Part II

Why and how we measure trade in value-added terms

85

3.3. Motivation – why?

3.4. Early evidence from the OECD-WTO database [7]

FIGURE 3.3: Domestic content of exports (domestic value-added exports, per cent of total gross exports), 2005 09

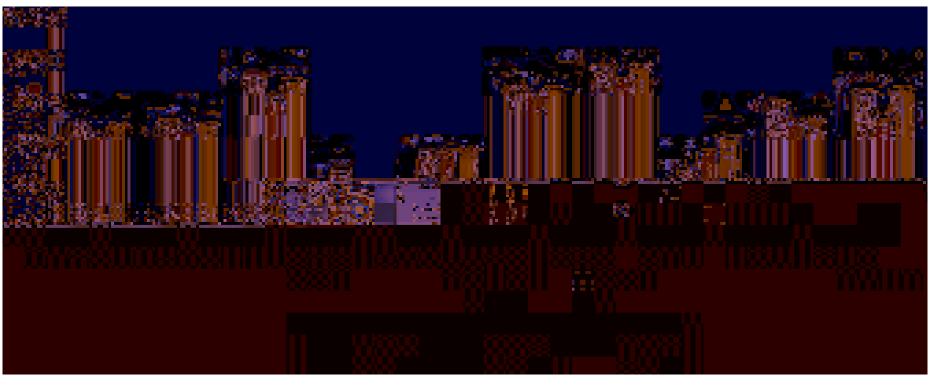


FIGURE 3.4: Transport equipment, gross exports decomposed by source, US$ billion, 2009

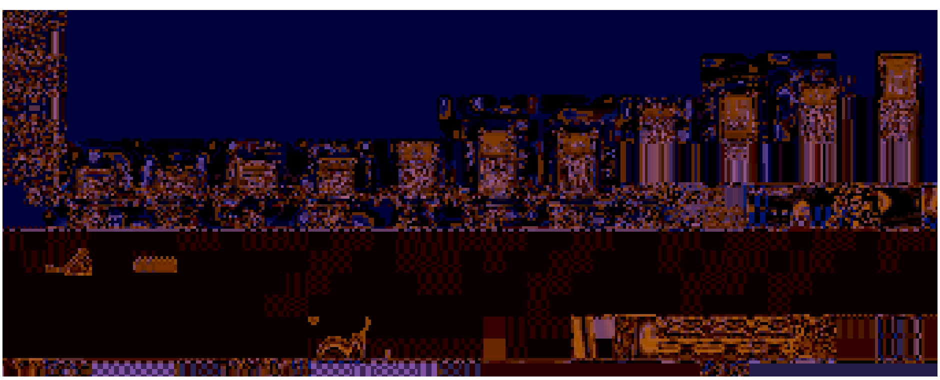
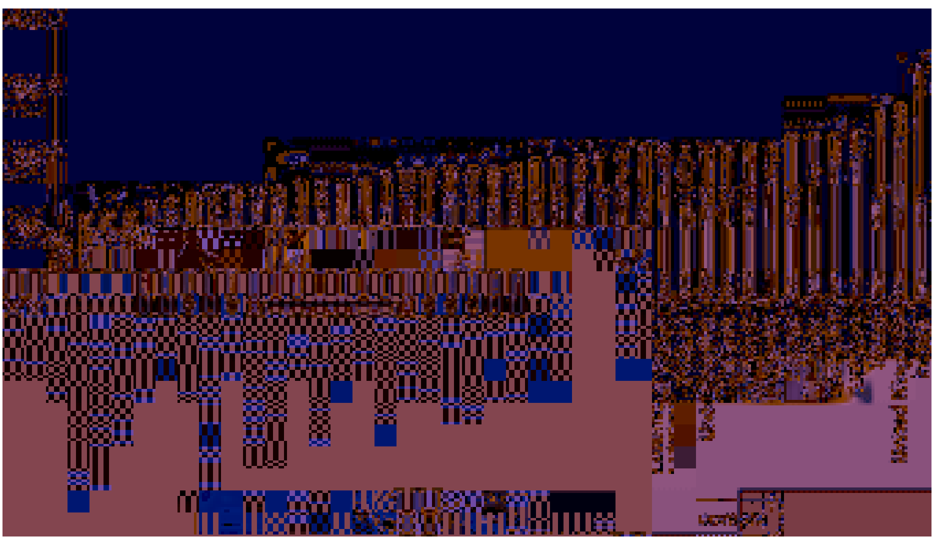


FIGURE 3.5: Electronic equipment, gross exports decomposed by source, US$ billion, 2009

FIGURE 3.7: Services value-added per cent of total exports, 2009



3.7. Estimating trade in value-added – how?

TABLE 3.1: OECD input-output industry classification

ISIC Rev.3 code	Description

TABLE 3.1: (Continued)

ISIC Rev.3 code	Description

3.8. Concluding remarks: challenges ahead

Endnotes

1

2

3

4

References

domestic product (GDP), purging double counting of intermediates and tracing the global value chain more precisely through countries' domestic production, exports and imports (see, for example, Timmer, 2012 regarding the World Input Output Database (WIOD), OECD/WTO, 2013, USITC, 2011).[2] These new databases tell a rich and consistent story of how production in many countries is dependent on imports, and that imports are often further transformed and exported. Thus we now have global databases of value-added trade at the broad sectoral level, consistent with global macro variables for GDP that also clearly capture empirically the stories widely circulated about value chains in specific products such as the iPod, iPad, iPhone, notebook computers and Barbie Dolls.[3] One of the iPhone calculations illustrates that a US$ 179 import from China contains approximately US$ 7 of Chinese value-added, and that the iPhone imported from China probably contains more US value-added than Chinese value-added.[4]

These databases are important because they provide a more accurate and nuanced understanding of trade flows that are often masked by the traditional trade data. For instance, policy debates around the US–China bilateral trade imbalance often propose policies to offset what are described as the artificially low renminbi–dollar exchange rate, unfair subsidies and trading practices of the Chinese Government and the inability to compete with exceptionally low Chinese wages. Policy prescriptions typically call for the Chinese to substantially appreciate the renminbi or for the US to place a tariff on imports from China to offset the perceived undervaluation. The value-added trade databases illustrate clearly at a more macro level the iPhone story. The WTO/OECD value-added estimates of the US-China merchandise trade balance for 2010 is US$ 131 billion, compared to the traditional trade data's balance of US$ 176 billion, while US deficits with Japan, the Republic of Korea and e4ften fu u standard, bilateral macro level comparisons of exchange rate effects on a country's exports could be very misleading.

