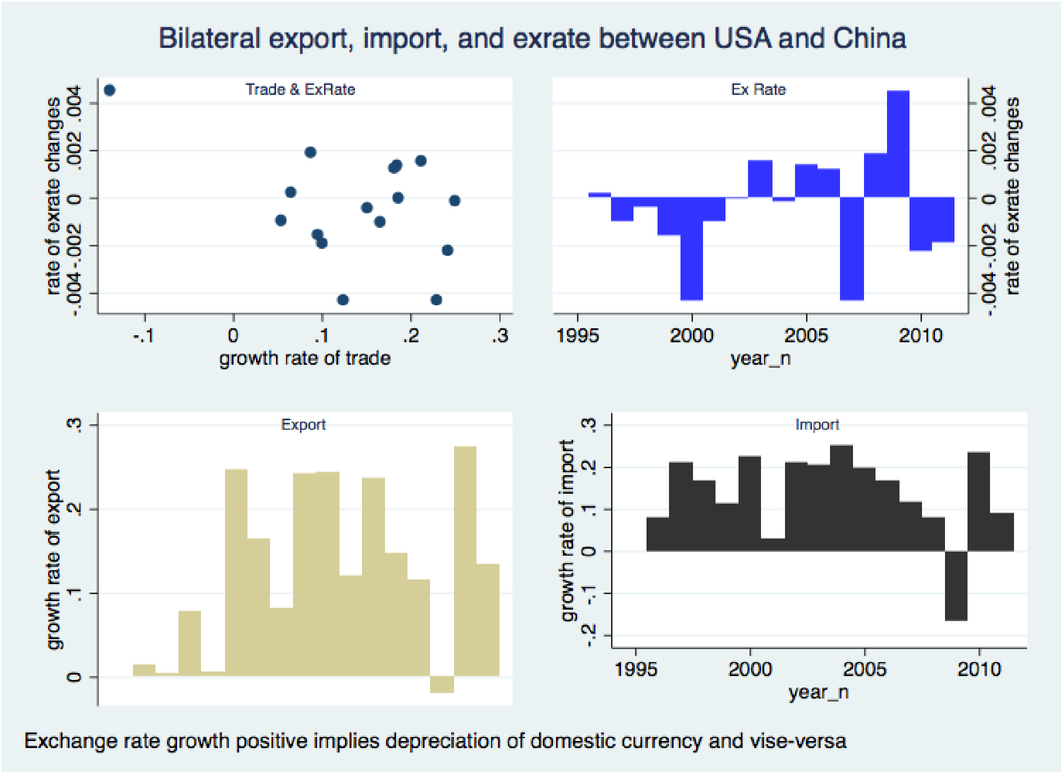


Figure 9: Bilateral exports, imports, and exchange rate for USA and Mexico

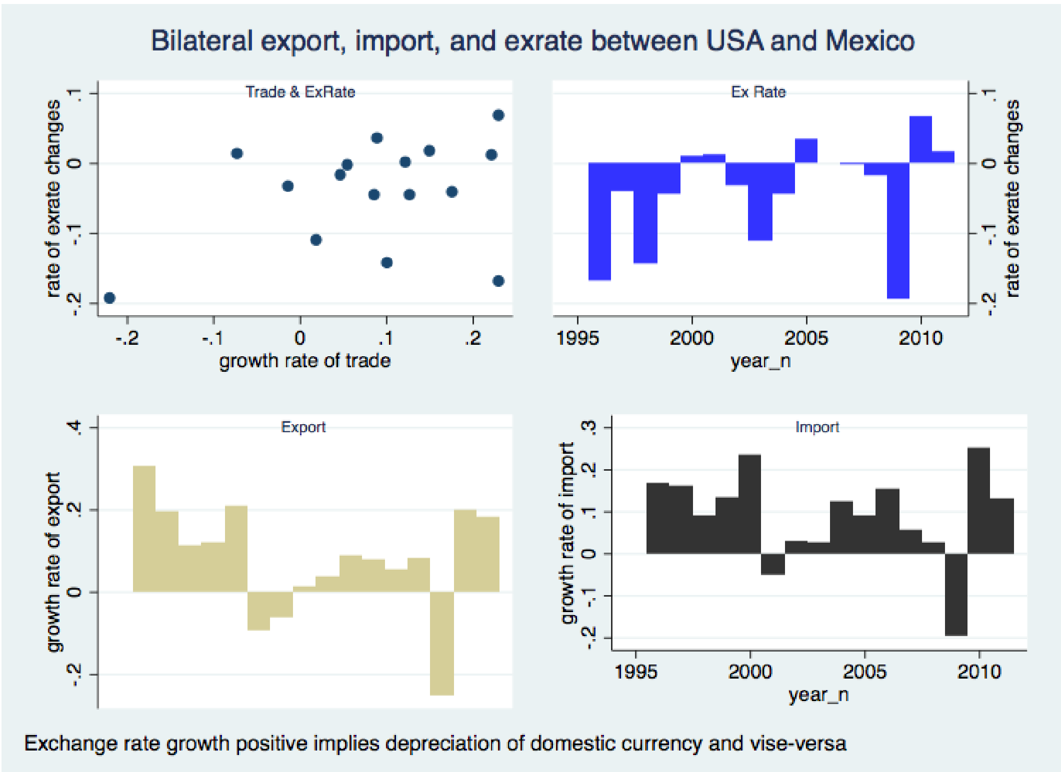


Figure 10: Bilateral exports, imports, and exchange rate for USA and Japan

