FIRMS IN GLOBAL VALUE CHAINS

An Analysis of the Determinants and Effects of the Changing Location of International Production

Trudy-Ann Stone

Blekinge Institute of Technology
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Department of Industrial Economics

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Contents

I Introduction and Summary **1**

1 Introduction and Summary **2**
1 Introduction . . . 2
2 Global Value Chains . . . 6
3 How much do we know about global value chains? . . . 11
4 Explaining the rise of global value chains . . . 21
4.1 Three stories . . . 23
5 Firms in the Global Value Chain . . . 29
5.1 Global value chains and firm location choice . . . 29
5.2 Global value chains and the organization of firms . . . 35
5.3 Global value chains and firm performance . . . 39
6 Summary of Papers 1-4 . . . 41
6.1 Paper 1 . . . 41
6.2 Paper 2 . . . 43
6.3 Paper 3 . . . 44
6.4 Paper 4 . . . 44
7 Suggestions for future research . . . 45

II Papers 1 – 4 **59**

1 International Outsourcing and Global Value Chains: Evidence from Sweden **60**
1 Introduction . . . 61
2 Measuring International Outsourcing . . . 63
2.1 Implementation . . . 65
3 Data . . . 68
4 The Position of Swedish Industries in the Global Value Chain . . . 69
5 Value chain Position and Participation . . . 71
6 Firm-level Evidence . . . 74
7 Value Chain Position and Trade Costs . . . 82
8 Summary and Conclusions . . . 84

2 Global Sourcing and Technical Efficiency: a firm-level study on the ICT industry in Sweden **91**
1 Introduction . . . 92
2 International trade and the performance of firms . . . 95
3 Data and Descriptives . . . 99
3.1 Data and Variables . . . 99
3.2 Imports of intermediate inputs of ICT manufacturing firms in Sweden . . . 102
4 Empirical Strategy and Estimation . . . 103
4.1 Estimating Technical Efficiency . . . 103
5 Results . . . 110
6 Summary and Conclusions . . . 115

Appendices **121**

3 Do Global Value Chains Make Firms More Vulnerable To Trade Shocks? Evidence from Manufacturing Firms in Sweden **127**
1 Introduction . . . 128
2 Data and Empirical Approach . . . 131
2.1 Empirical approach . . . 131
2.2 Data Description . . . 133
3 Results . . . 136
3.1 Industry exposure to trade and firm performance . . . 139
4 Conclusions . . . 142

4 Institutional Quality, Knowledge Intensity and Multinational Location Choice: Evidence from Developing Countries **148**
1 Introduction . . . 149
2 Multinational Location Choice . . . 152
3 Empirical Specification . . . 154
3.1 Institutional distance . . . 155
4 Data and Variable Definition . . . 156
4.1 Country Characteristics . . . 159
4.2 Industry Characteristics . . . 161
5 Results . . . 161
6 Conclusions . . . 170

Abstract

This thesis deals with the globalization of production, a salient feature of the modern economy. The development of international outsourcing as a widespread business practice and the simultaneous decrease in trade and transport costs have contributed to the growth of a phenomenon known as global value chains. The main aim of the thesis is to understand how global value chains alter the location of economic activity. The thesis also studies the extent of firms' participation in global value chains and its consequences for firm performance.

The thesis consists of four papers studying the behavior of firms in global value chains. Paper 1 analyzes how production fragmentation influences the importing and exporting behavior of Swedish firms in the manufacturing sector. Paper 2 focuses on manufacturing firms in the ICT sector and analyzes the effect of global sourcing on firm performance. In Paper 3, the thesis examines deeper implications of global production by investigating whether exposure to trade raises firms' sensitivity to external shocks. The final paper in the thesis studies the location patterns of multinational firms and analyzes the effect of institutional distance on the number of multinational entries in developing countries.

A number of patterns emerge from these studies. The first is that Swedish manufacturing firms increasingly participate in global value chains by sourcing production inputs from overseas to create products for local and foreign customers. As a result, global value chains help to alter the specialization patterns of manufacturing firms. The second finding is that firms reap benefits from global sourcing in the form of greater efficiency. However, global sourcing may also raise the responsiveness of firms to negative external shocks. The final key result points to a developing trend in the location of activity in which emerging market multinational firms are becoming significant sources of foreign direct investment flows and their investment patterns challenge existing theories of multinational location choice.

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Malmö, October 2016

Part I

Introduction and Summary

Chapter 1

Introduction and Summary

1 Introduction

> As manufacturing goes digital, a third great change is now gathering pace. It will allow things to be made economically in much smaller numbers, more flexibly and with a much lower input of labor, thanks to new materials, completely new processes such as 3D printing, easy-to-use robots and new collaborative manufacturing services available online. The wheel is almost coming full circle, turning away from mass manufacturing and towards much more individualised production. **And that in turn could bring some of the jobs back to rich countries that long ago lost them to the emerging world.**[emphasis added]) - The Economist, April 21, 2012

In this thesis, I study one recent development in international trade and investment, namely the changing geography of production. Policymakers across the world are grappling with the effects of changes in technology and international trade on firms and workers (Feenstra 2007). The above excerpt from The Economist highlights the current level of uncertainty regarding the relationship between technology, trade, and employment. Technology has enabled firms to 'slice up their value chains' across locations so that the production of a single product may require inputs from many countries (De Backer and Miroudot 2013; Krugman 1995). In a recent study by the OECD, it was shown that producing a single iPhone 4 requires intermediate inputs from many countries. Inputs are produced in countries such as Germany, France, Taiwan, Japan and South Korea. These inputs are then assembled in China before the final product is shipped to the U.S.

The OECD study shows that assembly in China accounts for just 3 percent of the factory gate price and 1 percent of the retail value of the iPhone 4. In contrast, intermediate inputs imported from Germany, South Korea, and France make up

51 percent of the factory gate price and 16 percent of the product's final value (De Backer and Miroudot 2013). The case of the iPhone4 represents just one example of what has now become a global phenomenon. This thesis analyzes the growth in the share of foreign production in Swedish exports and evaluates how purchasing inputs from abroad influences firm performance. In addition, this thesis examines the location behavior of multinational enterprises.

