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Southeast Asia's International Production Networks: Implications for Macroeconomic Stability

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Abstract

Using the case of five Southeast Asian countries - Indonesia, Malaysia, Thailand, Singapore, and the Philippines - this paper examines the relationship between participation in international production networks and the volatility of export values in small, open developing economies. The region's growth has been driven by the electronics and automotive industries over the past two decades, industries that rely on a system of intra-regional intermediate goods trade. While these countries diversified out of the agricultural industries in part to reduce volatility, there is evidence that they face new volatility risks in the new industries, as a result of dependence on the performance of other links in the supply chain.

The study provides an investigation of the question: How has dependence on the electronics and automotive industries impacted the stability of the Southeast Asian economies? My hypothesis holds that the new industries are inherently less volatile than the old industries. However, because the countries inserted themselves into these industries through the supply chain system, they became subject to new sources of volatility.

The first part of the study provides a comprehensive overview of the region's structural shift over time, with regard to both supply chain participation and volatility patterns. In the second part of the study, I create an econometric model using data from the United Nations Commodity Trade database. Concentration in the new industries is represented by machinery and transport exports, which I expect to have a negative correlation with volatility. Supply chain participation is measured by the share of parts

and components exports in the new industries, which I expect to show a positive correlation with volatility. I run time series regressions for each of the individual countries, and then pool the countries together for a panel data regression. My results indicate that within each country, volatility is not associated with concentration in new industries or participation in production networks. When all countries are pooled together, supply chain participation is significantly negatively correlated with volatility. My conclusions contradict my hypothesis. For individual countries, supply chains have not been de-stabilizing, while region-wide supply chains have helped to stabilize the region.

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Chapter 1. Introduction

Supply chains, or international production networks, have grown to play an increasingly important role in the global economy. Suppliers in leading industries, notably the electronics and automotive industries, have fragmented their production facilities across multiple countries, resulting in a system of vertical supply chains. As globalization advances and supply chains become more prominent in the international economy, a new look at the opportunities and dangers of this form of organization is essential. Its macroeconomic implications have not been sufficiently analyzed, especially in the case of small open developing economies.

Participation in a vertical chain could lead to a change in volatility patterns. Research has shown that industry performance may demonstrate more stability when multinational corporations (MNCs) have multiple locations of production. However, the system also creates the possibility of greater risk, as the impact of trade shocks in one country could be transmitted across the entire chain. It is not clear to what degree industry and national interests coincide. In Southeast Asia, for instance, the supply chain system has catalyzed booming growth in specific industries. The strong, intra-regional trade networks have encouraged heavy specialization in these industries, which has made the region vulnerable to instability, as shocks such as natural disasters in one country have crippled trade throughout the region.

My objective in this study is to consider the implications of the supply chain system for individual economies, which I expect to experience greater volatility as a growing proportion of their national production and export performance relies on the

performance of the other countries in the chain. This study focuses on the five most industrialized Southeast Asian economies: Singapore, Thailand, Malaysia, the Philippines, and Indonesia. These countries have a long history of export-oriented development, depending originally on primary product exports. In the past three decades or so, they have chosen to diversify into new industries as a development strategy, partially in an attempt to reduce volatility. The strongest two new industries that emerged were electronics and automobiles.

Thailand is becoming a leading player in the global auto market, as well as a major hard drives exporter. Malaysia, Singapore, and the Philippines are all major exporters of semi-conductor devices, consumer electronics, and telecommunication products. Indonesia is home to one of Asia's most rapidly growing auto markets, though the market is primarily domestic as Indonesia is overall less export-oriented than the other Southeast Asian countries.

Worldwide, these industries are recognized in the literature as the most dependent on supply chains. The shift into them has therefore occurred simultaneously, with a dramatic rise in intra-regional intermediate goods trade.

Southeast Asia presents an ideal case study for the analysis of macroeconomic implications of international production networks. The region has become one of the biggest global production hubs for electronics and auto production, and has achieved this through a highly integrated network of intra-regional supply chains. While the developing Southeast Asian countries have long been studied with regard to their export-oriented industrialization, the intra-regional supply chain system receives less attention. We don't have a definitive answer to the question: How has dependence on

the electronics and auto industries impacted the stability of the Southeast Asian economies? My hypothesis is that the new industries themselves are less volatile than the old ones, as industry risks are lower in manufacturing than in agriculture. However, because the countries inserted themselves into these industries through the supply chain system, they became subject to new sources of volatility.

Chapters 2 and 3 incorporate an extensive literature review as well as data analysis. Chapter 2 provides an overview of the region's structural shift into new industries and the intra-regional international production network. Chapter 3 discusses changes in the region's volatility patterns before and after the structural shift, and in response to various types of trade shocks. In Chapter 4, I investigate the relationship between integration in the supply chain and the volatility of export values with an econometric analysis using data mainly from the United Nations Commodity Trade database (Comtrade). I design an econometric model that distinguishes between two competing factors on export volatility, concentration in the electronics and automotive industries, and participation in the supply chain within these industries. Interpretations of my results and conclusions are discussed in Chapter 5.

Chapter 2. Southeast Asia's Structural Shift

In the first section of this chapter, I describe Southeast Asia's current trade dynamic with regard to concentration in the electronics and automotive industries and participation in an intra-regional production network. In the second section, I explore Southeast Asia's structural shift into these industries and into the supply chain system in greater detail.

Part 1. Features of the Current Trade System:

Figure 1 compares the trade profiles of the five countries in this study in 2011. The figure shows the correlation between total export values and manufacturing export values,[1] while the color gradient represents the percentage contribution of exports to gross domestic product (GDP). The countries are ranked one to five with red representing the highest percentage contribution and yellow representing the lowest. Singapore has the highest values of total and manufacturing trade, and is most export oriented. Thailand and Malaysia (which is mostly blocked by Thailand's data point) have very similar levels of both manufacturing and total trade, though Malaysia's darker color indicates that it is more export-oriented. Indonesia is only slightly lower with regard to total trade value, but its export value is smaller as a proportion to its GDP. The Philippines has a substantially lower total export value than the others, though its manufacturing exports are only slightly lower than Indonesia's.

[1] This refers to manufacturing exports in the Standard International Trade Classification (SITC) Category 7 in Revision 3. The category represents machinery and transport equipment, the main category of manufacturing central to this study.

The Southeast Asian economies owe much of their growth in the past two decades to their thriving electronics and automotive export sectors. Worldwide, the electronics and automotive industries rely on international production networks more than on any other manufactured goods. This is mainly because these industries have little need for co-location of production parts, and it is easy for factories to be re-located (Sturgeon and Kawakami, 2010). It is therefore not surprising that Southeast Asia's move into the electronics and auto industries occurred simultaneously with the emergence of an international production network. By the late 1990s, multi-national corporations (MNCs) were fragmenting production of parts and components into different countries, in effect creating a division of labor within the region (Fujita and Hill, 1997).

The New Industries

In recent years the Blueprint plan for the Association of Southeast Asian Nations (ASEAN) has identified electronics goods as one of the top two priority goods sectors, as it comprises approximately one third of the region's merchandise exports. The automotive sector is in the top nine priorities (Fukasaku, 2011). The Southeast Asian countries tend to focus on either electronics or automotives, and even within these industries, the five countries in my study specialize in different subsectors.

Indonesia

Indonesia is home to a fast-growing automotive industry, though it is largely domestically oriented. Like other countries in the region, the government promoted domestic automotive production in the 1990s by providing incentives to producers for

using domestic components. Liberalization policies implemented since 2000 have resulted in marginal export growth, albeit at a much slower rate than in neighboring economies. Indonesian firms tend to develop basic components and conduct low value-added assembly activity, while importing high technology parts and components from countries that include Japan and Thailand. Foreign-owned manufactures, especially Japanese companies, comprise most of the country's export sales. The industry has not achieved economies of scale, perhaps because firms in Indonesia produce a wide range of brands and models compared to in neighboring countries, where governments encourage the firms to specialize in a particular model.

Thailand

Thailand is the clear leader in the automotive industry. By 2004, the government was planning for Thailand to become one of the top ten auto producers worldwide by 2016. It is on track to do so, as it moved up from the 19th largest in 2000 to 12th in 2010, and has gained the reputation as the "Detroit of Asia." Within the auto industry, Thailand specializes in pick-up trucks and passenger cars (Natsuda and Thoburn, 2011). Thailand is also a world-leading producer of hard disk drives for computers and phones.

Malaysia

The electronics industry is Malaysia's largest contributor to exports. Malaysia's central bank has recently reported that the percentage that electronics contributes to Malaysia's total exports has declined in the past decade because Malaysia is most specialized in personal computers, while the electronics segments demonstrating the fastest growth are tablets and smart phones (Bank Negara Malaysia, 2011). Nonetheless, the electronics industry continues to drive Malaysia's export growth in subsectors

including hard disk drives, consumer electronic products, and semiconductor devices. Malaysia's major export destinations for these goods are the U.S., China, and Singapore. Recently, semiconductor producers have upgraded from basic assembly and testing to higher value-added operations (German Chamber Network, 2012).

Singapore

Singapore is one of the world's top three hard disk drive manufacturers and a leading producer of semiconductors. MNCs arrived in Singapore in the 1960s to take advantage of cheap labor, driving the country's technological advances in the electronics industry (Matthews, 1999). The hard disk drive industry remains dominated by American and Japanese firms that have achieved vertical integration. Volume production of basic hard drives and other labor-intensive products has transitioned from Singapore to Malaysia and Thailand, while Singapore is trying to retain dominance in high value-added hard drive manufacturing. Singapore will continue to face challenges: It is no longer a cheap location for manufacturing, but it is also not as sophisticated as other advanced economies (Peebles and Wilson, 2002).

The Philippines

Semiconductors comprise over half of the Philippines' electronics production. MNCs from the U.S., Japan, and Europe have played a large role in the market. Though semiconductor production generally requires advanced technology, manufacturers in the Philippines are mainly focused in low-skilled low value-added assembly. More advanced components are imported from the U.S. However, producers are now striving to upgrade, because the Philippines has begun to lose competitiveness in the labor-intensive stages of assembly.

The International Production Network

The term 'supply chain' may be misleading, in that it implies a linear production process, while the type of global production networks recently observed in Asia do not follow a linear process. High-skilled parts and components are manufactured in the relatively more developed countries, and exported to the less developed countries for labor-intensive, lower technology assembly and testing. The final products are often exported back to developed economies for consumer sale (Austria, 2010). 'Low' placement in the supply chain, therefore, indicates high value-added operations at early stages of production.

In the literature, Japan is frequently identified as standing at the top of the chain, using the East Asian countries as assembly bases and exporting final goods to the rest of the world (Athukorala and Yamashita, 2006). But the placements and roles of the Southeast Asian countries are less clear because studies in the literature do not have consistent conclusions. For instance, Fukasaku (2011) found that Thailand, Singapore, and the Philippines export intermediate goods to China; the Philippines and Indonesia export to Japan; and Malaysia exports to the United States. But other sources did not find this pattern, especially with regard to China's role in the network. Part of the difficulty is that the countries have shifted placements over time.

Because of a lack of consensus about what the supply chain looks like or the ideal method of measurement, it is helpful to consider a range of measures to develop a picture of the system in Southeast Asia. Various methods have been discussed in the literature to assess individual countries' participation in the supply chain; each captures

a different aspect of the supply chain system. In this section I survey a number of indices and summarize the findings of studies that have applied them to Southeast Asia.

The most general method to estimate a country's involvement in international production networks is to examine the proportion of parts and components to total exports (Kimura and Obashi, 2011). Since this measure accounts for only intermediate goods exports, it could exclude countries at the top of the chain that import intermediate goods and export final products. By this measure, the Southeast Asian economies show high participation. In all five countries, parts and components comprised over one third of manufacturing exports in 2011 (see Figure 2). In the Philippines and Singapore, parts comprised over 70%- almost double the world average. On the global rankings of intermediate electronics exporters, Singapore, Malaysia, the Philippines, and Thailand have all been in the top 15, and Singapore in the top five (Sturgeon and Kawakami, 2010).

A number of indices provide more specific measurement of supply chain participation. The Grubel-Lloyd (GL) index of intra-industry trade indicates the degree to which a particular product comprises both imports and exports for a country, which indicates the country's integration with the global economy in that industry.[2] Using this index, Fukasaku (2011) identified Singapore as the Southeast Asian country most integrated with the global economy. Malaysia, the Philippines, Singapore, and Thailand show high integration with global electronics supply chains, reflecting their prominence as parts and components suppliers to the world.

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[2] $\frac{GLi}{100} = 1 - Absolute\ Value\left\{\frac{Xi - Mi}{Xi + Mi}\right\}$ where i represents a specific product, Xi represents exports, and Mi represents imports. The index is 100 when exports and imports are equal and 0 when either exports or imports measure 0.

Hummels et al. (2001) use an indicator of Vertical Specialization (VS) that measures the import contents of exports,[3] in other words, the imported goods used as inputs for exported products. Using this index, Fukasaku (2011) found that the contribution of vertical specialization to total exports rose in recent decades in Malaysia, the Philippines, and Thailand for high technology-intensive products in the manufacturing sector. The share of import contents for high technology products was lower in Japan and Singapore. This result likely reflects the tendency of less advanced Southeast Asian economies to import sophisticated parts and components from more advanced economies before operating basic assembly of final goods.

Beyond measuring the degree of involvement in the chain, various measurement techniques have been used to determine the roles individual countries play in the chain. Fukasaku (2011) builds on the Hummels et al. Vertical Specialization index with the Re-Exported Intermediate Exports (REI) indicator, which measures a country's re-exported intermediate inputs as a share of total intermediate exports.[4] The REI index shows high values for countries providing intermediate goods to other countries that assemble intermediate goods. The REI value is lower for intermediate goods exports to countries that sell final goods abroad, and lowest for countries that produce intermediate inputs for domestically consumed goods. Singapore, Malaysia, the Philippines, and Thailand have high REI values (see Figure 3), indicating that they export parts and components exports at early production stages in the supply chain.

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[3] This index uses data from the OECD Input-Output Database, and is measured as $VS_i^k = u\, Am^k\, (I - Ad^k)^{-1} EX_i^k$ where k is country k, i is product i, Ad is a coefficient matrix for domestically produced goods, Am is that of imported goods, and EX is a vector of export value.

[4] $REI = (\sum p \sum i\, VS_i^{Bp})/(\sum p \sum i\, IMEX_i^{Bp})$ where VS_i^{Bp} is the intermediate imports from country p used as inputs in Country B's exports of product i, and IMEX is the share of intermediate exports of product i supplied Country B to partner country p.