Obviously China is not the only country affected by such factors. De La Cruz et al., (2010) illustrate that Mexican exports to the US have less domestic value-added than Chinese exports to the US. The efforts to create global databases such as (1) WIOD, (2) Global Trade Analysis Project (GTAP) based databases (used by Koopman et al., and Johnson and Noguera, among others), and (3) the WTO-OECD database demonstrate clearly that all countries participate in global value chains and the extent and depth to which they participate can be masked when using databases based on traditional gross trade statistics. These new databases suggest that traditional economic models that use databases built using simplifying assumptions about import uses in consumption, investment and export production in the domestic economy may not accurately capture the value chain impacts across countries.[7]

In the remainder of this paper we examine the effect of using the new value-added trade databases on two important empirical applications. First, we build a version of the now standard computable general equilibrium (CGE) trade model, using a GTAP based database and a model that uses information derived from the USITC global value chains work instead of traditional trade data and examine the impact of two scenarios – a US tariff placed on Chinese imports aimed at offsetting a low exchange rate and a second scenario approximating an appreciation of the renminbi by a similar amount as the US tariff. We then compare the results of this global value chains (GVC) based model with results from a model based on traditional data and find that the GVC trade model has quite important differences that more clearly illustrate how global value and supply chains work through the

4.2. Value-added trade data and CGE experiments of two hypothetical US-Asia rebalancing scenarios [8]

In this section we examine the potential effects of two US-Asia rebalancing scenarios using two different CGE models and databases. We compare selected results from the GTAP global trade CGE model (Hertel, 1997; Narayanan et al., 2012) with results from a CGE global trade model based on the global value chain (GVC) data discussed

TABLE 4.1: Regions and sectors in the GVC CG E model

Regions		Sectors	
1	China	1	Crops
2	China – export processing zones	2	Livestock
3	Hong Kong, China	3	Forestry
4	Chinese Taipei	4	Fishing
5	Japan	5	Coal
6	Korea, Republic of	6	Oil and gas
7	Indonesia	7	Minerals nec
8	Philippines	8	Meat and dairy products
9	Malaysia	9	Other foods
10	Singapore	10	Beverages and tobacco products
11	Thailand	11	Textiles
12	Viet Nam	12	Wearing apparel
13	India	13	Leather products
14	Australia, New Zealand	14	Wood products
15	Canada	15	Paper products, publishing
16	United States	16	Petroleum, coal products
17	Mexico	17	Chemical, rubber, plastic products
18	Mexico – export processing zones	18	Mineral products nec
19	Brazil	19	Ferrous metals
20	European Union – 12	20	Metals nec
21	European Union – 15	21	Metal products
22	Russian Federation	22	Motor vehicles and parts
23	South Africa	23	Transport equipment nec
24	Rest of high income countries	24	Electronic equipment
25	Rest of South America	25	Machinery and equipment nec
26	Rest of Asia	26	Manufactures nec
27	Rest of East Asia	27	Electricity
28	Rest of the world	28	Gas manufacture, distribution
		29	Water
		30	Construction
		31	Trade
		32	Transport nec

(Continued)

TABLE 4.1: (Continued)

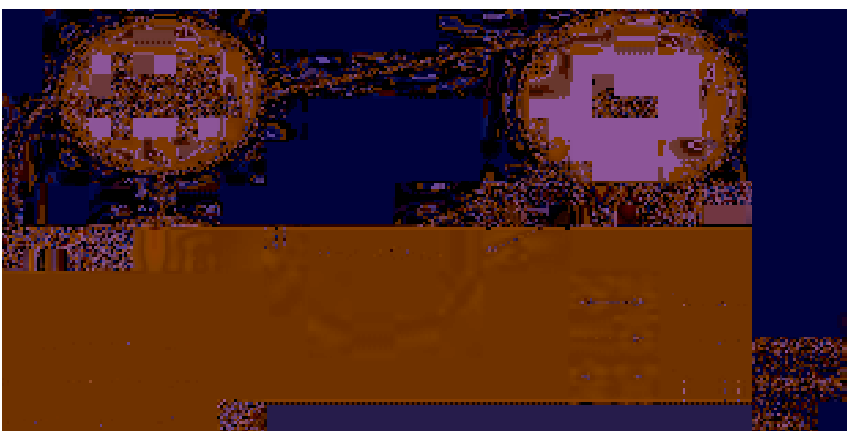
Regions	Sectors	
	33	Water transport
	34	Air transport
	35	Communication
	36	Financial services nec
	37	Insurance
	38	Business services nec
	39	Recreational and other services
	40	Public Admin., Defense, Educ., Health
	41	Dwellings

Source: Authors.

bilaterally between Japan and China, as China processing is subsumed in China, and similarly with respect to the Mexico component.

Trade flows in both models are represented by gross trade figures. The global value chain aspect of current international trade is reflected in the GVC model via the Armington tr[odels ( )- GG G GGG

FIGURE 4.1: Linkages between processing trade in China, the rest of China, and Japan in the GVC Model

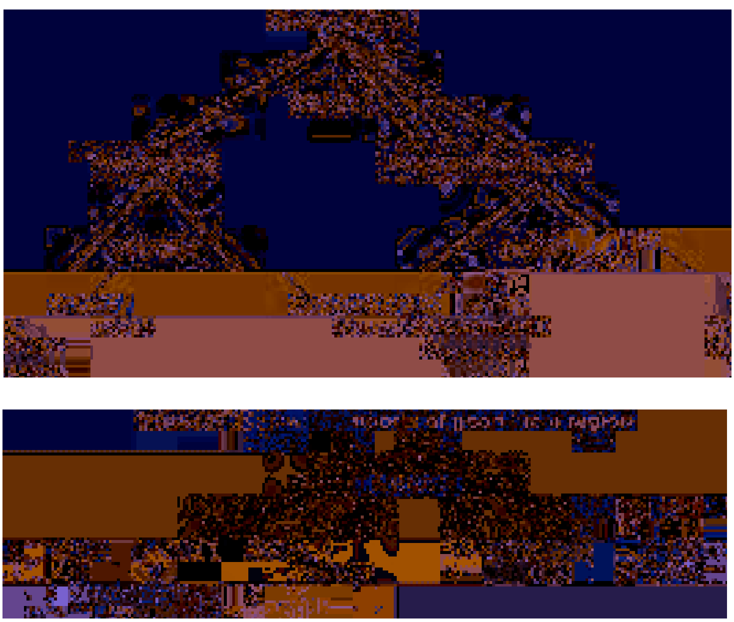


Source: Authors.

services) are assumed to be differentiated by their region of origin, i.e., the Armington specification is applied (Armington 1969a; 1969b). The two models, however, implement the Armington assumption in different ways.

