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IMPACT OF HUMAN CAPITAL ON GLOBAL VALUE CHAINS IN ASIA AND SOUTHEAST ASIAN REGION

a thesis
by

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Abstract

This thesis examines the relationship between human capital development and global value-chain (GVC) activities in East Asia. It seeks to examine the following: (a) the impact of human capital development on the domestic firm participation in global value chains, (b) impact of human capital development and the impact of SME participation in the GVC, and (c) the effects of servicification and impact on productivity of the firms.

The first empirical approach adopted in the thesis is the gravity model framework to identify the relationship between a human capital and GVC participation based on cross-country panel data of 11 countries in East and Southeast Asia. The GVC participation is decomposed into forward GVC and backward GVC linkages at the firm level for the respective ASEAN and East Asian countries. Empirical results indicate the importance of education and skills in enhancing the domestic firm engagement in GVC activities. The results indicate that countries in the sample with higher education and skills are more likely to join forward GVC participation through the supply of domestically produced intermediate inputs to other countries along global production networks. For backward GVC participation, skills of workers seemed to be more important than education level in the GVC participation. We also find evidence that trade policies in form of tariff, free trade agreements and trade facilitation, proximity and quality of transport and logistics system play significant roles in determining the magnitude of value-added trade in East and Southeast Asia.

The second approach adopts firm heterogeneity theory based on firm-level analysis in selected ASEAN countries. The firm level GVC participation is measured by status of import of raw materials and exporting products, while human capital is proxied by share of skilled workers. The results suggest that firms that join global value chain activities are more likely to have higher levels of human capital, higher productivity, more capital assets, and higher technological capacities. The result also highlights the importance of a conducive business environment in the GVC participation of the firms. The firm heterogeneity approach in our study is extended to understand the effects of human capital on SMEs' GVC participation based on Indonesian firm-level data. The results suggest that SMEs that are export-based and with linkages to global value chain activities are more likely to have a higher level of human capital, higher productivity, more assets, and investment in research and development.

The third approach adopted in the thesis is the semi-parametric method to understand the productivity effect of servicification of manufacturing GVC activities in Indonesia. Empirical strategy involves two procedures. The first stage involves the estimation of productivity from the Cobb-Douglas

production function using a semi-parametric method developed by Levinsohn and Petrin (2003). The second stage involves regressing the estimated productivity with servicification variables, which is measured by share of industrial service cost to total input and share of service revenues to total output. Our results demonstrate the significant contribution of services both in supply side and demand side in helping firms raise productivity. We also find evidence suggesting the importance of firm heterogeneity in boosting productivity. Factors such as foreign ownership, access to finance, and participation in global value chains are positively associated with productivity.

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Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Chapter 1

Introduction

1.1. Background

Global production has undergone dramatic change to a higher degree of fragmentation, in which several countries are involved in supply of parts, components and then assembly and distribution of final outputs into consumers worldwide. The classic example of production fragmentation is the manufacturing of Apple iPhone, which involves a series of complex tasks performed in various countries. The design is made in the United States; software from India; a silicon chip from Singapore and basic resources such as metals that are mined in Bolivia. Other major countries that supply iPhone parts and components include Korea, Japan, Germany and France (OECD, 2011). All components are shipped to China for assembly into final products and then exported to the United States for global marketing and distribution. Apple Inc. is the lead firm in charge of slicing up the iPhone production into various stages and then coordinating the manufacturing and services activities with its affiliates, contractual partners and arm's-length suppliers in the production and distribution of final goods. Fragmentation of production dated back since 1970s during which US retailers and big brand-name companies offshore their labour-intensive activities overseas in search of cheap labour advantage (Gereffi, 2013). However, the dynamics of the GVC changed due to the speed, scale, depth and breadth of value chains in which production fragmentation occurred beyond the manufacturing sector to services such as accounting, medical procedure and call centres (Elms & Low, 2013; Gereffi & Sturgeon, 2013). Moreover, value chains networks have expanded geographically involving countries with different levels of development from various regions as well as organizationally creating the more complex and multi-layer inter-firm networks across the globe. The rise of GVC is driven by technological progress, advance in transport and logistic sector that lead to significant decline in trade costs, a more liberal regional and national policies toward freer trade and investment flows, and the opening up of emerging economies, especially China and India (Amador & Cabral, 2016; Athukorala,

2011; R. Baldwin, 2012, 2013; De Backer, De Lombaerde, & Iapadre, 2018; Humphrey & Schmitz, 2002). Many scholars believe GVC will continue to increase in its prominence in the 21st century.

There are several theories from different disciplines that explain GVC paradigm. For instance, what was initially termed 'global commodity chains' and later fine-tuned to 'global value chains' was pioneered by Gereffi and Korzeniewicz (1994) and further crystallised by Gereffi et al. (2005); and Gereffi and Fernandez-Stark (2011). Their frameworks employ the chains analysis to explain the relationship of economic actors in a specific industry value chains. Arndt and Kierzkowski (2001) constructed what is called the 'production fragmentation' theory to explain the role of location advantages and service activities in linking production blocs across geographical areas. Economists like Grossman and Rossi-Hansberg (2008) defined such production process as a 'trading tasks'; R. Baldwin (2016) termed it as 'globalization's second unbundling'; while economic geographers like Coe et al. (2008) and Henderson et al. (2002) conceptualized it as 'global production network'. This thesis acknowledges the different underlying concepts and terminologies of global value chains. Nevertheless, we use these terminologies interchangeably.

The rise of GVC has transformed international economic landscape in several ways. One of the most notable change is trade pattern, shifting from trade in final goods to trade in parts and components. WTO and IDP-JETRO (2011) estimated that trade in intermediate goods in 2009 represents more than 50% of non-fuel merchandise trade. The share of intermediate input trade is found even higher (over 50% of goods trade and almost 70% of services trade) in Gurría (2015) and roughly two third in Johnson and Noguera (2012). In his latest book on the new globalization, R. Baldwin (2016) describes the '21st century trade' as growing exchange of parts and components along with international movement of production facilities, personnel and know-how. Another major shift caused by GVC relates to the growing role of services in manufacturing production and international commerce. Specifically, service has been increasingly integrated in manufacturing production in particularly in terms of the increasing use of service inputs in production process; consumption of service activities in manufacturing; and the bundle of services with products to add value and sharpen customer relationship. These shift in service-manufacturing linkages is termed as 'servicification' (Baldwin et al. 2015; Kommerskollegium, 2010; Lanz and Maurer, 2015; Miroudot and Cadestin, 2017). In similar discussion on the role of services in production and international trade, R. W. Jones and Kierzkowski (1990) argues that the speed and efficiency of service links would result in optimal degree of fragmentation and that the gains from service liberalization may exist in form of greater participation in production process. R. Baldwin (2016) regards services such as telecommunication, transport and logistics, trade-related finances and custom clearance necessary to coordinate fragmented production. The importance of services in GVC is manifest in large by increasingly share

of service in value added trade, accounting for more than 40% in 2009 rising from 30% in 1985 (Heuser & Mattoo, 2017).

The critical question for us is why GVC matters? There are at least two important explanation to believed why GVC is critical to scholars and policy makers. The most important rationale relates to economic significance of GVC. Despite having no consensus, there is a growing thinking that participating in GVC is the fundamental element in the modern development policy that offers wide range of economic benefits especially in terms of increasing trade and investment, enhancing greater competitiveness and growth. R. Baldwin (2012) and OECD (2013) firmly argue that joining value chains is the easier and faster way to industrialization and development. Similarly, there are growing evidences suggesting that countries with faster economic growth and higher income are strongly associated with higher GVC participation (Cattaneo, Gereffi, Miroudot, & Taglioni, 2013; Gereffi & Sturgeon, 2013; Saito, Ruta, & Turunen, 2013). Bair (2005) and Gereffi (1999b) attributed the growth trajectories of East Asian economies in the 1980s to their success of integrating into global value chains. There are also increasing evidences for example in Kang et al. (2010) and Miroudot et al. (2009) that GVC enhances industrial productivity and thus leading to improvement in the performance of private sector including small and medium enterprises (SMEs) through supplying intermediate goods and services (Cattaneo et al., 2013; De Backer et al., 2018). Key to industrial and economic upgrading is acquisition of new technology and knowledge to enhance supply competence. GVC is associated with transfer of knowledge and technology (Cattaneo et al., 2013; Humphrey & Schmitz, 2002) and can push countries to acquire new competency and skills (Sturgeon, 2001). Finally, there is general agreement that GVC has become a transformational force in global economy, and it is an increasingly important area in international trade, investment and economic development.

The way in which GVC has changed the way in which economic policies are designed makes it crucial and necessary to development policy. Gereffi (2014), for example, criticises the existing nation-centred development model known as the Washington Consensus, which is primarily concerned with whether economic policy is market-friendly or overly interventionist that it has been severely weakened. He then proposes the post-Washington Consensus agenda taking account of the role of GVC as alternative development strategy. For Gereffi, GVC has opened a radically new development path and participation in global value chains is a necessary step for industrial upgrading. Cattaneo et al. (2013) asserted that competitiveness of the GVC framework shifts from industries to tasks and business functions and the way forward for most countries is not about developing integrated industries, but to identify the best position in the GVC. For R. Baldwin (2013), the GVC has altered concept of comparative advantage from a national to an increasingly regional one due to the fact that most goods are now produced using productive factors from many countries. In effect, GVC changes

the process of industrialization. Specifically, GVC allows developing countries to industrialize at lower cost and investment by just joining GVC, rather than building whole industrial supply chains within their national boundaries. While R. Baldwin (2012) proposes a 'join-instead-of-build development paradigm', Gereffi and Sturgeon (2013) calls for 'GVC-oriented industrial policy' to leverage dynamic global production networks to improve a country's role in global value chains. In parallel, GVC has been increasingly incorporated in the policy agenda of national economic strategy as well as international organizations' development interventions. Many countries have embraced the idea that integrating into GVC is the key to economic growth. Even international institutions that provide the underpinning for the Washington-Census, such as the World Bank, the IMF and the WTO as well as major bilateral development agencies have embraced GVC framework as new heterodox model of development thinking (Gereffi, 2014; Neilson, 2014). In effect, developing countries are advised to open up their economies to international trade and investment and to improve infrastructure and logistics services so that they can join GVC. This has led to widespread adoption of value chain framework as development practice over the past decades.

Given its economic significance and policy relevance, there are growing and strong interests from academic and policy research on GVC. Existing literature can be grouped into three broad strands namely mechanics of production fragmentation (i.e. Arndt and Kierzkowski (2001); Grossman and Helpman (2005)); the analysis of value chain governance (i.e. Gereffi (1994), Gereffi et al. (2005)), and measuring global value chains (i.e. Chen et al. (2008) , De Backer and Miroudot (2014), Koopman et al. (2014)). A more comprehensive review of conceptual and empirical literature on GVC, which will be thoroughly discussed in Chapter 2, suggests that there have been limited empirical investigation into nexus between human capital and GVC. Among them are studies by Kowalski et al. (2015) and Cheng, Rehman, Seneviratne, and Zhang (2015) which assessed the impacts of education and policy factors on GVC participation. Their overall finding is that education is key to GVC participation. In the East Asian region, Kimura et al. (2007); Athukorala (2011) and Taguchi et al. (2014) used trade in parts and components to measure GVC trade and incorporated income and wage gaps to capture the impact of diversity of the labour market on GVC trade. Their results indicated that logistic quality, market structure, and features of the labour market help developed and developing countries to integrate in global production networks. There were also some studies that examined the role of human capital and GVC activities in Asia and important role of education and training in helping countries and firms to integrate in supply chains (Thangavelu et al., 2017; Wignaraja, 2015).

However, the previous studies on human capital and GVC have several limitations. The first major shortcoming relates to the measure of GVC participation which is often proxied by trade in parts and components. Although parts and components trade represent GVC-intensive activities, the measure

per se neither completely captures the magnitude of GVC activities nor does it cover the value-added trade in services (De Backer et al., 2018). Kowalski et al. (2015) and Cheng et al. (2015) attempt to remedy that statistical weakness by using an alternative GVC participation index from a well-established database known as Trade in Value-added (TiVA) as the dependent variable in their empirical analysis. Although the index provides insights on the degree and type of a country's contribution in the value chain, there was still econometric issues with regards to sample size. The second major limitation of ins the existing GVC-human capital literature relates to the lack of aggregate indicator to capture whole dimension of human capital. The research to date has used years of schooling or share of tertiary education to measure human capital and ignore other key dimensions of human capital such as quality of education and skills. Inability to appropriately capture the full effects of human capital on GVC represents a significant research gap in the current literature. This thesis, therefore, intends to remedy this knowledge gap by empirically assessing the extent to which human capital affects GVC participation for countries in East and Southeast Asia. In particular, we employ two different but complementary empirical approaches. The first approach adopts production fragmentation theory and uses a gravity model to analyse the role of human capital, market structure and trade policies on value-added trade. In this approach, human capital is measured by three proxies: year of schooling, quality of education and skills. The second approach adopts firm heterogeneity theory and uses firm-level analysis to understand the contribution of education and training to a firm's participation in value chain activities. Evidence from both approaches provide insightful relationships between effects of country-level factors and policies as well as firm-level endowment and participation in value chains.

In the age of global value chains, service activities have emerged as even more crucial inputs in the whole manufacturing process. Firms consume greater business services, ICT and financial services to coordinate and operate their production linkages and activities in the GVC. They also consume transport, logistics, wholesale and retails services to ease flow of products from one stage of production to another. Some scholars have described services as a 'glue' in GVC (Baldwin et al., 2014; Low, 2013; Miroudot and Cadestin, 2017; Heuser and Mattoo, 2017). Further, recent trade data shows that aggregate share of service inputs in manufacturing has risen in most parts of the world including in OECD countries (Miroudot & Cadestin, 2017; Nordås, 2010), in Europe (Kommerskollegium, 2016), in Asia (Baldwin et al., 2014; Mercer-Blackman & Ablaza, 2018; Thangavelu et al., 2017). Another associated shift in service-manufacturing linkage is the growing numbers of manufacturing firms that have integrated the services into their core products in order to differentiate their products and enhance the competitive edge of business. The growing importance of service in manufacturing is termed as 'servicification of manufacturing' (Baldwin et al., 2015; Kommerskollegium, 2010; Miroudot & Cadestin, 2017).

Amidst the rising servicification in the manufacturing activities, there were concerns about the impact of servicification on the productivity growth of firms and respective countries. Empirical studies on servicification and productivity to date have been restricted to services outsourcing and offshoring. For example, Girma and Görg (2004), Görg et al. (2008), Amiti and Wei (2009), Winkler (2010) and Schwörer (2013) used firm-level data to assess the effect of servicification on firm productivity. Their results suggest that service offshoring has a significant positive effect on productivity in the manufacturing sector. However, there is still lack of empirical investigation on service revenue and productivity, which represents a huge knowledge gap in international trade literature. This thesis aims to remedy this limitation by assessing the effects of servicification on productivity from aspects of purchasing services (supply side of service) as well as selling services (demand side of service).

1.2. Research objectives

The overall objective of the thesis is to examine the relationship between human capital development and GVC activities in East Asia and ASEAN. Particularly, the dissertation has four specific objectives:

1) To map the nature and degree of participation in the global chain activities for Asia and ASEAN (Association of South East Asian Nations);
2) To determine the extent to which human capital affect GVC participation using firm level study (panel data);
3) To assess the role of human capital and other factors that will influence the participation of firms in the GVC activities using micro level data.
4) To estimate the productivity effect of servicification using a semi-parametric approach based on panel firm census data for Indonesia

To achieve these objectives, this thesis carefully undertakes the empirical estimation for Asia and ASEAN region. The reasons we chose this region for empirical investigation are three folds. Firstly, most economies in the region have been successfully integrated in and benefited from GVC (ADB, 2014; Constantinescu et al., 2018). R. Baldwin and Lopez-Gonzalez (2015) defined widespread emergence of production network in the region as 'Factory Asia'; while Kimura and Obashi (2016) portrayed the GVC activities in East Asia as distinctive and most developed production network due to its extensive participation by most economies and sophistication in network structure. Any in-depth analysis on the nature and factors influencing the region's GVC participation would add critical value to existing literature. Secondly, economies in East and Southeast Asia differ substantially in type and quality of human capital. The World Bank's human capital index in 2018 reveals that high-income

countries like Singapore, Japan and Korea are ranked top in human capital development, whereas lower middle countries such as the Philippines, Indonesia and Cambodia made slow progress in building human capital. The critical issue in this regard is the role of human capital in the GVC participation, and its impact on GVC activities and participation of the respective ASEAN countries. Thirdly, early academic works in East Asia focus primarily on mapping GVC (ADB, 2014; Obashi & Kimura, 2017; WTO & IDP-JETRO, 2011) and on effects of structural and trade policies on regional production networks (Athukorala, 2011; Kimura et al., 2007; Taguchi et al., 2014) . However, these studies did not fully address the relationship between human capital and GVC participation.

1.3. Structure of the thesis

This thesis is organized as follows. Chapter 2 reviews literature on GVC. It starts with a summary of key GVC concepts, followed by thorough discussion of existing literature on determinants of GVC participation and on servicification and productivity. The chapter concludes with identification of research gaps. Chapter 3 empirically assesses the impact of human capital on GVC participation using cross-country analysis. Chapter 4 quantifies the effects of human capital and other firm attributes on GVC participation in selected ASEAN countries based on firm-level analysis. The analysis consists of two parts: the first part involves pooling WBES (World Bank Enterprise Survey data) from Indonesia and the Philippines; and the second part is the country-specific case study of post-conflict least developed countries with Cambodia and Myanmar being chosen to represent newer ASEAN countries. Chapter 5 extends the analytical framework in the previous chapter to study the effects of human capital on SMEs' participation in global value chains using Indonesian firm-level data. In chapter 6, the research examines the effect of servicification on productivity using unbalanced panel firm-level data from Indonesian manufacturing industries. Chapter 7 provides the policy recommendations.

Chapter 2

Literature Review

This chapter reviews the conceptual and empirical literature on global value chains and its relevance to East Asia. It comprises of five sections. Section 1 briefly discusses key concepts of value chains. A comprehensive review of empirical studies on determinants of GVC participation is examined in section 2. It comprises of discussion both on cross-country studies and firm-level analysis. Section 3 reviews the literature on servicification of manufacturing with particular emphasis on the effect of servicification on productivity. Section 4 identifies research gaps.

2.1. Key concepts of global value chains

The evolution of global production value chains and its profound impacts on international trade, industrialisation and development has attracted various conceptual and empirical studies. There are at least five key concepts of global value chains that clearly defines the analytical and empirical literature.

Value chain system

The business management literature uses the term 'value chain' to identify the functional activities within firms that link together to create value for businesses and their customers. Conceptualised by Michael Porter in his book on 'Competitive advantage: creating and sustaining superior performance' in 1985, value chain framework is a tool for devising corporate strategy to promote competitiveness through analysing the relationship between various activities within organization with a view to minimise cost and maximise value creation (Porter, 1985). The principal argument grounded in Porter's value chain framework is that competitive advantage of a firm depends on its ability to manage various functional activities in the way that create value for customers. The concept classifies firm's activities into two broad categories according to the extent to which they are concerned with the

production and delivery of goods and services (Abe, 2015). Primary activities include inbound logistics, operations, outbound logistics, marketing and sales, services. Support activities are business functions such as procurement, human resource management, and infrastructure that support primary activities toward a greater effectiveness and efficiency. Since the concept allows researchers to analyse a firm's organisational system to improve competitiveness, it has gained popularity among business scholars (Henderson et al., 2002). Nevertheless, it has limited application especially when it comes to understand the institutional and locational factors that shape the nature and power relationship of the production networks. As a result, this concept has little relevance to the analysis of how global industries are organised and managed within and across nations and regions (Henderson et al., 2002).

Global commodity chain

The term 'global commodity chain or GCC' is originated in the field of economic sociology (Gereffi (1994); Gereffi (1996); Gereffi (1999a). The GCC framework seeks to understand the coordination of entire production and distribution system, and how risks and benefits are distributed among key economic actors. Specifically, it looks at three inter-related issues within value chain networks: (1) mapping input-output structure (a sequence of activities linking together to produce one commodity); (2) tracing the extent of dispersion of the production and distribution networks across the nation or what Gereffi and his collaborator refer to 'territoriality'; and (3) analysing the internal governance structure of supply chains. The GCC typified the chains governance structure into two categories. First is 'producer-driven commodity chains or PDCC, in which manufacturers play a crucial role in setting up and controlling the production and distribution system (Gereffi & Korzeniewicz, 1994). The second type of governance is known as 'buyer-driven commodity chains or BDCC', which is predominant in labour intensive industries such as garment, footwear, consumer electronics, toys and houseware. In this chain, the production networks are decentralised in various countries especially those adopting export-promotion development strategy. Oversea buyers or trading companies receive orders with exact product specification from retailers or brand-name companies, which are directly involved in the production and distribution of a commodity. Although retailers or brand-name companies do not own production facilities, they manage to extract large share of profits from these businesses through high capabilities in coordinating complex inter-firm network arrangements together with core competency in the design, marketing, and distribution of a commodity.

GCC had been widely influential in both academic and policy circles in the 1990s as manifest in the rise of GCC studies and a growing integration of the concept into the design of development policies by several international organizations (Bair, 2005, 2009). In his thorough discussion of the

origin and trajectories of global value chains, Kaplinsky (2013, p. 8) even regards GCC framework as 'parent of modern GVC theory'. Despite its methodological and policy-relevant merit, GCC framework encountered a few limitations notably in terms of difficulty to capture emerging types of production networks beyond manufacturing sectors. While the use of word 'commodity' implies ambiguity and restrictive to manufacturing, the categorization of chain types seems to lack important features of chain governance (Bair, 2009; Gereffi et al., 2001; Henderson et al., 2002) . Subsequently, a new generation of value chain concept known as 'global value chain or GVC' analysis was crystalized by Gereffi et al. (2005) .

Global value chain (GVC)

GVC analysis injects concepts of transaction economics and organizational economics into GCC framework to explain an emerging and ever evolving global production and distribution networks (Gereffi, 2013; Gereffi et al., 2005). In order to explain power relations among the chain actors, GVC framework identifies five different types of governance structure namely (a) market, (b) module, (c) relational, (d) captive, and (e) hierarchy based on a combination of the complexity of transactions, the ability to codify transaction, and the capacity in the supply-based measured as low or high. The underlying argument grounded in this framework is that power relation between lead firm and suppliers varies due to the sophistication of production process, organizational arrangement and effectiveness of industry actors. For example, in the market governance category in which transaction requires little explicit coordination, power balance is more symmetrical. In the modular category of governance that suppliers have capacities to produce complex product yet lead firm still needs direct control and monitoring, power asymmetries remain relatively low because both parties could engage multiple partners. Power balance is more asymmetrical toward lead firm such as in the case of captive governance in which production require high capacities to codify but supplier capacity is low. This leads to the situation where suppliers are confined to narrow range of tasks and lead firm exerted strong power and intervention on its partners.

Another key aspect in GVC framework is industrial upgrading defined as "the process by which economic actors—nations, firms, and workers—move from low-value to relatively high-value activities in global production networks" (Gereffi, 2005, p. 171). The underlining importance of upgrading is that participating in value chains does not guarantee social and economic developing and thus upgrading is critical to social and economic upgrading (Gereffi, 2005; Gereffi et al., 2001; Gereffi & Luo, 2014). The analysis identifies conditions and trajectories for countries to upgrade value chains. The framework suggests four potential modes of upgrading: product upgrading (moving to a production of more sophisticated or higher value-added goods); process upgrading (a more efficient rearrangement

of production networks e.g. via adopting a new technology); functional upgrading (a moving into high-skilled content of production); and chain upgrading (ability to move into new industries). The success of upgrading critically depends on a combination of factors including national government policies and institutions, private sector governance, technological capacities, and worker skills. Thus the development of the GVC framework has gained popularity as a tool to analyse international production configuration since 2000s (Bair, 2005; Gereffi & Lee, 2012). In addition, the increasing number of international institutions including World Bank, WTO, UNIDO, ILO and OECD and bilateral donors have embraced GVC framework as part of the development policies and framework (Cattaneo et al., 2013; De Backer et al., 2018; Gereffi, 2014; Lauridsen, 2018) .

Global production network

Another relevant value chain concept is rooted in economic geography. Developed by researchers in Manchester and their collaborators including Coe et al. (2008); Henderson et al. (2002), the concept known as 'global production network or GPN' defines value chains as "the nexus of interconnected functions and operations through which goods and services are produced, distributed and consumed" (Henderson et al., 2002, p. 445). The principal concern of GNP is factors that shape the nature and outcomes of production networks through insertion of three broad elements: value, power and embeddedness. Value is central to social and economic outcomes from the production network, in which the creation and capture of value vary according to access to technology, organizational and managerial skills, and inter-firm relationship. The concept of power involves two different layers. The corporate power, on the one hand, explains the extent to which lead firm can influence the decision of network arrangement and resource allocation. The institutional power, on the other hand, refers to those used by government and international organizations that can influence the configuration of production networks. GNP framework also believes that social, economic and political context can shape the nature and outcomes of the network. Those factors, which the framework labelled as 'territorial embeddedness', include state policy and legal frameworks, public institutions, training and labour system and corporate governance. This led to corresponding analysis of multi-stakeholders mainly firms and national economies as well as their diverse forms of relationship. Although GNP framework could capture greater complexity through its broader conceptual dimension, its influence and popularity has not yet widely spread as compared to GVC approach. Nevertheless, there are growing studies applied this framework to answer critical questions as follows: how are global production networks constructed and how do they evolve? what are the underlying governance structure behind these evolutions? and how benefits and lose? (Hess & Yeung, 2006).

Production fragmentation

This framework is one of influential concepts in the field of economics. Developed by R. W. Jones and Kierzkowski (1990) and R. W. Jones (2000), production fragmentation framework adopts doctrine of comparative advantage along with concepts of production block and service links to explain the fragmentation of production process. The primary focus is the role of service activities such as coordination, communication, administration, transportation, and financial services in linking production blocs across geographical areas. Under key assumptions that technology in each production blocs contains element of increasing return to scale and that increased specialization and division of labour alter the trade-off between fixed cost and variable cost, splitting up of production process into various blocs would occur if there is greater difference in input factors among those places along with significant reduction in service-link costs. The former factor is called 'location advantage' and is possibly influenced by low wage, availability and quality of human capital, existence of supporting industries, infrastructure services, and conducive policy environment. The greater disparities in productivities and factor prices, the more likely it encourages production fragmentation. For example, firms might locate labor-intensive block in less developed countries, while maintaining skill or capital-intensive component at home.

Cost of service links is also crucial in production fragmentation because firms need to coordinate and communicate among production block as well as to move components to other production blocks. Therefore, the reliability and cost of service links are very important in decision to split production stages. Factors attributive to cost of service links include tariff, quality of transport and logistics services, hard and soft infrastructure, quality of trade facilitation and financial services. This means country-specific factors including, but not limited to, market structure, human capital and labour market, quality of infrastructure and logistics along with more liberal policies in favour of cross-border trade and services will help countries join global value chains in some ways. Drawing on this conceptual construct, R. W. Jones and Kierzkowski (1990) argues that liberalization of service sectors is critical to participation in production blocks and gains from service liberalization may exist in form of greater participation in production process.

Trade in tasks

Another economic concept on value chain is offshoring model based on tradeable tasks or commonly known as 'trade in tasks' by Grossman and Rossi-Hansberg (2008). Unlike production fragmentation concept, which tries to understand factors and conditions lead to splitting of production process, trade in task framework examines the consequences of global production networks on price, resource allocation and welfare. The impacts of offshoring can be decomposed into three categories.

While productivity effects arise from cost saving from offshoring and usually skewed toward low-skilled labour, a relative price effect is a result of change in terms of trade as a result of fall in offshoring cost. Labour supply will be affected when factor price responds to factor supplies at a given relative price. The effects of offshoring differ from one condition to another. For example, reduction in cost of trade in tasks boost productivity factors whose tasks can be move offshoring easier. Also, all domestic parties can share gains from offshoring if the relative prices do not fluctuate significantly. In his review of analytical framework for global value chains, Inomata (2017) regards fragmentation theory and trade in task model as a third wave of reconstructing classical theory of international trade. The models are motivated by rapid change in international trade pattern and the boom in offshoring manufacturing tasks and business function that cannot be explained by classic theories. Over the past decades, trade in task theory has been widely used to explain impacts of global value chains on national economies.

Table 2.1 presents summaries of key value chain concepts discussed above. Two important points are worthy of noting. Firstly, there are multi-disciplinary theories that emerge to explain GVC paradigm, for example, from business management and economics fields to sociology and economic geography. While some of them share similar object of enquiry and analytical approach, others are developed independently. For example, GCC and GVC frameworks employ the chains analysis to explain the relationship of economic actors in a specific industry. Their primary objectives are to understand how that industry is organised and managed and to analyse how the chains governance shape a country's development prospect. In contrast, value chain constructs like production fragmentation is based on 'supply-use' relationship between trading partners to explain condition under which it encourages the splitting of production processes (Inomata, 2017, p. 28). Secondly, diversity of value chain frameworks permits wider scope of research collaboration across social science subjects (Inomata, 2017). For instance, one can link global value chains to industrialization or private sector development or it can be related to other broad economic issues including labour market, regional development, innovation and technology spill-overs, and trade regime (Inomata, 2017). This also signifies the vast significance and relevance of empirical investigation about the relationship between human capital and global value chains, the principal subject of investigation in this thesis.

Table 2.1: Summaries of key value chain frameworks

Concept	Disciplinary background	Object of enquiry	Orienting concept
Value system	Business management	Relationship between various activities within organization	• Effective management of functional activities is source of competitiveness • Primary activities (those directly involved in production and delivery of goods and services) are key and need to be added by ssupporting activities to achieve greater effectiveness and efficiency
Global commodity chains	Economic sociology	Inter-firm networks in global industries	• Industry's input-output structure and internal governance of supply chains • Distribution of benefits and risks differs according to type of governance typified as producer-driven commodity chains and buyer-driven commodity chains
Global value chains	Development economics	Sectoral logics of global industries	• Five types of governance (market, modular, relational, captive, and hierarchy) determined by the sophistication of production process, organizational arrangement and effectiveness of industry actors. • Each governance type implies different trade-off between benefits and risk • Conditions and trajectories for industrial upgrading (product, process, functional, and chains upgrading) are crucial to social and economic upgrading
Global production networks	Economic geography	Global network configurations and regional development	• Value creation and capture as well as corporate and institutional power are key to the nature and outcomes of production networks • Territorial embeddedness (e.g. state policy and legal frameworks, public institutions, training and labour system) are also influential on the outcomes of the production networks
Production fragmentation	Economics and trade	Factors and conditions that lead to the splitting up of production process into various components/blocs	• Fragmentation of production occurs if there are greater disparities in productivities and factor prices among various geographical locations • Significant reduction in service-link costs will also encourage fragmentation • Key to fragmentation processes are location advantages and liberal policies that reduce trade costs and improve service sector efficiencies
Trade in tasks	Economics and trade	Consequences of global production networks on resource allocations and welfare	• Impacts can be channeled through productivity, price and labour supply • Reduction in cost of trade in tasks boost productivities factors whose tasks can be move offshoring easier • All domestic parties can share gains from offshoring if the relative prices do not fluctuate significantly

Source: Bair (2005) and Coe and Hess (2008)

2.2. Empirical literature on GVC participation

As discussed in the earlier section, participating in GVC has been increasingly recognized as the fundamental element in economic growth trajectory. Almost all countries strive to join GVC but not every country succeeds. Factors that determine value chains activities are multi-facet and they can be location advantages, structural and economic conditions, regulatory and policy frameworks, the quality of infrastructure and logistics services, business and investment facilitation, and the availability and quality of human capital. This section reviews empirical studies on the determinants of GVC participation with great emphasis on the role of human capital in GVC. Our discussion focuses on two broad strands of literature: cross-country analysis (some scholars prefer to term it macro studies) and firm-level analysis (micro studies).

2.2.1. Determinants of GVC participation: cross-country analysis

Location advantage is a prerequisite to GVC participation

The production fragmentation theory states that firms have a couple of options to decide on production methods: they can either maintain all production stages in single block at home or outsource certain segments from domestic or international suppliers. The arrangement of production blocks can be in a sequent setting whereby each block supplies intermediate goods to other blocks until the final stage of production. The production arrangement can also be organized with a group of simultaneous production of inputs supplying to the final assembly elsewhere. Decision on production fragmentation arrangement broadly depends on the cost efficiency. In other words, firms would split production into various blocks at different locations if two fundamental prerequisites are satisfied. The first condition relates to location factors that cause greater differences in input factors or productivity. This condition, which is known as location advantage, is shaped by, among other things, low wage, availability and quality of human capital, existence of supporting industries, and conducive policy environment. The greater the disparities in productivities and factor prices, the more likely it encourages production fragmentation (R. W. Jones & Kierzkowski, 1990). Geography, market size and institutional quality also influencing a country's GVC trajectory (World Bank, 2020). For example, while low-skilled labor and foreign capital are central backward participation in GVC, an abundance of natural resources drives forward GVC integration (World Bank, 2020). On the other hand, remoteness, and longer geographical distances from the major GVC hubs have major negative impact on both backward and forward GVC participation (World Bank, 2020).

There are voluminous studies that attempt to test this theorem. Although using different statistical data and indicators to measure GVC participation and location-specific factors, empirical evidence

generally confirms the theoretical prediction that location advantage is critical to production fragmentation and integration in global value chains. Among the influential works is the study by Kowalski et al. (2015), which attempted to understand factors that drive GVC participation. The paper classified explanatory variables into two broad groups. The first category is called non-policy or structural factors and they include market size, level of development, degree of industrialization and remoteness. The second category refers to policy factors that include tariff, openness to investment, quality of institutions and access to finance. GVC participation is disaggregated into backward and forward GVC participation extracted from Trade in Value Added (TiVA) database. The paper adopts two estimation specifications. The first one regressed backward and forward participation index with structural and policy factors. This specification was better able to capture the effects of country-specific conditions and policies on the degree of GVC participation. The shortcoming, though, was small number of observation and inability to incorporate certain policy factors such as logistic performance and education and training due to lack of data for the long period of time. The second specification applied gravity model as empirical framework with bilateral trade in value added being proxied as GVC participation. The overall findings were that structural factors such as market size, distance to manufacturing hubs and degree of industrialization have a stronger effect on GVC participation. In more specific terms, the larger the market size, the lower backward engagement, and the higher forward participation, while higher capita income has positive impact on backward and forward participation. Policy factors such as intellectual property protection and quality of institution were also found to have positive effects on GVC participation.

The latest empirical assessment of the determinants of GVC participation reported in World Bank (2020) utilised econometric approach similar to Kowalski et al. (2015). GVC participation is decomposed into backward and forward GVC participation while the determining factors are classified into seven broad types: (1) factor endowments, (2) geography, (3) market size, (4) trade policy and FDI, (5) quality of institutions, (6) connectivity, and (7) financial and business environment factors. The findings confirm the importance of a country's fundamental macro conditions shaped by factors such as skills, market size, institutions, connectivity, and distance to GVC hubs in driving GVC participation. Larger domestic market size, for example, backward GVC participation but it increases forward GVC participation. Also attributive to an increase in GVC participation are political stability, better logistic infrastructure and liberal trade and investment policies (World Bank, 2020).

Other seminar works that quantified locational effects on GVC participation are Kowalski et al. (2015), Dollar et al. (2016) , Pathikonda and Farole (2017), and Zeddies (2011). To capture the effect of location advantage on GVC participation, Kowalski et al. (2015) included level of development measured by GDP per capital, while Zeddies (2011) used market size, number of firms and

productivity difference. The results suggested a significant and positive relation between these factors and GVC integration. Besides, structural factors such as skill endowment was found to be an important source of comparative advantage in GVC (Dollar et al., 2016), and the proximity to market and natural capital or defined as fixed capabilities were strongly associated with value added exports (Pathikonda and Farole (2017). Institution is often regarded as a major factor driving the global value chains in most studies, despite being measured somehow differently. For instance, Dollar et al. (2016) and Kowalski et al. (2015) calculated institution and governance index as the function of political stability, absence of violence/terrorism, government effectiveness, regulatory quality and rule of law as set of indicators to measure institution; whereas Pathikonda and Farole (2017) proxied it with rule of law ranking. Their findings, though, were similar that institution and governance had a significant and positive association with GVC participation. Specifically, countries with better institutions have higher GVC participation ratio. This empirical evidence was consistent with qualitative evidence from firm executive survey indicating that lack of regulatory certainty, and corruption and graft were cited as factors negatively influencing sourcing and investment decisions (WTO, 2014).

East Asia economies has transformed itself into one of the most dynamic regions in production networks and seen unprecedented expansion of trade in intermediate goods. Such successful story has attracted wider academic research to understand factors driving participation in global value chains. Seminar works by Athukorala (2011); Kimura et al. (2007); Obashi and Kimura (2017) provide useful insights and evidence on the determinants of GVC integration in East Asia. Specifically, Kimura et al. (2007) adopted the production fragmentation theory to test the hypothesis that trade in parts and components in region is influenced by fragmentation forces. They used trade in parts and components from conventional trade statistics to proxy trade in value added and regressed with income gap (to capture location advantage) and distance (to capture service link cost). The findings confirmed theoretical explanation that difference in location advantage measured by income gap was important in production networks. Taguchi et al. (2014) replicated the empirical strategy in Kimura et al. (2007) to estimate the effect of location advantage and service link cost on production fragmentation between Thailand and other countries in the Mekong sub-region. The findings support the fragmentation framework that significant differences in location advantage and low service cost encouraged firms to fragment production processes. Also using trade in parts and components to measure participation in GVC is the work by Athukorala (2011). He applied gravity model to estimate the impacts of pair countries' characteristics and policies on trade in parts and components. Explanatory variables included world demand (measured by world income), level of economic development, and diversity in labour supply (proxied by relative manufacturing wages). He found that stage of development and wage gaps significantly affect the country's attractiveness as location of production network.

Commercial policies and infrastructure are key to GVC participation

The production fragmentation theory also suggests that firm considers cost of movement of inputs and components across various production blocks in deciding production arrangement. Factors that affect cost of transporting inputs include, *inter alia*, import tariff, transportation cost, facilitation and financial services and coordination cost. The decline in relative price of many services, which fragmentation theory refers as service link cost, are very important in decision to fragmentation. Quality of infrastructure and logistics along with more liberal policies in favour of cross-border trade and services generally contribute to lower service link costs and therefore help countries join the global value chains. Most empirical works on the determinants of GVC participation include service link factors in their estimation. However, they differ notably in terms of measurement and choice of data sources. Kowalski et al. (2015), for example, uses tariff, regional trade agreement and openness to inward FDI to capture the effect of commercial policies, whereas Cheng, Rehman, Seneviratne, and Zhang (2015) prefers tariff on intermediate goods and also computes the infrastructure index using the first principal components of five variables (communication, electricity, road density, paved road and power distribution). Similarly, Zeddies (2011) includes set of indicators such as internet hosts to capture the communication cost, and infrastructure ranking to capture the service link cost. Despite variation in indicators, these studies come up with similar results that barrier to trade and investment negatively affect GVC participation, while the quality of infrastructure and logistics are strongly associated with value chain integration through an increase in value added exports. Notably different from the above mentioned studies are works by Athukorala (2011) and Taguchi et al. (2014) which used the world bank logistic performance index as proxy to quality of infrastructure. Kimura et al. (2007) regarded distance between source and trading partners as proxy to transport cost. These studies found that transportation and trade-related cost as well as logistic quality are major determinants of trade in parts and components. Latest empirical evidence on the determinants of GVC participation collaborate the previous findings about the detrimental effects of higher trade barrier and poor logistic connectivity (Fernandes, Kee, & Winkler, 2022; World Bank, 2020). Empirical results specifically suggest that sectors facing on average lower tariffs in destination markets exhibit stronger backward and forward GVC participation while membership to FTAs and the depth of those agreements also increase GVC participation.

It is worthy to note that findings from empirical works on the role of trade policies and infrastructure in value-added trade are in line with perception of private sector. According to survey cited in WTO (2014), the main barriers that firms in developing countries face in seeking to join value chains are inadequate infrastructure, limited access to trade finance, standards compliance and market entry cost. Poor business environments, customs delays, lack of regulatory certainty, and corruption and

graft were cited as factors negatively influencing sourcing and investment decisions. Consistent results across major empirical works have led to similar policy recommendations that for countries to participate in the global value chains, they need to, inter alia, : (1) ensure cost competitiveness in production, labour and transport; (2) reduce trade barrier and in the meantime improve business and investment climate; (3) improve transports, logistics and telecommunication; (4) invest in education and skill of workforce, and (4) build stronger institutions (Cattaneo et al., 2013; Cheng et al., 2015).