Gangnes and Van Assche (2010) use the Revealed Comparative Advantage (RCA) Index, which measures an individual country's concentration in a subsection of an industry relative to the world's concentration in that subsection.[5] Values greater than one indicate greater than average specialization, while values lower than one indicate lower than average specialization. The authors found that in low to middle income Asian countries, specifically Indonesia, Malaysia, the Philippines, and Thailand (also known as the ASEAN-4), final goods comprised a larger-than-average share of electronics exports while intermediate goods comprised a lower than average share. The finding supported the theory that less-developed economies specialize in labor-intensive assembly of final goods, rather than capital and skill intensive production of intermediate goods. However, given the rapidly changing roles of these countries, the RCA index may show a different result with recent data.

Other methods make an even more direct attempt to assess the role of each country with regard to value-added production. These methods seek to evaluate the levels of technology and skill contributed by each country. Gangnes and Van Assche (2010) use the Reed Electronics Production data set to estimate the degree of sophistication of countries' electronics production.[6] According to this index, Japan and Singapore, as well as other developed economies outside of the region, are leaders in radio, communications, and radar, which the authors identify as the highest value-added final goods. Japan, Singapore, and the ASEAN-4 specialize in the next tier down,

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[5] The RCA index is calculated as a ratio of two ratios. *RCA = {(Country A exports in Subsection of Industry 1/Country A exports in Industry 1)/(World exports in Subsection of Industry 1/World exports in Industry 1)}.*

[6] $Sophistication_i = \sum_c \frac{\frac{x_{i,c}}{X_c}}{\sum c(\frac{x_{i,c}}{X_c})} Y_c$ where $x_{i,c}$ is theproduction value of an electronics subcategory, using the weighted average income of its producers. $X_c$is country c's total electronics production, and Y_c is country c's GDP per-capita.

electronic components, which includes semiconductors. Finally, the ASEAN-4 and China specialize in computers, audio, and video, the least sophisticated category of electronics production.

The Intra-Regional Trade Phenomenon

What makes Southeast Asia a fascinating case is that that the supply chains in these industries were developed to operate almost entirely within the region. This catalyzed the growth of a strong regional economy. Asia's intra-regional trade more than doubled from 1980 to the mid 2000s, and has since continued to climb. In Southeast Asia we are witnessing a degree of intra-regional integration unparalleled in North America and Europe, where intra-regional trade has actually declined in the past decade (Fukasaku, 2011). Unlike in North America and Europe, countries within Southeast Asia have demonstrated a simultaneous increase in export competitiveness; the amount of electric machinery in each country is positively correlated with the amount in neighboring countries (Hayakawa et al., 2009). These features distinguish Southeast Asia's system of intra-regional production as one of the strongest networks in the world, and may put the region in a position to rival more highly developed regions if the trend continues. But most importantly for purposes of this paper, the interconnectedness of Southeast Asian countries with one another has important implications for its vulnerability to trade shocks, which will be discussed in a later section.

The intra-regional supply chain system in these industries is a recent phenomenon. Three decades ago, the countries were neither as regionally integrated

nor as specialized in the electronics and automotive industries. In the next section I will focus on how this structural shift led to the current economic system.

Part 2. The History Behind Southeast Asia's Structural Shift

An Overview of Changes During the Past Three Decades

Southeast Asia has demonstrated sustained export growth since the early fifteenth century, accelerating in recent decades (see Figure 4). While the region generally pursued export-led growth, it is important to note that the five countries vary greatly with regard to their contribution of exports to GDP (Figure 5). Singapore has led Southeast Asia in export-oriented industrialization, followed by Thailand, Malaysia, and the Philippines in the late 1960s and early 1970s, while Indonesia remained committed to the domestic market through the 1970s. This pattern has remained relatively consistent over time. Singapore is by far the most export-oriented, with exports comprising almost 209% of GDP in 2011.[7] Malaysia and Thailand follow next, at 91.6% and 76.9% respectively. The Philippines and Indonesia have remained the least export-oriented economies, barely ever exceeding 50%. In 2011, exports comprised 31.0% of GDP in the Philippines, while Indonesia was down at 26.3%.

An abundance of natural resources enabled the Southeast Asian countries to have growth driven by primary product exports, which reduced incentives to export manufactured goods. Agricultural production therefore became the driver of growth by the nineteenth century, as the region experienced rising primary product exports to North America and Europe. After achieving independence from colonial rule, the

[7] Though this figure is inflated because Singapore is a transshipment port.

countries began to shift away from agriculture towards modern industry in the 1960s, and made a strong push to export these manufactured goods. Available industrial raw materials and energy also contributed to the move up the ladder from primary raw materials. The increasing trend in manufacturing exports has continued to the present day.

Figure 6 shows the positive trend for increasing exports in machinery and transport equipment from the late 1980s through 2011. This category does not account for all manufacturing exports, but rather only the leading industrial sectors that the countries have made an effort to diversify into, including automotive products, electronic goods, and electrical machinery, among others. Singapore began with higher exports and trended similarly to the others before surging ahead in the 2000s, reaching $188 billion by 2011. Malaysia and Thailand followed similar growth trajectories to each other; Malaysia demonstrated higher exports than Thailand until the two nearly converged in 2011. Indonesia has recorded the lowest machinery exports since 1989, reaching $21.8 billion in 2011. The Philippines is the only country out of the five that did not show a consistent positive trend through the present. Machinery exports there peaked in 2007 at a level below the others, and has since been on the decline.

The shift into the advanced industrial sector has largely taken place in the automotive and the electronics industries. Looking first at automobiles, the five countries followed similar patterns in the 1960s through the first half of the 1990s (see Figure 7). The point of divergence was the Asian Financial Crisis of 1997-1998, after which Thailand dramatically surpassed its Southeast Asian neighbors in auto exports. Thailand's leap above the rest can be explained by policy differences between the

countries. In the 1960s through the 1980s, national policies throughout the region aimed to protect the domestic economies. In the 1990s, Thailand began to take a different path as it introduced liberalizations that encouraged foreign MNCs. The other countries, meanwhile, continued to promote national firms. Coming out of the crisis, a plunge in domestic demand created a new need for auto suppliers to export. Thailand was more successful than the other Southeast Asian economies whose national firms lacked advanced technology and access to international production networks that the MNCs in Thailand had (Wad, 2009; Pollio, 2012; Natsuda and Thoburn, 2011; Kasuga et al., 2005). By 2011, Thai auto exports exceed $18 billion, a major step above the next follower - Singapore with $4.8 billion.

The shift into the electronics industry[8] is demonstrated in Figure 8. Exports have shown a positive trend since the electronics industry boom of the late 1980s,[9] despite temporary declines following the 2008 Global Financial Crisis. Singapore has long been the leader, with over $13 billion in 2011, followed by Malaysia, Thailand, the Philippines, and finally Indonesia. While Thailand's primary focus has been the automotive industry, its robust export growth in electronics reflects the country's status as a leading exporter of hard disk drives. Indonesia is the country demonstrating the flattest export growth in this industry.

The second half of the twentieth century also marked the emergence of an integrated Asian economy as Japan and the newly industrializing economies of East Asia

[8] The selection of electronic goods within SITC Revision 3 is a revised version by the author of the identification of electronic goods in SITC Revision 2 by Kumakura (2005) and Gangnes and Van Asssche (2010). The selection includes categories 75, 76, 771, 772, 774, 776.

[9] The Comtrade data on the electronics industry used in this study is only available beginning in the late 1980s to early 1990s for various countries.

became important destinations for Southeast Asia's exports for the first time (Brown, 1997). This was in part due to a wave of liberalization policies that promoted intermediate goods trade in the auto and electronics industries, and in effect catalyzed the emergence of a regional production network.

Southeast Asia's proportion of parts and components in manufacturing exports has well exceeded that of other regions of the world for decades, surpassing the North American Free Trade Agreement (NAFTA) and European Union (EU) averages by the early 2000s (Athukorala and Yamashita, 2006). Figure 2 shows that Singapore is the only country to demonstrate a consistent increase in intermediate goods exports within the machinery and transport industries. The time trends in the other countries are less clear, but have all remained consistently above the world average for the past two decades.

Theories on the Emergence of the Trade Network

There are competing theories that attempt to explain the structural shift. The first is the Old (classical or neoclassical) Trade Theory, stemming from David Ricardo, which holds that countries specialized in particular industries based on comparative advantage, or lower opportunity cost. As a country becomes more developed, it gains a comparative advantage in a more advanced good. According to this theory, American and Japanese electronics firms began offshoring their less sophisticated production to low-wage Taiwan, South Korea, Hong Kong, and Singapore, also known as the Newly Industrializing Economies (NIEs), as electronics production became increasingly modular and transportation costs declined. As labor costs rose in the NIEs, labor-

intensive production shifted to less developed East Asian economies (Gangnes and Van Assche, 2010; Hobday, 2001). Proponents of the Old Trade Theory depict the region as following the 'flying geese' pattern (see Akamatsu, 1962). Japan was the leading goose in the electronics industry from the 1970s until the 1990s, when the NIEs became more competitive. Finally, the NIEs were followed by the ASEAN-4 countries - Malaysia, Thailand, Indonesia, and the Philippines.

New Trade Theory does not support the view that comparative advantage consistently shifted from the leader, Japan, to the less developed Asian countries that followed behind. Instead, New Trade theorists argue, there are arbitrary reasons that countries specialize in particular goods; the advantage is to specialize in only one type (Krugman, 1979). The reasoning is that suppliers face lower production costs with economies of scale and agglomeration, and trade allows countries to gain economies of scale in industries in which they would not otherwise have a comparative advantage. For instance, in the 1980s and 1990s, Japanese auto companies began to consolidate a regional production network by encouraging national specialization of products (Pollio, 2012). In other words, specific vehicle lines were produced in each country in order to achieve economies of scale, and from there exported back to Japan for sale to final consumers.

Theories That Explain Diversification into New Industries

While old and new trade theories provide explanations for the emergence of fragmentation and the overall trade network, a different body of literature addresses the

region's move away from the agricultural sector towards advanced industrial activity. A number of explanations for Southeast Asia's effort to diversify have been proposed.

The first is the New Endogenous Growth Theory, which became popular in the 1980s and 1990s (Romer, 1986). This theory holds that increasing returns is an endogenous explanation for economic growth, and attributes increasing returns to specialization and investment in knowledge capital. Productivity growth is driven by the rate of technological innovations, in the form of new products, processes, and ways of organizing production. This theory identifies research and development investment as the cause of innovations. Proponents of this theory encouraged less developed countries to emphasize human capital more than physical capital (Meier and Rauch, 2005).

Another explanation is that the countries shifted away from agricultural exports due to declining terms of trade, or price of exports relative to the price of imports. According to the Prebisch-Singer theory, primary product prices are on a declining trend relative to the price of manufactured goods (Prebisch, 1959; Singer, 1950). Primary product prices have fallen since the 1960s as a result of incentive policies implemented to benefit other sectors at the expense of farmers (Banerjee et al., 2006). Declining and volatile terms of trade led to weakened export revenues for developing economies (Eichengreen, 1996). A number of studies (see Mendoza, 1997) found a significant negative relationship between the volatility of terms of trade and growth.

The Dutch disease (or resource curse) explanation holds that countries with large natural resource endowments tend to have slower growth over time. Natural resource exports appreciate currency, which in turn makes other industries less competitive and can bring about political conflicts and corrupt institutions. Most importantly, wealth

generated by natural resource exports creates demand for non-traded goods, which then compete with the manufacturing sector for scarce inputs, such as skilled labor. This theory sees manufacturing as the engine of economic growth, because it yields positive externalities for the economy (Meier and Rauch, 2005).

As each of these theories gained popularity, they contributed to the decision of the recently independent Southeast Asian governments to shift away from agriculture. But of all the reasons the countries diversified, the one most relevant to this project is volatility, which is the topic of the following section.

Chapter 3. Southeast Asia's Volatility Over Time

The Volatility of Primary Product Exports

By the 1950s concerns arose that growth of production and exports in developing countries was hindered by volatility in export earnings. In the export sector, less developed countries had greater short run fluctuations than advanced economies. Several Asian economies even demonstrated less stability in comparison to other developing countries outside of the region (Naya, 1973). A large body of research attributed volatile export earnings to concentration in primary products.

A number of factors contributed to the volatile export earnings of primary products. Primary products have low income elasticity of demand and low price elasticity of supply, both of which impacted export revenues (Naya, 1973). Prebisch (1950) made the seminal argument that primary products faced price fluctuations that, in combination with declining terms of trade, resulted in volatile export revenues. One reason for price volatility is that domestic production of primary products, unlike manufacturing, is impacted by the unstable climate. When faced with export price volatility, wealthier countries with more advanced institutions are better able to stabilize than developing countries (Blattman et al., 2007). Volatility was therefore not a huge problem for large, diversified and industrialized nations during this time period, but had a strong negative impact on developing commodity-dependent economies.

The attempt to reduce export volatility was one of the major factors that led the Southeast Asian countries to directly induce diversification out of agriculture through policy initiatives after gaining independence in the 1950s and 1960s.

Diversification both into industry and into a broader range of agricultural goods was intended to counter vulnerability to the global markets caused by a narrow range of primary product exports. For example, Malaysia's diversification in the 1970s was driven by efforts to reduce reliance on tin and rubber exports that had seen dramatic price fluctuations in the 1950s, in addition to falling rubber prices (Jomo and Rock, 1998).

Volatility After Diversification

As developing countries worldwide began to diversify for reasons similar to Southeast Asia, a number of empirical studies examined the improvement in stability after diversification. Many found that economies concentrated in primary products were indeed more volatile than countries that diversified. For instance, using data for 35 countries from 1870 to 1939, Blattman et al. (2007) found that among periphery economies (price-taking economies), countries with volatile primary product prices demonstrated slower growth than countries exporting less volatile products. These countries also grew more slowly than core economies (price-setting economies).

However, the relationship between concentration in primary products and export earning stability still poses an interesting question, because a number of studies have challenged the popular theory that concentration and stability are negatively related.

In a 1964 paper, Massell investigated the extent to which countries' volatile export earnings are related to their concentration in exports, and found a low

correlation between instability and concentration.[10] While Massell's study looked at concentration of exports rather than primary product exports, exports in primary products were more concentrated than the range of manufacturing exports to which countries diversified. One proposed explanation for the weak relationship is that highly specialized countries tend to deliberately concentrate in commodities with stable earnings (MacBean and Nguyen, 1980). Empirically, however, that may not be the case in Southeast Asia. The aim of the following chapter is to investigate the stability of the industries in which the Southeast Asian economies have concentrated.

Massell's finding contradicted popular theory and suggested that policies aimed toward increased diversification could not improve stability. MacBean and Nguyen (1980) found that when there is an observed negative relationship between export concentration and stability, an increase in diversification does not lead to stabilized export earnings. Rather, diversification could only lead to greater export earnings stability if it entailed increasing shares of commodities with stable export proceeds.