The practice of purchasing production inputs from foreign countries began in the 1960s and became more popular in the ensuing decades (Grunwald and Flamm 1985). Sourcing intermediate inputs from overseas has helped to shape the geography of production as well as patterns in international trade flows. There is now a vast and growing body of work on the factors explaining the growth in trade in intermediate inputs. This new phenomenon has been dubbed 'global sourcing', 'production fragmentation', 'global production networks' and 'global value chains.' This thesis uses the term global value chains to describe these current trends in international trade.

There are three main factors explaining the rise of global value chains. First, changes in international trade and investment policy since the 1940s have led to increased economic integration between countries (Sachs and Warner 1995). The establishment of General Agreement on Tariffs and Trade (GATT) in 1947 marked the beginning of a series of reduction in trade barriers that helped to restore world trade to its pre-war levels (Irwin 1993). The U.S. reduced tariffs by 35 percent as a result of the first round of GATT negotiations (Irwin 1993). Subsequent rounds of negotiations saw even more tariff reductions on a wider range of goods. After the establishment of the World Trade Organization (WTO) in 1995, average tariff rates declined even further and now ranges between 5 and 10 percent for developed countries, a small fraction of their 1940s levels (WTO). These policy changes have also benefited trade in intermediate goods. The elimination of tariff barriers enabled greater fragmentation of production since the cost of shipping goods-in-process between countries declined substantially (Hummels 2007). Other policy changes include financial liberalization, which also contributed to the growth in bilateral trade and investment flows.

Another factor explaining the growth of global value chains is the decline in transportation costs (Baldwin 2012; McCann and Acs 2011). The development and diffusion of containerization technology have reduced the transit time by 20 times and contributed to an increase in international trade (Bernhofen et al. 2016). The third and final development influencing global production fragmentation is the Information and Communication Technology (ICT) revolution (Baldwin 2012). The ICT revolution allowed firms to coordinate production activities over long distances more cheaply. Lower communication costs have allowed firms to separate stages of production, which contributed to the growth of global value chains.

Understanding the effects of these recent trends in international trade is important for the following reasons. There is overwhelming evidence that production fragmentation has helped to bring about structural change in advanced economies (Statistics Denmark 2008; Tillväxtanalys 2010; Pilat el at. 2006). The practice of relocating production to countries such as China and Mexico has led to a decline in the share of manufacturing in total output across many industrialized countries. As a result, there has been a shift away from manufacturing towards services (Leamer 2006; Greenhalg and Gregory 2001). In addition to changes in industrial structure, production fragmentation has led to a decline in manufacturing employment which in turn has reduced the demand for unskilled workers (Feenstra 2007). At the same time, the shift towards services has increased the demand for skilled workers. There are therefore two opposing forces at play, which shape the structure of employment and wages. The decline in manufacturing employment together with growing demand for skilled labor has led to a widening of the wage gap in virtually all advanced economies (Harrison et al. 2010; Feenstra and Hanson 2001). Ekholm and Hakkala (2006) find that global fragmentation leads to a reduction in labor demand for Swedish workers with lower levels of educational attainment. They conclude that workers whose highest level of education is at the secondary level are negatively affected by global fragmentation. Similarly Warda (2015) shows that there is a relationship between the types of inputs a firm sources internationally and the skill composition of its workers. Importing high-quality inputs is associated with a reduction in labor demand for unskilled workers in Swedish firms.

The rise of international outsourcing has also helped to transform the economies of many host countries. Relocating production to foreign countries has resulted in technology transfer to host economies, which in turn has increased international competition within these industries. For example, the origins of the electronics industry in developing East Asian countries such as South Korea, Singapore, and Taiwan can be traced back to the 1960s when Fairchild, an American firm, relocated production to Hong Kong. This practice soon spread to other American firms as well as Japanese firms (Dedrick and Kramer 1998; Grunwald and Flamm 1985). Multinationals established assembly plants in countries such as Taiwan, Singapore, and Mexico to reduce production costs (Grunwald and Flam 1985). Modular manufacturing processes facilitated the separation of different stages of production and the geographic dispersion of production. With the dispersion of production plants and the use of licensing as the dominant entry mode, technology transfer to local firms enabled the growth of a domestically grown industry. By 2005, East Asian countries accounted for 43 percent of total production in the electronics sector (Gagnes and Van Assche 2010).

This thesis focuses on the globalization of production activities. However, it is important to note that firms increasingly outsource both manufacturing and services activities to distant locations. There is a branch of literature documenting and analyzing the growth in globalization in back-office services such as accounting

and human resources (Blinder 2006). There is also evidence that knowledge intensive activities like R&D are outsourced (Bardhan and Kroll 2003). One explanation for outsourcing knowledge-intensive activities in high-skilled sectors is that firms choose to locate in regions where innovation activity and access to technology is greater (Mudambi 2008).

In light of these developments, this thesis aims to address the following questions: Where do multinational firms locate production? What are the effects of internationalization of production on firms' performance?

To answer these questions, the thesis draws on recent research in the field of international trade that uses the firm as the unit of analysis to examine and explain current trends in the growth of global value chains. The thesis contributes to the literature on trade in value added as well as the body of work on heterogeneous firms in international trade. Theoretical insights from related fields also inform much of the work in this thesis. In particular, the thesis uses theories on multinational firms from international business as well as location theory from economic geography.

This thesis is divided into four main papers, each addressing a single aspect of global value chains. Papers 1-3 focus on Swedish firms in global value chains. Paper 1 studies changes in the international orientation of Swedish firms. The paper finds that Swedish firms have become more deeply integrated into global value chains since 1995, importing and exporting products that lie downstream the global value chain. The findings from Paper 1 show that one of the most internationally-oriented industries in Sweden is the electronics industries. Paper 2 builds on these findings by focusing on manufacturing firms in the information and communications technology (ICT) industry and investigates the impact of global sourcing on technical efficiency. Increasing global integration may increase the exposure of firms to external shocks. Paper 3 investigates this claim by evaluating how participating in global value chains influenced the effect of the financial crisis of 2008-2009 on firm performance. The final paper in this thesis examines the determinants of firm internationalization by analyzing the interplay between knowledge intensity and institutional quality and how this influences multinational location choice.