Because of the lack of necessary data, the Armington assumption is implemented in two levels in the GTAP model: producers and consumers distinguish the domestic variety of a good from its imported variety without regard to the country of origin of the imported input; the sourcing of imported goods is placed at the border of an economy. Figure 4.2 illustrates the implementation of the Armington specification in the GTAP model. The left-hand side of Figure 4.2 sketches substitution possibilities in the production process of a particular sector. At the top level, valued-added, a composite of labour and capital, can be substituted with intermediate inputs. At the second level, the domestic variety of a particular intermediate input can be substituted with its imported variety; this is the first component of the Armington assumption. The GTAP model incorporates similar substitution possibilities for household demands. The left-hand side of Figure 4.2 shows that the sourcing of imported goods, for instance how much to import from particular countries, is modelled for the economy as a whole;

FIGURE 4.2: Sourcing of imported goods in the GTAP model



Source: Authors.

this is the second component of the Armington assumption. We can visualize the economic mechanisms incorporated in Figure 4.2 as follows: for each economy and for each good, there is an importing firm which imports the good from other countries; the sourcing of imports changes as the relative prices change. This importing firm blends the country varieties of the particular good and supplies the blended imported good to producers and consumers.

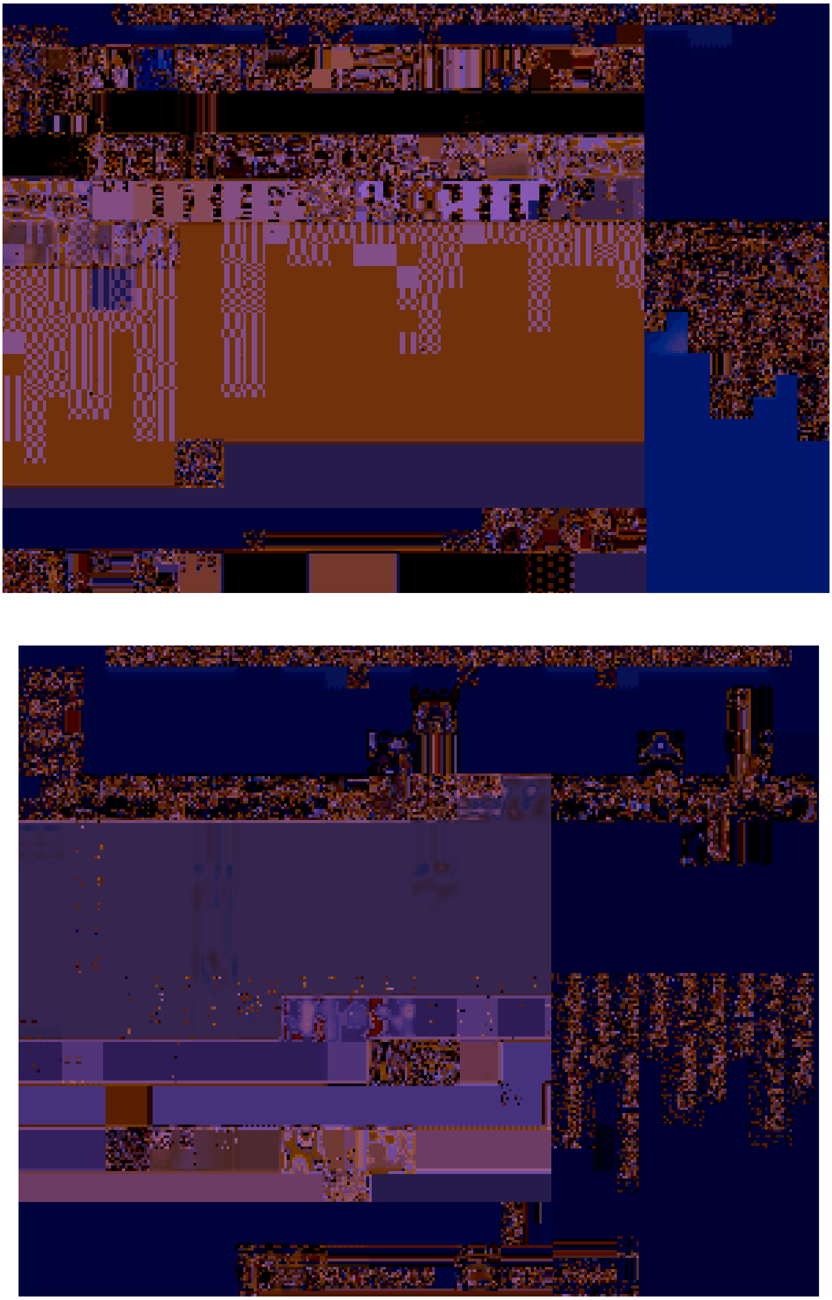
Because of additional data work done for the development of the GVC data, it is possible to place the sourcing of imports in the GVC model at the agent level as shown in Figure 4.3. This is the second difference between the GTAP model and the GVC model. Figure 4.3 shows that in the GVC model, a particular producer decides not only how much to import of a particular good, but also from where to source these imports from. Thus in the GVC model we have potentially established tighter linkages between sectors located in different economies than the linkages contained in the GTAP model. We have also substituted an aggregate mechanism that determines bilateral trade, i.e., sourcing of imports for the economy as a whole in the GTAP model, with a micro-based mechanism of bilateral trade, such as the sourcing of imports at the agent level.

In Figure 4.4 we present GDP results from the two rebalancing scenarios in the GTAP and GVC models. We can see that country level GDP effects

FIGURE 4.3: Sourcing of imported goods in the GVC model

Source: Authors.

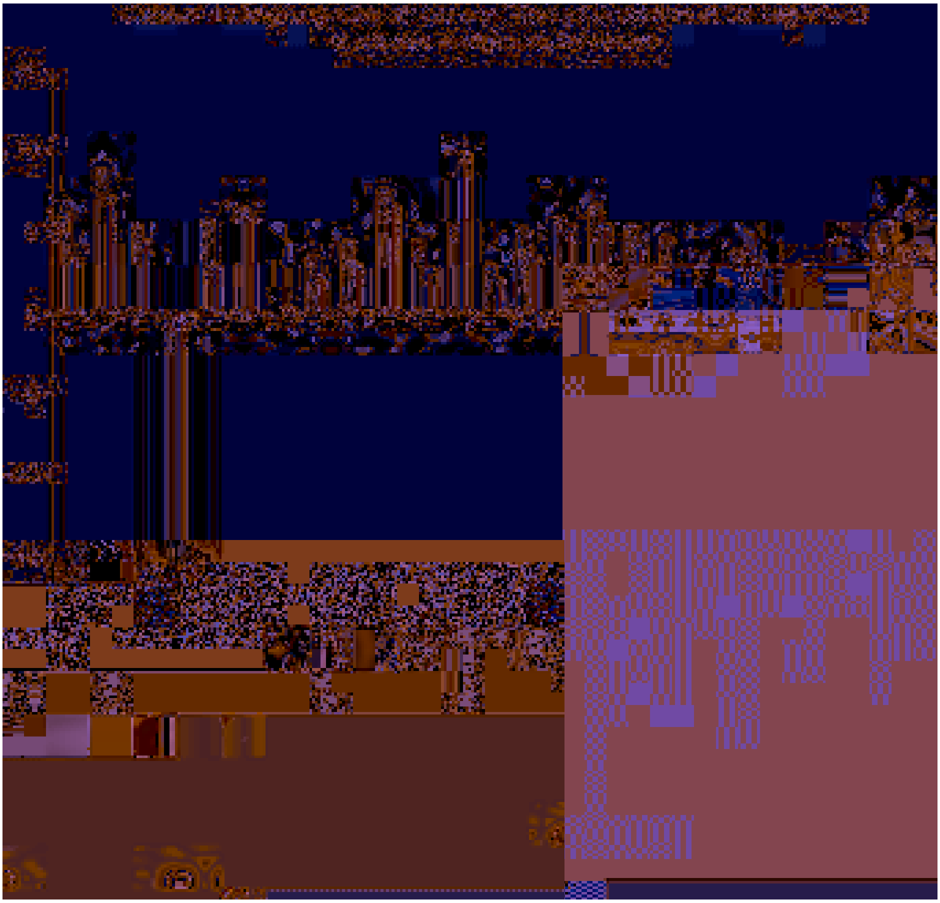
FIGURE 4.4: Per cent change in GDP volume