In a more recent study, Bebczuk and Berrettoni (2006) likewise challenged popular theory with a cross-sectional analysis using data from Latin America, where countries diversified largely in response to volatile commodity prices. To indicate concentration, the authors used the Herfindahl index, which equals the sum of squared proportional exposures to various sectors (a maximum score of 1 indicates complete

[10] A number of ways to measure volatility of export earnings have been used in different studies: "the standard errors of estimate obtained from regressions with linear [Massell: 1964], exponential [Massell: 1970] and moving average [MacBean: 1966] trend forms" (Love, 1990).

concentration, while lower values indicate diversification).[11] Nine East Asian Countries recorded a Herfindahl index declining from 0.151 in 1970 to 0.108 in 2000, parallel to the region's diversification over time. The results show that high GDP, stability, and openness are correlated with concentrated rather than diversified exports. In other words, the study found that concentration has positive effects for stability.

Implications of Southeast Asia's Structural Shift for Volatility

Southeast Asia's structural shift, discussed in Chapter 2, calls for a re-evaluation of the region's export stability. The move towards supply-chain focused industries, characterized by intra-regional and intermediate goods trade, has likely coincided with changing patterns in volatility of export revenues.

The literature has pointed out that the new industries may demonstrate more volatility than the old industries. The electronics industry, especially semiconductors, has extreme booms and busts, driven by uneven technological progress, demand fluctuations in particular products, and demand conditions in consumer economies. As a result, electronics industry cycles are more dramatic than the average business cycle (Gangnes and Van Assche, 2010). The literature on macroeconomic stability in Southeast Asia focuses on factors such as yen/dollar fluctuations, but does not pay enough attention to the impact of the global electronics industry on the region's trade performance (Kumakura, 2005).

[11]For measuring concentration in exports, the most frequently used method is based on the Gini coefficient and the modified Gini-Hirschman coefficient. Another index is the Herfindal-Hirschman concentration index, which was used to take into account globalization (Hamid, 2010).

In addition to the potential for new volatility patterns related to industry-specific factors, the question remains as to how the intra-regional trade integration will affect the region's export performance. There are competing theories in the literature about the implications of the supply chain system for macroeconomic stability (see Rana, 2007).

The first body of literature is focused on how demand will impact stability of the production network. There is a general theory in the literature that supply chains tend to synchronize business cycles across countries (Calderon et al., 2007). Though fragmentation has increased intra-regional trade for parts and components, this has required reliance on external demand for final goods (Jongwanich, 2010).

A major source of vulnerability to export fluctuations stems from reliance of the new industries on final demand from highly developed countries, mainly the U.S. Some of the literature argues that this will make East Asia susceptible to demand contractions outside of the region (Athukorala and Yamashita, 2006), meaning that tighter trade integration should increase co-movement of East Asia's trade performance with global business cycles. However, the system has the potential to be stabilizing if intermediate goods trade within the region continues in spite of external conditions. This could be the case if firms at the top of the supply chain continue to pile up intermediate goods inventory during demand shocks.

The other side of the debate is concerned with supply shocks. Inter-industry trade, whereby countries specialize in different industries, should not lead to co-movement of business cycles and therefore greater integration of trade should not have a substantial impact on export volatility (Rana, 2007). However, as Chapter 2 discussed,

East Asia's cross-national trade has coincided with increasing vertical specialization within industries. The interdependence of the countries creates the possibility that supply shocks in one country could generate a 'chain reaction,' disrupting exports at the successive stages of production.

Given the theoretical debate, assessing the supply chains' responses to trade disturbances requires looking at empirical evidence of both external demand shocks and internal supply shocks. In the wake of the 2008 Global Financial Crisis (GFC) and a number of recent natural disasters in Asia, a great deal of research has focused on the resilience of Southeast Asia's supply chains. The events provided effective case studies of both types of shocks, as the GFC took a toll on external demand, while natural disasters disrupted production within the network.

Empirical evidence has supported the view that vertical specialization and trade within industries leads to synchronized business cycles in East Asia. Using data from 1976 to 1997 from 10 East Asian economies (including the five in this study), Shin and Wang (2004) found strong correlation of output between countries that participated in trade within industries. Rana (2007) followed up on Shin and Wang's study using data from 1993 to 2004 and confirmed this result, suggesting that, on the demand side, supply chains could make the Southeast Asian economies vulnerable to export fluctuations.

To identify implications of the 2008 GFC for Asia's production networks, Obashi (2009) analyzed the stability of intra-regional machinery supply chains during the Asian Financial Crisis of 1997 to 1998. During this period, weakened domestic demand led to the increased importance of external demand in explaining business cycles. The results

showed that intermediate goods trade was less likely to be interrupted than final goods trade, and in the case of a disruption, trade was discontinued for a shorter amount of time. Obashi concluded that the relationships within the network are robust enough to withstand a temporary disruption of demand for final goods in a country like the U.S.

In line with Obashi's findings, most empirical evidence suggests that, while the GFC slowed down trade in East Asia, the dense production network provided a cushion for the region's recovery. Particularly in the machinery sector, exports within the region recovered faster than exports to the U.S. and Europe. Japan's exports to East Asia picked back up ahead of its exports to outside of the region, reflecting the robust intra-regional parts and components trade relationship. Machinery parts and components exports demonstrated a stronger recovery than final goods, both in the short term (within 4 months of the crisis) and the longer term (within the year), supporting the view that intermediate goods trade is more resilient than final goods trade (Ando, 2010; Ando and Kimura, 2012).

A study by Uchida and Inomata (2009) confirmed the robustness of intermediate goods trade. The authors used the Hummels et al. (2001) Vertical Specialization index discussed in the previous chapter. The measure calculates the amount of imported inputs used for production of goods that are thereafter exported. The authors improved upon the index by distinguishing between countries mainly producing intermediate goods, and those mainly assembling final goods. The result showed that vertical specialization of intermediate goods was less severely affected by the GFC than that of final goods. One explanation could be a time lag, as the plunge in U.S. demand

immediately affected final goods. The authors also suggest that intermediate goods trade could benefit from contractual commitments to parts and components orders.

Most studies, then, found that intra-regional intermediate goods trade was a source of stability for East Asia after the GFC caused a major external demand shock. But recent supply shocks have drawn attention to the more problematic consequences of tight integration.

In March 2011, a massive earthquake hit Japan's Tohoku (Northeast) region, triggering a tsunami that crippled production in a major hub for both intermediate and final goods. Japan's exports recovered quickly, particularly in the auto industry, which surpassed the previous year's exports just a few months after the disaster. But the supply shock, particularly devastating in the electronics and auto industries, was transmitted to other countries as parts were not delivered to production sites that function on a just-in-time basis. Production and exports dropped in China and Thailand, though only after a one-month lag, because the sites had enough parts and components inventory to continue production for a short period. The problem was exacerbated by the supply chain system, which could not accommodate replacements from other suppliers due to specific customization of parts (Fujita and Hamaguchi, 2012).

Despite the shock to the supply chain, intra-regional parts and components trade was less affected than inter-regional final goods trade. Using an econometric model to measure fall and recovery in Japan's exports, Ando and Kimura (2012) found that parts and components machinery trade with East Asian countries showed a smaller exit effect than final goods, and was more likely to recover after trade was discontinued. The quick

recovery of machinery parts and components trade suggests that firms prioritized maintaining stability in international supply chains after the earthquake.

In October 2011, a major flood caused serious damage to production sites in Bangkok and surrounding areas. Thailand's auto exports decreased by one half following the flood, and electronics finished goods exports to the European Union, Japan, and the U.S. fell significantly. Industrial exports to other East Asian countries remained steadier than final goods exports. Nonetheless, the flood affected not only production in the immediate region, but in other parts of Thailand and extended outside of the country, due to the disruption to the supply chain. Parts and components were not delivered on a just-in-time basis, forcing operations to halt at other stages in production. Japan recorded a decline in knocked down vehicle exports, or final vehicles with parts and components manufactured in other countries. The worst affected of Japan's exports were pickup trucks and hard-disk drives, which have intermediate production in Thailand (Chongvilaivan, 2012).

In response to recent empirical findings that supply chains experience volatile export earnings following production disruptions, there have been efforts to reduce their risk of instability. Final goods manufacturers have ramped up efforts to build up sufficient inventories, arrange back-up production sites, and use products that are compatible with multiple sources (Chongvilaivan 2012).

In sum, the literature reveals contradictory theories about the relationship between Southeast Asia's structural shift and the volatility of export earnings, and the empirical studies have likewise not drawn consistent conclusions. On the demand side, the intra-regional intermediate goods trade showed more resilience to the 2008 GFC

than popular theory would anticipate. The supply side story is less clear. In the aftermath of two recent natural disasters, the supply chains were disrupted as expected, and yet showed signs of strength, especially with regard to speedy recovery. There is a need for more analysis of the supply chain system's implications for macroeconomic stability.

Additionally, much of the literature assesses stability from a regional standpoint, rather than on a country-by-country basis, which is part of the motivation for this study. In the following section I create a model to investigate how participation in intra-regional supply chain impacts export revenue stability in the five countries selected for this study.

Chapter 4: Econometric Model and Data

Section 1. Econometric Model

A linear regression model is used to test whether participation in the supply chain has a positive relationship with volatility of export values. Time-series models are estimated to analyze each country individually, followed by panel data regressions for the pooled sample. The purpose of the model is to isolate the effects of two competing factors on export volatility: specialization in the new industries and participation in the supply chain within these industries.

The dependent y-variable in the model is volatility of export values. The first main x-variable is the proportion of manufacturing exports out of each country's total exports (*manufexports*). As discussed in Chapter 2, the Southeast Asian economies have increased concentration in particular manufacturing industries such as electronics and automotives. This variable does not account for all manufacturing goods but rather manufacturing goods in the new industries, and will be explained further in the following section.

The second main x-variable is a proxy for participation in the supply chain. While the new industries represented by the *manufexports* variable are highly supply chain oriented, exporting goods in these industries does not necessarily require participation in the supply chain. Relevant studies in the literature use the proportion of parts and components out of total exports as a measure for participation in vertical specialization (see for instance Kimura and Obashi, 2011). In line with this measurement technique,

the variable *partsofmanuf* is used to account for the share of parts exports within the new leading manufacturing industries that are represented by *manufexports*.

My hypothesis holds that the shift into the new manufacturing industries has improved stability. However, because the countries inserted themselves into these industries through the supply chain system, they were subject to new sources of volatility. In line with this hypothesis, a negative correlation between manufacturing exports and volatility of export values is expected, along with a positive correlation between volatility and participation in the supply chain.

Because of the structural shift over time in composition of exports, time trends for manufacturing and parts exports, as well as volatility, were expected. For this reason, a time trend is added as a control variable in the model.

A number of control variables are included to improve the accuracy and efficiency of the model. Exposure to global demand could impact both volatility and the independent variables. The share of export revenues in GDP (*exportsgdp*) is added to control for each country's level of export orientation. This measure is especially important to include given the disparities between the countries included in this study. Singapore, for instance, is far more export-oriented than the other four countries while Indonesia focuses more on the domestic market.

The basic regression model estimates is as follows;

$$volatility = \beta_0 + \beta_1 manufexports + \beta_2 partsofmanuf + \beta_3 exportsgdp + \beta_4\, year + u$$

After examining the initial round of results, revisions were made to the model. The first was an attempt to improve the proxy for supply chain participation. The shortcoming with *partsofmanuf* is that participation in the supply chain does not require exporting intermediate goods for countries at the top of supply chain that assemble and export final products. Also added is the variable *partsimports*, which accounts for the proportion of parts and components imports out of total imports in the new industries. The combination of intermediate imports and exports within these industries should provide a more accurate representation of participation in the supply chain.

$$volatility = \beta_0 + \beta_1 manufexports + \beta_2 partsofmanuf + \beta_3 exportsgdp + \beta_4\, year + \beta_5\, partsimports + u$$

Because the results indicate that there are differences between the countries that the model does not account for, an additional control variable is added to account for exchange rate volatility, *currencyfluct.* Similar control variables are included in relevant studies in the literature.

$$volatility = \beta_0 + \beta_1 manufexports + \beta_2 partsofmanuf + \beta_3 exportsgdp + \beta_4\, year + \beta_5\, partsimports + \beta_6 currencyfluct + u$$

Finally, because the parts imports and parts exports variables turn out to be correlated, in a revised version of the model a new measurement is adapted for supply chain participation as an alternative to the original *partsofmanuf* proxy. The "Revealed

Comparative Advantage" (RCA) Index, discussed in Chapter 2, is used to specify whether countries mainly export intermediate goods, placing them lower in the supply chain (*lowinchain*), or assemble final goods, placing them higher up in the supply chain (*highinchain*).

$$volatility = \beta_0 + \beta_1 manufexports + \beta_2 lowinchain + \beta_3 highinchain + \beta_4 exportsgdp + \beta_5\, year + \beta_6 currencyfluct + u$$

Section 2. Data

The dependent variable "volatility" serves as a proxy for volatility of export values. Nominal monthly export data from the International Monetary Fund's (IMF) International Financial Statistics is used, measured in millions of U.S. dollars free on board.[12] To calculate volatility, one measure from the various methods used in the literature is selected. The measure takes the natural log of the monthly export data, creates a lag of the export data from the previous month, and squares the result in order to account for both positive and negative fluctuations.[13] For every year from 1988 through 2011, the squared deviations for each year are summed in order to estimate volatility for each country on a yearly basis.

The first independent variable is *manufexports*, which represents the contribution of exports in the new industries to total exports. The total annual export

[12] This study uses code 70, exports in nominal terms (the value series). IFS also includes the monthly export data in real terms (the volume series).

[13] $volatility = \sum[\ln(exp_t) - \ln(exp_{t-1})]^2$ where exp is the monthly export value, t is the current month, and t-1 is the previous month.

values are drawn from the World Bank's World Development Indicators, measured in current U.S. dollars.[14] The new industries are measured using Category 7, "machinery and transport equipment," of the Revision 3 Standard International Trade Classification (SITC) from the United Nations Comtrade database. It is important to note that this variable does not represent all manufactured goods. The goods in this category include power, metalworking, and general industrial machinery; electricity and electronic machinery; and automotive and other transport equipment. The electronics and automobile industries comprise a large share of this category, and it is therefore representative of the new industries.

The variable *partsofmanuf* is a proxy for participation in the supply chain, and represents the proportion of intermediate goods exports within all machinery and transport exports. Similarly, the *partsimports* variable is the proportion of parts and components imports within all machinery and transport imports. The major advantage of the SITC Revision 3 data is that it clearly distinguishes parts and components exports from final goods exports. Because of this feature, the UN Comtrade database is commonly used in studies on international production networks. The data for parts and components is based on the author's selection of Category 7. [15]

[14] Indicator code NE.EXP.GNFS.CD.

[15] The list of exported goods distinguished as parts and components selected by the author using SITC Rev. 3 includes categories 7119, 7128, 71319, 7139, 7149, 7169, 71819, 71878, 71899, 72119, 72129, 72139, 72198, 72199, 7239, 72439, 72449, 72467, 72468, 72488, 7249, 7259, 72689, 7269, 72719, 72729, 72819, 72839, 72847, 7285, 735, 73719, 73729, 73739, 73749, 74128, 74135, 74139, 74149, 74159, 74172, 7419,7429, 7438, 7439, 74419, 7449, 74519, 74529, 74568, 74597, 7469, 7479, 74839, 7489, 7499, 759, 7649, 771, 772, 77429, 77549, 77579, 77589, 776, 77817, 77819, 77829, 77833, 77835, 77848, 77869, 77879, 77883, 77885, 77889, 784, 78535, 78536, 78537, 78689, 79199, 7929.

