THE AUSTRALIAN NATIONAL UNIVERSITY

Working Papers in Trade and Development

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July 2010
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Abstract

This paper examines the extent and pattern of global production sharing, focusing on East Asia, and probes its implications for the analysis of the determinants of trade flows. Reflecting rapid global spread of production sharing, trade in parts and components has increased at a much faster rate than total manufacturing trade in recent years and East Asia (both including and excluding Japan) is unique in the world for its heavy reliance on this new form of international exchange. The econometric analysis reveals that parts and components are highly insensitive to changes in relative prices and; as a result, the impact on aggregate trade flows of relative price changes diminishes as its share increases. This implies that exchange rate policy may be less effective in balance of payments adjustment, in countries where component trade is high and growing.

Keywords: Global production sharing; product fragmentation; determinants of trade flows; exchange rate policy.
JEL Codes: F10; F13; F23

Global Production Sharing, Trade Patterns and Determinants of Trade Flows

1. Introduction

Global production sharing—the breakup of a production process into vertically separated stages carried out in two or more countries—has become one of the defining characteristics of world trade over the past few decades.[1] It began in electronics and garments in the late 1960s but has spread to many other industries. As the scale of activities in a vertically integrated production process expands, so do the opportunities for reducing costs by locating parts of the production process in different countries. This has resulted in a steady rise in the trade in parts and components across national borders. And it has grown into a global phenomenon involving countries at varying stages of development. However, there is evidence that it is far more significant in East Asia and has played a critical role in the region's economic growth and structural transformation.

There are many theoretical studies examining the causes and modalities of global production sharing, and implications of the growing dichotomy between parts and components and final products for trade flow analysis and trade policy (Jones 2000; Jones and Kierzkowski 2001; Helpman 2006; Feenstra 2008). A number of recent studies also document the increasing importance of global production sharing and the prominent role played by China and other East Asian economies in promoting this type of exchange (Athukorala 2005 and 2009; Arndt 2008, Ng and Yeats 2001). However, applied trade economists have been rather slow to incorporate this new form of international specialization into trade flow analysis, which continues to rely upon the traditional notion that countries trade goods that are produced from start to finish in a single country (products that are "made" in a given country). Global trade flow modeling is still carried out using trade elasticities estimated at highly aggregated levels, grouping parts and components and final goods together as one within product categories.

The purpose of this paper is two-fold: (i) to examine the extent and emerging pattern of global production sharing, with an emphasis on the role played by East Asian economies; and (ii) to probe the implications of the dichotomy between trade in parts and

[1] This phenomenon has also been described as international production fragmentation, vertical specialization, slicing the value chain, and outsourcing.

components, and final goods, for analyzing determinants of trade flows. The analysis uses the most recent data from the United Nations (UN) trade database, based on Revision 3 of the Standard International Trade Classification (SITC Rev 3). For the purpose of this paper, East Asia is defined to include Japan, the newly industrialized economies (NIEs) of the Korea, Taiwan, Hong Kong, China, and the six largest economies of the Association of Southeast Asian Nations (ASEAN)—Indonesia, Malaysia, Philippines, Thailand, Singapore, and Viet Nam. Brunei Darussalam, Cambodia, Lao People's Democratic Republic (Lao PDR), and Myanmar have been excluded due to data limitations. The analysis is conducted in the wider global context, focusing on the region's performance relative to the North American Free Trade Area (NAFTA) and the European Union (EU).

This paper uses data extracted from the UN trade database based on Revision 3 of the SITC. In its original form (SITC Rev 1), the UN trade data reporting system did not provide for the separation of fragmentation-based trade (in components) from final manufactured goods. SITC Revision 2—introduced by the UN in the late 1970s and implemented by most countries in the early 1980s—adopted a more detailed commodity classification that allowed for the separation of components for machinery and transport (SITC 7). There was, however, considerable overlap between some advanced-stage component production and assembly, and assembly of final goods in SITC Revision 2 (Ng and Yeats 2001). SITC Revision 3, introduced in the mid-1980s, was a significant improvement. Apart from providing comprehensive coverage of components in SITC 7, it also separately reports components of some products belonging to SITC 8 (miscellaneous manufactures).

The list of parts and components was prepared by carefully linking the parts and accessories identified in the United Nations Statistical Division: Classification Registry with the 5-digit SITC products. The list contains a total of 225 5-digit products—168 products belonging to SITC 7 and 57 belonging to SITC 8.[2] The data are tabulated using importer rather than exporter records, because they are less susceptible to double-counting and erroneous identification of the source and destination in *entrepôt* trade.

[2] See Appendix Table A-1 in Athukorala and Menon (2010) for the complete list.

The analysis covers the period 1992–2006. The year 1992 was selected as the starting point because countries accounting for over 95% of total world manufacturing trade had adopted the revised data reporting system by this time. Meanwhile, 2006 was the most recent year for which data were available for all reporting countries. In terms of country coverage, the analysis covers East Asia as defined earlier. As Taiwan is not covered in the UN data system, trade data from the Council of Economic Planning and Development based in Taiwan is used. All data are in current USD terms.

The paper is organized as follows. Section 2 provides an overview of the process of international product fragmentation, followed by a survey of theories on how new forms of international specialization are determined, along with what this means for trade flow analysis. Section 3 considers data and measurement issues, and examines the extent and pattern of global production sharing. Section 4 presents the results of a trade flow modeling exercise illustrating the implications of this dichotomy. It also discusses the implications of these findings on reshaping standard trade flow analysis to capture the growing importance of global production sharing in world trade. The final section summarizes key findings and considers implications for policy and further research.

2. Global Production Sharing: An Overview

The Process

Production sharing and trade in parts and components[3] is not a new phenomenon. Pollard (1981) tells a fascinating story of how at the height of the Industrial Revolution British textile and clothing manufactures began to shift labor intensive segments of the production process to countries in continental Europe due to domestic labor shortages and mounting wage pressures. Young (1928) observes that "over a large part of the field of industry, an increasingly intricate nexus of specialized undertakings has inserted itself between the production of raw materials and the consumer of the final product." By the late 1950s, when national statistical agencies began reporting data disaggregated enough to allow for tentative estimations, machinery components accounted for nearly 15% of the manufacturing exports of mature industrial countries.[4]

[3] For simplicity, "components" is used henceforth to refer to "parts and components."
[4] Calculation based on the data appendix of Maizels (1963).

What is new about the contemporary process of global production sharing is its increasingly wide product coverage and its rapid spread from mature industrial countries to developing countries (for example, from the developed North to the developing South). With a modest start in electronics and garments in the late 1960s, the North–South exchange within international production networks gradually evolved and spread to industries such as sports footwear, automobiles, radio receivers, sewing machines, office equipment, electrical machinery, power and machine tools, cameras, and watches. Cost competitiveness and economies of scale achieved this way provided the setting for product innovation and a growth in world trade much faster than world production.[5]

In its infancy, North–South production sharing was predominantly a two-way exchange between the home and host countries; components were exported to the low-cost, host country for assembly and the assembled components were re-imported to the home country for final sale or further processing (as in the case of electronics). Over the years, production networks have evolved to encompass multiple countries in different stages of the assembly process. Today, product fragments will typically have gone through multiple border crossings before being incorporated into a final product.

Two recent developments set the stage for the rapid increase in fragmentation-based trade as a share of world trade. First, some fragments of the production process have become standard fragments which can be effectively used in a number of products. For instance, long-lasting cellular batteries, which were originally developed by computer manufacturers, are now widely used in mobile phones and electronic organizers; transmitters, designed originally for radios, are now used in personal computers and missiles; and the use of electronic chips has spread well beyond computers to consumer electronics and motor vehicles. Second, as international supply networks of components have become firmly established, producers in advanced countries have begun to move final assembly of an increasing range of consumer durables (such as computers, cameras, televisions, and automobiles) to overseas locations to be physically closer to final users and/or to take advantage of inexpensive labor.

