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Three Essays on International Trade and Finance

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THREE ESSAYS ON INTERNATIONAL TRADE AND FINANCE

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by

Syed Al-Helal Uddin

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To: Dean John F. Stack, Jr.
Steven J. Green School of International and Public Affairs

This dissertation, written by Syed Al-Helal Uddin, and entitled Three Essays on International Trade and Finance, having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

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The dissertation of Syed Al-Helal Uddin is approved.

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Florida International University, 2017

DEDICATION

I dedicate this dissertation to my parents and my wife, Kaniz Fatema, who have been a constant source of support, encouragement, and who have always loved and supported me unconditionally.

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ABSTRACT OF THE DISSERTATION

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This dissertation is composed of three essays at the intersection of international trade and finance. In the first chapter, I measure exchange rate pass-through (ERPT) for value-added exports, where intermediate input requires sharing among countries in a back-and-forth manner for producing a single final product. I derive an estimating equation for ERPT and value-added trade following a partial equilibrium model, which also leads to decomposition of the trade elasticity into the own price effect and the price index effects. From the empirical estimation, I find that ignoring the value-added trade will cause a systematic upward bias in the estimation of ERPT. I also find that there exists substantial heterogeneity in pass-through rates across sectors: sectors with high-integration into global markets functions with a lower rate of exchange in comparison to sectors with less integration.

The second essay focuses on a specific market, where I examine the relationship between product attributes and ERPT. This paper estimates the ERPT by using good-level daily data on wholesale prices of imported agricultural products, where the identification is achieved by using daily data on the domestic inflation rate. The results of standard empirical analyses are in line with existing studies that employ lower frequencies of data by showing evidence for incomplete daily ERPT of about 5 percent. The key innovation is achieved when nonlinearities in ERPT are considered, where ERPT is doubled to about 10 percent when daily nominal

exchange rate changes are above 0.55 percent, daily frequencies of price change are above 3.12 percent, storage life of a product is above 10 weeks, and for the non-zero price changes, the ERPT is complete.

In the final essay, I focus on the firms' export pricing strategy: pricing-to-market strategy. To achieve this, I introduce a partial equilibrium model of firm's pricing strategy, where the market share of a firm plays an important role in the determination of markup. The empirical estimation is that markup ranges from 1.25 to 1.5 across years and 1.25 to 51.23 across firms. I also find that markups come back to their average level within 30 to 60 days of the initial date.

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CHAPTER 1

VALUE-ADDED TRADE, EXCHANGE RATE PASS-THROUGH, AND TRADE ELASTICITY: REVISITING THE TRADE COMPETITIVENESS

1.1 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

[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.

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?

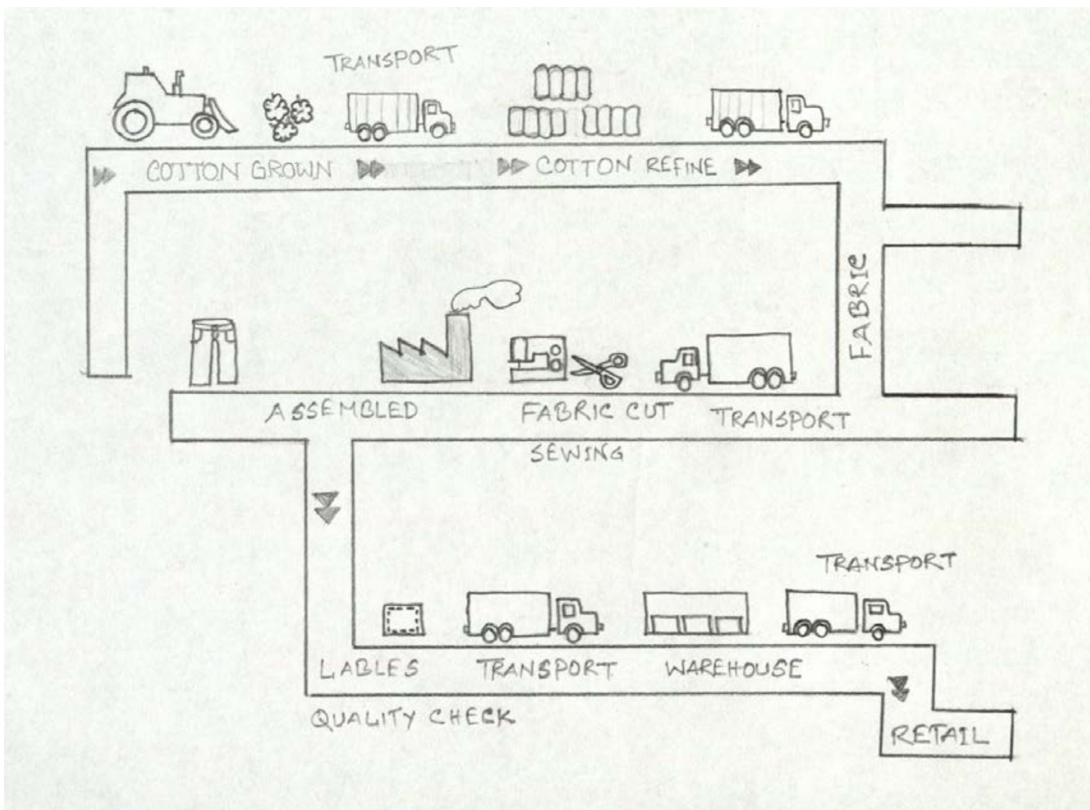
This paper considers a back-and-forth trade structure as follows: assume there are four countries in the world, namely Bangladesh (B), India (I), China (C), and the USA (U), engaged in a global value chain of trade.[3] In this hypothetical trade structure, countries are producing apparel and textile products. Figure 1.1 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 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

[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.

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?

Figure 1.1: Back-and-forth trade structure for apparel and textile products



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 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,

[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.

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

[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).

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 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.

1.2 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), 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 disaggregation 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); 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.

1.3 Methodology and Data

1.3.1 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.

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:

$$V_i = \left(\sum_j (\alpha_{ij})^{1/\sigma} \, q_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{1.1}$$

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

Solving the maximization problem in (1.1), yields the demand function as follows:

$$q_{ij} = (\alpha_{ij}) \, (P_{ij})^{-\sigma} P_i^{\sigma-1} V_i \tag{1.2}$$

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:

$$V_{ij} = (\alpha_{ij}) \, (P_{ij})^{1-\sigma} P_i^{\sigma-1} V_i \tag{1.3}$$

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.

$$\frac{V_{ij}}{V_{jj}} = \left(\frac{\alpha_{ij}}{\alpha_{jj}} \right) \left(\frac{P_{ij}}{P_{jj}} \right)^{1-\sigma} \tag{1.4}$$

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 (1.4) as follows:

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = (1-\sigma)(\hat{p}_{ij,t} - \hat{p}_{jj,t}) \tag{1.5}$$

$\hat{P}_{ij,t}$ 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.

$$\hat{p}_{ij,t} = \lambda \Sigma_k \theta_{ki,t} (\hat{p}_{kk,t} - \hat{E}_{kj,t}) \tag{1.6}$$

$\theta_{ki,t}$ captures the cost share of country k's exports in the sector s in country i at year t. Using equation (1.5) and (1.6)

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = -(1-\sigma)\hat{p}_{jj,t} - \lambda(1-\sigma)\Sigma_k \theta_{ki,t} (\hat{p}_{kk,t} - \hat{E}_{kj,t}) \tag{1.7}$$

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:

$$V_{ij,t} = Y_{j,t}(P_{j,t})^{\sigma}(P_{ij,t})^{-\sigma} \tag{1.8}$$

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,

$$\hat{v}_{ij,t} = \hat{y}_{j,t} + \sigma(\hat{p}_{j,t} - \hat{p}_{ij,t}) \tag{1.9}$$

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

$$\hat{p}_{jt} = \Sigma_k \gamma_{kj,t} \hat{p}_{kj,t} \tag{1.10}$$

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 (1.5) and (1.9) into (1.8) and setting $\hat{y}_{j,t} = 0$, yields as follows:

$$\hat{v}_{ij,t} = \sigma \left(\Sigma_k \gamma_{kj,t} \hat{p}_{kj,t} - \lambda \Sigma_k \theta_{ki,t} (\hat{p}_{kk,t} - \hat{E}_{kj,t}) \right) \tag{1.11}$$

$$\hat{v}_{ij,t} = \sigma \lambda \Sigma_k \theta_{ki,t} \hat{E}_{kj,t} + \sigma \left(\Sigma_k \gamma_{kj,t} \hat{p}_{kj,t} - \lambda \Sigma_k \theta_{ki,t} \hat{p}_{kk,t} \right) \tag{1.12}$$

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 (1.10) as follows:

$$\hat{v}_{ij,t} = -\sigma(-\lambda \theta_{iit} \hat{E}_{ijt} + \lambda \Sigma_k \theta_{ikt} \gamma_{kjt} \hat{E}_{ijt}) \tag{1.13}$$

From equation (1.12), 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.

$$TE_{ij,t} = \underbrace{-\sigma\lambda(-\theta_{ii,t})}_{\text{own price effect}} + \underbrace{(-\sigma\lambda)\Sigma_k \theta_{ik,t} \gamma_{kj,t}}_{\text{prices index effect}} \tag{1.14}$$

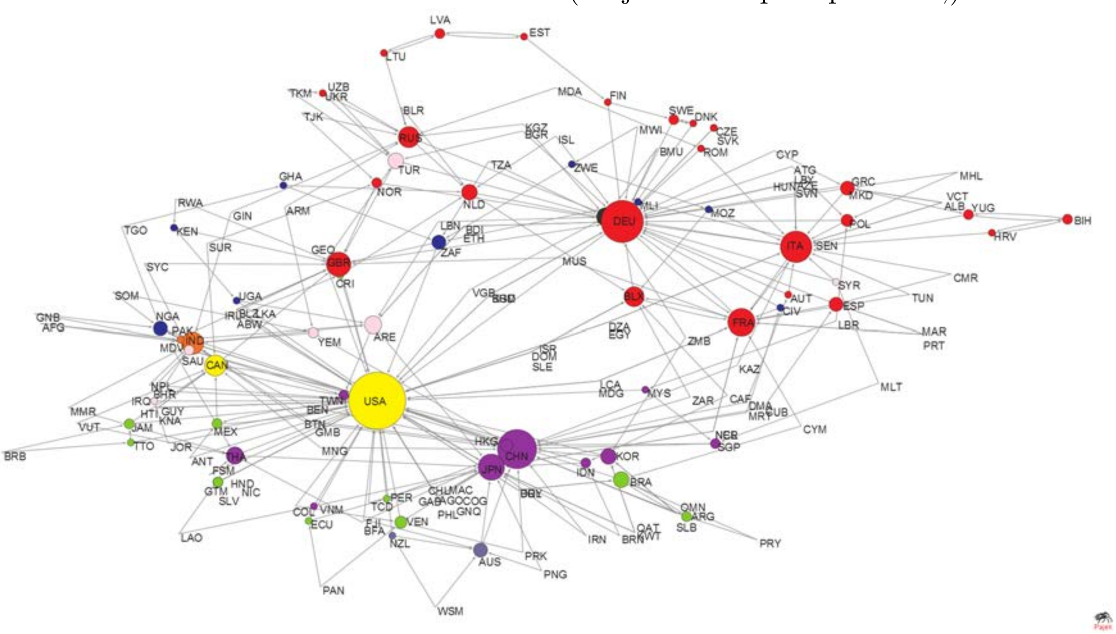
From equation (1.13), we expect that the trade elasticity is positive. The own price effect is always positive, and it is increasing in the country i's share of the value added in its own production in the sector. The price index effect is always negative, and it is declining in the country j expenditure-weighted 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).

1.3.2 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 1.2: Bilateral trade among countries with top importing and exporting pairs'

Figure 3 –
The Network of World Trade in Goods (major two export partners,) 2007.



Note:For each country, only the export flows toward the first and second trade partner are considered. Country labels are the iso3 country codes. The size of the circle associated to each country is proportional to the number of inflows. Different colors correspond to different geographical regions. Trade data come from BACI-CEPII dataset. The network is drawn using `Pajek`. The sequence of `Pajek` commands necessary to reproduce the above figure is included in the Appendix.

Figure 1.2 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

international trade as a network of trade flows is therefore the possibility to visualize the effect of the relationship between the trading countries and the structure of the network itself, revealing patterns that are difficult to see using other approaches.

The network depicted in figure 3 is characterized by several features. Since we are accounting for just the two major export markets for every country, no specific weight is attached to the links, and the figure represents a directed unweighted (binary) network. By construction there is no disconnected component in the network (i.e. no county or group of countries is isolated from the rest of the network). As in figure 2 the size of the circle corresponding to a country is proportional to the number of receiving links, and is highly heterogeneous. In figure 3 highly connected nodes are generally placed at the center of the network (i.e US, Germany, China and Japan (JAP), France (FRA) and the

[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).

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 1.3: 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

Figure 1.3 summarizes the available global input-output database. The WIOD database 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.

Figure 1 Schematic outline of Input-Output Tables

A. National Input-Output Table

		Industry	Final use		Use	Supply	
	Industry	Intermediate use	Domestic final use	Exports	Total use	Domestic supply	Imports
		Value added by labour and capital					
		Gross output					

Figure 1.4: Single country input-output table structure

source: Timmer et al. (2014a)

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

B. World Input-Output Table (WIOT), three regions

		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				

use tables (SUTs), which 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 1.4 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 1.4 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 1.5 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 1.5 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 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

[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.

	Value added by labour and capital
	Gross output

Figure 1.5: WIOD: 3 country Input-Output table structure

B. World Input-Output Table (WIOT), three regions

		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)

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 1.8 - 1.16 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 (1.8) 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]

1.4 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.

1.4.1 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 1.15

[10]Figures 1.8 – 1.16 shows some contradiction with the traditional theoretical prediction that when exchange 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.

$$V = F(I - A)^{-1}C \tag{1.15}$$

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 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 1.16. 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 vari-

[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).

able. 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.

1.4.2 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 1.14.

Exchange Rate Pass-Through

For the empirical econometric estimation, we used equation (1.6) in the following equation (1.16):

$$\hat{v}_{ij,t} - \hat{v}_{jj,t} = \beta_0 + \beta_1 \hat{p}_{jj,t} + \beta_2 \Sigma_k \theta_{ki,t} (\hat{p}_{kk,t} - \hat{E}_{kj,t}) + \eta_{ij,t} \tag{1.16}$$

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 1.1 shows the estimation results for exchange rate pass-through and elasticity of substitution for different specifications of value-added exports. In table

[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 1.1: 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

1.1, 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 1.1, 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 1.1, 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 1.1, 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 1.1) 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 1.2 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 A1 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*,

Table 1.2: 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

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 A1 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 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 1.6 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)

Figure 1.6: ERPT and share of DVA returned home by countries

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].

[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 1.7: ERPT and share of DVA returned home by sectors

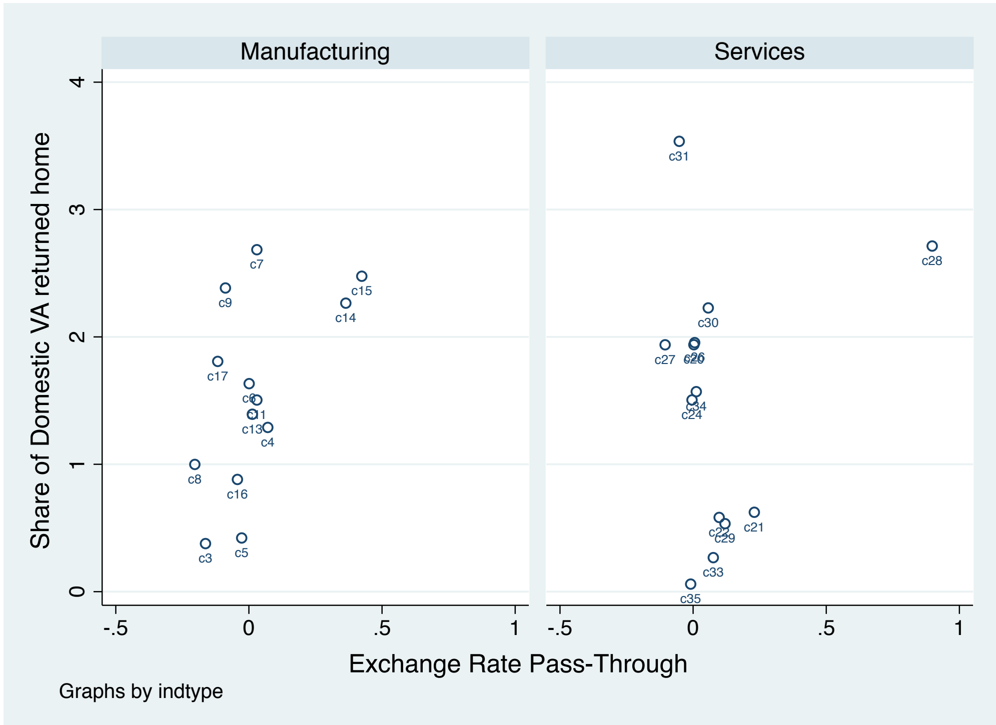


Figure 1.7 shows the relationship between exchange rate pass-through coefficients and share of domestic value-added that returned home (RDV) by sector. From figure 1.7, it is evident that there is a lot of heterogeneity in ERPT across sectors. The first segment shows the ERPT estimate and share of domestic 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.

Trade Elasticity

Following equation 1.14, we calculated trade elasticity and decomposed it into own price effect and price index effect. Table 1.3 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 (1.14), and the σ and λ coefficients are obtained from regression estimation. The first panel of table 1.3 shows the elasticity of substitution 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 1.3 also confirmes that there is substantial heterogeneity across countries in trade elasticity.

In the second panel of table 1.3, 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 exports from India to the United States by 0.051%. These

Table 1.3: Trade Elasticity for the selected sectors and countries to USA in 2011

Panel One: Trade Elasticity for Agriculture, Hunting, Forestry and Fishing for 2011 for USA						
	BRA	CAN	CHN	IND	JPN	MEX
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

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 1.3 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 1.3 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%.