The *lowinchain*[16] and *highinchain*[17] variables were measured using the RCA Index, and calculated based on Comtrade data (see Table 1 and Table 2). The index, discussed in Chapter 2, is measured as a ratio of ratios: the proportion of one country's exports in a subsection of an industry to their total exports in that industry, as a fraction of the world's proportion of exports in that subsection to the world's total exports in that industry. Gangnes and Van Assche (2010) use this index to measure individual countries' electronics exports, and distinguish between intermediate and final goods. They are able to estimate countries' placements in the supply chain based on whether they export more or less than the world average amount of parts and final goods. This study extends the index to account for both the electronics industry and the automotive industry by measuring parts and components in the new industries (machinery and transport goods; those represented by the *manufexports* variable).

Turning to the control variables, the percentage contribution of export revenues to GDP data is drawn from the World Bank's World Development Indicators. The currency fluctuation variable is calculated using monthly averages of national currency per U.S. dollars (USD), measured in USD,[18] drawn from the IMF's International Financial Statistics. For Indonesia, the Philippines, and Singapore, this is based on the market rate, while the data for Malaysia and Thailand are based on the official rate. Fluctuations of the currency are calculated using the same method as volatility of export values.[19]

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[16] $lowinchain = \frac{(country\ A\ exports\ of\ new\ industry\ parts)/(country\ A\ total\ new\ industry\ exports)}{(world\ exports\ of\ new\ industry\ parts)/(world\ total\ new\ industry\ exports)}$

[17] $highinchain = \frac{(country\ A\ imports\ of\ new\ industry\ parts)/(country\ A\ total\ new\ industry\ imports)}{(world\ imports\ of\ new\ industry\ parts)/(world\ total\ new\ industry\ imports)}$

[18] IFS series code RFZF.

[19] $currency\ fluctuation = \sum[\ln(cur_t) - \ln(cur_{t-1})]^2$ where cur is the monthly average of national currency per U.S. dollar, t is the current month, and t-1 is the previous month.

Section 3. Descriptive Statistics

Figures 9, 10, and 11 provide an initial view of the relationship between the dependent and independent variables. The countries are shown in different colors in order to distinguish between general trends of the independent variables for all countries pooled together, and fixed differences across countries.

The relationship between export volatility and manufacturing exports, seen in Figure 9, does not show a clear pattern for any of the countries. Turning to Figure 10, the relationship between parts exports and volatility again is not conclusive within each country. However, looking at all countries pooled together, a negative relationship is observable. This indicates that for each country, participating in the supply chain did not have an effect on volatility. However, the countries in the region that have higher participation seem to show more stability. Figure 11 portrays the relationship between volatility and the percent contribution of exports to GDP. Within countries, particularly Singapore and Thailand, there does appear to be a negative relationship between volatility and contribution of exports. The relationship is unclear for all countries pooled together.

Looking at the time trends of the variables, volatility of all countries pooled together shows a slightly negative trend over time (see Figure 12), while patterns within each country are unclear. Manufacturing exports of all countries pooled together demonstrate a slight positive time trend (see Figure 13). Within each country, Indonesia, Malaysia, and Thailand show increased manufacturing exports over time. Singapore showed an increase through about 1995 before declining and remaining stable through

the 2000s, while the Philippines peaked in the early 2000s before declining. The observed time trends provide reason to include a linear time trend in the model.

The means and variance of both variables plotted over time provide preliminary assessment of the variables' stationarity. Figure 14 demonstrates that volatility does not appear to have constant variance over time; it spikes in the late 1990s, which is most likely a reflection of the major trade shock created by the Asian Financial Crisis of 1997-1998. While there are not dramatic changes in variance over time for manufacturing exports and parts and components exports, shown in Figures 15 and 16 respectively, the figures are not conclusive. These figures suggest that the model may have a non-stationarity problem, and formal testing will be required.

Section 4. Regression Results

Original Model

Time Series

The analysis began with an OLS time series regression of the independent variables on volatility for each of the five countries. The results are shown in columns 1-5 of Regression Results Table 1. The coefficients for *manufexports* do not reveal a consistent pattern. The sample coefficient for *partsofmanuf* is negative for all countries with the exception of the Philippines, suggesting that there could be a negative correlation, but the results are statistically insignificant. While the results suggest that the main independent variables are not significantly correlated with the dependent variable for the most part, there are a few exceptions. For Thailand, *partsofmanuf* is significant with a p-value of 0.027. The coefficient is negative and the standardized

coefficient is -.726, indicating that as the proportion of parts to manufacturing exports increases by 1 standard deviation, volatility tends to decrease by .726 standard deviations on average. The regression results for the Philippines show that *manufexports* and *year* are highly significant; *manufexports* has a p-valueof 0.009. The coefficient is positive, suggesting that an increase in the value of manufacturing exports in proportion to the Philippines' total export value is correlated with higher volatility. The *year* variable has a p-value of 0.005, and a negative coefficient, indicating that as years progress, volatility tends to decrease.

Tests for Time Series Regressions

A number of tests were run to assess the strength of the model. To check for non-stationarity, the formal Dickey-Fuller test was run on the residuals. The results for all countries showed that the null hypothesis of a unit root was rejected for all five countries (Table 3), indicating that none of the countries have a random walk and that the model is stationary.

Next the residuals were examined to test for serial correlation. The partial autocorrelation plots do not appear to show a problem with serial correlation for the most part (Figure 18). However, the plots for the Philippines and Singapore indicate that the early lags may be correlated (Figure 17), and therefore showed a need for formal testing. To formally test for serial correlation, the Durbin Watson Test was performed (see Table 4). The results indicate that the model does not have a serial correlation problem for all countries except for the Philippines (d-statistic 1.104). This problem is

likely related to the outliers in my dataset, which was addressed and corrected for in later models.

Finally, the model was checked to see if it would be improved with the addition of lags. The lag did not have a strong effect for any of the countries. It was concluded from these tests on the original time series regressions that the model is robust and does not need to be adjusted to correct for non-stationarity or serial correlation.

Panel Data

In order to further investigate the relationship between participation in the supply chain and volatility of exports, the countries were pooled together for an OLS panel data regression. The results are shown in Column 6 of Regression Results Table 1. All of the x variables are significant with the exception of *partsofmanuf*. The contribution of exports to GDP has a negative correlation with volatility, and is highly significant with a p-value less than 0.01. Manufacturing exports was highly significant with a p-value less than 0.01, and a positive coefficient. Parts of manufacturing had a positive coefficient but was not significant. There is a significant negative correlation between volatility and time, indicating that region-wide, volatility has diminished as years have progressed.

The pooled OLS panel data regression may not provide accurate results, given that there could be unobserved time-invariant characteristics (fixed effects) of the countries that affect volatility and therefore bias the coefficient estimates. Country dummies are added to the original model to show the fixed effects between countries (and the robustness of the panel model is further tested once the variables have been revised and improved). Column 7 of Regression Results Table 1 shows the results for the

panel regression with country fixed effects. The results were significant for all of the variables with the exception of *exportsgdp*. Manufacturing exports again were highly positively correlated with volatility, and *partsofmanuf* showed a positive correlation, this time significant with $p<0.05$. *Year* continued to show a negative correlation with greater significance. Finally, the fixed effects show that Malaysia has the strongest negative correlation with volatility, followed by the Philippines and Thailand, while Singapore does not show a significant relationship.

The panel data results for the initial model suggest that both the new industries and supply chain participation are destabilizing for export revenues. However, the country fixed effects show that there are additional time-invariant factors not addressed in my model that have a significant correlation with volatility. Before drawing conclusions from these results, an effort is made to improve the accuracy and efficiency of the model by making adjustments and including additional variables.

Revised Models

As discussed earlier, the variable *partsimports* is added to improve the proxy for supply chain participation by accounting for countries at the top of the chain. With the addition of *partsimports*, the time series results remain insignificant with the exception of the Philippines (see Regression Results Table 2), but all results are highly significant when all countries are pooled together. *Manufexports* show a highly significant positive correlation with volatility, while the country fixed effects demonstrate that in this revision of the model time-invariant characteristics of the countries continue to affect volatility. Interestingly, *partsofmanuf* shows a positive correlation with volatility (p-

value<0.01), while *partsimports* shows a negative correlation (p-value<0.05), suggesting that effects on volatility may vary for countries in different places in the supply chain. Specifically, countries lower in the chain may experience greater fluctuations while the system may have stabilizing effects for countries at later stages of assembly. However, the two supply chain proxy variables demonstrate multicollinearity, suggesting that this is not the ideal measurement of supply chain participation. Therefore *partsimports* is not kept, and a further attempt to improve this variable is made in a later revision of the model.

While the original model showed strong panel data results, three outliers of extremely high volatility distorted the results. The outliers were all within the Philippines and reflected the major trade shock created by the Asian Financial Crisis of 1997-1998. The regressions were run again, this time controlling for outliers that fell when the standard deviations of volatility were greater than 0.5 (see Regression Results Table 3). With the omission of the outliers, the time series regression for the Philippines shows that the only significant result is a negative correlation between *partsofmanuf* and volatility (see Column 5 of Regression Results Table 3). Analyzing the pooled regression in Column 6, the main variables are insignificant, indicating that they are biased. Column 7 of Regression Results Table 3 shows that with country fixed effects, *partsofmanuf* is significantly negatively correlated with volatility, while the rest of the variables are insignificant. The R-squared of the fixed effects regression lowered to 0.169 from 0.260 in the original fixed effects regression that did not remove outliers (Regression Results Table 1), and the F-statistic likewise lowered to 2.565 from 4.554. However, the dramatic change in results with the omission of outliers indicates that the three

exceptional data points within one country were driving the results for all countries pooled together, leading to misleading results.

Regression Results Table 4 shows the results with the added variable to account for fluctuations in the currency, again excluding the outliers. In the time series regressions, *currencyfluct* does not show a significant relationship with volatility and does not substantially change the results for the main independent variables, though it does slightly reduce their significance (see Columns 1-5). When all countries are pooled together (Column 6), only *year* shows a significant negative coefficient. With the inclusion of country fixed effects (Column 7), *partsofmanuf* shows a negative relationship with export volatility (p-value<0.05). *Currencyfluct* shows a positive correlation significant with a p-value<0.1, and the addition of this variable increases the R-squared and the F-statistics. These changes indicate that the revised model has a better fit and explains more about the relationship between the independent and dependent variables, confirming its efficiency as a control variable.

Regression Results Table 5 shows the results for the model with alternative proxy variables for supply chain participation, *lowinchain* and *highinchain*. When the two variables are included simultaneously, none of the main independent variables are significant in the time series or panel data regressions. When only *highinchain* is added, the main variables are not significant for any time series or panel regressions (see Regression Results Table 6). In Regression Results Table 7, only *lowinchain is included*, which shows that in the time series regressions the only significant result is a negative correlation between *lowinchain* and volatility for the Philippines. For the OLS pooled regression (Column 6), the main variables are not significant. However, with country

fixed effects *currencyfluct* shows a positive correlation and *lowinchain* is negatively correlated with a p-value less than 0.5. This outcome is very similar to the fixed effects regression with the *partsofmanuf* variable, which had only a slightly stronger coefficient and marginally larger R-squared and F-statistic values.

Tests for Panel Data Regressions

The pooled OLS estimation results may be biased and inefficient because of two specification problems. First, the unobserved error terms may be correlated with the variables, making the estimate biased. Second, there could be correlation between the time-invariant errors across countries, or the errors within each country for each year. In other words, the error terms may be serial correlated, making the OLS model inefficient. To find unbiased and efficient effects, adjustments are made to the revised model (Regression Results Table 4) that omits outliers and adds *currencyfluct*.

The GLS Fixed Effects model is tried first, a slightly different approach than including the country dummies used in previous models, but the results do not change. There is also the possibility that the OLS results are not biased (the error term is not correlated with the independent variables), but the estimates are inefficient because the error terms are serially correlated. As an alternate model to correct for inefficiency, the GLS Random Effects panel model is employed. The results from this model (see Regression Results Table 8) show that *partsofmanuf* remains negatively correlated, but is now only marginally significant; the p-value is slightly above 0.1 (0.122). The currency fluctuation variable is no longer statistically significant (p-value of 0.211), while in this

model the *year* variable becomes highly significant (p-value=0.003) with a negative coefficient.

To test whether Fixed Effects or Random Effects are a more appropriate adjustment to my model, the Hausman test is run. The null hypothesis of the test is that the Random Effects model is appropriate, suggesting that the model does not demonstrate a correlation between a time-invariant component of the error term and the independent variables. The concept behind the test is that the Fixed Effects model has the limitation that it is a "within country estimator" in that it exploits variation of the variables within each country. However, the weak result of the Hausman test[20]suggests that Random Effects is the preferred specification.

A number of tests on the panel data regressions were run to further assess the strength of the model. Woolridge's Test for serial correlation is tried, and the result does not reject the hypothesis of no first order autocorrelation. This result leads to the conclusion that the model does not have a serial correlation problem. Next was the Likelihood Ratio Test for heteroskedasticity, and the results show that the model does have a heteroskedasticity problem. The corrections for heteroskedasticity do not alter the main findings of the study, that the proportion of parts out of total exports in the new manufacturing industries is significantly negatively correlated with export volatility while the other main variables are not significant. Therefore only changes to *partsofmanuf* are shown in Table 5. The correction for heteroskedasticity in the pooled regression (Row 4) results in the same coefficient as the uncorrected pooled regression, but interestingly, a slightly more significant p-value. Row 5 shows the GLS estimate

[20] The Hausman test result was 0.088, while test results less than 0.05 are considered appropriate to use the Fixed Effects model.

corrected for heteroskedasticity of the pooled regression with country fixed effects. The coefficient is only marginally lower in absolute value, while the p-value is likewise more significant. The correction for heteroskedasticity therefore improves the robustness of the result.

Chapter 5: Interpretations and Conclusions

I conclude from these results that supply chain participation is not correlated with higher volatility within each country, while region-wide participation in the supply chain may be a source of export stability for the region, contradicting my hypothesis. As discussed in the previous chapter, tests showed that the original model was not entirely accurate or efficient. I therefore base my main conclusions on the final revised model with omitted outliers and additional control variables.

I expected to find a positive relationship between manufacturing exports and volatility of export values, and a negative relationship between parts and components exports and volatility. Beginning with the time series regressions, the results do not show a significant relationship between export volatility and participation in the supply chain for each country. In other words, for each of the countries, with the exception of Thailand, shifting into the new supply chain oriented industries and increasing levels of intra-regional intermediate goods trade did not trigger greater volatility.