[5] Mass production of products such as laptop computers, hand phones, and various entertainment devices (eg., music and DVD players) would not have been commercially viable without the cost reductions associated with global production sharing.

In the case of standard consumer goods such as garments and footwear, global production sharing normally takes place through arm's length relationships, with international buyers playing a key role in linking producers and sellers in developed countries. Global production sharing in electronics and other high-tech industries, on the other hand, evolved differently. Early on, the process essentially involved a multinational enterprise (MNE) establishing an overseas subsidiary to perform some functions it once did at home (Helleiner 1973; Gereffi *et al.* 2005). As production in host countries became more firmly established, production fragmentation eventually spread beyond the MNEs. Some subsidiaries began to subcontract activities to local firms, providing detailed specifications and even disclosing some of their own technologies. At the same time, many firms that were not part of MNE networks began to procure components globally through arm's length trade. These new developments suggest that an increase in fragmentation-based trade may or may not be accompanied by an increase in the host country's stock of foreign direct investment (FDI) (Brown *et al*., 2004). Nevertheless, the bulk of global production sharing within high-tech industries still takes place under the aegis of MNEs.

A major development in the institutional setting for global production sharing has been the emergence of independent contract manufacturers, which produce and assemble components for original manufacturing MNEs (Sturgeon 2003; Brown and Linden 2005). Many of the original MNEs in electronics and related industries increasingly rely on contract manufacturers to operate their global production networks, allowing them to focus on more skill-intensive competencies such as product design and marketing. Helped by some component standardization and by advances in modular technology, this process has become a major contributor to the rapid spread of global production sharing. It has also allowed the original MNEs to rely almost entirely on foreign sources of production, retaining only design and coordination functions at home.

Determinants

In a series of papers, Jones and Kierzkowski (1990; 2001) and Jones (2000) extended traditional (comparative-advantage-based) trade theory to account for global production sharing. Their framework identifies two mutually reinforcing developments that help explain production-sharing-based international exchange—comparative advantage and increasing returns. These, in turn, have been spurred by (i) rapid advancement in production technology, which has enabled the industry to slice the value chain into finer, portable components; (ii) technological innovation in communication and transportation, which has not only shrunk physical distance, but also allowed the establishment of services links that combine various fragments of the production process in a timely and cost-effective way; and (iii) policy reforms in both home and host countries, which have significantly reduced barriers to trade and investment.

The differences in factor proportions required for different parts of the production process permit global production sharing to lower marginal costs of production. However, the cross-border spread of production involves new fixed costs, including services links—arrangements for ensuring a smooth sequence in producing the final good. Innovations in communications technology and reductions in trade and investment barriers have eased linking the services required, thus substantially reducing the costs involved. Moreover, a more fragmented production process means that the fixed cost of services links gets spread over a larger output, enabling the firm to reap the benefits of lower average production costs based on international specialization.

Although the Jones–Kierzkowski framework represents a major improvement in our understanding of global production sharing, it is still based on the notion of trade between countries, with little scope for firms or other economic organizations to have any significant influence on trade patterns between countries. This contradicts empirical evidence showing that firms play a crucial role in determining how the value chain is sliced within vertically integrated global industries.

In recent years, there have been some attempts to fill this analytical vacuum by incorporating firm-specific considerations into general equilibrium models, with a focus on both trade that is internal to MNEs and trade that occurs between firms that have special arm's length relationships.[6] This fledgling literature attempts to explain a firm's decision to integrate globally in terms of the cost of market transactions under incomplete contracts. The decision to outsource production processes to another country—either by setting up an affiliated company or by establishing an arm's length relationship with a local firm—entails country risk. In many instances, it is impossible to fully offset these risks because complete contracts cannot be written. Under incomplete

[6] Spencer (2005) and Helpman (2006) provide a comprehensive survey of this literature.

contracts, the threat point (or outside option) indirectly determines the firm's optimal engagement in global production sharing.

Thus, in addition to relative cost considerations, various institutional factors that affect the threat point are relevant to the decision. Hidden transaction costs associated with inadequate institutions can constrain trade just as much as tariffs or high labor costs. These costs are presumably much more important in fragmentation-based international exchange than in the conventional trade in goods because a single weak link could disrupt the entire production chain. If the costs associated with these incomplete contracts are too great, then firms buying inputs will tend to choose vertical integration over arm's length relationships. This would favor the internalization of transactions as the cost of external transactions is too great. Thus, factors impacting incentives to operate affiliated firms in foreign countries, which generally go beyond factor price differences across countries, become relevant in explaining production-sharing-based trade patterns.

3. Trends and Patterns of Global Production Sharing

Table 1 depicts patterns of production sharing in world manufacturing trade, focusing on the share of components by major product categories and their contribution to export increments between 1992/93 and 2005/06.[7] World trade in components increased from about USD502 billion (18.9% of total exports) in 1992/93 to USD1,762 billion (22.3%) in 2005/06. Components accounted for nearly a quarter of the total increase in world manufacturing exports over this period.

There has been a palpable shift in global production sharing away from mature industrial economies toward developing countries (**Table 2**). Developing countries' share of total component exports increased from 27% in 1992/93 to 47% in 2005/06, driven primarily by the growing importance of East Asia in global production sharing. The share of East Asia (including Japan) in total world exports of components increased steadily from 27% in 1992/93 to 39% in 2005/06, despite a notable decline in Japan's share in recent years. The share of developing East Asia increased from 17.8% to 32.3% in the

[7] Throughout the paper, inter-temporal comparison calculations are made for the 2-year averages relating to the end points of the period under study so as to reduce the impact of year-to-year fluctuations in trade flows.

same period. In 2005/06, developing East Asia accounted for over two thirds of the total component trade of developing countries. Developing countries, led by developing East Asia, accounted for over 70% of the expansion in the global components trade during 199293–206/7. Neither the formation of NAFTA in 1991, which enticed US MNEs' to establish production bases in Mexico, nor the successive enlargement of the EU beginning in the late 1990s, which encompassed relatively low-wage countries in Eastern Europe, have diminished East Asia's dominance in global production networks. In sum, while the rapid growth of production sharing is a global phenomenon, East Asia is unique for its preeminent position in this relatively new form of international exchange

Several factors appear to be behind East Asia's continued attractiveness as a center of global production sharing. First, despite rapid economic growth, manufacturing wages in several of the region's economies remain significantly lower than those in Mexico and the European periphery (Athukorala and Menon 2010, Table 6). Perhaps more importantly, significant wage differences among economies in East Asia in fact encourage the rapid expansion of intra-regional product sharing systems, giving rise to increased cross-border trade in components.

Second, the relative factor cost advantage of these economies has been supplemented by more favorable trade and investment policies along with better ports and communication systems—which facilitate trade by reducing the cost of maintaining services links (Carruthers et al., 2003). Most of the region's economies, including China, rank favorably in the World Bank's global logistics performance index (Athukorala and Menon 2010, Table 7).

Third, as the early-birds of international specialization, Southeast Asia (in particular Malaysia, Singapore, and Thailand) seems to offer considerable agglomeration advantages for companies already located there. Site selection for MNE assembly operations are strongly influenced by the presence of other key market players in a given country or its neighbors. Having long enjoyed successful operations in the region, many MNEs (particularly US-owned MNEs) have significantly upgraded the technology employed by regional production networks and assigned greater global production responsibilities to local affiliates. This is especially true in Singapore and more recently Malaysia and Thailand (Borrus et al., 2000; McKendrick et al.; 2000). In sum, the Asian experience substantiates the view that, the longer they stay, MNE affiliates tend to become increasingly entrenched in their host countries—particularly as longer-term reforms better the overall investment climate (Rangan and Lawrence, 1999).