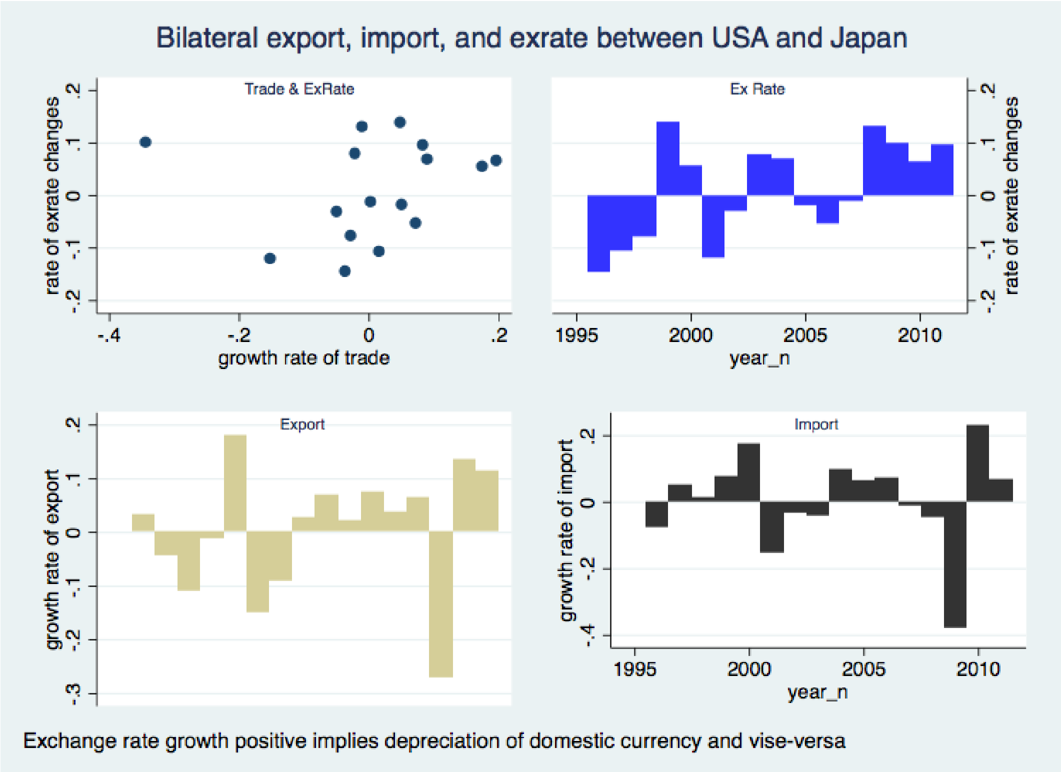


Figure 11: Bilateral exports, imports, and exchange rate for China and Japan

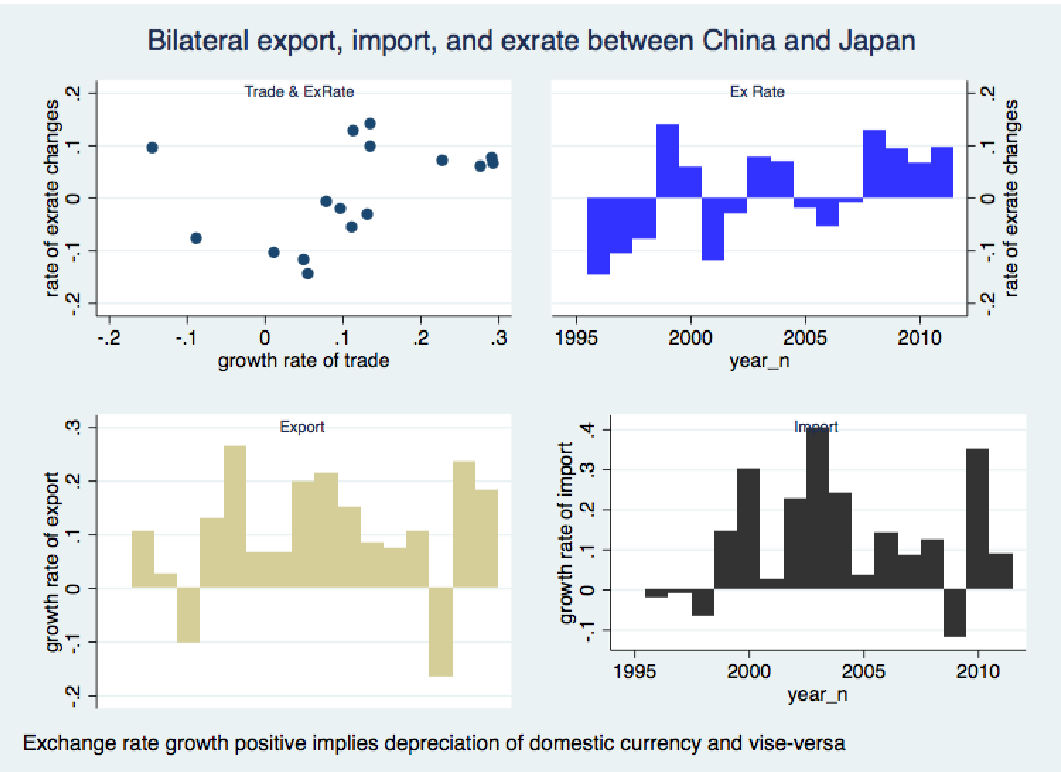


Figure 12: Bilateral exports, imports, and exchange rate for China and South Korea