Source: Authors' calculations.

are sensitive to the model chosen, despite identical parameterization and experimental shocks. In the savings experiment, the GVC model produces a smaller impact on China's GDP than in the traditional model, while many other countries experience larger GDP effects. In the tariff experiment, the GDP effects on China are muted in the GVC model compared to the GTAP model, and the other countries experience large differences in impacts with particularly big differences for Mexico, Malaysia, Singapore, Thailand, Chinese Taipei and Viet Nam. Clearly, at the GDP level in the models, the GVC model produces quite

FIGURE 4.5: United States' imports of electronics



Source: Authors' calculations.

different results from the traditional GTAP model. GDP is a much-aggregated measure of model impacts and can be complicated to explain the various factors driving its change. Thus we now turn to some sectoral examples that highlight more clearly the impact of a GVC based model compared to a traditional GTAP model.

Figure 4.5 presents the change in US imports of electronic equipment in the two savings-rate experiments. The two experiments show almost exactly the same decline in imports from China (15 per cent), but results for other suppliers differ widely depending on their roles in the electronics value chain. For example, Mexico experiences the largest export gain because its exports of electronics to the United States contain very little Chinese content. In fact, China had a lower market penetration in Mexico for imported intermediate inputs in 2007 than it did in any other country in our data set. Hence, when Chinese exchange rates rise, driving up the cost of Chinese intermediate inputs, prices of electronics from Mexico rise less than electronics from its competitors. Viet Nam has a very different role in the electronics supply chain. In 2007, Viet Nam was largely an assembler of Chinese intermediates, with little production of its own intermediates. Hence, it is quite negatively affected by the rise in price of Chinese intermediates. For other countries, the two models showed much smaller differences. Particularly for East Asia, results are similar because these countries are both upstream and downstream, exporting intermediates to China and receiving intermediates from it.

Figure 4.6 presents Chinese imports of electronic equipment in the two experiments. The GVC model shows substantial deviations from the standard GTAP model, particularly for countries outside of East Asia. In many cases, countries have higher exports in the GVC experiment. In both models, the resulting rise in China's real exchange rate causes substitution away from Chinese sourcing of electronics inputs. Only the GVC model, however, captures the important differences between Chinese processing and non-processing imports. In this model, Chinese non-processing imports rise, but Chinese processing imports fall. Even though these imports fall by 10–20 per cent for many countries, processing zones become relatively less reliant on domestic sourcing because of the even greater (42 per cent) decline in domestic inputs. Hence, the overall change in Chinese imports 2 ps 2 ps 2 ps 2 ps nes3
For exay countries, p Chit Asia, res oveline p Chicessing imports falesti ofr (

the rise in non-processing imports, and so overall Chinese imports from these sources decline.

Figure 4.7 presents Chinese imports of iron and steel in the two experiments. As for steel. In 2007, processing trade constituted 90 per cent of overall electronics imports but only 17 per cent of iron and steel imports. Processing trade for iron and steel come mostly from specific East Asian suppliers (for example, Chinese Taipei, Japan, the Republic of Korea) which were the most negatively affected suppliers in Figure 4.7.

These experimental results illustrate that a CGE model specified in such a

4.4. Value-added trade data and estimation of exchange rate and price pass through effects [9]

We now examine the impact of using value-added trade data compared to traditional gross trade data to examine exchange rate pass-through. Fluctuations in exchange rates can have significant effects on the competitiveness of foreign producers who export to the US market. As long as there are rigidities in nominal wages and prices, reductions in the nominal value of an exporter's currency will lower its relative costs of production and the relative price of its exports. The magnitude of the resulting change in the demand for US imports will depend on the substitutability of imports from other countries and on the currency denomination of the costs of these international competitors.

There is a sizeable empirical and theoretical literature that investigates the pass-through of nominal exchange rate fluctuations into import prices and the resulting change in international trade flows. Goldberg and Knetter (1997) provide a broad review of the literature on exchange rate pass-through. Marazzi et al., (2005) and Brun-Aguerre et al., (2012) are important recent contributions. A common assumption in empirical studies of exchange rate pass through is that each exporter's entire marginal cost of product is denominated in the exporter's domestic currency. However, if some of the exporter's intermediate inputs are imported, and these costs are not denominated in the exporter's domestic currency, then the exporter's marginal costs of production will only be partly exposed to fluctuations in the value of its currency. In this more realistic case, the effect of the exchange rate changes will depend on the share of domestic value-added in marginal costs.

This limitation — the unrealistic representation of the currency exposure of production costs — is often recognized in the literature as a caveat, but it is difficult to resolve because there is often only limited information on costs of production. More realistic modelling of costs requires information about value-added shares in the exporting country, but it also requires information about the currency denomination of the marginal costs of all of the other countries that compete in the same destination market. For example, an appreciation of the renminbi will affect the marginal costs (and prices) of exporters from China, according to the domestic share of the value-added in their exports, but it will also affect the marginal costs (and prices) of any exporters in Mexico or other countries whose products include value-added from China. Thus the recent developments in the estimation of value-added trade flows provide the needed information in a form that is easy to use and

combined with information on price changes in that country and nominal exchange rate changes that the country had with the importing country j. Thus, rather than explaining the change in export values with only the final exporter i's price and exchange rate information, the model uses the price and exchange rate changes of all countries adding value to i's exports, weighted by the share of value each of these countries contributes. Appendix A specifies the estimating equation and shows how the exchange-rate pass-through (ϕ) and elasticity of substitution (γ) are calculated from the regression coefficients.

For our econometric estimation we use data from WIOD.[14] The estimate of value-added shares relies on a transformation from the direct input-output table provided by WIOD into the Leontief inverse matrix, which describes all inputs, direct and indirect, used in the provision of final goods.[15] For our estimates, the WIOD database provides the required data on sectoral trade, domestic expenditure, and, after transformation, the value-added shares. We estimate the model using OLS and a panel of log-first-differences from 2000 to 2009 for 13 non-petroleum manufacturing sectors in 28 of the largest countries in the WIOD dataset.