While the effect of supply chains was neutral and not de-stabilizing within each country, the panel data results show that supply chains have actually helped stabilize the region. The supply chain participation proxy variable, *partsofmanuf*, showed a statistically significant negative relationship with volatility that remained consistent throughout several improvements to the model.

While this study expected to find de-stabilizing effects of supply chain participation, many studies in the literature (discussed in Chapter 3) found that supply

chains were stabilizing. My result could reflect the features of Asia's intra-regional production network observed by other empirical studies. In the case of external demand shocks, such as the 2008 Global Financial Crisis, studies found that Asia's trade network helped the region withstand external headwinds. The network's resilience to demand shocks may be explained by the Southeast Asian countries' tendency to continue to conduct intermediate goods trade and allow inventory to build up. In the case of supply shocks, the region's reliance on intermediate goods trade could pressure firms to prioritize maintaining stability and resuming trade. However, supply shocks occur less frequently in manufacturing industries than in agriculture and primary products, and may be too rare to cause a noticeable result in a long-term study such as this one. Supply chains could therefore be more susceptible to supply shocks than my results suggest.

In addition to contradicting my hypothesis, my results provide a number of interesting implications. First, supply chain participation has a stronger effect on volatility than does specialization in new industries. I conclude this from the significance of the supply chain participation proxy variable, but the lack of significance of the proxy for concentration in new industries in the final adjusted model.

Another interesting finding is that supply chain participation does not appear to be the major factor determining volatility differences between the countries. Region-wide, volatility has declined over time. In most of the regressions, volatility displayed a negative time trend, though it was not always significant. This indicates that the region has seen greater export stability in the past few decades. However, it is not clear to what extent my model can explain these changing patterns. This is because volatility is influenced by additional time-invariant characteristics of the countries that my model

does not account for. It is to be expected that supply chain participation is not the only factor determining volatility differences between the countries. However the high significance of country fixed effects shows that there are substantial factors missing from this model. The model was not strong with regard to the proportion of the dependent variable that was explained by the independent variables. I conclude from this that the structure of the region's trade network is not the major driver of volatility patterns.

My results also indicate that export volatility has varied for countries located at different parts in the supply chain, though the results were not entirely consistent across models. When I included the additional variable to measure participation in the supply chain, the share of parts and components imports in the new industries, parts imports had a negative correlation with volatility, while parts exports had a positive correlation. This suggests that being lower down in the supply chain tends to have destabilizing effects, while the members of the chain at the final assembly stages have greater benefits from the supply chain system with regard to export stabilization. However, these results were not entirely accurate because parts imports and parts exports demonstrated multicollinearity. I therefore draw my conclusions from the alternative measure of countries' placement in the supply chain, the RCA index.

Using the RCA index to estimate countries' placement in the supply chain, I tried two separate models to compare results when a country was low in the chain and high in the chain. For the *highinchain* variable, based on a relatively high concentration in parts and components imports relative to the world's concentration in parts and components imports, an increasing value did not show a significant relationship with

volatility either within countries or across countries. However, when countries had greater participation lower in the chain, a negative correlation was observed across countries. For the time series regressions, the Philippines also demonstrated a negative correlation for *lowinchain.* This is consistent with the finding from my main model that concentrating in intermediate goods exports is stabilizing. As discussed in Chapter 2, intermediate goods production entails capital-intensive high value-added operations. This result therefore suggests that supply chains may have more benefits for the high-skilled countries than for the comparatively low-skilled countries that specialize in basic final assembly.

The main limitation of this study is the lack of consensus in the literature about measurement technique for most of the variables used here: participation in the supply chain, export volatility, and the role of each country in the supply chain. There is also a lack of available data pertaining to country placement in the supply chain, partially because the Southeast Asian economies have changed specialties within the electronics and automotive industries over time. This makes it difficult in a time series study to identify countries primarily as intermediate goods producers lower in the supply chain, or as final goods assemblers at the top of the chain. Testing a range of measurement techniques was outside of the scope of this study, but the number of significant findings in this study suggests that further research on more accurate and efficient measurements would be useful.

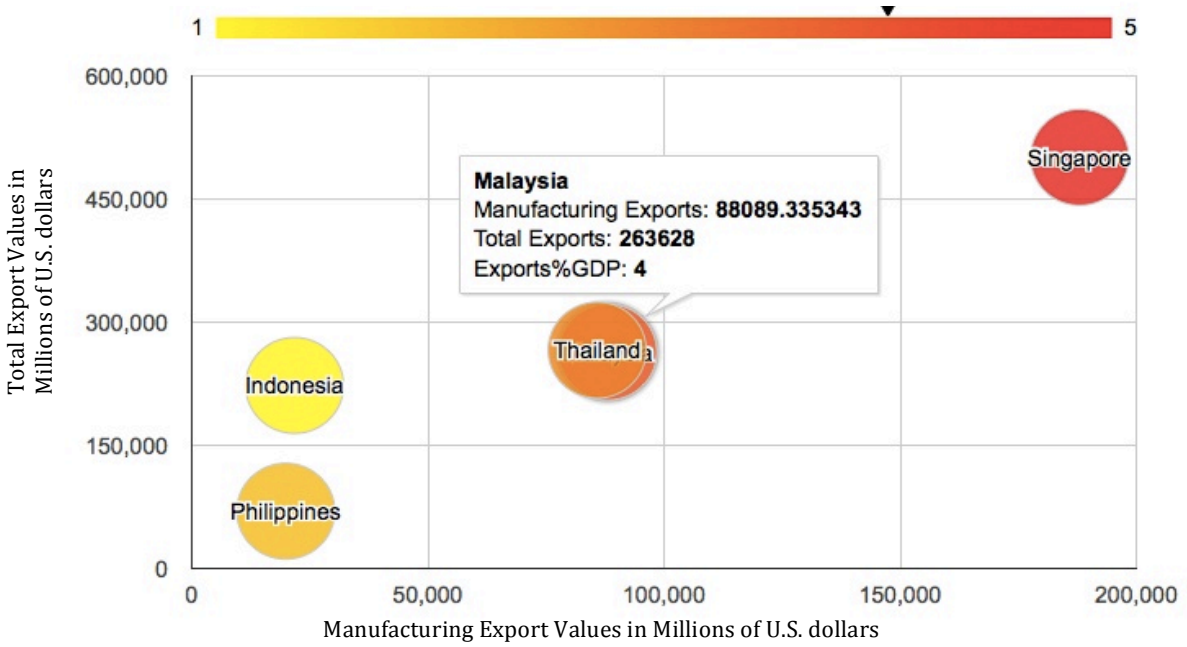
This study demonstrates the need for further research on this topic. With supply chains becoming more integral to the global economy, and Southeast Asia becoming a center for manufacturing supply chains, policymakers and manufacturers need to know

how much volatility to expect and tolerate, and consider steps to mitigate the problem. This study finds that supply chains have a positive effect for stabilizing the region, and, furthermore, that for individual countries they are not de-stabilizing.

Appendix: Figures and Tables

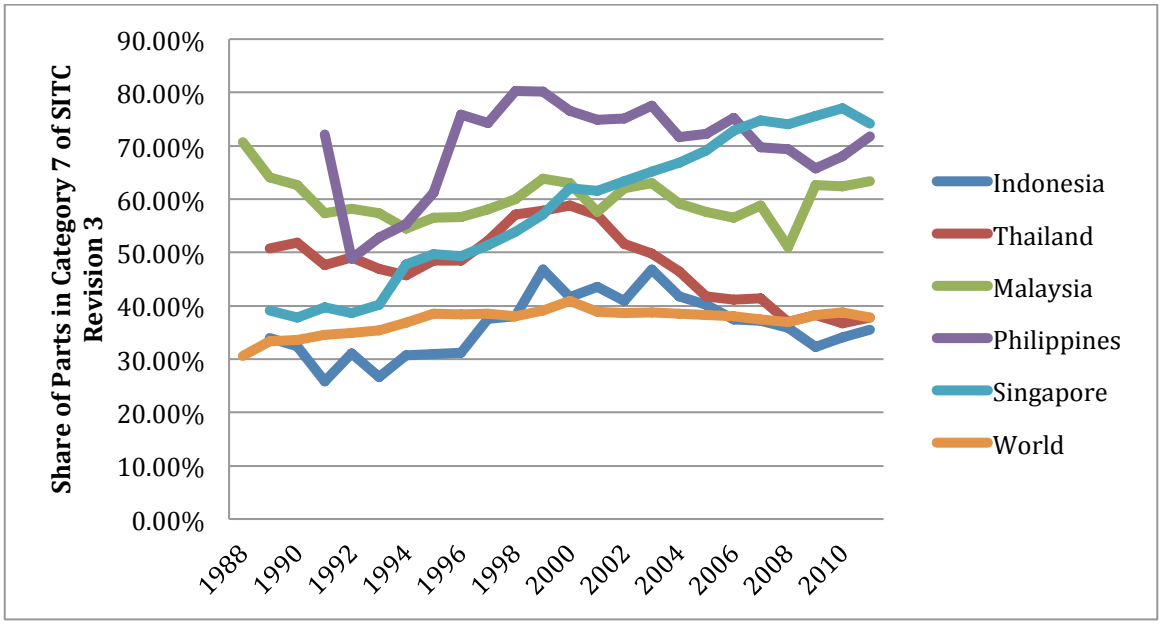
All figures and tables created by the author using the specified data sources, except Figure 3.

Figure 1: Trade Profile of Five Economies



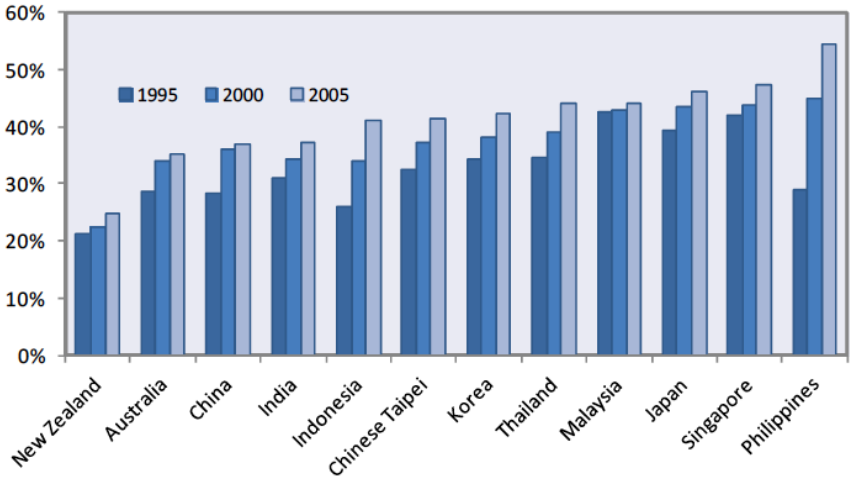
Source: UN Commodity Trade Database; World Bank World Development Indicators

Figure 2: Contribution of Parts to Transport and Machinery Exports



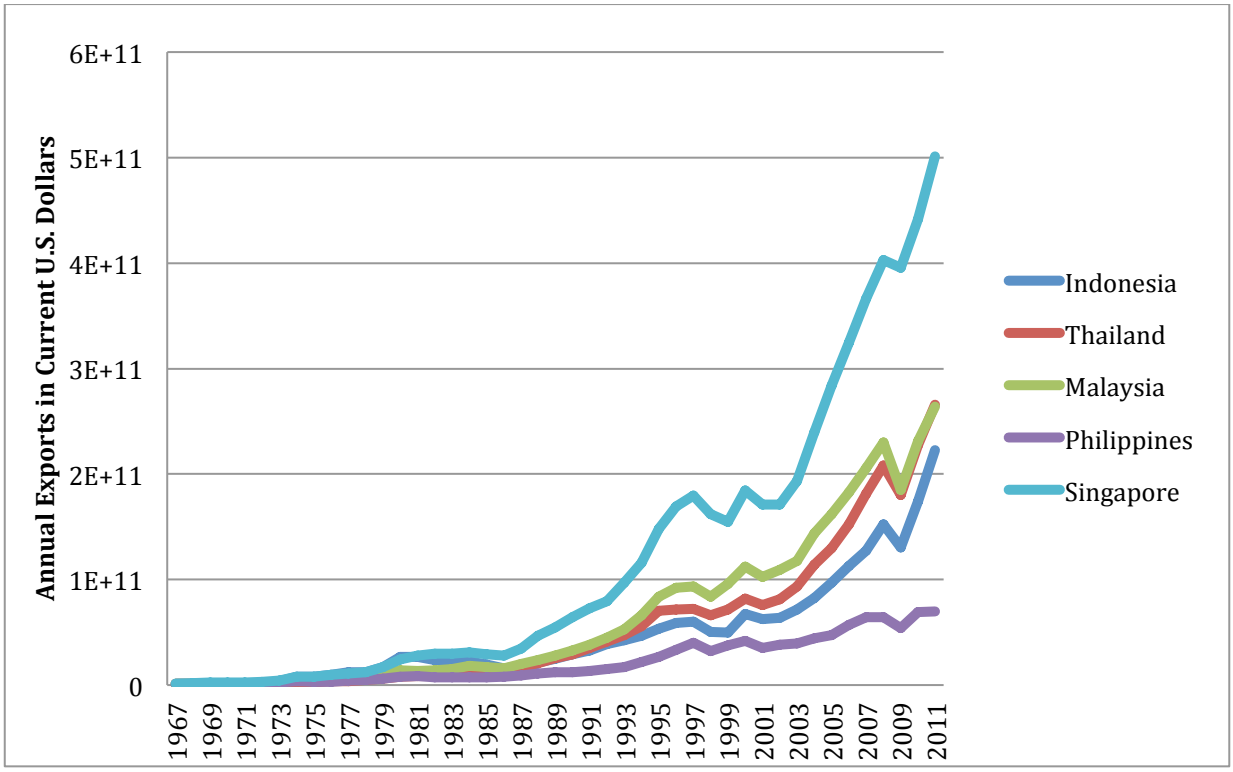
Source: World Bank World Development Indicators