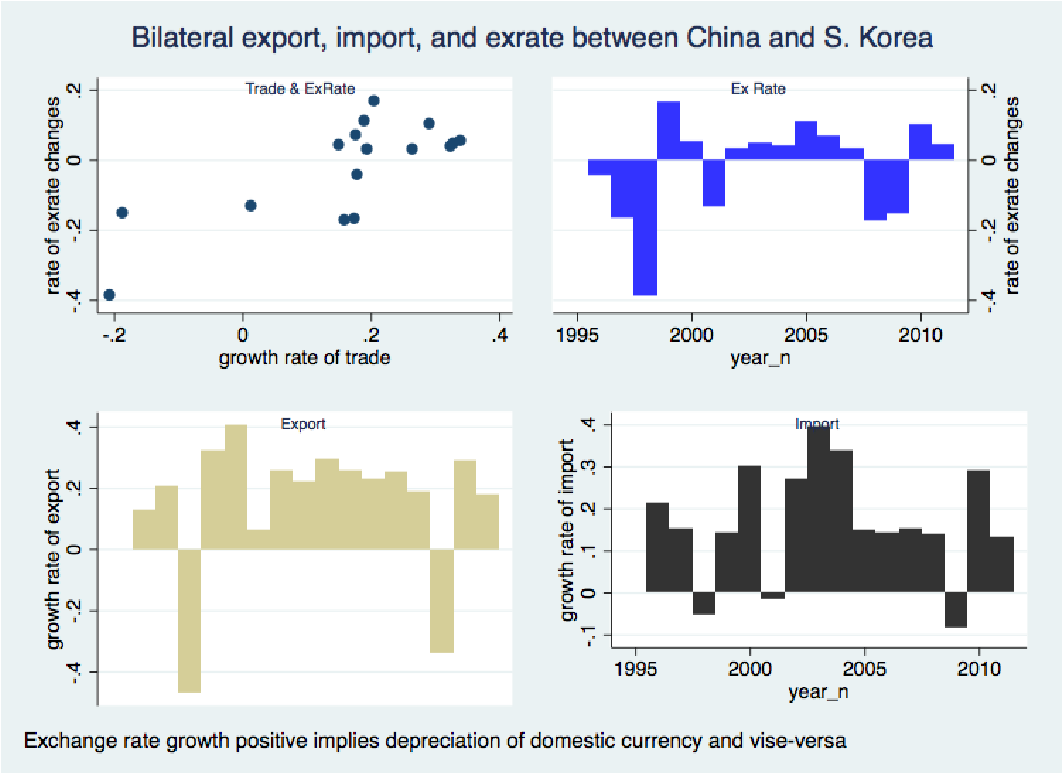


Figure 13: Bilateral exports, imports, and exchange rate for China and India

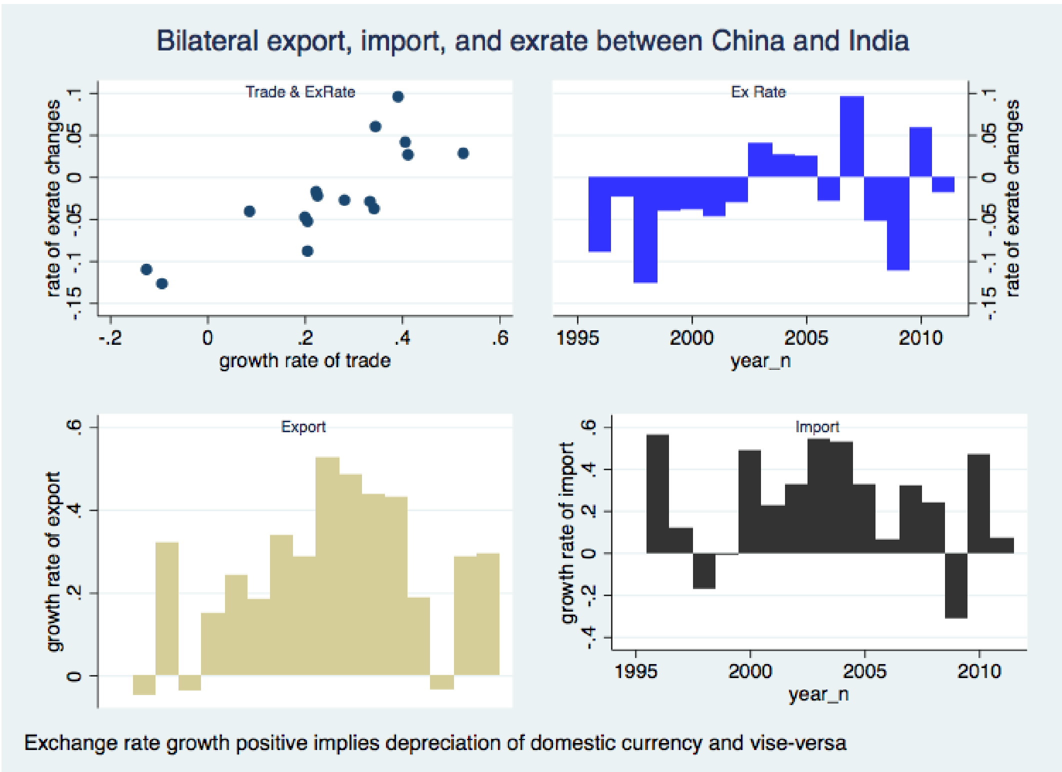


Figure 14: Bilateral exports, imports, and exchange rate for Germany and United States

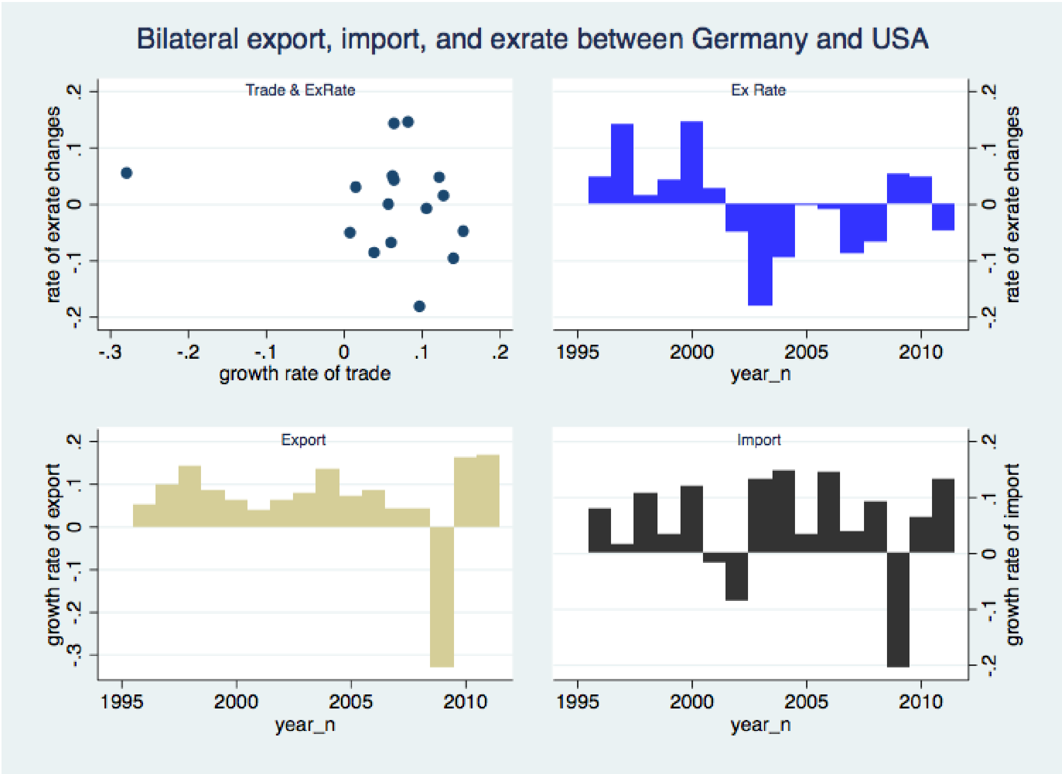


Figure 15: Bilateral exports, imports, and exchange rate for Germany and United Kingdom