Finally, China's emergence as the premier low-cost assembly hub for a wide range of electrical and electronics products has boosted component production and assembly in other economies in the region. Here, China's role is particularly important due to its hinterland advantage—its vast supply of labor readily brought into production activities and its ability to meet changing international demand without causing large factor price disturbances (Jones 2000).

The share of components in trade for East Asia is much higher than for all other regions in the world[8] In 2005/06, components accounted for over 35.0% of total manufacturing trade in developing East Asia, compared with the world average of 22.2%. Within East Asia, ASEAN countries stand out for their heavy dependence on production fragmentation trade, which is a critical part of their export dynamism. In 2005/06, components accounted for 44% of total manufacturing exports in the ASEAN Free Trade Area (AFTA), up from 29% in 1992/93. The data for all economies and country groups show that parts and components account for a much larger share of exports and imports of information and communication technologies (ICT) products and electrical goods sub-categories compared with other product categories. Also, the import and export shares of components in these two commodity groups are strikingly similar, reflecting two-way trade occurring within production networks. These patterns are much more prominent in East Asian economies than in the rest of the world (ROW).

Components account for a relatively larger share of intra-regional exports and imports of East Asian economies compared with their trade with ROW (**Table 3**). For instance, in 2005/6, components' share of the total intra-regional manufacturing exports of developing East Asia amounted to 37% compared with 17.5% and 18.0% of manufacturing exports to NAFTA and the EU15, respectively. The component intensity of intra-ASEAN trade is even greater. In 2005/06, components accounted for nearly half

[8] See Table 3 in Athukorala and Menon (2010) for comparative statistics on the share of components in total manufacturing exports, imports, and total manufacturing trade (imports plus exports), disaggregated by major product categories.

of intra-ASEAN manufacturing exports compared with less than a third of ASEAN manufacturing exports to NAFTA and the EU-15. The data point to a clear dichotomy in the geographic profile of emerging trade patterns in East Asia; the expansion of final goods exports (total exports – components) of ASEAN countries depends more on extra-regional markets (particularly NAFTA and the EU), while there is a clear intra-regional bias in their trade in components.

Product Composition

Data on the composition of component exports are summarized by major country groups in Table 3. A striking feature of component trade in East Asia is its heavy concentration in electrical machinery, particularly semiconductors. In all countries and regions, component trade is heavily concentrated in the machinery and transport equipment sector, which accounts for over 90% of the combined component trade of SITC 7. Within SITC 7, East Asian component exports and imports are heavily concentrated in electronics and electrical industries. Semiconductors and other electronics components (SITC 77) alone accounted for 50% of component exports from East Asia in 2004/05.

The concentration of component trade in electronics is much larger in AFTA (over 60%) compared with the regional average. Electronics and electrical products are also major areas of activity in other countries and regions. But the trade patterns of these countries and regions are characterized by a significant presence of other items, especially automotive components (SITC 78) and other transport equipment (SITC 79). For instance, components of these two product categories accounted for a mere 4.7% of total component exports in developing East Asia in 2005/06 compared with more than one-third in NAFTA and the EU15. Moreover, unlike in NAFTA and the EU15, the share of automotive components in East Asian imports is much higher than exports. This asymmetry is an indication of automotive and transport equipment components' relatively low level of participation in network trade.

East Asia's involvement in global production networks clearly predates the emergence of China as a major player in this area. Nonetheless, China's rapid rise has undoubtedly added a new dimension to East Asia's position in global production sharing. Between 1992/93 and 2005/06, China's share of world exports and imports of components increased from 1.1% to 10.9% and from 2.4% to 11.5%, respectively (see

Table 2). Components also accounted for a much larger share of imports (60.4% in 2005/06) compared with exports (34.8%) in China compared to other East Asian countries (Table 3). In other East Asian countries, the percentage shares were broadly similar for both imports and exports, reflecting a predominant role in component production and assembly within regional production networks (Athukorala 2009).

4. Global Production Sharing and Determinants of Trade Flows

How does global production sharing affect the degree of sensitivity of trade flows to changes in international prices relative to domestic prices? Does it call for a re-think of the role of exchange rate policy (and other domestic policies that affect relative prices) in the balance of payments adjustment process? In recent literature, two competing views have emerged on this issue.

One view holds that global production sharing has increased the sensitivity of trade flows to relative price changes, thereby enhancing the efficacy of exchange rate policy (Obstfeld 2002). The increasing importance of global production sharing induces firms to respond swiftly to changes in relative prices (brought about by changes in exchange rates and tariffs) by switching between domestic and imported inputs, shifting tasks across borders, or changing procurement sources of final (assembled) products. Production networks not only open up greater opportunities for shifting production and procurement sources in line with price changes, but also act as swift and efficient purveyors of market information among participants.

The alternative view—which takes a broader perspective of the nature and modalities of international exchange based on global production sharing—holds that global production sharing could in fact weaken the link between international price changes and trade flows for several reasons (Arndt 2008, Jones and Kierzkowski 2001). First, setting up overseas production bases and establishing services links entail high fixed costs. Once incurred, relative price and cost changes become less important in business decision making. This may be particularly true in business dealings with production bases located in developing countries, because the initial wage gap is so large that other cost changes are unlikely to significantly alter relative profitabilities.

Second, activities within production networks are generally characterized by fixed-coefficient production techniques (Leontief technology) and, therefore, the substitutability of components obtained from various sources is rather limited, irrespective of price changes. Within global production networks, production units located in different countries normally specialize in specific tasks that are not easily substituted elsewhere (Jones 2000).

Third, global production sharing weakens the link between the domestic cost of production and export competitiveness. When a firm is engaged in a given segment (slice) of a vertically integrated production process, its export profitability depends not only on external demand and the domestic cost of production, but also on supply conditions in economies supplying components and their bilateral exchange rates. Consequently, the change in the price of imported inputs becomes an important determinant of export profitability, inversely related to the share of domestic content (value added plus domestically produced inputs) in exported goods.

Fourth (and related to the first), changes in exchange rates affect component imports and end-product exports differently. If exports are made with imported components, then currency depreciation (appreciation) increases (reduces) the domestic price of its exports. But it also reduces (increases) the domestic price of its component imports. This reduces (increases) the overall profitability of exports compared with products entirely based on locally-procured inputs. The relationship becomes more complicated when (i) components are procured from countries other than those for which the final products are destined, and (ii) the number of countries involved in the production chain increases (Arndt 2008). In some cases, exchange rate fluctuations have offsetting effects on imports and exports, with the net effect on exports consequently weaker than in cases where the entire product is produced in one country.

These competing views suggest that the impact of global production sharing on the price and income elasticities of world trade is very much an empirical issue. However, to date, it lacks sufficient empirical scrutiny despite its important implications for trade and macroeconomic policy in open economies. There are at least three relevant studies, however: Athukorala (2004), Jongwanich (2009), and Arndt and Huemer (2007). Athukorala (2004) examines determinants of manufacturing exports from Thailand at the one-digit SITC level for 1995–2003. The results suggest that the magnitude of price elasticity of exports of machinery and transport equipment (SITC 7), which is dominated by network trade, is rather small compared with that of the other three export categories. Jongwanich (2009) confirms this finding in a comparative analysis of the determinants of manufacturing exports from nine East Asian countries between 1993-2008. Arndt and Huemer (2007) assess the extent to which the sensitivity of US–Mexico bilateral manufacturing trade to the key explanatory variables in the standard trade equation (relative price and home and foreign income) is affected by production networks. Their econometric estimates based on 1989–2002 data show that exports of automotive components do not respond to relative price changes and are solely determined by income levels in the two countries.