Impact of human capital on GVC participation

Amidst the rise of global value chains and the emergence of GVC-oriented development paradigm, human capital remains the fundamental element for economic and social progress. Although theoretical construction varies[1], the role of human capital in stimulating economic development is indisputable. Majority of influential works including Mankiw et al. (1992) , Barro (2001) and Sianesi and Van Reenen (2000) firmly asserted that human capital supports growth. Rapid industrialization and economic growth in East Asian countries relied on their ability to achieve high accumulation of physical and human capital (World Bank, 1993). In their recent review of literature on human capital and growth, Flabbi and Gatti (2018) conclude that investing in human capital is fundamental to achieve sustainable growth. The role of human capital in global value chains is implicitly explained in production fragmentation framework as a factor that leads to location advantage. In other words, apart from regulatory and policy frameworks, and business facilitation policies, availability and skills of workforce are key to value chains activities (Cattaneo et al., 2013; R. W. Jones & Kierzkowski, 1990; UNCTAD, 2013). Empirical literature on human capital and GVC is growing reflecting the significance and relevance of the topic to the current economic landscape. However, the volume of literature remains limited in comparison to other areas in international trade. Compounding this lack of research is the fact that most studies have their own limitations most notably in terms of lack of consensus indicators to measure human capital.

Kowalski et al. (2015), for example, used share of tertiary graduate to labour force and share of technical occupation in total workforce in quantifying the impact of human capital on GVC participation. Cheng et al. (2015), on the other hand, adopted year of schooling and the quality of education system to allows the differentiation of effects among basic education (measured by year of schooling) and

[1] For example, in the neoclassical growth model pioneered by Solow (1957), human capital or specifically improvements in education of labour force is considered as a factor that determines the aggregate production function. Whereas in the endogenous growth model (i.e. Romer (1994) and Lucas (1998)), human capital is thought to influence technical progress and other economic factors within the growth framework.

more skills-intensive education. Pathikonda and Farole (2017) followed Barro (2001) by employing year of schooling of population aged 15 and above to measure human capital. In terms of empirical results, education and training are generally found to have positive and significant impact on trade in value added. When it comes to the magnitude of effects between manufacturing in low-tech and high-tech sectors, the results in Cheng et al. (2015) suggested that basic education is a significant driver for participating in low-tech manufacturing; while quality of education system was more conducive to integration in high-tech manufacturing. Higher capacities of human were highly associated with transport and electronic sectors. Human capital, proximity to markets, efficient logistics, and strength of institutions were among the most important capabilities determining GVC participation (Pathikonda & Farole, 2017).

Other empirical research on human capital and GVC are Grundke et al. (2017) , Jona-Lasinio et al. (2017) , Wang et al. (2017) and Wignaraja (2015). Grundke et al. (2017) explored the relationship between skills and trade in value added using two major datasets namely TiVa and the OECD Survey of Adult Skills. Independent variables are foreign value added (backward participation) and domestic value added in gross export (forward participation). Skill variables are categorised into nine types: numeracy, literacy, problem solving, ICT, STEM, marketing/accounting, managing/communication, self-organization and readiness to learn. The results suggested that cognitive skills, ICT skills, managing and communication skills and readiness to learn were fundamentally linked to international integration in all industries. R&D expenditure was also included in the estimation and found to significantly link with value added trade (a billion increase in R&D expenditures corresponds to higher value added embedded in exports by 0.4%). Jona-Lasinio et al. (2017) assessed the casual relationship between knowledge-based capital, which was broadly defined to include computerized databases, R&D, design, brand equity, firm-specific training, organizational efficiency and GVC participation. The estimation was made for 11 European countries from 1995-2011. GVC participation index was derived from TiVA dataset, while the set of knowledge-based indicators were extracted from INTAN-Invest. The findings confirmed the hypotheses that all intangible assets were positively link to GVC participation. The effects varied across sectors. Specifically, R&D was important to participate in manufacturing value chains, but it was not significant for service sector. ICT was a stronger impact on service value chains than manufacturing. With regards to different types of value chain activities, organizational asset, and training as well as R&D were more important for forward than backward integration.

Finally, Wang et al. (2017) quantified the effects of human capital in source, partner, and third countries on value-added exports using gravity model. The World input-output data (WIOD) was used to calculate export of value-added measuring participation in GVC. Human capital was proxied by

wage per hour for three different categories (wage for the skilled, wage for semi-skilled and wage for unskilled), while other explanatory variables were distance, sectoral outputs, common language, and regional trade agreements. Overall, it was found that human capital affected value-added exports. The observed that the increase in wage of skilled and unskilled workers or decrease in wage of semi-skilled in exporting country improved value-added exports. It was also found that human capital in partner and third countries affected value-added exports and these results confirmed the theoretical prediction that human capital of all the countries had both direct and indirect linkages with the cross-border production and exports. Also assessing the effect of human capital on GVC participation is the latest research by Fernandes et al. (2022). In their study, human capital is regarded as factor endowment and proxied by low-skill and medium/high-skill labour whereas GVC participation is decomposed into backward and forward GVC participation. They found that abundance of low-skill labour is attractive to downstream assembly-type stage of production, and it is strongly associated with higher backward GVC participation. But being abundant in medium and high-skill labour increase forward GVC participation.

2.2.2. Determinants of GVC participation: firm-level analysis

The conceptual frameworks adopted by empirical studies on firm's participation in GVC are grounded in firm heterogeneity theory. Motivated by stylized facts about significant variation in input factors, productivity, technological capacity, capital and skills intensity among enterprises, firm heterogeneity theory primarily examines the relationship between firm characteristics and behaviour in international trade and tests the firm attributes affecting the overall performance and internationalized strategy (e.g. exporting, importing the intermediate inputs abroad, and engaging in certain value chains activities). The widely recognized concept and empirical model that explain strategies of firms in international commerce are elaborated in Antras and Helpman (2004); Bernard and Jensen (1999, 2004); Melitz (2003); Roberts and Tybout (1997). More precisely, Roberts and Tybout (1997) developed a dynamic discrete-choice model of export behaviour to quantify the effect of sunk cost (cost of entry into export market) on the propensity to export. The model basically stipulated that a firm decides to export if its expected revenue is greater than current period costs plus sunk cost of entry. Dependent variable was export decision taking value 1 if firm exports and 0 otherwise. Factors incorporated in their empirical estimation include prior export experiences (a proxy to sunk cost), firm characteristics such as size, age, capital, wage, and structure of ownership, and macro shocks. Using Colombian manufacturing census during 1981-1989, they found sunk cost increased the probability to export. Adopting similar empirical framework but using US longitudinal manufacturing plant data during 1984-1992, Bernard and Jensen (2004) proved significant differences between exporters and non-exporter, notably in size, wage and productivity. Their results also

indicated that entry cost and plant attributes were positively related to the propensity to export. Melitz (2003) analysed intra-industry effects of international trade by incorporating firm heterogeneity into Krugman (1980)'s model of intra-industry trade under monopolistic competition and increasing returns. The main insight from Melitz's model was interaction between differences in firms' productivity and choice of markets. Firms produced variety of products for either domestic market or export market. Because entry into export market incurs fixed or sunk cost, only relatively more productive firms chose to export while the least productive firms served domestic market. The main argument from Melitz (2003) was that exposal to trade resulted in reallocation of resources among firms within industries, which contributed to aggregate industry productivity growth and welfare gains.

Given its flexibility in empirical specification, Melitz's model has become a standard framework for analysing wider range of issues in international trade (Bernard, Jensen, Redding, & Schott, 2012; Melitz, 2008). For example, Helpman et al. (2004) extended Militz's model to explore firm's choice between exports and horizontal foreign direct investment; Acemoglu et al. (2007) examined relationship between contractual incompleteness, technological complementarities, and technology adoption. Specifically relevant to GVC analysis is theoretical model developed by Antras and Helpman (2004) to study firms' global sourcing strategies. The model incorporated firm heterogeneity framework of Melitz (2003) into two-country (North-South) two-sector (final-intermediate) equilibrium framework to show how country-level differences in wage and trade costs together with firm's variation in productivity shape firm's organizational structure, which is either integrate into the production of intermediate inputs or outsource them. The model suggested that high-productivity firms tend to outsource intermediate inputs abroad, whereas low-productivity firms outsource at home. Antras and Helpman (2004) also argued that greater gap in wage between the North and the South or reduction in trade costs raised foreign sourcing of intermediate inputs. There is growing agreement that firm heterogeneity approach has become the standard framework for empirical studies on the role of firm in international. The widely researched themes include productivity and exports, which is known as self-selection hypothesis, the role of sunk cost in export decision, exports and firm's performance, trade and organizational structure, and the determinants of firm's participation in global value chains.[2]

Literature on firm-level determinants of GVC participation can be grouped into two broad categories. The first strand of literature focuses on conceptualizing firm engagement in production networks. The firm-level approach described in WTO (2016), Antras and Chor (2021) and Antràs (2019) are among the influential theoretical constructs that explain a firm's trajectories in GVC.

[2] . For thorough review of theoretical and empirical literature on firm heterogeneity and international trade, see Bernard et al. (2012); Greenaway and Kneller (2007); Elhanan Helpman (2006); Melitz (2008); Redding (2011); Wagner (2012).

According to their concepts, firms participate in GVC through either exporting goods or services directly to overseas firms or supplying inputs to local firms whose production are made for export. The concept defines such engagement as *'forward GVC participation'*. Alternatively, firms can still participate in value chain activities through sourcing inputs from foreign suppliers to produce goods and services for domestic consumption and exports. Such mode of integration reflects upstream linkage with foreign partners and is known as *'backward GVC participation'*. Also highly relevant to firm-level GVC analysis is the framework on small and medium enterprises (SMEs) in production networks in Harvie (2010b). It elaborates possible pathways for SMEs to join the networks. SMEs can join GVC at various levels: they can be the lower tier or higher tier suppliers according to their resources, and psychological factors. Resource factors, which include, *inter alia*, financial resource, technology, market access and skilled labour, essentially influence SME capacities. Psychological factors relate to corporate norms such as self-efficacy, business culture, desire, and commitment. External environment such as government policies, domestic and overseas market conditions can also influence SMEs' trajectory in production networks. It should note that these two concepts have different focuses. Harvie's framework, on the one hand, articulates how firm capacities, corporal culture, and national business environment influence SMEs' behaviour in value chains activities. The WTO (2016)'s framework, on the other hand, articulates possible trajectory in which firms participation in GVC. Notwithstanding, these influential concepts have been widely used as the basis for designing empirical specification by several empirical studies. For example, Harvie, Narjoko, and Oum (2010a) applies Harvie's framework to draw econometric specification for assessing determinant factors that facilitate SMEs in joining the production networks. The framework is also used as the guideline to design country-specific case study on SME integration in the production networks in Thanh, Narjoko, and Oum (2009). Cadestin et al. (2018) adopted definition of SME participation in GVC from WTO (2016) and merged the WTO-OECD's Trade in Value-Added (TiVA) with enterprise data to maps the participation of multinational enterprises in GVC. González (2017) followed the same procedure to map GVC participation for SMEs in ASEAN.

The second strand of literature empirically assesses factors affecting firm's integration in GVC. While some employed pooled firm-level data from various countries for empirical analysis, others adopted country case study approach. Wignaraja (2015), for example, used data from the WBES to investigates factors influencing firm's participation in supply chains for five ASEAN economies. Firm-specific factors included size, year of establishment, type of ownership, technological capabilities, access to finance, education and skills of employees, and education and experiences of executives. He tested several hypotheses and one of them was higher level of human capital is positively correlated with joining supply chain trade. The findings supported the hypothesis that human capital was vital in supply chains. Specifically, having workers at high level of education increased probability

of firm joining the supply chain trade. Other firm-specific factors such as size, technological capacities and access to credit were also important for firms to join GVC. Also using firm data from multiple countries is the work by Harvie et al. (2010a). The unique feature of their research was its specific focus on SMEs and factors affecting their participation in production networks. The authors used SME survey data in seven ASEAN countries and applied the Probit model accounting for the size, age, ownership structure, productivity, innovation, access to finance, and location of firms and a few other firm attributes being explanatory variables. They found that productivity, foreign ownership, and access to financial institution significantly determined the participation of SMEs in production networks. SMEs that were active in innovation process also increased their likelihood to engage in the production networks. interestingly, proximity to SEZs and ports, size and age appears to have no effect on SMEs' participation in production networks. Skill intensity, which is measured by ratio of non-production workers to production work, denotes human capital resources of firm. However, the results were quite unstable across specifications and in general human capital appears to be insignificant.

Empirical research using specific country case analysis are also relevant to our study. Despite different thematic focuses, majority of them adopted similar econometric specification and estimation method. We provide a brief discussion of country studies with Aggarwal and Steglich (2018). Using firm-level data in India, firms were classified into different categories according to level of engagement in GVC and test the extent to which firm attributes affect different degree of participation. Independent variables are grouped into two broad categories: cost-based factors including size, unit cost, SEZ, profit margin, bank loan and efficiency-based factors such as capital intensity, technological capacity, skill, age. Skill is proxied by the ratio of wage over sales. Using Probit model to estimate, this study found that size, technological capacities, research and development and location in SEZ are important for Indian enterprise to join GVC. Skill was also found to have positive effect on intensity of GVC participation. Similarly, Chuc et al. (2019) quantified factors that help Vietnamese enterprises to effectively participate in the production networks. Their research used the survey of 208 SMEs. Explanatory variables in their model are age, size, foreign ownership, productivity, and several other dummy variables. Skill intensity, which is defined as share of workers with higher education to total workers, and training expense are also accounted for in the estimation. Like earlier studies, coefficients of size, foreign ownership and productivities are positive and statistically significant. Skills are found to have positive and significant association with propensity to join the production networks, but such effect does not happen for investment in training. The findings also indicate that SMEs that have better connection with foreign markets and more active industry and business associations are relatively like to join GVC. Also using micro-level data from Vietnamese manufacturing firms is the work by Thangavelu (2014) . Although this study primarily focused on quantifying the productivity spillovers of horizontal and backward FDI linkages, it highlighted the importance of investment in

human capital in helping local firms to improve efficiency and productivity, which consequently increased probability to link with foreign firms and the production networks.

2.3. Servicification and productivity

The terms 'servicification' refers to an increasing importance of service sector in manufacturing (Baldwin et al., 2015; Kommerkollegium, 2010; Lanz & Maurer, 2015; Miroudot & Cadestin, 2017). It pertains to three dimensions of service-manufacturing linkages: an increase in use of service inputs in production process; the shift toward service activities or professions in manufacturing; and the bundle of services with products to add value and sharpen customer relationship. An illustrative example of servicification is the Swedish engineering company named Sandvik Tooling, which uses some 40 types of services in order to uphold its delivery chains (Kommerskollegium, 2010). Recent studies also highlight that the share of services inputs in manufacturing has risen across OECD countries (Miroudot & Cadestin, 2017; Nordas, 2010) , in Europe (Kommerskollegium, 2016), in Asia (R. Baldwin, Ito, & Sato, 2014; Mercer-Blackman & Ablaza, 2018), and other individual economies. In addition, the share of service employment in manufacturing has also increased markedly (according to Miroudot & Cadestin (2017) , the ratio varies from 25% to 60% across OECD economies), reflecting the shift of manufacturing activities to service-intensive tasks. The rising servicification of manufacturing is driven by rapid proliferation of GVC. Seminar works such as R. Baldwin et al. (2014); Low (2013); Sébastien Miroudot and Cadestin (2017) and Heuser and Mattoo (2017) described services as a 'glue' in GVC linking fragmented production components across whole value chains; while Kommerskollegium (2016) argued that firms use more services to participate in GVC. The other reasons for servicification include: enhancing efficiency and productivity, a shift in corporate market strategy to add value and sharpen customer relationship, reclassification of services, and increase in price of service tasks in relation to manufacturing tasks (R. Baldwin et al., 2014; Gereffi & Fernandez-Stark, 2010; Kommerskollegium, 2016; Lodefalk, 2014; Hildegunn Kyvik Nordås & Kim, 2013).

Conceptual and empirical researches on servicification are diverse in terms of thematic analysis, methodology, and geographical coverage. The first strand of literature works on measuring the extent of servicification. Some studies used inter-country input-output table to derive share of service inputs in manufacturing exports in value-added terms. For example, Lanz and Maurer (2015) used OECD-WTO TiVA database to provide evidences of servicification and illustrated that considerable (about a third) value-added in gross exports come from services. Also using macro data to analyse the role of services in manufacturing are studies by Miroudot & Cadestin (2017) for OECD countries, Kommerskollegium (2016) for European Union, R. Baldwin et al. (2014); Mercer-Blackman and Ablaza (2018); and Thangavelu et al. (2017) for Asia. These macro studies provide similar evidence across

different regions and economies that considerable proportion of manufacturing export and outputs come from service sector. Precisely, about half of manufacturing value added in OECD economies comes from service sector (Miroudot & Cadestin, 2017); share of service value added in Asia in 2017 accounted for 34% of total exports, a considerable increase from 27.7% in 2000 (Mercer-Blackman & Ablaza, 2018). Another type of studies relied on firm-level data to generate indicators such as share of services inputs to total sale, ratio of service occupations to total employment, and revenue from services as proxies to servicification of manufacturing firms. Despites variations across countries, evidences show that manufacturing firms consume more service inputs, increasingly shift to service tasks and provide services bundled with products (Aquilante & Vendrell-Herrero, 2019; Cadestin & Miroudot, 2020; Crozet & Milet, 2017; Kelle & Kleinert, 2010; Lodefalk, 2014).

The second strand of literature is empirical analysis of servicification. One of the widely researched areas in the context of service-manufacturing linkage is the relationship between servicification and export performance. Lodefalk (2014) assessed the role of services on export intensity using Swedish firm data and found that firms with more in-house service and bought-in service have greater share of exports. Similar results are found in German firms (Aquilante & Vendrell-Herrero, 2019) and Indian manufacturing firms (Golda et al., 2017; Mukherjee, 2015). Thangavelu et al. (2017) is among a few empirical studies using macro data to assess factors that affect degree of servicification in Asian countries. It regressed share of service value added in export with range of indicators including participation, GVC positions, infrastructure, human capital, technological, and institutional factors and proved that those factors are the key to the increasing services activities in the region. The study highlighted that the productivity gain has often been cited in servicification literature as the motive behind the fact that firms become more servicified. Conceptually, it is argued that enabling services such as transport and logistics, telecommunication and business services along with technology and R&D services can help improve production coordination and efficiency (Amiti & Wei, 2009; Arnold et al., 2016; Lodefalk, 2014; Nordas & Kim, 2013) .

Moreover, firms can achieve static gains from better reallocation of resources by outsourcing service activities and specializing in core manufacturing activities (Winkler, 2010). This conceptual explanation has yet to be supported by conclusive empirical evidence. In addition, the empirical studies on productivity effect of servicification are drawn from varied theoretical frameworks. Some studies examined the productivity effect of servicification are based on the outsource and offshore framework. For example, Girma and Görg (2004) used establishment-level data from UK manufacturing industries to examine if outsourcing lead to productivity growth. Similar investigations were conducted by Görg et al. (2008) for Irish manufacturing firms, Amiti and Wei (2009) for US firms, Winkler (2010) for Germany manufacturing, Schwörer (2013) and Kang, et al. (2010) for firms in

Europe and East Asia, respectively. Most of these studies used micro data to estimate productivity and regress with service offshore and other firm attributes. The results are similar that service offshoring has a significant positive effect on productivity. Other studies specifically look at productivity effect of service input intensity proxied by share of service outsourced over overall inputs. For instance, Thangavelu et al. (2019) quantified the impact of different service activities on the productivity of manufacturing sector in Indonesia and found that the use of enabling services such as financial and business services has positive and significant impact on productivity. However, industrial service has negative effect on productivity, which implied lack of serviced-based domestic firms including SMEs to support manufacturing activities. In Czech Republic, service inputs not only help firms to improve productivity but also serve as the catalyst for service policy reform to exert positive impact on manufacturing productivity (Arnold et al., 2006) . It is important to note that empirical studies on servicification and productivity to date has tended to focus on the effect of service inputs rather than service outputs, which provides little discussions on the productivity effects between firms selling services and those selling only goods. As more manufacturing firms offer services in bundle with goods and as secondary source of revenues, lack of study on productivity effect from service output represents huge knowledge gap in international trade literature. Chapter 5 in this thesis, therefore, aims to address this gap by evaluating whether servicification measured both in terms of service input and service output (income) help firms to improve productivity.

2.4. Research gaps

Three important observations can be drawn from our thorough review of GVC literature. Firstly, there are notable variations in measurement of GVC participation and human capital. In several macro studies, year of schooling and skills are often used to measure human capital. For instance, Cheng et al. (2015); Jona-Lasinio et al. (2017); Kowalski et al. (2015) used available annual data on year of schooling or/and share of secondary education to proxy human capital. Others including Cheng et al. (2015) and Grundke et al. (2017a) preferred more complex indicators such as quality of education system or skill categories. Similarly, Fernandes et al. (2022) uses low-skill and medium/high-skill labour to capture the skill factor endowment in relation to GVC participation. The absence of standard indicator for human capital is certainly a major limitation in empirical literature and consequently it cannot fully capture its impact on GVC as explained in the theories. Chapter 3 in this thesis builds on existing literature and assess the impacts of human capital on participation in global value chains for economies in East and Southeast Asian region. We measure human capital with three variables namely year of schooling, learning outcomes and skill proportion that allow us to capture various

aspects of human capital. We believe that our measure of human capital makes significant contribution to the understanding on the role of human capital in production fragmentation and global value chains.

On GVC participation measure, lack of appropriate GVC data partly explains the different choices to measure the participation rate. For instance, studies by Kimura et al. (2007); Saslavsky and Shepherd (2014); Taguchi et al. (2014); Zeddies (2011) used trade in parts and components extracted from the UN Comtrade data as a proxy to value-added trade. Using the Standard International Trade Classification (SITC) system, these studies define parts and components as those products in the machinery and transport equipment group (SITC 7) and miscellaneous manufacturing (SITC 8). Although this classification provides comprehensive and consistent coverage, it is limited to two major product categories and ignores some major emerging manufacturing sectors including pharmaceutical and chemical products, machine tools and various metal products (Athukorala, 2011). In addition, the classification is subjective based on the assumption that the product groups account for majority of value chain trade. Another major limitation of this measure is that it totally ignores value added trade in agriculture and services, which are merging as key products in value chains (De Backer et al., 2018). Other studies including Amador and Cabral (2016); Cheng et al. (2015); De Backer and Miroudot (2014); Grundke et al. (2017); Jona-Lasinio et al. (2017); Kowalski et al. (2015); OECD (2017) and Fernandes et al. (2022) used a recently constructed GVC indicators calculated using Inter-Country Input-Output (ICIO). The TiVA database appears to be the popular source for GVC participation indicator. The data covers 63 economies including 13 from East Asia and 34 industrial sectors including agriculture and services over the period of 1995-2011. The indicators provide insights into several aspects of value chain trade. Most importantly, the dataset distinguishes the downstream and upstream of value chain activities. For example, it measures foreign value added embodied in exports or known as backward GVC participation and domestic value added in partners' exports or forward GVC participation (OECD, 2018b). Even more important is the fact that the database covers majorities of East Asia economies. Other sources of statistics used to capture GVC participation are the World Input Output Database (WIOD). It covers 43 countries and 56 sectors for the period 2000-2014. Koopman, Powers, Wang, and Wei (2010), for example, used WIOD to construct GVC participation indicators. Their work is later referred by several other scholars including Dollar et al. (2016) and Wang et al. (2017). Although this source of data is popular for empirical studies on value chains, its major limitation, however, is the smaller coverage for East Asia economies. Therefore, for global chain studies in East and Southeast Asia, TiVA database has wider coverage than WIOD. Based on this grounds, Chapter 3 in this thesis uses TiVA data to study the impact of human capital on GVC participation.

Furthermore, because firm-level data are increasingly available and accessible to public and researchers, there are growing empirical studies using firm-level analysis framework to understand the impact of human capital and firm attributes on participation in value chain activities. While World Bank (2020) and Antras and Chor (2021) provide precise firm-level approach to GVC studies, Taglioni and Winkler (2016) reiterates the important features and effects of firm-level differences on the wider economy and provides brief econometric specification to assess the determinants of firm-level GVC entry. The structure of this thesis follows this narrative by empirically assessing the impact of human capital and other factors on GVC participation using both cross-country analysis and firm-level analysis. Evidence from both macro and micro approaches will provide insightful relationship between of effects of country-level factors and policies as well as firm-level endowment and participation in value chains.

Finally, servicification of manufacturing has been a key feature of global economy and its trend has been in line with rapid proliferation of global value chains. In the same vein, there is growing research on servicification, many of which work on measuring the scale and depth of servicification and others assess the impact of servicification on firm performances such as export and productivity. Empirical research on servicification and productivity is largely based upon service outsourcing and offshoring framework with most of them applying semi-parametric approach to estimate production function and then regressing the derived productivity with servicification variables. The major research gap we observe in servicification-productivity literature is lack of studies to examine the importance of service revenues in enhancing efficiency and productivity. This thesis aims to fill this gap by assessing the effects of servicification on productivity from aspects of service input and service output. The analysis is based on firm-level data from the Indonesia's Annual Manufacturing Survey from 2005-2015 and is in line with the current thinking and common conceptual framework that servicification pertains to the increasing utilization of services in the production process along with growing adoption of diversifying revenues from services.

Chapter 3

The Impact of Human Capital on Participation in Global Value Chains: Evidence from Cross-country Analysis in East and Southeast Asia

3.1. Introduction

Global production is now structured into a vertically integrated and complex networks of firms from several countries in supply of parts and components with assembly and distribution of final outputs to consumers worldwide. The rise of GVC is largely driven technological progress, advancement in transport and logistic sector leading to declining trade costs, and economic liberalization in terms of regional and multilateral free trade agreements (Amador & Cabral, 2016; Athukorala, 2011; Baldwin, 2012, 2013; De Backer et al., 2018; Humphrey & Schmitz, 2002). Integrating in GVC through specializing in certain production components allows developing countries to industrialize at lower cost and investment rather than building whole industrial supply chains within their national boundaries. On this grounds, Baldwin (2012) proposes a 'join-instead-of-build development paradigm'. Similarly, Gereffi and Sturgeon (2013) suggests a 'GVC-oriented industrial policy' to improve a country's role in global value chains and thus leveraging it for economic development.

The choice of production location within the production networks is made by the lead firms based on a combination of factors including factor intensity and price, market size, efficiency of input supplies, business services, quality of transport and logistics, trade and investment policies, and proximity to final market (Cattaneo et al., 2013; Jones & Kierzkowski, 1990; UNIDO, 2018). Recent evidence

indicates liberal commercial policies such as tariff, regional trade agreement or/and openness to investment), conducive economic conditions (e.g. market size, existing industrial/private sector capacity), efficient infrastructure and logistics, and quality of institution are crucial to GVC activities. The role of human capital in GVC participation is critical for developing countries to participate and position at a higher value-added activity in the regional and global production value-chains. The host country's factor endowment in terms of the quality of education and skills of workforce are among the important criteria in attracting GVC activities in the domestic economy. This chapter examines the impact of human capital development in the participation in global production value chains for economies in East and Southeast Asia.

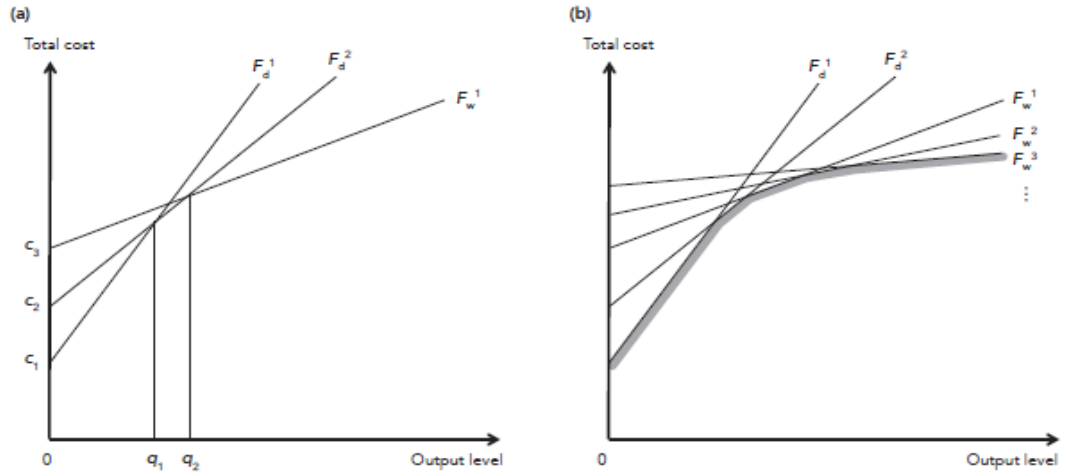
We adopt the production fragmentation theory suggested by Jones and Kierzkowski (1990) as the framework to guide our empirical specification. The theory defines fragmentation as "a splitting up of a previously integrated production process into two or more components or fragments" (Jones & Kierzkowski, 2001, p. 18) and stipulates that international fragmentation will happen if two fundamental prerequisites are satisfied. Firstly, there must be a significant difference in productivity and factor prices among production locations. Secondly, there must be significant reduction in cost of service links determined by a combination of factors including trade and investment policies, transport and logistics services, and financial services. We utilize the gravity model to construct econometric specification and empirical analysis based on cross-country panel data covering 11 countries in East and Southeast Asia for the period 2005-2015.

The remainder of this chapter is organised as follows. Section 2 provides an overview of theoretical concepts to guide the selection of empirical models. Section 3 explains data and empirical specification. Section 3 also elaborates empirical specification with emphasis on gravity equations and variables and estimation methods. Section 4 presents empirical results of our analysis. In section 5, we provide the policy discussions.

3.2. Theoretical background

The production fragmentation framework implicitly explains the role of human capital, location conditions, and service link on GVC participation. In this framework, firms have a number of options to decide on production methods: they can either maintain all production stages in a single block at home or outsource certain segments from domestic or international suppliers. The arrangement of production blocks can be in a sequential setting whereby each block is used as outputs of the preceding block as intermediate inputs until the final stage of production. It can also be organized with a group of simultaneous production of inputs supplying to the final assembly elsewhere.

Figure 3.1: Optimal forms of outsourcing options



Source: Inomata (2017, p. 21)

Figure 3.1 illustrates the relationship between cost and output at different production stages. The line F_d^1 represents the cost schedule of vertically integrated production methods with cost increasing relative to output. The framework argues that with rapid advancement in transportation modes and information and communication technology together with significant differences in wage and production factor endowment, firms find it more profitable to split production into several production segments. Line F_d^2 represents the cost schedule for the production that breaks into two blocks but at the domestic economy. It is flatter than the line F_d^1 reflecting lower marginal cost of production. However, fragmentation incurs extra cost arising from coordinating among the production blocks, which is represented by the distance c_1c_2 in the graph. In similar manner, two countries are set in the framework as the two potential production blocks with line F_w^1 and line F_w^2 representing cost configurations. When production segments are located abroad, there are few implications. Firstly, the cost schedules are progressively flatter reflecting the lower total marginal cost of production arising from greater gains from finer specialization and division of labour. Secondly, fragmentation is associated with higher service link requirements. Despite incurring high cost, fragmentation based on increasing return to scale reduces the average costs making such production method more efficient.

The cost-output nexus in the context of fragmentation presented in Figure 3.1 can be extended to multiple countries as production blocks connected by service links. In the context that almost all countries opened up their economies to be part of global production and value chains and that technological advance and deregulation of service sectors contribute to significant reduction in service link costs (Jones et al., 2005; Jones & Kierzkowski, 2001), finer specialisation and division of labour among different countries across various regions lead to high degree of fragmentation. For international fragmentation of production to take place, two fundamental prerequisites must be

satisfied. Firstly, there must be a significant difference in productivity and factor prices among production blocks. The greater the disparities, the higher the degree of fragmentation. This condition is known as location advantage and shaped by a combination of factors such as low wage, availability and quality of human capital, existence of supporting industries, and conducive policy environment. Factor-intensity rankings and relative cheapness of factors are key to the assignment of production blocks. In this case, firms might locate labour-intensive blocks in countries with labour abundance, while maintaining skill or capital-intensive components at home. Secondly, there must be significant reduction in costs of service links, which are defined as bundles of activities like coordination, communication, administration, transportation and financial services that support production blocks. The reliability and cost of service links are very important in the decision to split production stages. Factors attributive to cost of service links include tariff, quality of transport and logistics services, hard and soft infrastructure, quality of trade facilitation and financial services. Jones and Kierzkowski (1990) highlight that the liberalization of service sectors is critical to participation in production blocks and gains from service liberalization may exist in the form of greater participation in the production process.

The several studies have highlighted the importance of education and training as key factors affecting the comparative advantage of domestic economies to participation and position in the regional and global value-chains. Cheng et al. (2015); Jona-Lasinio et al. (2017); Kowalski et al. (2015) indicates that the year of schooling or/and share of secondary education as key factors for GVC participation. Cheng et al. (2015); Grundke et al. (2017b) adopts the complex indicators such as quality of education system or skill categories and assess how these indicators affect the domestic economy participation in global production value chains.

3.3. Data and empirical specification

3.3.1. Data and descriptive statistics

The data for the study is extracted from several sources. GVC indicators, which include forward GVC participation (defined as domestic value added in a third country's gross export) and backward GVC participation (foreign value-added content in gross export), are derived from the TiVA dataset. Human capital is measured by three variables in terms of years of schooling, education quality and skill. Mean year of schooling is derived from Human Development Reports (several years); education quality variable is proxied by averaging test scores from Program for International Student Assessment (PISA); and the skill level of labour force is taken from ILOSTAT. Other sources of data are CEPII gravity dataset, the World Development Indicator (WDI), The UNCTAD Trade Analysis Information System (TRAINS), Global Competitiveness Index, and the world development indicators.

Measuring GVC participation

Several studies have used various measures for GVC participation of respective countries. For example, Kimura et al. (2007) and Athukorala and Yamashita (2006) used trade in parts and components to measure the extent of production network trade. Despite illustrating some extent of intermediate goods trade, this measure has severe limitations with regards to inability to capture the full magnitude of GVC including value added trade in services (De Backer et al., 2018). With a growing availability of Inter-Country Input-Output (ICIO) tables, growing studies have drawn several indicators to capture sequential and vertical trade chains. For example, Hummels et al. (2001) used trade statistics from input-output tables to gauge imported content of exports, labeled as vertical specialization (VS). They also measure the exported intermediates embodied in other countries' exports or known as VS1. The construction of these indicators rests on the assumption that intermediate goods from a given country have 100 percent domestic content and therefore it rules out scenarios in which intermediate goods are produced from a mix of domestic and foreign content. This implies that VS and VS1 do not capture all sources of value-added in export (Koopman et al., 2010; Mattoo et al., 2013) . Another measure often used in recent studies is the ratio of value-added exports to gross exports or VAX ratio by Johnson and Noguera (2012). Its major drawback is that it is a summary measure of value-added content of trade that does not distinguish between the domestic and foreign value content in exports.

Koopman et al. (2010) traced value-added trade using a block-matrix structure of GTAP Multi-Country Input-Output (MCIO). According to them, gross exports are decomposed into five components: (1) domestic value-added embodied in exports of final goods and services absorbed by the direct importer; (2) domestic value-added embodied in exports of intermediate inputs used by the direct importer to produce its domestically needed products; (3) domestic value-added embodied in intermediate exports used by the direct importer to produce goods for third countries; (4) domestic value-added embodied in intermediate exports used by the direct importer to produce goods shipped back to source; and (5) value-added from foreign countries embodied in gross exports or known as foreign value added used in exports. Furthermore, Koopman et al. (2010) defines GVC participation index as a measure to capture a country's involvement in a vertically fragmented production process. It is given as:

$$\text{GVC\_participation}_c = \frac{DVA_c}{EXGR_c} + \frac{FVA_c}{EXGR_c}$$

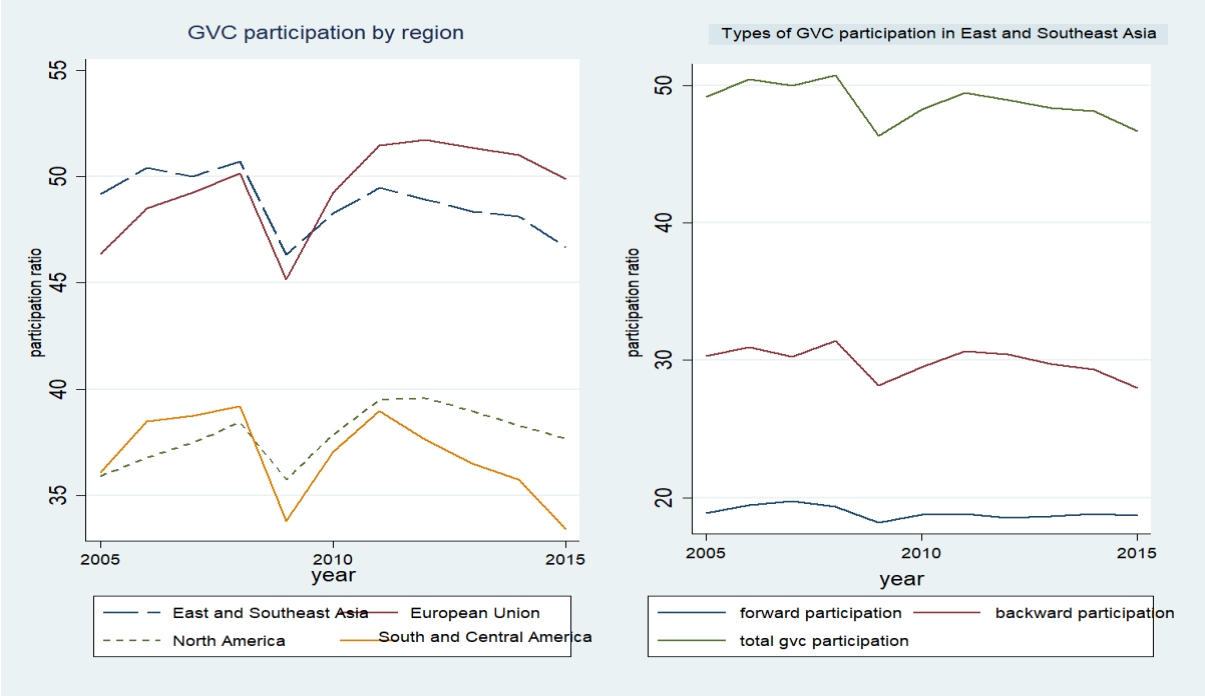
Where $EXGR_c$ denotes gross export of country c; DVA_c is domestic value added of country c in third country's exports (forward GVC participation); and FVA_c refers to foreign value-added embodied in exports of country c (backward GVC participation).

This chapter adopts the definition and measure for GVC participation from Koopman et al. (2010). The dataset on value-added trade (TiVA) follows the concept and measure from Koopman et al. (2010) to construct its GVC-related indicators. Since our analytical framework uses a gravity model as estimation strategy, dependent variables are bilateral trade flow (in value) between source and exporting countries. The TiVA database, which covers 64 countries including 11 from East and Southeast Asia from the period of 2005-2015, allows us to derive bilateral volume in US$ million for forward GVC participation and backward GVC participation. The data involves five dimensions: source country, source industry, exporting country, exporting industry and time.

- Forward GVC participation (DVA) is given as the export country as world and source country as economies in East and Southeast Asia. In the gravity estimation, the export country is the original country and the trade flow value refers to exports of East and Southeast Asian countries to their partner.
- Backward GVC participation (FVA) is given as the export countries as economies in East and Southeast Asia, and source country as world. In the gravity estimation, the export country is the original country and the trade flow value refers to the original country's imports of inputs from its partner.
- Reference and original countries in our study refers to East and Southeast Asian economies in TiVA database, which include Cambodia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Thailand and Vietnam.

Figure 3.2 demonstrates the ratio of GVC participation for key regions during 2005-2015. Before the global financial crisis in 2008, East and Southeast Asia had the most dynamic production networks given by the highest GVC participation ratio at 50.4% in 2005, compared to 46.4% for European Union, 36.1% for South and Central America and 35.9% for North America. The global financial crisis affected value-added trade resulting in moderate decline in GVC participation ratio. For example, the ratio in East and Southeast Asia declined from 51.7% in 2008 to 47.3% in 2009. The adverse effect of the crisis on GVC is consistent with findings by Bems et al. (2011) arguing that value-added trade fell by 10.3 percent when the crisis started. Despite a quick recovery after the crisis, value-added trade in East and Southeast Asia has witnessed the steady decline making the region as the second most dynamic production networks after the European Union. Decomposed by different types of value-added content, East and Southeast Asia has high foreign inputs in its exports and low domestic value-added inputs used by third country's exports. During 2005-2015, an average backward GVC participation rate was 31.5% and 18.2% for forward GVC participation.