1.5 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 1.8: Bilateral exports, imports, and exchange rate for USA and China

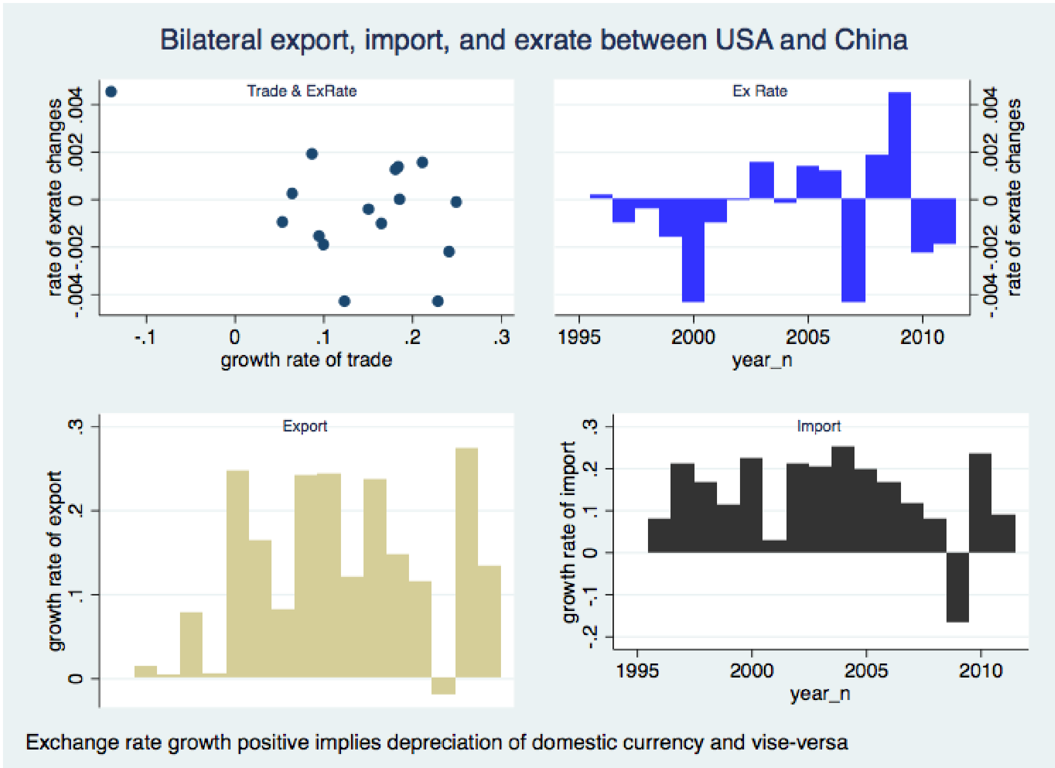


Figure 1.9: Bilateral exports, imports, and exchange rate for USA and Mexico

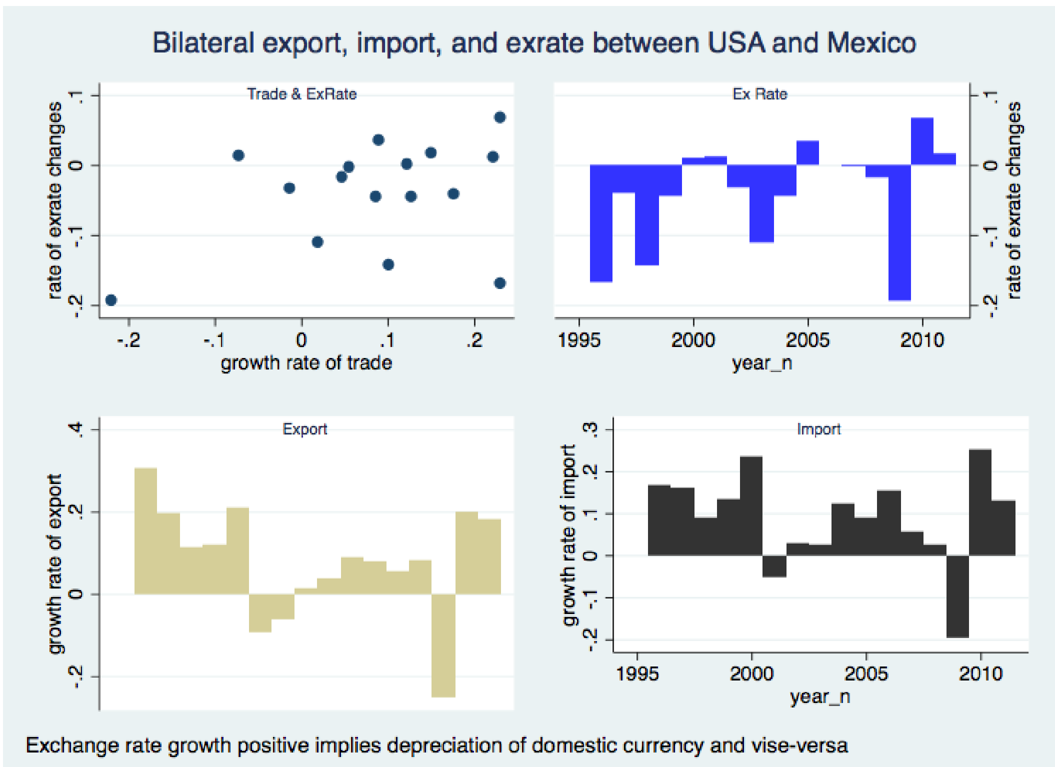


Figure 1.10: Bilateral exports, imports, and exchange rate for USA and Japan

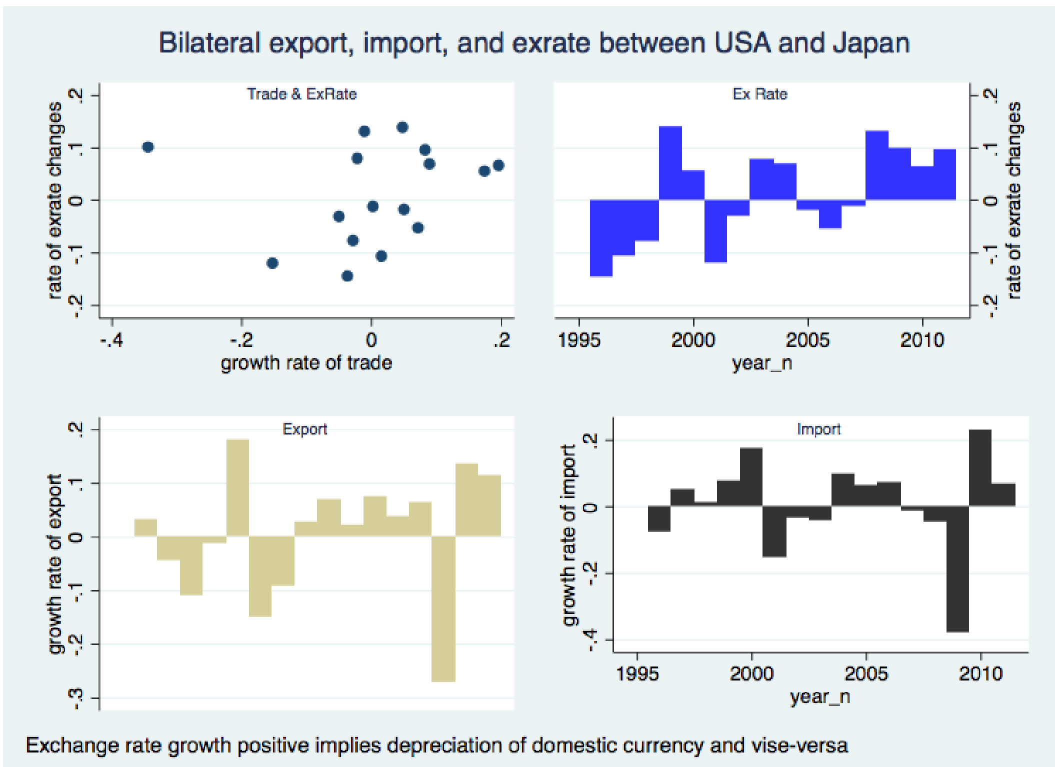


Figure 1.11: Bilateral exports, imports, and exchange rate for China and Japan

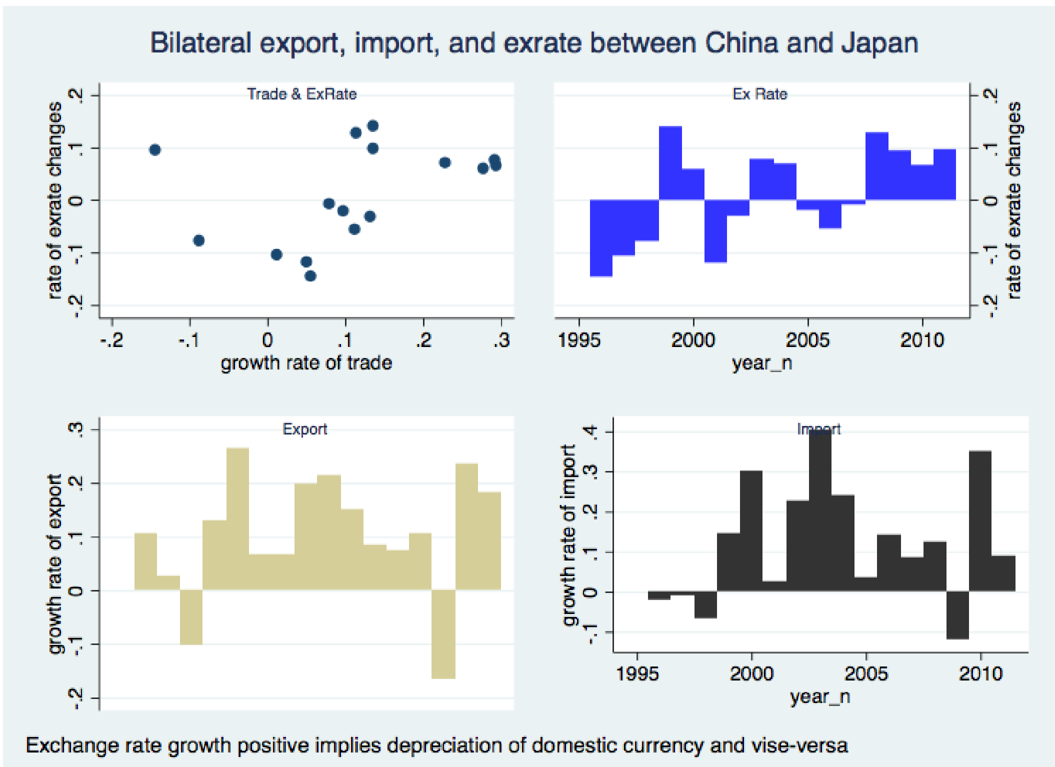


Figure 1.12: Bilateral exports, imports, and exchange rate for China and South Korea

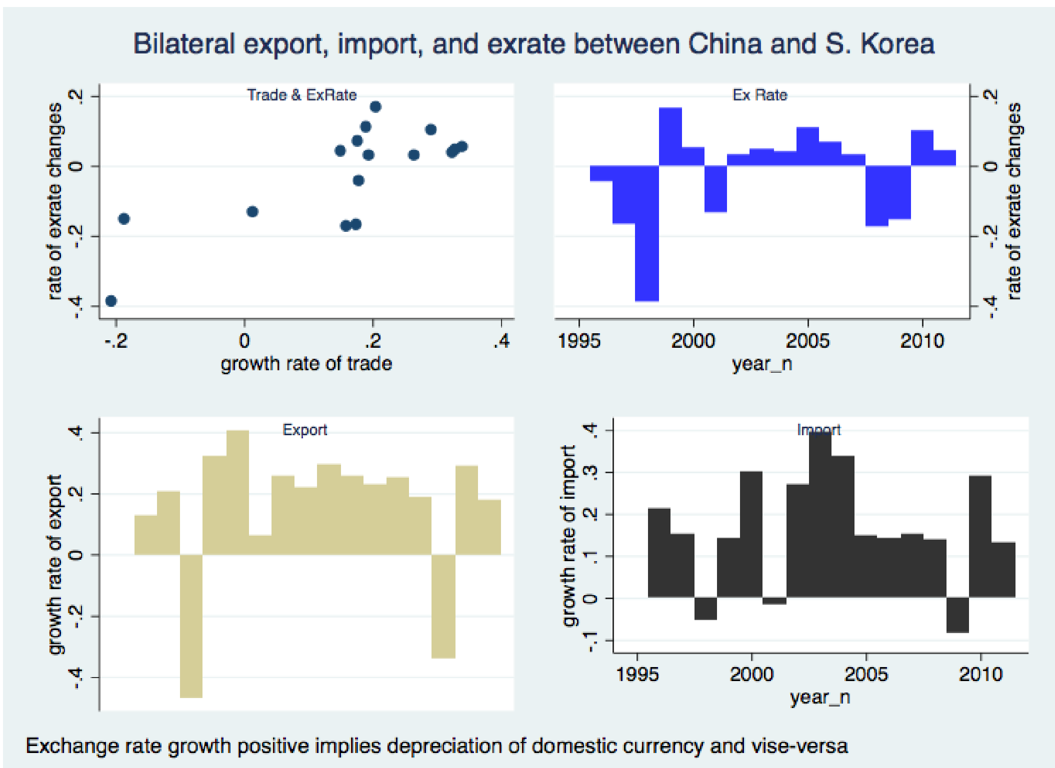


Figure 1.13: Bilateral exports, imports, and exchange rate for China and India

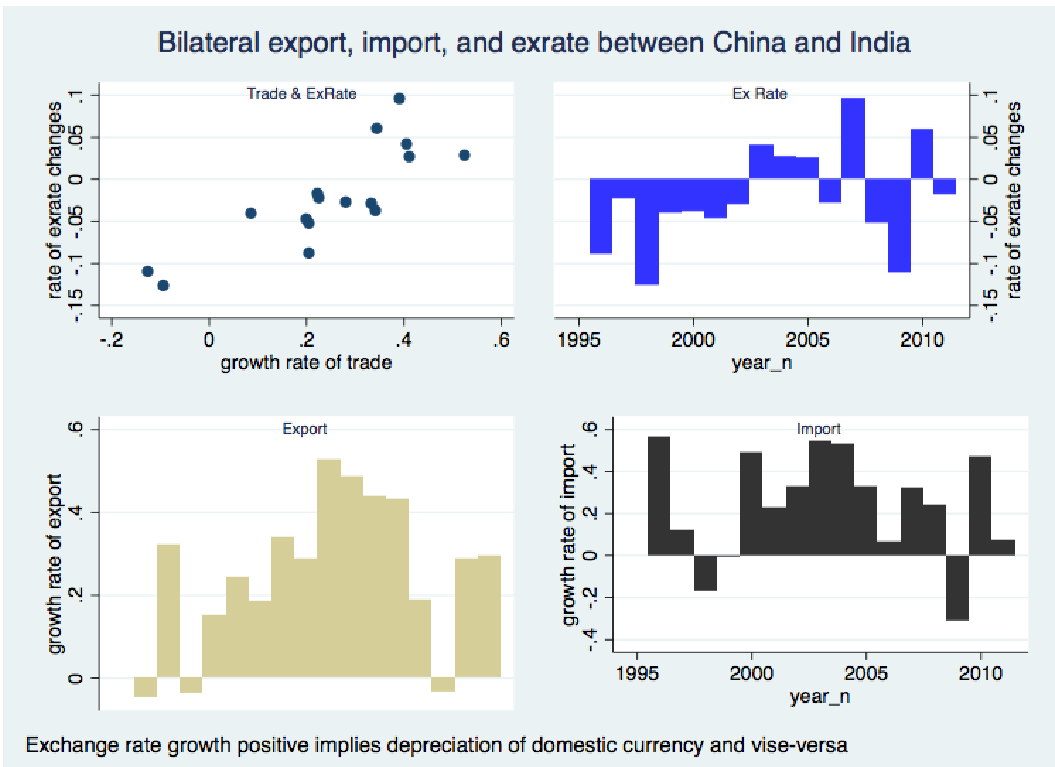


Figure 1.14: Bilateral exports, imports, and exchange rate for Germany and United States

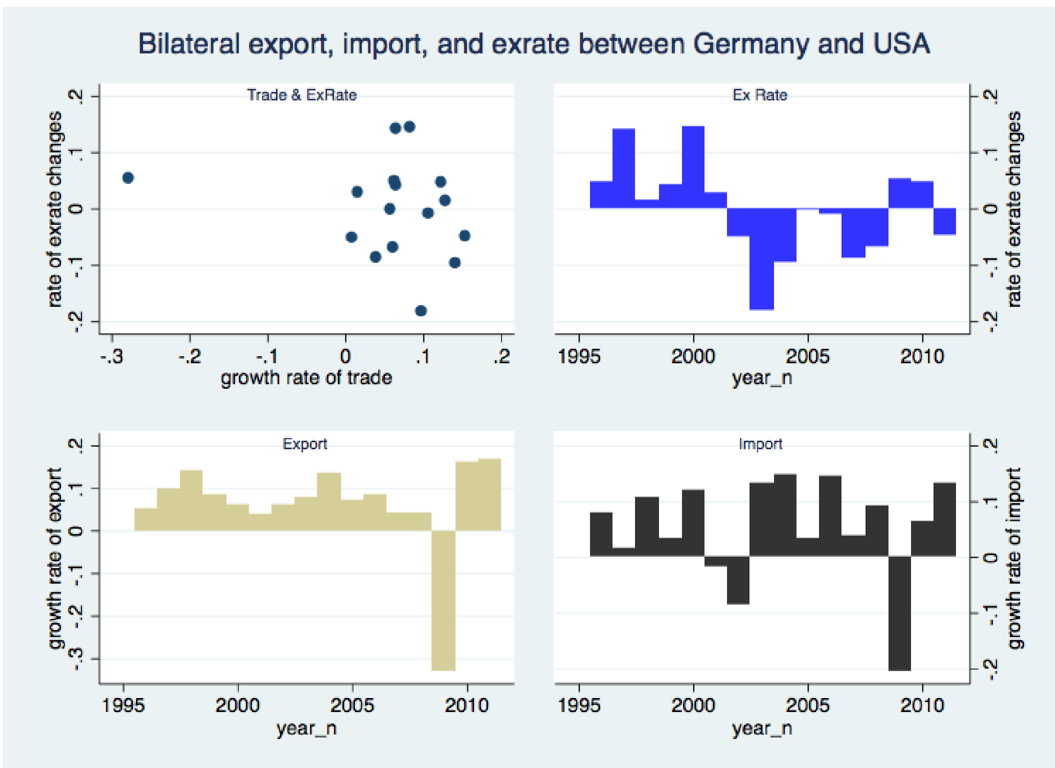


Figure 1.15: Bilateral exports, imports, and exchange rate for Germany and United Kingdom