This section seeks to add to this fledgling literature using a new data set for world manufactured exports. This data set allows the examination of the sensitivity of the standard import and export demand function to the presence of product fragmentation trade, with broader commodity and country coverage than so far attempted. The methodology involves comparing the results (i) when the standard model is estimated for total imports and exports of different product categories, among which the relative importance of production sharing varies; and (ii) when the same model is applied to components and final goods within a given product category. It is important to emphasize at the outset that the purpose here is to examine the implications of global production sharing for price elasticities of trade, estimated using the standard trade model, rather than to formulate a best-fit model for explaining trade flows in the presence of global production sharing.

World Export Demand

The starting point of the modeling exercise in this section is the standard export demand equation, which relates real exports to world income and the relative export price (world price as a ratio of domestic price). In estimating export demand using cross-country panel data, it is necessary to augment the original formulation by incorporating variables to capture inter-country heterogeneity. Thus, four control variables are added, guided by the standard practice in the recent literature on estimating cross-country trade equations.[9] These are the precipitate income of the exporting country (*PGDP*), an index of the quality of trade-related logistics (*LPI*), trade-weighted distance to major markets (*DST*), and a dummy variable that distinguishes land-locked countries from other countries (*LNDL*).

Among the control variables, *PGDP* is included to capture the impact of the initial level of economic advancement on export performance, operating through channels other than logistics quality. We can hypothesize that GDP per capita has a positive effect on export performance: as countries grow richer, the scale of industrial output becomes conducive to global production sharing. The quality of trade-related logistics has received increased emphasis in recent years as a key determinant of the trade performance of developing countries. In particular, a country with better infrastructure (for example, well-established broadband networking) is presumably a preferable location for global sourcing because of the lower cost of establishing service links.

Distance (*DST*) is a proxy for transport (shipping) costs and other costs associated with time lags,, and costs associated with physical distance, including ignorance of foreign customs and tastes. Distance can, in fact, be a more important influence on component trade compared with final trade because of multiple border-crossings involved in the value-adding chain. *LNDL* is included to capture possible disadvantages for a landlocked country (such as the lack of direct access to sea routes) that are not captured by the standard distance measure. Country group dummies for China, other developing East Asian economies, and other developing countries are also added, treating developed countries as the base dummy, to allow for possible deviation in the overall levels of exports from these country groups from that of developed countries after controlling for the other explanatory variables. Finally, the time-specific fixed effects (*T*) are included to control for general technological change and other time-varying factors.

[9] See Limao and Venables (2001), Soloaga and Winters (2001), and works cited therein.

The estimation equation is:

$$QX = \alpha \quad + \beta_1 RP \quad + \beta_2 YW \quad + \beta_3 PGDP \ + \beta_4 LP \quad + \beta_5 DIST \ + \ \beta_6 LNDL + \ \beta_7 DCH$$
$$+ \beta_8 DEA \quad + \beta_9 ODC \quad + \gamma T \ + \varepsilon_{ij}$$

where *QX* is the volume of the country's exports (export value deflated by world price). The explanatory variables are defined below, with the expected sign of the regression coefficient in parentheses.

RP	Relative price: world price (expressed in domestic currency), *PW* relative to domestic price, *PD* (+)
YW	world income (weighted average GNP of major importing countries) (+)
PGDP	Real GDP per capita (+)
LPI	an index of logistics performance (trade-related institutional setting and infrastructure) (+)
DST	Distance to major export markets (–)
LDL	A binary variable assuming the value 1 if *i* and *j* share a common land border and 0 otherwise (+)
DCH	Intercept dummy variable for China (+ or –)
DEA	Intercept dummy variable for developing East Asian economies (other than China) (+ or –)
DODC	Intercept dummy variable for other developing countries and Korea (+ or –)
T	A set of time dummy variables to capture year-specific fixed effects
α	Constant term
ε	Stochastic error term, representing omitted influences on bilateral trade

RP, *YW*, *PGDP,* and *DST* are measured in logarithms so that the respective regression coefficients can be interpreted as elasticities.

Data

Estimates were done using the export demand equation for total manufactured exports (SITC 5–8 less SITC 68) and two subcategories: machinery and transport equipment (SITC 7) and miscellaneous manufacturing (SITC 8), each of which was decomposed into components and final goods. The main data source is the UN Comtrade database.

For the purpose of the analysis, only countries with data on manufactured exports and components for at least 5 consecutive years up to 2005/2006 were included. There are 158 countries that met this criterion. The earliest starting year was set at 1992, which is when the SITC Rev 3 had been fully implemented by almost all countries under the coverage of the US trade data reporting system. Data on manufacturing exports were disaggregated into components and final goods following the procedures explained in Section 3. The US import price index (extracted from the US Trade Commission database) is used as the proxy for world price for all countries. For each country, the world price index is the weighted average of 3-digit US import price indexes computed using export shares of that country in 2000. The domestic price is measured by the domestic implicit GDP deflator. The data on PGDP and GDP deflators come from the World Bank's *World Development Indicators* database.

Data on *LPI* come from the newly-developed *Logistics Performance Index* database of the World Bank (Arvis et al., 2007), which provides the first in-depth, cross-country assessment of trade-related logistic provisions. It covers 150 economies, including 28 in developing Asia. It is based on a worldwide survey of global freight forwarders and express carriers, complemented by a number of qualitative and quantitative indicators of the domestic logistics environment, institutions, and performance of supply chains.

DST is the export-share weighted distance between a given country and its 10 major export destinations, as reflected in export data for 2000. The data on bilateral distance come from the trade patterns database of the French Institute for Research on the International Economy (CEPII). The CEPII distance measure is a composite measure of the bilateral great-circle distance between major cities of each economy compiled by taking into account the trading significance of each city in each economy. Export shares for 2000 are used in compiling the distance measure for each economy.

Results

The fixed-effects estimator is not appropriate because our model contains a number of time-invariant variables. Both pooled OLS and random-effects estimators were used, with the pooled OLS as the preferred estimator based on the Breusch–Pagan Lagrange multiplier test. The results are reported in **Table 4**. Regression estimates based on data for all countries (158) are reported in **Panel A**. Estimates undertaken separately for developed (22) and developing (136) economies are reported in **Panel B** and **Panel C**, with the latter estimates further distinguishing between developing Asian economies (9) and other developing countries (127) (**Panels C1 and C2**).

For all economies (**Table 4, Panel A**), the coefficient of the relative price variable is smaller in magnitude and not statistically different from zero in the equation for machinery and transport equipment exports. In the equation for total manufacturing and miscellaneous manufacturing, the coefficient is statistically significant with the expected (positive) sign, but smaller in magnitude compared with total imports. Reflecting the dampening effect of the share of components on the overall price responsiveness of total exports, the price elasticity of demand for total machinery and transport equipment exports is 0.16% compared with 0.19% for total manufacturing exports. The world income elasticity coefficient is statistically significant in all equations with the expected positive sign. However, for machinery and transport equipment, the magnitude of this coefficient is much smaller in the components equation (0.19) compared with that for total exports (0.52). For miscellaneous manufacturing and total manufacturing, the comparable estimates are 0.46 and 1.07, and 0.62 and 0.82, respectively.