2 Global Value Chains

To understand current trends in the global geography of production, one natural starting point is to study the evolution of trade in recent decades. Over the last 30 years, the nature and pattern of international trade in goods have changed tremendously. This section will discuss some of these changes by focusing on the following aspects of international trade. The section will begin by studying major changes in the composition and geographic orientation of trade since the 1960s. The section then charts changes in the role of multinational firms in global trade and reviews the academic literature on the rise of global value chains (GVC). Finally, the section concludes with a discussion of the effects of global value chains on firm performance.

One of the most remarkable changes in the composition of global trade in recent times is the growth in intermediate goods as a share of total trade flows. Before the 1960s, international trade flows consisted of the exchange of final goods between countries. Ricardo's famous wine for cloth example represents this type of trade (Ricardo 1817). Another traditional pattern in international trade included the exchange of raw materials for finished goods. Resource-rich countries in the global South exported raw materials such as iron ore and imported finished goods such as cars from the North (Yeats 1998). However, since the mid-1960s, the composition of trade flows has expanded to include not only raw materials and final consumer products but also unfinished goods used as inputs to manufacturing (Yeats 1998).

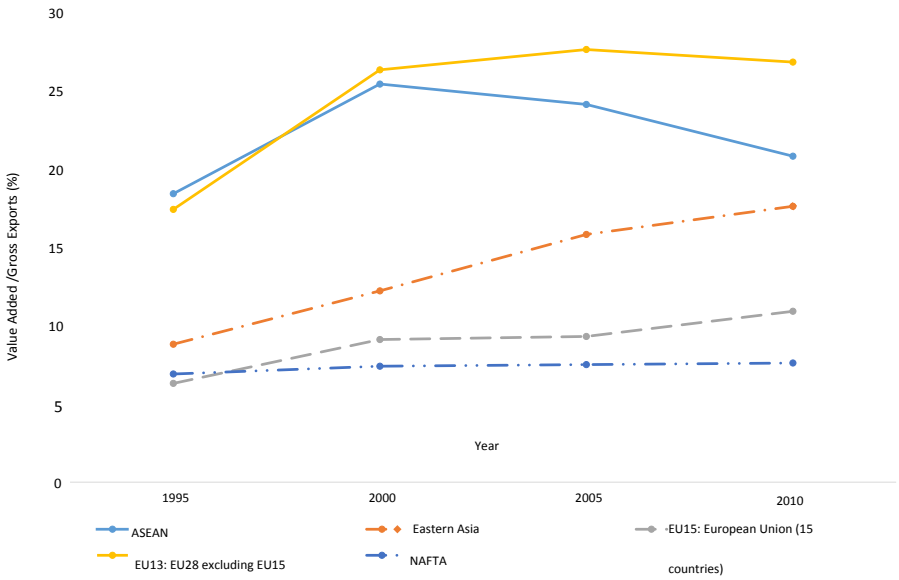
Hummels, Ishii and Yi (2001) show that trade in intermediate goods increased by 40 percent between 1970 and 1995. This growth in intermediate inputs in international trade accounts for one-third of the increase in world trade over the same period (Yi 2003; Hummels et al. 2001). Indeed, trade in intermediate inputs accounted for more than 50 percent of world trade in 2009 (Gereffi and Sturgeon 2013). One important implication of the rise of trade in intermediate goods is that finished goods increasingly embody inputs from two or more countries. Additionally, production in many countries relies on value-added imported from abroad. Figure 1 shows the share of foreign value added in gross exports for select regions across the world. Here we see that the contribution of foreign output to export growth has increased since the 1990s in virtually all countries represented.

The second feature that this thesis highlights is the changing geography of international trade. Changes in the composition of trade flows are closely intertwined with changes in the geography of trade. Regions such as East Asia now account for a significant share of global production and exports. In 1990, China's share of world trade amounted to 1.4 percent. Today, China is the world's biggest exporter, overtaking the U.S. in 2013. China accounted for 11 percent of world exports in 2013[1]. Other large developing countries such as Brazil and Russia have also become

[1] http://wits.worldbank.org/CountryProfile/en/CHN

more integrated into the global economy and are now important exporters of raw materials. In addition, changes in the geography of world trade have also seen a change in specialization patterns across countries. For example, the electronics industry has become one of the most globalized industries and accounts for the second largest share of total trade in intermediate inputs (Sturgeon and Kawakami 2010). Before the 1980s, the electronics industry was dominated by American firms who, in search of lower costs, relocated production to industrializing economies in Asia such as Taiwan, Hong Kong, South Korea and Singapore (Dedrick 1998). East Asian countries became more competitive over time and by 1995 total production in East Asia exceeded that of the U.S. The U.S. accounted for just 22 percent of global production in the electronics sector in 1995 (Dedrick 1998). East Asian countries now account for the bulk of world output and exports in the electronics industry.

Figure 1: Foreign value added as a percentage of gross exports 1995-2010



Source: OECD TiVA Database

Another important feature of international trade is the increasing importance of multinational enterprises (MNE) in world trade. The number of multinational affiliates across the world has grown from 7,000 in 1960 to 780,000 in 2006 (Iammarino and McCann 2013). Multinationals have an enormous impact on total trade flows due to the sheer size of their operations across the globe. For example, the sales of multinational affiliate sales exceed total trade flows (Navaretti and Venables 2004).

As MNEs locate production stages across countries to benefit from differences in production costs or to gain efficiency improvements, this influences both the volume and direction of trade in intermediate goods[2]. For example, multinationals account for more than half of total exports in the U.S. (Slaughter 2000). Intra-firm trade accounts for a large share of these exports as multinationals ship goods-in-process to affiliates overseas for further processing.

Recent developments in trade in motor vehicle parts and components illustrate the effect of multinational location choice on the location of production and international trade patterns. Between the 1960s and the 1980s, automotive firms in the U.S. and Europe responded to growing competition from Japanese firms by relocating production to low-cost locations (Gereffi and Lee 2012). One such example was Volkswagen's decision to relocate production from the U.S. to Mexico and serve the U.S. market entirely from its Mexican facilities (Sturgeon and Florida 1999). This example is representative of broader industry trends which helped to shape the composition of U.S.-Mexico trade. The flow of intermediate inputs goods from the U.S. to Mexico for further assembly increased exponentially in the 1990s in response to growing production sharing between U.S. and Mexican auto plants (Sturgeon and Florida 1999).