Table 4.2 presents the estimates of the exchange rate pass-through rate (ϕ) and the substitution elasticity (γ) for each sector. Overall, the estimated pass-through rates are sensible and precisely estimated in our preferred specification (the first three columns of the table). In eight of the 13 sectors, estimates are bounded between zero and one at the 95 per cent significance level, and only two sectors (transportation equipment and food, beverages and tobacco) have point estimates outside this range. Thus for most sectors, we can strongly reject the hypothesis that there is complete pass through of nominal exchange rate fluctuations. The median pass-through estimate is 0.44. Estimated pass-through rates of this magnitude are consistent with the finding of incomplete pass-through in the prior studies cited above. The estimates for substitution elasticity for our preferred specification in table 4.1 are also precisely estimated. The point estimates are all greater than one and significantly different from one in nine sectors at the 95 per cent significance level. The median elasticity is 1.84. For comparison, we are not aware of any estimates employing the current methodology or WIOD data, but elasticities in the GTAP model may be the closest available estimates at a similar level of aggregation. The median elasticity in the 15 non-food, non-petroleum manufacturing sectors in the GTAP model is 3.75, twice the median estimate in this study.

Table 4.2 also presents estimates employing an alternative specification that assumes that exports contain 100 per cent domestic content (a constraint on the value-added shares in equation (1)). These estimates depart from the preferred estimates employing

relatively large domestic value-added share in its exports and its relatively small

TABLE 4.4: Average trade elasticity for each exporting country

Exporting country	Trade elasticity with value-added data	Trade elasticity without value-added data	Ratio of trade elasticity estimates
Australia	0.2925	0.3236	0.9038
Austria	0.2495	0.3239	0.7704
Belgium	0.2109	0.3234	0.6522
Brazil	0.3109	0.3235	0.9613
Canada	0.2602	0.3147	0.8269
China	0.2176	0.2637	0.8253

Ce7o Tfr69a -276yh3ic572 0 Td (0.2176)Tj 12.15 0 Tdd (0.3235)Tj 14215 0 Td (0.6522)Tj 890.578 -2.306 Td (BelgiumD
BelgiumFinland572 0 Td (0.2602)Tj 12.856 0 Td (0.2637)0cc60cEcS4 3660856 0.82

Table 4.5 reports sector-specific estimates for US imports from China. For each of the sectors, the trade elasticity estimate based on the value-added data is less than the alternative estimate that assumes 100 per cent domestic content. The largest reduction (in percentage terms) is for the electrical and optical equipment sector. The smallest reduction is for the food products sector. The final column reports the ratio of the price index effect to the own price effect for the trade elasticity based on the value-added data. For some of the sectors, there is a large price index effect that offsets much of the own price effect. This is the case for the textiles, electrical and

TABLE 4.5: Estimated trade elasticity for U

optical equipment, and metal products sectors. For other sectors like transportation equipment and paper, there is almost no price index effect.

4.7. Conclusions

We have presented two empirical examples that illustrate the relevance for policy makers of using value-added trade data compared to traditional trade data. We specified a new CGE model based on additional information derived from the USITC work on value-added trade data and the implied global linkages between countries. Using this new model we find substantial and important quantitative differences for the size of macro, sectoral and geographic impacts along supply chains compared with a more traditional gross trade based model. We also developed a practical tool for estimating the effect of fluctuations in nominal exchange rates on the value of US imports of manufactured goods using a structural model of trade and a value-added decomposition of gross trade flows. We find that estimates of pass through rates that do not incorporate value-added trade data can be systematically understated, while estimates of trade elasticities that do not incorporate value-added trade data can be systematically overstated.

Appendix A: Econometric specifications

Equation (1) gives the estimating equation used to determine the exchange rate pass-through and elasticity of substitution.

$$\hat{V}_{ijt} - \hat{V}_{jjt} = \beta_0 + \beta_1 \hat{P}_{jjt} + \beta_2 \sum_k \theta_{kit} (\hat{P}_{kkt} - \hat{E}_{kjt}) + \varepsilon_{ijt}. \quad (1)$$

The variable $\hat{V}_{jjt}$ is the first difference of the log of the value of domestic shipments in country j in year t, $\hat{V}_{ijt}$ is the first difference of the log of the value of exports from country i to country j in the currency of country j, $\hat{P}_{jjt}$ is the first difference of the log of the price of domestic goods in country j in the currency of country j, and $\hat{E}_{kjt}$ is the first difference of the log of the country k currency price of the currency of country j. The variable θ_{kit} represents the cost share of country k in the sector's exports from country i in year t. Finally, the variable ε_{ijt} is an error term with conventional distributional assumptions. We do not include a subscript for sector, since we estimate a separate set of econometric models for each sector. We can recover the underlying parameters of the model from the regression coefficients in (1). The elasticity of substitution, σ, is equal to $1+\beta_1$. The exchange rate pass through rate, ρ, is equal to $-\beta_2/\beta_1$.

13 As with export value, the exporter’s price change is measured relative to the importer’s price change in this sector.

14 The database contains data on the international sourcing of intermediate inputs and final goods in 35 sectors among 40 countries (27 EU plus 13 other major countries) for 1995–2009. We also use local-currency deflators from the IMF to measure local prices.

15 See Timmer et al., (2012) for a discussion of the Leontief inverse. We thank Zhi Wang for the provision of these inverses.

16 Powers and Riker (2013) derives this formula and discusses these two effects in more detail.

17 The exporters include all countries in the estimation sample except for the United States.

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5 Geometry of global value chains in East Asia: the role of industrial networks and trade policies

Hubert Escaith and Satoshi Inomata

5.1. Introduction

East Asia is one of the best-known examples of a regional economic integration process that was initially driven by deepening industrial relations, rather than by political agreements, among countries of the region. The institutional or legal aspects of regional integration came only afterwards, in a typical "bottom-up" way. The situation differs from what has occurred in North America, where the ratification of the North America Free Trade Agreement (NAFTA) was a catalyst for the build-up of the US-Mexico economic ties.

What is important about East Asian integration, however, is that the deepening economic interdependency was not just a spontaneous phenomenon but it has been carefully aided and facilitated by the series of policies implemented by national governments. It is this interactive dimension of Asian integration, between industrial dynamics on the one hand and institutional development on the other, which presents the focus of this study.

In this line, the paper is structured as follows. The first part will show the evolution of regional supply chains in East Asia, using the information derived from international input-output (I-O) tables in order to map the dynamics of industrial linkages. The

5.2. Evolution of regional supply chains in East Asia

In the modern production system, goods and services are processed through the progressive commitment of various industries in which a product of one industry is used as an intermediate input of others.

Input-output models and supply chains analyses

The conventional input-output approach to supply chains generally focuses on measuring interconnectedness, or “strength” of linkages among industries, based on the traditional demand-pull or cost-push impact models. Now, in addition to the strength of linkages, the increasing complexity of production networks due to the participation of the variety of industries requires measuring the “length” of linkages for mapping the geometry of supply chains. The strength of an input-output table, and what makes it special, is indeed its information of production linkages that are derived from supply-use relations between industries, which is totally absent in other types of data such as industrial statistics or foreign trade statistics.