All control variables included in the regression specification carry statistically significant coefficients with signs consistent with *a priori* expectations. The disaggregated estimates point to an interesting contrast between developed and developing economies, and within the latter group between developing East Asian and other developing economies in relation to the implications of global production sharing on the explanatory power of the standard export equation. Relative price and world income do a much better job of explaining both exports of components and final goods from developed countries. The coefficients of both variables are much larger in magnitude and highly significant in equations for both total exports and components of total manufacturing and the two sub-categories. Interestingly, in all three cases, the magnitude of the coefficient of the relative price variable is larger compared with that of total and final exports.

By contrast, the coefficient of the relative price variable is either statistically insignificant and/or significant with the perverse sign in equations for developing economies, in particular for developing East Asian economies. Non-price factors—exporters' per capita income, world income, and logistics performance—are the prime determinants of exports from these economies with respect to both components and final goods. The results for total manufacturing are strikingly similar to those for machinery and transport equipment. This is understandable given the dominant role played by machinery and transport equipment in the rapid export expansion of these economies during the period under study.

5. Conclusion and Policy Implications

Production sharing has been one of the defining characteristics of economic globalization over the past three decades. World trade in parts and components increased from about 18.9% to 22.3% of total exports between 1992/93 and 2005/06. While production sharing is now a global phenomenon, its share of total exports is disproportionately high in East Asia, having risen from 27% to 39% between 1992/93 and 2005/06. There was a notable decline in Japan's share towards the end of this period, but this was more than offset by the rising importance of China. It is also heavily concentrated in machinery and transport equipment (SITC 7). Within SITC 7, electronics and electrical industries, especially semiconductors, make up the bulk.

The rapid expansion of global production sharing poses a challenge to the standard approach to trade flow modeling, which still does not distinguish between components and final goods within a given product classification. Any analysis of trade patterns or its determinants that ignores this phenomenon, and the trade in parts and components that it generates, is likely to result in erroneous conclusions The findings of the econometric analysis suggest that components are highly insensitive to changes in relative prices. Consequently, the sensitivity of aggregate trade flows to relative price changes tends to diminish as trade cuts ever more rapidly into the production process. This seems to be a particularly important issue when it comes to modeling manufacturing trade flows in developing economies.

The finding that global production sharing may dampen the sensitivity of trade flows to changes in relative prices has important implications for the contemporary debate on the choice of exchange rate regime and the efficacy of exchange rate movements in balance of payments adjustments. For instance, a key concern underpinning the case against a more flexible exchange rate regime is the likely adverse effects of exchange rate volatility on trade expansion. The rapid expansion of global production sharing could diminish the importance of this criticism to the extent that network-related trade erodes the influence of changes in relative price on overall trade flows.

With regard to the role of the exchange rate in balance of payments adjustment, the finding has direct implications for the current policy concern about the role of China's exchange rate policy. It is alleged that China maintains an artificially undervalued currency in order to maintain or increase its trade surplus. But given China's pivotal role as the premier assembly hub within global production networks, the potency of exchange rate adjustment in determining the current account surplus could well be subdued.

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Table 1: Parts and Components (P&C) in World Manufacturing Trade, 1992/93 – 2005/06

Product groups (SITC code in brackets)	Composition: total trade (%)		Composition: P&C trade (%)		P&C share in total trade (%)		Contribution of P&C to growth of Mfg trade (%)
	1992/93	2005/06	1992/93	2005/06	1992/93	2005/06	
Chemicals (5)	12.33	15.15	n.a	n.a	n.a	n.a	n.a.
Resource based products (6 – 68)	18.90	16.18	n.a.	n.a.	n.a.	n.a.	n.a.
Textiles (65)	4.45	2.52	n.a.	n.a.	n.a.	n.a.	n.a.
Machinery and transport equipment (7)	49.32	52.38	95.26	95.70	36.5	40.7	42.7
Power generating machines (71)	3.20	3.22	11.32	9.73	66.9	67.3	67.5
Specialized industrial machine (72)	4.29	3.37	5.67	4.13	25.0	27.3	29.0
Metal working machine (73)	1.00	0.87	1.39	1.07	26.3	27.4	28.1
General industrial machinery (74)	5.24	5.08	4.74	4.12	17.1	18.1	18.6
ICT products (75+76+772+776)	16.07	21.19	42.92	52.68	50.5	55.5	57.1
Office machines and automatic data processing machines (75)	6.43	6.70	10.85	11.55	31.9	38.4	41.5
Telecommunication and sound recording equipment (76)	4.69	6.74	7.25	8.27	29.3	27.3	26.7
Semiconductors and semiconductor devices (772+776)	4.96	7.74	24.82	32.87	94.8	94.7	94.7
Electrical machinery (77 – 772 – 776)	9.32	12.53	7.68	6.58	15.6	11.7	10.4
Road vehicles (78)	12.18	11.61	16.83	14.43	26.1	27.7	28.6
Other transport equipment (79)	2.97	2.26	4.71	2.96	30.1	29.3	28.6
Miscellaneous manufacturing (SITC 8)	19.45	16.29	4.74	4.30	4.6	5.9	6.7
Fabricated building fixtures and machines (81)	0.52	0.50	0.55	0.36	19.9	15.7	13.5
Furniture and parts thereof (SITC 82)	1.27	1.41	0.86	1.22	12.7	19.2	22.0
Apparel and clothing accessories (84)	5.39	3.76	0.02	0.01	0.1	0.0	0.0
Professional and scientific equipment (87)	2.25	3.10	1.57	1.78	13.2	12.8	12.7
Photographic apparatus (88)	1.85	1.13	1.43	0.83	14.6	16.5	18.8
Total manufacturing trade	100.00	100.00	100.00	100.00	18.9	22.3	24.0
USD billion	2,650.5	7,901.7	501.6	1,762.0			

Note: The UN trade data reporting system does not provide for the separation of parts and components from total (reported) trade in these product groups. However, according to evidence from case studies, production sharing practices are not still widespread in these industries.
Source: Compiled from UN Comtrade database (importer records).

Table 2: Geographic Profile of World Trade in Parts and Components, 1992/93 and 2005/06

	Exports		Imports		Trade (exports + imports)	
	1992/93	2005/06	1992/93	2005/06	1992/93	2005/06
East Asia	30.1	40.6	24.4	38.1	27.3	39.4
Japan	15.7	10.0	3.3	4.0	9.5	7.0
Developing East Asia	14.4	30.6	21.1	34.1	17.8	32.3
ASEAN + 3	26.4	25.6	18.1	29.4	22.2	27.5
Korea	2.3	4.9	2.7	2.7	2.5	3.8
China	1.1	10.9	2.4	11.5	1.8	11.2
ASEAN 10	6.1	10.7	9.6	11.1	7.8	10.9
Indonesia	0.1	0.5	0.9	0.3	0.5	0.4
Malaysia	2.1	3.8	2.6	2.8	2.3	3.3
Philippines	0.6	2.1	0.5	1.4	0.5	1.8
Singapore	2.5	2.7	4.0	4.9	3.3	3.8
Thailand	0.8	1.4	1.6	1.4	1.2	1.4
Viet Nam	0.0	0.1	0.0	0.2	0.0	0.1
Other ASEAN	0.0	0.0	0.1	0.0	0.0	0.0
Taiwan	3.3	3.3	2.8	2.6	3.1	3.0
Hong Kong	1.7	0.8	3.6	6.1	2.6	3.4
South Asia	0.1	0.3	0.6	0.7	0.4	0.5
India	0.1	0.3	0.4	0.6	0.2	0.5
Oceania	0.3	0.2	1.3	0.8	0.8	0.5
NAFTA	24.8	17.6	26.9	20.4	25.8	19.0
Mexico	2.4	2.7	1.9	3.4	2.1	3.1
EU15	36.0	27.7	38.3	28.7	37.2	28.2
Developed countries	76.2	53.9	69.7	51.6	72.9	52.7
Developing economies	23.8	46.1	30.3	48.4	27.1	47.3
World	100	100	100	100	100	100
	502	1762	502	1762		

Source: Compiled from UN Comtrade database (importer records).