Changes in the organization of activities within the MNE also help to shape the pattern of trade flows. Cantwell and Piscitello (1999) trace changes in the importance of the subsidiary in multinational firms' innovation strategies and find that subsidiaries increasingly pursue their own innovation strategies, which creates the need for affiliates to develop their own regional networks across countries and this has further increased internationalization of multinational firms. These changes in the organization of multinationals and their subsidiaries have helped to create a network-like structure in global production and trade. Academic researchers have labeled the current network-like structure of world trade as global value chains or global production networks. In a recent report, UNCTAD finds that as much as 80 percent of GVC trade is accounted for by MNE production networks (UNCTAD 2013).

In the next subsection, I will review the academic literature on the globalization of production by tracing the origins of the concept *global value chains* and highlighting how research in international trade has helped to document, analyze and explain recent patterns in global production and their effects on firms and workers.

[2]Trade between multinational sub-units makes up a large share of world trade. In 1999 intermediate goods accounted for more than 90 percent of exports by U.S. multinationals in the manufacturing sector (Hanson, Mataloni and Slaughter 2005). On the import side, intra-firm trade accounts for 46 percent of U.S. imports (Bernard et al. 2010).

Overview of GVC literature

The growth of intermediate input trade and global production linkages between countries have led researchers to revisit existing theories of international trade. International trade research on global value chains[3] began in the late 1980s to 1990s but suffered from a lack of evidence due to the way in which trade statistics was collected (Yeats 1998). The Standard International Trade Classification (SITC) Revision 1 system did not distinguish between final and intermediate goods and therefore it was not possible to classify goods by end use. Sociologists, however, observed a change in the nature of exports from developing countries, particularly rapidly developing countries such as South Korea. The emergence of export processing zones that import inputs and assemble final goods for export exemplifies developments in global production that were not reflected in the way trade statistics was reported.

The concept *global value chains* has its origins in the economic sociology literature and was previously referred to as global commodity chains (GCC) (Bair 2009). Hopkins and Wallerstein (1986: 159) define global commodity chains as "a network of labor and production processes whose end result is a finished commodity". This branch of literature has produced a wealth of industry and product studies documenting how globally oriented production and consumption have become over the years[4].

Research on global commodity chains has evolved to address a wider range of questions using new analytical lenses. This change came about in response to some weaknesses identified by researchers. For example, economic geographers advancing the global production networks approach criticize the GCC view, arguing that global commodity chains ignore the role of geography. Proponents of the 'global production networks' view global production as being socially embedded at different spatial scales (Henderson et al. 2002). To address this and other shortcomings, sociologists have merged the global commodity chain perspective with insights from transaction cost economics and economics of organization to produce a new understanding of the global organization of production (Bair 2009; Gereffi, Humphrey and Sturgeon 2005). This new theory of global production was termed global value chains.

One of the central goals of the global value chain view is to consider all stages of value creation. That is, the global value chain approach aims to shift focus

[3]World systems scholars argue that "Commodity chains have been global since the emergence of modern capitalism." "translate, geographically extensive commodity chains are not a recent phenomenon, dating from say the 1970s or even 1945,...they have been an integral part of...the functioning of the capitalist world since it came into existence in the long sixteenth century" (Bair 2009, p9)

[4]For an example of the range of industries and products studied using this approach, see http://www.globalvaluechains.org

away from production activities to analyze all stages of value creation. The term 'value' in the global value chain framework is defined as profits, mark-ups or value added at each stage in the value chain. The GVC approach emphasizes the role of international networks in the introduction of new products to the market. International networks are active in many stages along the value chain from pre-production activities such as design to post-production activities such as distribution. Global value chain scholars study how these networks are organized in order to understand factors such as how new firms become international or how firms from developing countries can enter international markets (Gereffi et al. 2005). Another key area of focus is the issue of governance of the value chain. Asymmetry in bargaining power between buyers and suppliers determine, for example, how profits are distributed among stages in the value chain (Gereffi and Korzeniewicz 1994). The GVC approach also considers factors such as coordination and control of activities across different stages of the value chain.

Research on the globalization of production emphasizes other aspects such as changes in the internal organization of firms that help to produce these observed changes in global production. Researchers in the fields of management and international business analyze strategic choices by firms that contribute to the growth of global value chains. One of the earliest uses of the 'value chain' concept was in Porter (1990). Porter (1990:41) builds on Porter (1986) and argues that "a firm's value chain is an interdependent system or network of activities, connected by linkages". Building on this concept, strategic management, and international business scholars study the relocation of production from the perspective of the firm. This branch of research focuses on explaining why multinationals arise, where they locate and what activities are performed in different locations (Rugman 1985). In general, this line of research focuses on questions such as the factors influencing firms' choice of organizational form in host countries as well as the issues concerning headquarter-subsidiary relationships. The terms 'international sourcing', 'global sourcing' and 'offshore outsourcing' are commonly used to refer to arm's length transactions by firms in foreign locations.

The international trade literature studies the wider economic and institutional context in which global value chain emerged as well as the effects of global value chains on welfare. As early as the 1960s researchers started to study the increasing dispersion of production activity. However, as trade statistics did not yet account for intermediate goods, it was difficult to conduct empirical studies on global production sharing. Most early papers in this field were, therefore, theoretical in nature (Arndt 1997; Deardorff 2001; Jones and Kierkowski 2000). Several different terminologies arose in the literature to describe the emerging phenomenon and terms such as 'international division of labor', 'international fragmentation' and 'global production sharing' were widely used.

Beginning in the 1990s, a new wave of research in international trade shifted the

focus away from industries to firms. A number of influential empirical papers using detailed micro-data on the activities of firms in foreign markets have brought to light certain empirical regularities. These studies have revolutionized current understanding of internationalization of firms (Antras 2015). This empirical turn in trade research has given birth to a new branch of studies on the globalization of production that uses the firm as the primary unit of analysis. More importantly, these new studies have made significant progress in documenting, analyzing and explaining the nature and extent of global value chains.