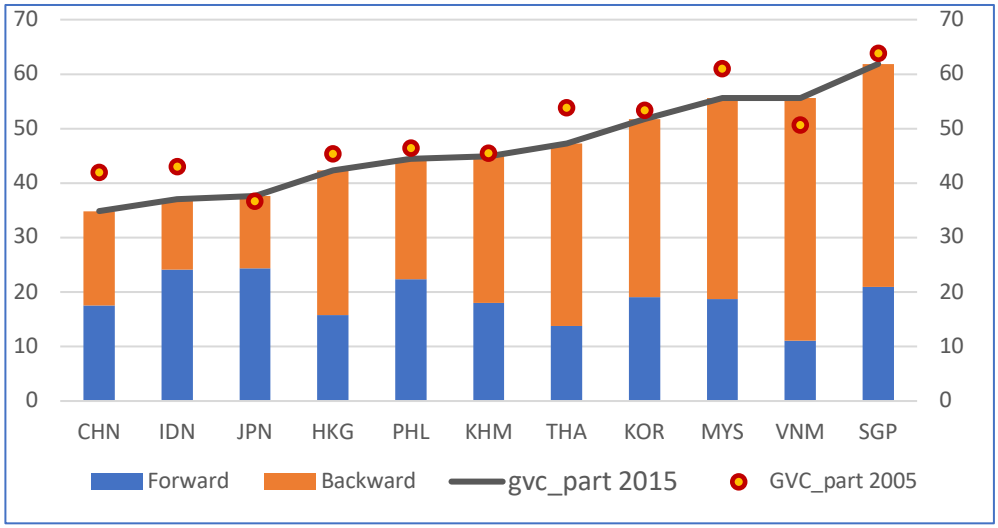
Figure 3.2: Global value chain participation by key regions, 2005-2015



Source: Author's calculation based on OECD's TiVA database

Figure 3.3 compares GVC participation ratio among countries in East and Southeast Asia. It shows that the nature of GVC participation varies significantly. Singapore and Hong Kong as well as Malaysia are highly integrated in GVC activities than larger economies like China, Japan and Indonesia. Except for Vietnam and Japan, all East and Southeast economies recorded a slight increase in GVC participation rate between 2005 and 2015. In terms of value-added content, countries like Singapore, Vietnam, Malaysia, Thailand and Malaysia rely more on foreign inputs to produce exports reflected by higher backward GVC participation.

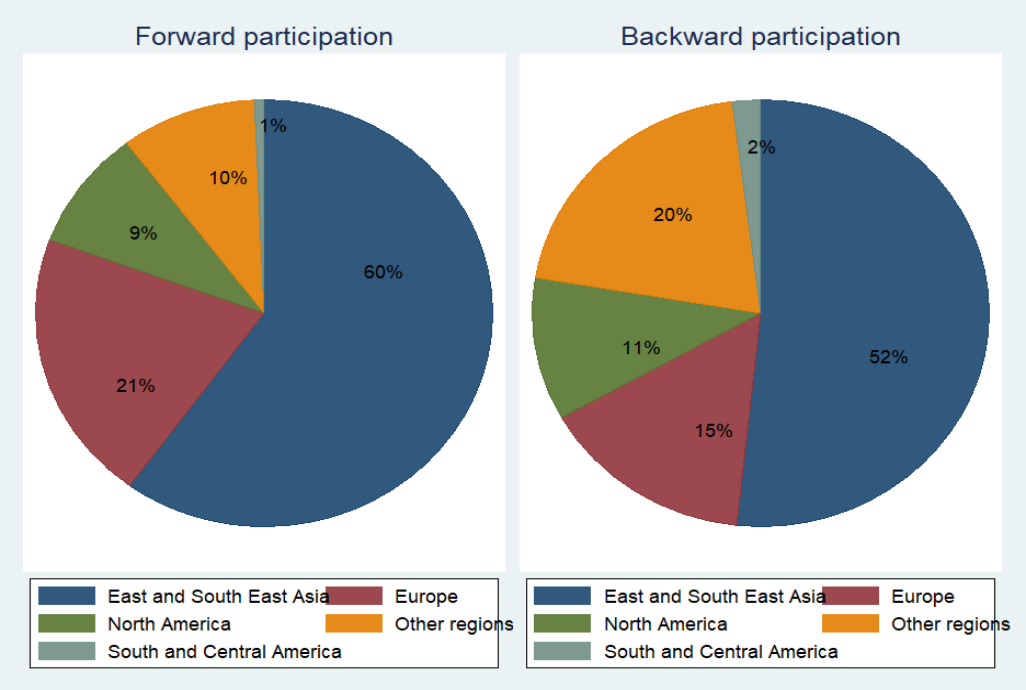
Figure 3.3: Global value chain participation disaggregated by types and countries, 2015



Source: Author's calculation based on OECD's TiVA database

Figure 3.4 shows sources of foreign inputs and destinations that use domestically produced inputs from East and Southeast Asian economies. It is evident that East and Southeast Asian region sources among themselves significantly more than from other regions. Precisely, 60% of foreign inputs in East and Southeast Asia's exports are sourced from its own region, 21% from Europe and 9% from North America. Similarly, 52% of domestic value-added was embodied in East and Southeast Asia's exports and 15% in European exports. This statistics is consistent with findings in Los, Timmer, and De Vries (2015) and R. Baldwin and Lopez-Gonzalez (2015) that global value chains are more a regional phenomenon and such a pattern leads R. Baldwin and Lopez-Gonzalez (2015) labelled it 'Factory Asia', 'Factory North America', or 'Factory Europe'. Source and destination of value-added trade for each country which is given in Figure A.3.1 in the Appendix is very similar to the average regional pattern. East and Southeast Asia is the largest destination for most ASEAN countries' backward GVC trade with the highest share of 72 percent for Cambodia, 69 percent for the Philippines and 67 percent for Malaysia. While Japan and Korea also export large proportion of its backward GVC activities to East and Southeast Asia, China and Hong Kong have a smaller share with the region. Pattern of backward GVC trade is quite similar to forward GVC trade.

Figure 3.4: Sources and destinations of value-added trade in 2015



Source: Author's calculation based on OECD's TiVA database

Measuring human capital

Human capital is defined as a stock of skills, knowledge, and attributes that reflects the capabilities of the workforce to do productive work. In the growth accounting framework, for example, human capital is regarded as a factor that determines aggregate production, fosters productivity, and increases innovative capacity of economy; all contribute to economic growth (Luca, 1988; Mankiw et al., 1992; Romer, 1994; Solow, 1957). There is growing agreement that investing in human capital is the fundamental strategy to achieve sustainable economic growth (Flabbi & Gatti, 2018). The experience of rapid industrialization and sustained economic growth in East Asia demonstrates even stronger the important role of human capital development (World Bank, 1993). Despite advances in theoretical concepts, measuring human capital remains a challenge. Most empirical works adopt a much narrower interpretation of human capital based on education inputs. For example, in the early works on human capital and growth, Romer (1989) and Azariadis and Drazen (1990) used adult literacy rate to proxy human capital; whereas Mankiw et al. (1992), Barro (1991) and Levine and Renelt (1992) employed school enrolment rate. However, Hanushek and Kimko (2000) ; Woessmann (2003) labelled these measures as poor proxies of human capital. For the adult literacy rate, its major weakness is that it is a minor part of the total stock of human capital emphasizing on basic learning. In essence, this misses out additional investment made in logical and analytical reasoning, scientific and technical knowledge that could substantially add to labour productivity (Wößmann, 2003). For school enrolment rate, it is a flow variable that can only capture students who are not yet in the labour market and may not correctly reflect the stock of human capital stock (Barro, 2001; Wößmann, 2003). In this chapter, we adopt three different indicators to capture various aspects of human capital: mean year of schooling, learning outcomes, and skill composition. Definitions and concepts of these measures are discussed below.

Mean year of schooling (MYS)

The popular measure of human capital is proxied by the mean year of schooling of the population aged 25 and older, which better reflects the level of education among the labour force. Some influential seminar works using year of schooling to proxy human capital include Barro (2001); Barro and Sala-i-Martin (1995) ; Benhabib and Spiegel (1994); Hanushek and Kim (1995) ; Krueger and Lindahl (2001). The availability of large-scale cross-country dataset including the international dataset for educational attainment constructed by Barro and Lee (2013) and key international organizations such as UNDP for its human development index, this measure has become the most popular variable for human capital in economic growth literature (Wößmann, 2003). For example, Noorbakhsh et al. (2001) used the number of accumulated years of secondary education of the working population to test the

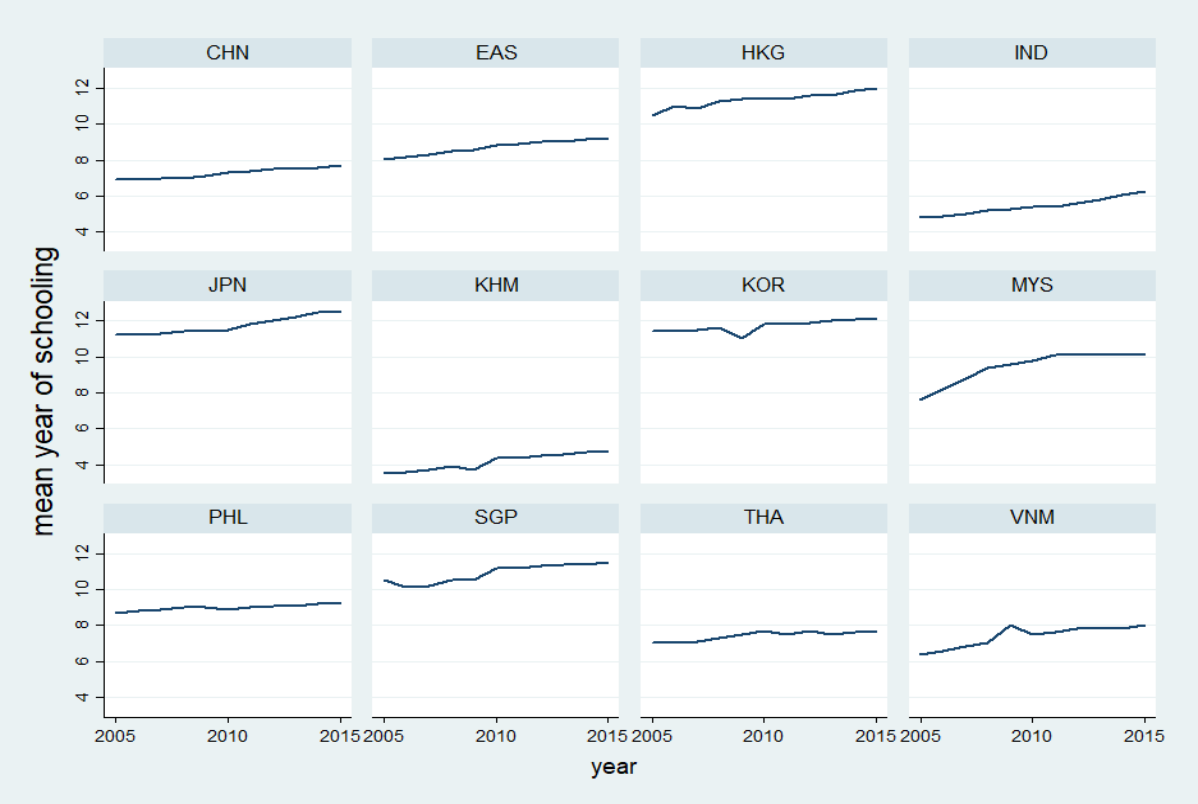
hypothesis that level of human capital in host countries may affect the distribution of FDI flow. Similarly, Nunnenkamp (2002) used Barro and Lee's average years of schooling of population aged 15 and above to assess its effect on FDI inflow. Among major works that use years of schooling to capture the effect of human capital on global value chain participation are Cheng et al. (2015); Pathikonda and Farole (2017) and Kowalski et al. (2015).

Our study uses this customary variable as one of human capital indicators. The data on mean year of schooling (MYS) is derived from the Human Development Report with estimation being based on data on educational attainment from UNESCO Institute for Statistics (UIS) and methodology from Barro and Lee (2013). MYS is calculated as:

$$MYS = \sum_{a} \sum_{l} HS_{al} YS_{al}$$

Where HS_{al} denotes proportion of population in age group *a* for which the level of education *l* is the highest education attained; YS_{al} is an official duration of education level *l* for an age group *a* at the time when this age group was in school. For example, let assume that 10% of population aged 25 years and older in country A have no school, 50% have completed primary school (official duration of 4 years), 30% have completed secondary school (official duration of 8 years), and 10% have completed tertiary education (official duration of 4 years). MYS in country A, therefore, is computed as: MYS= 0.1x0 + 0.5x4 + 0.3x8 + 0.1x4 = 4.8 years. We choose data from the Human Development Report Office (HDRO) based on the grounds that the calculation method is widely accepted. We compare MYS from HDRO and Barro and Lee's dataset by conducting paired *t-test*. The test output suggests mean difference between MYS from the two sources of 0.036 with a standard deviation of 0.860 and a standard error of the mean of 0.0358. Since *p-value* (0.314) is greater than 0.05, it can be concluded that there is not a statistically significant difference between MYS from HDRO and Barro and Lee's dataset. We also consider the availability of data in the selection of data sources. However, Barro and Lee's dataset is only available until 2010 and thus it misses out the crucial period during which educational development notably progressed on a global scale. Moreover, Barro and Lee's panel data has a 5-year interval which does not match so well with yearly value-added trade data. MYS from HDRO is available on a yearly basis during 2005-2015 for all East Asia economies. Figure 3.5 provides summary statistics on MYS for East and Southeast Asia. It shows that the region has witnessed steady progress in building human capital with MYS increasing from 8.04 in 2005 to 9.26 in 2015. Nevertheless, there is a significant gap across countries. Emerging economies like Cambodia, Indonesia, Vietnam and Thailand have significantly lower MYS than more advanced economies including Singapore, Hong Kong, Korea and Japan.

Figure 3.5: Mean year of schooling by country 2005-2015



Source: Author's calculation based on data from HDRO

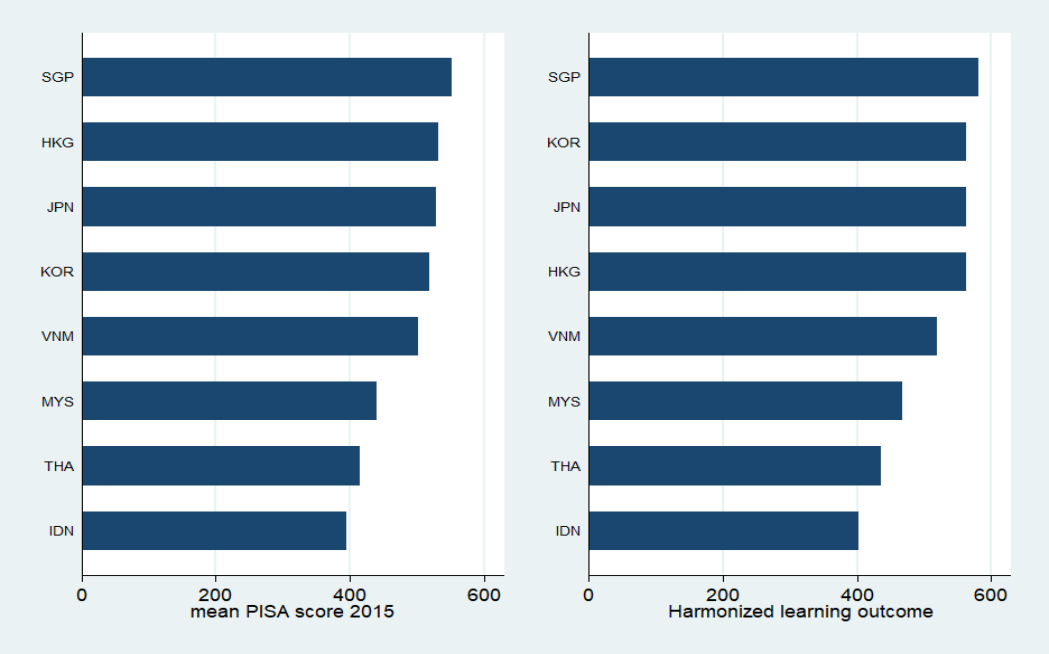
Quality of education

In this chapter, we also adjust the human capital by the quality of education, as the quality of education system varies so substantially across countries (Wößmann, 2003). For example, a year of schooling in a country with poor quality education does not create the same increase in human capital as a year of schooling in a country with a good education system. The variation would be greater with the comparison of least-developed and advanced economies. In addition, Hanushek and Kimko (2000) argued that quality of each year of schooling i.e. cognitive skills learned is highly crucial to human capital formation and therefore difference in quality of education should be incorporated in the measurement of human capital in addition to quantity of schooling. The learning quality as additional proxy to human capital is given by the student assessment tests such as Program for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) and Program for the International Assessment of Adult Competencies (PIAAC) are widely available. In the latest attempt to improve human capital indicators, the World Bank through the work by Patrinos and Angrist (2018) has constructed a global dataset on education quality by harmonizing learning outcomes from various student assessment scores.

The empirical analysis in our chapter includes quality of education to quantify the effect of human capital by adopting a similar approach used by Hanushek and Kimko (2000) and Patrinos and Angrist

(2018) by averaging cognitive test scores on math, science and reading from PISA. This test is an age-based survey designed to assess the ability of 15-year-old students to use their skills and knowledge to meet real-life challenges. It has taken place every three years since 2000 initially with 32 countries participating in the test. The number of participating countries has increased over time exceeding 80 countries in 2018 with 9 from the East Asian region. So far, there are 7th rounds of the PISA test conducted in 2000, 2003, 2006, 2009, 2012, 2015 and 2018. We chose the PISA cognitive test over TIMSS and PIAAC for two reasons. Firstly, the PISA test relies on three core subjects namely math, reading and science, which sufficiently and accurately capture the cognitive skill component of human capital. In contrast, TIMSS only covers math and science subjects, while PIAAC focuses on literacy, numeracy and technology. Secondly, PISA has attracted wider recognition from education policy makers and scholars manifest in broader participation in the test and growing use of the test results in empirical research. Further, the test scores are available for many East and Southeast Asian economies. Figure 3.6 compares the average PISA score for East and Southeast Asian countries in 2015 with harmonised learning outcomes derived from World Bank's education quality dataset. The figure suggests that Singapore achieved the best quality of education manifest in the highest score of cognitive tests, followed by Hong Kong, Japan and Korea. The learning outcomes are found considerably lower in Indonesia and Thailand. It is interesting to note that the measure on quality of education from PISA is highly consistent and compatible with outcomes from the global dataset on education quality by Patrinos and Angrist (2018).

Figure 3.6: Average PISA score and harmonised learning outcome in 2015



Source: Author's calculation from PISA test and World Bank's education quality dataset

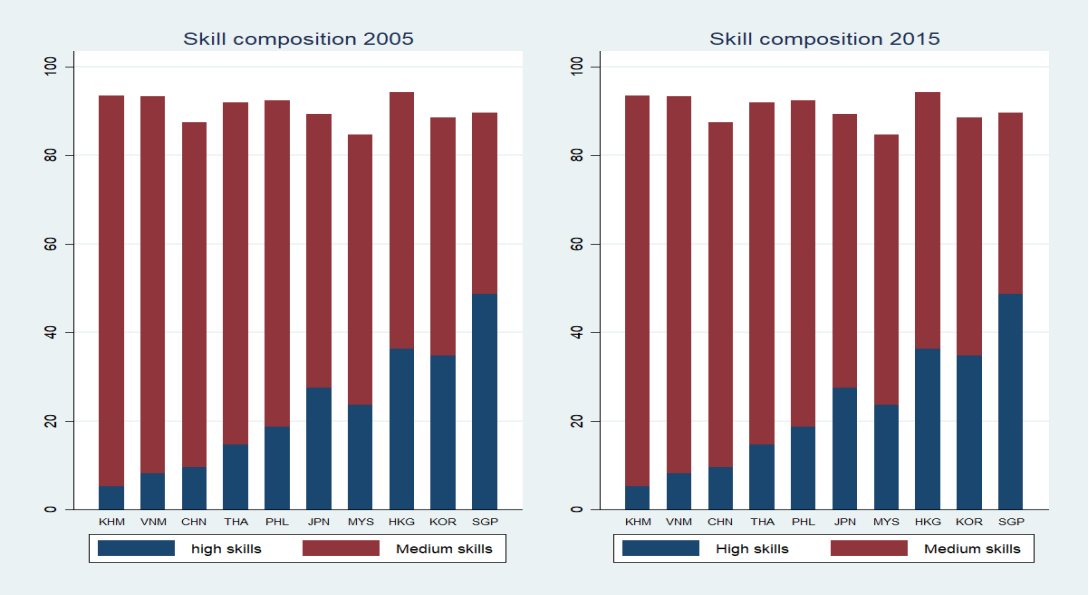
Skill composition

The skill composition of the labour force is critical to remain competitive in the regional and global production value-chain and helps countries to seize the benefits from GVC (OECD, 2017). Grundke et al. (2017) explores the relationship between skills and trade in value added using two major datasets: TiVA and the OECD Survey of Adult Skills. Skill variables are categorised into nine types: numeracy, literacy, problem solving, ICT, STEM, marketing/accounting, managing/communication, self-organization and readiness to learn. Their results suggest that cognitive skills, ICT skills, managing and communication skills and readiness to learn are fundamentally linked to participation in GVC. Although, the OECD Survey of Adult Skills was conducted twice in 2012 and 2015, it contains with a few sample countries from East and Southeast Asia leading to severe limitations for our empirical analysis.

As an alternative, our analysis opts for a skills dataset from ILOSTAT instead. Two measures of skills are used: first is the percentage of medium-skilled workers to total workforce and second is the percentage of high-skilled workers to total workforce. ILOSTAT contains data on employment across skill levels based on aggregate categories under the International Standard Classification of Occupation (ISCO). ILO (2012) classifies four broad skill levels according to complexity and nature of tasks and duties performed in the occupation and they are: skill level 1 (low), skill level 2 (medium) and skill levels 3 and 4 (high). Medium-skilled workers, on one hand, refer to those with skill level 2. The performed tasks for this skill level require advanced literacy and numeracy skills as well as good interpersonal communication skills. Occupations corresponding to the medium-skilled category include clerical support workers, clerks, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, and plant and machine operator and assembler. Knowledge and skills required to perform these tasks are generally obtained from the completion of lower secondary school and in some circumstances up to upper secondary school or vocational training. High-skilled category, on the other hand, refers to upper level occupations including technicians and associate professionals, professionals, and managers. These high-skilled works usually involve complex technical, practical and problem-solving tasks that require a high level of technical, procedural and theoretical knowledge. The performance of these tasks usually requires higher education and advanced qualifications. Figure 3.7 indicates that skill level varies significantly across East and Southeast Asian economies. Medium-skilled workforces are predominant in developing economies such as Cambodia, Vietnam, China, Thailand and the Philippines. The pattern is opposite for advanced countries like Singapore, Hong Kong, Korea and Japan in which the share of high-skilled is significantly higher. The figure also suggests insignificant difference in skill composition between the two periods in most economies implying that they made little progress in

improving skills. For example, while the percentage of skilled workforce in Cambodia had increased 5% percentage point between 2005 and 2015, the percentage of skilled workers in Thailand remains stable around 14.5%.

Figure 3.7: Skill composition by country, 2005 and 2015



Source: Author's calculation based on data from ILOSTAT

3.3.2. Empirical specification

We adopt a gravity model to estimate the effect of human capital on the GVC participation for East Asian countries. Head and Mayer (2014) and Yotov et al. (2016) describe gravity model as a workhorse of applied international trade analysis that produces the most robust estimation. Moreover, there are growing GVC empirical studies adopting the gravity model as a method to investigate the determinants of value-added trade and GVC participation. Those influential works include Baldwin and Taglioni (2011), Noguera (2012), Choi (2013) , Kimura et al. (2007), Athukorala (2011), Kowalski et al. (2015), Taguchi et al. (2014), and Saslavsky and Shepherd (2014).

Gravity model stimulates that trade flow between two countries is a function of economic mass and geographic distance among them. Its basic specification can be expressed as follows:

$$X_{ij} = G S_i M_j \varnothing_{ij} \quad (3.1)$$

Where:

X_{ij} is bilateral trade flow from exporter *i* to partner country *j*
G is a variable that does not depend on *i* or *j* (world liberalization)
S_i represents characteristics and capacities of exporter *i*

M_j denotes characteristics of partner country *j*
$Ø_{ij}$ denotes bilateral accessibility between *i* and *j*

The standard estimating procedure involves taking logs of equation (3.1), which give us the following expression:

$$\log X_{ij} = \log G + \log S_i + \log M_j + b_4 \log Ø_{ij} \quad (3.2)$$

As elaborated in the earlier section, production fragmentation and its resulting exchange of intermediate goods can be determined by, *inter alia*, human capital and labour market, trade policies, and quality of logistics and infrastructure. Given the flexibility of the theoretical framework in the gravity equation, we extend the basic gravity specification by adding a number of explanatory variables drawn from the theory of international production fragmentation. Therefore, equation (3.2) can be augmented as follows:

$$LogX_{ijt} = c + b_1\, log\_output_{it} + b_2\, log\_output_{jt} + b_3\, log\_dist_{ij} + b_4\, cont_{ij} + b_5\, comlang_{ij} + b_6 FTA_{ijt} + b_7\, log\ (1+tar_{ijt}) + b_8\, log\_incgap_{ijt} + b_9\, log\_humcap_{it} + b_{10}\, log\_infra_{it} + b_{11}\, log\_trade\_fac_{it} + e_{ijt} \quad (3.3)$$

The denotation of variables is summarised below:

- X_{ijt} denotes value of value-added export by country *i* to country *j* at time *t*. To differentiate the effects of human capital and other policy variables on different types of GVC activities, we use two different dependent variables and run regression separately. The first variable is 'domestic value added embodied in gross export (DVA_{ij}) or forward GVC participation. The second variable is 'foreign value-added content of gross export (FVA_{ij}) or backward GVC participation.
- $Output_{it}$ and $output_{jt}$ denote total outputs of country *i* and country *j* at time *t,* respectively. Unlike most empirical works, which use GDP as proxy to economic mass, this chapter follows recommendation by R. Baldwin and Taglioni (2011) by opting for total output as economic mass on the grounds that total output is more appropriate for value-added trade estimation. Data on outputs is derived from TiVA database.
- $Dist_{ij}$, $cont_{ij}$, $comlang_{ij}$, and FTA_{ijt} represent conventional trade costs. They refer to distance, contiguity, common language and free trade agreement between country *i* and *j*, respectively. Data for these conventional gravity variables are extracted from CEPII's gravity dataset.
- $Tarr_{ijt}$ is the average MFN tariff. For forward GVC participation equation, $Tarr_{ijt}$ refers to tariff imposed by country *j* on exports from country *i* at time *t.* For backward GVC participation equation, $Tarr_{ijt}$ refers to tariff imposed by country *i* on imports from country *j* at time *t.* Data on tariff is derived from the UNCTAD Trade Analysis Information System (TRAINS).

- $incgap_{ijt}$ denotes absolute differences in GDP per capita between country *i* and *j* at time *t.* Data on GDP per capita is derived from world development indicators.
- $Humcap_{it}$ denotes the human capital of country *i* at time *t*. We employ three main measures: mean year of schooling (to capture basic education), the quality of education, and skill levels.
- $Infra_{it}$ refers to overall quality of transport infrastructure country *i* at time *t.* The source of data is from the global competitiveness index.
- $trade\_fac_{it}$ is a trade facilitation measure. For the forward GVC participation equation, it refers to the number of days to complete the process of export. For the backward GVC participation equation, it refers to the number of days to complete the import procedure. The data is extracted from the World Bank's Ease of Doing Business.

3.3.3. Estimation methods

Despite its several advantages, there are a few empirical issues in the estimation of the above gravity model and failure to deal with them properly will lead to estimation bias (Anderson & Van Wincoop, 2003; R. Baldwin & Taglioni, 2011; Yotov, Piermartini, Monteiro, & Larch, 2016). The most common issue is cross-section correlation between the observables and unobservable or known as multilateral resistances. R. Baldwin and Taglioni (2011) describe this particular econometric issue as 'gold-medal error'. Many papers including Wei (1996) and Baier and Bergstrand (2007) constructed 'remoteness index' based on the function of bilateral distance and GCP to correct multilateral resistance issue. However, they bear little resemblance to the theoretical counterpart of multilateral terms (Head & Mayer, 2014). This chapter acknowledge the importance to introduce multilateral resistance terms in the gravity model estimation (Anderson & Van Wincoop, 2003) but as suggested in Feenstra (2002), we control them by introducing exporter-year and importer-year fixed effects. R. Baldwin and Taglioni (2011) proved that these time-varying country dummies can correct the 'gold-medal error' in the gravity model. Secondly, there is the issue of zero-value trade as trade values could be systematically zero and eliminating them in the sample would potentially remove useful information and also develop sample selection bias (Melitz, 2003; Silva & Tenreyro, 2006). We adopted the Pseudo-Poisson Maximum Likelihood (PPML) technique to overcome this issue (Silva & Tenreyro, 2006). As well as addressing both multilateral resistances and zero-value trade issues, PPML estimator is more efficient in the presence of heteroscedasticity. Silva and Tenreyro (2006) proved that PPML is robust to different patterns of heteroskedasticity and, in addition, provides a natural way to deal with zeros in trade data.

To establish the robustness of our result, we provide estimation from two estimators and then assess which estimator provides unbiased and consistent estimation.

- Firstly, we apply *Ordinary Least Squares method* controlling exporter and importer-time fixed effects, hereafter refers to OLS-FE. By definition, exporter and importer-time fixed effect variables absorb unobserved exporter and importer-specific factors that could influence bilateral trade (Yotov et al., 2016). Consistent with several gravity literature, the advanced guide to gravity model by Yotov et al. (2016) recommended to include OLS-FE in gravity estimation with panel trade data.
- Secondly, we estimate equation (3.3) using the Poisson pseudo-maximum-likelihood (PPML) method controlling exporter and importer-time fixed effects. PPML method is able to fix multilateral resistances, zero trade and heteroscedasticity issues, which results in a more robust estimation for gravity model for trade.
- Since we employ three different measures for human capital, we introduce three separate specifications for estimation.
    - *Specification 1* includes only mean years of schooling as proxy to human capital along with other regressors. In the result tables, we denote OLS-FE I for estimation using OLS fixed effect for specification 1 and PPML-FE I for estimation using PPML method.
    - *Specification 2* includes both mean years of schooling and quality of education along with other regressors in the equation. The aim is to capture effects of level of education and learning outcomes on value-added trade. Column OLS-FE II and PPML-FE II represent the results using OLS-FE and PPML estimators, respectively, for specification 2.
    - *Specification 3* replaces mean years of schooling and quality of education with skill variables namely share of medium-skilled and high-skilled to total labour force. This specification allows us to capture the effect of skill composition in the labour market on value-added trade. Similarly, we denote OLS-FE III for estimation using OLS fixed effect for specification 3 and PPML-FE III for estimation using PPML estimator.

For every specification, we conduct Ramsey Regression Equation Specification Error Test (RESET) test to detect the general functional form. More precisely, we compare RESET test results between OLS-FE I and PPML-FE I, OLS-FE II and PPML-FE II, and OLS-FE III and PPML-FE III and conclude which estimation method provide a more consistent and unbiased results. The *p-values* for each estimation are given in the result tables.

3.4. Empirical results

3.4.1. Results for forward global value chain participation

Table 3.1 presents empirical results of the impacts of human capital and other structural and policy variables on a country's forward GVC participation. Colum (1), (2) and (3) store estimates for specification 1, 2 and 3, respectively using OLS-FE method, while column (4), (5), and (6) are results for specification 1, 2 and 3 from PPML-FE estimator.

Table 3.1: Estimation results for forward global value chain participation

Forward GVC participation	OLS-FE I (1)	OLS-FE II (2)	OLS-FE III (3)	PPML-FE I (4)	PPML-FE II (5)	PPML-FE III (6)
Gross output of exporter	0.355***	1.139***	3.141***	0.644***	0.762***	0.858***
	(0.00502)	(0.0180)	(0.0312)	(0.0564)	(0.0670)	(0.0347)
Gross output of importer	0.761***	0.870***	0.724***	0.515***	0.448***	0.479***
	(0.0170)	(0.00504)	(0.0187)	(0.0583)	(0.0756)	(0.0554)
Distance	-0.490***	-0.382***	-0.450***	-0.504***	-0.377***	-0.460***
	(0.0243)	(0.0374)	(0.0320)	(0.141)	(0.141)	(0.113)
Contiguity	0.546***	0.478*	0.604***	0.164	0.190	0.298**
	(0.0465)	(0.114)	(0.0594)	(0.164)	(0.167)	(0.131)
Common official language	0.264***	0.315***	0.277***	-0.145	0.0742	-0.0711
	(0.0163)	(0.0142)	(0.0168)	(0.185)	(0.222)	(0.196)
Free Trade Agreement (FTA)	0.0892**	0.0895	0.0741**	0.109	0.0503	-0.00807
	(0.0313)	(0.101)	(0.0313)	(0.138)	(0.148)	(0.143)
Mean year of schooling	-4.915***	0.342**		2.179***	3.796***	
	(0.0465)	(0.0698)		(0.400)	(0.574)	
Education quality		0.155**			1.834**	
		(0.0294)			(0.7785)	
Medium skilled in labor force (%)			1.781***			0.178***
			(0.0216)			(0.0384)
High skilled in labor force (%)			2.501***			0.158***
			(0.0306)			(0.0392)
Income gap	-0.0365***	-0.0719***	-0.0318***	-0.0524	-0.0760*	-0.0504
	(0.00625)	(0.00324)	(0.00640)	(0.0440)	(0.0396)	(0.0405)
Tariff	0.322***	1.201***	0.101	-0.823***	-0.738***	-0.781***
	(0.0936)	(0.0216)	(0.105)	(0.118)	(0.134)	(0.119)
Quality of infrastructure	2.107***	-1.955***	-9.020***	0.735***		0.303
	(0.0183)	(0.0395)	(0.106)	(0.182)		(0.395)
Trade facilitation	0.282***	-1.361***	-2.466***	1.440***	-0.628***	-0.692**
	(0.0154)	(0.0161)	(0.0124)	(0.331)	(0.112)	(0.337)
Constant	-0.281	-15.87***	-195.9***	-13.45***	-3.811**	-20.91***
	(0.497)	(0.141)	(2.970)	(1.475)	(1.767)	(4.109)
Observations	4,696	1,101	4,230	4,696	1,101	4,230
R-squared	0.960	0.946	0.962	0.939	0.928	0.956
Exporter-time FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes	Yes	Yes
RESET test (p-value)	0.0001	0.2816	0.0001	0.8797	0.7787	0.5194

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

Impacts of structural factors on forward global value chain participation

Before discussing key findings on the effect of human capital on forward GVC participation, let examine the results for conventional variables and other policy factors. The coefficients for outputs, distance, contiguity and common language have expected sign and statistical significance across different specifications and estimation methods. Even more important is that the signs are consistent with most empirical results using gravity model estimation. The result implies that economic mass between the two countries have significant and positive effects on forward GVC participation. The positive effect of outputs on value-added trade is consistent with findings in Baldwin and Taglioni (2011) and Noguera (2012), which supports the theoretical foundation of the gravity model predicting that volume of bilateral trade is attracted by the size of economic mass.

Also consistent with most gravity literature is the finding of negative association between distance and forward GVC participation. This can be interpreted that a country tends to link more of its domestic value-added content as intermediate inputs to its partners that are located at closer distance. The result not only supports the claim by Johnson and Noguera (2012b) that proximity plays a strong role in explaining production fragmentation but also confirms a stylised fact discussed in Baldwin (2012) that most global value chains are a regional phenomenon. This empirical evidence also confirms the above descriptive statistics explaining that the majority of intermediate inputs in East and Southeast Asia are sourced from within the region. Therefore, proximity which incurred relatively low trade cost matters for forward GVC.

Impacts of trade policies on forward GVC participation

Empirical results for trade policy variables are somewhat inconsistent across different specification and estimation methods. For example, the sign and magnitude for tariff are positive and significant in OLS-FE but negative and significant in PPML-FE; coefficient of free trade agreement (FTA) estimated by OLS-FE III is positive and significant, but it appears negative and insignificant in PPML-FE III. These raise a critical question of which estimator provides a more consistent and robust estimate. To clarify this issue, we conduct a RESET test for pair estimation of each specification. The *p-value* from RESET tests for all PPML-FE estimations are well above 0.05 suggesting that they pass a misspecification test and therefore we can conclude that these estimates favour the PPML-FE method over the OLS-FE. For tariff, it can be argued that higher tariff imposed on exports of intermediate inputs tends to reduce domestic value-added content of East and Southeast Asian countries and thus lowering forward GVC participation. The negative association between tariff and GVC participation is

not unexpected and in fact is similar to several empirical literature on the determinants of GVC participation i.e. Kowalski et al. (2015) and Cheng et al. (2015). Like final goods, trade restriction in form of tariff hinders value-added trade and lower participation in value chain activities.

Since FTA is usually formed to boost trade, investment and integrated production networks through removing barriers to trade, we revaluated the negative results of the FTA variable. However, we note that the whole sample consists of two most liberal economies in terms of tariff measure namely Singapore and Hong Kong. These countries impose zero tariff on imports of all kinds of goods, final and intermediate goods alike. This could potentially nullify the real impact of FTA on GVC trade. To validate our suspicion, we re-estimate all specifications using the PPML-FE estimator with sub-sample that exclude Singapore and Hong Kong as partners. Interestingly, the coefficient of FTA as shown in Table 3.2 turns out to be positive and significant, which indicates that FTA enhances forward GVC participation.

Table 3.2: New estimation results for FTA and forward global value chain participation

Forward GVC participation	(4) PPML-FE I	(5) PPML-FE II	(6) PPML-FE III
Free Trade Agreement (FTA)	0.346***	0.248***	0.236***
	(0.0932)	(0.0761)	(0.0705)
Constant	-5.243***	-17.82***	-57.54***
	(1.784)	(1.636)	(7.684)
Observations	3,755	786	3,289
R-squared	0.968	0.968	0.985
Exporter-time FE	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: the sub-sample excludes Singapore and Hong Kong

Impacts of transport and trade facilitation on forward GVC participation

Theory of production fragmentation stipulates the importance of transport and trade facilitation as key service link factors that influence degree of fragmentation. In other words, a more efficient transport and logistics and effective trade facilitation will reduce cost of service links and thus boost exchange of intermediate inputs along the production networks. As to our empirical results, although the significant level varies slightly across different specifications, they are to large extent in line with theoretical prediction. More precisely, the quality of infrastructure, which is measured in the form of ranking from 1 (worst) to 7 (best) by the World Economic Forum in its annual global competitiveness report, is found to have positive and significant impact on forward GVC participation for specification 1. While its coefficient is omitted in PPML-FE II due to perfect collinearity; it appears positive but not

statistically significant in PPML-FE III. The estimate for trade facilitation is rather consistent. Measured by the number of days to complete all necessary export procedures, trade facilitation matters for value-added trade. The longer it takes for the whole export process, the lower volume of domestic value-added content export. This implies that the inefficiency of export facilitation are likely to lower the degree of participation in forward GVC activities.

We are aware of a benchmarking measure of overall quality of transport and logistic system known as Logistic Performance Index (LPI) constructed by the World Bank and use it as an alternative proxy to transport and logistics variables. In fact, LPI has been used by a number of trade policy empirics, for instance in Athukorala (2011) and Saslavsky and Shepherd (2014) to assess the impacts of logistics and transport on value-added trade. LPI is derived from the weighted average scores on six key broad areas namely efficiency of the clearance process; quality of trade and transport related infrastructure; ease of arranging competitively priced shipments; competence and quality of logistics services; ability to track and trace consignments; and timeliness of shipments. The score indicates comparative performance of a country's transport and logistics system. For example, Singapore was ranked 5th in logistic performance in 2016 with LPI score of 4.14 while Cambodia was ranked 73th LPI score of 2.8. As a way to conduct robustness checks on the impact of transport and logistics on forward GVC participation, we replace infrastructure and trade facilitation variables with LPI and re-estimate with all specifications using PPML-FE method. The results shown in Table 3.3 clearly indicate the positive and significant effect of logistics and transport on forward GVC participation.