Table 3: Parts and Components share in bilateral trade flows, 2005/06

Reporting country/region	EA	JAP	DEA	ASEAN3	CHN	ASEAN	SAS	OCE	NAFTA	EU-15	World
(a) Export											
East Asia (EA)	37.0	25.8	38.8	32.0	39.9	43.8	14.9	10.0	20.0	19.6	26.8
Japan (JAP)	35.8		35.8	33.2	35.1	42.5	14.6	10.1	27.3	25.0	29.7
Developing East Asia (DEA)	37.4	25.8	40.1	31.6	42.1	44.3	15.0	10.0	17.5	18.0	25.9
ASEAN +3	36.8	24.5	38.8	31.5	41.6	43.7	15.6	9.5	19.9	19.2	26.4
People's Rep. of China （PRC)	27.2	16.9	30.6	28.7	48.3	35.0	12.7	6.3	11.9	11.5	17.5
Korea	40.8	39.8	40.9	34.3	36.4	41.6	15.3	7.6	24.0	18.5	29.1
ASEAN	49.7	34.7	52.6	31.1	53.5	49.7	20.1	14.4	27.4	29.5	38.1
Indonesia (IND)	28.7	17.1	32.2	5.2	18.8	40.9	7.3	6.0	9.3	8.9	18.6
Malaysia (MAL)	57.6	36.5	60.5	32.4	69.7	55.9	21.8	18.3	35.2	47.6	46.8
Philippines (PHL)	73.4	56.7	77.3	53.2	75.5	80.4	53.6	30.3	45.8	56.3	64.0
Singapore (SNG)	49.5	44.2	49.9	45.4	41.2	40.9	22.0	18.7	33.8	33.8	40.9
Thailand (THL)	35.2	28.8	37.1	17.1	35.5	40.3	17.0	9.0	17.2	15.9	25.5
Viet Nam (VTN)	22.1	24.1	19.8	2.7	8.9	28.3	14.7	6.7	1.4	1.1	7.1
Hong Kong (HK)	40.5	26.7	41.2	22.8	35.9	42.4	7.7	17.1	8.4	17.7	25.2
Taiwan (TWN)	38.7	41.6	38.4	35.9	28.9	45.6	17.2	17.6	25.7	29.0	33.0
South Asia (SAS)	5.6	9.2	5.2	2.7	5.4	8.6	3.6	5.1	3.9	4.8	4.7
Oceania (OEC)	17.1	7.5	18.8	9.4	10.4	23.0	15.9	8.5	17.3	17.9	14.8
NAFTA	39.7	30.8	42.5	17.6	28.5	64.1	17.2	19.9	25.6	26.9	27.6
EU-15	24.0	13.9	26.9	14.6	24.4	38.3	12.0	11.5	17.1	17.2	17.5
World	35.0	24.2	37.1	27.0	35.7	43.8	12.3	12.0	20.7	18.5	22.0

Table 3 continued

(b) Imports Reporting country/region	EA	JAP	DEA	ASEAN3	CHN	ASEAN	SAS	OCE	NAFTA	EU-15	World
East Asia (EA)	37.9	33.9	39.1	36.1	24.2	49.0	5.3	17.2	38.1	25.7	34.9
Japan (JAP)	27.4		27.4	26.5	17.3	39.1	7.1	10.7	26.9	15.8	23.5
Developing East Asia (DEA)	39.6	33.9	41.5	37.8	26.6	51.1	5.1	18.3	41.7	28.5	37.1
ASEAN +3	38.3	34.2	39.4	36.2	21.9	46.6	7.2	18.7	38.5	26.2	35.4
People's Republic of China (PRC)	42.2	33.8	44.7	39.1		47.1	5.5	15.1	30.7	28.0	39.3
Korea	36.8	42.0	35.9	35.7	25.9	61.6	1.2	10.8	42.3	24.8	33.5
ASEAN	33.0	26.1	38.7	29.8	21.6	56.4	7.2	37.3	38.2	23.3	30.8
Indonesia (IND)	37.0	26.8	47.1	36.8	32.8	55.4		9.9	31.6	21.9	33.8
Malaysia (MAL)	41.7	39.6	42.4	41.4	29.2	48.2	7.9	17.6	54.9	35.3	40.8
Philippines (PHL)	33.9	36.8	33.1	34.8	18.7	40.1	7.7	17.7	23.3	21.4	31.7
Singapore (SNG)	48.9	42.2	50.4	49.6	38.9	56.6	14.7	16.4	69.6	51.1	51.5
Thailand (THL)	47.6	51.8	45.8	46.1	33.2	45.1	4.5	5.5	77.2	46.5	50.2
Viet Nam (VTN)	48.9	40.0	51.3	47.5	36.5	54.8	6.9	25.8	46.8	36.3	43.6
Hong Kong (HK)	37.1	37.2	37.1	37.8	23.5	46.9	7.5	15.5	49.4	21.8	35.3
Taiwan (TWN)	15.5	20.5	14.3	15.7	11.4	20.0	3.9	8.9	12.8	19.7	15.1
South Asia (SAS)	18.2	25.9	16.9	19.0	10.1	26.2	5.0	19.7	19.4	16.4	15.8
Oceania (OCE)	12.1	9.3	13.3	11.9	5.1	22.9	5.2	11.4	25.3	13.5	14.4
NAFTA	20.8	27.6	18.3	21.7	11.8	30.5	4.2	23.2	26.8	19.6	22.0
EU-15	36.5	45.4	32.0	37.2	21.5	38.0	11.1	15.9	34.8	23.5	32.4
World	20.9	27.0	19.1	21.1	11.8	33.1	5.3	19.8	27.3	16.6	18.1

Source: Compiled from UN Comtrade database (importer records).

Table 4: World Demand for Manufacturing Exports
(Pooled OLS estimates)[1]

	Total	Parts and components	Final
(A) All countries (number: 158)			
(1) Total manufactured exports (SITC 5 to 8 – SITC 68)			
Relative price (RP)	+ 0.19 (10.26)***	+0.16 (5.59)***	+0.18 (8.56)***
World income	+0.82 (15.55)***	+0.62 (11.87)***	+0.82 (15.47)***
Per capita GNP of exporting country	+0.23 (4.66)***	+0.56 (9.90)***	+0.21 (4.20)***
Logistic performance index of exporting country	+2.27 (16.71)***	+2.80 (17.24)***	+2.29 (15.88)***
Land-locked dummy	–0.65 (6.65)***	–0.24 (1.97)*	–0.73 (6.99)***
Distance to export markets	–0.79 (13.77)***	–0.82 (12.12)***	–0.79 (13.97)***
China dummy	+1.61 (4.41)***	+2.25 (4.92)***	+1.57 (4.01)***
DEA dummy	+1.28 (10.77)***	+2.79 (14.37)***	+1.25 (9.32)***
ODC dummy	–0.26 (1.76)*	–0.17 (0.87)	–0.27 (1.82)*
Constant term	–9.58 (7.02)***	–9.28 (6.13)****	–9.73 (6.48)***
Number of observation	1679	1679	1675
Number of countries	153	153	153
R-sq	0.76	0.80	0.75
F	283.14	372.84	276.47
Root MSE	1.48	1.69	1.49
(2) Machinery and transport equipment (SITC 7)			
Relative price (RP)	+ 0.16 (5.77)***	+0.08 (1.18)	+0.18 (6.65)***
World income	+0.52 (10.02)***	+0.19 (2.48)**	+0.51 (8.57)***
Per capita GNP of exporting country	+0.36 (6.17)***	+0.65 (8.77)***	+0.35 (5.79)***
Logistics performance index of exporting country	+3.07 (20.36)***	+2.00 (7.47)***	+3.09 (19.63)***
Land-locked dummy	–0.43 (3.95)***	–0.52 (3.34)***	–0.45 (3.80)***
Distance to export markets	–0.79 (12.14)***	–0.31 (2.66)**	–0.80 (11.61)***
China dummy	+1.82 (3.95)***	+2.66 (5.67)***	+1.61 (3.21)***
DEA dummy	+2.24 (12.14)***	+0.92 (2.45)***	+2.19 (11.01)***
ODC dummy	–0.23 (1.30)	–0.92 (2.91)***	–0.28 (1.53)*
Constant term	–5.70	+1.52	–5.65