All three fields discussed above describe the same phenomenon using a different label. Today, the three streams of literature have converged to some degree. In one of the first books dedicated to the topic, Gereffi and Korzeniewicz (1994) write

> How do we know where [global commodity chains] GCCs start and where they end?... For instance a manufacturing plant might be a central unit in the production network of a GCC, but this node may also serve as the end-point of the raw material supply network and as the starting point for the export network. Pushed to an extreme, we would need a Leontief-type input-output matrix of the entire world economy just to do a comprehensive analysis of an automobile with its 15,000 individual parts.

International trade scholars have answered this call and have produced a vast and growing body of literature using international input-output tables to answer important questions on the globalization of production. International trade research has incorporated contributions from international business research and now accounts for the role multinational firms international trade and investment. Also, insights from sociology and economic geography have made their way into economics and the terms *global value chains* and *global production networks* are now standard terminologies used to describe globalization of production. Likewise, the management terms *international outsourcing* and *offshoring* are also commonly used in international trade research to describe the phenomenon. Paper 1 in this thesis uses a global input-output table to document the growth in foreign value-added as a share of Swedish exports.

3 How much do we know about global value chains?

Early research documenting the growth of global value chains include empirical studies on intra-industry trade between regions. Fontagné and Freudenberg (2002) show that a significant portion of international trade consisted of the exchange of similar products between similar countries. Much of this trade consisted of the exchange of different varieties of final goods such as motor vehicles. This type of trade has been termed horizontal intra-industry trade. They also find that a significant share of intra-industry trade consisted of trade in intermediate

inputs (vertical intra-industry trade). However, establishing just how much of international trade was due to global value chains proved difficult. Fontagné and Freudenberg (2002) argue that using existing measures such as the Grubel-Lloyd index to measure intra-industry trade between country pairs was not particularly informative, since this index does not take into account the input-output structure of production sharing.

One of the earliest attempts to analyze global value chains using an inter-country input-output model[5] was put forward in Campa and Goldberg (1998). The authors analyze the use of intermediate inputs in total production for Canada, Japan, the U.K. and the U.S. Campa and Goldberg (1998) find that manufacturing sectors in all four countries are externally oriented with the U.S. and Canada becoming increasingly so between the 1970s and 1990s (Campa and Goldberg 1998). In addition, they show that, during the 1980s, U.S. manufacturing became more reliant on imported intermediate inputs. Undoubtedly, these findings point to the growth in global production sharing, which accelerated in later decades when countries such as China became important sources of manufacturing output. The rest of this section highlights four key changes in global value chains in recent decades and summarizes existing research on their growth and development.

1. Globalisation of production has increased over time

In a seminal paper Hummels et al. (2001) develop a new method to analyze the growth of global value chains using inter-country input-output data for 10 OECD countries. International input-output tables are useful since slicing the value chain into smaller segments involves shipping a greater number of parts and components between countries to produce one unit of a final product. Hummels et al. (2001) measure the importance of 'vertical specialization' in gross exports for these countries. Vertical specialization describes the use of intermediate inputs from country X in country Y's production. The concept models the use of imported intermediate inputs in sequential stages of production located in different countries. Hummels et al. (2001) show that global production sharing grew by 30 percent between 1970 and 1990. Also, roughly 30 percent of the growth in world trade could be explained by global value chains. Hummels et al. (2001) also examine the contribution of vertical specialization to export growth for individual countries. They show that 50 percent of the growth of Canadian exports as a share of total output can be explained by global production sharing. Similar results were found in the cases of Mexico, Taiwan, and the Netherlands.

The literature quantifying global value chains has grown substantially since Hummels et al. (2001). New measures and new datasets[6] have allowed researchers to

[5]Input-output analysis used in this stream of research is based on Leontief (1936)

[6]The OECD has created a trade in value added (TiVA) database that reflects inter-country and inter-sectoral linkages for all OECD countries as well as large emerging market economies.

quantify the extent of global production sharing. Johnson and Noguera (2012a) devise a method to measure the domestic content of exports. They combine bilateral trade data with national input-output matrices for 69 countries. Similar to the findings in Hummels et al. (2001) Johnson and Noguera (2012a) show that domestic content of exports has been decreasing over time. Since 1975 the share of domestic output in exports in regions such as Europe, North America, and East Asia declined on average by 10-15 percent (Johnson and Noguera 2012a). However, Johnson and Noguera (2012a) propose that a better measure of a country's exports is the value-added to export (VAX) ratio. The VAX ratio modifies gross export flows by accounting for the value of total production in each country. That is, the VAX ratio accounts for the use of imported intermediate inputs in total exports[7]. Another advantage of this approach is that it corrects for double counting [8] that plagues trade data. By correcting for double counting, Johnson and Noguera (2012a) show that the U.S. trade deficit with China shrinks by 40 percent while the U.S. trade deficit with Japan increases by a third.

The VAX ratio is comparable to vertical specialization proposed by Hummels et al. (2001) in that both methods aim to derive a measure of the domestic content of imports. There is, however, an important distinction between the VAX ratio and vertical specialization. The VAX ratio accounts for both imported and exported intermediate goods while vertical specialization only takes into consideration the former. Value added as a proportion of exports, therefore, measures a country's backward linkage in global trade. Koopman, Wang and Wei (2014) build on Hummels et al. (2001) and Johnson and Noguera (2012a) and measure not only foreign value added in total production but also what they term *indirect* value added. This measure takes into account the role of third countries as well as 'roundabout' value added. This method addresses the shortcomings in the other two approaches by accounting for processing trade in China and Mexico. Koopman et al. (2014) develop an index of GVC participation and an index measuring the *upstreamness* of countries along the global value chain. An industry or a country is upstream the value chain if the output it produces is used as inputs in other industries. Conversely, an industry is said to be downstream if it produces finished goods that are sold to final consumers. Koopman et al. (2014) use these measures to identify the position of individual countries in the global value chain and quantify the extent to which a country is integrated into the world economy.