Suppose that there is an increase in the demand for cars by JPY 10 billion (Figure 5.1). The output expansion of cars brings about the secondary repercussion on the production of other products. Apparently, it increases the demand for car parts and accessories such as chassis, engines, front glass and tyres. The increase in production of these goods, however, further induces the demand for, and hence the supply of, their sub-parts and materials such as steel, paints and rubber. A change that occurs in one industry (say, an increase in demand for cars) will be amplified through the complex production networks and bring about a larger and wider impact on the rest of the economy.

The length is estimated using the concept of average propagation length (APL) developed in Dietzenbacher et al., (2005). As an illustrative example, consider the following hypothetical supply chains in Figure 5.2. If we want to measure the length of supply chains between Industry A and Industry E, we should look at the number of production stages of every branch of the supply chains. In this illustrative example, there are four paths leading from Industry A to Industry E. The path on the top involves two production stages. The second one has four stages, the third has three stages and the last one at the bottom has four stages.

FIGURE 5.1: An image of demand propagation (automobile industry)

Source: Calculated and drawn by the authors.

Now, when the shares of a delivered impact for each path are calculated as given in parentheses at the ends of branches, the APL between Industry A and Industry E is derived as:

$$APL_{(A \to E)} = 1 \times 0\% + 2 \times 50\% + 3 \times 30\% + 4 \times (10 + 10)\% + 5 \times 0\% + \ldots = 2.7.$$

That is, APL is formulated as a weighted average of the number of production stages that an impact from Industry A to Industry E goes through, using the share of an impact at each stage as a weight.[1] It represents the average number of production stages lining up in every branch of all the given supply chains, or, in short, an industry's level of fragmentation. (For a formal description of the APL, see Technical Note.)

analysis of international production sharing basically responds to the following three motivations.

(1) As has just been demonstrated, it measures the degree of technological fragmentation and sophistication of particular supply chains.

(2) APL can be measured both in forward-looking and backward-looking ways. So, by comparing the lengths between the two for cross-national supply chains, we can identify the relative position of a country in the global production networks.

(3) If the production process is fragmented and shared among different countries, it increases the impact of trade policies on the volume and direction of international trade.

The relevance of the APL model to the issue of fragmentation was already suggested in the seminal paper of Dietzenbacher et al., (2005), although the paper did not explicitly used the term.[3] The APL model was applied at the international level in Dietzenbacher and Romero (2007), in which international linkage was analysed for major European economies using the international input-output table of 1985. The paper also employed the hypothetical extraction method to evaluate the influence of a single country on the APL of the chosen regional system, with the result of Germany by more countries, the intermediate products cross national borders more frequently, and hence the volume of traded products become more sensitive to the change in a country's trade policies. The detrimental effect of protectionist measures in an international production network becomes much larger than when the production process was relatively simple and taking place in a limited number of countries.

Analytical results

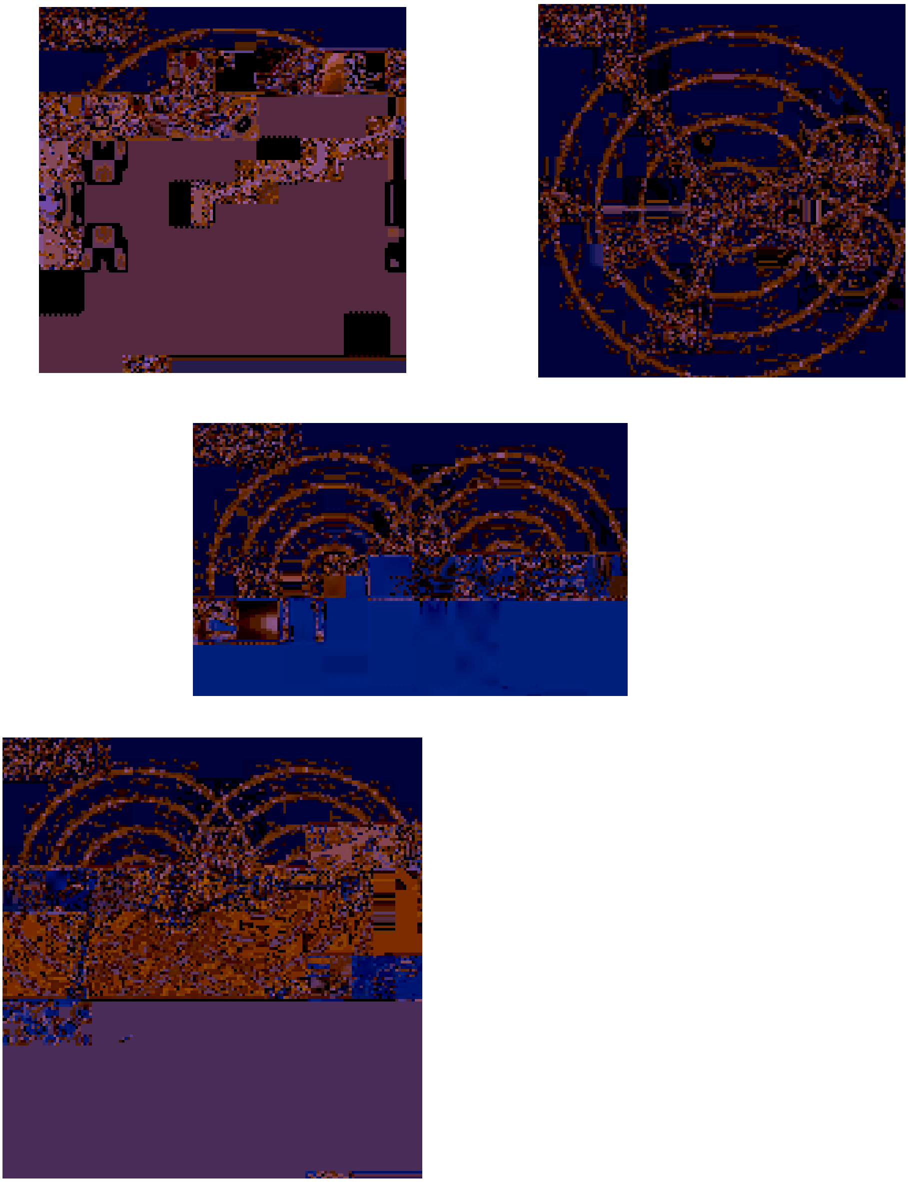
The diagram in Figure 5.3 traces the evolution of production networks in the Asia-US region over the last two decades. The visualization of the calculation results is based on the method presented in Dietzenbacher et al., (2005) with some graphical elaboration developed in Inomata (2008b). Arrows represent selected supply chains among the countries of the region with the direction of the arrows corresponding to the flow of intermediate products. Each arrow has two features: thickness and length. The thickness indicates the strength of linkages between industries, while the length, as measured against the ripple in the background, is given by APL. The number of rings that an arrow crosses represents the rounded value of APL, the average number of production stages, and thus indicates the level of technological fragmentation and sophistication of that particular supply chain.[3]

The analysis uses the Asian International Input-Output Tables for the reference years of 1985, 1990, 1995, 2000 and 2005, constructed by the Institute of Developing Economies, JETRO.[4] While conventional input-output analysis is usually concerned by a single country, the treatment is similar for international matrices. The table combines the national I-O tables of ten economies: China(C), Indonesia (I), Japan (J), Republic of Korea (K), Malaysia (M), Philippines (P), Singapore (S), Thailand (T), Chinese Taipei (N) and United States (U).