	(3.98)***	(0.60)	(3.53)***
Number of observation	1679	1656	1614
R-sq	0.79	0.54	0.78
F	373.73	91.67	356.42
Root MSE	1.62	2.63	1.68
(2) Miscellaneous manufactured goods (SITC 8)			
Relative price (RP)	+ 0.19 (5.78)***	+0.16 (4.59)	+0.20 (3.60)***
World income	+1.07 (15.10)***	+0.46 (6.82)**	+1.26 (14.98)***
Per capita GNP of exporting country	+0.42 (6.20)***	+0.64 (8.98)***	+0.34 (3.56)***
Logistics performance index of exporting country	+1.84 (9.53)***	+2.22 (10.76)***	+1.33 (4.79)***
Land-locked dummy	–0.63 (4.86)***	–0.88 (5.75)***	–0.56 (3.14)**
Distance to export markets	–1.15 (16.12)***	–0.86 (11.24)***	–1.60 (18.48)***
China dummy	+3.05 (7.60)***	+2.84 (6.24)***	+4.18 (12.40)***
DEA dummy	+2.10 (11.94)***	+2.22 (10.58)***	+2.80 (12.51)***
ODC dummy	+0.07 (0.41)	–0.37 (1.61)*	+0.34 (1.56)*
Constant term	–14.72 (7.87)***	–5.11 (2.65)***	–16.18 (6.89)***
Number of observation	1650	1609	1641
R-sq	0.7o	0.73	0.55
F	190.10	259.47	94.00
Root MSE	1.81	1.94	2.37
B. Developed countries (Number 22)			
(1) Total manufactured exports (SITC 5 to 8 – SITC 68)			
Relative price (RP)	+ 0.28 (12.70)***	+0.35 (13.82)***	+0.27 (12.48)***
World income	+0.40 (2.15)**	+0.43 (1.76)*	+0.41 (2.15)**
Per capita GNP of exporting country	+1.47 (4.16)***	+2.02 (4.90)***	+1.35 (3.96)***
Logistics performance index of exporting country	+1.81 (5.27)***	+2.20 (5.70)***	+1.75 (5.25)***
Land-locked dummy	–3.06 (5.44)***	–3.76 (6.05)*	–2.94 (5.39)***
Distance to export markets	–0.18 (0.86)	–0.12 (0.51)	–0.21 (1.08)
Constant term	–4.94 (1.07)	–12.07 (2.15)**	–4.45 (1.02)
Number of observation	280	280	280
R-sq	0.47	0.51	0.46

F	66.10	85.94	63.96
Root MSE	1.10	1.32	1.06
(2) Machinery and transport equipment (SITC 7)			
Relative price (RP)	+ 0.34 (6.08)***	+0.43 (6.29)***	+0.33 (12.39)***
World income	+0.49 (2.06)***	+1.07 (3.20)**	+0.45 (2.11)**
Per capita GNP of exporting country	+1.98 (5.34)***	+6.78 (5.83)***	+1.73 (4.88)***
Logistics performance index of exporting country	+2.35 (6.08)***	–4.01 (2.94)**	+2.64 (7.87)***
Land-locked dummy	–3.64 (6.13)***	–8.93 (4.32)***	–3.65 (6.50)***
Distance to export markets	–0.19 (0.88)	–0.60 (1.09)	–0.30 (1.45)
Constant term	–13.93 (2.16)**	–17.67 (1.78)*	–10.24 (2.01)**
Number of observation	280	267	278
R-sq	0.51	0.35	0.55
F	40.01	30.89	35.87
Root MSE	1.30	2.65	1.18
(2) Miscellaneous manufactured goods (SITC 8)			
Relative price (RP)	+ 0.29 (10.85)***	+0.31 (13.32)***	+0.21 (5.04)***
World income	+0.21 (1.15)	+0.31 (1.35)*	+0.02 (0.12)
Per capita GNP of exporting country	+1.29 (3.74)***	+2.27 (5.95)***	+0.64 (1.60)*
Logistics performance index of exporting country	+1.25 (3.31)***	+1.39 (3.64)***	+0.48 (1.11)
Land-locked dummy	–3.37 (5.50)***	–4.30 (7.46)***	
Distance to export markets	–0.15 (0.69)	–0.12 (0.52)	–0.12 (0.62)
Constant term	–0.88 (0.09)	–9.02 (1.70)**	–12.20 (2.69)**
Number of observation	280	280	280
R-sq	0.36	0.46	0.13
F	77.16	29.91	3.70
Root MSE	1.19	1.32	1.35
C. Developing economies (136)			
(1) Total manufactured exports (SITC 5 to 8 – SITC 68)			
Relative price (RP)	+ 0.06 (0.98)	–0.22 (2.69)**	+0.07 (1.22)
World income	+0.84 (15.32)**	+0.67 (12.11)***	+0.84 (15.18)***
Per capita GNP of exporting country	+0.22 (4.24)***	+0.57 (9.68)***	+0.24 (4.50)***

Logistic performance index of exporting country	+2.29 (14.38)***	+2.70 (15.22)***	+2.26 (14.05)***
Land-locked dummy	–0.59 (5.79)***	–0.11 (0.95)	–0.66 (6.36)***
Distance to export markets	–0.90 (15.20)***	–0.96 (14.38)***	–0.89 (15.12)***
China dummy	+1.97 (4.92)***	+2.60 (5.50)***	+1.92 (4.74)***
DEA dummy	+1.82 (12.45)***	+3.10 (14.97)***	+1.59 (4.74)***
Constant term	–9.53 (6.56)***	–7.21 (4.82)***	–9.47 (6.45)***
Number of observation	1399	1399	1395
R-sq	0.68	0.74	0.66
F	172.89	376.63	157.65
Root MSE	1.52	1.71	1.55
(2) Machinery and transport equipment (SITC 7)			
Relative price (RP)	–0.19 (2.70)**	–0.61 (4.98)**	–0.44 (3.52)***
World income	+0.55 (10.21)***	+0.22 (2.98)**	+0.52 (8.58)***
Per capita GNP of exporting country	+0.36 (5.98)***	+0.53 (7.32)***	+0.38 (5.87)***
Logistics performance index of exporting country	+3.01 (18.20)***	+2.18 (7.87)***	+2.94 (16.87)***
Land-locked dummy	–0.34 (3.22)***	–0.47 (3.09)***	–0.36 (3.15)***
Distance to export markets	–0.94 (14.43)***	–0.46 (4.31)	–0.92 (13.10)
China dummy	+0.93 (4.68)***	+3.54 (6.96)***	+2.11 (4.07)***
DEA dummy	+2.59 (13.39)***	+1.80 (4.74)***	+2.62 (12.28)***
Constant term	–3.75 (2.65)**	–3.72 (1.61)*	–2.07 (1.20)
Number of observation	1399	1389	1336
R-sq	0.72	0.45	0.69
F	280.80	57.69	174.89
Root MSE	1.65	2.50	1.73
(2) Miscellaneous manufactured goods (SITC 8)			
Relative price (RP)	+ 0.04 (0.51)	–0.04 (0.28)	+0.08 (0.60)
World income	+1.13 (15.28)***	+0.50 (6.99)***	+1.32 (14.63)
Per capita GNP of exporting country	+0.39 (5.46)***	+0.70 (9.83)***	+0.26 (2.59)**
Logistics performance index of exporting country	+1.84 (8.57)***	+2.17 (9.37)***	+1.66 (5.45)
Land-locked dummy	–0.52	–0.75	–0.53