Table 3.3: Estimation results for LPI and forward global value chain participation

Forward GVC participation	(1) PPML-FE I	(2) PPML-FE II	(3) PPML-FE III
Logistics performance index (LPI)	0.710***	1.612***	3.829***
	(0.0972)	(0.320)	(0.155)
Constant	-0.690	5.503***	47.74***
	(0.966)	(1.714)	(7.378)
Observations	2,858	891	2,600
R-squared	0.920	0.908	0.932
Exporter-time FE	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes

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

In sum, the findings point to the significant role of trade cost, which is jointly influenced by distance, quality of infrastructure and trade policy in forward GVC engagement. Countries that are more open to international trade along with an efficient and extensive infrastructure system and effective and simple export procedure are more likely to engage relatively actively in forward GVC participation. It is important to note that our results are in line with the majority of existing literature. For example, in

their investigation of the determinants of production networks in East Asia, Athukorala (2011), Kimura et al. (2007) and Taguchi et al. (2014) draw similar conclusion that more liberal trade policy, quality of logistics and infrastructure are key drivers that transform the region into the most dynamic production networks.

Impacts of human capital on forward global value chain participation

Now let's turn to the discussion of results for human capital variables. We start with a customary variable which is mean year of schooling. The results in Table 3.1 show the opposite sign for schooling coefficients: negative for OLS-FE I but positive for PPML-FE I. But since RESET tests favour the PPML-FE estimator, we can highlight that attaining higher level of education helps enhance forward GVC participation. This finding is similar to the one in Cheng et al. (2015) that year of schooling, which is regarded as basic education, is a significant driver for GVC participating in low-tech manufacturing. The quality of education is added in the estimation and the sign and significance of mean year of schooling on forward GVC participation remain unchanged. The estimate also provides strong evidence about positive association between education quality and forward GVC participation. Countries that achieve higher education quality reflected through better learning outcomes are likely to integrate more in the production network through provision of intermediate inputs. It is interesting to note that the estimates are consistent across different methods and that both OLS-FE II and PPML-FE II pass the misspecification test.

As one might notice, the numbers of observations in specification 2 are a lot smaller than other specifications. This is because education quality measured by the average score of PISA tests is available every 3 years for a limited number of economies in East Asia. Given the potential challenges of small observations, we try another estimation using alternative variables for quality of education from the global competitiveness indicator dataset. Quality of the education system is ranked from 1 to 7 according to its performance to meet the needs of a competitive economy. The higher the value, the better is the education system of a country. We re-estimate specification 2 by replacing learning outcomes with score of education ranking and results are shown in Table 3.4. With the new education quality variable, observation increases to 4699. More important than the greater number of observations is the sign and significance of coefficients for both schooling and education quality being unchanged. Therefore, we can conclude that the level and quality of education are crucial in boosting forward GVC participation.

Table 3.4: Estimation results for MYS, quality of education and forward GVC participation

Forward GVC participation	(1) PPML-FE II
Mean year of schooling	1.344***
	(0.309)
Quality of education system (ranking by WEF)	2.016***
	(0.361)
Constant	-12.38***
	(1.499)
Observations	4,696
R-squared	0.939
Exporter-time FE	Yes
Importer-time FE	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Re-estimate specification (2) with PPML-FE by replacing PISA test score with education system ranking as alternative measure of education quality

The last measure for human capital is skill composition. The underlying concept linking skills to GVC participation is implicitly explained in the production fragmentation framework arguing that skill intensity is the key to attract value chain activities. It provides firms with greater division of tasks according to skill availability and thus resulting in high degree of production fragmentation. We used two skill variables in our estimation: (a) the share of medium-skilled and (b) high-skilled in the total labour force. As elaborated in the earlier section, to avoid unnecessary collinearity, we took out mean years of schooling and education quality from the gravity equation and replaced them with skills variables. The result in Table 3.1 suggests that greater availability of medium and high-skilled workers contributes to higher degree of forward GVC participation. The finding is consistent with several previous studies arguing that availability of skilled workers is also an important criterion for a country to attract GVC (Wang et al., 2017; Grundke et al., 2017b; Jona-Lasinio et al., 2017). Moreover, the evidence is also consistent with qualitative evidence from a firm survey reported in WTO (2014) that lack of skilled labour force is one of key impediments that could potentially constraints countries to join global value chains.

Robustness Checks

To establish robustness of our results, we introduce several alternative econometric specifications and run regression separately. Firstly, we estimate equation (3.3) for sub-sample of ASEAN countries and East Asia countries (Japan, China, Korea and Hong Kong or CJKH). The results are given in Table A.3.1 in the Appendix. While the estimate is fairly consistent with the baseline results, a couple of variation stands out. For ASEAN, quality of education, skills and infrastructure are crucial to increase forward GVC participation, they appear the opposite for CJKH. Free trade agreements tend to have

significant effect on forward GVC participation in CJKH but it is not the case for ASEAN. Secondly, we add new variable, which is gap in year of schooling between origin and partner countries in equation (3.3), to capture differences in structural factor endowment. The third robustness check involves the introduction of interactive terms in equation (3.3). Specifically, we interact FTA with quality of education to capture the combined effect of both variables. We also capture the combined effect of quality of infrastructure and quality of education in another estimation. The results are shown in Table A.3.2 in the Appendix. It is found that the greater difference in factor endowment in terms of educational gap the more countries trade in value-added terms. The coefficients of both interactive terms are positive and significant indicating an additional effect of FTA and quality of education, and quality of infrastructure and education, respectively.

3.4.2. Results for backward global value chain participation

The empirical results of association between human capital, policy factors and backward GVC participation is given at Table 3.5. As discussed earlier, a country that imports more foreign inputs for the production of export goods is interpreted as having higher backward GVC participation. Like forward GVC participation, estimates are made for specification 1, 2 and 3 using OLS-FE and PPML-FE methods. Colum (1), (2) and (3) presents results for specification 1, 2 and 3, respectively using OLS-FE method, while column (4), (5), and (6) store results for specification 1, 2 and 3 from PPML-FE. We also conduct RESET tests for every specification and the results suggest that PPML-FE produces more robust estimations compared to its counterpart method.

Impacts of structural factors on backward global value chain participation

The relationship between economic mass and backward GVC participation is straightforward. It is found that gross outputs of the host country and its partners have positive and significant association with backward GVC participation. This means that the more output a country produces, the higher likelihood it imports foreign inputs. A country also tends to import more of foreign intermediate goods from partners that have greater production. The result points to the important role of economic mass in bilateral value-added trade and it holds for both backward and forward GVC participation. The results for distance are also similar to most gravity literature implying that proximity matters for intermediate goods trade. Therefore, it can be concluded that regional phenomena of GVC take place in both forms of forward and backward linkages. Last in the structural variables are geographic contiguity and common language. Despite notable variation across different specifications, contiguity appears to have positive and significant effects on backward GVC participation, whereas common language plays insignificant role in enhancing backward GVC activities.

Table 3.5: Estimation results for backward global value chain participation

Backward GVC participation	OLS-FE I	OLS-FE II	OLS-FE III	PPML-FE I	PPML-FE II	PPML-FE III
	(1)	(2)	(3)	(4)	(5)	(6)
Gross output of exporter	1.257***	1.338***	1.798***	0.820***	0.566***	0.760***
	(0.0116)	(0.0203)	(0.165)	(0.0567)	(0.0882)	(0.0366)
Gross output of importer	0.412	-0.776	0.128	0.791***	0.856***	0.784***
	(0.526)	(0.994)	(0.489)	(0.0667)	(0.0461)	(0.0679)
Distance	-0.539***	-0.371**	-0.499***	-0.321***	-0.290***	-0.308***
	(0.0221)	(0.0454)	(0.0202)	(0.0799)	(0.0788)	(0.0834)
Contiguity	0.344***	0.371**	0.368***	0.185	0.268**	0.192
	(0.0135)	(0.0520)	(0.0120)	(0.124)	(0.131)	(0.127)
Common language	0.0283	0.0627	0.0197	0.0597	0.0622	0.0751
	(0.0207)	(0.0361)	(0.0209)	(0.115)	(0.129)	(0.117)
Free Trade Agreement	0.105***	0.0710	0.0919***	0.0600	0.143*	0.0498
	(0.0189)	(0.0418)	(0.0199)	(0.0617)	(0.0765)	(0.0632)
Mean year of schooling	0.459***	-3.799***		-0.474	-2.299**	
	(0.0725)	(0.112)		(0.430)	(0.9645)	
Education quality		4.349***			0.568	
		(0.0731)			(0.6079)	
Medium skilled (%)			0.338***			0.0979***
			(0.0934)			(0.0367)
High skilled (%)			0.501***			0.0853**
			(0.138)			(0.0403)
Income gap	-0.0706***	-0.0533*	-0.0739***	-0.0737**	-0.0609*	-0.0731**
	(0.00347)	(0.0170)	(0.00334)	(0.0291)	(0.0338)	(0.0298)
Tariff	-0.0831***	-0.146**	-0.0745***	-0.0843	-0.273**	-0.0797
	(0.0140)	(0.0236)	(0.0172)	(0.0686)	(0.130)	(0.0693)
Quality of infrastructure	-0.467***	-0.141**	-1.626***			
	(0.0250)	(0.0247)	(0.367)			
Trade facilitation	0.301***	-0.766***	0.576***	-0.935***	-0.121	-0.724***
	(0.00588)	(0.0259)	(0.0593)	(0.140)	(0.179)	(0.242)
Observations	5,310	1,239	4,779	5,310	1,239	4,779
R-squared	0.969	0.963	0.970	0.955	0.948	0.956
Exporter-time FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes	Yes	Yes
RESET test	0.0000	0.0002	0.0000	0.6254	0.6254	0.2233

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

Impact of trade policies on backward global value chain participation

The effect of trade policies on backward GVC participation is examined in forms of tariff and FTA. Conceptually, high tariffs raise the price of imports which could lead to reduction in import volumes. The intuition holds for both final and intermediate goods. The results for tariff vary notably in terms of magnitude in which coefficients are negative but insignificant in specification 1 and 3 but it appears negative and significant in specification 2. The latter result implies that barriers to trade measured by higher tariffs decrease imports of foreign inputs and thus lower backward GVC participation. The mixed results might be explained by the fact that import tariffs are already low. Economies like

Singapore and Hong Kong impose zero tariff on all imports while other East and Southeast Asian economies impose on average as low as 6 percent of tariff on imports. Lack of significant power to explain tariff influence could be due to its less importance compared to technical barriers to trade and other non-tariff measures (Kowalski et al., 2015). Overall, a country's own tariff policy can shape the degree of engagement in intermediate inputs exchange.

The hypothesis that participating in FTA can facilitate backward GVC participation holds with all OLS-FE estimation and specification 2 in PPML-FE estimates. But since OLS-FE suffers from misspecification (*p-value* of RESET test is below 0.05), the results seem inconsistent. Like in the previous section, we drop Singapore and Hong Kong and re-estimate specification 1, 2 and 3 with the PPML-FE method. Table 3.6 suggests that zero tariff significantly reduces the real effect of FTA. Regardless of econometric specifications, evidence from East and Southeast Asian economies suggest that FTAs increase intermediate input trade and raise backward GVC participation. The results imply that trade policies both in form of tariff and FTA play an important role in determining the degree of engagement in backward GVC. It is worth noting that East and Southeast Asia has witnessed rapid proliferation of FTA with partners from within and outside the region. Intensity of bilateral and regional FTAs has created a complex and to some extent overlapping web of trade deals, commonly known as spaghetti bowl. The overall aims are obviously to promote freer movement of goods, services and investment as well as to transform the region into a competitive and dynamic hub of regional production networks. Therefore, a parallel proliferation of FTAs and regional production networks is not a coincidence but indeed it happens by policy design.

Table 3.6: New estimation results for FTA and backward global value chain participation

Backward GVC participation	(1) PPML-FE I	(2) PPML-FE II	(3) PPML-FE III
Free Trade Agreement (FTA)	0.105*	0.223***	0.0968*
	(0.0538)	(0.0656)	(0.0561)
Tariff imposed on imports	-0.0403	-0.152	-0.0343
	(0.0664)	(0.130)	(0.0662)
Constant	-12.59***	9.040***	1.053
	(1.650)	(0.542)	(2.465)
Observations	4,248	1,062	3,717
R-squared	0.977	0.977	0.978
Exporter-time FE	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: the sub-sample excludes Singapore and Hong Kong

Impacts of infrastructure and trade facilitation on backward global value chain participation

Estimates in Table 3.5 indicate that coefficients of quality of infrastructure for specification (1), (2) and (3) using OLS-FE method are negative and significant; yet they are excluded in all specifications using PPML-FE estimate due to collinearity. However, because no OLS-FE estimation passes the misspecification test, we cannot conclude that quality of infrastructure reduces intermediate imports. To get an estimate for quality of infrastructure in PPML-FE, we drop variables with high correlation with quality of infrastructure and re-estimate the equations. Column (1) and (2) in Table 3.7 present results from specification 1 and 3, respectively but without import time variable. It is evident from these estimations that quality of infrastructure has positive and significant association with backward GVC participation. This means countries with more intensive and efficient infrastructure systems are more likely to import more foreign inputs to embody in their exports.

Table 3.7: Estimation results for infrastructure and backward global value chain participation

	(1)	(2)
Backward GVC participation	PPML-FE I	PPML-FE II
Quality of infrastructure	0.621*	3.604***
	(0.327)	(0.240)
Constant	-13.12***	-3.892
	(1.268)	(2.389)
Observations	5,841	5,841
R-squared	0.950	0.950
Exporter-time FE	Yes	Yes
Importer-time FE	Yes	Yes

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

Trade facilitation variable for backward GVC participation is the number of days required to complete the import process. It covers time for documentary compliance and border compliance when importing goods. The data is extracted from the World Bank's Ease of Doing Business. The longer it takes to complete the import procedure, the higher the transaction cost of exchange and trade. Results in Table 3.5 vary notably across specifications and estimation methods. The coefficients are positive and significant for specification 1 and 3 using OLS-FE but negative and significant for specification 1 and 3 using PPML-FE. But since the later estimation method passes the misspecification test, we can conclude that it provides a more robust estimate. Therefore, we can argue that length of import procedure has negative and significant effects on backward GVC participation. The slower and inefficient custom procedure for imports is likely hindering foreign intermediate trade and thus lowering backward GVC engagement.

We drop infrastructure and trade facilitation variables and replace them with LPI index to capture the effect of the whole quality of trade and logistics system on backward GVC participation. Estimation

results are presented in Table 3.8. Despite certain variation among all specifications, we are confident to conclude that LPI has positive and significant effects on backward GVC participation. Countries with better quality of transport and logistics systems tend to import more of foreign inputs for the production of exports. Overall, evidence supports the important role of infrastructure and trade facilitation in boosting a country's engagement in backward GVC activities.

Table 3.8: Estimation results for LPI and backward global value chain participation

backward GVC participation	(1) PPML-FE I	(2) PPML-FE II	(3) PPML-FE II
Logistics performance index (LPI)	1.096***	-0.115	3.375***
	(0.154)	(0.278)	(0.413)
Constant	-4.310***	11.07***	10.28
	(1.159)	(1.532)	(9.303)
Observations	3,245	1,003	2,950
R-squared	0.947	0.942	0.947
Exporter-time FE	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes

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

Impacts of human capital on backward global value chain participation

The results of human capital and backward global value chain participation is given at Table 3.5. The coefficient for schooling shown in Table 3.5 is found positive and significant for specification 1 using the OLS-FE method, but negative and insignificant once PPML-FE is applied. But since OLS-FE fails the misspecification test, it is argued that schooling does have insignificant impact on foreign input imports. But once we include quality of education in the equation, the magnitude of impact becomes stronger reflected by negative and significant association. This implies that countries whose population aged 25 and above with higher levels of education tend to import less of foreign inputs to be embodied in their export. For the quality of education, it does not matter significantly. As in previous analysis, we conduct a similar estimation for specification (2) by replacing PISA test score with education ranking from Global Competitiveness Index. The result is consistent with baseline estimates and therefore we can conclude that quality of education is not an important driver of a country's backward GVC participation.

As opposed to quality of education, the effect of skill levels on backward GVC participation is positive and significant. Countries with a greater share of medium and high skilled workforce are likely to import more foreign intermediate inputs. This evidence seems to support a fragmentation framework signifying the skill complementarity among countries in global production networks. The results

highlight that factor endowment including difference in skill categories are key to specialization in production chains. The results can also be loosely interpreted that countries with medium and high-skilled workforce still need to import foreign intermediate inputs in the production and exports. Yet, because data on imports of foreign inputs used as dependent variables in our estimation is aggregate at total industry, we have no sufficient evidence to firmly prove finer division of labour and specialization among countries in the production networks. But overall, we can conclude that skilled labour helps enhance the degree of backward GVC participation.

Robustness Check

Like in the previous session, we implemented same robustness check procedures for backward GVC participation. Firstly, we estimate equation (3.3) separately for ASEAN countries and CHJK. The results for each sub-sample countries are given in Table A.3.3 in the Appendix. Two important observations can be drawn from both regions. For ASEAN, quality of education and continuity are found to have positive and significant impact on forward GVC participation, but they appear otherwise for CJKH. Economies with higher share of skilled labour have lower foreign value added in exports and this result is consistent across ASEAN and CJKH. Secondly, we introduce new variable on gap in year of schooling to capture differences in structural factor endowment. Thirdly, we introduce two interactive terms: (1) FTA and quality of education; and (2) infrastructure and quality of education in equation 3.3 and run regression separately. The results are shown in Table A.3.4 in the Appendix. It is found that the greater difference in factor endowment in terms of educational gap the more countries trade in value-added terms and thus increasing backward GVC participation. The coefficients of both interactive terms are positive and significant indicating an additional effect of FTA and quality of education, and quality of infrastructure and education, respectively.

3.5. Conclusion

This chapter firmly recognizes the prevalence of GVC and quantifies the effect of human capital on participation in value chain activities for economies in East and Southeast Asia based on the gravity model. The results suggest that countries that have a workforce with higher education and skills are more likely to supply domestically produced intermediate inputs to global production networks. This highlights the importance of education and skills in enhancing a country's engagement in forward GVC activities. For backward GVC participation, skills are much more important than education level, which manifests in a significant and positive relationship between availability of medium and high skills and backward GVC participation. Regardless of skill composition, countries in East and Southeast Asia import foreign inputs for their production of outputs. This evidence reflects the incidence of skill complementarity in a vertically integrated production network. It also supports the claim by production

fragmentation theory that factor intensity and relative cheapness of factors are key to production fragmentation. Overall, our findings provide evidence on the critical role of human capital in participation and positioning at a higher regional and global value-added GVC activities (UNIDO 2018; OECD 2017; Cattaneo et al., 2013).

We also found evidence that trade policies in form of tariff, free trade agreements and trade facilitation, proximity and quality of transport and logistics systems play significant roles in determining the magnitude of value-added trade in East and Southeast Asia. This evidence is consistent with existing literature and supports the evidence that trade cost and connectivity are important elements in production fragmentation and GVC integration. The overall results highlight the importance of improving connectivity through reducing trade barriers, streamlining custom procedures and improving transports, logistics and investment climate, and on investing in education and skills of the workforce in order to seize the benefits from global value chains.

Chapter 4

Human Capital and GVC Participation of Firms in Selected ASEAN Countries

4.1. Introduction

Global value chain has transformed industrial activities of developing countries through creating linkages between global and domestic trade and industrial structure. For developed countries, they can participate in the global value chain based on their extended 'comparative' and competitive advantages due to fragmentation effects of GVC. There is growing evidence that participating in GVC offers a wide range of economic benefits in terms of increasing trade and investment, enhancing greater competitiveness and growth (UNCTAD 2013; OECD 2013; Cattaneo et al. 2013; World Bank 2020) . The prevalence of GVC has also changed the roles of firms including small and medium enterprises (SMEs) in both regional intra- and inter-industry activities. Firms can participate and link in the value chains by specializing in specific tasks or stages in the GVC. Such an internationalization strategy can offer them substantial gains including, among others, enhancement of efficiency and productivity (Kang et al. 2010; Miroudot et al., 2009) and potential transfer of technology and knowledge (De Backer et al., 2018; Cattaneo et al. 2013). For local enterprises, GVC offers them a new platform to connect to foreign partners that could eventually help them to upgrade products, boost productivity and output growth (González et al. 2019). However, participation in GVC is very competitive and challenging. Firms especially in developing countries are constrained by major obstacles including a less conducive business environment, lack of effective institutions and infrastructure, and higher cost of trade. This raises the key question of what type of firms can overcome these challenges to join the GVC activities.

This chapter examines the performance of firms in terms of linkages with the global value chains. In particular, we look at the factors that affect firm participation in GVC by selected ASEAN countries using firm-level analysis. Further, we examine human capital development and its impact on GVC

participation using firm-level data from the World Bank Enterprise Survey (WBES). The study focuses on selected ASEAN countries of Indonesia, Philippines, Cambodia and Myanmar and highlights the importance of human capital development and its impact on participation in the regional and global GVC. The level of education and skills in the labour market plays an important role in absorbing and disseminating technologies and knowledge in the domestic economy, increasing the innovative activities of domestic firms.

The remainder of this chapter is organized as follows. Section provides an overview of selected ASEAN countries' participation in the GVC. Section 3 provides the data and empirical framework. In Section 4 and 5, we provide the results of our analysis for developing ASEAN countries and LDC ASEAN countries, respectively. The policy discussion is given at Section 6.

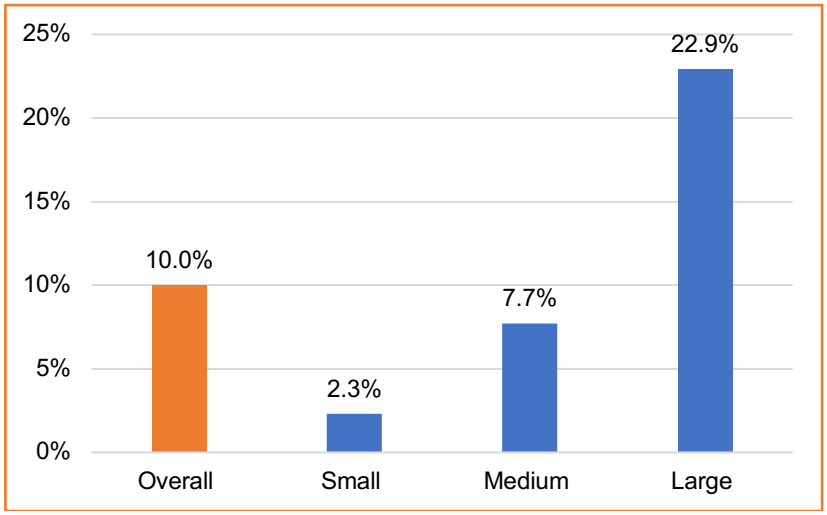
4.2. Overview of firms' participation in GVC in ASEAN

This section examines the GVC participation of enterprises in selected ASEAN countries. It also compares the characteristics of firms that are participating in GVC (denoted as GVC firms) with those that are not in GVC (denoted as non-GVC firms). The data for our study is from the World Enterprise survey database. Conceptually, enterprises can participate in GVC in two different ways. They can engage in GVC either through exporting intermediate goods or services directly to firms overseas or via supplying inputs to local firms whose production is made for export. WTO (2016) calls this measure as a 'seller-related or supply-side' approach and labels this mode of engagement as 'forward GVC participation'. Alternatively, enterprises can participate in GVC through sourcing inputs from foreign suppliers in order to produce goods and services for domestic consumption and exports. This mode of participation is known as 'backward participation', reflecting the upstream linkages with foreign partners (WTO 2016). This chapter focuses on firms' productive capacity and their ability to link both upstream and downstream within the production networks as the proxy to firms' participation in GVC. Our selection of conceptual definition is inspired by an argument in Antràs (2019) stating that when a firm both imports and exports, it is natural to conclude that this firm participates in GVC. We are particularly interested in firms that intensively link with value chain activities and set a third of proportions of imported inputs and export share as a threshold for GVC participation.

Figure 4.1 suggests that not many enterprises have been able to effectively link with global production networks and this is manifest in low GVC participation ratio (10 percent). The level of integration in GVC varies notably according to firm size with relationships being linear—the bigger firms have higher GVC participation rate. Precisely, only 2.3 percent of small-sized enterprises could join the GVC activities, and this ratio is about three times greater for the medium-sized enterprises and ten times bigger for the large firms. Such stylized fact confirms that firm heterogeneity is important

in the export and GVC firm activities. For example, WTO (2016) found that about 18 percent of enterprises in developing countries are involved in direct and indirect manufacturing exports; and Melitz (2008) and Bernard et al. (2007) asserted that only a small proportion of firms engage in exports. The proportion of firms participating in GVC also varies notably across countries. Only 3.4 percent of Indonesian enterprises are engaged in GVC compared to 17.5 percent in the Philippines. The distribution of GVC firms of each country is similar to the overall sample by which smaller firms have lower participation rate.

Figure 4.1: Share of firms participating in GVC



Source: Author's calculation based on the WBES

We also examine GVC and non-GVC firms' attributes and how the differences in firm endowment and capabilities affect their outcomes in regional and global trade. Table 4.1 compares average value of firm characteristic variables across the GVC and non-GVC firms. It is evident that there is significant heterogeneity between GVC and non-GVC firms as illustrated in Antràs (2015); Bernard and Jensen (2004); Bernard et al. (2012) ; Harvie et al. (2010a); Wignaraja (2013). Overall, GVC firms are larger, more productive, more capital and skill intensive as well as more technologically capable than non-GVC firms. Further, on an average the GVC firms have 394 employees compared to 109 for non-GVC firms; yet the former type of firm is younger as evident by shorter years of operation. About 69 percent of GVC firms are foreign owned, compared to just 12 percent for non-GVC firms. An average value of sales per employee, proxy to labour productivity, is US$ 324.6 thousand for GVC firms, and this is about twice that of non-GVC firms. We also observe that the technological capacity of GVC firms is twice higher than non-GVC firms. It is also clear that GVC firms tend to have a higher level of human capital than non-GVC firms as reflected by greater emphasis on hiring a larger proportion of skilled

workers. Our descriptive statistics and the t-test results provide some insights on potential relationships of firm characteristics and participation in GVC.

Table 4.1: Characteristics of GVC firms and non-GVC firms (in mean value)

	GVC firms	Non-GVC firms	Statistically different
Size	394	109	Yes ***
Age	18.3	21.6	Yes ***
Share of foreign ownership	68.5	11.7	Yes ***
Share of skilled production workers	65.7	57.4	Yes ***
Capital intensity (ratio of value of equipment over total fixed assets)	60.6	38.4	Yes ***
Labour productivity (sales per employee, thousand USD)	324.6	148.9	Yes ***
Technological capacity	2.4	1.2	Yes ***

*Note: a) * p<0.05; ** p<0.01; *** p<0.001*
b) The figures are mean values
c) Mean value for technological capacity ranges from 0 (weak) to 4 (strong)

4.3. Econometric specification and data

4.3.1. Econometric specification

The analysis adopts firm heterogeneity theory (also known as 'New-New Trade Theory') pioneered by Bernard and Jensen (1999); Bernard et al. (1995) ; Roberts and Tybout (1997) and Melitz (2003) to guide our empirical framework. The framework takes firm as the central unit of analysis and incorporates firm attributes such as size, ownership structure, capital, skills, technological capacity, and productivity to explain how these heterogeneities influence firm performances and strategies in international trade. This framework is the standard approach to explain the decisions of firms in export and value chain activities (Antràs, 2019; Antras & Chor, 2021). Its modelling is so flexible that can be modified to study a wider range of issues including, *inter alia*, productivity and exports or known as 'self-selection hypothesis'; export entrance and sequencing performance, which is called 'learning by exporting hypothesis'; firm decision on investment mode (either horizontal foreign direct investment or vertical FDI); firm performance in response to trading environment and contract and outsourcing (Antràs, 2015; Bernard et al., 2012; Melitz, 2008; Melitz & Redding, 2014).

We estimate the effects of human capital and other firm attributes on firm's GVC participation using the following econometric specification:

$$gvc_{istj} = \alpha_0 + \beta_1 \ln size_{istj} + \beta_2 sizesqr_{istj} + \beta_3 \ln age_{istj} + \beta_4 for\_own_{istj} + \beta_5 training_{istj} + \beta_6 skill_{istj} + \beta_7 \ln cap_{istj} + \beta_8 \ln prod_{istj} + \beta_9 \ln invest_{tj} + time + country + industry + \varepsilon_{istj} \quad (4.1)$$

Where subsript *i* denotes firm, *s* is sector, *t* is time, and *j* refers to country.

The definition and measurement of variables as well as their relationship with decision to join GVC are discussed below:

- *GVC participation* (gvc_{isrt}): it is a dummy variable with value 1 if firm *i* in sector *s* at time *t* from country *j* join GVC and 0 otherwise. Our selection of conceptual definition is inspired by an argument in Antràs (2019), Antras and Chor (2021) and World Bank (2020) stating that when a firm both imports and exports, it is natural to conclude that this firm participates in GVC. We are particularly interested in firms that intensively link with value chain activities and set a third of proportions of imported inputs and export share as a threshold for GVC participation. This means $gvc_{\boldsymbol{isrt}}$ equals 1 if a firm has both ratio of imported raw material and percentage of export greater than 33 percent and 0 otherwise.
- *Size ($size_{istj}$):* We measure firm size by total number of employees and hypothesize that size has positive and significant association with a firm's decision to participate in value chains.
- *Age (age_{istj}):* it refers to the number of years in operation. Like most firm heterogeneity empirics, it is anticipated that firms that participate in value chain activities have started businesses longer than their counterparts.
- *Foreign ownership (own_{istj}):* It is a dummy variable with value 1 if the establishment is foreign owned and 0 otherwise. Our study follows the definition of foreign firm by UNCTAD and Taglioni and Winkler (2016) using a benchmark of 10 percent of foreign capital as a threshold level. Therefore, foreign owned firm is defined as the one with 10 percent or more of its capital stake owned by foreign individuals, companies or organizations. The underlying rationale associating firm ownership and GVC participation lies on explanation that foreign firms usually have certain advantages especially in terms of knowledge on foreign markets, know-how, technical and financial capabilities, and better access to foreign inputs and networks (Harvie et al., 2010a; Wignaraja, 2015). These advantages put foreign firms in a superior position to enter into export and global production networks. Thus, it is hypothesized that firms with foreign ownership are positively associated with propensity to participate in GVC.

- *Capital intensity ($capint_{istj}$):* Given narrowly available information in the WBES, this chapter follows Farole and Winkler (2012) measuring capital intensity[3] by the ratio of value of machinery, vehicles and equipment to total sales. Since joining GVC requires substantial entry cost, it is expected that GVC firms are more capital intensive.

- *Human capital ($hcap_{istj}$):* Skill intensity is used to proxy for human capital of enterprises. It is measured by the share of skilled production workers to total employees. In theory, skilled workforces are critical to a firm's export performance and success and therefore it is hypothesized that firms engaging in GVC are more likely to have higher skill intensity.

- *Technological capacity ($tech_{istj}$):* we construct the technological capacity of a firm by summing up four dummy varialbes: internationally-recognized quality certification (ISO), adoption of foreign technology, website, and E-mail. Technological capacity, whose value ranges from 0 (weak) to 4 (strong), is important in securing quality compliance and communicating effectively with partners within value chains. Therefore, it is expected that firms with higher technological capacity will have higher probability to join GVC.

- *Labour productivity ($prod_{istj}$):* This variable is proxied by ratio of total annual sales to total number of employees. Like most firm heterogeneity studies, this chapter hypothesizes labour productivity to be positively associated with GVC participation.

- *Investment climate ($invest_{tj}$)*: It is a country-level policy variable that reflects the conduciveness of investment climate in country *j* at time *t*. It is proxied by ease of doing business score, which ranges from 0 to 100, where 0 represents the lowest and 100 represents the best performance.

4.3.2. Estimation strategy

We estimate equation (4.1) using the maximum likelihood method known as probit model as the baseline estimator. Several empirics including Sjöholm (2003); Roberts and Tybout (1997); Harvie et al. (2010a); Wignaraja (2012) have applied probit model to quantify decision to participate in export and global value chain activities. To account for variations across different industries, periods and countries, we control sector, time and country-fixed effects in our estimation. To show that our baseline results are robust, we introduce two robustness checks. First, we change the measure of GVC participation by distinguishing backward GVC from forward GVC participation. Second, we adopt

[3] In fact, WBES questionnaire also asks firms to report the value of land and buildings along with the value of machinery, vehicles and equipment. The sum value of these two items would represent a better proxy for capital intensity. However, we observe in our dataset that a considerable number of sample firms did not report the value of land and building making it an incomplete measure.

instrument variables as an alternative strategy to address endogeneity concern. It is highly likely that skill intensity is endogenous and thus being instrumented by three variables namely government expenditure on education as share of Gross Domestic Product (GDP), average ratio of skilled workers for each sector in a given year and country, and average ratio of firms providing formal training to employees in a given year and country. The IV regression is estimated using the Two-Stage Least Square (2SLS) method.

4.3.3. Source of data

Data used in our empirical analysis is derived from the World Bank's Enterprise Survey. It is the standardized survey of representative firms in 139 countries covering a broad range of business environment topics including labour, access to finance, technology and innovation, competition, and performance measures. We pool the WBES data from two ASEAN countries namely Indonesia and the Philippines for two periods: 2009 and 2015. The primary reason for selecting Indonesia and the Philippines for analysis is because the two countries had the Enterprise Survey conducted on the same timeframes which were 2009 and 2015. Also crucial is the fact that Indonesia and the Philippines arguably better represent the developing ASEAN-5 members that strive to capture much of regional value chain activities. Altogether, there are 5, 425 enterprises, of which 2, 764 are from Indonesia and 2, 661 from the Philippines. We exclude observations with missing data for any variable. Such a data cleaning procedure leaves us with 2,057 observations for estimation. We also conduct separate analysis for firms in Cambodia and firms in Myanmar to understand the differential effects in LDC ASEAN countries. For Cambodia, the survey was conducted in 2013 with 472 firms and in 2016 with 373 firms. Of the total 845 sample firms, 131 were interviewed in both rounds, 341 were interviewed in 2013 and 242 were in 2016. After dropping observations with missing data for any variable, it remains 509 observations for estimation. For Myanmar, the survey was conducted in 2014 and 2016 with a total sample of 1,239 firms, of which 278 were selected in both years. After a similar data cleaning procedure, it leaves us with 652 observations for empirical analysis.

4.4. Empirical results

4.4.1. Baseline results

Table 4.2 shows the baseline results. Standard errors are reported in parentheses below each coefficient while the power of statistical significance is codified in the number of stars. For regression estimation to be robust, there must be low incidence of multicollinearity among independence variables in the econometric specification. We verify if our regression suffers multicollinearity problem

by running correlation matrix among independence variables. As clearly shown in in Table A.4.1 in the Appendix, correlation coefficients for all variables are well below 0.5 indicating weak correlation among the right-hand side variables. Therefore, there is no multicollinearity problem in our econometric specification.

Table 4.2: Results on probability to join GVC, firm characteristics and human capital

Probability to join GVC	Probit
Size	0.250***
	(0.00342)
Square size	8.19e-10
	(3.15e-08)
Age	-0.222***
	(0.0531)
Foreign ownership	0.967***
	(0.0387)
Skill intensity	0.00726*
	(0.00379)
Capital intensity	0.0000153
	(0.00721)
Labour Productivity	0.0453***
	(0.00544)
Technological capacity	0.195***
	(0.0269)
Investment climate	32.81***
	(2.439)
Constant	-136.0***
	(9.320)
Year-FE	Yes
Country-FE	Yes
Sector-FE	Yes
Observation	2007
Pseudo R-sq	0.4313

Standard errors in parentheses
** p<0.1; ** p<0.05; *** p<0.001*

Except for age, all coefficients have expected signs and are statistically significant. Also chief to our estimates is the goodness of fit measured by pseudo R-square being sufficiently acceptable. The coefficient of size is positive and strongly significant, indicating that larger firms have higher propensity to participate in value chain activities. The finding is similar to prior estimates in Aggarwal and Steglich (2018); Wignaraja (2015); Lu et al. (2018) ; Harvie et al. (2010b) and is explained by the importance of scale of economy to overcome fixed cost of entry into GVC. As well as having more resources to offset the considerable necessary cost of entry, larger firms tend to be more competitive to sustain in international markets. It should be noted that the coefficient of firm size square is positive but it is

insignificant, which implies that size does not have a statistically significant impact on participation in the GVC. Ownership structure appears to have a positive and significant effect on firms' decision to join GVC. The finding confirms the descriptive statistics presented earlier and also support the general claim that foreign ownership offers enterprises superior advantages including networks with foreign partners, access to technology and management experiences, and learning from exporting from parent companies (Sjöholm 2003; Wignaraja 2015; Srinivasan and Archana 2011), which in return improve firms' efficiency and competitiveness and thus facilitating the entry into the production networks.

Age of the firms is found to have negative and significant effects on GVC participation. The result implies that young firms are relatively likely to integrate in value chains and appears to contradict the theoretical prediction stipulating that experience can boost firms to enter into foreign markets relatively easily. However, the empirical evidence on the impact of firm age on firm behavior in international trade are still inconclusive. For example, Roberts and Tybout (1997) and Anas et al. (2017) found positive association between age and decision to export, whereas Harvie et al. (2010); Wignaraja (2012); Sjöholm (2003) and Aggarwal and Steglich (2018) found otherwise. Various reasons were given to the contending relationship between age and GVC participation. For example, Wignaraja (2012) speculates that younger firms are more flexible and quicker to capture new technologies and understand new markets, which in turn help facilitate them to integrate into production networks. Sjöholm (2003), on the other hand, accounts for this finding to import substitution policies that encourage older enterprises to focus more on domestic market rather than export activities.

Estimated coefficient for skill intensity is strongly positive, allowing us to argue that firms having higher levels of human capital are more effective in engaging in the global value chains. The importance of human capital in shaping firm's behaviour in international trade is not uncommon in empirical literature. For example, Wignaraja (2015) revealed that having a high school-educated workforce increases the potential for enterprises to join supply chains; while Aggarwal and Steglich (2018) found that skill intensity increases the probability of firms participating in value chains. Similarly, ADB and ADBI (2015) asserted that human capital is among the critical factors that significantly contribute to firms' success in GVC. One might dispute the general conclusion on the ground that several empirics measure skill intensity somehow differently. We took into consideration and included an alternative variable for skill in our estimation (see Table 4.3). We follow Thangavelu (2014) to measure skill intensity based on wages and salaries. Precisely, skill intensity is defined as the ratio of wages and salaries to total employees which can be called the average wage of a firm. This proxy was used in Thangavelu (2014) to measure the quality of human capital under the assumption that firms with higher average labour costs per worker employ higher skilled labour. The signs and

magnitudes of all variables are comparable to previous estimations with coefficients of size, foreign ownership, productivity, capital intensity and technological capacity all being positive and significant. Therefore, we can conclude with high confidence that human capital is critically important for firms to join GVC.

Table 4.3: *Results on probability to participate in GVC using alternative skill intensity*

Probability to join GVC	Skill (wage/total employee)
Skill intensity	0.0747***
	(0.000968)
Year-FE	Yes
Country-FE	Yes
Sector-FE	Yes
Observation	1973
Pseudo R-sq	0.4319

Standard errors in parentheses
** p<0.1; ** p<0.05; *** p<0.001*

Other firm attributes also play an important role in shaping firms' outcome in GVC. Coefficient of labour productivity is positive and significant indicating that higher productive firms choose to join GVC. The finding supports the well-known self-selection hypothesis in firm heterogeneity literature. Since integration into the production network requires considerable initial investment, only firms with higher productivity can offset the entry cost and self-select to enter into value chain activities. The signs of coefficient for technological capacity are positive and statically significant, indicating the importance of quality compliance, adoption of foreign technology and investment in information and telecommunication in integrating into the global and regional production networks. However, we do not find statistically significant impact of capital-intensity and GVC participation in the Indonesian manufacturing firms.

We also consider the importance of macroeconomic factors and test how a country's investment climate would affect firms' trajectory in international trade. Proxied by ease of doing business, the result in Table 4.2 indicates that a country with an environment conducive to investment and business operation increases firm's engagement in GVC activities. It should be noted that the investment climate covers broad spectrums of laws, policies and structural factors affecting the operation of businesses that either facilitate or hinder the movement of a product or service along its value chain. Most often we see countries that actively and intensively engage in international trade i.e. Singapore, Hong Kong, Korea and the United State are among the best performers in the business climate. Our results together with these stylized facts allow us to draw a modest conclusion that the business environment does matter for firms to successfully integrate into exports and value chain activities.