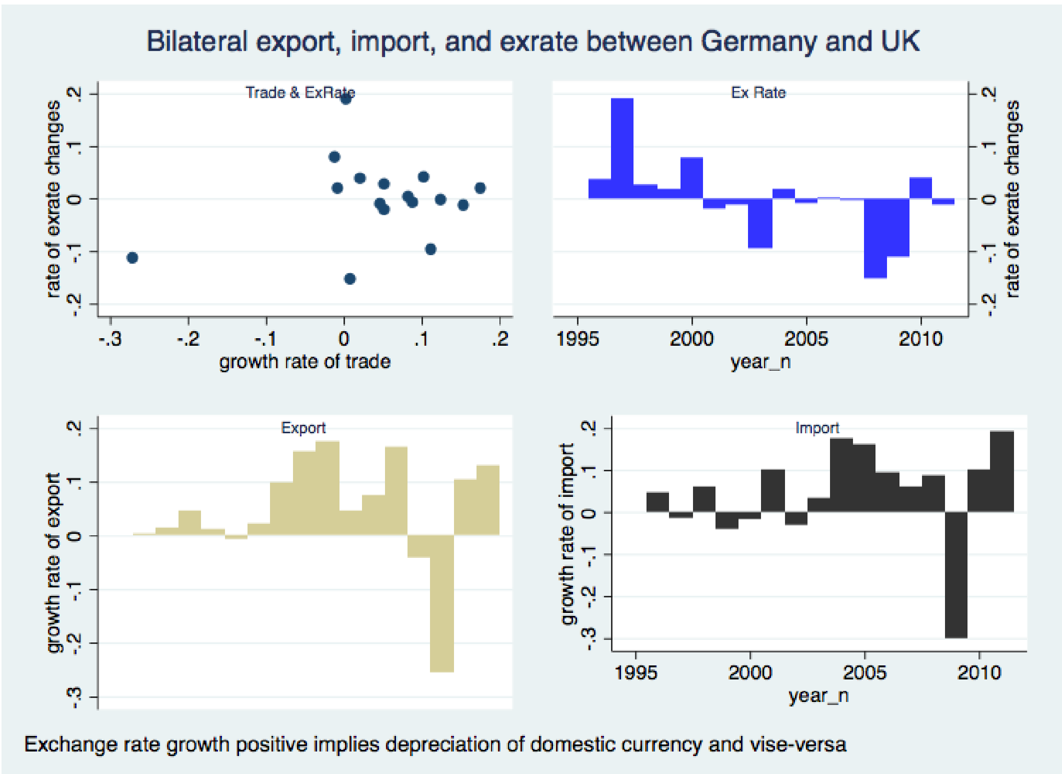
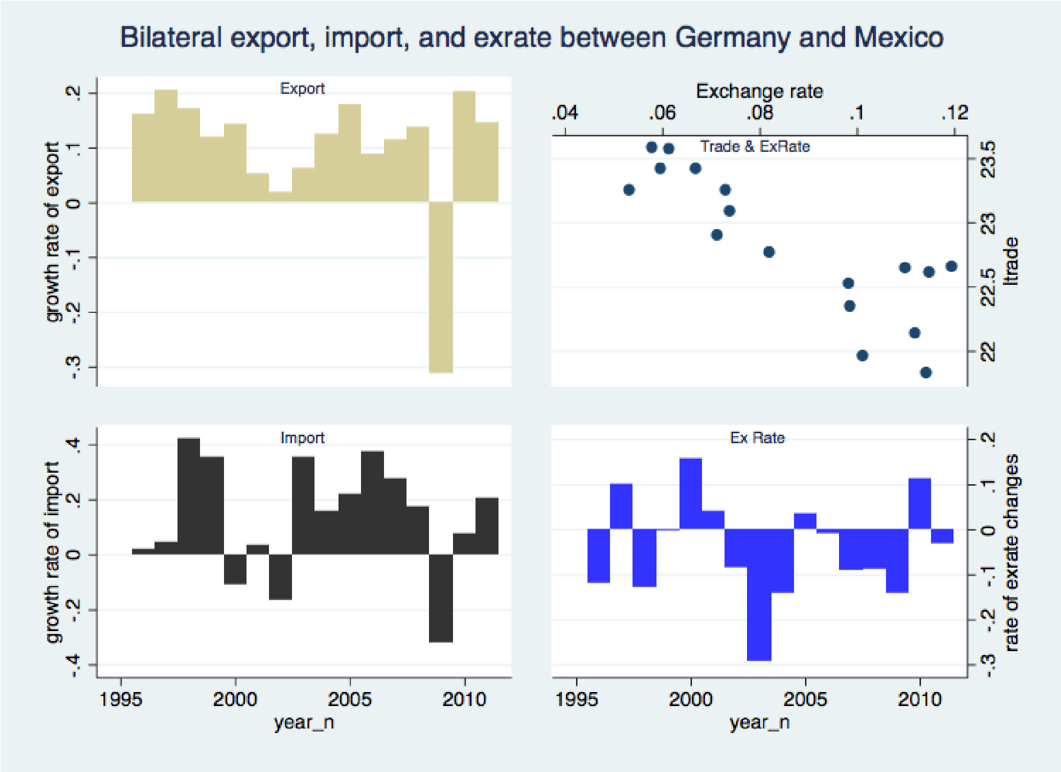


Figure 16: Bilateral exports, imports, and exchange rate for Germany and Mexico



References

Amiti, M., Itskhoki, O., and Konings, J. (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review*, 104(7):1942–1978.

Armington, P. (1969). A theory of demand for products distinguished by place of production. *IMF Staff Papers*, 16:159–176.

Arndt, S. W. (2008). Cross-border production sharing and exchange rates in east asia. *SSRN Working Paper Series*.

Arndt, S. W. et al. (2014). Evolving patterns in global trade and finance. *World Scientific Books*.

Arndt, S. W. and Kierzkowski, H. (2001). *Fragmentation: New production patterns in the world economy*. OUP Oxford.

Baldwin, R. and Venables, A. J. (2013). Spiders and snakes: offshoring and agglomeration in the global economy. *Journal of International Economics*, 90(2):245–254.

Bayoumi, T., Saito, M., and Turunen, J. (2013). Measuring competitiveness: Trade in goods or tasks? *IMF Working Paper*, May 2013(WP/13/100).

Bayoumi, T. A., Lee, J., and Jayanthi, S. (2006). New rates from new weights. *IMF Staff Papers*, 53(2).

Bems, R. (2014). Intermediate inputs, external rebalancing and relative price adjustment. *Journal of International Economics*.

Bems, R. and Johnson, R. C. (2015). Demand for value added and value-added exchange rates. *NBER Working Paper*, (w21070).

Brun-Aguerre, R., Fuertes, A.-M., and Phylaktis, K. (2012). Exchange rate pass-through into import prices revisited: what drives it? *Journal of International Money and Finance*, 31(4):818–844.

Burstein, A. and Gopinath, G. (2014). International prices and exchange rates. *Handbook of International Economics,*, 4:391–451.

Campa, J. M. and Goldberg, L. S. (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics*, 87(4):679–690.

Campa, J. M. and Mínguez, J. M. G. (2006). Differences in exchange rate pass-through in the euro area. *European Economic Review*, 50(1):121–145.

Cheung, Y.-W., Chinn, M. D., and Qian, X. (2012). Are chinese trade flows different? *Journal of International Money and Finance*, 31(8):2127–2146.

Chungy, W. (2012). Back-and-forth trade and endogenous exchange rate pass-through.

Daudin, G., Rifflart, C., and Schweisguth, D. (2011). Who produces for whom in the world economy? *Canadian Journal of Economics/Revue canadienne d'économique*, 44(4):1403–1437.

De Benedictis, L., Nenci, S., Santoni, G., Tajoli, L., and Vicarelli, C. (2014). Network analysis of world trade using the baci-cepii dataset. *Global Economy Journal*, 14(3-4):287–343.

Gaulier, G., Lahrèche-Révil, A., and Méjean, I. (2008). Exchange-rate pass-through at the product level. *Canadian Journal of Economics/Revue canadienne d'économique*, 41(2):425–449.

Ghosh, A. (2009). Implications of production sharing on exchange rate pass-through. *International Journal of Finance & Economics*, 14(4):334–345.

Ghosh, A. (2013). Cross-border production sharing and exchange-rate sensitivity of mexico's trade balance. *The Journal of International Trade & Economic Development*, 22(2):281–297.