In 1985, there were only four key players in the region: Indonesia (I), Japan (J), Malaysia (M) and Singapore (S). The basic structure of the production network was that Japan built up supply chains from resource-rich countries like Indonesia and Malaysia. In this initial phase of regional development, Japan drew on a substantial amount of productive resources and natural resources from neighbouring countries to feed to its domestic industries.

By 1990 the number of key players had increased. In addition to the four countries already mentioned, Japan had extended its supply chains of intermediate products to the Republic of Korea (K), Chinese Taipei (N) and Thailand (T). While still relying

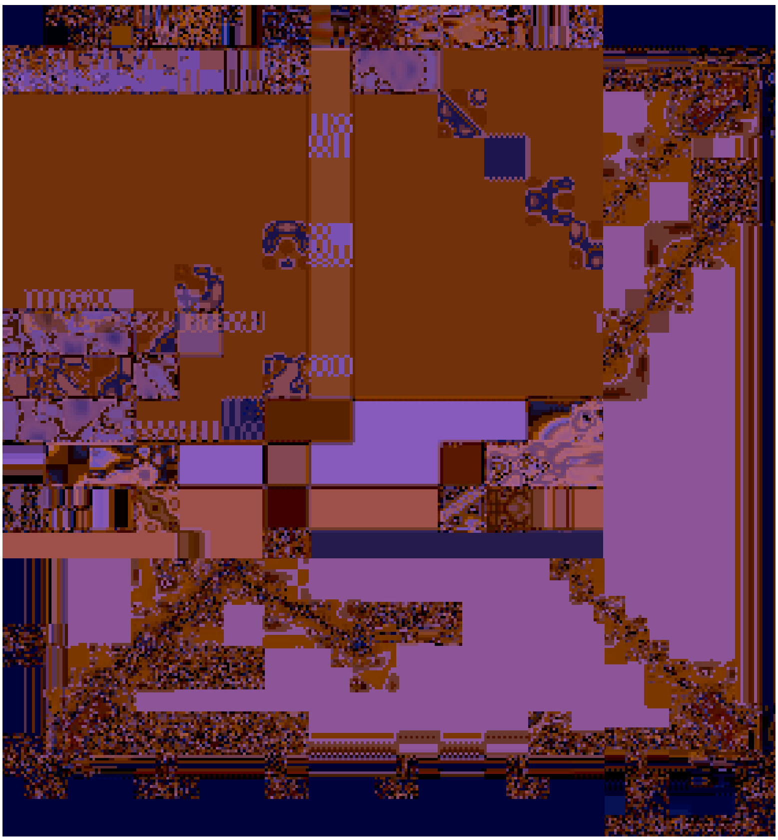
FIGURE 5.3: Evolution of regional supply chains in East Asia: 1985–2005



The southwest-northeast diagonal presents the average length of supply chains that each country participates in. Most economies have moved towards the northeast corner, which means that they increased the length of supply chain linkages between 1985 and 2005. The exceptions to this trend are the United States and Chinese Taipei, while, Japan almost did not change; on the contrary, China demonstrates an outstanding increase in the length of supply chains. It is considered that inter-linking of its domestic supply chains with overseas production networks was accelerated by the country's accession to the WTO in 2001, as suggested by the big leap of the value from 1985 to 2005.

The northwest-southeast diagonal draws the relative position of each economy within the regional supply chains, as determined by the ratio of forward and backward APL. The United States and Japan, the most advanced economies in the region, are located

FIGURE 5.4: Change of relative positions in the regional supply chains, 1985–2005



Source: Based on Inomata (2008b) methodology and IDE-JETRO Asian input-output matrix.

in the upstream position, though the United States moved downwards during the period and swapped its position with the Republic of Korea. China stays in the downstream segment of the regional supply chains, which reflects the country's position as a "final assembler" of the regional products. The other economies more or less remain in the middle range spectrum, though the notable change is that Thailand went downstream to a large extent, and Chinese Taipei moved up into the middle cluster.

5.3. Tariffs, transport and trade facilitation

As shown above, international input-output matrices can be useful in revealing the topological characteristics of inter-industrial networks and their evolution. The present section aims at underlining some empirical characteristics of the bilateral

to their international, or free market price. From a “trade in tasks” perspective, not only the value of nominal tariffs, but also their distribution between unprocessed and processed goods – a feature of nominal schedules known as tariff escalation – have a particular importance. By increasing the domestic prices of finished goods more than intermediary ones, tariff escalation creates a significant anti-export bias when value-added is the traded “commodity”, as is made clear when looking at effective protection rates (EPRs).

Effective protection compares the nominal protection received on one unit of output produced by an industry and sold on the domestic market (at a price higher than the free market because of the duty charged on competitive imports) with the additional production cost the producer had to pay because of the tariff charged on the importable inputs required for producing this unit of output. Note that the value of one unit of output minus the value of the intermediate inputs required is equal to the rate of value added at domestic prices.

Tariff duties do influence the domestic price of all inputs, including domestically produced ones. Domestic suppliers of tradable goods will be able to raise their own prices up to the level of the international price plus the tariff duty, without running the risk of being displaced by imports. If the tariff schedule is flat (all tariffs are equal), the effective protection on the value added is equal to the nominal protection. In the presence of tariff escalation, downstream industries producing final goods will benefit from a higher effective protection. Upstream industries producing inputs will have, on the contrary, a lower protection and possibly a negative one if the sum of duty taxes paid on the inputs is higher than the taxes collected on the output.