4.4.2. Sensitivity analysis

To check if the baseline results are robust, this section introduces several sensitive analyses. The first robustness check involves series of changes in measure of dependent variables. As mentioned earlier, we defined GVC firms as those that are engaging in both substantial importing raw materials and exporting outputs. This definition is highly restrictive and fails to capture enterprises that have a ratio of raw material import and export below a one thirds threshold. To account for all firms that engage in value chains regardless of their depth and scope, we redefine GVC firms as those that have ratios of input imports and exports greater than 0 and estimate equation (1) again. The result of this sensitive analysis is reported in column (4.1) in Table 4.4. One might also notice that the baseline GVC participation measure fails to capture firms that only link with either side of supply chains: upstream or downstream. Conceptually, these firms can be loosely defined as GVC firms. To understand how human capital affects different modes of value chain activities, we conduct another robustness check by constructing separate GVC participation variables according to firms' commercial transactions. More precisely, enterprises that source intermediate inputs from foreign suppliers are defined as '*backward GVC participation'.* This variable takes value 1 if firms import raw material from abroad and 0 otherwise. Another measure is called *'forward GVC participation',* which captures value chain involvement through directly or indirectly exporting goods or services. In terms of firm distribution for the revised definition, there are more enterprises engaging in both forward and backward GVC activities the ratio of 17.7 percent compared to 10 percent for a more restrictive definition. Disaggregating by upstream and downstream activities, 25.6 percent of firms involve forward GVC participation while 36.1 percent participate in backward GVC.

We estimate equation (4.1) separately for backward GVC participation and forward GVC participation. The estimates for forward GVC participation and backward GVC participation are reported in column (2) and column (3), respectively in Table 4.4. For the first sensitivity estimation, age is found to have no effect on GVC participation while capital intensity is strongly negatively associated with GVC participation. The estimates for these two variables somewhat contradict the baseline results. Findings for other variables firmly hold with coefficients being positive and statistically significant. More precisely, regardless of the depth and scope of engagement in value chains, factors such as size, foreign ownership, human capital, productivity and technical capacity are crucial for firms to successfully integrate in GVC. Conducive business environment also plays an important role in shaping firms' performance in value chains.

Results for the second sensitivity analysis are largely consistent. Regardless of modes of GVC engagement, size and ownership structure are important factors facilitating firms to join GVC. The coefficient of age is positive but statistically insignificant for backward and forward GVC participation

indicating that year of operation does not have effect on firm behavior in international trade and value chain activities. Coefficients of labour productivity and technological capacity are positive and strongly significant for all specifications. This suggests that firms with higher productivity and stronger technological capacity are more likely to join supply chains. The findings are consistent with the previous estimation and still supports the self-selection hypothesis that high-productivity firms choose to focus more on international trade. As expected, skill variables turn out as significant with the correct sign, indicating the important role of human capital in facilitating enterprises to join supply chains, either upstream or downstream linkages.

Table 4.4: Results on probability to join backward and forward GVC

Probability to join GVC	(1) Forward and backward GVC (ratio >0)	(2) Forward GVC participation	(3) Backward GVC participation
Size	0.322***	0.241***	0.256***
	(0.0103)	(0.0593)	(0.0372)
Square size	-3.28e-08	-3.24e-08	-4.18e-08**
	(2.94e-08)	(2.85e-08)	(1.96e-08)
Age	0.0622	0.139*	0.0229
	(0.0402)	(0.0808)	(0.0792)
Foreign ownership	0.939***	0.857***	0.695***
	(0.00979)	(0.0288)	(0.113)
Skill intensity	0.00516**	0.00407***	0.00246***
	(0.00160)	(0.00137)	(0.000669)
Capital intensity	-0.0103**	0.0192**	-0.0387
	(0.00420)	(0.00756)	(0.0214)
Labour Productivity	0.0381	0.0499***	0.112***
	(0.0298)	(0.0148)	(0.00792)
Technological capacity	0.339***	0.298***	0.257***
	(0.0164)	(0.0239)	(0.0551)
Investment climate	31.64***	17.18***	24.23***
	(2.058)	(2.377)	(3.900)
Constant	-131.7***	-72.38***	-100.4***
	(8.270)	(9.864)	(15.77)
Year-FE	Yes	Yes	Yes
Country-FE	Yes	Yes	Yes
Sector-FE	Yes	Yes	Yes
Observation	2054	2053	2046
Pseudo R-sq	0.4330	0.3418	0.4095

Standard errors in parentheses
** p<0.1; ** p<0.05; *** p<0.001*

Our second sensitivity analysis involves the separate estimation for Indonesia and Philippines and assess if the results remain robust across countries. The estimation results in Column (1) and (2) in Table 4.5 suggest that the sign and significant level for most variables are consistent with estimation for the combined samples, indicating the robustness of our estimation. Like in the pool country estimate, coefficients of size, foreign ownership, skill intensity and technological capacity are positive and statistically significant for both Indonesia and Philippines. For skill intensity, it is found to have insignificant association with GVC participation for Indonesian firms, but such relationship proves to be positive and significant among firms in Philippines. The last sensitivity analysis examines sectoral differential effects via separate estimation for three major sectors: garment and textile, electronics and machinery, and other manufacturing. The regression results are given in Column (3), (4) and (5) in Table 4.5. Although we observe some variations across sectors, the overall findings are largely consistent with the baseline estimation.

Table 4.5 Estimation results by country and sectors

Probability to join GVC	(1) Indonesia	(2) Philippines	(3) Garment and textile	(4) Electronic & Machinery	(5) Other Manufacturing
Size	0.326***	0.181***	0.666***	-0.159***	0.232***
	(0.0879)	(0.0531)	(0.0543)	(0.0209)	(0.0503)
Square size	-2.56e-09	-4.66e-09	-6.61e-07***	9.81e-08**	3.14e-08
	(1.65e-08)	(4.67e-09)	(6.15e-08)	(4.57e-08)	(3.35e-08)
Age	-0.145***	-0.292**	-0.0529	-0.0149	-0.310***
	(0.0450)	(0.130)	(0.0765)	(0.108)	(0.110)
Foreign ownership	0.887***	1.048***	1.069***	1.131***	1.049***
	(0.175)	(0.259)	(0.278)	(0.109)	(0.125)
Skill intensity	0.00284	0.0137***	0.00710***	0.0137*	0.00754
	(0.00259)	(0.00269)	(0.00156)	(0.0173)	(0.00669)
Capital intensity	0.0736	-0.0464	0.0163	0.135***	-0.0202***
	(0.0711)	(0.0838)	(0.0449)	(0.0435)	(0.00573)
Labour Productivity	0.0528*	0.0485*	0.116**	0.0562*	0.0192***
	(0.0309)	(0.0251)	(0.0558)	(0.0607)	(0.00383)
Technological capacity	0.124**	0.263***	0.225	0.449***	0.152***
	(0.0517)	(0.0315)	(0.146)	(0.149)	(0.00558)
Investment climate	-		60.69***	-117.0***	37.28***
			(5.725)	(0.478)	(4.438)
Constant	-3.374***	-4.062***	-250.3***	466.5	-153.7***
	(0.944)	(0.730)	(23.97)	(0)	(17.75)
Observations	1,362	562	490	98	1,419
Year-FE	Yes	Yes	Yes	Yes	Yes
Sector-FE	Yes	Yes	No	No	No
Country-FE	No	No	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.4.3. Addressing endogeneity concerns

Endogeneity is the most common problem in applied economic research. In our econometric specification, we suspect that the skill intensity variable is endogenous due to reverse causality. The proceeding analysis proved that having a higher level of skilled workforce helps firms to integrate in GVC. However, the relationship could be the opposite as GVC firms are inclined to hire higher quality and skilled workers. Another potential source causing endogeneity in our model is the omitted variable. Enterprises connecting with value chains might possess exceptional corporate culture and leadership. Our data could not capture these factors and as a result they were embodied in error terms. Clearly, exceptional leadership and skill intensity are correlated in the sense that firms with such a management tend to hire higher skilled human resources.

In the presence of endogeneity, ordinary least square estimation is biased. To address endogeneity concerns, we apply IV method to estimate equation (4.1) using the two stage least square (2SLS) estimator—the most common strategy researchers use to address endogeneity problems (Wooldridge 2016; Bascle 2008). Despite its superiority over OLS estimator to address endogeneity issues, selection of IV proves very challenging. Weak and invalid instruments can cause estimation less efficient than OLS. We opt for three variables to instrument skill intensity, and they are government expenditure on education as share of Gross Domestic Product (GDP); average ratio of skilled workers for each sector in a given year and country; and average ratio of firms providing formal training to employees in a given year and country. The instruments are selected based on a widely recognized GVC framework that says higher skill of human capital is crucial for countries and firms to integrate in GVC. We believe that educational spending along with availability of skills and trained workforce could indirectly affect firms' strategy in GVC via their direct impact on firms' ability to hire skilled workforce. We are not yet sure if these IVs are valid and will conduct a series of tests after estimation. Table 4.6 presents results of IV estimation.

To check if the estimates are robust across different GVC participation definitions, we estimated equation (4.1) three times. Column (1) reports results for default definition of GVC, and Column (2) and (3) for forward and backward GVC participation, respectively. Before discussing results, let us examine two standard tests to check if our instruments are valid. Instrument relevance test is designed to measure instruments' strength. Ideally, there must be a strong fit between endogenous regressor and instruments, which is proved by first-stage F-statistics greater than 9.08 (Stock and Yogo 2002; Bascle 2008). The value of first-stage F-statistics of all 2SLS regressions are well above the threshold value implying that the instruments are strong and thus satisfying the relevance condition. Next, we look at instruments exogeneity test, in which the null hypothesis is that instrument variables are

exogenous. Since *p-value* for all specifications are greater than 0.05, we cannot reject the exogeneity of our instruments and thus we can argue that the exogeneity condition is also satisfied.

Table 4.6: Results on probability to join GVC with 2SLS estimator

Probability to join GVC	(1) Participation in both modes of GVC	(2) Forward GVC participation	(3) Backward GVC participation
Size	0.0454***	0.0552***	0.0543***
	(0.00687)	(0.00822)	(0.00801)
Square size	-4.60e-09	-1.15e-08	-1.06e-08
	(6.09e-09)	(7.29e-09)	(7.09e-09)
Age	0.00393	0.0306**	0.00393
	(0.0123)	(0.0147)	(0.0143)
Foreign ownership	0.308***	0.284***	0.217***
	(0.0225)	(0.0270)	(0.0262)
Skill intensity	0.00451***	0.00596***	0.00327*
	(0.00160)	(0.00191)	(0.00186)
Capital intensity	0.00153	0.00659	-0.00610
	(0.00481)	(0.00575)	(0.00560)
Labour Productivity	0.00874*	0.0144***	0.0324***
	(0.00455)	(0.00544)	(0.00527)
Technological capacity	0.0516***	0.0774***	0.0659***
	(0.00799)	(0.00955)	(0.00925)
Investment climate	5.939***	8.083***	6.987***
	(1.902)	(2.278)	(2.231)
Year-FE	Yes	Yes	Yes
Country-FE	Yes	Yes	Yes
Sector-FE	Yes	Yes	Yes
Observations	2,058	2,057	2,049
R-squared	0.288	0.256	0.392
First-stage F-statistic	29.67	29.63	29.35
Exogeneity test –p-value	0.1450	0.4516	0.5365

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Results from 2SLS regression are not only similar to the baseline estimation but also stable across all specifications. Except for age with coefficient being strongly negative in the baseline estimation but appearing insignificantly positive in IV regression, other variables including size, foreign ownership, skill, labour productivity, capital intensity, technological capacity and investment climate are found to have positive and significant impacts on firm's propensity to participate in GVC. Estimates using alternative method allow us to conclude that our empirical results are robust across various alternative measurements and estimation methods. Most importantly, we can draw a conclusive argument that a higher level of human capital is crucial for firms to participate in GVC, being upstream or downstream supply chains or both modes.

4.5. Firm Determinants of GVC Participation in ASEAN LDCs of Cambodia and Myanmar

In this section, we examine if ASEAN LDCs have the similar characteristics to join GVC as more developed ASEAN member states such as Indonesia and Philippines. The most striking difference is the development gap, which separates original members or ASEAN-6 (namely Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand) from newer members of Cambodia, the Lao People's Democratic Republic, Myanmar, and Viet Nam or known as CLMV countries (Menon 2013) . Apart from economic transition to market economy, the new ASEAN countries have undertaken a series of domestic reforms in trade policy, regulatory and institutional building, logistics and infrastructure, and human resource development with a view to promote economic growth and bridge development divide. Despite relatively rapid economic growth and development, huge development gaps in ASEAN remain. The conduciveness of business climate and quality of human capital as reported by the World Bank's Ease of Doing Business and human capital development index, respectively, are a few of major divisions that could possibly distinguish firms' performance in export and GVC activities in ASEAN-6 and CLMV countries.

In the analysis of ASEAN LDCs, we adopt country-case study analysis with Cambodia and Myanmar being our cases. Like in the previous sections, the unit of analysis is firm, and the source of data is the WBES. For Cambodia, the survey was conducted in 2013 with 472 firms and in 2016 with 373 firms. For Myanmar, the survey was conducted in 2014 and 2016 with a total sample of 1,239 firms. As with the previous estimation, we estimate using Probit and 2SLS controlling time and sector.

4.5.1. Evidence from Cambodia

Table 4.7 presents empirical results for Cambodia, where column (1) shows the probit estimation results and column (2) reports the 2SLS estimation results. As in the main section, IV is used to correct endogeneity problem in which skill intensity is endogenous variable and the instruments are government expenditure on education as share of GDP, average ratio of skilled workers for each sector in a given year, and average ratio of firms providing formal training to employees in a given year and sector. The instrument variables satisfied both relevance and exogeneity conditions as reflected by F-statistics greater than 9.08 and p-value bigger than 0.05. Coefficient of size is positive and significant in both regressions, implying that bigger firms are more likely to join value chains. The causal explanation for this result is that smaller firms usually encounter extreme difficulty to overcome significant sunk cost of international transactions due to insufficient scale of economy and thus choose

to focus more on the domestic market. Coefficient of size square is negative but insignificant, indicating that firms do not have to be very large to be effectively participating in supply chains.

Table 4.7: Results on probability of Cambodia's firms to join GVC

Probability to join GVC	(1) Probit	(2) 2SLS
Size	0.0531*	0.0289***
	(0.0320)	(0.00976)
Square size	-1.51e-08	-2.30e-09
	(4.59e-08)	(3.87e-09)
Age	0.0475	-0.00528
	(0.217)	(0.0231)
Foreign ownership	1.258*	0.169***
	(0.654)	(0.0328)
Skill intensity	0.00327***	0.000385 a)
	(0.00123)	(0.000912)
Labour Productivity	-0.00773	-0.000131
	(0.0804)	(0.00673)
Technological capacity	0.316***	0.0164 b)
	(0.00826)	(0.0128)
Investment climate	122.7***	12.53**
	(40.86)	(5.022)
Constant	-490.6***	-49.91**
	(163.4)	(19.99)
Year-FE	Yes	Yes
Sector-FE	Yes	Yes
Observation	509	509
Pseudo R-sq	0.4142	0.2202
First-stage F-statistic	-	52.55
Exogeneity test –p-value	-	0.2356

Standard errors in parentheses ;
** p<0.1; ** p<0.05; *** p<0.001*

a) Significant at 80% confident interval
b) Significant at 85% confident interval

Coefficient of age is positive in probit estimation, but negative 2SLS. However, the magnitude is statistically insignificant in both specifications, which implies that business experience in terms of year of operation is not important for export and value chain activities. Coefficient of foreign ownership is positive and significant, reflecting the importance of ownership structure in GVC participation. This means that foreign-owned firms are more likely to link with supply chains and such finding is in accordance with most prior studies including our earlier results. Foreign ownership usually associates with foreign networks, access to technology and know-how; all help firms improve productivity and efficiency necessary for entry into the production networks (Sjöholm 2003; Wignaraja 2015; Srinivasan

and Archana 2011). Also consistent to theoretical prediction are the impacts of technological capacity, with coefficients being positive and statistically significant in both models. In other words, GVC firms are technologically capable in terms of ICT adoption, use of foreign technology, and international standard recognition.

What is unexpected for Cambodia is the unusual productivity-GVC nexus, which appears negative but insignificant. The finding contradicts most firm heterogeneity empirics and thus does not support the self-selection hypothesis stipulating that only highly productive enterprises are able to offset significant cost of entry into export and value chains. One possible explanation for this result is that labour productivity among Cambodian firms is generally low, which is constrained by policy and structural factors including weak absorptive capacities, lack of skilled labour forces, and somewhat troublesome business environment. For skill intensity, the sign is positive but statistical power varies across estimation methods, where it is statistically significant in probit but insignificant in 2SLS. If the confidence interval is reduced to 80 percent, the coefficient of skill intensity is strongly significant, leading us to make a modest conclusion that higher skills of the workforce can help firms to integrate in supply chains. Finally, macro variables like investment climate proxied by the World Bank's ease of doing business score is also incorporated in our regression. Its coefficient is positive and significant in both specifications, indicating the importance of enabling and conducive business environment in enhancing firms to effectively link with supply chains.

4.5.2. Evidence from Myanmar

The empirical result for Myanmar is presented in Table 4.8. As mentioned earlier, estimation employed probit (column 1) and 2SLS (column 2). Skill intensity is instrumented by government expenditure on education as share of GDP, average ratio of skilled workers for each sector in a given year, and average ratio of firms providing formal training to employees in a given year and sector.

It should be noted that instrument variables are strongly correlated with endogenous variables but are not exogenous and thus violate good instrument conditions. In such circumstances, we argue that the probit model is more efficient. Column (1) in Table 7 suggests that size and foreign ownership are found to have positive and significant effect on firms' decision to join GVC. Although GVC firms have lesser years of operation, empirical results indicate that it does not influence a firm's strategy in GVC. However, what it does matter are skill intensity, technological capacity and investment climate; all found to have positive and significant effect on GVC participation. The findings are consistent with other most firm heterogeneity literatures in general and firm analysis in other ASEAN countries presented earlier. The only unusual and contradictory estimate is found in labour productivity which suggests GVC firms are relatively less productive.

Table 4.8: Results on probability of Myanmar's firms to join GVC

Probability to join GVC	(1) Probit	(2) 2SLS
Size	0.667***	0.600***
	(0.0612)	(0.116)
Square size	-1.14e-07	-9.50e-08
	(7.49e-08)	(1.45e-07)
Age	-0.121	-0.0988
	(0.243)	(0.173)
Foreign ownership	1.394***	1.428**
	(0.122)	(0.697)
Skill intensity	0.864*	0.503
	(0.499)	(3.382)
Labour Productivity	-0.247***	-0.297
	(0.0134)	(0.418)
Technological capacity	0.0477[a)]	0.0696
	(0.0312)	(0.135)
Investment climate	2.128***	(omitted)
	(0.108)	
Constant	-12.15***	-3.527**
	(0.554)	(1.774)
Year-FE	Yes	Yes
Sector-FE	Yes	Yes
Observation	644	652
Pseudo R-sq	0.6464	-
First-stage F-statistic	-	95.91
Exogeneity test –p-value	-	0.000

Standard errors in parentheses
** p<0.1; ** p<0.05; *** p<0.001*
a) Significant at 85% confident interval

4.6. Conclusion

This chapter quantifies the effects of human capital and other firm attributes on GVC participation in selected ASEAN countries based on firm-level analysis. The results suggest that integrating in upstream and downstream value chains is undoubtedly difficult for ASEAN enterprises as manifested in low GVC participation ratio. Effective integration into the global production networks require firms to have superior capability and networks with foreign business networks together with a conducive business environment. Specially, size of enterprise matters as it gains from economy of scale and helps offset cost of entry into the production networks. We also find evidence that linkage with value chain activities requires enterprises to have higher levels of human capital, better foreign networks

(i.e. in terms of foreign ownership and foreign technology) and superior production capacity measured by higher productivity, more capital and technological capacity. We have also assessed the effect of human capital on different modes of GVC participation and results are largely robust. Whether it is backward or forward GVC linkages, firm resources and capabilities reflected in size, foreign networks, productivity and human capital are critically important for firms to integrate in value chain activities.

Also unique in this chapter is the adoption of country-specific case studies to test if the effects of human capital and other firm characteristics on firms' GVC participation still hold in the context of post-conflict lower income countries in ASEAN. Evidence from Cambodia and Myanmar carry at least two reflections. The first and perhaps foremost reflection concerns the intuitive and consistent results of estimation. Except for labour productivity and age, all coefficients have predicted sign and magnitude. Factors such as size, foreign ownership and skilled human resource and technological capacity remain so important for firms in LDCs to successfully engage in production networks. The importance of technological capacity varies slightly among ASEAN economies as reflected by different levels of statistical power. For upper middle-income ASEAN economies, technology tends to play an important role in helping firms to connect to supply chains. For LDCs, the effect of technology appears neutral or significant at confidence intervals lower than 90 percent. The different contribution of technology to GVC participation could be explained by varied positions of firms in the value chains and varied quality of technology and innovation ecosystem. Most often, firms in higher income countries specialize in higher value-added segments of the value chains, in which such engagement requires, among other things, higher technology. On the contrary, enterprises in lower-income countries might choose to involve the low-end and low-tech segment, in which labour availability, foreign networks and market access are far more important than technology. Also important from empirical results is the importance of conducive business environment in firms' GVC participation and most importantly such finding is consistent and robust across all specifications.

The second key reflection is about complementarity between our research methods namely firm-level analysis for pooled countries and country-specific case studies. Such methodological selection is justified by the huge diversity in ASEAN, which we thought would influence firms' characteristics and thus performance in international trade. The results are largely expected as they provide additional evidence from ASEAN region supporting general firm heterogeneity literature that firms are systematically different in terms of size, ownership structure, skill and capital intensity and productive capacity and these differences shape firms' outsourcing strategy as well as behavior with regard to export and value chain participation.

Chapter 5

Human Capital and Participation in Global Value Chains: Evidence from Small and Medium-Sized Enterprises in Indonesia

5.1. Introduction

This chapter extends the conceptual and analytical framework used in the previous chapter to study the performance of SMEs in terms of linkages with global value chains. In particular, we closely look at human capital development and its impact on SMEs' participation in GVC using firm-level data from Indonesia's Annual Manufacturing Survey in 1996 and 2006.

The discussion of GVC literature in the earlier chapters point to the fact that the prevalence of GVC is changing the role of firms, including small and medium-sized enterprises (SMEs), in international trade. Firms no longer strive to develop integrated industries but rather to link with value chain actors, specialize in a specific task or stage in the GVC, and move up value chains. Such a business strategy can in turn bring them substantial gains, including, among others, enhanced efficiency and productivity (Kang et al., 2010; Sébastien Miroudot et al., 2009) and the potential transfer of technology and knowledge (Cattaneo et al., 2013; De Backer et al., 2018). GVC offer SMEs a new platform to connect to foreign partners that could eventually help them to upgrade their products and boost their productivity and output growth (González et al., 2019) . However, the critical challenge is that only a small proportion of SMEs manage to join production networks effectively. According to the WTO (2016), about 10% of manufacturing SMEs and 3.5% of services are involved in supply chain activities. The level of integration for large firms is significantly higher (26.7% for the manufacturing sector and 36% for services). This raises the fundamental question of which factors help SMEs to join GVC.

The empirical research examining the effects of SMEs on GVC activities in developing countries remains limited. Some recent studies, including Abe (2015); Harvie et al. (2010a); Thanh et al. (2009); Wignaraja (2012); and Abe (2016), have examined the challenges and opportunities for SMEs in GVC as well as empirically assessing the factors shaping SMEs' role in production networks. However, the major limitation of some prior studies rests on their research methods and sources of data. Some relied on perception from a survey of a limited number of firms to draw an argument that the low GVC participation of SMEs is mainly due to their lack of business networks, limited financial and human capital resources, lack of production and distribution competence, and difficulties in complying with complex trade procedures. The findings from studies of this sort provide insights into SMEs' challenges, yet they lack rigorous and econometric techniques to explain these relationships. Others, such as Harvie et al. (2010a) and Wignaraja (2012), applied an appropriate method to assess the determinants of SMEs' participation in GVC. Nevertheless, these studies did not focus on Indonesian SMEs and on quantifying the impact of human capital on SMEs' participation in GVC. This chaper, therefore, aims to fill this gap by focusing on the effect of human capital and other firm-level characteristics on SMEs' participation in global value chains in Indonesia.

The remainder of this chapter proceeds as follows. Section 2 briefly discusses the theoretical background and the literature review of SMEs and GVC. Section 3 provides an overview of Indonesian SMEs with a strong emphasis on economic significance and participation in global value chains. Section 4 elaborates the empirical specification and data sources. Section 5 discusses the empirical results. Section 6 concludes.

5.2. Theoretical Background and Literature Review

The literature on SMEs and global value chains can be grouped into two broad categories. The first strand of literature focuses on conceptualizing SMEs' engagement in production networks. Harvie (2010b) framework of SMEs and production networks is one among a few that elaborate the possible roles of SMEs in production networks and the factors determining their business outcomes. SMEs can join the production process at various levels. They can be lower- or higher-tier suppliers according to their resources and psychological factors. Resource factors, which include, among others, financial resources, technology, market access, and skilled labor, essentially influence SMEs' capacities. Psychological factors relate to corporate norms, such as self-efficacy, business culture, desire, and commitment. The external environment, such as government policies and domestic and overseas market conditions, can also have an effect on SMEs' trajectory in production networks. Also highly relevant to the SME–GVC nexus is the WTO (2016) illustration of alternative trajectories for SMEs to engage in GVC. According to this report, SMEs can participate in GVC by either exporting goods or

services directly to firms overseas or supplying inputs to local firms that produce for exporting. Studies refer to this mode of engagement as “forward GVC participation.” Alternatively, SMEs can participate in value chain activities by sourcing inputs from foreign suppliers to produce goods and services for domestic consumption and exports. Such a mode of integration reflects upstream linkages with foreign partners and is known as “backward GVC participation.”

It is worth noting that these two concepts have different focuses. Harvie’s framework, on the one hand, articulates how firm capacities, the corporal culture, and the national business environment influence SMEs’ behavior in value chain activities. The WTO (2016) definitional concept, on the other hand, specifically focuses on measuring firms’ participation in GVC. Notwithstanding, several empirical studies have used these concepts as the basis for designing empirical specifications. For example, Harvie et al. (2010a) applied Harvie’s framework to draw an econometric specification for assessing the determinant factors of SMEs’ participation in production networks. Thanh et al. (2009) also used the framework as a guideline for designing a country-specific case study on SME integration. The production networks in Cadestin et al. (2018) study followed the definition of SME participation in GVC from the WTO (2016) and merged the WTO–OECD’s Trade in Value-Added (TiVA) with enterprise data to map the participation of multinational enterprises in GVC. González (2017) followed the same procedure to map the GVC participation of SMEs in ASEAN.

The second strand of literature emphasizes the empirical investigation of the factors affecting SMEs’ integration into GVC. Some studies have used pooled firm-level data from various countries, while others have specifically examined a country case study. Harvie et al. (2010a); Wignaraja (2013); Duval and Utoktham (2014); Wignaraja (2013) and Arudchelvan and Wignaraja (2016) are a few examples of studies on SMEs’ participation in GVC using multi-country firm-level data. Despite using different datasets, these studies adopted similar econometric specifications and explanatory variables. Specifically, Wignaraja (2012) used the World Bank Enterprise Survey (WBES) to investigate the factors influencing SMEs’ participation in supply chains for five ASEAN economies. The firm-specific factors included firm size, year of establishment, type of ownership, technological capabilities, access to finance, education and skills of employees, and education and experience of executives. He tested several hypotheses, one of which was that a higher level of human capital correlates positively with joining supply chain trade. The findings supported the hypothesis that human capital is vital in supply chains. Having workers with a high level of education increases the probability of a firm joining supply chain trade. Other firm-specific factors, such as size, technological capacities, and access to credit, were also important for SMEs to join GVC.

Duval and Utoktham (2014) used the WBES from 122 countries to conduct a similar empirical assessment. They defined SMEs as participating in a production network if they engaged in direct

exports or indirect exports (supplying goods and services to domestic firms that produce for exporting). Their empirical results suggested that technology, international quality certification, access to finance, and foreign ownership increase the probability of SMEs' participating in international production networks. They chose the proportion of unskilled workers as a proxy for human capital and generally found no significant effect on SMEs' participation in value chains. Harvie, Narjoko, and Oum (2010b) constructed a dataset from an SME survey in seven ASEAN countries to identify the challenges facing SMEs and then to assess the determinants of SMEs' participation in production networks. They examined the direct and indirect effects of SMEs' activities in production networks. The study found that productivity, foreign ownership, and access to financial institutions significantly determines the participation of SMEs in production networks. SMEs that were active in the innovation process also increased their likelihood of engaging in production networks. Interestingly, proximity to SEZs and ports, size, and age appeared to have no effect on SMEs' participation in production networks. Skill intensity, which the study measured using the ratio of non-production workers to production workers, denoted the human capital resources of firms. However, the results were quite unstable across specifications and in general human capital resources appeared to be insignificant. The findings highlighted the importance of technology and know-how, foreign connection through ownership, and the adoption of new business ideas for SMEs to be competitive and participate successfully in production networks.

The recent study by Chuc et al. (2019) quantified the factors that help Vietnamese SMEs to participate effectively in production networks based on a survey of 208 enterprises. The estimation also accounted for skill intensity, which the study defined as the share of workers with higher education in the total number of workers, and training expenditure. Like earlier studies, the coefficients of size, foreign ownership, and productivities were positive and statistically significant. The authors found that skills have a positive and significant association with the propensity to join production networks, but such an effect does not happen for investment in training. The findings also indicated that SMEs that have a better connection with foreign markets and more active industry and business associations are relatively more likely to join GVC. Also using micro-level data from Vietnamese manufacturing firms is the work by Shandre Thangavelu (2014). Despite quantifying the productivity spillovers of horizontal and backward FDI linkages, this study highlighted the importance of investment in human capital in helping local firms to improve their efficiency and productivity, which consequently increases their probability of linking with foreign firms and production networks.

Empirical research on Indonesian SMEs in GVC is scarce in the existing literature. Machmud and Siregar (2009) compared the characteristics of SMEs joining production networks based on data from a survey of 105 firms. They found that SMEs in production networks are generally bigger, use modern

production methods, are more open to international business, and have a higher percentage of workers with a high level of education. Although most of these results are consistent with the theoretical prediction, it is hard to draw a conclusive statement due to the problem of sampling and the absence of empirical procedures to quantify the effects. Anas et al. (2017) used descriptive statistics from an SME survey to portray the nature of Indonesian SMEs in the ASEAN economic integration. They also applied the probit estimation approach to assess the impact of free-trade agreements (FTAs) on exports and imports. The results indicated that exporting and importing SMEs are more likely to understand ASEAN economic integration better and have business relationships with foreign partners. The study also found that FTAs have encouraged firms to export and import. The research by Shandre Thangavelu et al. (2019) differs from the other two studies in the sense that it used a large dataset from the Indonesian Annual Manufacturing Survey for its empirical estimation. Despite focusing primarily on the impact of service activities on the productivity of the manufacturing sector, the findings implied that the servicification of manufacturing activities helps to foster Indonesian firms' participation and moving up in value chains. Human capital is one of the fundamental factors that drive service activities, and therefore the development of skills for workers will be critical to support and develop new service linkages and the productive capacity of the Indonesian manufacturing sector in global and regional production value chains (Shandre Thangavelu et al., 2019).

5.3. Overview of Indonesian SMEs

5.3.1. SMEs in the Indonesian Economy

The latest statistics on the contribution of SMEs[4] to business establishments, employment, GDP, and exports prove that these enterprises are critical for Indonesia's economy. The consistent provision for SME development in the Indonesian Government's five-year development plans as well as considerable program support for SMEs have also magnified their significance in the economic trajectory and social inclusion. According to statistics from the Ministry of Co-operatives and SMEs, which Table 5.1 presents, Indonesia had 62.93 million enterprises in 2017, of which 99.99% were SMEs. Micro enterprises were predominant, accounting for 98.92% of the total establishments. In

[4] There is no single official definition of SMEs in Indonesia. Although the country has a legal SME definition in the Law No. 20/2008 that differentiates MSMEs by sales turnover and net assets, other public administrations, such as the Central Board of Statistics (BPS), use employment criteria to define SMEs. This chapter adopted the SME definition in the Law No. 20/2008. Precisely, micro enterprises are those with assets below Rp50 million or sales below Rp300 million; small enterprises are firms with assets of Rp50 to Rp500 million or sales between Rp300 million and Rp2.5 billion; and medium enterprises are firms with assets between Rp500 million and Rp5 billion or sales between Rp2.5 and Rp50 billion. Although many official statistics disaggregate micro enterprises, the term "SMEs" in this chapter often includes micro enterprises.

terms of economic activities, the wholesale and retail trade sector accounted for 46% of non-agricultural Indonesian SMEs in 2016, followed by the manufacturing sector and hospitality and catering services, each representing 17% of the total (OECD, 2018a). Undoubtedly, the dominance of establishments has made SMEs the biggest source of employment in Indonesia. About 97% of occupations in 2017 were in SMEs, and the remaining 2.7% were in large enterprises. Again, the largest proportion of employment was in micro enterprises.

Table 5.1: Key Characteristics of Indonesian Enterprises by Firm Size, 2017

	% of Total Enterprises	% of Employment	% of GDP	% of Exports	Labor Productivity*
A. MSMEs	99.99	97.3	57.08	14.17	USD 44 133
Micro enterprises	98.92	90.8	30.06	1.26	USD 8 400
Small enterprises	0.99	3.5	12.54	2.48	USD 41 460
Medium-sized enterprises	0.08	3	14.49	10.44	USD 82 540
B. Large enterprises	0.01	2.7	42.92	85.83	USD 266 328

Source: Ministry of Co-operatives and SMEs.

* The figure refers to the average GDP per employee for 2013, cited from OECD (2018a).

Note: Micro enterprises are those with assets below Rp50 million or sales below Rp300 million; small enterprises are firms with assets of Rp50 to Rp500 million or sales between Rp300 million and Rp2.5 billion; and medium enterprises are firms with assets between Rp500 million and Rp5 billion or sales between Rp2.5 and Rp50 billion.

The contribution of SMEs to national outputs is not as dominant as that of employment. SMEs contributed about 57% to the GDP in 2017 compared with 42.9% from large enterprises. This outcome reflects a significant gap in labor productivity. The average value added per employee at the current price in 2013 for SMEs was $44,133, which was 6 times lower than that of large enterprises. The lowest productivity was in micro enterprises, with a productivity level that increased with the size of enterprises. SMEs' participation in export activities was significantly lower. The share of micro enterprises in the total exports was 1.26%; it was 2.48% for small and 10.44% for medium-sized enterprises. Large enterprises accounted for the remaining 86% of exports. The under-representation of SMEs in export activities is actually a common pattern in most developing countries, since exporting requires significant initial investment in foreign market research, business networks with foreign partners, and product standards and compliance. These require financial resources and technical capabilities, which are often the major constraints facing SMEs.

5.3.2. SME Development Policies

The Indonesian government has adopted a number of strategic directions for SME development. The key directive is the Law on Micro, Small, and Medium Enterprises (MSMEs), which it enacted in 2008 and which formally sets the definition of SMEs and mandates the Ministry of Co-operatives and SMEs to lead policy co-ordination. The law also puts forward a series of policy measures, including, among other things, access to finance, business information, business support infrastructure, and business licensing, to enhance SMEs' contribution to economic growth. Apart from the Law, the National Mid-term Development Plan 2014–2019, the five-year policy direction for all ministries and government agencies to formulate their respective strategic plans, envisions the improvement of the productivity and competitiveness of SMEs. Relevant to SMEs are the strategies proposed to support SMEs' development objectives. They include (1) improving human resource quality, (2) enhancing access to finance, (3) increasing the value added of SMEs' products and their international presence, (4) strengthening partnerships and networks, and (5) improving rules and regulations.

The strategic programs and actions aiming to support the aforementioned strategies are diverse, and various ministries and public ministries manage them. For example, the Finance and Development Supervisory Agency, in cooperation with the Bank Indonesia, implemented the so-called "Kredit Usaha Rakyat" (KUR) program in 2007 and manages it. It is by far the largest micro credit program in Indonesia and provides business loans to SMEs at a lower interest rate, with a backing loan in 2014 reaching IDR 49.5 trillion (OECD, 2018a). The establishment of the SME Productivity Center under the supervision of the Ministry of Manpower and Transmigration also aimed to improve the productivity of SME workforces through the provision of technical training. Also relevant to human resources for SMEs are the entrepreneurship and management training programs that many other ministries and public institutions provide.

SME internationalization strategies primarily aim to promote SMEs' exports and participation in global value chains. The programs supporting SME internationalization are diverse in focus and management. For example, Indonesia Eximbank introduced export financing to help firms acquire export credit, export guarantees, and export insurance services. Besides, Indonesia Eximbank administers export-oriented training on export regulations, customs procedures, packaging, and online marketing as well as a coaching program for new exporters (OECD, 2018a). The Ministry of Trade, on the other hand, is in charge of non-financial aspects of internationalization. Key measures include the provision of export market information, product design and packaging for exporting, and export training. The Ministry also created the AEC Center in September 2015 as a venue to provide business

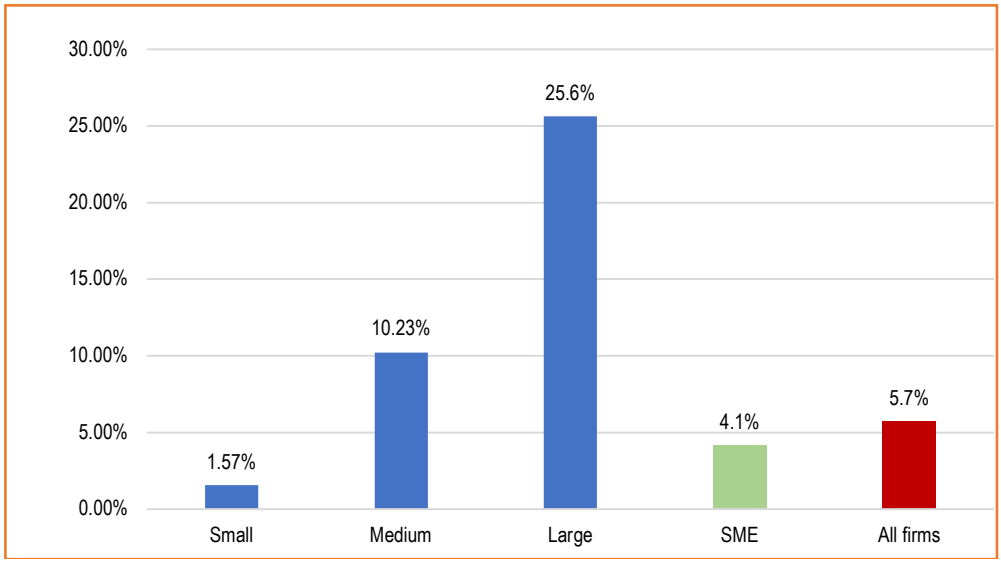
counseling and market intelligence services for Indonesian firms that are striving to increase their exports to the ASEAN region.

Besides generic export support programs, the Indonesian Government has introduced a number of specific measures to promote SMEs' integration into global production networks. The local content requirement that the Indonesia Investment Co-ordinating Board has imposed in certain sectors (i.e., machinery, motor vehicles, food, beverages, etc.) is among the policy directions aiming to promote the sourcing of domestic inputs in the production for exports and hence enhancing the participation in value chains. Moreover, the Indonesia Investment Co-ordinating Board has recently introduced a matchmaking program through events and a website to enable local SMEs to be potential suppliers of multinational corporations.

5.3.3. SMEs' Participation in Global Value Chains

This section highlights the extent to which SMEs join global value chains. It then compares the characteristics of the SMEs that are effectively participating in GVC (denoted as GVC SMEs) with those that are not participating in GVC (denoted as non-GVC SMEs). As a later section will discuss in detail, the chapter defines GVC SMEs as those that source raw material from abroad and produce outputs for exporting. Figure 5.1 suggests that not many Indonesian SMEs are effectively linked with global production networks, and this is manifest in a significantly low GVC participation ratio (4.1%).