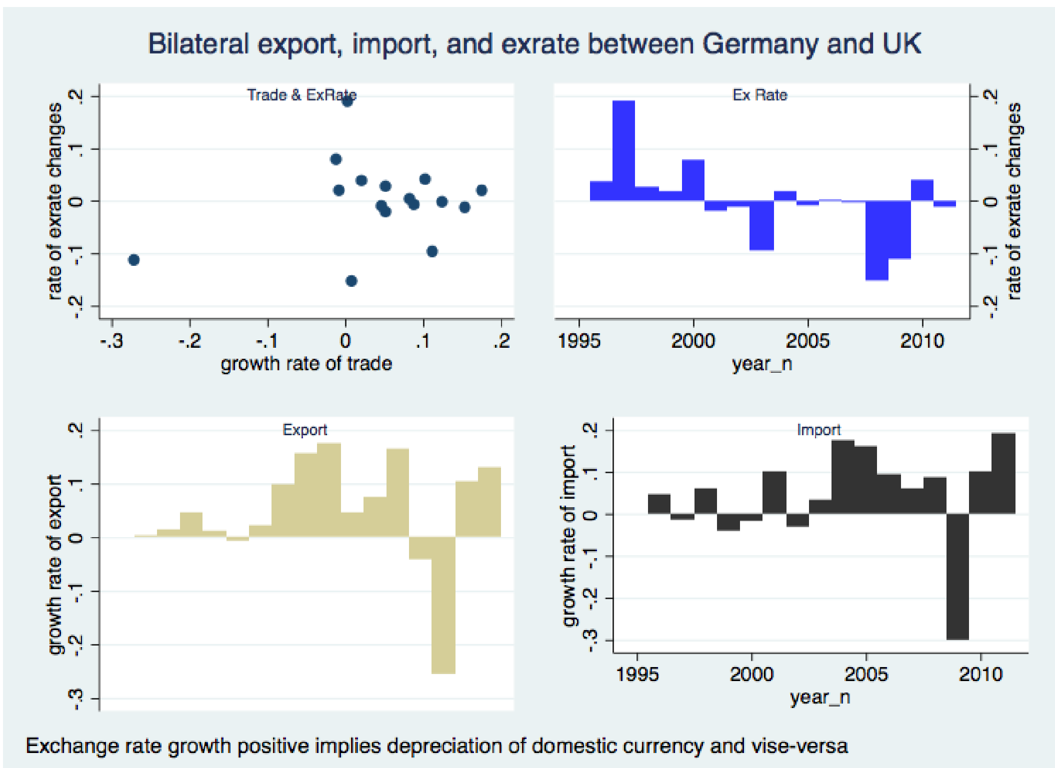
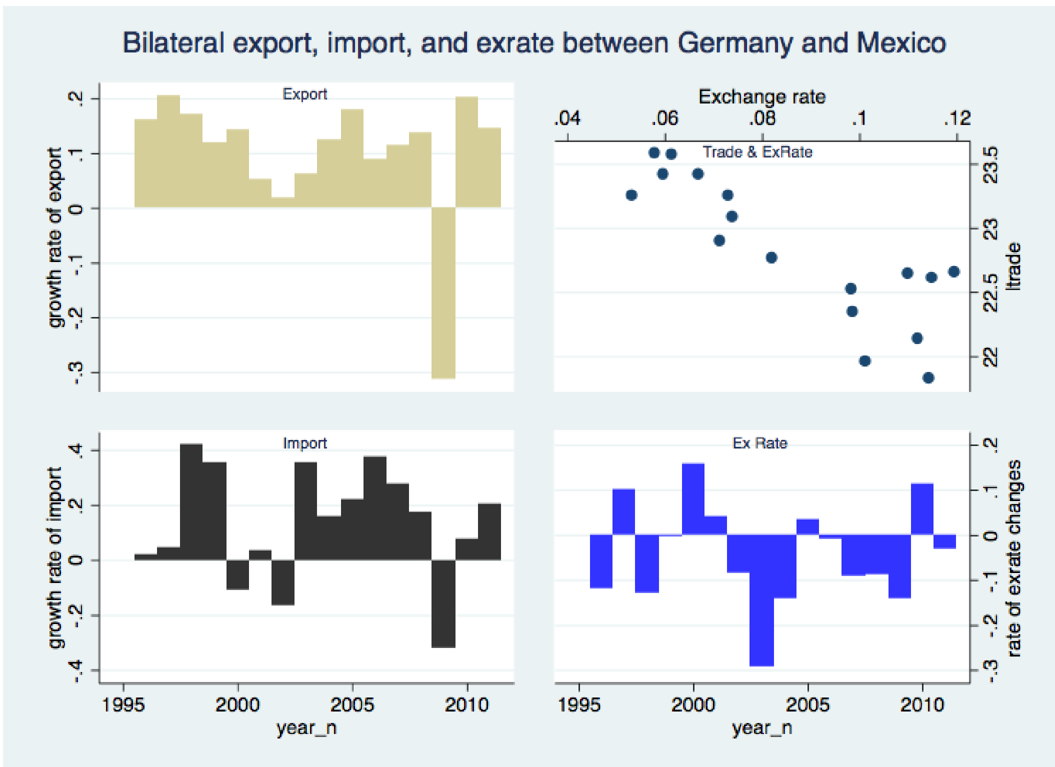


Figure 1.16: Bilateral exports, imports, and exchange rate for Germany and Mexico



CHAPTER 2

DAILY EXCHANGE RATE PASS-THROUGH INTO MICRO PRICES

2.1 Introduction

Exchange rate pass-through (ERPT) is the standard measure used to represent the relationship between nominal exchange rates (NER) and prices of internationally traded goods.[1] Since central banks that have the objective of price stability can intervene in the exchange rate market to have full or partial control over the value of their currency, policy makers simply would like to know how prices would react to changes in NER. Such knowledge is also essential for individual welfare through income and substitution effects, especially for small-open economies.

Within this picture, we investigate ERPT at the product-level by introducing a new data set that has two main advantages over those employed in the existing literature. First, we have daily wholesale price data on 52 imported agricultural products for the period between January 2005 and August 2015 in Turkey; to our knowledge, this is one of the few rich data sets based on daily observations of micro prices. Second, we have the corresponding daily prices for domestically produced agricultural products, so that the pure effects of NER changes on prices can be identified with respect to other macroeconomic developments.[2]

[1]This paper follows the textbook definition of ERPT as described in Goldberg and Knetter (1997), which is the percentage change in local currency import prices resulting from a one percent change in the exchange rate. Accordingly, *complete* ERPT corresponds to a value of 1 (or 100%), while *incomplete* ERPT corresponds to values below 1 (or 100%).

[2]Another daily data set is by Lott and Einav (2013) who have considered daily ERPT evidence based on *eBay* transactions of U.S. imports from Australia, Canada, Germany, Japan and the U.K. that constitute a small portion of the overall expenditure in the U.S. without controlling for domestic price changes; in comparison to such online price data, our data set not only represents offline wholesale prices of agricultural products

We combine the daily price data of agricultural products with the corresponding data on NER, frequency of price change (measured over the sample period, thanks to the micro-price nature of the data) and storage life (a concept corresponding to the opposite of perishability/depreciation) to estimate ERPT, where we also consider potential nonlinearities through estimated thresholds in these variables. The benchmark results show evidence for an *incomplete* ERPT of about 0.05%, which is in line with the existing studies based on good-level data sets (e.g., see Aron et al. (2014), Gopinath et al. (2010) or Lott and Einav (2013)), although the coefficients are lower compared to the studies based on aggregate-level data sets (e.g., see Goldberg and Knetter (1997) or Menon (1995)). The corresponding threshold analyses further show that ERPT is about 11% when NER changes are above 0.55% (consistent with studies such as that by Burstein et al. (2005), who showed that the magnitude of NER changes may be effective in the determination of ERPT), about 9.1% when frequency of price change is higher than 3.12% (consistent with studies such as those by Gopinath and Itskhoki (2010) and Antoniades and Zaniboni (2016), who showed that there is a positive relationship between frequency of price change and ERPT), or about 9.4% when storage life is higher than 10 weeks (which is new in this paper, suggesting that ERPT decreases with perishability/depreciation). When the investigation is restricted to non-zero price changes, as in studies such as that by Gopinath et al. (2010), the tables turn with evidence of *complete* ERPT for observations with values above such thresholds.

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that constitute about 22% of overall consumption expenditure in Turkey (according to the Turkish Statistical Institute) but also controls for domestic price changes.

2.2 Data and Empirical Methodology

The micro-price data that cover daily wholesale prices of 52 *imported* agricultural goods in Istanbul, Turkey between January 2005 and August 2015 have been obtained from the web page of Istanbul Metropolitan Municipality.[3] The data source distinguishes between imported products and goods that are domestically produced in Turkey, which is a perfect fit for our daily investigation of ERPT for identification purposes; accordingly, in order to control for local macroeconomic developments, we construct the daily *domestic* inflation rate using daily price data of 311 agricultural goods produced within Turkey and sold in Istanbul.[4] We combine this data set with the daily nominal exchange rate (NER) between the Turkish Lira and the U.S. dollar that has been obtained from the web page of The Central Bank of the Republic of Turkey.[5] The micro-price data are also used in order to calculate the good-level frequencies of price change. Given that our data set consists of perishable imported goods, we would also like to study whether ERPT varies with respect to the storage life of a commodity. Our motivation comes from studies such as those by Kryvtsov and Midrigan (2012) or Alessandria et al. (2013), which have shown that the optimal price (and thus markups) of any seller decreases with the depreciation rate of inventories. Intuitively, since sellers may want to sell more perishable goods as soon as possible due to their high depreciation rate, the seller may accept lower price offers, independent of NER changes. This translates into an ERPT that is higher

[3]The web page of Istanbul Metropolitan Municipality is www.ibb.gov.tr.

[4]In particular, for each day, we calculate the average percentage change in good-level prices, after ignoring the outlier goods, defined as those that have price changes more than two standard deviations away from the average inflation.

[5]The web page of The Central Bank of the Republic of Turkey is www.tcmb.gov.tr.

for less-perishable products in relative terms. Accordingly, we use the storage life measures provided by Cantwell (2001) that cover all of our agricultural products.

Following studies such as those by Campa and Goldberg (2005) and Burstein and Gopinath (2014), we use the following standard specification in order to measure ERPT:

$$\Delta p_{g,t} = \alpha + \left(\sum_{k=0}^{T} \beta_k \Delta e_{t-k} \right) + \gamma \pi_t + \delta_g + S_t + \epsilon_t \tag{2.1}$$

where $\Delta p_{g,t}$ is the daily change in log wholesale price of imported good g, β_k measures the exchange rate pass through of the k'th lag of the log NER change, Δe_{t-k} is the k'th lag of the log NER change, π_t is the daily domestic inflation rate (as a control variable), δ_g's are good-fixed effects, S_t represents seasonality controls, and ϵ_t is the error term.

The number of daily lags T in Equation 2.1 is determined by using standard criteria of AIC and BIC, together with the significance of the corresponding coefficients. The usage of the domestic inflation rate π_t as a control variable is essential to identify the pure effects of NER changes as a source of daily foreign shocks. Good-fixed effects of δ_g's are useful to control for good-specific factors. Following studies such as those by Al-Khazali (2008), Al-Ississ (2010), Anson et al. (2014), and Ali and Akhter (2016), which uses daily data sets, we control seasonality S_t; weekday fixed effects, monthly fixed effects, and Ramadan fixed effects, where the period of Ramadan changes each year with respect to the religious calendar.

We also consider potential nonlinearities in the determination of ERPT by using a threshold approach according to the following specification:

$$\Delta p_{g,t} = \alpha + \left(\sum_{k=0}^{T} \beta_k \Delta e_{t-k} I\left(q_{g,t} \leq \tau\right) \right) + \left(\sum_{k=0}^{T} \beta_k \Delta e_{t-k} I\left(q_{g,t} > \tau\right) \right) + \gamma \pi_t + \delta_g + S_t + \epsilon_t \tag{2.2}$$

where $q_{g,t}$ is the threshold variable (representing NER, frequency of price change, or storage life), τ is the corresponding threshold value, $I(q_{g,t} \leq \tau)$ is an indicator function taking a value of 1 if $q_{g,t} \leq \tau$ or 0 otherwise, and $I(q_{g,t} > \tau)$ is an indicator function taking a value of 1 if $q_{g,t} > \tau$ or 0 otherwise. Following studies such as by Chan (1993) and Hansen (2000), τ is estimated using least squares with the objective of minimizing the residual sum of squares.

2.3 Empirical Results

The results for the benchmark specification in Equation 2.1 are given in Table 1, where we show the estimation results based on lags of NER up to $T = 1$, although we considered lags up to $T = 8$.[6] Although the criteria of AIC and BIC both select $T = 1$ (followed by $T = 0$), the corresponding coefficient of lagged NER is statistically insignificant in all specifications; accordingly, we consider the lag selection of $T = 0$ for the rest of our investigation, which is in line with studies based on daily data, such as those conducted by Lott and Einav (2013). It is implied that the coefficient of the current log NER change β_0 corresponds to the measure of ERPT as well. Within this picture, the results in Table 1 show that ERPT is about 5% on average across goods and time. Compared to the existing studies, this ERPT measure is very similar to the ones estimated at the good level, especially for the category of foods (e.g., see Aron et al. (2014), Gopinath et al. (2010) or Lott and Einav (2013)). The results are also robust to the consideration of alternative control variables, where domestic inflation contributes to log price changes with a

[6]The results based on higher number of lags have much higher AIC and BIC criteria (and thus are not selected) that have been skipped to save space, but they are available upon request.

coefficient of about 0.34 when $T = 0$ and all control variables are included in the regression in column (7).

The results for the threshold analyses represented by Equation 2.2 are given in Table 2, where we distinguish between all price changes and non-zero price changes following studies such as those by Gopinath et al. (2010). When all price changes are included in the regression (including zero price changes), there is evidence for incomplete ERPT of around 10% only when log daily NER changes are above 0.55%, when goods with frequency of price change over 3.12% are considered, or when goods with storage life of more than 10 weeks are considered. When only non-zero price changes are included in the regression, the tables turn, showing evidence for *complete* ERPT, since a positive and significant coefficient of 1 is within any confidence interval. In this case, the ERPT coefficients take values of about 1.20, 0.73, and 1.55 for observations with values above the threshold levels of NER percentage change, frequency of price change, and storage life, respectively. These results are in line with studies such as those by Gopinath et al. (2010) who show that non-zero price changes correlate with higher ERPT estimates, although daily ERPT measures, as well as threshold values and results based on storage life, are new in this paper.

2.4 Concluding Remarks

Policy makers are interested in exchange rate pass-through (ERPT) measures not only because of price-stability concerns in especially small-open economies, but also because ERPT measures are mapped into real effects of nominal exchange rate (NER) changes. By using daily good-level wholesale price data on imported agricultural products, this paper has shown that ERPT is *incomplete* and about 5% on

average across goods and time, and robust to the consideration of several control variables, including the daily domestic inflation rate.

When nonlinearities are considered through threshold analyses, we have shown that ERPT is doubled to about 10% when daily NER changes are above 0.55%, frequency of price change is above 3.12%, and storage life is above 10 weeks, while ERPT is statistically insignificant below these threshold values. When we further consider these threshold values for non-zero price changes, ERPT becomes *complete* since 100% is included within the estimated confidence intervals. Here the consideration of a threshold in storage life contributes most to the investigation by leading into an ERPT of about 155% for products with storage life of more than 10 weeks, followed by an ERPT of about 120% for days when the NER change is higher than 0.55%, and an ERPT of about 73% for products with a frequency of price change larger than 3.12%.

These results are in line with existing studies in the literature (that employ lower frequency data sets) such as: (i) Burstein et al. (2005), who have shown that the magnitude of NER changes may be effective in the determination of ERPT; (ii) Gopinath and Itskhoki (2010) and Antoniades and Zaniboni (2016), who have shown that there is a positive relationship between frequency of price change and ERPT; and (iii) Kryvtsov and Midrigan (2012) or Alessandria et al. (2013), who have shown that the optimal price (and thus markups) of any seller decreases with the depreciation rate of inventories. Intuitively, since sellers may want to sell the more perishable goods as soon as possible due to their high depreciation rate, they may accept lower price offers, independent of NER changes. This translates into an ERPT that is higher for less-perishable products in relative terms, which is new in this paper.

Table 2.1: Daily ERPT with Alternative Lags and Control Variables

VARIABLES	Dependent Variable: Δ Log Daily Product-level Price							
	Without Fixed Effects				With Fixed Effects			
	1	2	3	4	5	6	7	8
Δ Log Daily Exchange Rate	0.0466**	0.0372	0.0516**	0.0454*	0.0452**	0.0367	0.0490**	0.0438*
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Δ Log Daily Exchange Rate, Lag 1		-0.0354		-0.0363		-0.0389		-0.0386
		(0.03)		(0.03)		(0.03)		(0.03)
Inflation			0.358***	0.351***			0.335***	0.325***
			(0.07)	(0.07)			(0.07)	(0.07)
Good Fixed Effects	NO	NO	NO	NO	YES	YES	YES	YES
Seasonality	NO	NO	NO	NO	YES	YES	YES	YES
AIC	-122766	-123944	-123365	-124572	-122976	-124180	-123466	-124685
BIC	-122748	-123918	-123339	-124538	-122831	-124027	-123312	-124523
R-squared	0	0	0.016	0.017	0.006	0.007	0.019	0.021
Observations	37,806	36,950	37,806	36,950	37,806	36,950	37,806	36,950

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors are in parentheses.

Table 2.2: Daily ERPT with Thresholds and Non-zero Price Changes

VARIABLES	Dependent Variable:Δ Log Daily Product-level Price					
	All Price Changes			Non-zero Price Changes		
	1	2	3	4	5	6
Δ Log Daily Exchange Rate >Threshold of 0.55%	0.110***			1.201**		
	(0.0389)			(0.494)		
Δ Log Daily Exchange Rate <= Threshold of 0.55%	-0.0166			-0.0329		
	(0.0392)			(0.342)		
(Δ Log Daily Exchange Rate)		0.0905***			0.732**	
x (Frequency of Price Change >Threshold of 3.12%)		(0.0245)			(0.317)	
(Δ Log Daily Exchange Rate)		-0.0307			-0.712	
x (Frequency of Price Change <= Threshold of 3.12%)		(0.0328)			(1.521)	
(Δ Log Daily Exchange Rate)			0.0940**			1.553**
x (Storage Life >Threshold of 10 weeks)			(0.0361)			(0.647)
(Δ Log Daily Exchange Rate)			0.0356			0.432
x (Storage Life <= Threshold of 10 weeks)			(0.0269)			(0.28)
Inflation	0.335***	0.335***	0.335***	1.680***	1.674***	1.681***
	(0.0694)	(0.0694)	(0.0694)	(0.101)	(0.0993)	(0.0999)
Goods FE	YES	YES	YES	YES	YES	YES
Seasonality	YES	YES	YES	YES	YES	YES
AIC	-123467	-123468	-123464	-4434	-4432	-4431
BIC	-123305	-123305	-123302	-4315	-4313	-4311
R-squared	0.019	0.019	0.019	0.116	0.115	0.115
Observations	37,806	37,806	37,806	3,989	3,989	3,989

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Robust standard errors are in parentheses. Following Chan (1993) and Hansen (2000), thresholds have been estimated by minimizing the overall residual sum of squares.