Figure 3: REI Index for Selected Asian Countries



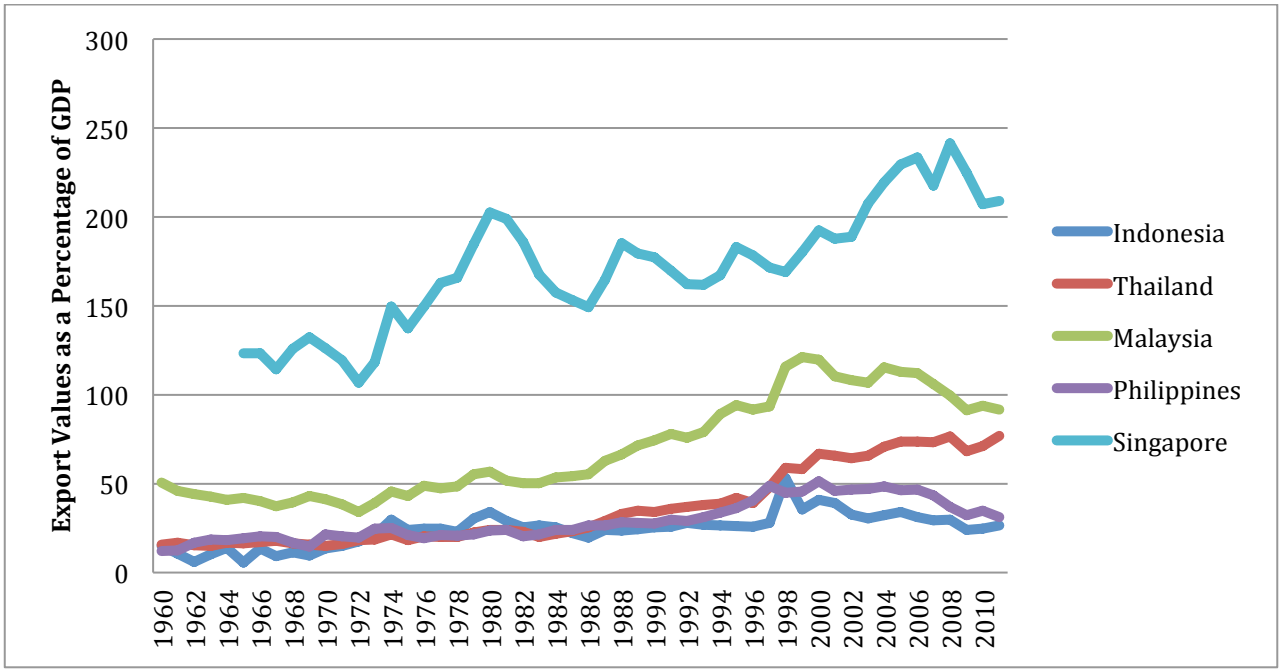
Source: Created by Fukasaku, 2011; OECD data

Figure 4: Annual Export Growth 1967-2011



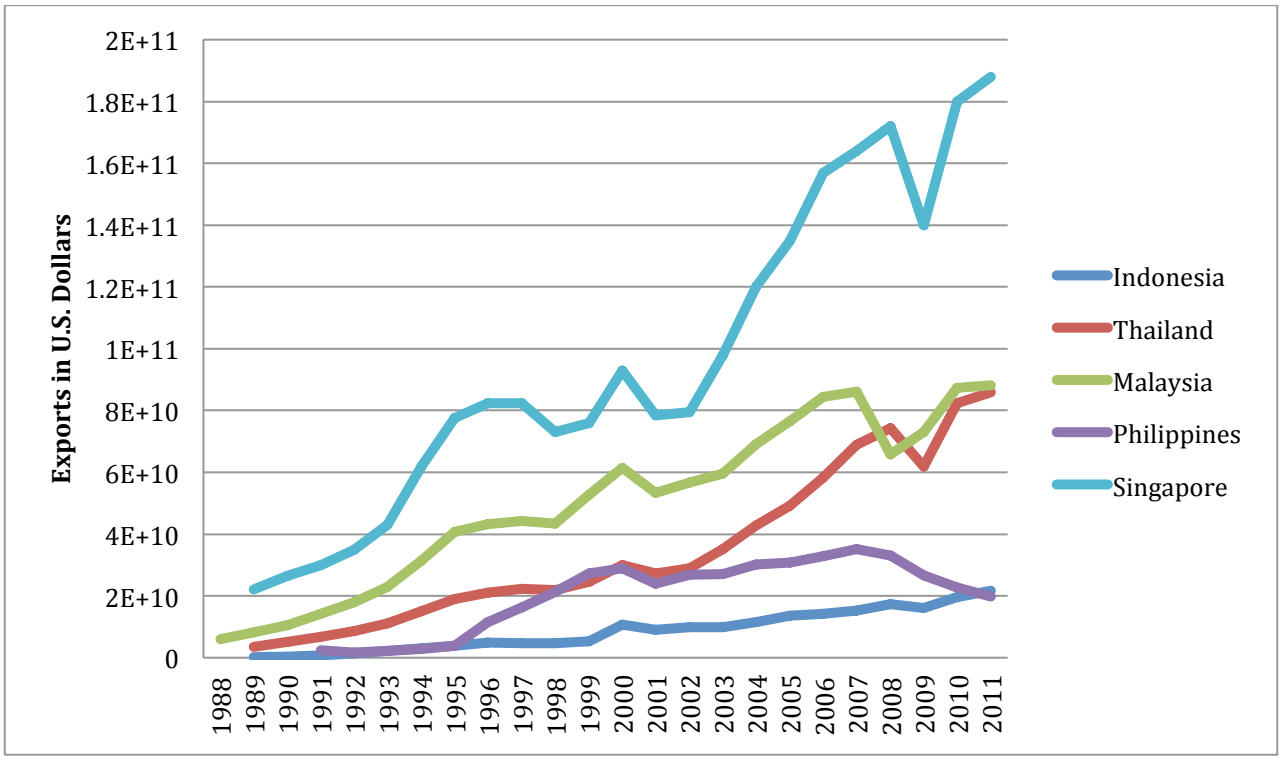
Source: World Bank World Development Indicators

Figure 5: Contribution of Exports to GDP



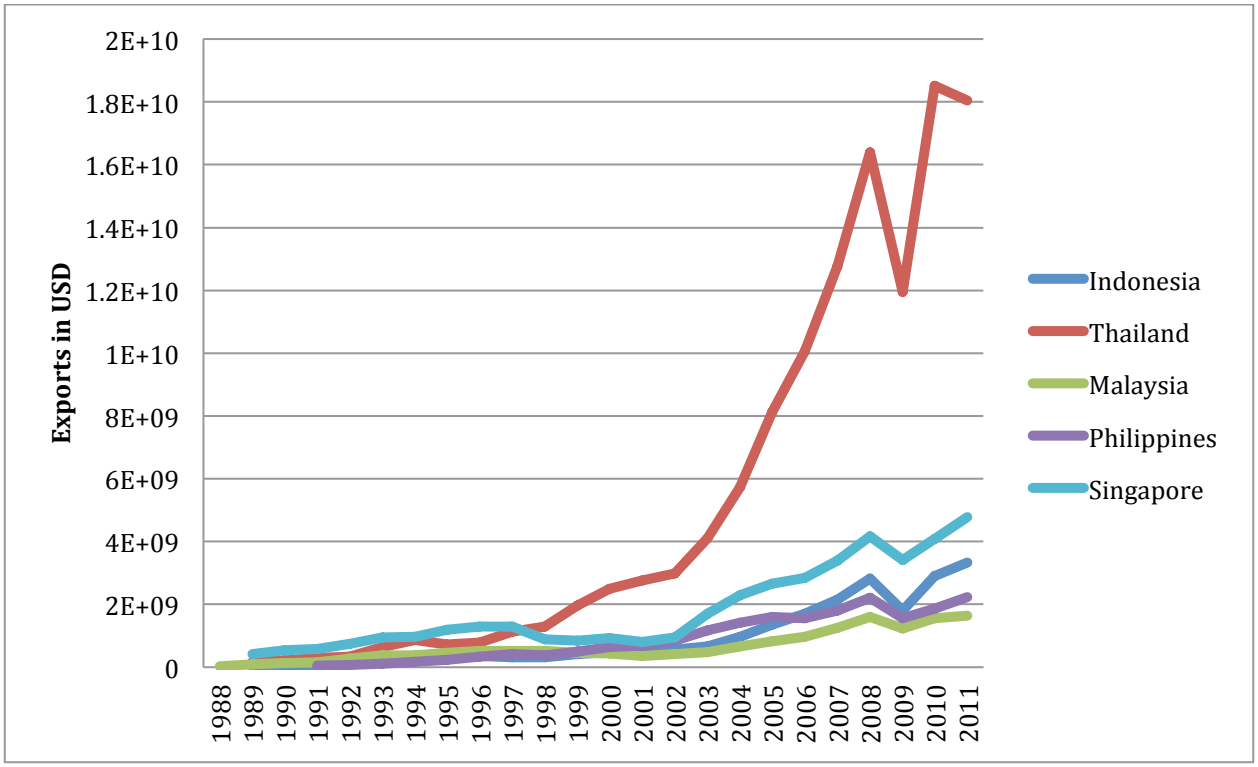
Source: World Bank World Development Indicators

Figure 6: Manufacturing Exports in the Machinery and Transport Equipment Industries



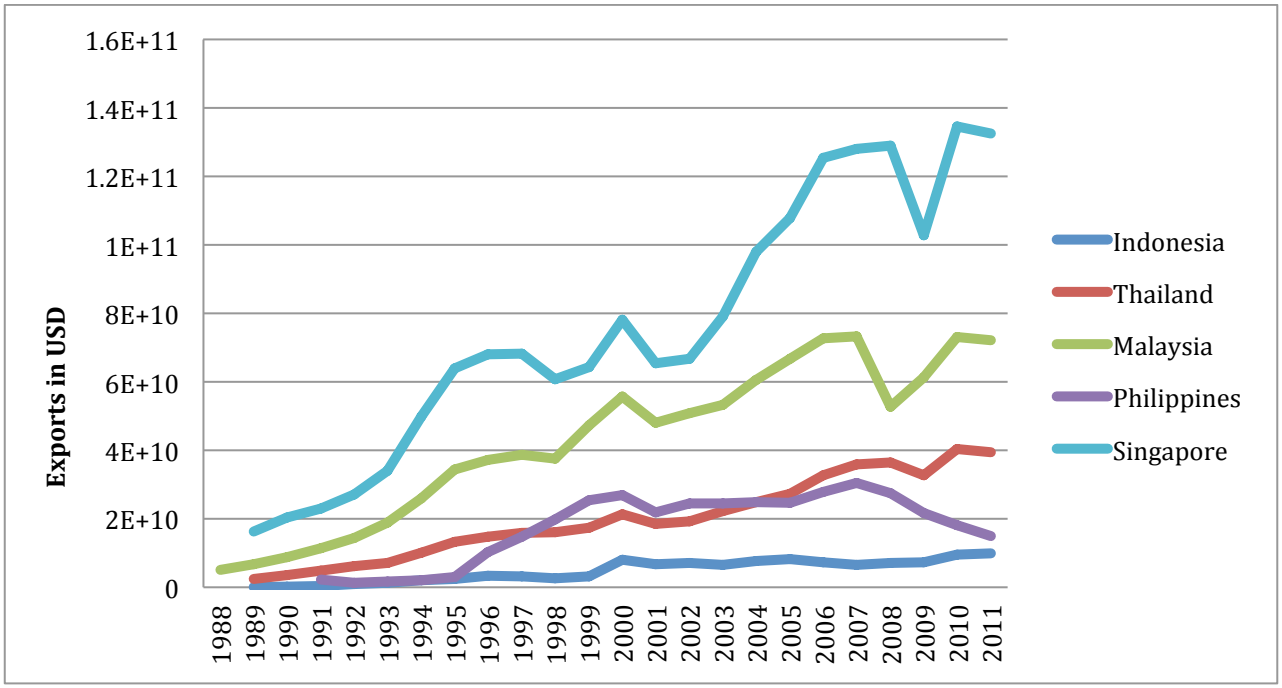
Source: UN Commodity Trade Database

Figure 7: Total Automotive Exports



Source: UN Commodity Trade Database

Figure 8: Total Electronics Exports



Source: UN Commodity Trade Database

Table 1

RCA Indices: Parts and Components Exports Within New Industries					
	Indonesia	Thailand	Malaysia	Singapore	Philippines
1988			2.3		
1989	1.0	1.5	1.9	1.2	
1990	1.0	1.5	1.9	1.1	
1991	0.7	1.4	1.7	1.1	2.1
1992	0.9	1.4	1.7	1.1	1.4
1993	0.8	1.3	1.6	1.1	1.5
1994	0.8	1.2	1.5	1.3	1.5
1995	0.8	1.3	1.5	1.3	1.6
1996	0.8	1.3	1.5	1.3	2.0
1997	1.0	1.4	1.5	1.3	1.9
1998	1.0	1.5	1.6	1.4	2.1
1999	1.2	1.5	1.6	1.5	2.1
2000	1.0	1.4	1.5	1.5	1.9
2001	1.1	1.5	1.5	1.6	1.9
2002	1.1	1.3	1.6	1.6	1.9
2003	1.2	1.3	1.6	1.7	2.0
2004	1.1	1.2	1.5	1.7	1.9
2005	1.0	1.1	1.5	1.8	1.9
2006	1.0	1.1	1.5	1.9	2.0
2007	1.0	1.1	1.6	2.0	1.9
2008	1.0	1.0	1.4	2.0	1.9
2009	0.8	1.0	1.6	2.0	1.7
2010	0.9	0.9	1.6	2.0	1.8
2011	0.9	1.0	1.7	2.0	1.9

Source: UN Commidity Trade Database

Table 2

RCA Indices: Parts and Components Imports Within New Industries

	Indonesia	Thailand	Malaysia	Singapore	Philippines
1988			1.8		
1989	0.8	1.5	1.6	1.5	
1990	0.9	1.5	1.5	1.5	
1991	1.0	1.5	1.5	1.4	1.8
1992	1.0	1.4	1.5	1.4	1.3
1993	1.1	1.4	1.6	1.4	1.3
1994	1.1	1.3	1.5	1.5	1.3
1995	1.0	1.3	1.5	1.6	1.1
1996	1.0	1.4	1.6	1.5	1.6
1997	0.9	1.4	1.6	1.5	1.8
1998	1.0	1.5	1.8	1.6	2.1
1999	1.0	1.5	1.9	1.7	2.0
2000	0.9	1.6	1.8	1.7	1.9
2001	1.0	1.5	1.8	1.6	2.1
2002	1.0	1.4	1.9	1.7	2.2
2003	0.9	1.4	1.9	1.7	2.2
2004	0.9	1.5	1.8	1.7	2.2
2005	0.8	1.4	1.8	1.8	2.2
2006	0.7	1.4	1.8	1.8	2.2
2007	1.0	1.5	1.8	1.8	2.1
2008	0.9	1.4	1.7	1.7	2.0
2009	0.9	1.4	1.7	1.7	1.9
2010	0.9	1.4	1.7	1.7	1.8
2011	0.9	1.2	1.6	1.7	1.5