Figure 5.1: Share of Indonesia's Firms Participating in GVC by Size



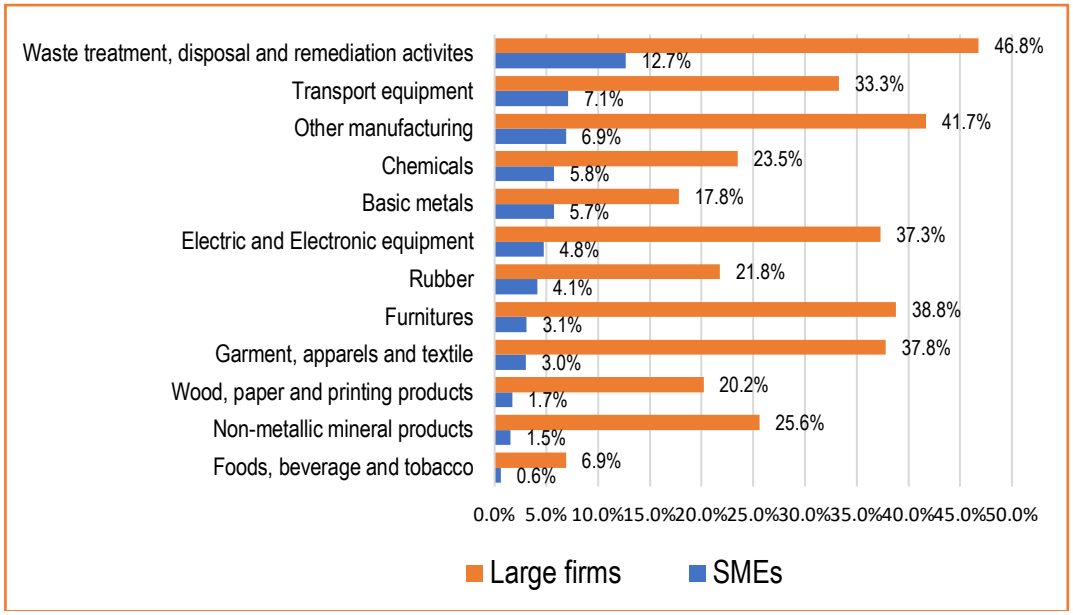
Source: Author's calculation based on the IAMS in 1996 and 2006.

Note: The study calculated the share as the number of firms participating in GVC divided by the total number of firms. It derived the share for SMEs from the ratio of SMEs participating in GVC to the total number of SMEs.

The level of integration in value chain activities for SMEs is comparable to the average for all manufacturing firms but significantly behind that for large firms (25.6%). Small enterprises have an even greater disadvantage when it comes to international transactions and are hardly able to connect to GVC. Medium-sized firms, on the contrary, are better able to link with production networks, with a participation ratio that is about twice as high as that for all firms. The pattern appears to show that the GVC participation ratio increases when firms are bigger, which indicates the significance of the economy of scale to overcome the cost of entry into GVC.

It should be noted that the extent of GVC participation varies notably across sectors. Figure 5.2 clearly shows that SMEs in the waste treatment and disposal sector are the most integrated into GVC, with a participation rate of 12.7%. The sector with the second-highest percentage of SMEs in GVC is transport equipment (7.1%), followed by other manufacturing (6.9%), chemicals (5.8%), and basic metals (5.7%). For the electric and electronic sector, despite having dynamic production networks linking various types of firms from different countries, only 5% of Indonesian SMEs could integrate into the networks. With even lower linkages with value chain activities are SMEs in the garment, apparel, and textile (3.1%), non-metallic mineral products (1.5%), and food, beverage, and tobacco (0.6%) industries. Also interesting is the fact that, even within the same sector, GVC integration differs according to the size of enterprises. For example, 38% of large enterprises in the garment and textile sector had upstream and downstream linkages with foreign partners compared with only 3% of SMEs in this sector. In the electric and electronic sector, the GVC participation ratio is 37.3% for large firms versus 5% for SMEs.

Figure 5.2: Share of Indonesia's Firms Participating in GVC by Sector and Size



Source: Author's calculation based on the IAMS in 1996 and 2006.

Note: The study calculated the share of SMEs in chemicals participating in GVC as the number of SMEs participating in GVC in that sector divided by the sector's total number of SMEs.

Table 5.2 compares the average value of the firm characteristic variables of GVC SMEs with those of non-GVC SMEs and clearly indicates the significant existence of heterogeneity. The notable differences are not unique to Indonesia, as Antràs (2015); Bernard and Jensen (2004); Bernard et al. (2012); Harvie et al. (2010a); Wignaraja (2013); and Antras (2015) highlighted similar facts for other countries. Overall, GVC firms are larger, more productive, more capital intensive, and more innovative than non-GVC firms. On average, GVC SMEs have 191 employees compared with 65 for non-GVC SMEs, yet the former type of firm is younger, as the fewer years of operation show. About 38% of SMEs are foreign owned compared with just 2.6% of non-GVC SMEs. The average value of sales per employee for GVC firms is US$94,720 thousand, which is about twice as high as that for non-GVC firms. The gap in capital intensity between the two types of SMEs is smaller. Moreover, GVC firms tend to have more formal training programs for staff and borrow more loans for investment than non-GVC firms. Table 5.2 also indicates that GVC SMEs employ significantly more skilled workers than non-GVC firms (49.7% versus 21.6%). The differences for all the variables are statistically significant. Although the t-test results provide some insights into the potential relationship of SME characteristics and participation in GVC, they cannot explain the direction of causality. The econometric analysis in the following section remedies this methodological shortcoming.

Table 5 2: Comparison of SMEs' Characteristics

	GVC SMEs	**Non-GVC SMEs**	**Statistically Different**
Size	191	65	Yes ***
Age	10.5	12.5	Yes ***
Share of foreign ownership	37.9%	2.6%	Yes ***
Access to finance (%)	25.9%	13.9%	Yes ***
Skill intensity (% of skilled workers)	26.4%	21.9%	Yes ***
Share of firms providing a formal training program	49.7%	21.6%	Yes ***
Capital intensity (value of fixed assets per employee, thousand USD)	1147.4	1001.7	Yes ***
Labor productivity (sales per employee, thousand USD)	94720.3	42618.0	Yes ***
Expenditure on R&D (thousand USD)	3.8	1.2	Yes ***

Source: Author's calculation based on the IAMS in 1996 and 2006.

5.4. Econometric Specification and Data Source

5.4.1. Econometric Specification

We adopt the concept and econometric specification used in Chapter 4 to estimate the effects of human capital and other firm attributes SMEs' participation in GVC. Specifically, the estimation regression can be written as follows:

$$gvc_{isrt} = \alpha_0 + \beta_1 lnsize_{isrt} + \beta_2 sizesqr_{isrt} + \beta_3 lnage_{isrt} + \beta_4 for\_own_{isrt} + \beta_5 acc\_fin_{isrt} + \beta_6 training_{isrt} + \beta_7 skill_{isrt} + \beta_8 lncap_{isrt} + \beta_9 lnprod_{isrt} + \beta_{10} ln\_R\&D_{isrt} + \beta_{11} reg\_exp_{isrt} + time + region + industry + \varepsilon_{isrt} \quad (5.1)$$

where subscript *i* denotes the firm, *s* is the sector, *r* is the region, and *t* refers to time. We discuss the definition and measurement of the variables below.

- *GVC participation (gvc_{isrt})*: Like in the previous chapter, this variable is a dummy variable with the value 1 if firm *i* in sector *s* at time *t* from region *r* joins a GVC and 0 otherwise. In the IAMS questionnaire, there are two questions capturing information on imports and exports. The first question asks about the source of raw material purchase in terms of quantity and value. It is possible to calculate the percentage of imported raw material simply as the ratio of the value of imported raw materials to the total value of raw materials. We can consider SMEs that source raw material from abroad to have upstream linkages with foreign partners. The second question enquires about the percentage of outputs that the company exports, which we interpret as the firm's linkage with foreign buyers. Therefore, we can classify SMEs that source raw material from abroad and produce outputs for exporting as participating in a GVC. This means that gvc_{isrt} equals 1 if a firm has both a ratio of imported raw material and a percentage of exports greater than 0 and 0 otherwise.
- *Size ($size_{isrt}$)*: Like in the previous, we measure firm size using the total number of employees.
- *Age (age_{isrt})*: This refers to the number of years in operation. To obtain the age of a firm, we subtract the firm's operating year from the year of the survey and then add one.
- *Foreign ownership (for_own_{isrt})*: This is a dummy variable with the value 1 if the establishment is foreign owned and 0 otherwise. We define foreign-owned firms as those for which foreign individuals, companies, or organizations own 10% or more of their capital stake.
- *Access to finance (acc_fin_{isrt})*: This variable takes the value 1 if a firm has a credit line/loan from a financial institution and 0 otherwise.

- *Human capital ($hcap_{isrt}$)*: We use two separate measures to capture various aspects of human capital in enterprises. The first variable is skill intensity within a firm ($skill_{isrt}$), which we measure as the share of skilled workers in the total number of employees. We follow Kasahara, Liang, and Rodrigue (2016) to measure skills based on educational attainment. Skilled production workers refer to production workers with at least senior high school education, while skilled non-production workers refer to this type of workers with a college degree. Thus, we calculate the share of skilled workers as the sum of skilled production and skilled non-production workers divided by the total number of employees. The second variable reflects firms' training program for employees ($training_{isrt}$). It takes the value 1 if a firm provides formal training to its employees and 0 otherwise. Since the quality and ability of workers within an enterprise is the fundamental resource for success, we hypothesize that SMEs with higher quality of human capital are more likely to engage effectively in GVC.
- *Labor productivity ($prod_{istj}$)*: We use the ratio of the total annual sales to the total number of employees for this variable. Like most firm heterogeneity empirics, this chapter hypothesizes that labor productivity is positively associated with GVC participation.
- *Capital intensity ($capint_{isrt}$)*: We measure capital intensity as the value of fixed assets per employee.
- *Research and development ($R\&D_{isrt}$)*: We use the annual expenditure on research and development and production engineering as a proxy for this variable. Firms' ability to innovate and upgrade their production capability would help them to link rather easily with foreign partners. Thus, we hypothesize that SMEs with higher expenditure on research and development are more likely to participate in GVC.
- *Regional knowledge ($\mathrm{reg\_exp}_{isrt}$)*: We follow Sjöholm (2003) to capture the export spillover effect on the propensity to join a GVC. We measure it as the average percentage of output that each region exports. We anticipate that regions that export a greater share of outputs are relatively likely to have more SMEs participating in GVC.
- As previously mentioned, the level of SMEs' integration into GVC varies across time, sector, and region. To account for time, industry, and region variation, we include time, industry, and sector dummy variables in our estimation.

5.4.2. Data

The data that we use for our empirical estimation come from the Indonesian Annual Manufacturing Survey (IAMS), which the Indonesian Central Bureau of Statistics manages. It has conducted the

IAMS annually since 1975 with manufacturing establishments employing 20 staff members or more using a predefined questionnaire. The questions cover a broad range of business operation topics from general information, workers' wages and education attainment, and itemized incomes and expenditures to imports of raw materials and export share. An important note on the IAMS dataset is that only the 1996 and 2006 rounds contained questions on employees' training and educational attainment, research and development, and business constraints and prospects. These allow us to construct human capital variables that align well with the human capital concept and empirics. On this ground, we choose the IAMS in 1996 and 2006 as a source of data. Altogether, there are a total of 52,456 enterprises, of which 22,997 are from the 1996 survey and 29,468 are from the 2006 survey. We define SMEs according to the Indonesian 2008 Law on Micro, Small, and Medium Enterprises (MSMEs), which classifies the sizes of enterprises according to the net assets or annual revenues. Based on the revenue criteria, we define SMEs as those with annual revenues less than 50 billion Indonesian Rupiah. This definition classifies 93% of enterprises as SMEs and the remaining 7% as large firms. Since we are interested in the factors that facilitate SMEs' joining of GVC, we drop large firms from our sample. We also exclude observations with missing data for any variable. Such a data-cleaning procedure leaves us with 41,227 observations for estimation.

The final note on data processing is that we redefine the regional and sectoral coverages at a more aggregate level. Specifically, we group the provinces in which enterprises were located into seven geographic regions: Java, Kalimantan, the Maluku Islands, the Lesser Sunda Islands, Western New Guinea, Sulawesi, and Sumatra. We group manufacturing activities, which we originally coded at the five-digit level using the International Standard Industrial Classification (ISIC), into a two-digit classification before we categorize them further into a more aggregate sector based on the similarity of economic activities. This gives us 11 sectors: foods, beverages, and tobacco; garments, apparel, and textiles; wood, paper, and printing products; chemicals; rubber; non-metallic mineral products; basic metals; electric and electronic equipment; transport equipment; furniture; and other manufacturing.

5.4.3. Estimation Methods

We estimate equation (5.1) using two econometric methods. The first estimation applies the linear probability model (LPM), which assumes that all regressors are exogenous and coefficients are the marginal effects. The second estimator is the Probit model, which is suitable for a binary choice. Several empirics on firm heterogeneity, for example Roberts and Tybout (1997); Harvie et al. (2010a); Roberts and Tybout (1997); Sjöholm (2003); Wignaraja (2012), have applied the Probit model to

quantify the decision to participate in exporting and global value chain activities. In all the estimations, we control sector, time, and region fixed effects.

To show that our baseline results are robust, we implement several robustness checks. First, we change the measure of GVC participation and distinguish backward GVC from forward GVC participation. Second, we adopt an employment-based definition of SMEs and re-estimate equation (2) using the LPM and probit model. Third, we introduce an instrumental variable as an alternative strategy to address the endogeneity concern. We suspect that skill intensity is endogenous and thus instrument it with two variables, namely the number of educational institutions in each region and the average ratio of skilled workers in each industry in a given year and region. We estimate the IV regression using the most common estimator, which is two-stage least square (2SLS).

5.5. Empirical Results and Discussion

5.5.1. Baseline Results

Table 5.3 shows the baseline empirical results from the linear probability framework (column 1) and the Probit method (column 2). We examine the potential multicollinearity problem in our regression model. The correlation matrix is given in Table A.5.1 in the Appendix. The correlation suggests that the explanatory variables are weakly correlated. The highest correlation is between skill and size, but the value is below 0.5, indicating that our regression does not suffer multicollinearity problem. Except for age, all the coefficients have the expected sign and are statistically significant. Our results seem stable across different specifications, reflecting the robustness of the estimates. The size coefficients are positive and strongly significant in both specifications. This means that larger SMEs are more likely to participate in value chain activities. The finding supports the prior hypothesis about the importance of the scale of economy to overcome the fixed cost of entry into GVC. The coefficient of firm size square is positive and significant, implying that SMEs must be very large to engage effectively in production networks.

The effect of enterprise age highlights that older SMEs tend not to join GVC activities, compared with younger SMEs, as the size coefficient is negative under the probit estimation. Our results are similar to those of Sjöholm (2003); Harvie et al. (2010a); Sjöholm (2003); Wignaraja (2012) and Aggarwal and Steglich (2018), who found negative and statistically significant coefficients. We try to explore the reason behind the negative association between age and participation in GVC by looking at expenditure on research and development and actual investment among firms with different years of operation from our database. The scatter plots suggest that younger SMEs tend to have more

capital investment and greater expenditures on research and development, reflecting their superior capacity, which could lead them to relative success in GVC integration.

Table 5 3: Estimation Results for SMEs' Decision to Participate in GVC

Probability of Participating in GVC	**(1)** **LPM**	**(2)** **Probit**
Firm size	0.0134***	0.470***
	(0.000241)	(0.0279)
Firm size squared	0.000000790***	0.000000556
	(0.0000000595)	(0.000000438)
Age	-0.00424	-0.0772***
	(0.00509)	(0.0170)
Foreign ownership	0.248***	0.925***
	(0.0284)	(0.0410)
Access to finance	0.0131*	0.140***
	(0.00559)	(0.0365)
Formal training	0.0159***	0.230***
	(0.00161)	(0.0312)
Skill intensity	0.0302***	0.414***
	(0.00404)	(0.0579)
Labor productivity	0.00632***	0.130***
	(0.000786)	(0.0141)
Capital intensity	0.000921	0.0114***
	(0.000470)	(0.00276)
Research and development	0.0105*	0.0158
	(0.00496)	(0.0210)
Export spillover	0.00129***	0.0563
	(0.000250)	(0.0452)
Constant	-0.122***	-6.918***
	(0.0151)	(0.900)
Year FE	Yes	Yes
Region FE	Yes	Yes
Sector FE	Yes	Yes
Observation	41227	41209
Adj. R-sq./pseudo R-sq.	0.1722	0.3231

Standard errors in parentheses; * p<0.05; ** p<0.01; *** p<0.001.

Source: Author's calculation based on the IAMS in 1996 and 2006.

The ownership structure appears to have a positive and significant effect on SMEs' decision to join GVC. More precisely, from column (1), foreign-owned SMEs are 25% more likely to engage in value chains than their domestic-owned counterparts. The results suggest that foreign ownership provides better networks with foreign partners, access to technology and management experiences, and learning from exporting from parent companies (Sjöholm, 2003; Srinivasan & Archana, 2011; Wignaraja, 2015). The coefficients of access to loans are positive and statistically significant in both models, implying that SMEs that borrow money from financial institutions for capital investment are relatively more likely to be GVC firms.

The estimated coefficients for training and skills are positive and statistically significant in both estimations, leading us to conclude that SMEs that have better-quality human capital, which we measure as having a formal training program and a larger share of skilled workers, are more likely to engage effectively in global value chains. The importance of human capital in shaping firms' behavior in international trade is not uncommon in the empirical literature. For example, Wignaraja (2012) revealed that having a high school-educated workforce increases the potential for SMEs to join supply chains, while Aggarwal and Steglich (2018) found that skill intensity increases the probability of firms participating in value chains. Similarly, ADB and ADBI (2015) and Shandre Thangavelu et al. (2019) asserted that skills and training are among the critical factors that contribute significantly to firms' success in GVC.

To establish the robustness of human capital effects, the new results allow us to check the sensitivity of the estimation. We follow Aggarwal and Steglich (2018) and measure skill intensity in terms of the ratio of wages and salaries to total sales. We then introduce another alternative proxy, which Shandre Thangavelu (2014) used, measuring the quality of labor via the average wage of a firm under the assumption that firms with higher average labor costs per worker employ more skilled labor. Table 5.4 provides the results of the estimation for alternative skill variables.

The signs and magnitudes of all the variables are positive and statistically significant, indicating that human capital is critical for SMEs to join GVC. Other firm attributes also play an important role in shaping SMEs' outcome in GVC. Specifically, more productive and capital-intensive firms appear to have a higher probability of GVC participation. The findings are in accordance with the theoretical prediction and support the well-known self-selection hypothesis in the firm heterogeneity literature. Since integration into production networks requires considerable initial investment, only SMEs with higher productivity and larger capital are able to offset the entry cost and self-select to enter into value chain activities. We observe a positive coefficient for expenditure on research and development, implying that SMEs that spend more on research and development have a higher chance of linking to production networks.

Table 5.4: Estimation Results Using Alternative Variables for Skill Intensity

	Skill (Wage/Sale)		Skill (Wage per Employee)	
	LPM	**Probit**	**LPM**	**Probit**
Firm size	0.0138***	0.501***	0.0155***	0.494***
	(0.000542)	(0.0297)	(0.00000365)	(0.0277)
Firm size squared	0.000000804**	0.000000533	0.000000779***	0.000000410
	(8.28e-08)	(0.000000460)	(5.65e-08)	(0.000000438)
Age	-0.00376	-0.0782***	-0.00480	-0.0960***
	(0.00509)	(0.0181)	(0.00521)	(0.0168)
Foreign ownership	0.251***	0.954***	0.252***	0.943***
	(0.0364)	(0.0426)	(0.0290)	(0.0409)
Access to finance	0.0148**	0.167***	0.0131*	0.143***
	(0.00539)	(0.0377)	(0.00545)	(0.0366)
Formal training	0.0167***	0.236***	0.0180***	0.253***
	(0.00348)	(0.0330)	(0.00162)	(0.0310)
Skill intensity	0.00185***	0.0837***	0.00442***	0.158***
	(0.000437)	(0.0197)	(0.000349)	(0.0265)
Labor productivity	0.0105***	0.265***	0.00617***	0.117***
	(0.0000284)	(0.0212)	(0.000747)	(0.0149)
Capital intensity	0.000916**	0.0114***	0.000934*	0.0111***
	(0.000323)	(0.00294)	(0.000442)	(0.00276)
Research and development	0.0111**	0.00774	0.0107*	0.0133
	(0.00429)	(0.0214)	(0.00512)	(0.0211)
Export spillover	0.000758***	0.0571	0.00135***	0.0587
	(0.000133)	(0.0479)	(0.000262)	(0.0436)
Constant	-0.151***	-8.173***	-0.157***	-8.088***
	(0.0225)	(0.958)	(0.0138)	(0.880)
Year FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Observation	38107	38090	41196	41178
Adj. R-sq./pseudo R-sq.	0.1751	0.3355	0.1713	0.3216

Standard errors in parentheses.

** p<0.05; ** p<0.01; *** p<0.001.*

Source: Author's calculation based on the IAMS in 1996 and 2006.

5.5.2. Sensitivity Analysis

To check whether the baseline results are consistent and robust, this section introduces a series of sensitivity analyses. First, we run regression with alternative dependent variables. Specifically, we construct three alternative GVC participation proxies. The first alternative variable involves adoption of stricter definition of GVC participation. Like in Chapter 4, we select firms that intensively link with value chain activities and set a third of proportions of imported inputs and export share as a threshold for GVC participation. This means gvc_{isrt} equals 1 if a firm has both ratio of imported raw material and percentage of export greater than 33 percent and 0 otherwise. Also, we separate GVC variables according to firms' commercial transactions in order capture firms involved in different modes of value chain activities Precisely, we define SMEs that source intermediate inputs from foreign suppliers as SMEs participating "backward GVC". This variable takes the value 1 if SMEs import raw material from abroad and 0 otherwise. Another measure is called "forward GVC participation," which captures value chain involvement through exporting goods or services directly to firms overseas. Disaggregating by the mode of value chain participation, 15.2% of Indonesian SMEs deal with forward GVC and 18.3% engage in backward GVC. We estimate equation (5.1) separately for backward GVC participation and forward GVC participation and validate the results with the previous estimates.

Columns (1), (2), and (3) in Table 5.5 report the results for overall GVC participation, backward GVC participation and forward GVC participation, respectively, using Probit estimator. Similar to the baseline model, the goodness of fit for our alternative estimations is acceptable and the results are generally stable across different estimation methods for each dependent variable. The signs of the coefficients of size and foreign ownership are positive and statistically significant for all the specifications. Regardless of the mode of GVC engagement, size and ownership structure are important factors facilitating SMEs' participation in GVC. The effect of age and access to finance varies according to the mode of GVC participation. For backward GVC participation, SMEs with more years of operation seem to have a higher GVC participation propensity; the sign is the opposite for forward GVC participation. Similarly, while access to finance does not matter for backward GVC participation, it is important for SMEs that engage in exporting activities. This is perhaps due to that fact that entry into export markets involves a significant cost, and therefore the ability to finance exports through bank loans or other sources of capital enables SMEs to join GVC relatively easy.

Also differing according to the mode of GVC participation are the effects of labor productivity, capital intensity, and R&D. For example, we find that labor productivity has a negative effect on backward GVC participation but a positive and significant effect on forward GVC participation. The result still supports the self-selection hypothesis that high-productivity SMEs choose to focus more on

export markets. Similarly, more capital-intensive SMEs have a higher probability of GVC participation, and the magnitude is much stronger for forward GVC participation. As expected, the training and skill variables turn out to be significant with the correct sign, indicating the important role of human capital in helping SMEs to join supply chains, through either upstream or downstream linkages. Thus, a higher level of human capital is important for SMEs to join supply chains successfully, and these results hold regardless of the different measures of GVC participation.

Table 5.5: Estimation Results for SMEs' Backward and Forward GVC Participation

	GVC participation	**Backward GVC Participation**	**Forward GVC Participation**
	(1)	**(2)**	**(3)**
Firm size	0.393***	0.237***	0.570***
	(0.0349)	(0.0156)	(0.0163)
Firm size squared	0.000000903	0.000000151	-0.000000630
	(0.000000527)	(0.000000329)	(0.000000331)
Age	-0.138***	0.0295**	-0.167***
	(0.0210)	(0.00919)	(0.00978)
Foreign ownership	0.949***	0.865***	0.729***
	(0.0473)	(0.0361)	(0.0369)
Access to finance	-0.00823	-0.00935	0.103***
	(0.0475)	(0.0233)	(0.0235)
Formal training	0.179***	0.155***	0.218***
	(0.0391)	(0.0190)	(0.0192)
Skill intensity	0.417***	0.439***	0.138***
	(0.0702)	(0.0343)	(0.0359)
Labor productivity	0.0638***	-0.0670***	0.151***
	(0.0172)	(0.00758)	(0.00820)
Capital intensity	0.00700*	0.00150	0.0141***
	(0.00340)	(0.00160)	(0.00168)
R & D	-0.0210	0.0801***	-0.0297
	(0.0256)	(0.0166)	(0.0165)
Export spill-over	0.0320	0.0499*	0.0578***
	(0.0584)	(0.407)	(0.393)
Year FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Observation	41209	41209	41222

Standard errors in parentheses.
** p<0.05; ** p<0.01; *** p<0.001.*

Source: Author's calculation based on the IAMS in 1996 and 2006.

Next, our sensitivity check involves a new estimation using an alternative definition of SMEs based on employment, which classifies enterprises with fewer than 100 employees as SMEs. This classification gives us a somewhat different distribution of firms, with SMEs accounting for 79% of the total Indonesian manufacturing firms. Table 5.6 presents the results from the estimation using the LMP and probit methods. In general, the signs and magnitude of most coefficients are stable and consistent with the baseline results.

Table 5.6: Estimation Results for SMEs' Decision to Participate in GVC Using an Alternative Employment-Based Definition of SMEs

	(1) LPM	**(2) Probit**
Firm size	-0.00329	0.501***
	(0.00314)	(0.117)
Firm size squared	0.00000490***	0.00000192
	(0.000000385)	(0.0000209)
Age	-0.00190	-0.0556*
	(0.00309)	(0.0237)
Foreign ownership	0.206***	1.013***
	(0.0307)	(0.0652)
Access to finance	0.00631***	0.139*
	(0.00167)	(0.0547)
Formal training	0.0116***	0.287***
	(0.000313)	(0.0469)
Skill intensity	0.0209***	0.487***
	(0.000895)	(0.0833)
Labor productivity	0.00452***	0.116***
	(0.000301)	(0.0200)
Capital intensity	0.000252***	0.00657
	(0.0000609)	(0.00414)
Research and development	0.00533	0.0114
	(0.00324)	(0.0430)
Export spillover	0.000910***	0.0290
Year FE	Yes	Yes
Region FE	Yes	Yes
Industry FE	Yes	Yes
Observation	41227	41209
Adj. R-sq./pseudo R-sq.	0.1033	0.2687

Standard errors in parentheses; * p<0.05; ** p<0.01; *** p<0.001.

Source: Author's calculation based on the IAMS in 1996 and 2006.

The last robustness check involves the analysis of differential impact of human capital and other firm characteristics on GVC participation across different sectors and firm sizes. In exact terms, we estimate equation (5.1) separately for four main manufacturing sectors: (1) foods, beverage and tobacco; (2) garment, apparels and textile; (3) electronic machinery and transportation; and (4) other manufacturing. The estimation result is given in Table A.5.2 in the Appendix. While results for key variables such as size, foreign ownership, labour productivity and R&D are robust across different sectors, there are a few notable variations. For example, while skill intensity is found to be an important driver to GVC participation for food, beverage and tobacco, electronic machinery and transportation and other manufacturing, it is not the case for garment, apparels and textile sector. Also differing across sectors are effects of access to finance and capital intensity on GVC. Specifically, coefficient of access to finance is positive and significant only for garment and textile and machinery and transportation, while capital intensity is found crucial for GVC participation for machinery and transportation, and other manufacturing. With regards to size, we analyse differential effects for small firms, medium-sized firms, and large firms and the results are presented in Table A.5.3 in the Appendix. Despite some variations, the results are fairly consistent and robust across different sizes of enterprises. While scale of economy and training matter for small and medium-sized firms to integrate in GVC activities, they are not quite so for large firms. Unlike small and medium-sized firms, access to finance is not a major issue for large firms. It is also found that skill and capital intensity are crucial in GVC activities for medium and large firms, but it is not the case for small firms.

5.5.3. Addressing Endogeneity Concerns

As discussed in Chapter 4, our econometric specification might suffer endogeneity problem because skill intensity variable is endogenous. The proceeding analysis proves that having a workforce with a higher skill level helps SMEs to integrate into GVC. However, the relationship would be the opposite in that GVC SMEs are inclined to hire higher-quality and skilled workers. Another potential source of endogeneity in our model is omitted variables. SMEs connecting with value chains might possess an exceptional corporate culture and leadership. Our data could not capture these factors, and as a result the error terms incorporate them. Clearly, exceptional leadership and skill intensity are correlated in the sense that firms with such management tend to hire more skilled human resources.

In the presence of endogeneity, ordinary least-square estimation is biased. Like in the previous chapter, we apply the IV method to estimate equation (5.1) using the two-stage least-square (2SLS) estimator to address the endogeneity problem (Bascle, 2008; Jeffrey M Wooldridge, 2016). We opt for

two variables to instrument skill intensity: 1) the number of high school and vocational training providers in each region; and 2) the average ratio of skilled workers for each sector in a given year and region. We select the instruments based on the widely recognized GVC framework in which higher skills of human capital are crucial for countries and firms to integrate into GVC. We believe that the quantity of educational institutions along with the availability of skills in a given region might indirectly affect firms' GVC strategy via their direct impact on firms' ability to hire a skilled workforce. We are not yet sure whether these IVs are valid and will conduct a series of tests after the estimation.

Table 5.7 presents the results of the IV estimation. To check whether the estimates are robust across different SME definitions, we estimate equation (5.1) twice: one for the default definition of SMEs based on the value of sales (column 1); and another for the employment-based definition (column 2). Before discussing the results, we adopt two standard tests to check whether our instruments are valid. The instrument relevance test aims to measure instruments' strength. Ideally, there must be a strong fit between the endogenous regressor and the instruments, which first-stage F-statistics greater than 9.08 prove (Bascle, 2008; Stock & Yogo, 2002). The value of the first-stage F-statistics of our 2SLS regression is 385.49, implying that our instruments are strong and thus satisfying the relevance condition. Next, we perform the instrument exogeneity test, in which the null hypothesis is that the instrumental variables are exogenous. Since the *p-value* is 0.1559, we cannot reject the exogeneity of our instruments and thus we can argue that the instruments satisfy the exogeneity condition.

The results from the 2SLS regression are not only similar to the baseline estimation but also stable across all the specifications using different definitions of SMEs. Except for the coefficient of size, which appears to be strongly positive for specification (1) and negative but insignificant for specification (2), other firm characteristics, including foreign ownership, access to finance, training and skill, labor productivity, capital intensity, and R&D, have positive and significant impacts on SMEs' propensity to participate in GVC. Like the baseline results, younger SMEs are more likely to be involved in value chain activities. In summary, the results from the alternative method allow us to conclude that the positive relationship between human capital and GVC participation is robust.

Table 5.7: Results for SMEs' Decision to Participate in GVC Using the 2SLS Estimator

	Sale-Based Definition of SMEs	**Employment-Based Definition of SMEs**
	(1) 2SLS	(2) 2SLS
Firm size	0.00462*	-0.00558
	(0.00258)	(0.00372)
Firm size squared	0.000000838***	0.00000456***
	(4.01e-08)	(0.000000789)
Age	-0.00224*	-0.00148*
	(0.00106)	(0.000743)
Foreign ownership	0.231***	0.190***
	(0.00582)	(0.00568)
Access to finance	0.0156***	0.00758***
	(0.00238)	(0.00185)
Formal training	0.00719*	0.00829***
	(0.00292)	(0.00228)
Skill intensity	0.124***	0.0493*
	(0.0267)	(0.0198)
Labour productivity	0.00223[a)]	0.00284**
	(0.00138)	(0.000944)
Capital intensity	0.000932***	0.000251*
	(0.000165)	(0.000126)
Research and development	0.0110***	0.00652***
	(0.00190)	(0.00173)
Export spillover	0.00203	0.00163
	(0.00172)	(0.00127)
Year FE	Yes	Yes
Region FE	Yes	Yes
Industry FE	Yes	Yes
Observation	39726	32677
Adj. R-sq.	0.149	0.085
First-stage F-statistic	385.49	334.901
Exogeneity test—p-value	0.1559	0.0875

Standard errors in parentheses; * p<0.05; ** p<0.01; *** p<0.001.

Source: Author's calculation based on the IAMS in 1996 and 2006.
a): Significant at the 10% level.

5.6. Conclusion

In this chapter, we examined the role of SMEs in GVC activities in the Indonesian economy using micro-level data. We carefully studied the effects of human capital and other firm attributes on Indonesian SMEs in GVC participation. The results suggest that integrating into upstream and downstream value chains is undoubtedly difficult for Indonesian SMEs, as the extremely low GVC participation ratio shows. Effective integration into global production networks requires SMEs to have superior capability and certain key fundamentals in addition to a locality that is conducive to peer learning. In particular, the size of an enterprise matters as it gains from economies of scale and helps to offset the cost of entry into production networks. We also found evidence that linkage with value chain activities requires SMEs to have a higher level of human capital, better foreign networks (i.e. in terms of foreign ownership and location to an export hub) and superior production capacity, which we measured using higher productivity, more assets, and more investment in research and development. We also assessed the effect of human capital and other firm attributes on different modes of GVC participation. Interestingly, several variables have robust and expected results. Most importantly, whether they involve backward or forward GVC linkages, firm resources, and capabilities, which their size, foreign networks, productivity, human capital, and location reflect, are critical for SMEs to integrate into value chain activities. Further, we applied the IV method to address the endogeneity problem in our model and found that the results are robust. Fundamentally, a higher quality of human capital helps SMEs to integrate successfully into GVC.

The chapter highlights the importance of SMEs in GVC activities and in particular in creating employment as well as forward and backward linkages. The potential of the domestic capacity to absorb key technologies and knowledge is critically dependent on the competitiveness and efficiency of domestic SMEs. It seems to be very important for the Indonesian economy to create stronger linkages to GVC activities and move up the value chain activities. In particular, the study also highlights the importance of agglomerative effects, and SMEs in a cluster with MNCs tend to learn faster and are more efficient in participating in GVC. Thus, policies are necessary to design industry strategies to create agglomerative effects either through cluster strategies or through a strategy for special economic zones, such as incubators and science parks.

In addition, the study highlights the importance of human capital as a critical factor in creating linkages for SMEs to participate in both manufacturing and service GVC. This will be a critical factor for Indonesia to be regionally and globally competitive. The following might be important policy considerations for developing human capital for SME development:

- The design of forward-looking educational institutions and improving the skills of workers will be critical for Indonesia to create competitive and sustainable economic growth in the long run. The formal education system could be a good backbone for building lifelong education and learning skills for SMEs and workers.
- The government could set up SME training funds that SMEs could use to develop the skills of their workers. They could also use the funds to develop the skills and training of middle management, which is critical to absorb and implement best practices in human resources and international standards and practices.
- The government could also set up incubators and innovation funds that will increase the research and knowledge collaborations between SMEs and universities. This will create linkages and spillovers in learning new innovation and technologies for SMEs. The innovation fund could also reduce the cost of research and development for SMEs.
- The government could also consider MNC–SME mentorship schemes in which it can create a network between MNCs and SMEs for closer discussions and sharing of knowledge. In some cases, it could encourage MNCs to mentor SMEs on best practices in human resources, marketing, and networking that will create strong linkages between MNCs and SMEs.
- Apart from building the quality of general education, which is a prerequisite condition for human capital development, the government might consider aggressively expanding technical and vocational training programs to sharpen the skills of the workforce that are of great use in value chain production. Our finding also suggests the importance of in-house formal training. The large-scale expansion of technical training services by the SME Productivity Centers that the Ministry of Manpower and Transmigration operates could be another policy option for the Indonesian Government to enhance human resource quality.

Chapter 6

Does Servicification Enhance Productivity? Evidence from Indonesia's Firm-level Analysis Using Semi-Parametric Approach

6.1. Introduction

Services activities in manufacturing are intensifying over past decade. The effects of services are increasing both supply-side and demand-side activities in the manufacturing process, increasing the linkages between manufacturing and services activities. From the supply, the intensity of services factors used in manufacturing production and service-based technology adoptions have intensified. Particularly, the GVC activities have increased the service linkages between manufacturing activities in regional and global activities. Services also increased the profit margins of manufacturing activities in terms seeking and building up the customer base via communication technologies and social technology platforms.

There is strong evidence of supply-side effects of services in manufacturing as more manufacturing firms use more service inputs in their production process. Firms acquire more business services, ICT and financial services to coordinate and operate production; they consume transport, logistics, wholesale and retails services to ease flow of products from one stage of production to another. Some of these services are in-house while others are outsourced. Consequently, the aggregate share of services inputs in manufacturing is found rising in most parts of the world including in OECD countries (Miroudot & Cadestin, 2017; Nordas, 2010) , in Europe (Kommerskollegium, 2016), in Asia (R. Baldwin et al., 2014; Mercer-Blackman & Ablaza, 2018; S. M. Thangavelu et al., 2017), and most other individual economies. In addition, we also observing the demand-side effects as the manufacturing

firms have integrated services into their core products. This strategy has been prevailing in almost all industries and in most parts of the world including OECD economies, Europe, North America and Asia (R. Baldwin et al., 2014; Cadestin & Miroudot, 2020; Crozet & Milet, 2017; Kelle & Kleinert, 2010; Kommerskollegium, 2016; Vandermerwe & Rada, 1988). Vandermerwe and Rada (1988) termed this phenomenon as 'servitization' and labelled it as a new market strategy adopted by high-performing companies to differentiate their products and to enhance competitive edge of business.

The growing importance of service in manufacturing is termed by the National Board of Trade Sweden as 'servicification' (Kommerskollegium, 2010) and the terminology has later been widely used by academic and policy circles (R. Baldwin et al., 2015; Lanz & Maurer, 2015; Lodefalk, 2017; Low, 2013; Miroudot & Cadestin, 2017). Conceptually, servicification of manufacturing pertains to three dimensions of linkages: (1) the increasing use of service inputs in the production process; (2) the shift toward service activities in manufacturing; and (3) the bundle of services with products to add value and sharpen customer relationships. The reasons behind the rising trend of servicification among manufacturing firms are three folds. First, it is largely driven by the rise of GVC, which in turn increases greater intra and extra-firm linkages and hence more service transactions. The greater dynamism of GVC results in greater demands for service linkages in the fragmented production, where it increases the intensity of the parts and components move across global value chains. Seminar works such as R. Baldwin et al. (2014); Low (2013); Miroudot and Cadestin (2017) and Heuser and Mattoo (2017) described services as a 'glue' in GVC linking one production component to another; while Kommerskollegium (2016) argued that firms use more services to participate in GVC.

Second, increase in servicification is due to the change in reclassification of services, and increase in the service tasks in relation to manufacturing tasks due to technological improvements and also improvements of skills and human capital development (R. Baldwin et al., 2014; Gereffi & Fernandez-Stark, 2010; Kommerskollegium, 2016; Lodefalk, 2014; Nordås & Kim, 2013). Third, firms are also becoming more servicified in order to enhance productivity and efficiency. Efficient and technology enabling services such as transport and logistics, telecommunication and business services can help firms save time and achieve efficient production coordination, while technology and R&D services are essential for firm to improve production process and efficiency (Amiti & Wei, 2009; Arnold et al., 2016; Lodefalk, 2014; Nordås & Kim, 2013). Enabling services are also essential for firms to establish and manage international production networks, which in return drive greater efficiency and productivity (Kommerskollegium, 2016; Lodefalk, 2017; Nordås & Kim, 2013). Moreover, firms can achieve static gains from better reallocation of resources by outsourcing service activities and specializing in core manufacturing activities (Winkler, 2010).

Empirical research on the effects of servicification on productivity has been mostly restricted to the aspect of services outsourcing and offshoring but least on the service revenue dimension. Offshoring service is generally defined as service that is produced in one country and consumed in another (Gereffi & Fernandez-Stark, 2010). Most often, it is measured by the share of imported services to total inputs at the firm level. Recent studies such as Girma and Görg (2004) used establishment-level data from UK manufacturing industries to examine if outsourcing led to productivity growth. Several studies have also explored for other developed countries such as Görg et al. (2008) for Irish manufacturing firms, Amiti and Wei (2009) for US firms, Winkler (2010) for Germany manufacturing, Schwörer (2013) and Kang et al. (2010) for firms in Europe and East Asia, respectively. Their results suggest that service offshoring has a significant positive effect on productivity in the manufacturing sector. For Irish manufacturing firms, 10 percentage point increase in international services outsourcing contributes to approximately 0.9% rise in productivity (Görg et al., 2008). The productivity effect is found greater in the US manufacturing in which service offshoring accounts for 10 percent of productivity growth (Amiti & Wei, 2009).

Other studies examined the impact of service inputs in the productivity of manufacturing firms. The research by Arnold et al. (2006) for enterprises in the Czech Republic indicates that service inputs not only support firms to improve productivity but also serve as the catalyst for service policy reform to exert a positive impact on manufacturing productivity (Arnold et al., 2006). It is important to note that empirical evidence on the effects of servicification on productivity are far from consensus. It is found in Turkey that servicification appears to have negative and statistically significant negative correlations with productivity across Turkey manufacturing firms (Haven & Van Der Marel, 2018). Specifically, firms that produce service outputs have experienced nearly 18 percent less productivity than non-servicified goods firms.