Table 2.3: Descriptive Statistics

Imported Good Name - Unit	Daily Price Changes: Average	Median	Minimum	Maximum	Standard Deviation	Storage Life in Weeks	Frequency of Daily Price Change
Apple (Gransimit) - Box	0.02%	0.00%	-51.08%	44.18%	4.30%	6	15.31%
Apple (Gransimit) - Kilogram	0.03%	0.00%	-28.77%	28.77%	5.43%	6	16.73%
Apple (Red) - Box	0.06%	0.00%	-28.77%	32.54%	4.40%	6	9.49%
Apple (Red) - Kilogram	0.00%	0.00%	0.00%	0.00%	0.00%	6	0.00%
Apple (Red) - Number	-0.89%	0.00%	-22.31%	0.00%	4.46%	6	4.00%
Apple (Starking) - Box	0.01%	0.00%	-28.77%	25.13%	3.63%	6	11.55%
Apple (Starking) - Kilogram	-2.39%	0.00%	-11.78%	0.00%	4.47%	6	23.53%
Apricot - Kilogram	0.00%	0.00%	0.00%	0.00%	0.00%	2	0.00%
Asparagus - Box	0.00%	0.00%	0.00%	0.00%	0.00%	3	0.00%
Asparagus - Kilogram	0.01%	0.00%	-55.96%	51.08%	6.15%	3	16.75%
Avocado - Quantity	-0.11%	0.00%	-40.55%	40.55%	5.41%	3	6.21%
Banana (1st Quality) - Box	0.05%	0.00%	-39.83%	28.77%	4.71%	3	40.33%
Banana (2nd Quality) - Box	0.04%	0.00%	-18.23%	40.55%	2.40%	3	3.12%
Banana (2nd Quality) - Kilogram	0.02%	0.00%	-25.13%	18.23%	2.03%	3	1.94%
Carambola - Box	-0.04%	0.00%	-26.24%	33.65%	1.71%	4	0.91%
Cherry - Kilogram	0.00%	0.00%	0.00%	0.00%	0.00%	7	0.00%
Coconut - Quantity	0.02%	0.00%	-51.08%	69.31%	3.50%	6	1.61%
Fresh Coconut - Quantity	0.00%	0.00%	0.00%	0.00%	0.00%	6	0.00%
Garlic - Box	-0.07%	0.00%	-18.23%	20.07%	2.87%	26	5.39%
Garlic - Kilogram	-0.02%	0.00%	-31.85%	35.67%	2.75%	26	2.18%
Ginger (Ginger) - Kilogram	-0.02%	0.00%	-61.90%	69.31%	3.88%	24	3.44%
Ginger (Ginger) - Number	0.02%	0.00%	0.00%	6.06%	0.38%	24	0.38%
Grape (Red) - Box	-0.12%	0.00%	-47.00%	18.23%	5.46%	14	8.93%
Grape (Red) - Kilogram	0.00%	0.00%	0.00%	0.00%	0.00%	14	0.00%
Grapefruit - Kilogram	0.48%	0.00%	-22.31%	47.00%	7.11%	7	9.93%
Grapes - Kilogram	0.18%	0.00%	-30.54%	33.65%	5.25%	14	13.35%
Grapes (Black) - Kilogram	-0.31%	0.00%	-45.20%	33.65%	4.44%	14	3.62%
Grapes (seedless) - Box	-0.08%	0.00%	-47.00%	18.23%	6.44%	14	10.14%
Grapes (seedless) - Kilogram	-0.05%	0.00%	-10.54%	4.08%	1.04%	14	1.68%
Iceberg - Box	-0.63%	0.00%	-40.55%	23.64%	6.33%	3	9.73%
Iceberg - Fund	-2.03%	0.00%	-18.23%	10.54%	6.05%	3	20.69%
Kiwi - Package	0.00%	0.00%	-51.08%	43.08%	5.88%	16	21.16%
Kiwi (30s) - Package	0.07%	0.00%	-35.67%	61.31%	5.96%	16	3.27%
Limes - Box	0.07%	0.00%	-40.55%	54.86%	3.31%	7	1.75%
Limes - Kilogram	0.04%	0.00%	-51.08%	30.23%	5.34%	7	15.29%
Mango - Quantity	-0.09%	0.00%	-281.34%	40.55%	6.55%	3	3.60%
Melon - Kilogram	-0.35%	0.00%	-34.83%	35.67%	4.15%	3	7.96%
Nectarine - Kilogram	-0.05%	0.00%	-15.42%	15.42%	1.82%	3	1.81%
Papaya - Quantity	0.07%	0.00%	-51.08%	69.31%	3.79%	2	2.74%
Pears - Kilogram	-0.04%	0.00%	-28.77%	36.77%	4.27%	18	6.12%
Pears - Package	-0.54%	0.00%	-30.54%	13.35%	7.35%	18	13.64%
Pepino - Kilogram	-0.01%	0.00%	-69.31%	69.31%	5.71%	4	3.39%
Pineapple - Quantity	0.01%	0.00%	-53.06%	58.78%	6.16%	3	21.82%
Pomegranate - Kilogram	-0.09%	0.00%	-55.00%	28.77%	6.58%	10	11.51%
Pomelo - Quantity	-0.03%	0.00%	-28.77%	87.55%	5.21%	7	3.09%
Physalis - Box	-0.03%	0.00%	-51.08%	61.90%	4.55%	4	3.91%
Physalis - Kilogram	-0.13%	0.00%	-15.42%	0.00%	1.38%	4	0.92%
Physalis - Quantity	0.00%	0.00%	0.00%	0.00%	0.00%	4	0.00%
Raspberry - Box	0.00%	0.00%	0.00%	0.00%	0.00%	1	0.00%
Tangerines - Kilogram	-0.31%	0.00%	-13.35%	0.00%	2.04%	3	2.33%
Watermelon (1st Quality) - Kilogram	-0.53%	0.00%	-69.31%	56.80%	9.51%	3	7.28%
Watermelon (2nd Quality) - Kilogram	-1.20%	0.00%	-28.77%	0.00%	5.87%	3	4.17%
Daily Exchange Rate	0.03%	-0.02%	-11.94%	7.04%	0.86%		
Daily Domestic Inflation	-0.07%	0.00%	-19.15%	8.82%	1.70%		

CHAPTER 3

MARKUPS AND PRICING-TO-MARKET

3.1 Introduction

Export prices at the factory gate consist of marginal costs of production and markups, where the former reflects components such as local input costs and productivity (e.g., efficiency wages) together with the quality of products. A recent study by Fitzgerald and Haller (2014) found that producers charge different prices across different markets and choose different markups for the same good in different markets. The existing literature has mostly focused on the marginal costs of a firm to analyze the price discrimination. Recent studies provide mixed evidence on the quality of exports and markups. Studies such as those by Verhoogen (2008); Bastos and Silva (2010); Sheu (2014); Manova and Zhang (2012); Martin (2012); Harrigan et al. (2015) provide theory and empirics consistent with the destination-specific quality measures. Other studies, such as those by Iacovone and Javorcik (2010) and Lugovskyy and Skiba (2015), provide evidence that is consistent with common quality across destination countries. In addition, studies on variable markups have found that more efficient firms will charge higher markups (Bernard et al. (2003) and Melitz and Ottaviano (2008)), higher market share induces firms to exert higher markups (Bernard et al., 2003), exporters on average charge higher markups than non-exporters (De Loecker and Warzynski, 2012), and firms charges higher prices in richer country markets (Manova and Zhang (2012) and Alessandria and Kaboski (2011)). Therefore, there is no consensus on firms' export pricing strategies, in particular, how much markup firms are charging for the same product across destination.

In order to examine the true nature of markups, we need information regarding the production costs and distribution costs of the firm for each product. Identifi-

cation is the key problem in empirical studies based on the decomposition of prices and marginal costs into their components. This paper introduces a simple partial equilibrium model of firms' pricing strategies and derives the empirical estimation equation from there. We combine the implications of alternative models based on variable markups (as discussed in De Loecker and Warzynski (2012)) with the transaction level data covering both quantities and prices at the 8-digit HS code level.

We exploit two different measures to characterize pricing-to-market and markups. First, we calculate market share for a particular product by each firm-destination pair. Then, using this market share, we calculate daily markups for each product across each firm-destination pair. Second, we estimate the half-life of markups. In order to find the half-life of markups, we employ the Augmented Dickey-Fuller regression technique.

From our empirical estimation, we find that markups vary across products and destinations. On average, markups range from 1.25 to 1.5 during the period from 2005 - 2013 and from 1.25 to 51.23 across the firm in 2013. The markup series shows mean reverting behavior, and it ranges from 30 to 60 days.[1]

This paper is organized as follows: section 2 reviews recent literature related to this paper. Section 3 describes the proposed model to estimate markups and section 4 describes the data source and their summary statistics. Section 5 discusses empirical results and, finally, section 6 concludes.

[1] A stationary series of I(0) with no unit roots postulates mean reverting behavior, the series has a tendency to revert back to its long-run mean after a shock occur.

3.2 Literature Review

Studies in international economics have evolved over several dimensions of pricing strategies, such as exchange rate pass-through into both first and second generation of pass-through, markups, trade cost, etc.; however, there is little consensus about how to estimate the markups. Empirically, there are two main distinctions in terms of estimation procedure: demand side and supply side analysis. Demand side analysis relies on the functional form for consumer utility maximization and making assumptions on the market structure of firms, whereas supply side analysis does not require any such functional form assumption about preferences; instead it assumes cost minimization with given zero input adjustment costs and different input price for each firm (Atkin et al., 2015).

Atkeson and Burstein (2008) present a nested CES model to study international trade and international relative prices, and thus pricing-to-market strategy in response to aggregate shock. Their model has two special features: variable markups and international trade costs, resulting in a deviation from relative PPP at the aggregate level, which comes from the choice of individual firms to price-to-market in response to aggregate shock. They find that within-sector cost dispersion is quantitatively important in generating price-to-market. They also find pricing-to-market at the level of the aggregate price indices, only because the pricing practices of the large firms in the model dominate the price indices.

Recent studies on pricing-to-market strategy focus on different dimensions, such as price stickiness in local currency, domestic input sharing in the exported items or something else. Fitzgerald and Haller (2014) is one of the first papers that studied producer behavior in regard to how producers adjust their prices in the destination market relative to the home market in response to exchange rate change for a given

product and conditional on changing prices in both markets. They used a partial equilibrium model of the producer's pricing problem. For their empirical estimation, they matched annual plant census data for Ireland with the monthly micro-data on producer prices. They found that producers choose markups in the foreign market relative to home market and it increases one-for-one with home currency depreciation and decreases one-for-one with home currency appreciations.

Atkin et al. (2015) show the behavior of markups for different firm characteristics, mainly firm size, productivity, and product quality. They used a survey data for the 135 soccer-ball producing firms from Sialkot, Pakistan and found that both costs and markups are positively related to firm size.[2] They found that larger firms charge a higher markup for a given type of ball in the same destination; the larger firms produce higher quality products compared to smaller firms.

De Loecker et al. (2016) studied the barriers to trade and markups behavior. They developed a unified framework for obtaining marginal costs and markups that are based on estimating production functions, where markup depends on the market structure, firm behavior, and demand. They found that trade liberalization led to significant cost decreases; on the other hand, markups increased as a result of tariff reductions. They described this fact as the reforms leading to an increase in the quality of the products which requires higher marginal costs of production. Thus, firms experienced the higher markup increases for their new products.

Anderson et al. (2015) studied firm heterogeneity and export pricing behavior of Indian manufacturing firms in the early 2000s using firm-level data. They found that firm productivity is negatively related to export prices, and the export prices are negatively associated with distance, and positively associated with remoteness.

[2]For calculating markups, Atkin et al. (2015), used two procedure. Firstly, from price and profit data they optimized the cost of production for each ball and then subtracting that from price gives the measure of markups

They explained this negative relationship between firm productivity and export prices is due to the higher cost of innovation for quality differentiation in India, thereby, price increase reduces overall production for firms on average.

Dhyne et al. (2011) analyze price and markup dynamics at the firm-product level. They used a Belgian manufacturing dataset which covers a large sample of manufacturing firms during the period 1995-2009. Their empirical result revealed that markup is positively related to firm productivity, and product price is positively related to TFPR, but negatively related to TFPQ. However, the relationship between price, marginal cost and quality is more complex. Dingel (2016) studies the home-market effect and the factor abundance mechanism in quality specialization across US cities. Using US manufacturing plants' shipments and inputs from the Commodity Flow Survey (CFS) and the Census of Manufactures (CMF), he finds that both the home market and the factor abundance plays a significant role in quality specialization by income.[3]

Manova and Zhang (2012) found that firms set higher prices in richer, larger markets across destinations within firm-products and Gullstrand et al. (2014) found that firms charges discriminated prices across markets by analyzing export-price strategies across export destinations using firm-product data. Studies such as those by Amiti et al. (2014) and Berman et al. (2012) used information on market shares to test firms' price differentiation across destination markets due to exchange rate shocks.

[3]Dingel (2016) measured quality in two distinct way: unit value and demand shifters. Unit value measure says that the higher the selling prices, the higher the quality. On the other hand, demand shifters measure says that in a given price, a product is considered to be higher quality when it has higher market share.

3.3 The Model

Our model is divided into three subsections: (i) individual maximizes their utility from consuming both home and foreign goods, (ii) firms maximizes their profit following a pricing-to-market strategy, and (iii) empirical estimation technique following the model.

3.3.1 Individuals

Individuals have the following type of CES aggregation representing utility C^h in home country h:

$$C^h \equiv \left(\sum_i \left(\beta_i^h\right)^{\frac{1}{\theta}} \left(C_i^h\right)^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{3.1}$$

where C_i^h represents the consumption of products coming from country i, θ is the elasticity of substitution across countries, and β_i^h is a taste parameter (satisfying $\sum_i \beta_i^h = 1$). C_i^h is further given by the following expression:

$$C_i^h \equiv \left(\sum_j \left(\beta_{ij}^h\right)^{\frac{1}{\eta}} \left(C_{ij}^h\right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{3.2}$$

where C_{ij}^h represents good j coming from country i, η is the elasticity of substitution across goods, and β_{ij}^h represent taste parameters (satisfying $\sum_j \beta_{ij}^h = 1$).

The optimal allocation of any given expenditure yields the following demand function:

$$C_{ij}^h = \beta_i^h \beta_{ij}^h \left(\frac{P_{ij}^h}{P_i^h} \right)^{-\eta} \left(\frac{P_i^h}{P^h} \right)^{-\theta} C^h \tag{3.3}$$

where P_{ij}^h, P_i^h and P^h are the corresponding prices per units of C_{ij}^h, C_i^h and C^h, respectively, and they are connected to each other through the standard expressions of $P^h \equiv \left(\sum_i \beta_i^h \left(P_i^h\right)^{1-\theta} \right)^{\frac{1}{1-\theta}}$ and $P_i^h \equiv \left(\sum_j \beta_{ij}^h \left(P_{ij}^h\right)^{1-\eta} \right)^{\frac{1}{1-\eta}}$.

3.3.2 Firms

Following a pricing-to-market strategy, the firm that produces good j in country i maximizes the following profit function regarding its products to be sold in country h:

$$\max_{P_{ij}^{h*}} \pi_{ij}^{h} = Y_{ij}^{h} \left(P_{ij}^{h*} - Z_{ij} \right)$$

where Z_{ij} represents the marginal cost of production (according to constant returns to scale production technology); $Y_{ij}^{h} \tau_i^h = C_{ij}^h$ is the market clearing condition, with Y_{ij}^h representing the amount of production and $\tau_i^h > 1$ representing gross iceberg transportation costs; P_{ij}^{h*} represents the source price that is further connected to the destination price through trade costs, $P_{ij}^h = P_{ij}^{h*} \tau_i^h$.

The firm competes with (i.e., takes into account the prices charged by) other firms in country i that sell products to country h during the profit maximization problem that results in:

$$P_{ij}^{h*} = \mu_{ij}^h Z_{ij} \tag{3.4}$$

where μ_{ij}^h represents gross markups further given by:

$$\mu_{ij}^h = \frac{\varepsilon \left(\eta, \omega_{ij}^h \right)}{\varepsilon \left(\eta, \omega_{ij}^h \right) - 1} \tag{3.5}$$

where

$$\varepsilon \left(\eta, \omega_{ij}^h \right) = - \frac{\partial C_{ij}^h}{\partial P_{ij}^h} \frac{P_{ij}^h}{C_{ij}^h} = \eta \left(1 - \omega_{ij}^h \right)$$

is the price elasticity of demand with expenditure share of ω_{ij}^h (that represents the share of good j among all goods produced in country i and consumed in country h) defined as:

$$\omega_{ij}^h = \frac{P_{ij}^h C_{ij}^h}{P_i^h C_i^h} = \frac{P_{ij}^{h*} \tau_i^h C_{ij}^h}{P_i^{h*} \tau_i^h C_i^h} = \frac{P_{ij}^{h*} C_{ij}^h}{P_i^{h*} C_i^h} \tag{3.6}$$

Hence, we need two pieces of information for the calculation of (gross) markups μ_{ij}^{h}'s at the firm level, namely the elasticity of substitution across goods η and the expenditure share of ω_{ij}^{h}'s.

3.3.3 Empirical Investigation

Following the international trade literature, we set the benchmark value of the elasticity of substitution across goods $\eta = 5$, although we allow for other values of $\eta = 2$ and $\eta = 10$ for robustness.

We use daily data on firm-level exports from Bangladesh that is represented by source country i in the model. Accordingly, we calculate ω_{ij}^{h} as the share of sales achieved by the firm that sells good j to country h among all sales (achieved by all firms) to country h. We pool firm-level observations across all firms exporting to a particular destination country h in the calculation of ω_{ij}^{h}'s.

In order to show how the frequency of firm-level exports data affects the calculation of markups (and thus the level of competition), we calculate expenditure shares of ω_{ij}^{h}'s by using alternative frequencies of data that range between 1 day and 365 days.

3.4 Data

For our empirical estimation, we used the daily transaction level exports data from the National Board of Revenue (NBR), Ministry of Commerce, Bangladesh. The board collects transaction level data from each firm under the Automated System for Customs Data (ASYCUDA ++/world), a computerized system designed by the United Nations Conference on Trade and Development (UNCTAD). The NBR requires the bill of entry for each export shipment, which is a detail associated

with export shipments. This automated process is one of the authentic sources for firm-level export data by destination-product, and for Bangladesh, this is the only source of firm-level export data. The database has information on export shipment date, the port of export shipment departure, the exporters' unique identification number, the 8 digit HS code of the exported products, the description of the exported products, the destination country, the total value of export shipments, and the total unit/quantity of export shipment. The database has information gathered during the period from 2003 to 2013. However, due to inadequate information for the years 2003 and 2004, we have dropped them from our working sample. For example, in 2003, the database has only 79 observations, compared to more than 300k observation in other years. In addition to that, we also excluded few more observations (roughly 0.0008 percent), for which there is no associated shipment or exporters' identifying number. Finally, we have considered 2005 - 2013 as our working sample.

For our study, we took date of export, exporters' unique identification number, HS codes of the product (8 digit level), the volume of exports, the value of exports, unit of measurement, and the destination country from the database.[4] We find that on each day, firms have multiple shipments to a particular destination for the very same goods; therefore, we aggregated these to ensure one observation for each firm-product-destination-port combination.

In table 3.1, we show some descriptive statistics of firms' export structures across destination and time. Column 1 shows the average number of firms exporting to a particular destination on each date/day, i.e., on average 49 firms are exporting to a particular destination on a given date. It is clear from the table that an average number of firms exporting to a particular destination country in a given date

[4] All monetary values reported in this dataset is in Bangladeshi Taka.

Table 3.1: Firms' export structure across destination and time

Year	$Firm^a$	$Destination^b$	$Frequency^c$
2005	49.66	1.64	297.5
2006	61.71	1.78	312.0
2007	50.04	1.83	341.8
2008	63.17	1.88	323.9
2009	59.54	1.96	323.1
2010	67.6	2.15	313.3
2011	62.68	2.5	284.4
2012	67.02	2.93	256.7
2013	74.33	3.46	150.6

[a] By firm, we mean that in each day how many firm is exporting to a particular destination.
[b] By destination we mean, how many destination each firm is exporting in a particular day.
[c] By frequency we mean, how many times (# of shipment) each firm is making to a particular destination during the whole year.

increases over time from 49 to 75. Column 2 presents the number of destinations each firm is exporting to on a particular date; in 2005, on average, each firm is exporting to 1 or 2 destinations.[5] In 2013, this number increased to 3-4. Column 3 shows the number of exports by a firm to a particular destination during the whole year, e.g., in 2005, on average, 297.5 export shipments were sent to a particular destination by each firm.

We used daily transaction-level exports data from Bangladesh. Our theoretical model guided us to construct our variable of interest from this database. In our sample period, several firms are exporting several times to a particular destination

[5]Murakozy (2015) find the majority of the firms in France exports once in a year and about 8% of firms' exports every month. They find that firms export in 5.4 months a year, on average, and the median number of months is 3, although larger firms ship more frequently. They also find at the firm-product-destination level, the mean drops to 3.6 months with a median of 2 months.

on a particular date. To avoid the problem of several transactions by a single firm in each day, we pool all export values by date and by the firm-destination-product combination. Then, we pool total export values for each firm on each date across destination.