Hummels, D., Ishii, J., and Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of international Economics*, 54(1):75–96.

Johnson, R. C. (2014). Five facts about value-added exports and implications for macroeconomics and trade research. *The Journal of Economic Perspectives*, 28(2):119–142.

Johnson, R. C. and Noguera, G. (2012). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, 86(2):224–236.

Koopman, R., Wang, Z., and Wei, S.-J. (2012). Estimating domestic content in exports when processing trade is pervasive. *Journal of Development Economics*, 99(1):178–189.

Koopman, R., Wang, Z., and Wei, S.-J. (2014). Tracing value-added and double counting in gross exports. *American Economic Review*, 104(2):459–494.

Marazzi, M., Sheets, N., Vigfusson, R., Faust, J., Gagnon, J., Marquez, J., Martin, R., Reeve, T., Rogers, J., et al. (2005). Exchange rate pass-through to us import prices: some new evidence. *Board of Governors of the Federal Reserve System, International Finance*, (DP 833).

Patel, N., Wang, Z., and Wei, S.-J. (2014). Global value chains and effective exchange rates at the country-sector level. Working Paper 20236, National Bureau of Economic Research.

Powers, W. and Riker, D. (2013). Exchange rate pass-through in global value chains: The effects of upstream suppliers. Working Paper 2013-02B.

Powers, W. and Riker, D. (2015). The effect of exchange rates on the costs of exporters when inputs are denominated in foreign currencies. *The International Trade Journal*, 29(1):3–18.

Purfield, C. and Rosenberg, C. B. (2010). Adjustment under a currency peg: Estonia, latvia and lithuania during the global financial crisis 2008-09. *IMF Working Papers*, pages 1–34.

Rodríguez-López, J. A. (2011). Prices and exchange rates: A theory of disconnect. *The Review of Economic Studies*, pages 1135–1177.

Saito, M., Ruta, M., and Turunen, J. (2013). Trade interconnectedness: The world with global value chain. Policy paper, IMF Policy Paper.

Thorbecke, W. and Smith, G. (2010). How would an appreciation of the renminbi and other east asian currencies affect china's exports? *Review of International Economics*, 18(1):95–108.

Timmer, M. P., Dietzenbacher, H., Los, B., and Robert Stehrer, G. J. (2014a). *The World Input-Output Database: Content, Concepts and Applications*.

Timmer, M. P., Erumban, A. A., Los, B., Stehrer, R., and de Vries, G. J. (2014b). Slicing up global value chains. *The Journal of Economic Perspectives*, 28(2):99–118.

Wang, Z., Wei, S.-J., and Zhu, K. (2013). Quantifying international production sharing at the bilateral and sector levels. Working Paper 19677, National Bureau of Economic Research.

A Appendix Tables

Table A.1: ERPT and elasticity of substitution by sectors

	rdv		rdv_int		rdv_fin		dva_int		texp		texp_int	
VARIABLES	σ	λ	sσ	λ	σ	λ	σ	λ	σ	λ	σ	λ
Agri_Forest_Fishing	1.226	0.023	1.081	-0.021	0.730	0.003	1.102	-0.054	1.079	-0.069	1.094	-0.062
Mining _Quarrying	1.064	0.025	1.204	0.070	0.982	0.250	1.249	0.167	1.018	2.591	1.268	0.173
Food, Beverages and Tobacco	0.990		1.063	0.852	0.973	-0.088	0.985	-1.532	0.905	-0.252	0.967	-0.833
Textiles and Textile Products	1.284	0.005	1.278	0.005	1.142	0.000	1.353	0.006	1.314	0.008	1.351	0.007
Leather, Leather and Footwear	1.501	-0.194	1.208	-0.047	1.462	0.431	1.290	-0.042	1.536	0.374	1.327	-0.040
Wood_Products_Cork	1.511	0.002	1.456	0.002	2.047	-0.001	1.786	0.001	2.011	-0.001	1.865	0.000
Paper_Printing_Publishing	1.528	0.064	1.171	-0.090	1.366	-0.022	1.225	-0.334	1.621	-0.021	1.212	-0.362
Petroleum_Nuclear_Fuel	1.769	-0.020	1.267	-0.024	1.517	-0.045	1.389	-0.048	1.473	-0.058	1.408	-0.048
Chemicals_Chemical_Products	1.190	-0.326	1.055	0.002	1.099	0.002	1.092	0.000	0.945	-0.002	1.097	0.000
Rubber and Plastics	1.251	0.755	1.099	1.878	1.089		1.131	2.770	1.077		1.137	2.702
Other Non-Metallic Mineral	1.559	1.008	1.004		1.049		1.014	2.292	1.044		1.013	2.373
Basic_Fabricated_Metal	1.351	-0.001	1.142	0.000	0.976	0.000	1.067	0.007	1.050	0.010	1.050	0.010
Machinery, Nec	1.347	0.314	1.081	0.004	1.080	-0.043	1.047	0.078	1.057	0.063	1.053	0.068
Electrical_Optical_Equipment	0.839	0.004	0.944	0.009	0.878	0.336	0.895	0.006	0.866	0.022	0.899	0.006
Transport Equipment	1.625	0.038	1.092	-0.866	1.247	-0.013	1.144	-0.974	1.220	-0.057	1.154	-0.981
Manufacturing	2.108	0.018	1.191	-0.024	1.262	0.205	1.208	-0.050	1.384	0.110	1.227	-0.051
Electricity_Gas_Water	2.008	0.024	1.173	0.002	1.162	-0.006	1.219	-0.005	1.150	-0.008	1.219	-0.005
Construction	1.400	-0.003	1.151	-0.005	1.098	-0.070	1.199	-0.008	1.275	-0.027	1.212	-0.008
Monotor Vehicle_Services	1.600	0.109	1.220	0.152	1.229	-0.681	1.286	-0.031	1.223	0.002	1.296	0.005
Wholesale_Trade_NonMotor	1.301	-0.017	1.190	0.022	1.508	-0.101	1.271	0.028	1.309	0.013	1.272	0.027
Retail_Trade_NonMotor	1.142	0.042	1.172	0.017	1.546	-0.001	1.349	0.036	1.518	0.025	1.362	0.035
Hotels_Restaurants	1.148	0.077	0.998		1.036		0.992		1.006		0.983	
Inland_Transport	1.289	-0.027	1.360	-0.009	1.043	0.313	1.746	-0.011	1.190	0.034	1.759	-0.012
Water_Transport	1.283	0.088	1.178	0.019	1.101	0.085	1.202	0.048	1.202	0.096	1.213	0.048
Air_Transport	1.218	-0.026	0.927	0.306	1.089	-0.104	0.876	0.428	1.065	-0.146	0.870	0.408
Other_Transport	0.814	-0.828	1.026	0.360	1.000		1.046	0.699	1.003		1.046	0.580
Post_Telecommunications	3.497	-0.159	0.988		0.944		0.969	2.130	0.956		0.969	1.388
Financial_Intermediation	1.214	0.034	1.067	0.134	1.272	0.013	1.063	0.174	1.142	0.054	1.061	0.178
Real_Estate_Activities		0.019	0.995		0.988		0.993		0.984		0.993	
Renting_Other_Business	1.339	-0.058	1.165	-0.006	0.971	0.150	1.171	-0.010	1.031	-0.228	1.198	-0.011
Public_Admin_Defence	1.410	-0.048	1.097	-0.079	1.085	0.369	1.174	-0.015	1.161	0.195	1.209	-0.265
Education	1.314	-0.117	1.141	-0.045	0.639	-0.029	1.063	-0.134	0.655	0.017	1.069	-0.103
Health_Social Work	1.187	0.068	1.103	-0.001	1.169	-0.012	1.040	0.003	1.269	-0.003	1.027	0.004
Other_Social_Personal_Services	1.321	-0.010	1.216	0.006	1.200	0.019	1.271	0.005	1.406	0.016	1.262	0.007
Private_HH_Employed_Persons	1.390	-0.005	1.157	0.016	1.582	-0.001	0.947	-0.187	0.925	-0.152	0.896	-0.110