In this chapter, we explore the servicification of Indonesian manufacturing firms from both supply-side and demand-side. Although there are several studies exploring the supply- and demand-side impacts of services on productivity of manufacturing firms, most of these studies are based on developed countries. Although we observe extensive research on the servicification-productivity nexus, few studies focused on the importance of service revenues in enhancing efficiency and productivity. Recent evidence indicates that increasingly manufacturing firms are offering services in bundles with products, which tends to be the secondary source of revenue for the firms. This chapter, therefore, aims to fill this gap by assessing the effects of servicification on productivity from aspects of purchasing services as well as selling services.

Our empirical analysis utilizes firm-level data from the Indonesia's Annual Manufacturing Survey from 2005-2015. Our dataset is very unique in the sense that it contains a wide range of corporate

information annually and most importantly it allows us to distinguish between share of service input to total inputs (our first proxy of servicification) and share of service revenues to total output (another proxy of servicification). We adopt two stage procedures to study the impact of servicification on manufacturing productivity. First, we estimate the production function based on Levinsohn and Petrin (2003) , hereafter refers to LP method, which uses intermediate inputs as proxy for unobservable productivity shocks and endogeneity the empirical analysis. In the second stage, we regress the derived productivity with servicification variables controlling firm heterogeneity including foreign ownership, access to finance, export spillover and participation in global value chains. The results indicate that firms with higher servicification intensity both in terms of service inputs and service revenue tend to have higher productivity levels. We also found that foreign-owned firms and enterprises that integrate into global and regional value-chain networks tend to have higher productivity. The evidence suggests the importance of services, foreign ownership and ability to participate in the global value chains experience positive productivity gains.

The remainder of this chapter is organized as follows. Section 2 briefly discusses the current status of servicification of the Indonesian economy. Section 3 provides an overview of empirical strategy, which include the discussion of estimation of production function and productivity, econometric specification to estimate the effect of servicification on productivity, and description of data. Section 4 discusses the empirical results and robustness checks. Section 5 provides policy conclusion.

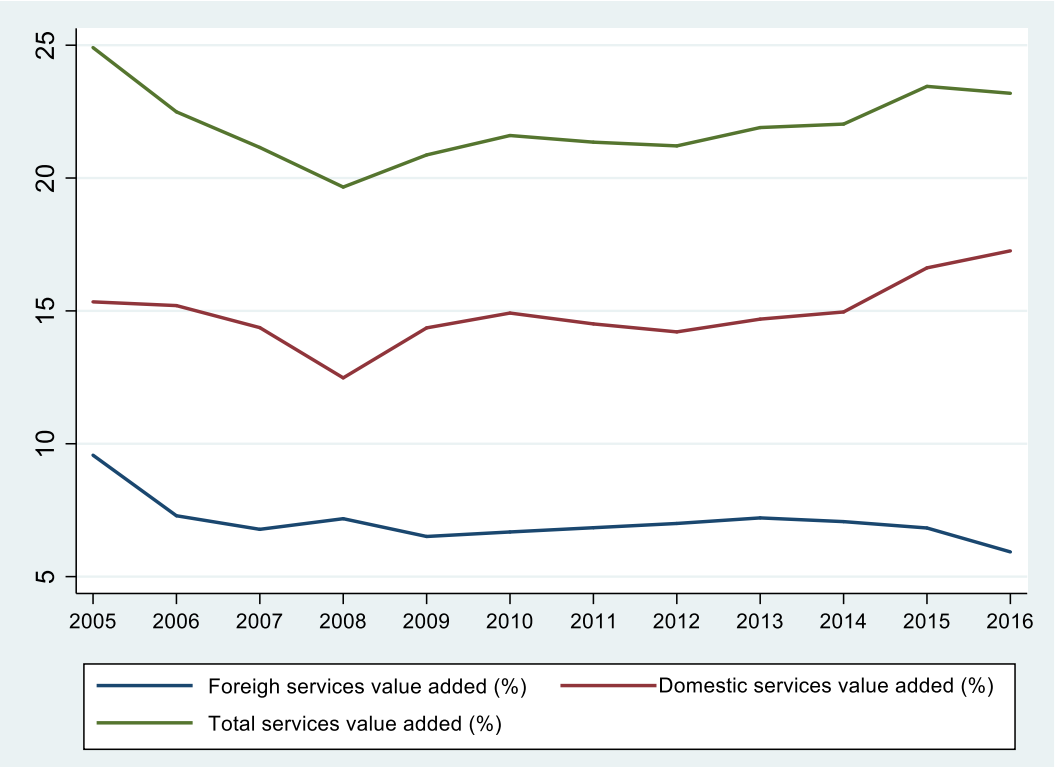
6.2. Servicification of the Indonesian economy

To illustrate the development of servicification of the Indonesian economy, we use three different measures namely services value-added share of gross exports, share of service input, and share of service incomes. Services value-added share of gross exports is calculated based on the Inter-Country Input Output table (ICIO) and it refers to the share of added originating from all service industries in total gross exports by manufacturing in Indonesia. To trace the source of service contribution in the manufacturing export, service value-added is further disaggregated into domestic service value added (value added originated from domestic service industries) and foreign service value added (value added originated from foreign service industries).

Figure 6.1 plots the trend of servicification of the Indonesian economy over the period 2005-2016. It suggests that service contributed about 25 percent of Indonesia's manufacturing exports in 2005. The level fell to about 20 percent in 2008 and it bounced back to around 23 percent in 2016. It is important to highlight that the servicification of manufacturing in Indonesia is comparatively lower than many countries in ASEAN region. For example, the share of services value added in gross export in 2016 was 47.4 percent for Singapore, 30 percent for Thailand, 27 percent for Malaysia and 25

percent for Vietnam. In terms of source of services, 17.3 percent of service value added in 2016 came from the domestic service industry and 6 percent originated from foreign supply. The low share of foreign services in the Indonesian manufacturing industry is partly explained by relatively high restriction of service sectors that cause firms to turn to domestic service supplies. According to OECD's Service Trade Restriction Index (STRI), Indonesian service sectors are relatively closed to foreign suppliers with the average STRI of 0.46 for all service sectors. The restriction is about twice as high as in Japan (0.19) and Korea (0.29) and 0.13 points higher than Malaysia. Services such as legal, telecommunication, accounting, distribution, maritime transport and logistics are among the highly restrictive sectors.

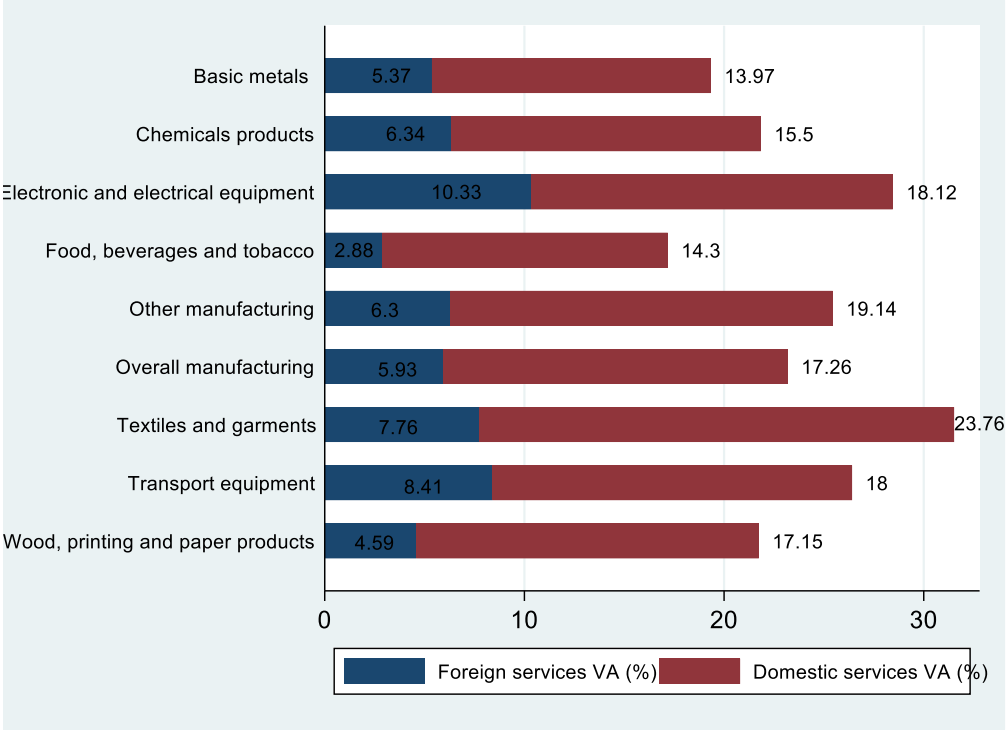
Figure 6.1: Services value added share of gross export in Indonesia, 2005-2016



Source: OECD-WTO's Trade in Value-Added (TiVA)

The contribution of services in Indonesia's manufacturing export varies notably across sectors. According to Figure 6.2, textiles and garments use services inputs the most with a share of 31.5 percent, followed by electronic and electrical equipment (28.45 percent), and transport equipment (26.4 percent). Food products, beverages and tobacco are found to consume the least services inputs for their export. Despite variation, all manufacturing sectors share a common feature that domestic service value added is significantly greater than the foreign services value added in their value of gross exports.

Figure 6.2: Services value added share by sector in Indonesia, 2016



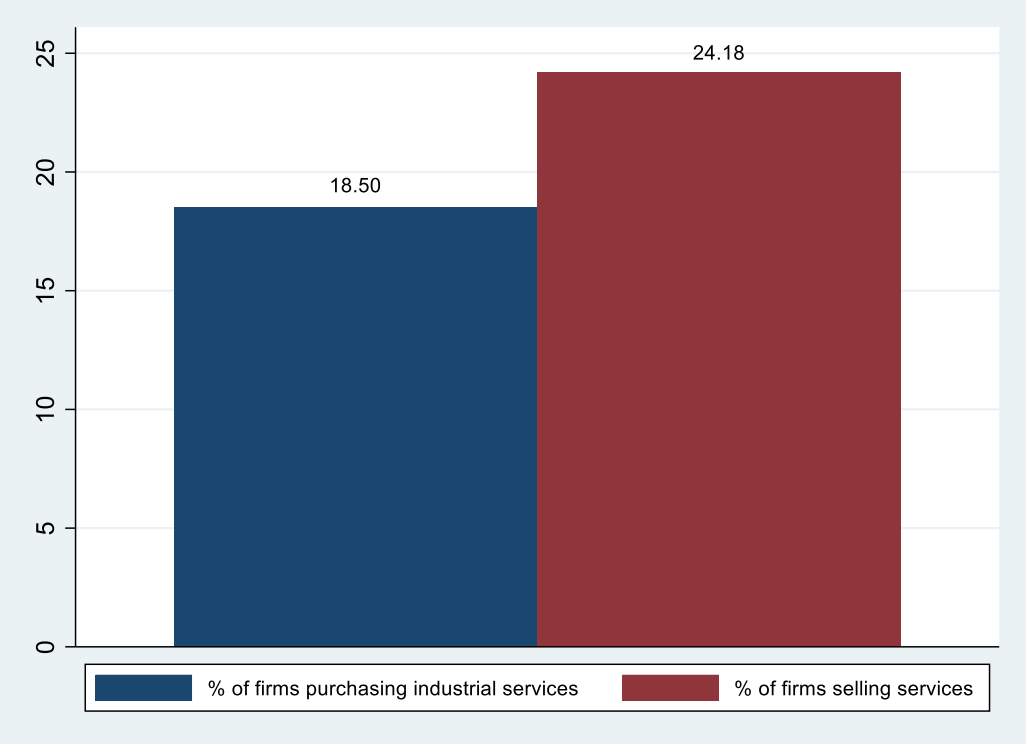
Source: OECD-WTO's Trade in Value-Added (TiVA)

Share of service value added presented above provides useful insights about service-manufacturing linkages in the economy. However, it is unable to capture firm dynamics with regards to purchasing services inputs and offering services. To understand firms' supply- and demand-side effects of servicification, we construct four firm-level indicators using the Indonesian Annual Manufacturing Survey (IAMS) over the period 2005-2015. Similar to measurement in Kommerskollegium (2016), servicification is measured by two separate sets of indicators. First in terms of purchasing service, servicification intensity is calculated as share of service inputs to total inputs, where the servicified firms are those that buy services from outside. Second, we also measure servicification of manufacturing firms in terms of selling service using two measures namely the share of service output and the percentage of firms offering services. Share of service output is defined as the ratio of revenues from selling services to total outputs. Firms that sell services in addition to their core products are defined as servicified firms from the demand-side.

Two important observations are identified in Figures 6.3 and 6.4. Firstly, servicification is considerably common among the Indonesian manufacturing firms. Specifically, 18.5 percent of Indonesian manufacturing firms sourced industrial services from suppliers. The average share of industrial services was just around 0.8 percent of total inputs. The servicification intensity, though, is comparatively low partly due to our restricted definition that only counts the purchased industrial services. If we include firms that use renting services, the servicified firms account for 37 percent of

manufacturing firms and share of service inputs increased to about 5 percent. It is important to highlight that the service input ratio does not include costs of many other necessary services such as ICT, business services, financial services and research and development as our dataset does not contain itemized expenses on those services every year. Therefore, intensity of service input consumption in our study is likely to be underestimated.

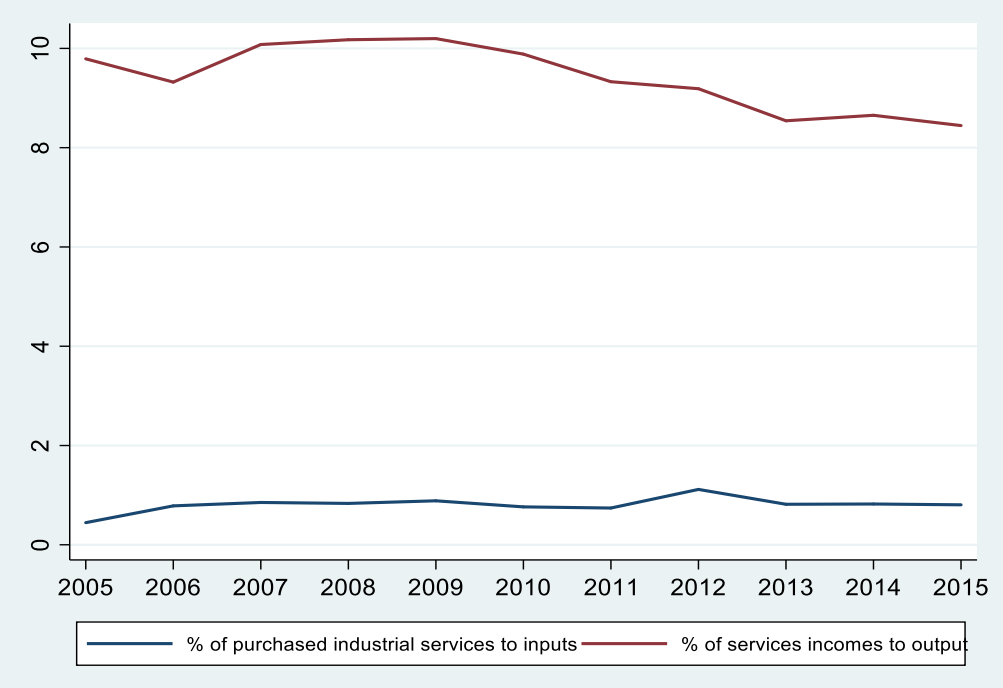
Figure 6.3: Share of servicified firms in Indonesian manufacturing industry



Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

Second, selling services is clear across the Indonesian manufacturing firms as given at Figure 6.3. The ratio of firms that are selling services in 2005 was 21.4 percent and this ratio increased to 23 percent and 28 percent respectively in 2010 and 2015. The average in 2005-2015 indicates that about 24 percent of Indonesian firms generated from services. In terms of intensity, the share of service revenue to total output among Indonesian manufacturing firms fluctuated slightly over the past decade, however, the average revenue generated from services represents around 9.4 percent of total outputs. The level is about twice as high as those in the EU manufacturing firms (Kommerskollegium, 2016).

Figure 6.4: Share of service inputs and service revenues among Indonesian manufacturing firms



Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

6.3. Empirical strategy

We adopt a two-stage approach as applied in Amiti and Konings (2007); Görg et al. (2008); Schwörer (2013) to estimate the effect of servicification on productivity. In the first stage, we estimate plant-level total factor productivity (TFP)—our measure of productivity—based on the Cobb Douglas production function. The estimation of the production function applies to the semi-parametric approach developed by Levinsohn and Petrin (2003). In the second stage, we regress the derived productivity with servicification and other firm attribute variables.

6.3.1. Estimation of productivity

Let assume the production of firm *i* at time *t* takes the form of Cobb-Douglas production function as follow:

$$Y_{it} = A_{it} K_{it}^{\beta_k} L_{it}^{\beta_l} M_{it}^{\beta_m} \quad (6.1)$$

Where Y_{it} represents physical output; A_{it} is the efficiency level; and K_{it}, L_{it}, $and\ M_{it}$ are capital, labour and material, respectively. Taking natural logs of equation (6.1) and denoting lower case for log form of all variables, we obtain:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \varepsilon_{it} \quad (6.2)$$

Estimation of equation (5.2) using Ordinary Least Square (OLS) could yield biased results due to endogeneity between regressors and error term (Arnold, 2005; Levinsohn & Petrin, 2003; Van Beveren, 2012). Traditional methods used by some researchers to deal with this econometric issue include fixed effect and instrument variable. However, those methods still cannot not generate consistent estimates primarily due to unrealistic assumptions of strict exogeneity of inputs conditional on firm heterogeneity (Van Beveren, 2012; Wooldridge, 2009). To correct the endogeneity problem, Olley and Pakes (1996) developed a semi-parametric technique (known as OP method) incorporating the firm's investment decision to control unobserved productivity shocks. It proves that their method can solve both simultaneity between input choice and productivity shocks and selection bias, thus it is able to generate consistent estimates of the production function. One major weakness of the OP method, though, is the truncation issue caused by a significant number of zero value of investment (Levinsohn & Petrin, 2003). Built on the work of Olley and Pakes (1996), Levinsohn and Petrin (2003) uses the intermediate inputs like material or electricity to proxy for the unobservable productivity term to correct the simultaneity between input choices and productivity shocks. Similar to OP, Levinsohn and Petrin (2003)'s method, hereafter refers to LP, satisfactorily addresses endogeneity problem and generates consistent estimates for production function estimation. From a data-driven perspective, LP is more efficient than OP estimator in the sense that the majority of firm-level data sets including the IAMS report non-zero value of intermediate inputs (Levinsohn & Petrin, 2003; Vial, 2006).

Providing its estimation consistency and efficiency, this study adopts a semi-parametric approach developed by Levinsohn and Petrin (2003) to estimate production function. Levinsohn and Petrin (2003) splits error terms in equation (6.2) into two components: the transmitted productivity component ω_t, which is a state variable that impacts a firm's decision of input choice and an error term η_t that is uncorrelated with input choices. Thus, equation (5.2) can be rewritten as follows:

$$y_t = \beta_0 + \beta_k k_t + \beta_l l_t + \beta_m m_t + \omega_t + \eta_t \quad (6.3)$$

Levinsohn and Petrin (2003) assumes that demand for intermediate inputs depends on firm's state variable k_t and ω_t, which can be expressed as $m_t = m_t(k_t, \omega_t)$. The demand function is also assumed to be monotonically increasing in ω_{it} allowing us to inverse and get ω_t as follows: $\omega_t = \omega_t\ (k_t, m_t)$. Subsequently, production function (3) can be rewritten as:

$$y_t = \beta_l l_t + \emptyset_t(k_t, m_t) + \eta_t \quad (6.4)$$

Where

$$\emptyset_t(k_t, m_t) = \beta_0 + \beta_k k_t + \omega_t(k_t, m_t)$$

The estimation procedure involves two steps. The first stage begins with substituting a third-order polynomial approximation in k_t and m_t in place of $\emptyset_t(k_t, m_t)$ and then estimating of output using OLS as:

$$y_t = \delta_0 + \beta_l l_t + \sum_{i=0}^{3} \sum_{j=0}^{3-i} \delta_{ij} k_t^i m_t^i + \eta_t \quad (6.5)$$

The second stage obtains β_k by minimizing the following function:

$$\min_{\beta_k^*} \sum_t \left(y_t - \hat{\beta}_l l_t - \beta_k^* k_t - \mathrm{E}[\omega_t | \omega_{t-1}]\right)^2 \quad (6.6)$$

Where $\hat{\beta}_l$ is the parameter estimated in stage one; β_k^* is a good value of β_k used to predict the ω_t and ω_{t-1} via the following function: $\widehat{\omega}_t = \widehat{\omega}_t - \beta_k^* k_t$.

In the LP method, output y_{it} can be measured by either value-added or revenues. In this study, output y_{it} is proxied by value-added; labour is disaggregated into skilled labour (l_{it}^s) proxied by number of non-production workers; and unskilled labour (l_{it}^u) measured by number of production workers; and capital k_{it} is measured by values of estimated fixed capital. As in Vial (2006), we opt for fuel and electricity as proxy variables to control unobserved productivity. To get real values of output, capital, fuel and electricity, we deflate nominal value using the wholesale price index obtained from BPS-Statistics Indonesia. All variables are defined in the log form.

Table 6.1 presents the estimation results of the production function of the Indonesian manufacturing firms during 2005-2015. The results with raw material as proxy are also included for comparison to the baseline results. As expected, the coefficients for all inputs are positive and significant. Elasticity of value-added with respect to skilled labour is 0.390, compared to 0.217 for unskilled labour. The coefficient for capital is 0.135, which is slightly lower than the estimate in Vial (2006). Even if we change specifications using material as proxy, coefficients are generally robust and comparable to the previous specification.

Table 6.1: Estimation of production function for Indonesian firms based on LP approach

Production inputs	(1) Fuel and electricity as proxy	(2) Materials as proxy
Skilled labour	0.390***	0.287***
	(0.00776)	(0.00545)
Unskilled labour	0.217***	0.216***
	(0.00532)	(0.00476)
Capital	0.135***	0.140***
	(0.00378)	(0.00376)
Observations	111,313	122,493

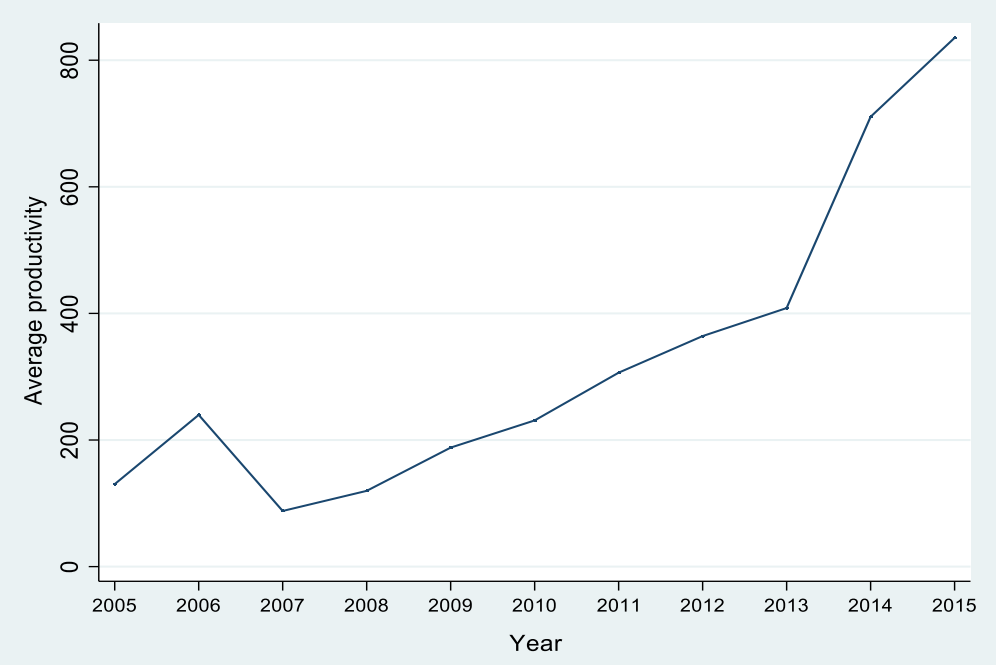
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

With the production input coefficients obtained from the estimation, we obtain the log of TFP of firm *i* at time *t* from the following expression:

$$tfp_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it} - \hat{\beta}_m m_{it} \quad (6.7)$$

Figure 6.5 plots average productivity levels of Indonesian manufacturing firms during 2005-2015. Despite fluctuations in the earlier period, the overall productivity level has grown significantly. The average productivity in 2005 was 119 million Ruppiah and increased steadily to 763 million Rupiahh in 2015.

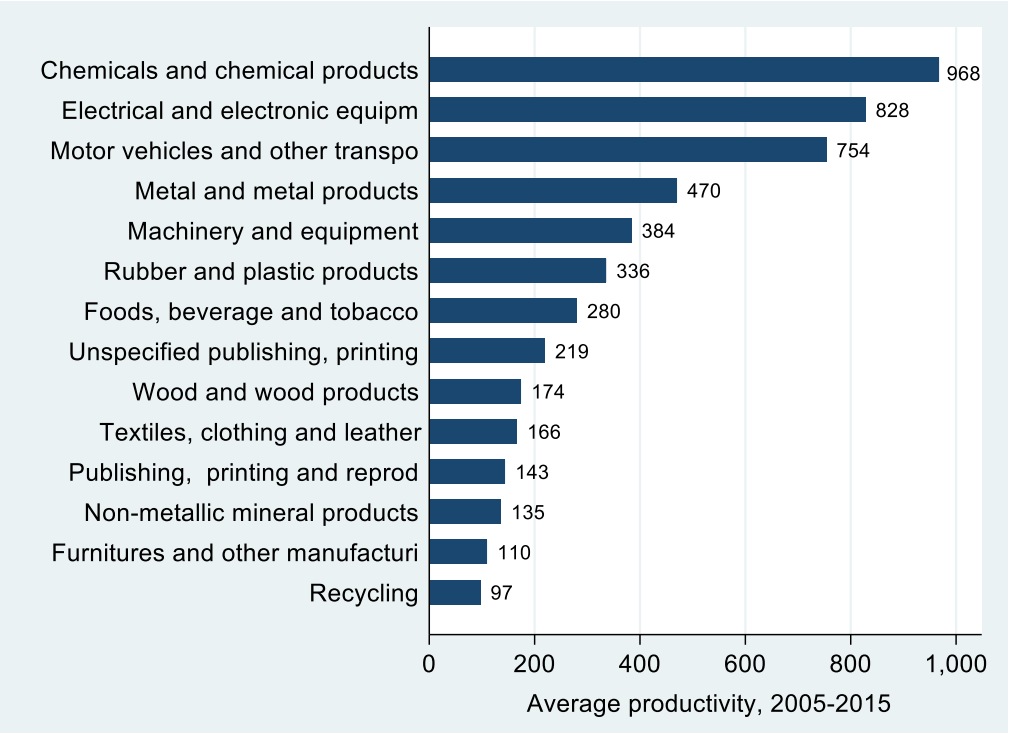
Figure 6.5: Average productivity level of Indonesian manufacturing firms, 2005-2015



Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

Productivity of the Indonesian manufacturing firms varies notably across sectors. According to Figure 6.6, the chemical sector is most productive with an average level of productivity in 2005-2015 at 968 million Rupiahh, whereas the recycling industry is the least productive across the manufacturing sector. Other sectors with comparatively high productivity are electrical and electronic equipment, transport equipment, machinery and equipment, and metal products.

Figure 6 6: Average productivity level of Indonesian manufacturing firms by sector



Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

Table 6.2: Average productivity level of Indonesian manufacturing firms by types of firm

	Average productivity (in million Rupiahh)
All firms	***290***
GVC firms	569
Non-GVC firms	273
Foreign-owned firms	869
Domestic firms	226
Firms sourcing industrial services	330
Firms not sourcing industrial services	252
Firms selling services	353
Firms not selling services	275

Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

To illustrate the variation of productivity level across different types of firms, we construct the average productivity level for various categories of firms as shown in Table 6.2. The statistics firmly suggest that firms participating in GVC exhibit higher average productivity than those that do not join GVC. Similarly, foreign-owned firms and servicified firms (both in terms of sourcing services and selling services) are more productive than domestic firms and non-servicified firms, respectively.

6.3.2. Servicification and impact on productivity

In the second stage, we examine the effects of servicification on manufacturing productivity via the following econometric specification:

$$ln\_tfp_{ist} = \alpha_0 + \beta_1 serv_{ist} + \beta_2 X_{ist} + d_t + d_s + \varepsilon_{isrt}, \quad (6.8)$$

where subscript *i* denotes firms, *s* is sector and *t* are time. Variable *tfp* is total factor productivity derived from estimation of equation (6.7), while variable *serv* refers to servicification. We use two variables to measure servicification. First, we define servicification in terms of purchasing service by share of expenses on industrial services to total expenses ($serv\_inp_{ist}$), hereafter refers to input servicification or interchangeably service input intensity. Second, servicification in terms of selling service is defined as the share of revenue generated from services to output ($serv\_outp_{ist}$), hereafter refers to output servicification or interchangeably service output intensity. X is a vector of other firm characteristics that may affect productivity.

As in most productivity studies, we control a number of firm characteristics that includes ownership structure, access to finance, participation in GVC and sector's export intensity. Foreign ownership (for_own_{isrt}) variable takes value 1 if the establishment is foreign owned and 0 otherwise. We define foreign-owned firms as those for which foreign individuals, companies, or organizations own 10% or more of their capital stake. Variable acc_fin_{isrt} is also binary with value 1 if a firm has a credit line/loan from a financial institution and 0 otherwise. In terms of participation in GVC, we follow Antràs (2019), Baldwin and Yan (2014) , and Urata and Baek (2020) to define GVC firms as those that link both upstream and downstream within production networks (two-way trade). This means that gvc_{isrt} equals to 1 if a firm has both a ratio of imported raw material and a percentage of exports greater than 0 and 0 otherwise. Lastly, we follow Sjöholm (2003) to capture the export spillover effect on productivity ($exp\_spillover$). We measure it as the average percentage of output that each sector exports. We anticipate that sectors that export a greater share of outputs are relatively likely to have higher productivity. To control unobserved shocks that may affect productivity over time and across different sectors, the specification also includes year-fixed effect d_t and sector-fixed effect d_s. The final estimation equation is given as:

$$ln\_tfp_{ist} = \alpha_0 + \beta_1 serv\_inp_{ist} + \beta_2 serv\_outp_{ist} \beta_3 for\_own_{ist} + \beta_4 acc\_fin_{ist} + \beta_5 gvc_{ist} + \beta_6 exp\_spillover_{ist} + d_t + d_s + \varepsilon_{ist} \quad (6.9)$$

6.3.3. Description of the data

The main source of data for our empirical analysis is the Indonesian Annual Manufacturing Survey over the period 2005-2015. The IAMS collects corporate information annually from all Indonesian manufacturing firms with 20 or more employees using a predefined questionnaire. The data contains a wide range of business information including establishment location and ownership, number of workers and their wage, itemized incomes and expenditures, imports of raw materials, export values and share, the purchase of industrial services, and incomes from selling services. On the average, about 24, 782 firms were surveyed during 2005-2015 and altogether there are a total of 272,605 enterprises. In our data cleaning procedure, we drop observations with missing data for any variable and hence leaves us with an unbalanced panel consisting of 127,335 firms.

The dataset has two other major advantages for our empirical investigation. First, it contains all information with regards to production inputs necessary for estimating productivity. The growing use of the IAMS for productivity studies i.e. in Amiti and Konings (2007) and Vial (2006) clearly suggests its significance and relevance for firm-level analysis. Second, the dataset allows us to break down servicification in terms of purchasing services and selling services. All variables in our study are deflated using the wholesale price index (WPI) obtained from BPS-Statistics Indonesia. Summary statistics are presented in Table 6.3.

Table 6.3: Summary statistics

Variable	Observations	Mean	Std. Dev.
Value added (in million Rupiah)	127,356	24503.7	335906.5
Number of production workers	127,356	161.8	546.8
Number of non-production number	127,356	35.6	150.6
Capital stock (in million Rupiah)	127,356	233978.7	34400000
Expense on fuel (in million Rupiah)	127,356	1243.4	21215.8
Expense on electricity (in million Rupiah)	127,356	1373.2	43224.3
Share of firm having access to finance (%)	127,356	40.9	49.2
Share of firm participating in GVC (%)	127,356	5.5	22.9
Share of service input to total input (%)	127,356	0.86	4.6
Share of service income to total output (%)	127,356	8.4	25.2

Std. Dev= standard deviation

Source: Author's calculation based on the Indonesian Annual Manufacturing Survey 2005-2015

6.4. Empirical results

6.4.1. Baseline results

The results by fixed effects and GMM are given at Table 6.4. The results of fixed effect estimation are given from column 1-4 at Table 6.4. The estimation includes year fixed effects to control for any unobserved time-varying shocks that affect productivity level of firms. We also account for unobserved factors that might affect a firm's productivity across different sectors by including industry fixed effects in our estimation.

Table 6.4: Estimation results of servicification effect on productivity

Total factor productivity	(1) FE Full sample	(2) FE Full sample	(3) FE Dynamic firms	(4) FE-lag regressors	(5) Diff GMM	(6) Sys GMM
Foreign ownership	0.717***	0.721***	0.732***	0.618***	0.716***	0.747***
	(0.0226)	(0.0225)	(0.0249)	(0.0233)	(0.134)	(0.150)
Access to finance	0.0973***	0.0973***	0.0943***	0.0689***	0.124***	0.129***
	(0.00887)	(0.00886)	(0.0101)	(0.00931)	(0.0243)	(0.0265)
Export spillover	0.570***	0.584***	0.494***	-0.0617	-0.318*	-0.294
	(0.129)	(0.129)	(0.145)	(0.101)	(0.187)	(0.193)
GVC participation	0.0882***	0.0896***	0.0980***	0.140***	0.138***	0.150***
	(0.0180)	(0.0180)	(0.0202)	(0.0177)	(0.0523)	(0.0577)
Share of service inputs to total expenses	-0.113	-0.112	-0.0229	0.125	0.705***	0.781***
	(0.0910)	(0.0912)	(0.0987)	(0.0887)	(0.266)	(0.270)
Share of service income to total revenues	0.122***	0.122***	0.128***	0.122***	0.481**	0.445*
	(0.0208)	(0.0208)	(0.0234)	(.0233)	(0.224)	(0.232)
Exit		-0.0455***				
		(0.00558)				
Lag total factor productivity					0.233*	0.200
					(0.136)	(0.152)
Constant	3.262***	3.270***	3.361***	3.668***	3.345***	3.473***
	(0.0270)	(0.0270)	(0.0312)	(0.0281)	(0.538)	(0.603)
Observations	127,537	127,537	93,848	108,525	86,263	86,263
R-sq	0.3252	0.3262	0.3192	0.3255	-	-
Year-FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector-FE	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) (*p-value*)	-	-	-	-	0.858	0.958
Hansen test (*p-value*)	-	-	-	-	0.116	0.106

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

The foreign ownership coefficient is positive and statistically significant, which implies that foreign-owned firms are more productive than domestic counterparts. The result is consistent with existing literature i.e. Görg et al. (2008) and supports the claim foreign-owned firms have several advantages

including in human and capital resources, technological and production capabilities and access to foreign networks, which are factors that contribute to higher productivity. Access to finance is also found to positively affect productivity level. Specifically, firms that get loans from banks or financial institutions are about 10 percentage points more productive than those that do not have any access to bank loans. The result for export concentration suggests that exporting firms will have higher productivity due there are competing in the global market. As anticipated, coefficient of GVC participation is strongly positive indicating that GVC increases the efficiency and productivity level of firms. This finding is consistent with the literature that GVC can stimulate productivity growth at both firm and industry level (Baldwin and Yan (2014); Criscuolo and Timmis (2017); Wagner (2012)). The channels in which GVC can increase productivity include more efficient supplies of inputs, high-quality standard of production and services as required by lead firms and to foreign networks. The positive GVC-productivity nexus offers additional evidence that explains the prevailing global trend of why firms strive to join value chains and production networks.

The estimates for servicification variables are somewhat contradictory to theoretical prediction. For share of services revenue, its coefficient is positive and significant indicating that revenues generated from services help firms to raise productivity. What is unexpected, however, is the negative but insignificant relationship between share of industrial services and productivity. However, one should note that the OLS-FE estimator encounters major econometric issues most notably the endogeneity problem which causes the results to be biased and inconsistent. We will address this particular issue in the GMM estimation. It is important to note that some firms in our database have failed to sustain and exit from the market. Precise statistics show that 16 percent of sample firms last just one year, and another 13 percent survive until their second year. The central questions to ask from this incidence are: to what extent does productivity vary among exit firms and non-exit firms? Do the results change if we estimate with firms that only stay longer than 2 years? To address the first question, we augment equation (9) by including the exit variable in the estimation. The variable takes value 1 if the firm lasts less than 3 years and 0 otherwise. We use OLS-FE to estimate the augmented specification and results are reported in column (2) of Table 6.4. Coefficient of exit is negative and statistically significant which can be interpreted that exit firms are about 5 percentage points less productive than non-exit firms. Next, to understand firm dynamics and productivity, we re-estimate equation (9) with restricted samples. We drop exit firms and keep only firms that stay longer than 2 years. The estimates are reported in Column (3) of Table 5.4. Overall, the sign and magnitude of all coefficients are comparable to the baseline estimates. Similar to the full sample, the OLS estimation indicates that the service input intensity has no effect on productivity whereas share of service revenue is crucial for firms to raise productivity.

Up to now we discussed empirical results from the OLS fixed effect estimator. As briefly mentioned earlier, this estimator suffers a number of econometric issues most notably with regards to endogeneity, which is often raised in empirical research on productivity including J. Arnold et al. (2006); Görg et al. (2008); Olsen (2006); and Amiti and Konings (2007). One possible source of the endogeneity is that one or more regressors are correlated with error terms. For example, higher productivity firms are more likely skill intensive and capital intensive. Skills and capital can also affect a firm's ability to offer services as a secondary revenue portfolio. If this problem persists, the OLS estimator generates biased and inconsistent estimates (Olsen, 2006; Wooldridge, 2016). To correct the endogeneity bias, we apply a lag estimator to estimate equation (6.9). Several empirical studies including Arnold et al. (2006); Crozet and Milet (2017) applied this method in their empirical analysis with the assumption that firm attributes in the previous year are unlikely to be correlated with the current-period error term. Results reported in Column (4) suggest somewhat different findings. The sign and magnitude of coefficients for foreign ownership, access to finance, and GVC participation remain positive and significant. Also remaining robust is the coefficient of service revenue which is strongly positive. What has changed is the estimate of export spillover which turns out to be negative but insignificant.

To deal with the endogeneity issue, we estimate equation (6.9) using the General Method of Movement (GMM) method. This approach has been popular in empirical research because it is much easier to get the instruments for endogenous variables just by internally transforming the data in which a variable's past value is subtracted from its present value and such process not only removes endogeneity but also gains more efficiency than simple IV estimator (Arellano & Bond, 1991; Roodman, 2009). In fact, IV estimator can deal with endogeneity problems quite efficiently. The most challenging issue, though, is that it is extremely difficult to find valid instruments for servicification variables used to correct endogeneity. Amiti and Wei (2009, p. 208) expressed strong preference in favor of GMM estimator with the clear argument that valid instruments for offshoring are unfortunately unavailable and thus we use lags as instruments to address potential endogeneity of offshoring. Also crucial is the fact that the GMM estimator is suitable for the dataset like ours that has a few time periods but many individual units and for dynamic panel data in which the relationship is linear with the left-hand variable depending on its own realizations (Roodman, 2009).

We start with estimation of equation (6.9) using the first difference GMM with lag value of productivity on the right-hand side because we believe productivity in the previous year determines the current productivity level. Such specification makes our model a dynamic panel. We treat lagged productivity, share of service inputs and share of service output as endogenous variables and use their lagged values as instruments. Other variables are regarded as strictly exogenous. Despite its

ability to address endogeneity concerns, first difference GMM might suffer from significant loss of observation due to missing value as well as from weak instruments (Arellano & Bond, 1991; Roodman, 2009). To avoid these problems, we follow Amiti and Wei (2009); Arellano and Bond (1991) and others to estimate equation (6.9) with a two-step GMM method known as system GMM. This estimator subtracts the average of all future available observations of a particular variable (Roodman, 2009). Such an estimation process provides more efficient and consistent results.