3.5 Empirical Results

This section has two main foci. First, we determine the market share and markup by each firm-destination-product combination. Second, we estimate the half-life of markups for the given time duration.

In order to achieve the first aim, we pool the data across all products for a firm by each day to the same destination (firm-destination combination). For example, if a firm exports more than two products (HS code), we add these two products to make each firm export a single/differentiated product. Following equation 3.6, we have calculated the expenditure share for each year. Figure A5 presents the daily expenditure shares for markup by 25th, 50th and 75th percentile. In figure A5, the horizontal axis presents time frequency and the vertical axis presents the expenditure shares for all firm across firm-destination combination. Figures 3.1 – 3.5 and A1 – A6 illustrate the main findings using the transaction-level data described in section 3.3. These figures show the behavior of markups by each year. Following equation 3.5, and considering the value of elasticity of substitution as 5, we created figures 3.1 - 3.5.[6] For example, in figure 3.1, the horizontal axis represents time frequencies (i.e., the number of days) and the vertical axis represents average markups charged by each firm across destinations, on average, in the year 2005. From the graph, it

[6]We did this exercise for two different values of elasticity of substitution, and these set of results are shown in the appendix.

is evident that markups decrease sharply after the first day and imove around the mean value. The lower panel of figure 3.1 shows the markup for the year 2006. We can see that markup varies substantially across days in 2006, compared to 2005. Similarly, figures 3.2 - 3.5 show daily markup during the period of 2007 - 2013. On an average, markup ranges from 1.25 to 1.5 across days, and from 1.25 to 51.23 across firms.[7]

Furthermore, in the second step, we employ formal statistical testing to confirm the mean reversion for markup series derived from the former section. Following the augmented Dickey-Fuller (ADF) regression technique, we confirm the stationarity of the markup series over the daily frequencies. We find that the markup series is stationary at the level. Using the information from the augmented Dickey-Fuller coefficient and standard definition of half-life, we find that the markups have a half-life of around 1 to 3 days across years (see table 3.2). We also calculate half-life following the method of Taylor (2001), and find that this half-life stands out as 50 to 60 days.[8] Thus, we confirm that the half-life calculated from the aggregate data (annual or quarterly or monthly data) overestimates the range for half-life compared to daily data.

[7] Our estimated value of markups are in line with the existing literature, such as Yilmazkuday (2016) find markup ranges from 1.03 to 2.10 for a constant markups and from 1.00 to 3.83 for variable markups; De Loecker and Warzynski (2012) find markup ranges from 1.03 to 1.28 for Slovenian manufacturing plants.

[8] Taylor (2001) and Ahmad and Craighead (2011) shown that aggregation bias can lead to a higher half-life compared to their true half-life. Using 216 years monthly data for US-UK bilateral nominal exchange rate, Ahmad and Craighead (2011) find that 34.6, 41.2 and 46.8 months for Monthly, Quarterly, and Yearly aggregation respectively.

3.6 Conclusion

The pricing strategy of a firm has long been of interest in policy setting, particularly, exchange rate induced trade policy studies. Recent studies find that producers charge different prices across distinct markets and they choose diverse markups for the same good in different markets. Using daily transaction-level data from Bangladeshi firms, this paper investigates how these components (of both price and marginal costs) change with respect to the destination market.

This paper is associated with the literature on variable markup and pricing-to-market in international economics. We contribute to the literature by introducing a simple partial equilibrium model of firms' pricing strategies, which also guides the empirical analysis. We combine the implications of alternative models based on variable markups (as discussed in De Loecker and Warzynski (2012)) with the transaction level data covering both quantities and prices at the 8-digit HS code level across destination.

We propose an alternative measure to characterize pricing-to-market and markups. First, we calculate market share for a particular product by each firm-destination pair. Then, using this market share, we calculate daily markups for each product across firm-destination pairs. Second, in order to find the half-life of markups, we employ the Augmented Dickey-Fuller regression.

From our empirical estimation, we find that markups vary across products and destinations. On average, markup ranges from 1.25 to 1.5 for the years from 2005 - 2013 and from 1.25 to 51.23 across the firm in 2013. The markup series shows mean reverting behavior and it ranges from 50 to 60 days.

In future work, we will investigate the pricing strategy of a firm by each product, both in HS code classification and quality (based on the product description). We

will also investigate our findings through alternative measure, such as, instead of simple average, we will use the weighted average. Furthermore, we will investigate the dynamism of firm entry and exit on markup behavior.

Figure 3.1: Daily Markups: $\eta = 5$

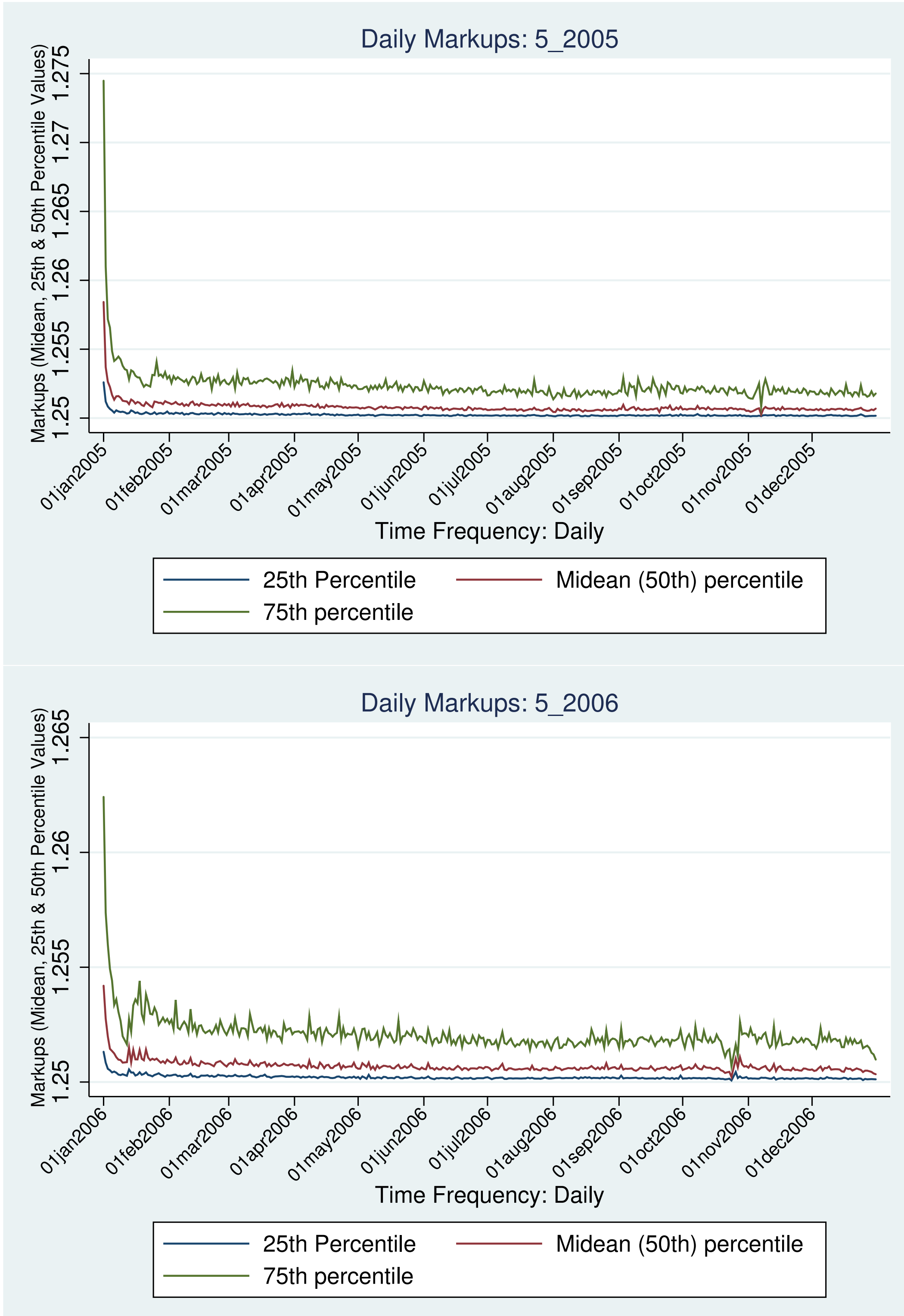


Figure 3.2: Daily Markups: $\eta = 5$

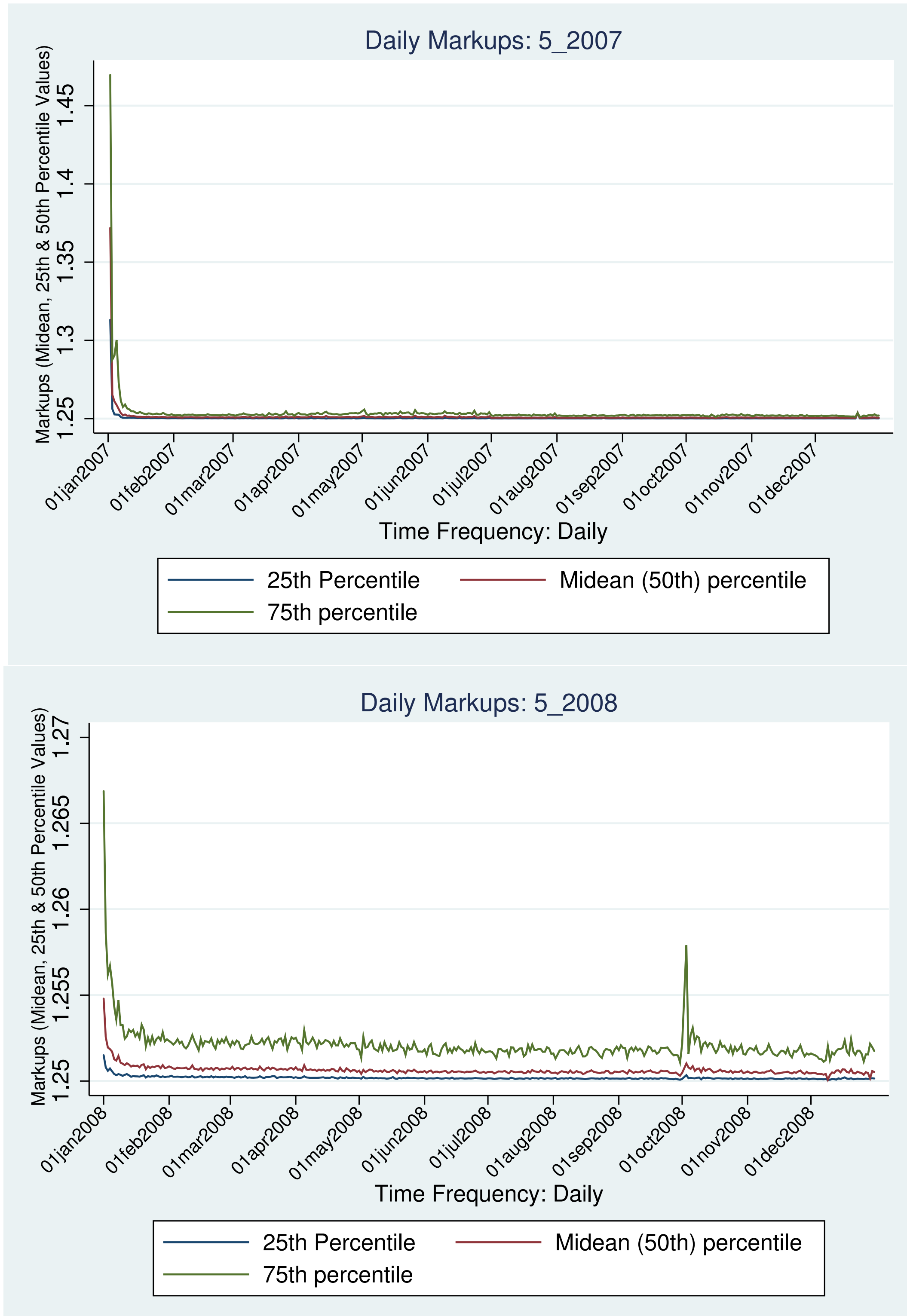
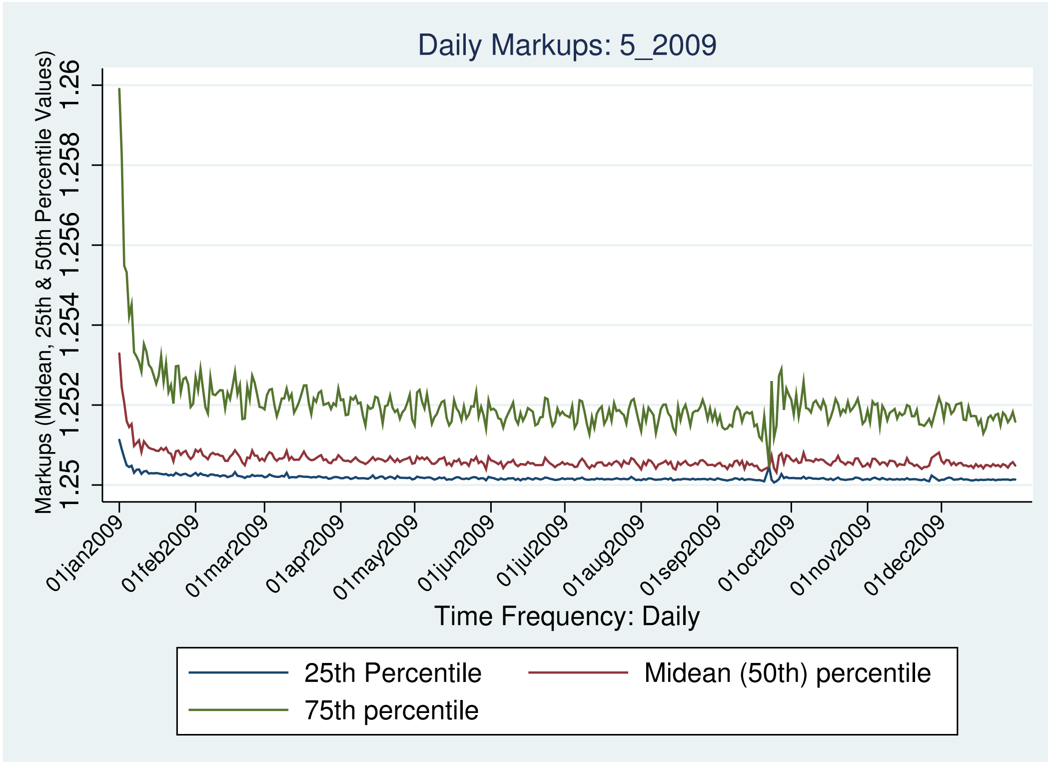


Figure 3.3: Daily Markups: $\eta = 5$



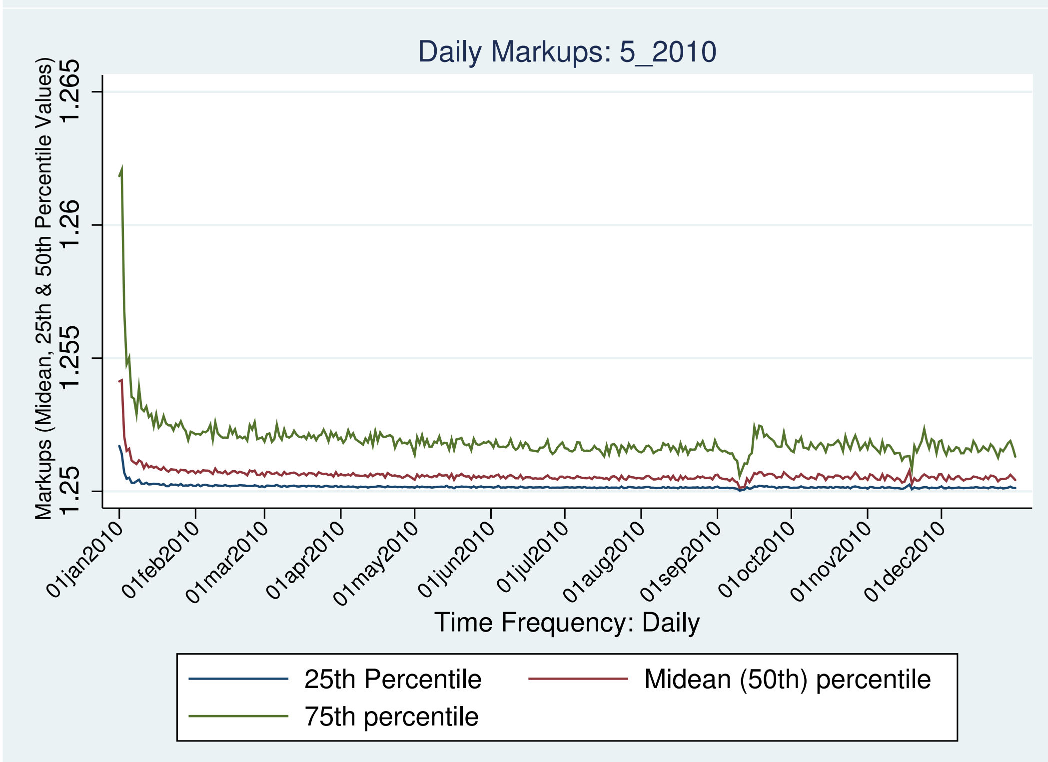
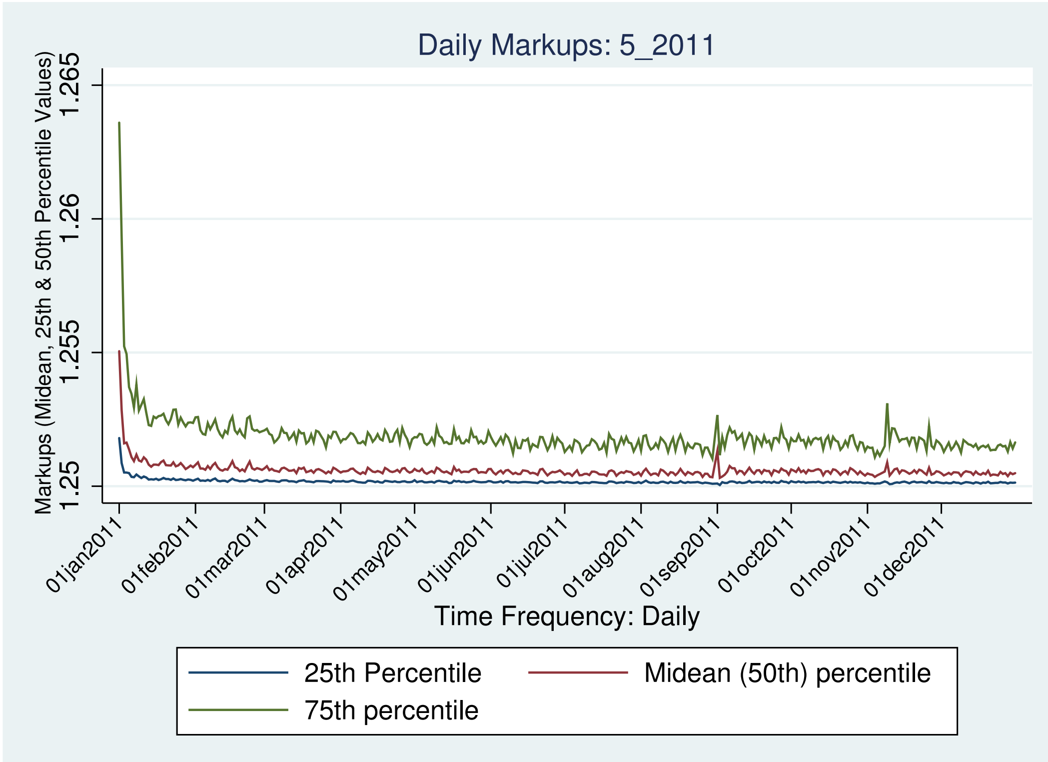