Table A.2: Estimated Exchange Rate Pass-Through (λ) and Elasticity of Substitution (σ)

Sectors	Estimates based on value added export		Estimates based on 100% domestic contents	
	σ	λ	σ	λ
Agri_Forest_Fishing	0.770	1.022	0.815	0.908
Mining _Quarrying	1.007	-33.529	0.969	5.111
Food, Beverages and Tobacco	0.937	3.470	0.969	4.595
Textiles and Textile Products	0.845	1.316	0.862	1.065
Leather, Leather P and Footwear	0.821	0.844	0.836	0.756
Wood_Products_Cork	0.794	0.587	0.794	0.483
Paper_Printing_Publishing	0.870	2.169	0.896	2.038
Petroleum_Nuclear_Fuel	0.548	0.825	0.609	0.688
Chemicals_Chemical_Products	0.913	-0.270	0.870	0.064
Rubber and Plastics	0.742	1.043	0.743	0.732
Other Non-Metallic Mineral	0.808	0.316	0.583	0.135
Basic_Fabricated_Metal	0.693	0.629	0.639	0.593
Machinery, Nec	0.978	0.548	0.967	0.480
Electrical_Optical_Equipment	1.268	-0.234	1.215	-0.167
Transport Equipment	0.664	0.750	0.694	0.598
Manufacturing	1.027	4.850	0.996	-34.163
Electricity_Gas_Water	2.282	0.287	1.950	0.341
Construction	0.886	0.991	0.887	0.785
Monotor Vehicle_Services	0.951	0.674	0.975	0.130
Wholesale_Trade_NonMotor	0.908	1.528	0.838	0.590
Retail_Trade_NonMotor	0.889	2.306	0.854	1.356
Hotels_Restaurants	1.264	0.879	1.059	0.793
Inland_Transport	0.674	0.883	0.705	0.793
Water_Transport	1.113	-0.232	1.031	-0.481
Air_Transport	0.915	2.192	0.949	2.237
Other_Transport	0.878	1.500	0.691	0.469
Post_Telecommunications	2.070	-0.377	1.793	-0.433
Financial_Intermediation	0.749	1.291	0.751	1.104
Real_Estate_Activities	-6.932	0.075	-7.251	0.061
Renting_Other_Business	0.858	1.437	0.943	1.545
Public_Admin_Defence	0.754	0.972	0.771	0.790
Education	0.788	1.759	0.830	1.541
Health_Social Work	0.899	2.436	0.914	2.282
Other_Social_Personal_Services	0.621	0.852	0.640	0.778
Private_HH_Employed_Persons	0.693	0.378	0.685	0.365

Table A.3: Regression Coefficients for foreign (intermediate) value-added shares in exported items.

VARIABLES	First-Diff. of ln(PriceIndex)		diff of log of exrate		Constant		Observations	R-squared
	β_1	(Std Err)	β_2	(Std Err)	β_0	(Std Err)		
Agri_Forest_Fishing	-0.230***	(0.0501)	0.235***	(0.0356)	0.0721***	(0.00508)	15,229	0.003
Mining _Quarrying	0.00680	(0.0606)	0.228***	(0.0277)	0.103***	(0.00387)	15,180	0.006
Food, Beverages and Tobacco	-0.0634	(0.0474)	0.220***	(0.0273)	0.0596***	(0.00407)	14,967	0.005
Textiles and Textile Products	-0.155***	(0.0475)	0.204***	(0.0303)	0.0987***	(0.00467)	18,430	0.003
Leather, Leather and Footwear	-0.179***	(0.0466)	0.151***	(0.0271)	0.104***	(0.00428)	18,918	0.002
Wood_Products_Cork	-0.206***	(0.0607)	0.121***	(0.0278)	0.107***	(0.00459)	19,014	0.001
Paper_Printing_Publishing	-0.130	(0.0895)	0.282***	(0.0417)	0.113***	(0.00678)	16,775	0.003
Petroleum_Nuclear_Fuel	-0.452***	(0.0554)	0.373***	(0.0312)	0.106***	(0.00438)	16,068	0.010
Chemicals_Chemical_Products	-0.0866	(0.110)	-0.0234	(0.0880)	0.125***	(0.00895)	7,712	0.000
Rubber and Plastics	-0.258**	(0.128)	0.269***	(0.0817)	0.0953***	(0.0108)	6,779	0.002
Other Non-Metallic Mineral	-0.192	(0.339)	0.0606	(0.113)	0.0632***	(0.0175)	3,382	0.000
Basic_Fabricated_Metal	-0.307***	(0.115)	0.193***	(0.0727)	0.0953***	(0.0105)	9,258	0.001
Machinery, Nec	-0.0217	(0.0962)	0.0119	(0.0578)	0.0785***	(0.00760)	10,577	0.000
Electrical_Optical_Equipment	0.268**	(0.133)	0.0627	(0.0730)	0.0397***	(0.00913)	7,189	0.001
Transport Equipment	-0.336*	(0.184)	0.252***	(0.0870)	0.102***	(0.0110)	5,699	0.002
Manufacturing	0.0266	(0.191)	-0.129**	(0.0649)	0.0840***	(0.0112)	10,513	0.000
Electricity_Gas_Water	1.282***	(0.397)	-0.368***	(0.0941)	0.00656	(0.0163)	6,976	0.003
Construction	-0.114	(0.0781)	0.113**	(0.0442)	0.101***	(0.00622)	11,846	0.001
Monotor Vehicle_Services	-0.0487	(0.137)	0.0328	(0.0537)	0.0974***	(0.00771)	11,546	0.000
Wholesale_Trade_NonMotor	-0.0916	(0.123)	0.140**	(0.0672)	0.107***	(0.00866)	10,186	0.000
Retail_Trade_NonMotor	-0.111	(0.162)	0.256***	(0.0804)	0.0628***	(0.0111)	10,139	0.001
Hotels_Restaurants	0.264	(0.335)	-0.232	(0.225)	0.0882***	(0.0257)	2,144	0.001
Inland_Transport	-0.326***	(0.0366)	0.288***	(0.0234)	0.0925***	(0.00360)	18,514	0.009
Water_Transport	0.113	(0.107)	0.0262	(0.0515)	0.121***	(0.00675)	14,341	0.000
Air_Transport	-0.0853	(0.177)	0.187**	(0.0939)	0.0592***	(0.0115)	5,854	0.001
Other_Transport	-0.122	(0.817)	0.183	(0.146)	0.0605**	(0.0260)	2,691	0.001
Post_Telecommunications	1.070	(0.848)	0.403**	(0.157)	0.0386	(0.0254)	2,708	0.004
Financial_Intermediation	-0.251*	(0.145)	0.324***	(0.0779)	0.0899***	(0.00870)	9,055	0.002
Real_Estate_Activities	-7.932**	(3.080)	0.596	(0.701)	0.280**	(0.109)	105	0.078
Renting_Other_Business	-0.142***	(0.0365)	0.204***	(0.0233)	0.0416***	(0.00332)	18,215	0.005
Public_Admin_Defence	-0.246***	(0.0553)	0.239***	(0.0338)	0.0459***	(0.00451)	12,134	0.005
Education	-0.212***	(0.0647)	0.373***	(0.0384)	0.0731***	(0.00486)	12,160	0.009
Health_Social Work	-0.101*	(0.0609)	0.246***	(0.0278)	0.0688***	(0.00451)	15,005	0.006
Other_Social_Personal_Services	-0.379***	(0.102)	0.323***	(0.0701)	0.159***	(0.00972)	11,131	0.002
Private_HH_Employed_Persons	-0.307***	(0.0379)	0.116***	(0.0234)	0.110***	(0.00373)	18,801	0.004