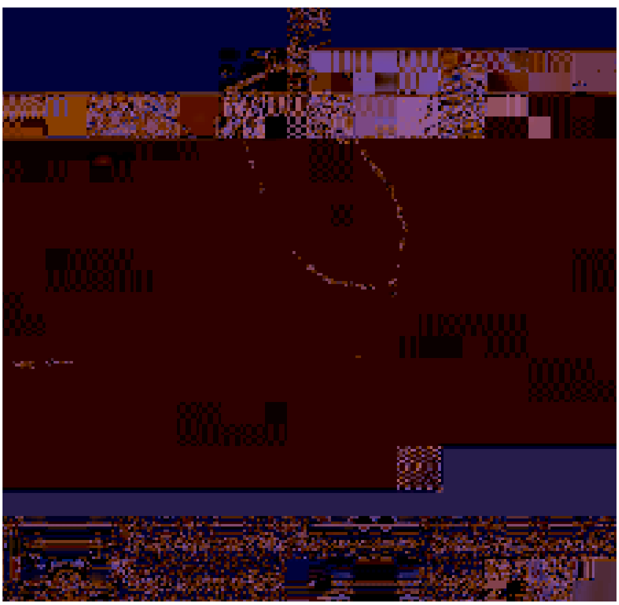
As shown in Appendix 5.2, EPR is a ratio comparing the value added per unit of output at domestic prices – tariffs applying on both output and inputs – with the value added the industry would have gained if operating at international prices (without tariff duties). It has been known for years that high EPRs discourage benefiting firms from exporting their output. This anti-export bias is even more relevant when analysing trade policy from a “trade in value added” perspective (Diakantoni and Escaith, 2012).

One option chosen by countries suffering from high and differentiated tariff schedules has been to establish duty-free export processing zones (EPZs). Another option is to implement draw-back schemes where domestic firms can have the duty taxes paid on inputs reimbursed when they export their products. Nevertheless, as

region by stating that, in 2009, of the top ten leading world ports in terms of container traffic, five were located in China and one each in Hong Kong, China; Republic of Korea and Singapore. These four economies represent 38 per cent of the world's container port traffic.

Figure 5.5 shows that, despite the high efficiency of the Asian hubs (Singapore ranks second after Germany on the World Bank's logistics index, while Japan is 7th and Hong Kong, China 13th, all ahead of the United States and Canada), there is still room for improvement in most of the region's countries. In particular, the region is still far from having the best practices in customs procedures found in high-income countries. Unlike with improving trade and transport-related infrastructure, which requires costly investment in ports, railroads, roads and information technology, improving efficiency in customs procedures is a relatively cost-free matter of introducing administrative reform.

FIGURE 5.5: Trade, logistics and transportation – East Asia in perspective



Source: Elaborated on the basis of World Bank LPI, 2012.

Note: Logistics Performance Index (LPI), weighted average on the six key dimensions.

Regional production networks and shock transmission

When trade partners are closely interconnected in production networks, as is the case in East Asia, a sudden change in one country (a tariff hike or a bottleneck in production or logistics) will generate a supply shock through the entire supply chain. The shock may increase the cost of the related product or stop production chains, if it is disruptive. The damaging impact will be greater the larger the volume of vertical trade processed in the originating country (size effect) and the more connected it is with other partners (network effect). As mentioned previously, in an input-output intensity and length are pondered. Japan comes a close second in terms of average APL indexes due to the high value of some sectors (metals, chemical products and computers). The United States comes in third. From a sectoral perspective, chemical products and metals and metal products are by far the sectors generating most of the depth in inter-industrial connections, Computers and electronic equipment are also highly interconnected.

5.4. Conclusions

Understanding trade in the global value chain perspective is greatly enhanced by adapting analytical tools derived from network economics and the study of inter-industry or inter-country relationships. Analysing the bilateral relationship between two nodes of a production network requires understanding the complementarity between them as well as with other partners in the network, as well as the factors that may explain the strength of the edges between them. International input-output (IIO) matrices are an effective way of describing and modelling the development of inter-industrial relationships in such a transnational context.

Thanks to a close relationship between input-output analysis and graph theory, diachronic IIOs serve also to map and visualize the evolution of productive networks and identify their main clusters. Applying these topological properties to the East Asian and Pacific context, we show that the inter-industry network moved from a simple hub and spokes cluster, centered on Japan in 1995, to a much more complex structure in 2005 with the emergence of China but also the specialization of several countries, such as Singapore or Malaysia, as secondary pivots.

The rise of “factory Asia” and its present topology were determined by specific policies. The densification of production networks in East Asia resulted from the coincidence of business strategies, linked to the widespread adoption of international supply chain management by lead firms in Japan and the United States, with the promotion of export-led growth strategies from developing East Asian countries. These countries applied a series of trade facilitation policies that lowered not only tariff duties, but also reduced other transaction costs.

We show that tariff escalation was greatly reduced in developing East Asia between 1995 and 2005, reducing the dissuasive anti-export bias attached to high effective protection rates and improving in the process the competitiveness of second-tier national suppliers. The other axis of trade facilitation focused on improving logistics services and cross-border procedures. While the East Asia region is well ahead of the rest of developing Asia in this respect, there is still a wide margin of progress in order to close the gap with best international practices, particularly in terms of administrative arrangements.

Appendix 5.1. Technical note on average propagation length

Suppose an n-industrial sector economy with a production structure defined by the

The exercise reveals that the impact of any two-step path, whatever the sequence of industries, can be given by feeding back a set of direct impacts, A, into the input coefficient matrix, i.e. $A \times A = A^2$. Similarly, the impact of three-step paths is given by $A \times A^2 = A^3$, that of four-step paths by $A \times A^3 = A^4$ and so on, which is evident from $[A^2]_{ij} = \Sigma_k a_{ik} a_{kh}$, $[A^3]_{ij} = \Sigma_k \Sigma_h a_{ik} a_{kh} a_{hj}$, etc. The amount of impacts shown in each layer of A^k ($k = 1, 2, 3, \ldots$) is a result of the initial demand injection passing through all k-step paths. It captures the effect of every direct and indirect linkage that undergoes exactly the k-round steps/stages of the production process.

Meanwhile, it is mathematically known that the Leontief inverse matrix L, which shows the total amount of goods and services required for the production of one unit of output, can be expanded as an arithmetic series, i.e. $L = (I - A)^{-1} = I + A + A^2 + A^3 + A^4 + \ldots$, where I is an identity matrix (with "1" in diagonal elements and "0" elsewhere). From what we saw above, it is immediately clear that the equation represents the decomposition of the total impact on output into its constituent layers according to the number of production stages involved. Matrix I corresponds to an initial (unity) matr0E>8

With a

3 For a detailed explanation of the visualization method, see Annex of WTO – IDE JETRO (2011).

4 The 2005 table is a preliminary table.

5 In a gravity model, bilateral trade is proportional to the size of the attractors – supply and demand – and inversely related to their economic distance (transaction and transportation costs). The influence of the ‘distance’ to other trade partners – or multilateral resistance – has been acknowledged in traditional trade analysis, but mainly as a statistical issue when estimating gravity model. Analysing complexinterdependence in trade relations is still in its infancy. For a review, see Abbate et al (2012) and Noguera (2012) for an application to the case of trade in value-added.

6 More formally, the total cost of delivering the product to the final consumer after (n) production stage is: $C(n) = \sum_{i=1}^{n} \frac{1}{n}(1+t)^i$ where $C(n)$: total cost of delivering the product as a proportion of the production cost, t : ad valorem transaction cost at each stage, N: number of stages in the supply chain.

7 Transaction costs – besides