Figure 3.4: Daily Markups: $\eta = 5$



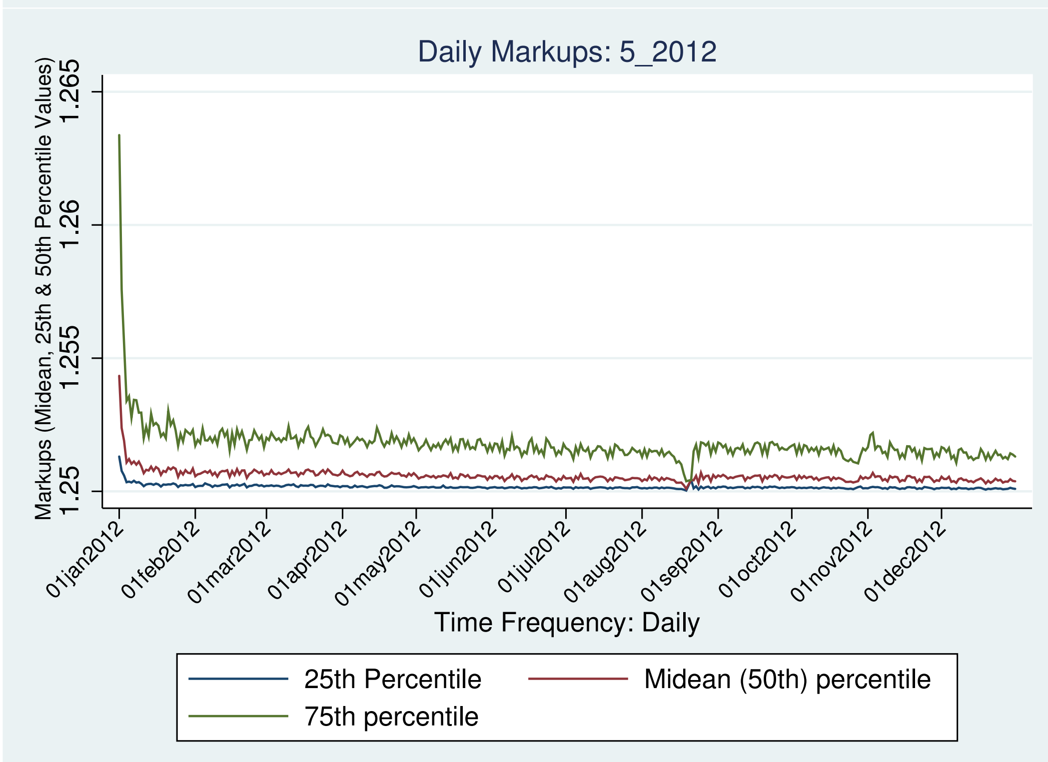


Figure 3.5: Daily Markups: $\eta = 5$

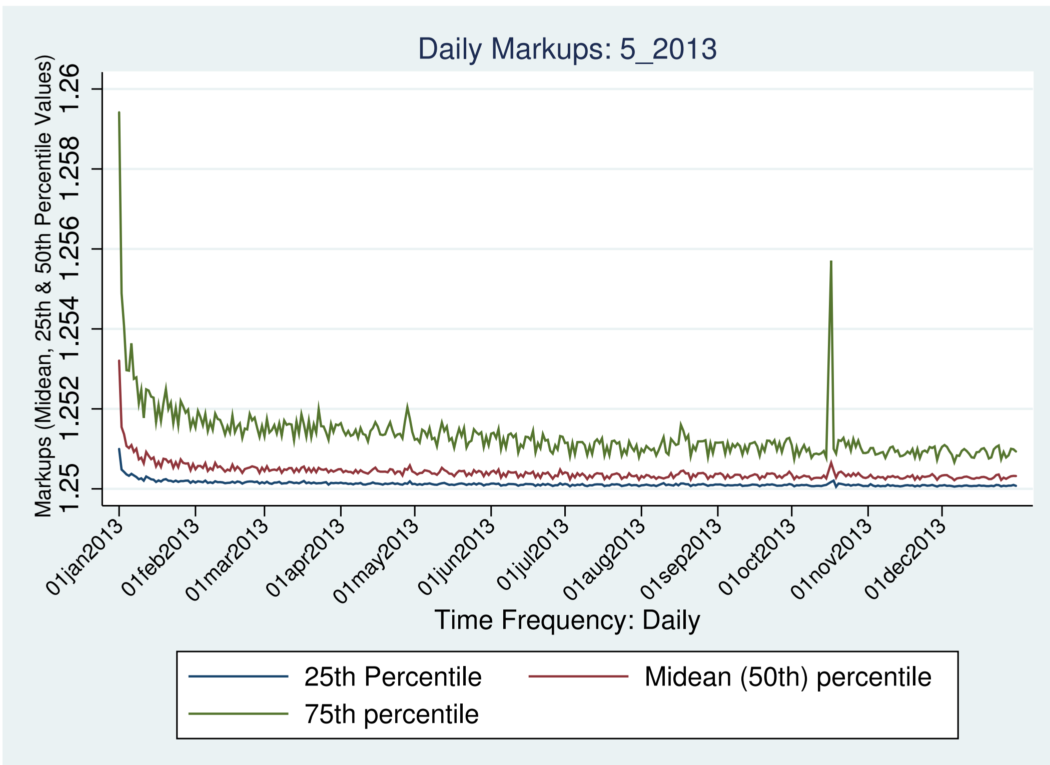


Table 3.2: Half-Life Estimation

Variable	2005					2006				
	rho	Half-life	Monthly	Quaterly	Yearly	rho	Half-life	Monthly	Quaterly	Yearly
Markup (25th P, $\eta = 2$)	0.553	1.2	5.8	20.5	56.6	0.657	1.6	6.4	21.4	58.1
Markup (50th P, $\eta = 2$)	0.511	1.0	5.5	20.3	56.1	0.629	1.5	6.2	21.1	57.7
Markup (75th P, $\eta = 2$)	0.506	1.0	5.5	20.2	56.1	0.617	1.4	6.1	21.0	57.5
Markup (25th P, $\eta = 5$)	0.534	1.1	5.7	20.4	56.4	0.650	1.6	6.4	21.3	58.0
Markup (50th P, $\eta = 5$)	0.497	1.0	5.5	20.2	55.9	0.627	1.5	6.2	21.1	57.6
Markup (75th P, $\eta = 5$)	0.476	0.9	5.4	20.1	55.7	0.611	1.4	6.1	21.0	57.4
Markup (25th P, $\eta = 10$)	0.535	1.1	5.7	20.4	56.4	0.651	1.6	6.4	21.3	58.0
Markup (50th P, $\eta = 10$)	0.497	1.0	5.5	20.2	56.0	0.627	1.5	6.2	21.1	57.6
Markup (75th P, $\eta = 10$)	0.473	0.9	5.4	20.0	55.7	0.614	1.4	6.1	21.0	57.4
	2007					2008				
Markup (25th P, $\eta = 2$)	0.129	0.3	3.8	18.0	51.8	0.634	1.5	6.3	21.2	57.7
Markup (50th P, $\eta = 2$)	0.117	0.3	3.8	17.9	51.6	0.596	1.3	6.0	20.9	57.2
Markup (75th P, $\eta = 2$)	0.148	0.4	3.9	18.2	52.1	0.485	1.0	5.4	20.1	55.8
Markup (25th P, $\eta = 5$)	0.100	0.3	3.6	17.8	51.3	0.634	1.5	6.3	21.2	57.7
Markup (50th P, $\eta = 5$)	0.135	0.3	3.9	18.1	51.9	0.601	1.4	6.0	20.9	57.2
Markup (75th P, $\eta = 5$)	0.229	0.5	4.3	18.7	53.1	0.510	1.0	5.5	20.3	56.1
Markup (25th P, $\eta = 10$)	0.103	0.3	3.7	17.8	51.4	0.633	1.5	6.3	21.2	57.7
Markup (50th P, $\eta = 10$)	0.133	0.3	3.8	18.0	51.9	0.597	1.3	6.0	20.9	57.2
Markup (75th P, $\eta = 10$)	0.210	0.4	4.2	18.6	52.9	0.500	1.0	5.5	20.2	56.0
	2009					2010				
Markup (25th P, $\eta = 2$)	0.711	2.0	6.9	21.9	59.1	0.669	1.7	6.5	21.5	58.3
Markup (50th P, $\eta = 2$)	0.731	2.2	7.1	22.2	59.5	0.713	2.0	6.9	22.0	59.1
Markup (75th P, $\eta = 2$)	0.689	1.9	6.7	21.7	58.7	0.739	2.3	7.2	22.3	59.7
Markup (25th P, $\eta = 5$)	0.714	2.1	7.0	22.0	59.2	0.672	1.7	6.6	21.5	58.3
Markup (50th P, $\eta = 5$)	0.723	2.1	7.1	22.1	59.4	0.714	2.1	7.0	22.0	59.2
Markup (75th P, $\eta = 5$)	0.697	1.9	6.8	21.8	58.8	0.743	2.3	7.3	22.4	59.8
Markup (25th P, $\eta = 10$)	0.714	2.1	7.0	22.0	59.2	0.671	1.7	6.5	21.5	58.3
Markup (50th P, $\eta = 10$)	0.722	2.1	7.0	22.1	59.3	0.713	2.1	6.9	22.0	59.1
Markup (75th P, $\eta = 10$)	0.696	1.9	6.8	21.8	58.8	0.742	2.3	7.3	22.4	59.8
	2011					2012				
Markup (25th P, $\eta = 2$)	0.545	1.1	5.7	20.5	56.5	0.604	1.4	6.1	20.9	57.3
Markup (50th P, $\eta = 2$)	0.535	1.1	5.7	20.4	56.4	0.585	1.3	5.9	20.8	57.0
Markup (75th P, $\eta = 2$)	0.617	1.4	6.1	21.0	57.5	0.582	1.3	5.9	20.7	57.0
Markup (25th P, $\eta = 5$)	0.532	1.1	5.6	20.4	56.4	0.601	1.4	6.0	20.9	57.2
Markup (50th P, $\eta = 5$)	0.533	1.1	5.6	20.4	56.4	0.580	1.3	5.9	20.7	57.0
Markup (75th P, $\eta = 5$)	0.616	1.4	6.1	21.0	57.5	0.575	1.3	5.9	20.7	56.9
Markup (25th P, $\eta = 10$)	0.530	1.1	5.6	20.4	56.3	0.599	1.4	6.0	20.9	57.2
Markup (50th P, $\eta = 10$)	0.533	1.1	5.6	20.4	56.4	0.580	1.3	5.9	20.7	57.0
Markup (75th P, $\eta = 10$)	0.614	1.4	6.1	21.0	57.4	0.574	1.2	5.9	20.7	56.9
	2013									
Markup (25th P, $\eta = 2$)	0.661	1.7	6.5	21.4	58.2					
Markup (50th P, $\eta = 2$)	0.615	1.4	6.1	21.0	57.4					
Markup (75th P, $\eta = 2$)	0.529	1.1	5.6	20.4	56.3					
Markup (25th P, $\eta = 5$)	0.652	1.6	6.4	21.3	58.0					
Markup (50th P, $\eta = 5$)	0.615	1.4	6.1	21.0	57.4					
Markup (75th P, $\eta = 5$)	0.533	1.1	5.6	20.4	56.4					
Markup (25th P, $\eta = 10$)	0.651	1.6	6.4	21.3	58.0					
Markup (50th P, $\eta = 10$)	0.615	1.4	6.1	21.0	57.4					
Markup (75th P, $\eta = 10$)	0.530	1.1	5.6	20.4	56.3					

Notes: _w represents expenditure shares and p25 represents 25th percentile. Thus p25_w represents 25th percentile of expenditure share series.

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Appendix

A. Decomposition of Gross exports into 9 parts by Wang et al. (2013)

Gross exports of 2-country

Let assume that there are 2 countries (Home and Foreign) in this hypothetical world, where each country produces goods in N tradable industries. Goods in each sector can be consumed directly or used as intermediate inputs, and each country exports both intermediate and final goods. The gross output produced by country h must be used as either an intermediate good or a final good at home or foreign country:

$$X^h = A^{hh}X^h + Y^{hh} + A^{hf}X^f + Y^{hf}; \{h, f\} = \{1, 2\} \tag{A.1}$$

Where X^h is the $(N*1)$ gross output vector of country h, Y^{hf} is the $(N*1)$ final demand vector that gives demand in country f for final goods produced in h. A^{hf} is the $(N*N)$ IO coefficient matrix that shows the intermediate used in f of goods produced in h. The intra-country input-output representation of the two-country production and trade procedure follows the following structure:

$$\begin{bmatrix} X^h \\ X^f \end{bmatrix} = \begin{bmatrix} A^{hh} & A^{hf} \\ A^{fh} & A^{ff} \end{bmatrix} \begin{bmatrix} X^h \\ X^f \end{bmatrix} + \begin{bmatrix} Y^{hh} + Y^{hf} \\ Y^{fh} + Y^{ff} \end{bmatrix}$$
$$\begin{bmatrix} X^h \\ X^f \end{bmatrix} = \begin{bmatrix} I - A^{hh} & -A^{hf} \\ -A^{fh} & I - A^{ff} \end{bmatrix}^{-1} \begin{bmatrix} Y^{hh} + Y^{hf} \\ Y^{fh} + Y^{ff} \end{bmatrix}$$
$$= \begin{bmatrix} B^{hh} & B^{hf} \\ B^{fh} & B^{ff} \end{bmatrix} \begin{bmatrix} Y^h \\ Y^f \end{bmatrix} \tag{A.2}$$

Here B^{hf} denotes the $(N*N)$ matrix, which is known as the Leontief inverse. This bloc matrix shows the total requirement for the gross output production in country h due to one unit increase in the final demand in country f. Y^h is an (N*1) vector of country h's final goods used globally: domestic use (Y^{hh}) and export to foreign country (Y^{hf}).

2-country 2-sector

Let consider the two-country have only two sectors. The gross exports of Country h can be decomposed into two parts: final goods exports and intermediate goods exports based on the following accounting identity:

$$E^{hf} = \begin{bmatrix} e_1^{hf} \\ e_2^{hf} \end{bmatrix} = \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} + \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} x_1^f \\ x_2^f \end{bmatrix} \tag{A.3}$$

The gross output of Country f can be decomposed into the following four components according to where they are finally absorbed:

$$X^r = \begin{bmatrix} x_1^r \\ x_2^r \end{bmatrix} = \begin{bmatrix} b_{11}^{rs} & b_{12}^{rs} \\ b_{21}^{rs} & b_{21}^{rs} \end{bmatrix} \begin{bmatrix} y_1^{rr} + y_1^{rs} \\ y_2^{rr} + y_2^{rr} \end{bmatrix} + \begin{bmatrix} b_{11}^{rr} & b_{12}^{rr} \\ b_{21}^{rr} & b_{21}^{rr} \end{bmatrix} \begin{bmatrix} y_1^{rr} + y_1^{rs} \\ y_2^{rr} + y_2^{rr} \end{bmatrix}$$
$$= \begin{bmatrix} b_{11}^{rr} & b_{12}^{rr} \\ b_{21}^{rr} & b_{21}^{rr} \end{bmatrix} \begin{bmatrix} y_1^{rr} \\ y_2^{rr} \end{bmatrix} + \begin{bmatrix} b_{11}^{rr} & b_{12}^{rr} \\ b_{21}^{rr} & b_{21}^{rr} \end{bmatrix} \begin{bmatrix} y_1^{rs} \\ y_2^{rs} \end{bmatrix} + \begin{bmatrix} b_{11}^{rr} & b_{12}^{rr} \\ b_{21}^{rr} & b_{21}^{rr} \end{bmatrix} \begin{bmatrix} y_1^{sr} \\ y_2^{sr} \end{bmatrix} \tag{A.4}$$

Insert equation (A.4) into the last term of equation (A.3), we can decompose Country h's gross intermediate goods export according to where they are absorbed as:

$$A^{hf} X^f = \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} x_1^f \\ x_2^f \end{bmatrix} = \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{ff} & b_{12}^{ff} \\ b_{21}^{ff} & b_{22}^{ff} \end{bmatrix} \begin{bmatrix} y_1^{ff} \\ y_2^{ff} \end{bmatrix} +$$
$$\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{ff} & b_{12}^{ff} \\ b_{21}^{ff} & b_{22}^{ff} \end{bmatrix} \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} + \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{hf} & b_{12}^{hf} \\ b_{21}^{hf} & b_{22}^{hf} \end{bmatrix} \begin{bmatrix} y_1^{hh} \\ y_2^{hh} \end{bmatrix}$$
$$+ \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{hf} & b_{12}^{hf} \\ b_{21}^{hf} & b_{22}^{hf} \end{bmatrix} \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} \tag{A.5}$$

The equation A.5 presents 2-country, 2-sector exports by their use. The first part of equation A.5 shows the amount of country h's intermediate goods exports utilized by country f in their final goods production, which is finally consumed by country f. The second part shows the amount of country h's intermediate goods exports to country f's final goods production, which then return to country h. The third part shows a number of intermediate goods exports by country h to country f to produce intermediate goods, which then returned to country h to make final goods for home domestic consumption. The last part shows the amount of country h's intermediate goods exports used by country f to produce intermediate goods and exported back to country h to produce final goods, which finally exported to country f as final goods.