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A.4: Regression Coefficients for 100% domestic value-added shares in exported items.

VARIABLES	First-Diff ln(PriceIndex)		diff of log of exrate		Constant		Observations	R^2
	β_1	(Std err)	β_2	(Std err)	β_0	(Std err)		
Agri_Forest_Fishing	-0.230***	(0.0501)	0.235***	(0.0356)	0.0721***	(0.00508)	15,229	0.003
Mining _Quarrying	0.00680	(0.0606)	0.228***	(0.0277)	0.103***	(0.00387)	15,180	0.006
Food, Beverages and Tobacco	-0.0634	(0.0474)	0.220***	(0.0273)	0.0596***	(0.00407)	14,967	0.005
Textiles and Textile Products	-0.155***	(0.0475)	0.204***	(0.0303)	0.0987***	(0.00467)	18,430	0.003
Leather, Leather and Footwear	-0.179***	(0.0466)	0.151***	(0.0271)	0.104***	(0.00428)	18,918	0.002
Wood_Products_Cork	-0.206***	(0.0607)	0.121***	(0.0278)	0.107***	(0.00459)	19,014	0.001
Paper_Printing_Publishing	-0.130	(0.0895)	0.282***	(0.0417)	0.113***	(0.00678)	16,775	0.003
Petroleum_Nuclear_Fuel	-0.452***	(0.0554)	0.373***	(0.0312)	0.106***	(0.00438)	16,068	0.010
Chemicals_Chemical_Products	-0.0866	(0.110)	-0.0234	(0.0880)	0.125***	(0.00895)	7,712	0.000
Rubber and Plastics	-0.258**	(0.128)	0.269***	(0.0817)	0.0953***	(0.0108)	6,779	0.002
Other Non-Metallic Mineral	-0.192	(0.339)	0.0606	(0.113)	0.0632***	(0.0175)	3,382	0.000
Basic_Fabricated_Metal	-0.307***	(0.115)	0.193***	(0.0727)	0.0953***	(0.0105)	9,258	0.001
Machinery, Nec	-0.0217	(0.0962)	0.0119	(0.0578)	0.0785***	(0.00760)	10,577	0.000
Electrical_Optical_Equipment	0.268**	(0.133)	0.0627	(0.0730)	0.0397***	(0.00913)	7,189	0.001
Transport Equipment	-0.336*	(0.184)	0.252***	(0.0870)	0.102***	(0.0110)	5,699	0.002
Manufacturing	0.0266	(0.191)	-0.129**	(0.0649)	0.0840***	(0.0112)	10,513	0.000
Electricity_Gas_Water	1.282***	(0.397)	-0.368***	(0.0941)	0.00656	(0.0163)	6,976	0.003
Construction	-0.114	(0.0781)	0.113**	(0.0442)	0.101***	(0.00622)	11,846	0.001
Monotor Vehicle_Services	-0.0487	(0.137)	0.0328	(0.0537)	0.0974***	(0.00771)	11,546	0.000
Wholesale_Trade_NonMotor	-0.0916	(0.123)	0.140**	(0.0672)	0.107***	(0.00866)	10,186	0.000
Retail_Trade_NonMotor	-0.111	(0.162)	0.256***	(0.0804)	0.0628***	(0.0111)	10,139	0.001
Hotels_Restaurants	0.264	(0.335)	-0.232	(0.225)	0.0882***	(0.0257)	2,144	0.001
Inland_Transport	-0.326***	(0.0366)	0.288***	(0.0234)	0.0925***	(0.00360)	18,514	0.009
Water_Transport	0.113	(0.107)	0.0262	(0.0515)	0.121***	(0.00675)	14,341	0.000
Air_Transport	-0.0853	(0.177)	0.187**	(0.0939)	0.0592***	(0.0115)	5,854	0.001
Other_Transport	-0.122	(0.817)	0.183	(0.146)	0.0605**	(0.0260)	2,691	0.001
Post_Telecommunications	1.070	(0.848)	0.403**	(0.157)	0.0386	(0.0254)	2,708	0.004
Financial_Intermediation	-0.251*	(0.145)	0.324***	(0.0779)	0.0899***	(0.00870)	9,055	0.002
Real_Estate_Activities	-7.932**	(3.080)	0.596	(0.701)	0.280**	(0.109)	105	0.078
Renting_Other_Business	-0.142***	(0.0365)	0.204***	(0.0233)	0.0416***	(0.00332)	18,215	0.005
Public_Admin_Defence	-0.246***	(0.0553)	0.239***	(0.0338)	0.0459***	(0.00451)	12,134	0.005
Education	-0.212***	(0.0647)	0.373***	(0.0384)	0.0731***	(0.00486)	12,160	0.009
Health_Social Work	-0.101*	(0.0609)	0.246***	(0.0278)	0.0688***	(0.00451)	15,005	0.006
Other_Social_Personal_Services	-0.379***	(0.102)	0.323***	(0.0701)	0.159***	(0.00972)	11,131	0.002
Private_HH_Employed_Persons	-0.307***	(0.0379)	0.116***	(0.0234)	0.110***	(0.00373)	18,801	0.004