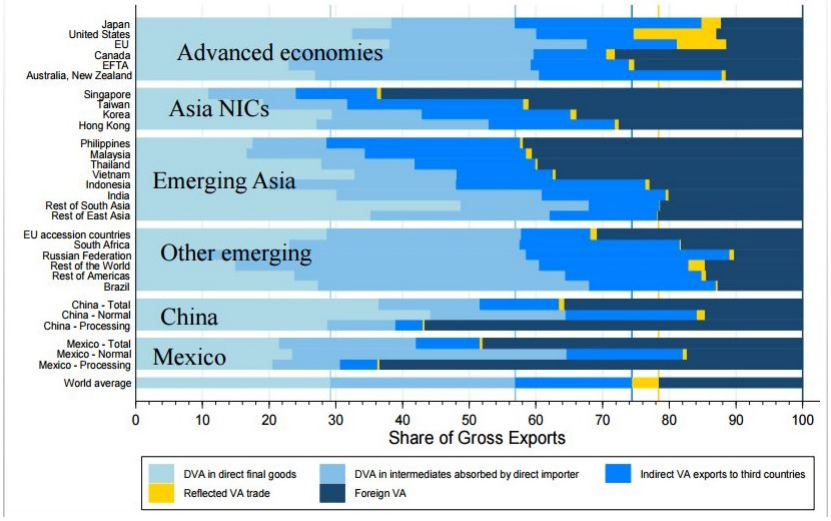
Other international input-output data sets include the World Input-Output Dataset (WIOD), the Global Trade Analysis Project (GTAP), and the Asian I-O among others.

[7]They caution, however, that this approach is not applicable where export processing trade is high such as in China and Mexico.

[8]Double counting occurs when goods cross national borders several times during the production process, which inflates data on global trade flows. In the example of the iPhone presented earlier, the value of intermediate inputs from Korea, Germany, France and the U.S. is counted at least twice in international trade statistics– once when these products are exported to China and once more when the final product is exported from China to the U.S.

Figure 1 shows that foreign value added as a percentage of total exports has increased since 1995. Figure 2 shows a more detailed picture of the composition of trade flows. On average, foreign value added accounts for 20 percent of gross exports. However, countries such as Singapore and Mexico rely more heavily on foreign value added. Foreign value added accounts for approximately 60 percent of gross exports from Singapore and Mexico. Reflected value added is greatest in advanced economies such as the U.S. and the EU. Koopman et al. (2014) decompose domestic value added into two components: domestic value-added in final goods and domestic value added in intermediate goods. On average, domestic value embodied in final goods accounts for one-third of gross exports. By definition, countries with a higher share of foreign value added also have a lower share of domestic value added in gross exports.

Figure 2: Decomposition of Gross Exports (2004)



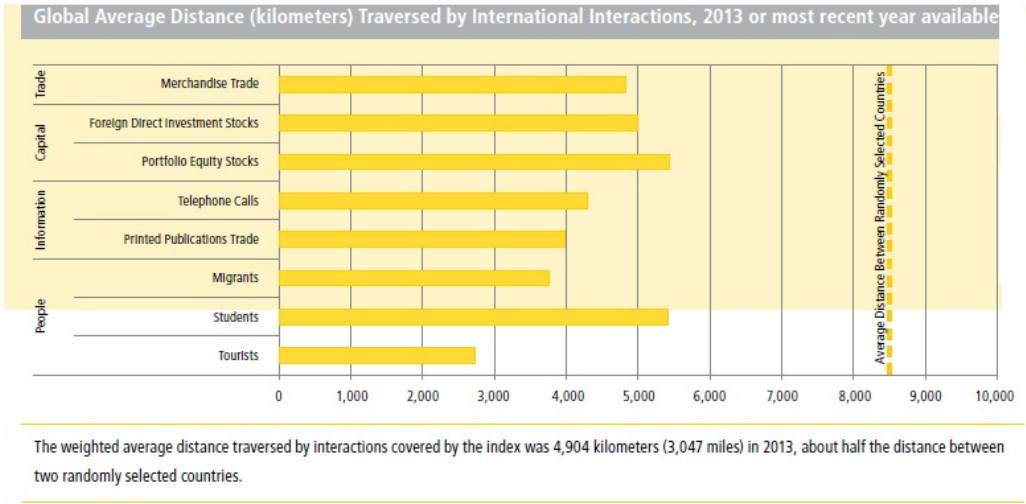
Source: Koopman, Powers, Wang, Wei (2010)

2. Global production is clustered among groups of neighboring countries.

So far, the discussion has shown that the pace of global integration has accelerated in recent decades. However, the distribution of production activities across the world remains highly uneven. The gravity model of international trade puts forward that bilateral trade flows increase with income similarity and decrease with physical distance (Anderson and van Wincoop 2004; Tinbergen 1962). Johnson and Noguera (2012b) examine whether patterns of global production sharing are consistent with the predictions of the gravity model. Johnson and Noguera (2012b) find that geographic distance continues to influence where production activities are located as well as the level of bilateral trade between countries. In fact, global production sharing has made geographic distance more important.

Using international input-output data, Johnson and Noguera (2012b) show that value added as a fraction of export (VAX ratios) within regions tend to be lower that VAX ratios outside these regions. In other words, there is greater production sharing at the regional level than at the inter-regional level. Greater regional production sharing implies, for example, that firms located in the EU rely more heavily on value added produced in other EU countries than they do for countries outside the EU. Johnson and Noguera (2012b) also find that there has been a decline in distance traveled for VAX. What this all means is that value chains tend to span countries within a confined geographic region. That is, global production sharing is more regional in nature.

Figure 3: Global average distance travelled



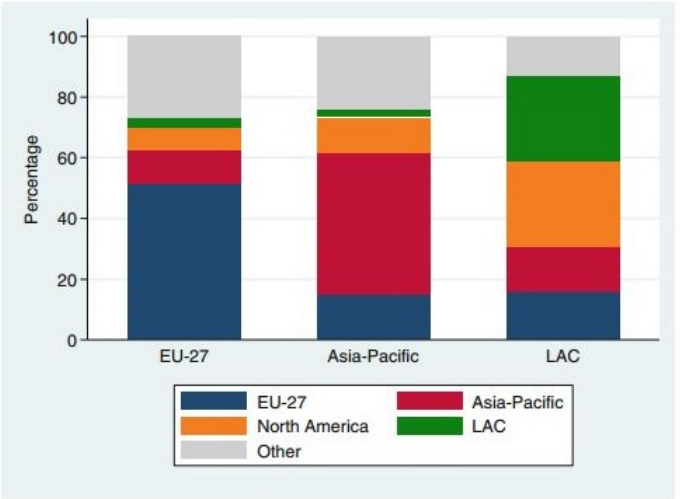
Source: DHL Global Connectedness Index 2014

Figure 3 shows the level of international interaction within regions as measured by the DHL global connectedness index (Ghemawat and Altman 2014). The dashed line to the right shows the average distance between countries. The figure compares the average distance crossed by trade and investment flows between two randomly chosen countries with the average distance between countries. We see that this distance traveled is less than half the average distance between two countries. What this means is that the world is far from flat[9]. If activities were evenly distributed across the world, then the distance traveled by goods trade would be approximately equal to the average distance between countries.