With some more algebraic manipulation, accounting identity and Leontief inversion, We obtain country h's gross exports as follows:

$$
\begin{aligned}
E^{hf} = \begin{bmatrix} e_1^{hf} \\ e_2^{hf} \end{bmatrix} &= \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} + \begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} x_1^{f} \\ x_2^{f} \end{bmatrix} \\
&= \begin{bmatrix} v_1^h b_{11}^{hh} + v_2^h b_{21}^{hh} \\ v_2^h b_{12}^{hh} + v_2^h b_{22}^{hh} \end{bmatrix} \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} + \begin{bmatrix} v_1^h b_{11}^{hh} + v_2^h b_{21}^{hh} \\ v_2^h b_{12}^{hh} + v_2^h b_{22}^{hh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{ff} & b_{12}^{ff} \\ b_{21}^{ff} & b_{22}^{ff} \end{bmatrix} \begin{bmatrix} y_1^{ff} \\ y_2^{ff} \end{bmatrix} \right) \\
&+ \begin{bmatrix} v_1^h l_{11}^{hh} + v_2^h l_{21}^{hh} \\ v_2^h l_{12}^{hh} + v_2^h l_{22}^{hh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{ff} & b_{12}^{ff} \\ b_{21}^{ff} & b_{22}^{ff} \end{bmatrix} \begin{bmatrix} y_1^{fh} \\ y_2^{fh} \end{bmatrix} \right) \\
&+ \begin{bmatrix} v_1^h l_{11}^{hh} + v_2^h l_{21}^{hh} \\ v_2^h l_{12}^{hh} + v_2^h l_{22}^{hh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{fh} & b_{12}^{fh} \\ b_{21}^{fh} & b_{22}^{fh} \end{bmatrix} \begin{bmatrix} y_1^{hh} \\ y_2^{hh} \end{bmatrix} \right) \\
&+ \begin{bmatrix} v_1^h l_{11}^{hh} + v_2^h l_{21}^{hh} \\ v_2^h l_{12}^{hh} + v_2^h l_{22}^{hh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} b_{11}^{fh} & b_{12}^{fh} \\ b_{21}^{fh} & b_{22}^{fh} \end{bmatrix} \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} \right) \\
&\left(\begin{bmatrix} v_1^h b_{11}^{hh} + v_2^h b_{21}^{hh} \\ v_2^h b_{12}^{hh} + v_2^h b_{22}^{hh} \end{bmatrix} - \begin{bmatrix} v_1^h l_{11}^{hh} + v_2^h l_{21}^{hh} \\ v_2^h l_{12}^{hh} + v_2^h l_{22}^{hh} \end{bmatrix} \right) \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} x_1^{hh} \\ x_2^{hh} \end{bmatrix} \right) \\
&\begin{bmatrix} v_1^h b_{11}^{fh} + v_2^h b_{21}^{fh} \\ v_2^h b_{12}^{fh} + v_2^h b_{22}^{fh} \end{bmatrix} \begin{bmatrix} y_1^{hf} \\ y_2^{hf} \end{bmatrix} + \begin{bmatrix} v_1^h b_{11}^{fh} + v_2^h b_{21}^{fh} \\ v_2^h b_{12}^{fh} + v_2^h b_{22}^{fh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} l_{11}^{ff} & l_{12}^{ff} \\ l_{21}^{ff} & l_{22}^{ff} \end{bmatrix} \begin{bmatrix} y_1^{ff} \\ y_2^{ff} \end{bmatrix} \right) \\
&+ \begin{bmatrix} v_1^h b_{11}^{fh} + v_2^h b_{21}^{fh} \\ v_2^h b_{12}^{fh} + v_2^h b_{22}^{fh} \end{bmatrix} \left(\begin{bmatrix} a_{11}^{hf} & a_{12}^{hf} \\ a_{21}^{hf} & a_{22}^{hf} \end{bmatrix} \begin{bmatrix} l_{11}^{ff} & l_{12}^{ff} \\ l_{21}^{ff} & l_{22}^{ff} \end{bmatrix} \begin{bmatrix} e_1^{fh} \\ e_2^{fh} \end{bmatrix} \right)
\end{aligned} \tag{A.6}
$$

The first term is domestic value-added embodied in the final exports of the 1st and 2nd sectors of country h by domestic value-added created by the other sector itself and domestic value-added created by the other sector embodied in the sector's final exports. The second term is domestic value-added embodied in the country h's 1st and 2nd sector's intermediate exports which are used by country f to produce final goods, y_1^{ff} and y_2^{ff}, that are consumed in f. The sum of these two terms are the value-added exports of country h.

The third term is domestic value-added embodied in the country h's 1st and 2nd sector's intermediate exports used to produce country f's final exports, in another way, country h's imports of final goods from country f. The fourth term is the domestic value added embodied in Country h's 1st and 2nd sector's intermediate exports that are used by country f to produce intermediate exports and return to country h via its intermediate imports to produce its domestic final goods. The first four terms are the domestic value added (GDP) embodied in the 1st and 2nd sectors' gross exports of Country h, which include value added created from all sectors in Country h.

The fifth and sixth term is the domestic value added of Country h's intermediate exports of 1st and 2nd sector's that returned home and are used for the production of country h's 1st and 2nd sectors' final exports that are finally consumed in country f. These are already counted once in the value-added by the first term. These double counted domestic value-added is caused by the back-and-forth intermediate goods trade but to produce intermediate goods exports in country h.

The seventh term is the foreign value-added imported by country h to produce exportable final goods by both 1st and 2nd sector. Each of the imported intermediate value-added has two parts: foreign value added from the sector itself and from the other sector used to produce final exports in country h.

The eighth term is the foreign value-added used to produce the 1st and 2nd sector intermediate exports of country h, which are then used by country f to produce its domestic final goods. The ninth term is the foreign value-added embodied in the 1st and 2nd sector's intermediate exports used by country f to produce its final and intermediate exports, which is a pure foreign double counted term of the country h's exports.

3-country 2-sectors

For a two-country, two-sector economy, it is easier to trace down country's exports and imports compared to a multi-country multi-sector settings. To make it clear, now consider a three-country and two-sector settings. We use a superscript h, to represent the home country, f to represent the partner country, and t to represent the third country, and define the country set $G = \{h, f, t\}$. Based on the Leontief insight, from a three-country two-sector ICIO model we can decompose Country f's gross output into the following nine components according to where they are finally absorbed:

$$\begin{aligned} X^f &= B^{fh}Y^h + B^{ff}Y^f + B^{ft}Y^t \\ &= B^{fh}Y^{hh} + B^{fh}Y^{hf} + B^{fh}Y^{ht} + B^{ff}Y^{fh} + B^{ff}Y^{ff} + B^{ff}Y^{ft} \\ &+ B^{ft}Y^{th} + B^{ft}Y^{tf} + B^{ft}Y^{tt} \end{aligned} \tag{A.7}$$

Where B^{fk} denotes a 2 * 2 Leontief inverse matrix, which is total intermediate input requirement coefficients that specify the amount of gross output from Country f required for a one-unit increase in final demand in country k. X^f and Y^k are vectors of Country f's gross output and country k's final goods outputs respectively.

$$\begin{aligned} x^f &= \begin{bmatrix} x_1^f \\ x_2^f \end{bmatrix} = \begin{bmatrix} x_1^{fh} + x_1^{ff} + x_1^{ft} \\ x_2^{fh} + x_2^{ff} + x_2^{ft} \end{bmatrix}; B^{fk} = \begin{bmatrix} b_{11}^{hk} & b_{12}^{hk} \\ b_{12}^{hk} & b_{22}^{hk} \end{bmatrix} \\ Y^k &= \begin{bmatrix} y_1^k \\ y_2^k \end{bmatrix} = \begin{bmatrix} y_1^{kh} + y_1^{kh} + y_1^{kf} + y_1^{kt} \\ y_2^{kh} + y_2^{kf} + y_2^{kf} + y_2^{kt} \end{bmatrix}; k \in G = \{h, f, t\} \end{aligned} \tag{A.8}$$

We can obtain the gross exports decomposition equation in the 3-country, 2-sector model in a similar fashion as the 2-country 2-sector case as follows:

$$
\begin{aligned}
E^{hf} &= Y^{hf} + A^{hf}X^{f} \\
&= (V^{h}B^{hh})^{T}Y^{hf} + (V^{h}L^{hh})^{T}(A^{hf}B^{ff}Y^{ff}) + (V^{h}L^{hh})^{T}(A^{hf}B^{ft}Y^{tt}) \\
&+ (V^{h}L^{hh})^{T}(A^{hf}B^{ff}Y^{ft}) + (V^{h}L^{hh})^{T}(A^{hf}B^{ft}Y^{tf}) + (V^{h}L^{hh})^{T}(A^{hf}B^{ff}Y^{fh}) \\
&+ (V^{h}L^{hh})^{T}(A^{hf}B^{ft}Y^{th}) + (V^{h}L^{hh})^{T}(A^{hf}B^{fh}Y^{hh}) + (V^{h}L^{hh})^{T} \\
&[A^{hf}B^{ff}(Y^{hf} + Y^{ht})] + [V^{h}(B^{hh} - L^{hh})]^{T}(A^{hf}X^{f}) + (V^{f}B^{fh})^{T}Y^{hf} \\
&+ (V^{f}B^{fh})^{T}(A^{hf}L^{ff}Y^{ff}) + (V^{f}B^{fh})^{T}(A^{hf}L^{ff}E^{r*}) + (V^{t}B^{th})^{T}Y^{hf} \\
&+ (V^{f}B^{th})^{T}(A^{hf}L^{ff}Y^{ff}) + (V^{t}B^{th})^{T}(A^{hf}L^{ff}E^{r*})
\end{aligned}
\tag{A.9}
$$

Now we are moving towards the general version of the equation as follows:

$$
\begin{aligned}
E^{hf} &= (V^{h}B^{hh})^{T}Y^{hf} + (V^{h}L^{hh})^{T}(A^{hf}X^{f}) + (V^{h}B^{hh} - V^{h}L^{hh})^{T}(A^{hf}X^{f}) \\
&+ (V^{h}B^{fh})^{T}Y^{hf} + (V^{h}B^{fh})^{T}(A^{hf}X^{f}) + (\Sigma_{t\neq s,r}^{G}V^{t}B^{th})^{T}Y^{hf} \\
&+ (\Sigma_{t\neq s,r}^{G}V^{t}B^{th})^{T}(A^{hf}X^{f}) \\
&= (V^{h}B^{hh})^{T}\#Y^{hf} + (V^{h}L^{hh})^{T}(A^{hf}B^{ff}Y^{ff}) + (V^{h}L^{hh})^{T}(A^{hf}\Sigma_{t\neq h,f}^{G}B^{ft}Y^{tt}) \\
&+ (V^{f}B^{fh})^{T}Y^{hf} + (V^{f}B^{fh})^{T}(A^{hf}L^{ff}Y^{ff}) + (V^{f}B^{fh})^{T}(A^{hf}L^{ff}E^{r*}) \\
&+ (V^{t}B^{th})^{T}Y^{hf} + (V^{f}B^{th})^{T}(A^{hf}L^{ff}Y^{ff}) + (V^{t}B^{th})^{T}(A^{hf}L^{ff}E^{r*})
\end{aligned}
$$

Explanations of each terms of equation (A.9) is similar to equation (A.6). There are few more terms compared to previous equation due to the introduction of the third country. Here, four of them are domestic value-added components. The third term is the domestic value-added of country h in its intermediate exports used by the direct importer (country f) to produce intermediate exports to the third country t for the production of latter's domestic final goods. The fourth term is the domestic value-added in country h's intermediate exports used by the direct importer (f) for producing final goods exports to the third country t. The fifth term is the domestic value-added in country h's intermediate exports used by the direct importer (f) to produce intermediate exports to the third country t for its production of final goods exports that are shipped back to the direct importer (f); and the seventh term is the domestic value-added in country h's intermediate exports used by the direct importer (f) to produce intermediate exports to the third country t for the latter's production of final goods exports that are shipped back to the source country h.

The fourteenth term is the foreign value added from the third country t used by country h's 1st and 2nd sectors to produce final exports from country h. The fifteenth term is the foreign value-added from the third country t used to produce the 1st and 2nd sectors' intermediate exports of country h, which are then used by country f to produce its domestic final goods.

Table A1: 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
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 A2: Regression Coefficients for 100% domestic value-added shares in exported items.

VARIABLES	First-Difference CPI		diff of log of exrate		Constant		Observations	R-squared
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

Table A3: Regression Coefficients for foreign (intermediate) value-added shares in exported items.

VARIABLES	First-Difference CPI		diff of log of exrate		Constant		Observations	R-squared
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

Table A4: Regression Coefficients using VA exports for Manufacturing sectors only

Variables	β_0	β_1	β_2	R^2
Food, Beverages, and Tobacco Products	0.0519 (0.01)	0.0614 (0.09)	-0.1744 (0.05)	0.0065
Textiles	0.0615 (0.01)	0.763 (0.14)	-0.2236 (0.07)	0.0524
Leather Products	0.0912 (0.01)	0.6734 (0.25)	-0.388 (0.10)	0.0029
Wood Products	-0.0183 (0.01)	1.2717 (0.23)	-0.6412 (0.09)	0.0099
Paper	0.0347 (0.01)	0.2383 (0.24)	-0.1941 (0.05)	0.0016
Chemicals	0.0638 (0.01)	0.9076 (0.25)	-0.3488 (0.07)	0.0126
Rubber and Plastic Products	0.0413 (0.01)	0.4029 (0.18)	-0.4831 (0.07)	0.0195
Non-Metallic Mineral Products	-0.0238 (0.01)	1.3428 (0.21)	-0.5846 (0.09)	0.011
Metal Products	0.0607 (0.01)	0.5329 (0.43)	-0.2721 (0.09)	0.0018
Machinery	0.0514 (0.01)	0.8105 (0.09)	-0.073 (0.02)	0.0236
Electrical and Optical Equipment	0.0326 (0.01)	0.9107 (0.07)	-0.2134 (0.03)	0.0092
Transportation Equipment	0.0428 (0.01)	0.8843 (0.26)	0.0378 (0.06)	0.0232
Other Manufacturing	0.0572 (0.00)	0.2913 (0.24)	-0.3298 (0.08)	0.0084

Table A5: ERPT and Elasticity of Substitution for Manufacturing sectors only

Sectors	λ	σ	F-Statistic
Food, Beverages, and Tobacco Products	2.84	1.061	5.02
	(9.632)	(0.436)	(0.013)
Textiles	0.293	1.763	5.1
	(0.323)	(0.3)	(0.005)
Leather Products	0.576	1.673	5.2
	(0.13)	(0.345)	(0.007)
Wood Products	0.504	2.272	19.78
	(0.032)	(0.243)	(0.000)
Paper	0.815	1.238	1.5
	(0.344)	(0.323)	(0.221)
Chemicals	0.384	1.908	15.21
	(0.131)	(0.212)	(0.000)
Rubber and Plastic Products	1.199	1.403	30.05
	(0.021)	(0.214)	(0.000)
Non-Metallic Mineral Products	0.435	2.343	12.8
	(0.043)	(0.321)	(0.000)
Metal Products	0.511	1.533	3.09
	(0.502)	(0.401)	(0.072)
Machinery	0.09	1.811	7.53
	(0.034)	(0.200)	(0.000)
Electrical and Optical Equipment	0.234	1.911	17.01
	(0.032)	(0.120)	(0.000)
Transportation Equipment	-0.043	1.884	5.67
	(0.141)	(0.32)	(0.009)
Other Manufacturing	1.132	1.291	23.43
	(0.456)	(0.213)	(0.000)
Median	0.504	1.763	7.53

Table A6: 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	Transition 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 A7: Sectors covered in WIOD database

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

Table B1: Unit Root Tests

Variable	2005		2006		2007	
	dfuller statistic	dfuller pvalue	dfuller statistic	dfuller pvalue	dfuller statistic	dfuller pvalue
Exp. share (25th P)	-29.474	0.000	-14.717	0.000	-156.047	0.000
Exp. share (50th P)	-36.318	0.000	-17.726	0.000	-121.261	0.000
Exp. share (75th P)	-36.843	0.000	-17.814	0.000	-55.354	0.000
Markup (25th P, $\eta = 2$)	-25.652	0.000	-13.909	0.000	-161.787	0.000
Markup (50th P, $\eta = 2$)	-32.078	0.000	-16.314	0.000	-186.012	0.000
Markup (75th P, $\eta = 2$)	-30.968	0.000	-16.971	0.000	-94.067	0.000
Markup (25th P, $\eta = 5$)	-27.459	0.000	-14.285	0.000	-208.598	0.000
Markup (50th P, $\eta = 5$)	-33.781	0.000	-16.613	0.000	-153.762	0.000
Markup (75th P, $\eta = 5$)	-34.991	0.000	-17.523	0.000	-62.098	0.000
Markup (25th P, $\eta = 10$)	-27.447	0.000	-14.270	0.000	-203.019	0.000
Markup (50th P, $\eta = 10$)	-33.688	0.000	-16.640	0.000	-149.865	0.000
Markup (75th P, $\eta = 10$)	-35.212	0.000	-17.300	0.000	-64.825	0.000
	2008		2009		2010	
Exp. share (25th P)	-19.104	0.000	-12.848	0.000	-21.463	0.000
Exp. share (50th P)	-23.488	0.000	-14.382	0.000	-15.587	0.000
Exp. share (75th P)	-21.576	0.000	-13.479	0.000	-15.289	0.000
Markup (25th P, $\eta = 2$)	-17.934	0.000	-12.839	0.000	-20.839	0.000
Markup (50th P, $\eta = 2$)	-21.761	0.000	-13.793	0.000	-13.895	0.000
Markup (75th P, $\eta = 2$)	-20.714	0.000	-13.465	0.000	-14.178	0.000
Markup (25th P, $\eta = 5$)	-18.020	0.000	-12.865	0.000	-20.729	0.000
Markup (50th P, $\eta = 5$)	-21.684	0.000	-14.305	0.000	-14.391	0.000
Markup (75th P, $\eta = 5$)	-20.163	0.000	-13.210	0.000	-14.125	0.000
Markup (25th P, $\eta = 10$)	-18.104	0.000	-12.872	0.000	-20.887	0.000
Markup (50th P, $\eta = 10$)	-22.035	0.000	-14.392	0.000	-14.522	0.000
Markup (75th P, $\eta = 10$)	-20.998	0.000	-13.275	0.000	-13.856	0.000
	2011		2012		2013	
Exp. share (25th P)	-29.382	0.000	-16.952	0.000	-17.124	0.000
Exp. share (50th P)	-24.808	0.000	-21.727	0.000	-19.457	0.000
Exp. share (75th P)	-26.904	0.000	-28.369	0.000	-17.335	0.000
Markup (25th P, $\eta = 2$)	-26.659	0.000	-16.550	0.000	-16.096	0.000
Markup (50th P, $\eta = 2$)	-23.787	0.000	-20.796	0.000	-18.266	0.000
Markup (75th P, $\eta = 2$)	-21.326	0.000	-23.918	0.000	-15.701	0.000
Markup (25th P, $\eta = 5$)	-27.701	0.000	-16.799	0.000	-16.503	0.000
Markup (50th P, $\eta = 5$)	-23.972	0.000	-21.105	0.000	-18.247	0.000
Markup (75th P, $\eta = 5$)	-21.657	0.000	-24.537	0.000	-15.681	0.000
Markup (25th P, $\eta = 10$)	-27.871	0.000	-16.903	0.000	-16.577	0.000
Markup (50th P, $\eta = 10$)	-24.023	0.000	-21.063	0.000	-18.270	0.000
Markup (75th P, $\eta = 10$)	-21.975	0.000	-24.493	0.000	-15.835	0.000

Notes: _w represents expenditure shares and p25 represents 25th percentile. Thus p25_w represents 25th percentile of expenditure share series.