Columns (5) and (6) of Table 6.4 report the results of first difference GMM and system GMM estimation respectively. Before discussing results, let us closely look at two standard post-estimation tests that determine whether our econometric specification is appropriate under the GMM model. First, we check if there is serial autocorrelation among the residuals under the null hypothesis that the error terms of two different time periods are uncorrelated. This test is known as the Arellano-Bond test and it is argued that estimation suffers serial autocorrelation if *p-value* of AR (2) is smaller than 0.05 (Roodman, 2009). Second, we investigate if the lagged instruments are jointly valid. The estimate is said to satisfy this condition if *p*-value of Sargan/Hansen test is greater than 0.05. The results in column (5) and (6) suggest that both first difference GMM and system GMM estimations satisfy both autocorrelation and instrument validity tests and therefore we can argue that GMM estimators provide more efficient and consistent estimates. Since the sign and magnitude of all coefficients in the first difference GMM and system GMM estimators do not differ significantly and to avoid repetition, we only discuss the results of system GMM estimation but might occasionally compare with the first difference GMM results if needed.

The GMM results are generally stable and robust. Like in the previous estimations, coefficients for foreign ownership, access to finance and GVC participation are positive and significant. For foreign ownership, we can interpret that foreign-owned firms are approximately 75 percentage points more productive than domestically-owned. Also having a strong positive effect on productivity is the integration in value chains and production networks. The result suggests that GVC firms have productivity levels 15 percentage points higher than non-GVC firms. The finding supports the well-known self-selection hypothesis, which states that only more productive firms self-select to enter into export and value chain activities because they can offset significant sunk cost of exports and GVC. (Bernard et al., 2012; Melitz, 2008; Roberts & Tybout, 1997). Also positively associated with productivity is service output intensity in which it can be interpreted that service revenues raise productivity on average by 0.4 percent. As mentioned earlier, we include a one-year lagged value of productivity as a regressor and it is found that productivity in the previous year is strongly and positively correlated with the current-period productivity. This result proves that our model is dynamic.

In the GMM estimation that corrects for endogeneity, service inputs coefficient is positive and statistically significant. The results indicate that an average 10 percent increase in service input intensity would lead to about 7 to 8 percent rise in productivity level. The evidence is in conformity with theoretical prediction asserting that enabling services sourcing from external suppliers could divert internal resources to focus on core manufacturing activities and thus fuel greater efficiency and productivity (Kommerskollegium, 2016; Lodefalk, 2017; Nordås & Kim, 2013). The finding is also consistent with evidences from manufacturing firms in the US (Amiti & Wei, 2009), in Germany (Winkler, 2010); in UK (Girma & Görg, 2004); and broadly in East Asian and European countries (Kang et al., 2010; Schwörer, 2011). Unlike in the previous estimates, we also see the coefficient of export spillover turning to negative and significant, which implies that productivity level is significantly lower in firms within the high export intensity sector than firms within lower export intensity sector. The leakage of export concentration might reflect the fact that domestic industry is not yet strong enough to absorb the spillover effect.

The estimations in Table 6.4 assumes that the effect of servicification to be the same across various types of firms. This assumption overlooks the widely recognized fact in firm heterogeneity literature that firms are vastly different especially in aspects of international engagement in the form of global value chains. More specifically, GVC firms are actively outsourcing intermediate goods and services while in the meantime supplying goods and services to other firms along the production networks. This implies GVC firms are more servicified especially in terms of service input than non-GVC firms and such a distinction might affect firms' productivity gains from servicification differently. In order to verify if productivity effect varies across GVC and non-GVC firms, we generate interactive term of two servicfication variables with dummy variable for GVC participation.

As shown in Table 6.5, coefficient of interactive term between service input and GVC participation is positive and significant indicating that productivity effect of service input intensity is greater among GVC firms. The finding provides evidence similar to Görg et al. (2008) which argued that exporters have greater productivity gains from service outsourcing. However, the productivity effect of service income intensity is indifferent as indicated by statistically insignificant coefficient of interactive term.

Table 6.5: Estimation results with interactive terms (GVC firms)

Total factor productivity	Sys GMM
Foreign ownership	0.735***
	(0.139)
Access to finance	0.127***
	(0.0247)
Export spillover	-0.301*
	(0.188)
GVC participation	0.153**
	(0.0671)
Share of service inputs to total expenses	0.618**
	(0.277)
Share of service income to total revenues	0.586**
	(0.229)
Share of service inputs* GVC firm	1.876*
	(1.145)
Share of service income* GVC firm	-0.474
	(0.654)
Lag total factor productivity	0.215
	(0.140)
Observations	86,263
Year-FE	Yes
Sector-FE	Yes
AR (2)	0.954
Hansen test	0.066

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

6.4.2. Robustness check

To demonstrate the robustness of our results, we offer additional specifications that contain alternative measures of total factor productivity and then swift to alternative proxies of servicification. Providing that the system GMM estimator generates a comparatively consistent estimator, we use this particular approach to estimate the mentioned alternative specifications.

Alternative measures of productivity

We introduce three different productivity measures which are widely used in empirical studies. First, we follow a number of seminar works including Amiti and Konings (2007); Amiti and Wei (2009); and Görg et al. (2008) by using log of real value added per worker as proxy for labour productivity. For specification with labour productivity, we include skill intensity proxied by ratio of non-production workers to total workers and capital intensity measured by log of real value of capital stock. Second,

we use the total factor productivity derived from production function estimates using the LP method with material as proxy to control unobserved productivity. Elasticities of inputs to value added are presented in Table 6.1 in the earlier section. Third, we derive separate productivity from production function with an alternative estimator. Wooldridge (2009) proves that the GMM framework can solve the complicated two-step nature of the LP estimation method by specifying different instruments for different equations and yield consistent estimates. Column (1) of Table 6.6 presents estimates for specification using labour productivity while Column (2) and (3) report the results of estimates with alternative productivity measures from LP and GMM estimator, respectively.

Table 6.6: Estimation results for alternative measures of productivity

Total factor productivity	(1) Labour productivity	(2) TFP-LP with material as proxy	(3) TFP with GMM estimator
Foreign ownership	0.0896	0.901***	0.718***
	(0.0651)	(0.171)	(0.144)
Access to finance	0.0399***	0.165***	0.121***
	(0.00786)	(0.0317)	(0.0251)
Export spillover	-0.0680	-0.369*	-0.306
	(0.207)	(0.201)	(0.190)
GVC participation	0.325***	0.245***	0.131**
	(0.113)	(0.0709)	(0.0543)
Share of service inputs to total expenses	0.468*	0.814***	0.761***
	(0.260)	(0.285)	(0.268)
Share of service income to total revenues	1.405***	0.390*	0.447*
	(0.185)	(0.234)	(0.232)
Lag total factor productivity	0.642***	.1215	0.204
	(0.105)	(0.158)	(0.151)
Skill intensity	0.233***		
	(0.0783)		
Capital intensity	0.0718***		
	(0.0203)		
Constant	1.247***	3.695***	3.107***
	(0.116)	(0.537)	(0.451)
Observations	137,304	86,263	86,263
Year-FE	Yes	Yes	Yes
Sector-FE	Yes	Yes	Yes
AR(2) (*p-value*)	0.01	0.579	0.975
Hansen test (*p-value*)	0.128	0.162	0.111

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Note: All alternative specifications are estimated using system GMM method.

It is important to note that all specifications fulfil the required conditions of no serial correlation and valid instruments as proved by *p-value* of the Arellano-Bond test and Hansen test greater than 0.05. Passing these tests are necessary conditions to adopt for GMM estimation. Second, results are generally robust and consistent regardless of the different measures adopted in the estimation. Foreign ownership, access to finance and GVC participation are positively associated with productivity. Most importantly, coefficients of both servicification variables are strongly positive as in the previous specifications. Results in column (2) and (3) imply that a percentage point rise in service input intensity leads to approximately 0.8 percent improvement in productivity. The contribution of service revenues to productivity varies slightly from one specification to another. For example, one percentage increase in service revenue ratio raises labour productivity level by around 0.39 percent in specification (2) and by 0.45 percent in specification (3). The estimate for export spillover differs notably across different productivity measures. Once we proxy productivity by log of value added per worker, the coefficient of export spillover is negative but insignificant. However, once productivity is measured by total factor productivity derived from production function estimation using LP method, the relationship between export spillover and productivity is opposite, implying the leakage of export spillover on a firm's productivity improvement. Lastly, it is important to note from column (1) that skills and capital intensity are crucial for labour productivity. Specifically, a percentage point increase in the share of skilled workers leads to 0.23 percentage rise in productivity level.

Alternative measures of servicification

To further demonstrate the robustness of our estimates, we present another specification using alternative measures of servicification. Instead of measuring servicification in terms of intensity, we use dummy variable to capture productivity differences between servicified firms and non-servicified firms. Servicified firms are classified into two categories. The first group refers to firms that purchase service inputs from suppliers and we denote binary variable taking value 1 if the share of service input is greater than the median value and 0 otherwise. The second servicified firms are defined as those whose share of service revenues to output greater than median value. For productivity, we maintain the baseline measure which is derived from the production function estimate with the LP method. The results shown in Table 6.7 are estimated using the system GMM approach.

The *p-value* of Arellano-Bond test suggests that this specification does not suffer serial correlation. For the Hansen test, it appears that the instruments are comparatively weak. Nevertheless, at 10 percent significance level, the instruments adopted in the estimation are valid. Overall, the results are robust and highly consistent with previous estimations. Ownership structure, access to finance and integration into value chains activities remain crucial for firms to increase productivity level. Crucial to

our robustness check is that servicified firms have productivity levels approximately 34 percentage points higher than non-servicified counterparts. This evidence points out the importance of servicification either in terms of purchasing service or selling services in helping firms to raise productivity level. After introducing various models with alternative specifications, we are confident to confirm that our results so far are robust and highly consistent with theoretical prediction and existing literature.

Table 6.7: Estimation results for alternative measures of servicification

Total factor productivity	Sys GMM
Foreign ownership	0.695***
	(0.0597)
Access to finance	0.112***
	(0.0140)
Export spillover	-0.216
	(0.179)
GVC participation	0.129***
	(0.0311)
Service inputs dummy (1= firms purchasing service inputs)	0.369***
	(0.0788)
Service income dummy (1= firms selling services)	0.373***
	(0.112)
Lag total factor productivity	0.199***
	(0.0670)
Constant	3.107***
	(0.451)
Observations	86,263
Year-FE	Yes
Sector-FE	Yes
AR (2)	0.884
Hansen test	0.016

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

6.5. Policy conclusion

This chapter examines the effect of servicification on productivity using unbalanced panel firm-level data from Indonesian manufacturing industries. Empirical strategy involves two procedures: (1) estimating productivity from the Cobb-Douglas production function using semi-parametric method developed by Levinsohn and Petrin (2003); and (2) regressing the derived productivity with servicification and other firm characteristics variables. Servicification is measured by two variables namely share of industrial service cost to total input and share of service revenues to total output. We

apply GMM technique to account for potential endogeneity of servicification in the productivity estimation. To further demonstrate the robustness of results, we introduce various alternative measures of productivity and servicification. Our results are robust across various econometric specifications that servification is positively related to productivity. More precisely, 10 percentage point increase in service input intensity leads to 7-8 percent rise in productivity and 10 percent growth in service revenue results in 4-5 percent increase in productivity.

We also classified firms either using service inputs or generating revenue from services as servicified firm, the result also shows robust evidence of a positive relationship between servicification and productivity. In other words, servicified firms are more productive than non-servicified firms. The findings highlight the significant contribution of services both in aspects of inputs and outputs in helping firms raise productivity. We also find evidence suggesting the importance of firm heterogeneity in boosting productivity. Factors such as foreign ownership, access to finance, and participation in global value chains are positively associated with productivity. Overall, the findings of this research imply productivity gains from servicification and such linkage partly explain the recent global trend of more and more manufacturing firms becoming more service intensive.

Human capital development and GVC participation are critical for the development of productivity of the manufacturing activities in Indonesia. There is a strong need to develop higher technical skills of workers and also to increase the educational level of workers beyond the secondary school level to upper secondary school level with a strong emphasis on technical education. We also observed that GVC participation tends to increase the productivity of manufacturing firms in Indonesia. This has important policy implications. The government should introduce more trade and investment facilitation measures to encourage more domestic firms to participate in the GVC activities in Indonesia.

Chapter 7

Conclusion

7.1. Concluding remarks

This thesis brings together three conceptual and empirical frameworks that are commonly used in empirical trade and GVC literature to quantify the effect of human capital on GVC participation for Asia and ASEAN economies. The first approach is a gravity model using country-level data to analyse the impact of human capital on GVC participation in terms of the level and quality of education, skill and structural factors of host countries increasing the competitiveness of domestic economy in the regional and global production value-chain of East Asian countries. We further analyse the disaggregated impact of human capital on forward and backward GVC participation. Our empirical results show that countries that have higher education and skills are more likely to engage in forward GVC activities through supply of domestically produced intermediate inputs to other countries' production within the value chain networks. For backward GVC participation, skills are much more important than education level as evident in a significant and positive relationship between availability of medium and high skills and backward GVC participation. This evidence reflects the importance of education and skilled intensity of labour factor in creating the skill complementarity in vertically integrated production networks in East and Southeast Asia. We also find evidence that trade policies in form of tariff, free trade agreements and trade facilitation, proximity to GVC hubs and quality of transport and logistics system are crucial in determining a country's GVC trajectory. Specifically, countries with more efficient and extensive logistic and infrastructure systems and more open to international trade are more likely to successfully integrate in GVC. In contrast, behind border issues tend to increase the cost of trade and exchange due to lake of investment and trade facilitation which hinders countries from actively participating in GVC activities. Evidences from cross countries analysis in East and Southeast Asia are consistent with the literature and support the new GVC development paradigm that stresses greater emphasis on improving connectivity through reducing trade barrier, streamlining custom

procedure and improving transports, logistics and investment climate, and on investing in education and skills of workforce in order to be part of global value chains.

The first approach, which is known as macro analysis, takes the country as the primary unit of analysis and operates under the assumption that firms are homogeneous within a specific economy. Its advantage is that it can explain the relationship between country-level trade policy and other fundamental factors such as education and skill, business environment and logistics system and GVC integration. The limitation, though, is that it fails to account for heterogeneity among firms most notably in terms of input factors, productivity, technological capacity, capital and skills intensity. Given firms are important agents in international trade and global production networks, it is extremely useful to understand the relationship between human capital and the export performance and GVC activities of firms. We also undertook the firm-level analysis to complement macro analysis on the determinants of GVC participation. Chapters 4 and 5 in this thesis adopted the firm-level analysis based on firm heterogeneity theory by taking firm as the central unit of analysis and incorporating firm attributes such as size, ownership structure, capital, skills, technological capacity and productivity to explain how these heterogeneities influence firm performances and strategies in international trade. Source of data is the World Bank's Enterprise Survey in selected ASEAN countries namely Indonesia, the Philippines, Cambodia and Myanmar. The results suggest that only a very small proportion of firms in ASEAN are able to participate in the regional and global production value-chain activities and these enterprises are generally bigger in size, more capital intensive and foreign-owned. We also found evidence that linkage with value chain activities requires enterprises to have a higher level of skilled workforce, higher productivity and greater technological capacity. The results also indicate the importance of conducive business climate that not only enhance and facilitate the cross-border movement of goods and substantially reduces trade transaction cost are important for successful GVC integration. Overall, the level of human capital, production capabilities and foreign networks together with conducive macroeconomic environment are critically important for firms to integrate in value chain activities.

For the analysis on GVC and SMEs, we found that integrating into GVC proves extremely difficult as it requires them to have superior capability and resources. In particular, the size of an enterprise matters as it gains from economies of scale and helps offset the cost of entry into production networks. We also find evidence that linkage with value chain activities requires SMEs to have a higher level of human capital, better foreign networks (i.e. in terms of foreign ownership and location to an export hub) and superior production capacity and investment in research and development.

Amidst the rise of GVC, servicification has emerged as a popular corporate strategy among high-performing firms. Growing manufacturing firms use more service inputs such as financial and business services, ICT, logistics, wholesale and retails services in their production process. There are also

increasing number of enterprises integrate services into their core products in order to enhance the competitive edge of business. Since servicifiation can help firms participate in GVC and improve productivity and efficiencies, this dissertation extends analysis from the determinants of GVC to servicification, GVC and productivity. Specifically, Chapter 6 maps the extent of servicification of the Indonesian economy and empirically assesses its effect on firm productivity. Unlike several studies which measured servicification from the service supply side, our study captures both supply side (service input intensity) and demand side of services (share of service revenue to output). Empirical result illustrates the positive and significant contribution of servicification both in aspects of inputs and outputs in helping firms raise productivity. We also found other firm attributes such as foreign ownership, access to finance, and participation in global value chains are positively associated with productivity level. Overall, our finding implies productivity gains from servicification and such casual relations partly explain the recent global trend of more and more manufacturing firms becoming more service intensive.

7.2. Policy implications

The following might be important policy considerations for developing right fundamental conditions and policy conduciveness for attracting GVC:

1) Reducing trade and investment barriers

Results from our study indicates that a protective tariff regime constrain countries from greater global production value-chain activities. Tariffs applied by host countries hinder its ability to gain wider and cheaper access to foreign intermediate inputs whereas tariffs imposed by partner countries reduce host country's supply and export of intermediate inputs. Thus, the unilateral tariff liberalization is necessary but not sufficient because it can only enhance backward GVC activities through greater use of foreign inputs. Since a country's ability to join GVC depends on its capacity to export domestic production to the world, it is also crucial for trade partner countries to lower tariffs. Reduction of tariff can be achieved via a number of platforms.

- First, a country should consider adopting a more comprehensive FTA strategy that targets the reduction of supply chain barriers to trade. Besides eliminating tariff which in return offer member countries greater access to regional markets and regional supplies of intermediate goods, FTAs need to address other broad issues including, *inter alia*, non-tariff barriers, behind-the-border issues, freer flow of services and investment, trade facilitation and standard recognition with a view to facilitate smoother movements of intermediate and final goods within the regional supply chains.

- Second, multilateral trading system remains a relevant and crucial platform for all countries to bring forward a deeper trade liberalization agenda for GVC.

Results from micro study suggest the importance of foreign ownership and networks in helping firms to join GVC. Because multinational corporations (MNCs) are key actors in the production networks and their presences can support and facilitate domestic firms including small and medium-sized enterprises (SMEs) to indirectly connect with GVC via outsourcing intermediate inputs and services from domestic suppliers, attracting MNCs is probably the effective way for host country to integrate in GVC. Key to attracting FDI is an investment regime that eases restriction on foreign ownership and on local content; facilitates investment process and movement of foreign personnel; and enhances investor protection. Creating a conducive investment and business climate is also vital in attracting foreign investment. Among key policy measures taken to improve investment climate are:

- Maintaining political and macroeconomic stability and improving efficiency of public services;
- Enhancing investment confidence through strengthening commercial law regime, improving the effectiveness of law enforcement, and protecting intellectual property rights;
- Strengthening business facilitation and support;
- Improving the efficiency of labour market efficiency through flexible labour market regulations and provision of quality workforce needed by private sector;
- Building entrepreneurial capacity to enable firms to deal better with large enterprises and foreign investors;
- Well-functioning and efficient special economic zones (SEZs) are also a means to attract MNCs.

2) Improve connectivity with international markets

Evidence from our cross-country analysis in East and Southeast Asia reflects the importance of connectivity in coordinating production stages and moving components efficiently across borders. The finding indicates the necessity to develop intensive and efficient infrastructure and logistics systems along trade-related infrastructure to facilitate value-added trade. Improving connectivity involves building hard infrastructure that connects different places within the country and with the rest of the world, and soft infrastructure for efficient border operations (i.e. fast and efficient port and custom procedures). Policy priorities to develop efficient and intensive transport infrastructure should focus on a number of key areas as follows:

- Improving road networks to ensure better connection between urban and rural areas along with upgrading of national highways, construction of expressways;
- Further development of water transport and linkages such as river and sea port facilities;
- Creation of logistics corridors;
- In the age of digital and internet of things, it is also important to develop information, communication and telecommunication (ITC) to efficiently facilitate coordination and transaction with key value chain actors;
- As well as hard infrastructure, essential logistic services including cargo handling, storage and warehousing should be promoted.

Alongside hard infrastructure, integration into global production networks requires smooth and efficient trade facilitation, which can be achieved through:

- Streamlining custom procedures;
- Eliminating informal payment and corruption;
- Sharing information more widely through trade information centres; and
- Strengthening the implementation of the cross-border transport facilitation agreement and Single Window mechanism.

3) Investing in education and skills

The results of the study indicate that accumulation of human capital in terms of education and skilled workforce are critical to secure export competitiveness and attract GVC. These are important productive factors that can foster productivity, industrial transformation and economic growth. The successful integration into global production networks of several East and Southeast Asian economies can be attributed to strong investment in human capital. The following might be important policy considerations for developing human capital for GVC integration:

- Creating a conducive ecosystem for human capital and skills development through coherent and cohesive education vision, aligning education policies with GVC and industrial development strategy, and establishing regular and genuine collaboration among government ministries, training institutions and industry.
- Developing high-quality basic education. Apart from building the quality of general education which is a prerequisite condition for human capital development, the government might consider aggressively expanding technical and vocational training programs to sharpen skills of the workforce that are of great use in the value chain production. It is also crucial for

educational institutions to ensure that training curricula and standards are in line with industrial skill needs.

- Our finding also suggests the importance of in-house formal training. The government should set up the 'training funds' that domestic firms including SMEs could use to develop the skills of their workers. These funds could also be used to develop the skills and training of middle management, which is critical to absorb and implement best practices in human resource and international standards and practices. A large-scale expansion of technical training services provided by the government's Productivity Centres could be another policy option for the government to enhance human resource quality.
- We also found evidence that having connections with MNCs facilitate domestic firms especially SMEs to integrate in value chain activities. It is, therefore, important for the government to consider MNC-SME Mentorship schemes where the network could be created between MNCs and SMEs for closer discussions and sharing of knowledge. In some cases, MNCs could be encouraged to mentor SMEs on best practices in human resource, marketing and also networking that will create strong linkages between MNCs and SMEs.

Successful human capital development requires active participation and collaboration between the government and the private sector. Key roles of the government include working with stakeholders such as the private sector, industry associations and educational institutions (public-private partnerships); providing financial support for education and training through such programs as tax incentives and scholarship programs; and regulating training quality through flexible scope accreditation. For firms, they should partner with education institutions to customise training and modify curricula for students, trainees and apprentices, and provide internships. Equally important is the provision of ongoing in-house formal training to improve workers' skills.

4) Key success factors for participating in GVC

The policy suggestions discussed above are broadly consistent with a new development paradigm that advocates for liberal trade and investment regimes, enhanced connectivity with global markets, investing in education and skills of the workforce in order to thrive and seize benefits from global value chains. Successful participation in GVC requires strong policy coherence, effective public and private institutions, and an unprecedented level of coordination and cooperation among ministries and between governments, private sector and education institutions. Also crucial are political and economic stability, a robust commercial regime, favourable business climate, and ecosystems conducive to human capital and technological development.

Appendix

Figure A.3.1: Destinations of value-added trade (Forward GVC) by country in 2015

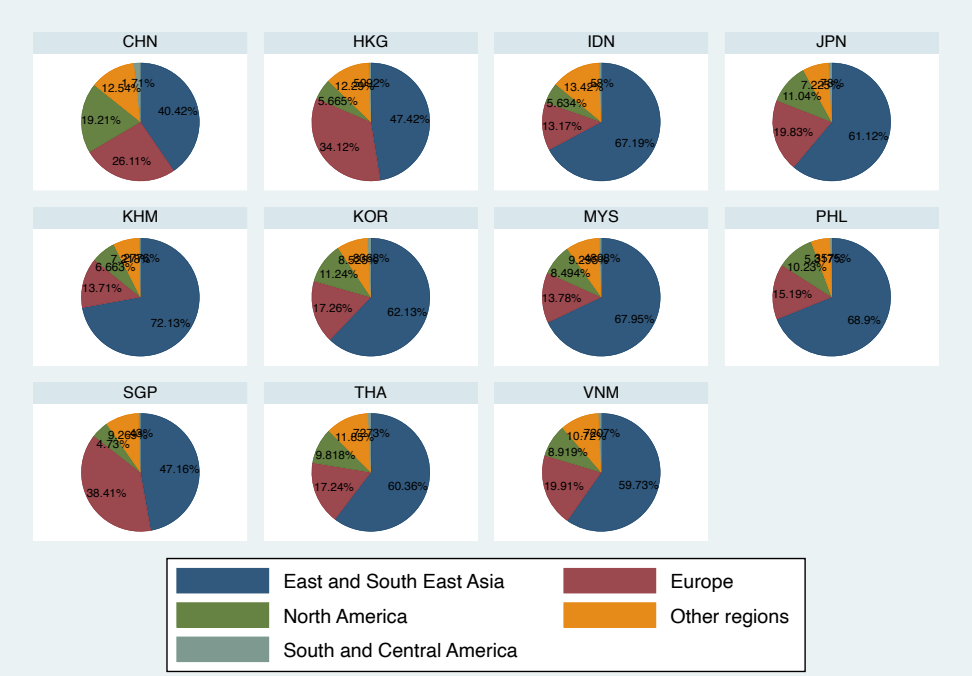


Figure A.3.2: Source of value-added trade (Backward GVC) by country in 2015

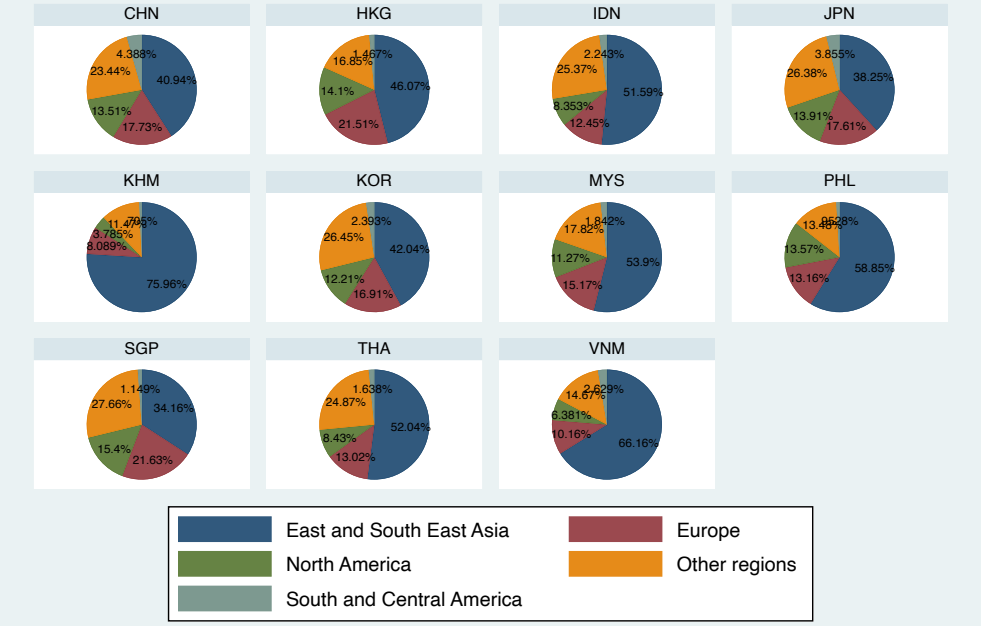


Table A.3.1: Estimation results for forward GVC participation by sub-region

VARIABLES	(1) ASEAN	(2) ASEAN	(3) CJKH	(4) CJKH
Gross output of exporter	1.298***	0.863***	1.097***	0.685***
	(0.0725)	(0.0165)	(0.127)	(0.0249)
Gross output of importer	0.638***	0.586***	0.654***	0.669***
	(0.0171)	(0.00789)	(0.0451)	(0.0149)
Distance	-0.837***	-0.693***	-0.515***	-0.363***
	(0.0105)	(0.0128)	(0.0461)	(0.0146)
Contiguity	0.327***	0.620***	-0.0597	-0.113
	(0.0544)	(0.0583)	(0.239)	(0.0783)
Free Trade Agreement (FTA)	-0.0473	0.0271	0.320**	0.217***
	(0.0585)	(0.0457)	(0.159)	(0.0638)
Mean year of schooling	-0.257**		-1.645***	
	(0.110)		(0.510)	
Education quality	0.957***		-2.551***	
	(0.351)		(0.935)	
Medium skilled in labor force (%)		0.0209***		-0.0854***
		(0.00488)		(0.00796)
High skilled in labor force (%)		0.0268***		-0.0843***
		(0.00207)		(0.00698)
Tariff	Tariff	-0.268***	-0.247***	-0.0283
	(0.0357)	(0.0302)	(0.0744)	(0.0215)
Income gap	-0.113***	-0.0556***	-0.141***	-0.109***
	(0.0354)	(0.0202)	(0.0459)	(0.0297)
Quality of infrastructure	3.152***	1.958***	-1.289**	-1.081***
	(0.312)	(0.331)	(0.531)	(0.361)
Trade facilitation	0.123	-0.0314	-1.145***	0.0342
	(0.155)	(0.0779)	(0.415)	(0.0824)
Observations	522	1,553	473	1,047
Exporter-time FE	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Note: ASEAN= Association of Southeast Asian Nations
CJKH= China, Japan, Korea and Hong Kong.

Table A.3.2: Estimation results for forward GVC participation with interactive terms

VARIABLES	(1) Education Gap	(2) Education Gap	(3) Interactive terms	(4) Interactive terms
Gross output of exporter	0.824***	0.708***	0.815***	0.838***
	(0.0135)	(0.0285)	(0.0125)	(0.0128)
Gross output of importer	0.616***	0.610***	0.614***	0.616***
	(0.00734)	(0.00914)	(0.00789)	(0.00775)
Distance	-0.538***	-0.482***	-0.519***	-0.525***
	(0.0124)	(0.0172)	(0.00874)	(0.00769)
Contiguity	0.203***	0.146**	0.217***	0.214***
	(0.0452)	(0.0600)	(0.0507)	(0.0491)
Common language	0.386***	0.563***	0.428***	0.383***
	(0.0354)	(0.0465)	(0.0227)	(0.0275)
Free Trade Agreement (FTA)	0.450***	0.316***	-0.0869	0.452***
	(0.0376)	(0.0557)	(0.148)	(0.0377)
Education quality	0.658***			0.470
	(0.150)			(0.380)
Tariff	-0.142***	-0.0843***	-0.140***	-0.145***
	(0.0258)	(0.0209)	(0.0258)	(0.0271)
Educational gap	0.0494***	0.0464***		
	(0.0151)	(0.0153)		
Income gap	-0.0613***	-0.0647***	-0.0509***	-0.0490***
	(0.0134)	(0.0180)	(0.0157)	(0.0155)
Quality of infrastructure	-0.0278		0.140	-0.335
	(0.127)		(0.114)	(0.261)
Trade facilitation	-0.115**	0.0398	-0.271***	-0.279***
	(0.0560)	(0.120)	(0.0656)	(0.0846)
Medium skilled in labor force (%)		-0.0502***		
		(0.00371)		
High skilled in labor force (%)		-0.0470***		
		(0.00467)		
Mean year of schooling			-0.594***	-0.567***
			(0.0762)	(0.121)
FTA*Quality of education			0.379***	
			(0.0854)	
Infrastructure* Quality of education				0.157*
				(0.226)
Observations	4,647	2,314	4,696	4,696
Exporter-time FE	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

**** p<0.01, ** p<0.05, * p<0.1*

Table A.3.3: Estimation results for backward GVC participation by sub-region

VARIABLES	(1) ASEAN	(2) ASEAN	(3) CJKH	(4) CJKH
Gross output of exporter	2.458***	0.828***	2.272***	0.383***
	(0.0322)	(0.100)	(0.392)	(0.135)
Gross output of importer	0.744***	0.763***	0.779***	0.781***
	(0.00163)	(0.00556)	(0.0140)	(0.00778)
Distance	-0.302***	-0.384***	-0.536***	-0.573***
	(0.0133)	(0.0399)	(0.0384)	(0.0329)
Contiguity	0.465***	0.578***	-0.283*	-0.326***
	(0.0215)	(0.0413)	(0.156)	(0.0304)
Free Trade Agreement (FTA)	0.799***	0.629***	0.229***	0.229***
	(0.0656)	(0.0957)	(0.000129)	(0.0510)
Mean year of schooling	-3.844		-2.996***	
	(0)		(0.965)	
Education quality	5.316***		-9.054***	
	(0.111)		(1.717)	
Tariff	-1.108***	-0.582***	-0.427*	0.384**
	(0.0263)	(0.169)	(0.235)	(0.193)
Income gap	0.0177	0.0130	-0.0127	-0.0581**
	(0.0202)	(0.0140)	(0.00850)	(0.0280)
Quality of infrastructure	-10.23***	3.649***	-4.034***	2.082
	(0.0815)	(0.704)	(1.345)	(2.114)
Trade facilitation	-0.991***	0.118	-4.490***	-0.352
	(0.0254)	(0.277)	(0.520)	(0.288)
Medium skilled in labor force (%)		-0.0365		-0.0488
		(0.0373)		(0.0377)
High skilled in labor force (%)		-0.0694**		-0.0820***
		(0.0343)		(0.0309)
Observations	354	1,475	531	1,180
Exporter-time FE	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: ASEAN= Association of Southeast Asian Nations
CJKH= China, Japan, Korea and Hong Kong.

Table A.3.4: Estimation results for backward GVC participation with interactive terms

VARIABLES	(2) Education Gap	(3) Education Gap	(4) Interactive terms	(5) Interactive terms
Gross output of exporter	0.685***	0.537***	0.719***	0.722***
	(0.0124)	(0.0466)	(0.0149)	(0.0164)
Gross output of importer	0.770***	0.790***	0.777***	0.780***
	(0.00471)	(0.00589)	(0.00436)	(0.00474)
Distance	-0.577***	-0.558***	-0.579***	-0.580***
	(0.0207)	(0.0313)	(0.0196)	(0.0188)
Contiguity	-0.157***	-0.187***	-0.0903***	-0.0955***
	(0.0222)	(0.0219)	(0.0171)	(0.0143)
Common language	0.0172	-0.00972	0.0548*	0.0491*
	(0.0271)	(0.0462)	(0.0306)	(0.0280)
Mean year of schooling			-2.022***	-1.743***
			(0.191)	(0.253)
Education quality	-0.0390		0.478***	-4.170***
	(0.289)		(0.180)	(1.376)
Medium skilled in labor force (%)		-0.0780***		
		(0.00925)		
High skilled in labor force (%)		-0.0867***		
		(0.0142)		
Tariff	0.0843***	0.0363	0.295***	0.349***
	(0.0293)	(0.0572)	(0.0185)	(0.0163)
Income gap	-0.0407**	-0.0377	-0.0202	-0.0193
	(0.0165)	(0.0304)	(0.0127)	(0.0134)
log of score of quality of infrastructure	0.836***		0.683***	-3.408***
	(0.142)		(0.110)	(1.244)
Quality of infrastructure	-0.317***	-0.342*	-1.022***	-0.869***
	(0.0583)	(0.202)	(0.0978)	(0.113)
Trade facilitation				
Free Trade Agreement (FTA)	0.416***	0.442***		0.367***
	(0.0274)	(0.0398)		(0.0254)
log of education gap	0.0495***	0.0171		
	(0.0101)	(0.0144)		
FTA*Quality of education			0.245***	
			(0.0164)	
Infrastructure* Quality of education				3.001***
				(0.852)
Observations	5,249	2,623	5,310	5,310
Exporter-time FE	Yes	Yes	Yes	Yes
Importer-time FE	Yes	Yes	Yes	Yes

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

Table A.4.1: Correlation matrix among independent variables in equation 4.1

	ln_size	ln_age	for_own	training	skill	ln_capital	ln_prod	tech_cap
ln_size	1							
ln_age	0.1878	1						
for_own	0.327	-0.0287	1					
training	0.3519	0.082	0.228	1				
skill	0.0612	-0.0175	0.0609	-0.0245	1			
ln_capital	0.1562	-0.0902	0.1286	0.1412	-0.0309	1		
ln_prod	0.2893	0.1116	0.252	0.2614	-0.0556	0.1422	1	
tech_cap	0.6228	0.1472	0.3461	0.4412	-0.033	0.136	0.4638	1

Table A.5.1: Correlation matrix among independent variables in equation 5.1

	ln_size	sizesqr	ln_age	for_own	fin_acc	training	ln_skill	ln_prod	ln_cap	ln_exp~I
ln_size	1									
sizesqr	0.7409	1								
ln_age	0.0783	0.0569	1							
for_own	0.2331	0.1841	-0.0431	1						
fin_acc	0.0783	0.0609	-0.0378	0.0418	1					
training	0.2755	0.1993	-0.0007	0.142	0.053	1				
Ln_skill	-0.1088	-0.0637	0.0456	-0.0919	-0.0633	-0.0709	1			
ln_prod	0.1578	0.0794	0.0778	0.1736	0.2702	0.1551	-0.451	1		
ln_cap	-0.0624	-0.0659	0.0737	0.0059	0.0474	0.0908	0.0298	0.1674	1	
ln_exp_RD	0.1298	0.1011	0.1528	0.0859	-0.188	0.051	-0.0664	-0.0537	-0.0019	
export_region	-0.0038	-0.0125	0.0275	0.007	-0.0314	0.1049	-0.0087	-0.006	0.0428	0.001

Table A.5.2: Estimation Results for SMEs' Decision to Participate in GVC by industry

	(1) Food, Beverage and Tobacco	(2) Garment, Apparels and Textile	(3) Electronics, Machinery and Transportation	(4) Other manufacturin sectors
Firm size	0.801***	0.556***	0.491***	0.462***
	(0.172)	(0.0997)	(0.0455)	(0.0710)
Firm size squared	-0.00000657	0.000000324	0.000000414	0.000000150
	(0.00000367)	(0.00000157)	(0.000000653)	(0.00000134)
Age	0.114	-0.0501	-0.0888***	0.0258
	(0.0903)	(0.0683)	(0.0262)	(0.0462)
Foreign ownership	0.583*	0.891***	0.972***	1.141***
	(0.252)	(0.176)	(0.0650)	(0.0955)
Access to finance	0.0560	0.313*	0.179***	-0.0672
	(0.249)	(0.142)	(0.0528)	(0.117)
Formal training	0.292	0.263*	0.320***	0.147
	(0.165)	(0.112)	(0.0505)	(0.0783)
Skill intensity	0.253*	-0.000241	0.111**	0.106*
	(0.114)	(0.0674)	(0.0358)	(0.0458)
Labor productivity	0.544***	0.218**	0.286***	0.324***
	(0.122)	(0.0752)	(0.0349)	(0.0483)
Capital intensity	0.0128	0.0143	0.0111*	0.0136*
	(0.0141)	(0.00948)	(0.00490)	(0.00586)
R & D	-0.0752	0.0468	0.0265	0.0371
	(0.127)	(0.145)	(0.0295)	(0.0625)
Export spill-over	-0.257	-0.0722	-0.00351	0.542
	(0.268)	(0.0381)	(0.125)	(1.003)
Year FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes
Observation	5576	3715	15422	6095

Standard errors in parentheses.

** p<0.05; ** p<0.01; *** p<0.001.*

Source: Author's calculation based on the IAMS in 1996 and 2006.

Table A.5.3: Estimation Results for Firm's Decision to Participate in GVC by size

	(1) Small Firms	(2) Medium-sized Firms	(3) Large Firms
Firm size	0.0128***	0.0315***	0.0193
	(0.00139)	(0.00635)	(0.0315)
Firm size squared	0.000000381***	0.000000688***	0.000000739*
	(5.97e-08)	(8.82e-08)	(0.000000293)
Age	-0.00269***	-0.0101**	-0.0288*
	(0.000651)	(0.00339)	(0.0123)
Foreign ownership	0.180***	0.244***	0.197***
	(0.00576)	(0.00923)	(0.0233)
Access to finance	0.00903***	0.0232**	0.0463
	(0.00173)	(0.00761)	(0.0292)
Formal training	0.0108***	0.0239***	0.0236
	(0.00149)	(0.00611)	(0.0250)
Skill intensity	0.000422	0.0214***	0.0688***
	(0.000731)	(0.00465)	(0.0154)
Labor productivity	0.00347***	0.0452***	0.0764***
	(0.000769)	(0.00533)	(0.0198)
Capital intensity	0.0000894	0.00238***	0.00315*
	(0.000127)	(0.000486)	(0.00157)
R & D	-0.000804	0.00903*	0.0195*
	(0.00174)	(0.00425)	(0.00918)
Export spill-over	-0.000282	0.000402	0.0182
	(0.00122)	(0.00411)	(0.0263)
Year FE	Yes	Yes	Yes
Region FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Observation	28512	9595	1373

Standard errors in parentheses.

** p<0.05; ** p<0.01; *** p<0.001.*

Source: Author's calculation based on the IAMS in 1996 and 2006.

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