[9]Friedman (2005) argues that developments in ICT and the rise of international outsourcing have rendered the world flat. This is strongly refuted in Leamer (2007) who argues that the growing importance of knowledge-intensive business services has made face-to-face contact even more important

Figure 2 shows that foreign value added as a share of exports varies substantially across regions. In what follows, I briefly highlight recent research on the presence of production networks for macro-regions.

Figure 4: Regional contribution to foreign value added



Source: Blyde (2014)

Europe

Figure 4 shows that the EU 27 has one of the highest rates of regional integration. Sterhrer and Stöllinger (2015) show that within the EU, manufacturing is concentrated inside a so-called 'manufacturing core' comprising Germany, Austria, Czech Republic, Poland, Hungary and Slovakia. These countries account for a growing share of total manufacturing in the EU. Together the 'manufacturing core' countries accounted for 34.5 percent of EU manufacturing in 1995. By 2011, their share grew to 42.6 percent.

East Asia

Nowhere is the role of regional production more visible than in China and East Asia. Industrial linkages among countries in the region have given rise to what is now known as *Factory Asia*. Baldwin and Forslid (2013) argue that the growth of Factory Asia is the result of production fragmentation due to advances in ICT [10]. Asian countries account for an increasing share of total manufacturing value added relative to other regions (ADB 2013). Additionally, supply chain trade within the region accounts for a significant share of total exports (Baldwin 2013a). This trend hold across sectors such as machinery and equipment, transport equipment, basic metals, and textiles, leather and footwear.

[10]Baldwin refers to the rise in fragmentation following the ICT revolution as the second unbundling. This will be discussed later in the next section (Baldwin 2013a)

North America
There is a high level of trade integration between The U.S., Canada and Mexico. However, trade between Europe and North America exceed intra-regional trade flows within North America (Feenstra and Taylor 2011). The auto sector in North America is one example of a regionally concentrated value chain. The Mexican, Canadian and American auto manufacturing industries are interdependent as more than 90 percent of Mexican exports in the automotive industry is destined for the U.S. or Canada (Sturgeon et al. 2008) nocitesturgeonvanbgereffi

Latin America and the Caribbean
Latin America and the Caribbean's integration in the global value chain is characterized by low technology content products such as wearing apparel, commodities, agriculture i.e. industries that lie downstream the value chain with lower foreign content (Blyde 2014). Blyde (2014) compares the Grubel-Lloyd index of intra-industry trade for Latin America and Asia. The author shows that Grubel-Lloyd index for Asia is twice as high as that of Latin America countries. However, as Latin American countries specialize in primary industries, the extent of regional production networks remains low.

Africa
Africa is one of the least integrated regions. In a survey of African countries' integration into global value chains, Farole and Winkler (2014) find that global supply chain management practices favor global sourcing or regional production networks instead of sourcing domestically. As such, supply chain linkages with poor countries tend to be very weak. Cultural and institutional factors make MNEs rely more extensively on their home markets. Other weaknesses in the domestic economy include: poor infrastructure, weak financial sector development, low human capital, among others.

3. Trade in tasks as important as trade in goods in GVCs

Research on global fragmentation shows how global value chains influence changes in the internal organization of firms (Alfaro et al. 2015; Antras and Chor 2012; Antras et al. 2006; Grossman and Rossi-Hansberg 2006). Jones and Kierkowski (2000) argue that production fragmentation is facilitated by service activities that link production stages together. Services such as transport, logistics, and ICT support the activities of multinationals in foreign locations and help to improve coordination between stages in the value chain. In their framework, firms have an incentive to fragment production into two or more stages to benefit from lower marginal costs in the foreign location. Fragmentation implicitly entails higher fixed costs associated with various service links needed to coordinate activities across location. However, increasing returns to scale imply that firms can reduce total production costs by relocating to low-cost locations.

Locating production units in far-flung places represents such a significant development in the geography of production that Blinder (2006) refers to global value chains as the next industrial revolution. As a result of the growth of global value chains and the resulting increase in the demand for service links, services now account for approximately half of total value created in value chains (Low 2013). To document and analyze these changes, researchers have begun to analyze not only the firm as an economic agent but also the specific activities of the firm. There is a growing body of literature that uses a "task-based" view of production. This new body of work goes beyond identifying how inputs are transformed into outputs and focuses on the specific units of "work activity" or *tasks* that make up global production networks. Timmer et al. (2013) summarize the main purpose of this literature as follows:

> Central in these new paradigms is the introduction of "tasks" as the units of work activity that produce output. Traditionally the production process was conceived of as a direct mapping from factor inputs to output. In recent thinking, output is generated as a result of a set of 'tasks' which are to be completed by various combinations of production factors. So rather than a direct mapping from labor and capital inputs to output, factors map into tasks, which map into output. - Timmer et al. (2013 p5)

Input-output studies are useful in that they provide some indication that domestic value added is much lower than previously thought. Timmer et al. (2013) use input-output analysis to show that global value chains have contributed to the increase in demand for skilled workers in advanced economies. However, input-output data may miss important details regarding the organization of firms at the task level (Sturgeon et al. 2013). There is also a substantial body of work on the geographic orientation of production for individual products such as the iPhone (De Backer and Miroudot 2013), Barbie Doll (Feenstra 1998), among others. Product level studies, while informative, do not represent a feasible or cost effective way to increase our understanding globalization at the level of the task. These studies often require extremely detailed data along with deep industry knowledge (Sturgeon et al. 2013). One useful approximation for tasks is business functions required to support production activities across locations.