	(4.03)***	(4.98)***	(3.02)**
Distance to export markets	–1.32 (17.79)***	–1.05 (13.54)***	–1.78 (18.55)***
China dummy	+3.21 (7.61)***	+3.36 (6.87)***	+3.60 (9.05)***
DEA dummy	+2.25 (11.87)***	+2.72 (12.42)***	2.29 (9.31)***
Constant term	–14.25 (7.38)	–3.79 (2.13)**	–16.41 (2.50)**
Number of observation	1370	1329	1361
R-sq	0.64	0.64	0.53
F	121.50	146.60	79.49
Root MSE	1.88	2.01	2.25
C1: Developing East Asia (DEA) (Number 9)			
(1) Total manufactured exports (SITC 5 to 8 – SITC 68)			
Relative price (RP)	–2.25 (5.21)***	–3.82 (4.68)***	–1.97 (3.53)***
World income	+2.25 (6.43)***	+4.07 (9.51)***	+2.42 (6.85)***
Per capita GNP of exporting country	+0.36 (2.69)**	+1.03 (5.91)***	–0.09 (0.61)
Logistics performance index of exporting country	+0.43 (1.17)	–0.86 (2.03)**	–1.58 (3.99)***
Distance to export markets	–0.20 (0.72)	+1.55 (3.69)***	–0.99 (3.24)**
China dummy	+2.51 (11.84)***	+2.94 (10.83)***	+2.03 (9.29)***
Constant term	–38.01 (3.09)*	–100.23 (6.54)***	–40.33 (3.14)***
Number of observation	125	125	125
R-sq	0.82	0.88	0.89
F	88.41	38.81	77.82
Root MSE	0.43	0.70	0.42
(2) Machinery and transport equipment (SITC 7)			
Relative price (RP)	–3.00 (4.95)***	–3.82 (4.68)***	–2.42 (3.42)***
World income	+4.47 (9.86)***	+5.32 (5.68)**	+5.61 (11.34)***
Per capita GNP of exporting country	+0.80 (4.80)***	–2.34 (6.32)***	+0.71 (3.48)***
Logistics performance index of exporting country	+0.05 (0.11)	+10.20 (9.58)***	–0.08 (0.16)
Distance to export markets	+0.97 (2.62)**	+9.71 (14.68)***	+0.07 (0.08)***
China dummy	+2.93 (11.30)***	+ 2.46 (4.32)***	+2.68 (9.03)***
Constant term	–109.48 (16.48)***	–241.75 (8.12)	–137.61 (8.17)***

Number of observation	143	125	125
R-sq	0.73	0.91	0.85
F	57.67	73.57	72.22
Root MSE	0.73	1.01	0.76
(3) Miscellaneous manufactured goods (SITC 8)			
Relative price (RP)	–2.18 (4.37)***	–2.95 (4.31)	–1.45 (2.54)**
World income	+ 0.30 (0.68)	+3.20 (5.92)***	+ 0.01 (0.01)
Per capita GNP of exporting country	+0.48 (2.88)**	+0.58 (2.85)**	+0.84 (3.49)***
Logistics performance index of exporting country	–0.57 (1.21)	+0.39 (0.69)	–2.26 (3.32)***
Distance to export markets	–0.25 (0.76)	+1.25 (3.81)***	–0.02 (0.04)
China dummy	+3.39 (13.28)***	+3.25 (10.05)***	+3.82 (10.74)***
Constant term	+20.67 (1.36)	–80.76 (4.45)***	+28.14 (1.43)
Number of observation	143	143	143
R-sq	0.85	0.92	0.67
F	101.27	72.65	76.03
Root MSE	0.50	0.54	0.78
C1: Other developing countries (Number 127)			
(1) Total manufactured exports (SITC 5 to 8 – SITC 68)			
Relative price (RP)	+ 0.05 (0.89)	–0.21 (2.67)**	+0.07 (1.19)
World income	+0.79 (14.54)***	+0.59 (10.95)***	+0.78 (14.40)***
Per capita GNP of exporting country	+0.30 (5.46)***	+0.65 (10.70)***	+0.28 (5.10)***
Logistics performance index of exporting country	+2.47 (15.07)***	+2.98 (16.88)***	+2.42 (14.61)***
Land-locked dummy	–0.50 (5.08)***	–0.02 (0.17)*	–0.58 (5.62)***
Distance to export markets	–0.81 (13.56)***	–0.87 (12.83)***	–0.80 (13.47)***
Constant term	–9.10 (6.30)***	–6.71 (4.54)***	–9.01 (6.18)***
Number of observation	1274	1274	1270
R-sq	0.60	0.66	0.58
F	94.07	131.98	90.53
Root MSE	1.55	1.70	1.57
(2) Machinery and transport equipment (SITC 7)			
Relative price (RP)	–0.17 (2.64)**	–0.63 (5.05)***	–0.44 (3.47)***
World income	+0.48	+0.19	+0.44

	(9.08)***	(2.44)**	(7.42)***
Per capita GNP of exporting country	+0.43 (6.82)***	+0.70 (9.37)***	+0.46 (6.67)***
Logistics performance index of exporting country	+3.26 (19.80)***	+2.00 (6.73)***	+3.26 (19.07)***
Land-locked dummy	–0.25 (2.41)***	–0.36 (2.40)**	–0.28 (2.41)**
Distance to export markets	–0.85 (13.66)***	–0.43 (3.99)***	–0.80 (11.16)***
Constant term	–3.27 (3.17)***	+0.66 (2.86)*	–1.56 (0.92)
Number of observation	1274	1264	1211
R-sq	0.63	0.36	0.61
F	136.11	39.64	543.35
Root MSE	1.63	2.50	1.72
(2) Miscellaneous manufactured goods (SITC 8)			
Relative price (RP)	+ 0.04 (0.43)	–0.04 (0.33)	+0.07 (0.51)
World income	+1.06 (14.33)***	+0.42 (5.91)**	+1.24 (13.81)***
Per capita GNP of exporting country	+0.46 (5.78)***	+0.75 (9.40)***	+0.37 (3.61)***
Logistics performance index of exporting country	+2.04 (9.33)***	+2.44 (10.17)***	+1.97 (6.35)***
Land-locked dummy	–0.40 (3.16)***	–0.61 (4.11)***	–0.40 (2.26)**
Distance to export markets	–1.20 (15.75)***	–0.94 (11.66)***	–1.65 (16.79)***
Constant term	–13.17 (7.11)***	–3.23 (1.57)*	–16.19 (6.46)***
Number of observation	1245	1204	1236
R-sq	0.57	0.55	0.46
F	86.84	86.05	59.04
Root MSE	1.92	2.05	2.57

1. T-ratios of regression coefficients (based on robust standard errors) are given in brackets with the level of statistical significance denoted as follows: *** 1%, ** 5%, and * 10%.

Source: Authors' calculation.

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