Figure A1: Daily Markups: $\eta = 2$

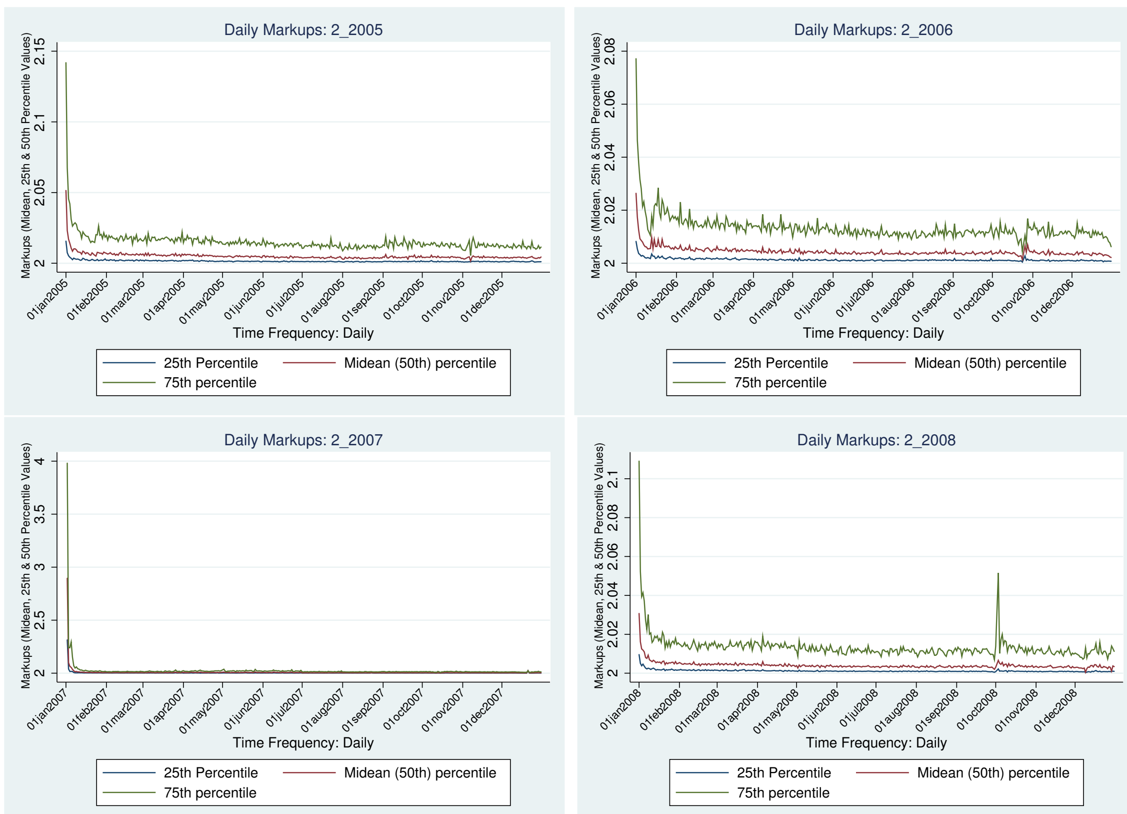


Figure A2: Daily Markups: $\eta = 2$

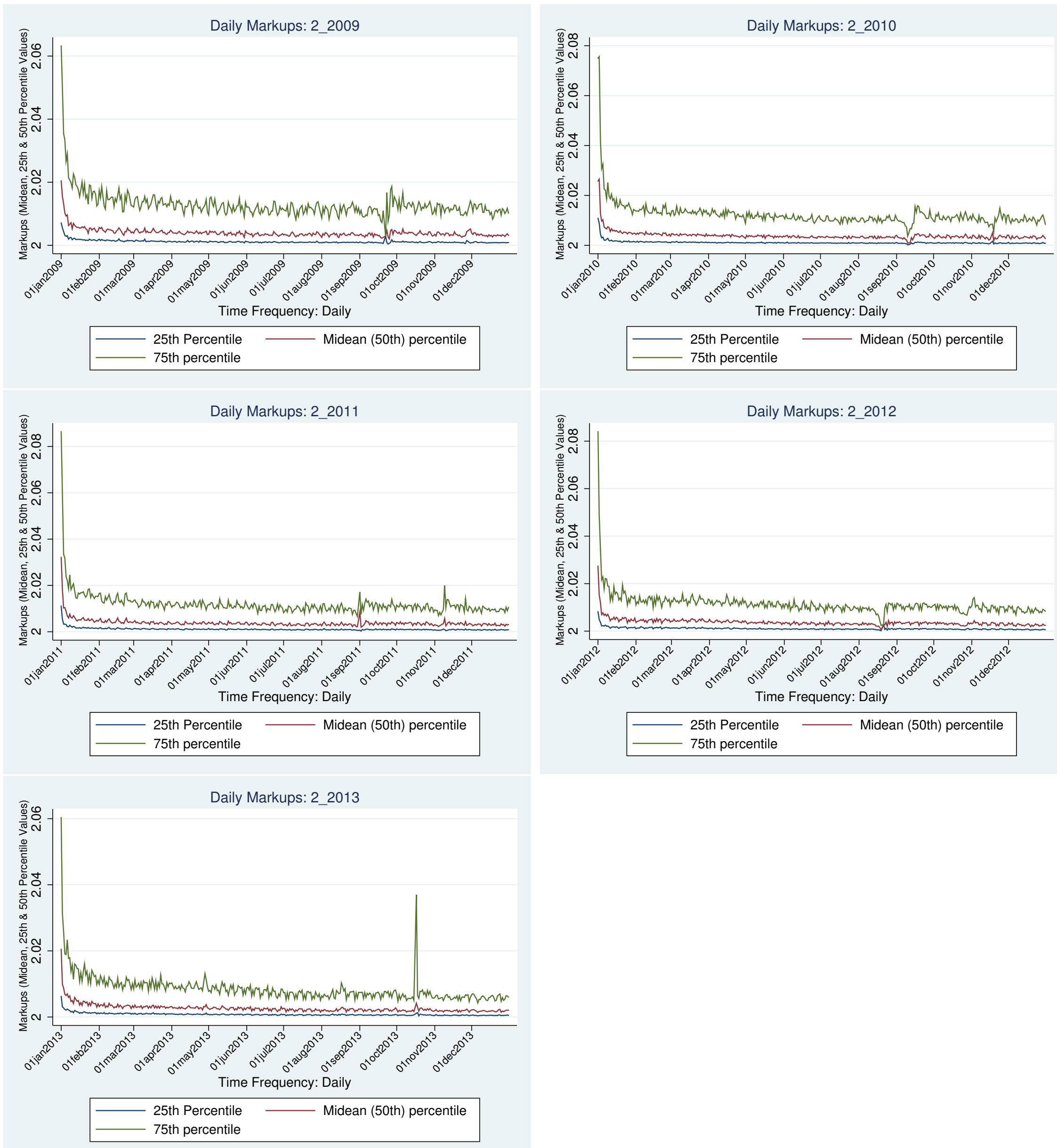


Figure A3: Daily Markups: $\eta = 10$

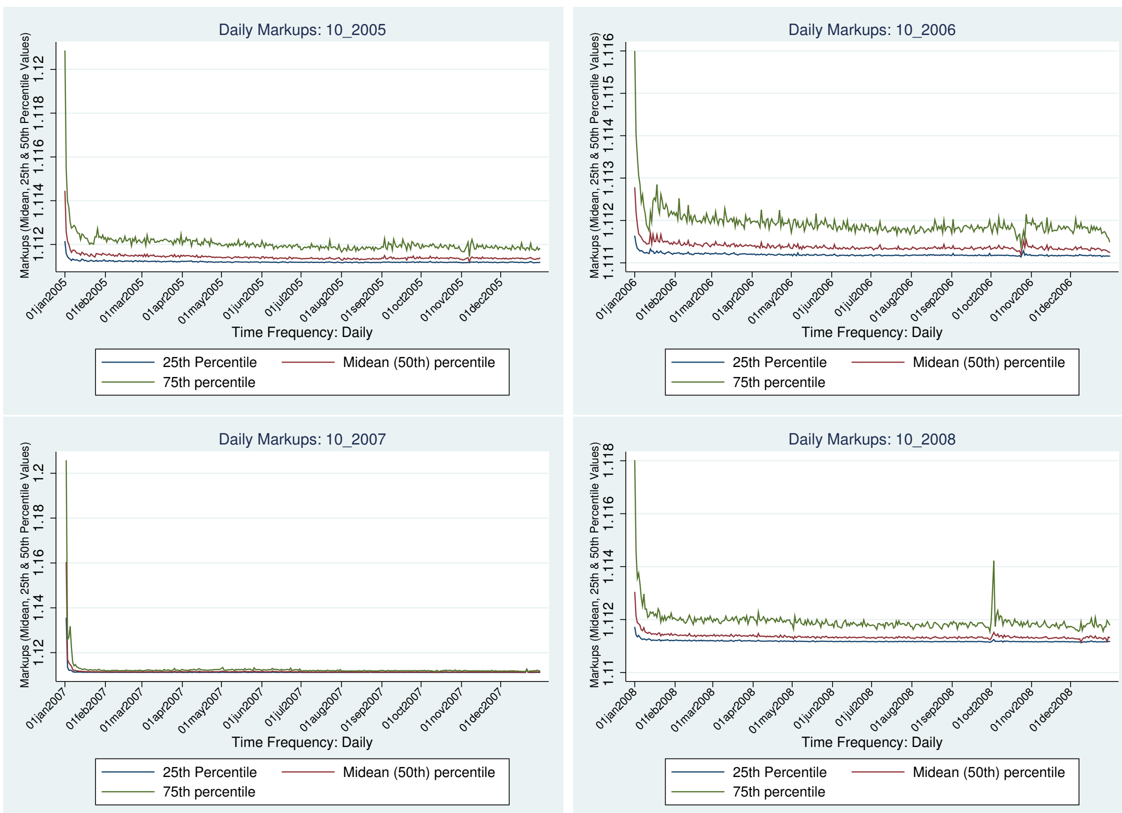


Figure A4: Daily Markups: $\eta = 10$

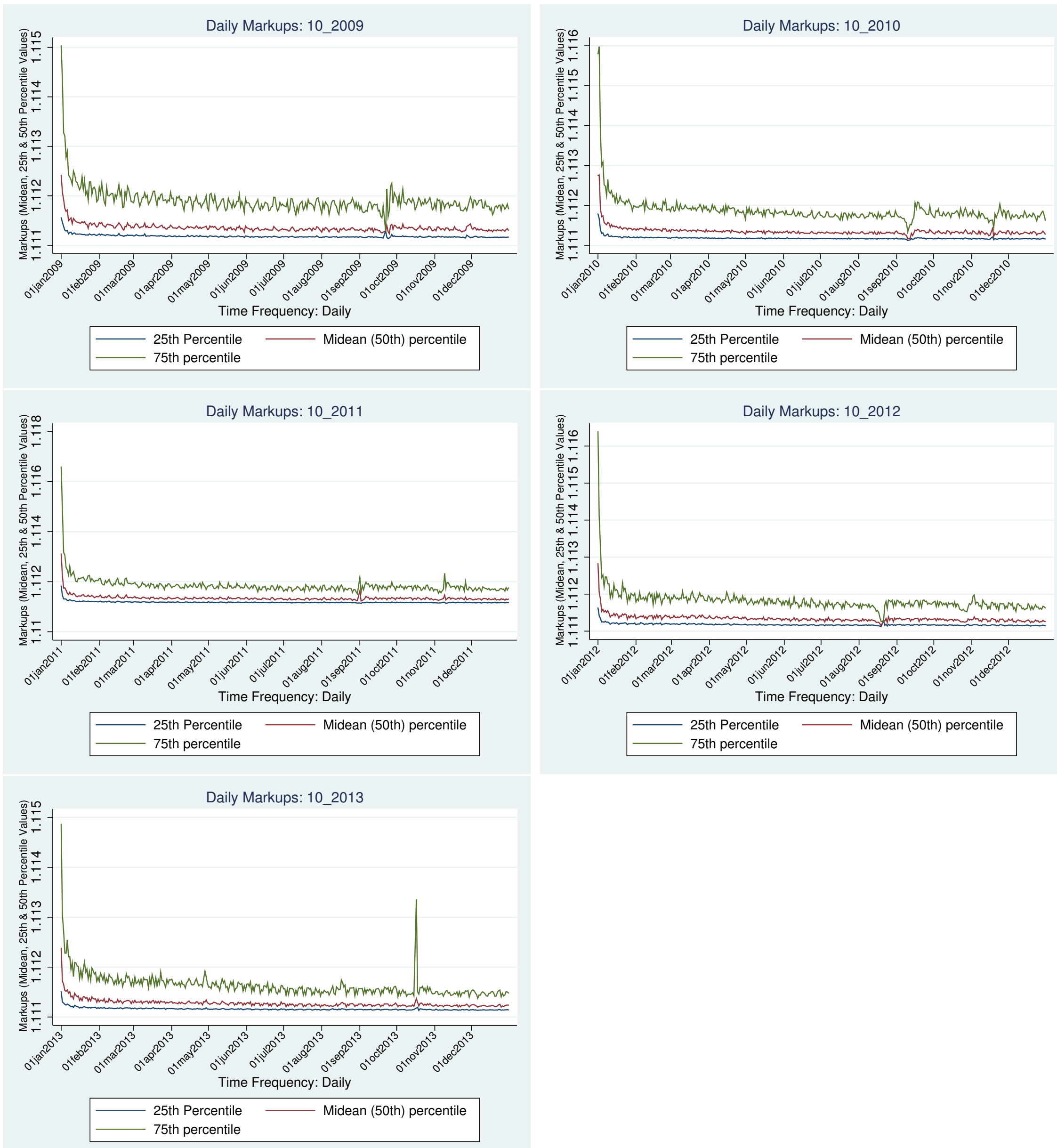


Figure A5: Expenditure shares

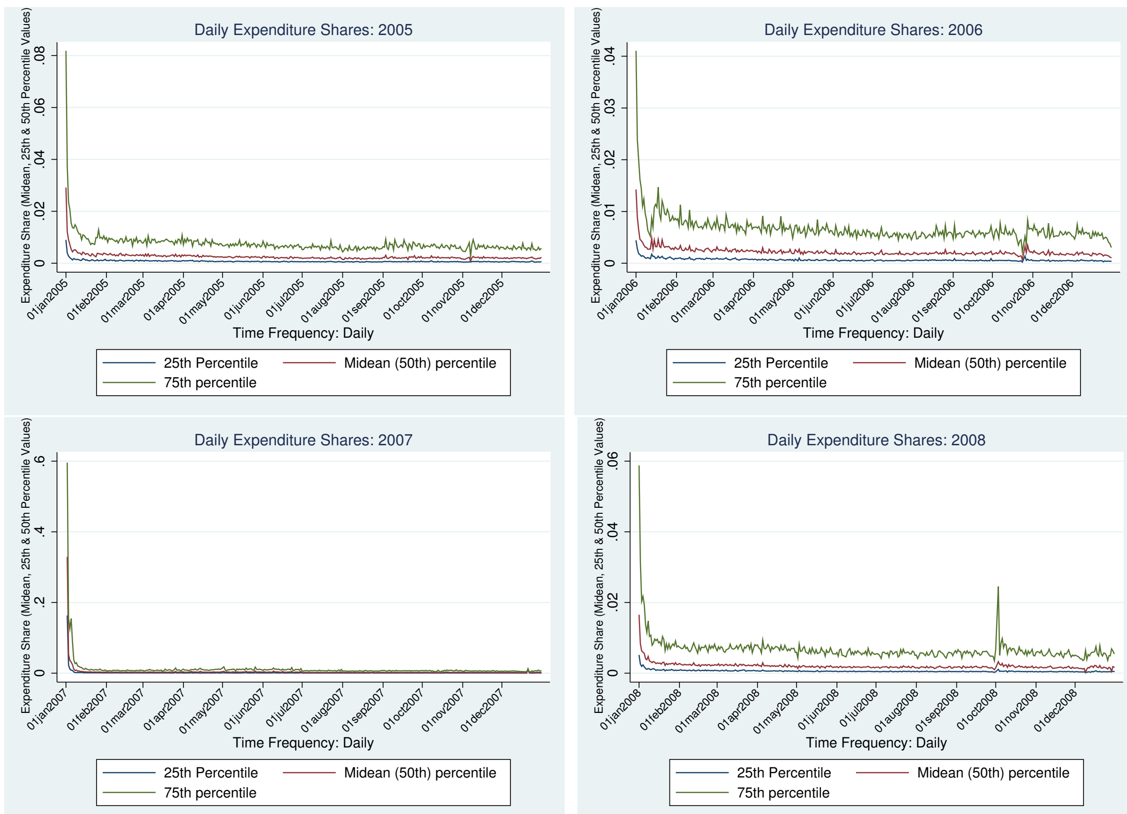
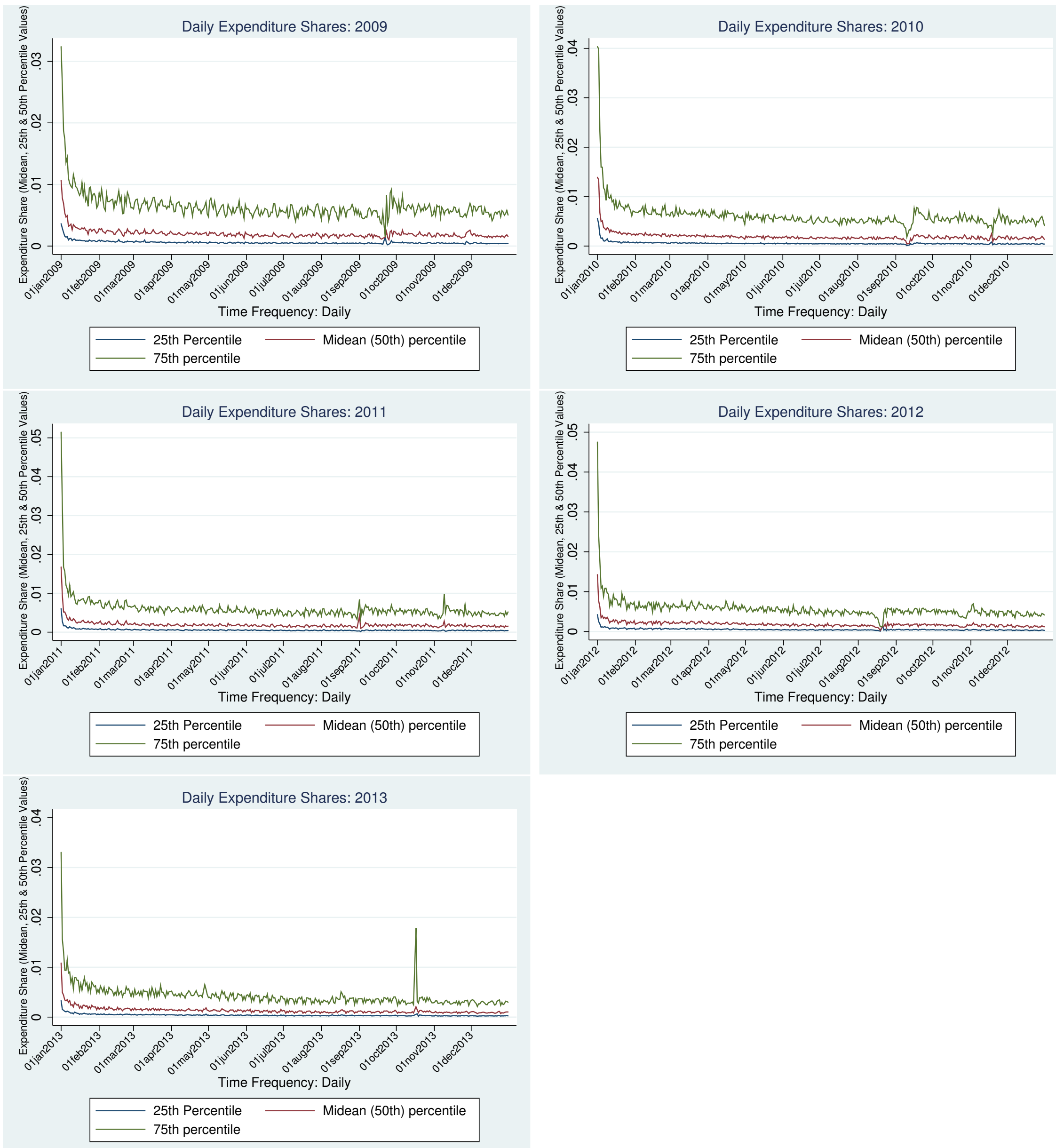


Figure A6: Expenditure shares



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  Presented at 86th Annual Southern Economic Association Meeting, Washington D.C., 2016
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