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A.5: Estimated Exchange Rate Pass-Through (λ) and Elasticity of Substitution (σ) for Manufacturing Sectors

Sectors	λ	σ	F-Statistic
Food, Beverages, and Tobacco	2.840	1.061	5.020
	(9.632)	(0.436)	(0.013)
Textile and Textile Product	0.293	1.763	5.100
	(0.323)	(0.300)	(0.005)
Leather Products	0.576	1.673	5.200
	(0.130)	(0.345)	(0.007)
Wood Products	0.504	2.272	19.780
	(0.032)	(0.243)	(0.000)
Paper	0.815	1.238	1.500
	(0.344)	(0.323)	(0.221)
Chemicals	0.384	1.908	15.210
	(0.131)	(0.212)	(0.000)
Rubber and Plastic Products	1.199	1.403	30.050
	(0.021)	(0.214)	(0.000)
Non-Metallic Mineral Products	0.435	2.343	12.800
	(0.043)	(0.321)	(0.000)
Metal Products	0.511	1.533	3.090
	(0.502)	(0.401)	(0.072)
Machinery	0.090	1.811	7.530
	(0.034)	(0.200)	(0.000)
Electrical and Optical Equipment	0.234	1.911	17.010
	(0.032)	(0.120)	(0.000)
Transportation Equipment	-0.043	1.884	5.670
	(0.141)	(0.320)	(0.009)
Other Manufacturing	1.132	1.291	23.430
	(0.456)	(0.213)	(0.000)
Median	0.504	1.763	7.530

Table A.6: Regression Coefficients using Value-added shares for Manufacturing sectors

Sectors	β_0	β_1	β_2	R^2
Food, Beverages, and Tobacco	0.0519	0.0614	-0.1744	0.0065
	(0.0109)	(0.0875)	(0.0508)	
Textiles and Textile Products	0.0615	0.7630	-0.2236	0.0524
	(0.0093)	(0.1399)	(0.0729)	
Leather, Leather P and Footwear	0.0912	0.6734	-0.3880	0.0029
	(0.0110)	(0.2538)	(0.0953)	
Wood_Products_Cork	-0.0183	1.2717	-0.6412	0.0099
	(0.0101)	(0.2343)	(0.0922)	
Paper_Printing_Publishing	0.0347	0.2383	-0.1941	0.0016
	(0.0081)	(0.2369)	(0.0490)	
Chemicals	0.0638	0.9076	-0.3488	0.0126
	(0.0090)	(0.2477)	(0.0716)	
Rubber and Plastic Products	0.0413	0.4029	-0.4831	0.0195
	(0.0076)	(0.1804)	(0.0702)	
Non-Metallic Mineral Products	-0.0238	1.3428	-0.5846	0.0110
	(0.0096)	(0.2132)	(0.0931)	
Metal Products	0.0607	0.5329	-0.2721	0.0018
	(0.0119)	(0.4339)	(0.0941)	
Machinery	0.0514	0.8105	-0.0730	0.0236
	(0.0074)	(0.0893)	(0.0174)	
Electrical and Optical Equipment	0.0326	0.9107	-0.2134	0.0092
	(0.0074)	(0.0721)	(0.0271)	
Transportation Equipment	0.0428	0.8843	0.0378	0.0232
	(0.0114)	(0.2639)	(0.0627)	
Other Manufacturing	0.0572	0.2913	-0.3298	0.0084
	(0.0034)	(0.2353)	(0.0823)	

Table A.7: Country and region list covered by WIOD database

Country	Region	Type
Australia	Rest	Developed
Austria	Euro Zone	Developed
Belgium	Euro Zone	Developed
Brazil	Rest	Developing
Bulgaria	Non Euro EU	Developed
Canada	NAFTA	Developed
China	Rest	Developing
Cyprus	Euro Zone	Developed
Czech Republic	Non Euro EU	Developed
Denmark	Non Euro EU	Developed
Estonia	Euro Zone	Developed
Finland	Euro Zone	Developed
France	Euro Zone	Developed
Germany	Euro Zone	Developed
Greece	Euro Zone	Developed
Hungary	Non Euro EU	Developed
India	Rest	Developing
Indonesia	Rest	Developing
Ireland	Euro Zone	Developed
Italy	Euro Zone	Developed
Japan	East Asia	Developed
South Korea	East Asia	Developing
Latvia	Non Euro EU	Developed
Lithuania	Non Euro EU	Developed
Luxembourg	Euro Zone	Developed
Malta	Euro Zone	Developed
Mexico	NAFTA	Developing
Netherlands	Euro Zone	Developed
Poland	Non Euro EU	Developed
Portugal	Euro Zone	Developed
Romania	Non Euro EU	Developed
Russia	Rest	Trasition Period
Slovak Republic	Euro Zone	Developed
Slovenia	Euro Zone	Developed
Spain	Euro Zone	Developed
Sweden	Non Euro EU	Developed
Taiwan	East Asia	Developing
Turkey	Rest	Developing
United Kingdom	Non Euro EU	Developed
United States	NAFTA	Developed

Table A.8: My caption

ISIC rev.3	Industry name	Sector Code
AtB	Agriculture, Hunting, Forestry and Fishing	c1
C	Mining and Quarrying	c2
15t16	Food, Beverages and Tobacco	c3
17t18	Textiles and Textile Products	c4
19	Leather, Leather Products and Footwear	c5
20	Wood and Products of Wood and Cork	c6
21t22	Pulp, Paper, Printing and Publishing	c7
23	Coke, Refined Petroleum and Nuclear Fuel	c8
24	Chemicals and Chemical Products	c9
25	Rubber and Plastics	c10
26	Other Non-Metallic Mineral	c11
27t28	Basic Metals and Fabricated Metal	c12
29	Machinery, Not elsewhere classified	c13
30t33	Electrical and Optical Equipment	c14
34t35	Transport Equipment	c15
36t37	Manufacturing, Not elsewhere classified; Recycling	c16
E	Electricity, Gas and Water Supply	c17
F	Construction	c18
50	Sale and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	c19
51	Wholesale Trade, Except of Motor Vehicles and Motorcycles	c20
52	Retail Trade and Repair, Except of Motor Vehicles and Motorcycles;	c21
H	Hotels and Restaurants	c22
60	Inland Transport	c23
61	Water Transport	c24
62	Air Transport	c25
63	Other Supporting Transport Activities	c26
64	Post and Telecommunications	c27
J	Financial Intermediation	c28
70	Real Estate Activities	c29
71t74	Renting of Machinery & Equipment and Other Business Activities	c30
L	Public Administration and Defence; Compulsory Social Security	c31
M	Education	c32
N	Health and Social Work	c33
O	Other Community, Social and Personal Services	c34
P	Private Households with Employed Persons	c35