Source: UN Commodity Trade Database

Figure 9: Twoway Scatterplot of *volatility* and *manufexports*

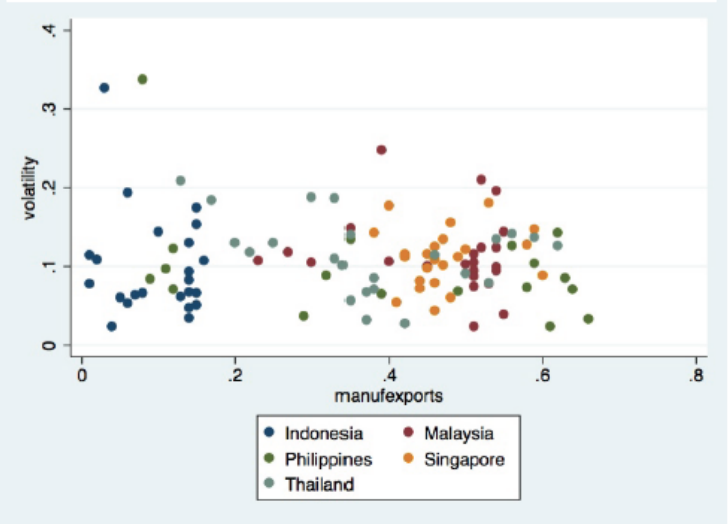


Figure 10: Twoway Scatterplot of *volatility* and *partsofmanuf*

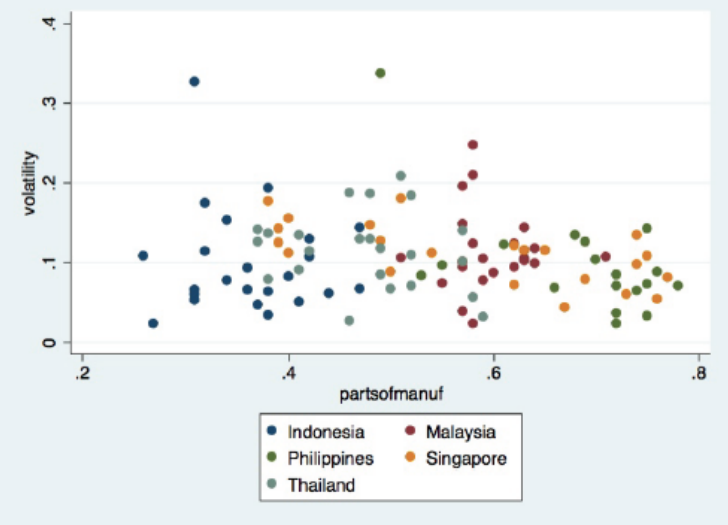


Figure 11: Twoway Scatterplot of *volatility* and *exportsgdp*

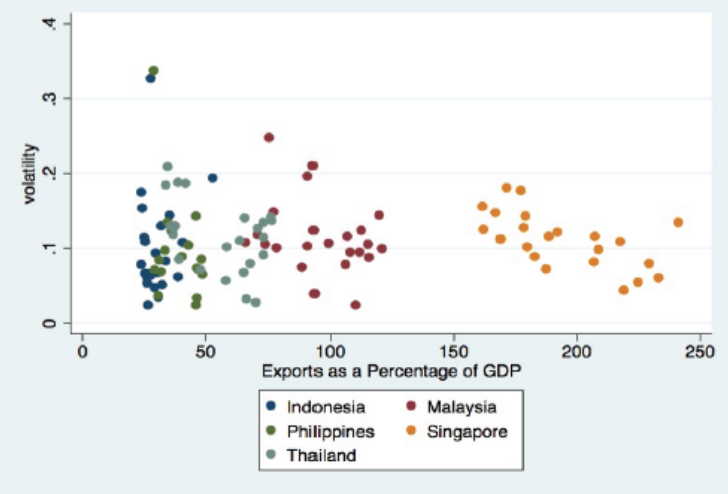


Figure 12: Scatterplot of *volatility* and *year*

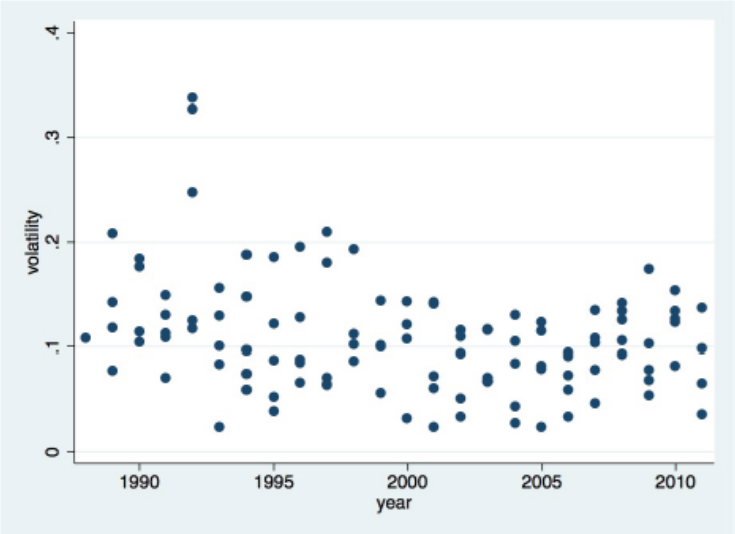


Figure 13: Scatterplot of *manufexports* and *year*

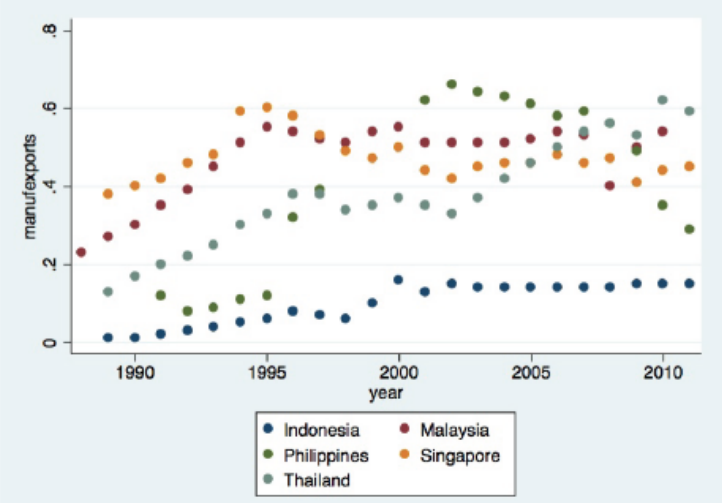


Figure 14: Twoway Line *volatility*

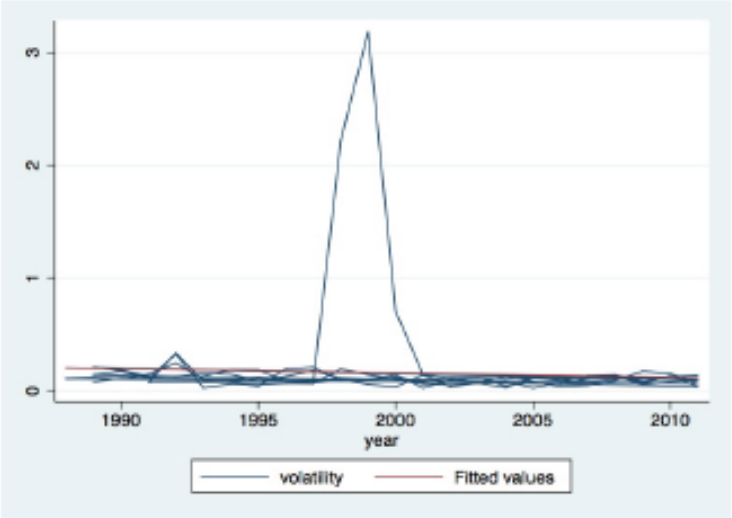


Figure 15: Twoway Line *manufexports*

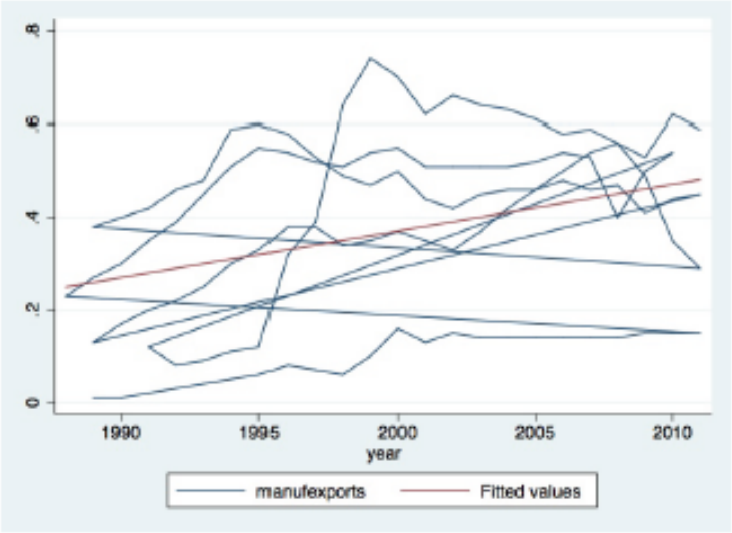
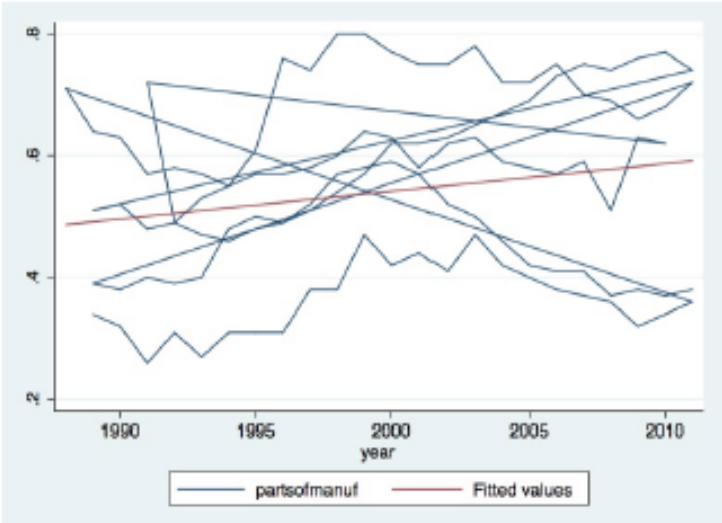


Figure 16: Twoway Line *partsofmanuf*



Regression Results Table 1

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.003	-0.001	0.001	-0.000	-0.094**	-0.002***	-0.000
	(0.003)	(0.001)	(0.003)	(0.001)	(0.040)	(0.001)	(0.003)
manufexports	-0.986	0.111	-0.087	0.035	4.659***	0.642***	1.258***
	(0.897)	(0.204)	(0.264)	(0.117)	(1.576)	(0.229)	(0.285)
partsofmanuf	-0.036	-0.042	-0.516**	-0.343	2.038	0.418	0.847**
	(0.407)	(0.298)	(0.214)	(0.315)	(2.659)	(0.273)	(0.410)
year	0.006	-0.001	-0.006	0.004	-0.102***	-0.010**	-0.021***
	(0.006)	(0.002)	(0.010)	(0.006)	(0.032)	(0.005)	(0.007)
country==Malaysia							-0.640***
							-0.219
country==Philippines							-0.420**
							-0.192
country==Singapore							-0.568
							-0.429
country==Thailand							-0.419***
							-0.139
Constant	-11.852	1.547	11.358	-7.302	205.792***	20.269**	41.435***
	(12.279)	(4.558)	(18.858)	(11.266)	(63.676)	(10.205)	(12.942)
Observations	23	23	23	23	21	113	113
R-squared	0.1326	0.1088	0.4050	0.4378	0.5027	0.1591	0.2594
Adjusted R-squared	-0.0601	-0.0892	0.2728	0.3129	0.3783	0.1280	0.2025
F	0.688	0.549	3.063	3.505	4.043	5.109	4.554
df_m	4.000	4.000	4.000	4.000	4.000	4.000	8.000
df_r	18.000	18.000	18.000	18.000	16.000	108.000	104.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 3

Results for Dickey Fuller Test on Uhat: P-Values	
Indonesia	0
Indonesia drift	0
Indonesia trend	0
Thailand	0.001
Thailand drift	0.0003
Thailand trend	0.0103
Malaysia	0.0003
Malysia drift	0.0001
Malaysia trend	0.0035
Philippines	0.0347
Philippines drift	0.0038
Philippines trend	0.1382
Singapore	0
Singapore drift	0
Singapore trend	0.0001

Figure 18: Partial Autocorrelation (PAC) Plots for Indonesia, Malaysia, and Thailand

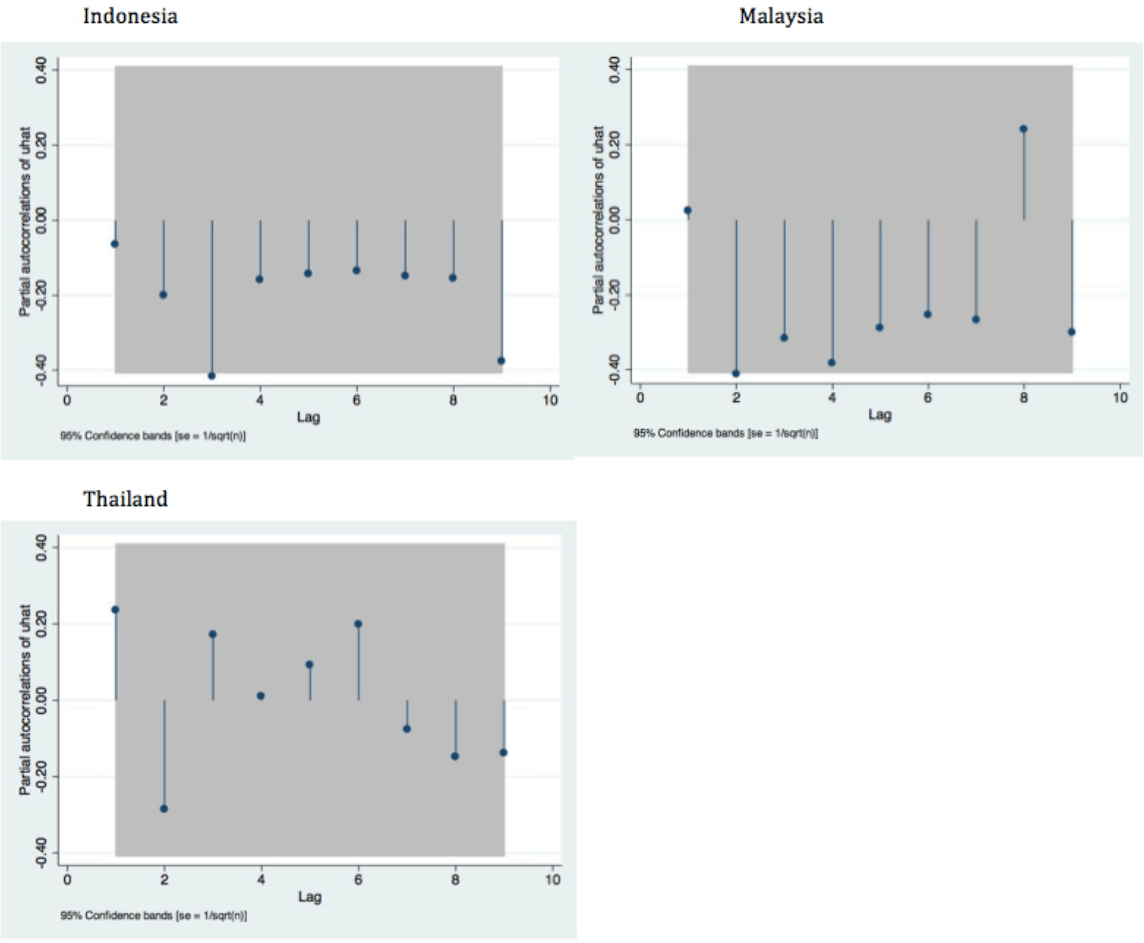


Figure 17: PAC Plots for Singapore and the Philippines

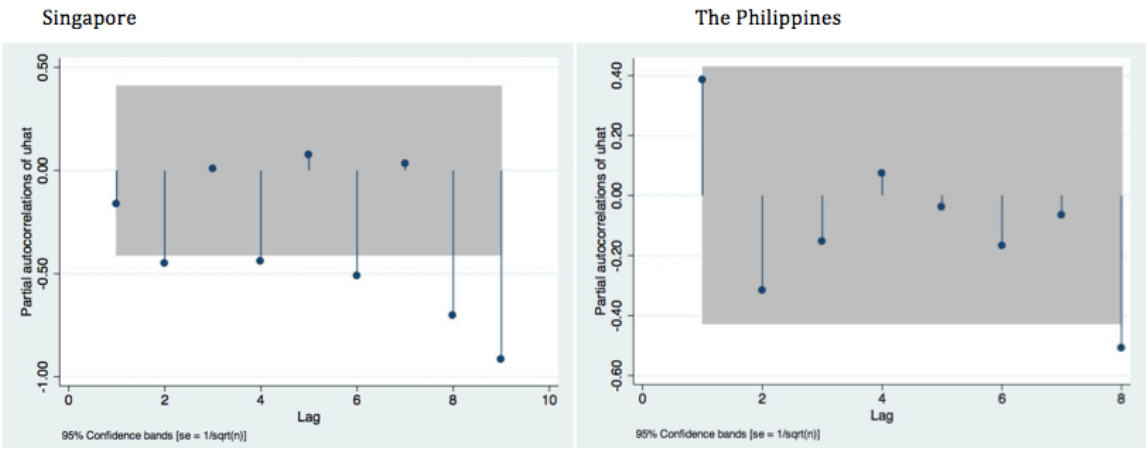


Table 4

Durbin-Watson: d-statistics	
Indonesia	2.104
Malaysia	1.941
Thailand	1.707
Philippines	1.104
Singapore	2.324

Regression Results Table 2

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.003	-0.002	0.003	-0.000	-0.097**	-0.002***	0.001
	(0.003)	(0.002)	(0.003)	(0.001)	(0.034)	(0.001)	(0.003)
manufexports	-0.954	0.119	0.086	0.055	8.321***	1.360***	1.841***
	(0.943)	(0.209)	(0.274)	(0.128)	(1.915)	(0.365)	(0.377)
partsofmanuf	-0.031	-0.222	-0.222	-0.208	3.311	1.362***	1.514***
	(0.420)	(0.455)	(0.274)	(0.440)	(2.309)	(0.463)	(0.495)
partsimports	-0.070	0.292	-0.682	-0.125	-7.084**	-1.648**	-1.537**
	(0.432)	(0.549)	(0.422)	(0.279)	(2.648)	(0.662)	(0.668)
year	0.006	-0.002	-0.009	0.003	-0.068**	-0.008*	-0.020***
	(0.006)	(0.003)	(0.009)	(0.006)	(0.030)	(0.005)	(0.006)
country==Malaysia							-0.639***
-0.215							
country==Philippines							-0.306
-0.195							
country==Singapore							-0.714*
-0.425							
country==Thailand							-0.398***
-0.137							
Constant	-11.446	4.068	18.277	-5.141	139.643**	17.005*	39.249***
	(12.871)	(6.638)	(18.567)	(12.490)	(59.487)	(10.053)	(12.718)
Observations	23	23	23	23	21	113	113
R-squared	0.1340	0.1234	0.4842	0.4444	0.6633	0.2052	0.2957
Adjusted R-squared	-0.1207	-0.1344	0.3325	0.2810	0.5511	0.1680	0.2341
F	0.526	0.479	3.192	2.720	5.911	5.524	4.804
df_m	5.000	5.000	5.000	5.000	5.000	5.000	9.000
df_r	17.000	17.000	17.000	17.			

Regression Results Table 3

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.003	-0.001	0.001	-0.000	-0.002	0.000	-0.000
	(0.003)	(0.001)	(0.003)	(0.001)	(0.004)	(0.000)	(0.000)
manufexports	-0.986	0.111	-0.087	0.035	0.147	0.026	-0.067
	(0.897)	(0.204)	(0.264)	(0.117)	(0.187)	(0.037)	(0.052)
partsofmanuf	-0.036	-0.042	-0.516**	-0.343	-0.535*	-0.069	-0.161**
	(0.407)	(0.298)	(0.214)	(0.315)	(0.266)	(0.043)	(0.068)
year	0.006	-0.001	-0.006	0.004	-0.003	-0.002***	-0.001
	(0.006)	(0.002)	(0.010)	(0.006)	(0.004)	(0.001)	(0.001)
country==Malaysia							0.091**
							-0.038
country==Philippines							0.073**
							-0.032
country==Singapore							0.106
							-0.07
country==Thailand							0.058**
							-0.024
Constant	-11.852	1.547	11.358	-7.302	6.453	4.903***	1.376
	(12.279)	(4.558)	(18.858)	(11.266)	(7.854)	(1.614)	(2.210)
Observations	23	23	23	23	18	110	110
R-squared	0.1326	0.1088	0.4050	0.4378	0.3981	0.1094	0.1688
Adjusted R-squared	-0.0601	-0.0892	0.2728	0.3129	0.2129	0.0755	0.1030
F	0.688	0.549	3.063	3.505	2.150	3.224	2.565
df_m	4.000	4.000	4.000	4.000	4.000	4.000	8.000
df_r	18.000	18.000	18.000	18.000	13.000	105.000	101.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Regression Results Table 4

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.004	-0.001	0.001	-0.000	-0.003	0.000	-0.000
	(0.006)	(0.001)	(0.003)	(0.001)	(0.005)	(0.000)	(0.000)
manufexports	-1.172	0.105	-0.063	0.039	0.168	0.033	-0.066
	(1.363)	(0.208)	(0.296)	(0.120)	(0.203)	(0.038)	(0.051)
partsofmanuf	-0.043	-0.028	-0.498*	-0.348	-0.528*	-0.067	-0.161**
	(0.421)	(0.305)	(0.236)	(0.322)	(0.276)	(0.043)	(0.067)
year	0.007	-0.000	-0.006	0.004	-0.003	-0.002***	-0.000
	(0.009)	(0.002)	(0.010)	(0.006)	(0.004)	(0.001)	(0.001)
currencyfluct	-0.046	0.515	-0.107	1.396	1.075	0.084	0.129*
	(0.248)	(0.870)	(0.510)	(2.779)	(3.036)	(0.067)	(0.068)
country==Malaysia							0.109***
							-0.038
country==Philippines							0.080**
							-0.032
country==Singapore							0.141*
							-0.072
country==Thailand							0.068***
							-0.024
Constant	-14.255	0.904	12.383	-6.952	6.888	4.997***	0.764
	(18.105)	(4.768)	(19.989)	(11.529)	(8.225)	(1.611)	(2.206)
Observations	23	23	23	23	18	110	110
R-squared	0.1344	0.1268	0.4065	0.4461	0.4043	0.1226	0.1978
Adjusted R-squared	-0.1202	-0.1300	0.2320	0.2832	0.1561	0.0804	0.1256
F	0.528	0.494	2.329	2.738	1.629	2.906	2.739
df_m	5.000	5.000	5.000	5.000	5.000	5.000	9.000
df_r	17.000	17.000	17.000	17.000	12.000	104.000	100.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Regression Results Table 5

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.004	-0.002	0.001	-0.000	-0.004	0.000	-0.001
	(0.007)	(0.002)	(0.003)	(0.001)	(0.006)	(0.000)	(0.000)
manufexports	-1.290	0.071	-0.064	0.051	0.125	0.031	-0.062
	(1.356)	(0.257)	(0.360)	(0.130)	(0.375)	(0.062)	(0.069)
lowinchain	0.027	-0.072	-0.125	0.092	-0.208	-0.015	-0.045
	(0.169)	(0.145)	(0.159)	(0.167)	(0.120)	(0.028)	(0.030)
highinchain	0.069	0.078	-0.173	-0.102	0.039	-0.005	-0.010
	(0.195)	(0.236)	(0.197)	(0.129)	(0.151)	(0.041)	(0.042)
year	0.008	-0.001	-0.007	-0.005	-0.004	-0.003***	-0.001
	(0.009)	(0.003)	(0.012)	(0.006)	(0.005)	(0.001)	(0.001)
currencyfluct	-0.053	0.522	-0.310	1.491	1.331	0.084	0.129*
	(0.260)	(0.889)	(0.601)	(2.943)	(3.140)	(0.068)	(0.069)
country==Malaysia							0.114***
							-0.041
country==Philippines							0.076**
							-0.035
country==Singapore							0.156**
							-0.073
country==Thailand							0.071***
							-0.025
Constant	-16.301	1.894	14.306	9.651	8.835	5.292***	1.266
	(18.899)	(5.374)	(23.233)	(12.346)	(9.213)	(1.684)	(2.292)
Observations	23	23	23	23	18	110	110
R-squared	0.1406	0.1399	0.3384	0.4358	0.4135	0.1130	0.1849
Adjusted R-squared	-0.1817	-0.1827	0.0903	0.2243	0.0936	0.0613	0.1025
F	0.436	0.434	1.364	2.060	1.292	2.187	2.245
df_m	6.000	6.000	6.000	6.000	6.000	6.000	10.000
df_r	16.000	16.000	16.000	16.000	11.000	103.000	99.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Regression Results Table 6

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.004	-0.001	0.000	-0.000	-0.007	0.000	-0.001
	(0.006)	(0.002)	(0.003)	(0.001)	(0.006)	(0.000)	(0.000)
manufexports	-1.263	0.105	0.072	0.029	0.327	0.048	-0.006
	(1.306)	(0.243)	(0.313)	(0.122)	(0.385)	(0.052)	(0.058)
highinchain	0.058	-0.008	-0.226	-0.088	-0.096	-0.023	-0.047
	(0.177)	(0.156)	(0.183)	(0.123)	(0.139)	(0.023)	(0.035)
year	0.008	-0.000	-0.005	-0.002	-0.006	-0.003***	-0.001
	(0.009)	(0.002)	(0.011)	(0.002)	(0.005)	(0.001)	(0.001)
currencyfluct	-0.059	0.519	-0.550	1.637	1.506	0.086	0.129*
	(0.251)	(0.870)	(0.512)	(2.870)	(3.394)	(0.068)	(0.069)
country==Malaysia							0.095**
							-0.039
country==Philippines							0.053*
							-0.031
country==Singapore							0.144*
							-0.073
country==Thailand							0.061**
							-0.025
Constant	-15.962	0.804	11.185	3.282	11.449	5.430***	2.020
	(18.232)	(4.797)	(22.633)	(4.356)	(9.828)	(1.658)	(2.249)
Observations	23	23	23	23	18	110	110
R-squared	0.1393	0.1266	0.3128	0.4250	0.2520	0.1105	0.1665
Adjusted R-squared	-0.1139	-0.1303	0.1107	0.2559	-0.0597	0.0677	0.0915
F	0.550	0.493	1.548	2.513	0.808	2.584	2.220
df_m	5.000	5.000	5.000	5.000	5.000	5.000	9.000
df_r	17.000	17.000	17.000	17.000	12.000	104.000	100.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Regression Results Table 7

	(1) Indonesia	(2) Malaysia	(3) Thailand	(4) Singapore	(5) Philippines	(6) PanelData	(7) CountryFixedEffects
exportsgdp	0.004	-0.001	-0.000	-0.001	-0.005	0.000	-0.001
	(0.007)	(0.001)	(0.003)	(0.001)	(0.005)	(0.000)	(0.000)
manufexports	-1.218	0.055	-0.124	0.031	0.205	0.025	-0.073
	(1.306)	(0.246)	(0.351)	(0.127)	(0.205)	(0.037)	(0.053)
lowinchain	0.006	-0.037	-0.173	0.065	-0.192*	-0.017	-0.050**
	(0.154)	(0.096)	(0.149)	(0.161)	(0.098)	(0.016)	(0.025)
year	0.007	-0.000	-0.003	-0.005	-0.005	-0.003***	-0.000
	(0.009)	(0.002)	(0.011)	(0.006)	(0.004)	(0.001)	(0.001)
currencyfluct	-0.042	0.507	-0.186	1.150	1.351	0.084	0.128*
	(0.252)	(0.865)	(0.580)	(2.880)	(3.015)	(0.068)	(0.069)
country==Malaysia							0.115***
-0.04							
country==Philippines							0.074**
-0.033							
country==Singapore							0.159**
-0.072							
country==Thailand							0.071***
-0.025							
Constant	-14.613	1.163	7.365	9.576	9.788	5.244***	1.127
	(17.809)	(4.777)	(21.693)	(12.212)	(8.126)	(1.625)	(2.210)
Observations	23	23	23	23	18	110	110
R-squared	0.1339	0.1339	0.3066	0.4135	0.4098	0.1129	0.1844
Adjusted R-squared	-0.1208	-0.1209	0.1027	0.2411	0.1639	0.0702	0.1110
F	0.526	0.526	1.504	2.398	1.667	2.647	2.512
df_m	5.000	5.000	5.000	5.000	5.000	5.000	9.000
df_r	17.000	17.000	17.000	17.000	12.000	104.000	100.000

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Regression Results Table 8

	(1) FixedEffects	(2) RandomEffects
exportsgdp	-0.000	0.000
	(0.000)	(0.000)
manufexports	-0.066	0.033
	(0.051)	(0.038)
partsofmanuf	-0.161**	-0.067
	(0.067)	(0.043)
year	-0.000	-0.002***
	(0.001)	(0.001)
currencyfluct	0.129*	0.084
	(0.068)	(0.067)
Constant	0.844	4.997***
	(2.186)	(1.611)
Observations	110	110
R-squared	0.1824	
Adjusted R-squared	0.1088	
F	4.462	
df_m	9.000	5.000
df_r	100.000	

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 5: Comparison of the *partsofmanuf* Result in Various Panel Models
(Based on the revised model excluding outliers and including *currencyfluct*).

		Coefficient	P-value	t-statistic
	Pooled OLS Panel Data	-0.67	0.125	-1.55
	Fixed Effects (Country Dummies)	-0.161	0.018	-2.4
	Random Effects	-0.067	0.122	-1.55
corrected for het.	**Pooled with xtpcse, het**	-0.67	0.108	
corrected for het.	**Country Dummies: GLS estimator**	-0.136	0.016	

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