A task-based view is also useful since the activities that take place in the foreign location will influence what "tasks" will be carried out in the home country. This has implications for factors such as labor demand and employment composition in the home country. Becker et al. (2013) find that when German multinationals locate production overseas, then this leads to an increase in the demand for workers capable of performing nonroutine tasks in the home country. As such, locating production overseas raises the demand for skilled workers in the home country and leads to a shift in the average educational level of workers towards more educated

employees.

4. Global value chains have become deeper

Another crucial insight from global value chain research concerns the distribution of value added across activities and locations. As firms slice up value chain activities and relocate standardized operations in foreign locations, firms may gain efficiency improvement or benefit from specialization in each location. One important implication is that the types of activities that are fragmented along the value chain have consequences for the distribution of 'value' across locations. Johnson (2014) finds that the value added created from manufacturing activities accounts for an increasingly small share of the value of final goods.

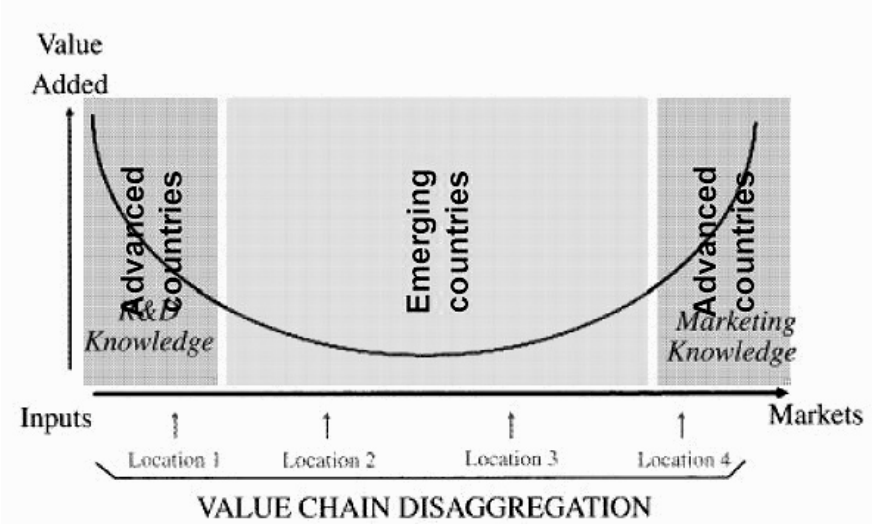
Dispersion of value creation within firms

Mudambi (2008) studies factors influencing the location of value-creating activities for firms in knowledge-intensive sectors. He argues that as intangible assets become more important, firms shift their focus toward activities that create more value. These may be upstream activities such as R&D or downstream activities such as marketing that create more value for knowledge intensive firms. Manufacturing and assembly generally create less value for firms in knowledge-intensive industries. As such, these activities are more easily relocated to other locations. Mudambi (2008) illustrates the distribution of value added across activities shown in Figure 5. By plotting value created at each stage in the value chain – from upstream to downstream activities – Mudambi (2008) shows that the distribution of value added reflects a 'smile curve.' High value-added activities take place at the initial stages of value creation. As we move toward more standardized activities such as production, the level of value created decreases. Moving downstream the value chain, i.e. towards the right of the figure, value added starts to increases once more. The smile curve summarizes the distribution of value added along a firm's production stages and shows that along the value chain value created decreases initially before increasing once more.

Dispersion of value creation across regions

The 'smile curve of value creation' can also be used to illustrate the effects of global value chains on the location of value creation across countries. That is, the curve can be used to show the dispersion of value added at the geographic level. As firms continue to pursue greater modularization in production, there is unevenness regarding where firms derive value. McCann and Mudambi (2005) argue that firms combine their competitive advantage in regions that possess a comparative advantage in specific activities. They show that the geographic orientation of value added across countries also follows the shape of the smile curve. High value added activities tend to cluster in advanced countries while emerging economies specialize

Figure 5: Value chain disaggregation



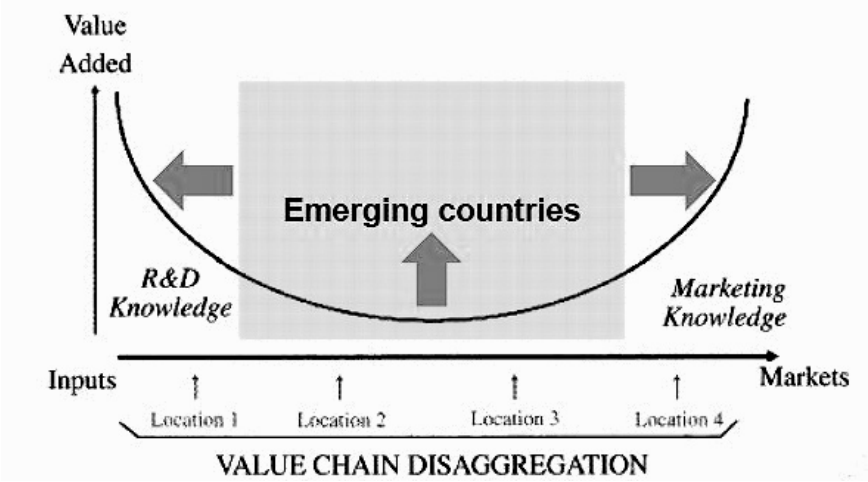
Source: Mudambi (2007)

in low-value-added activities. This is illustrated in Figure 6.

High value added are concentrated in advanced economies due to "stickiness" of knowledge or location-specific factors such as agglomeration economies that generate innovation. McCann and Mudambi (2005) argue that firms producing high value added activities generally originate from advanced economies. Competition from emerging economies in low value-added stages then forces these firms to locate more standardized activities in emerging markets by outsourcing to local firms. This further reduces the value created at those stages (low value-added stages). As a result, emerging market firms then try to 'upgrade' by moving to higher value-added activities.

The 'smile curve' of the value chain is also informative in that it illustrates how changes in the organization of production at the firm level influences changes in the distribution of value added across regions. Baldwin and Evenett (2015) advances that international fragmentation has made the smile curve deeper over time. That is, the share of value added attributed to activities such as assembly has decreased since the 1970s due to factors such as technological advancement that have helped to reduce production costs. These cost reductions are represented by a steeper decline towards the middle of the smile curve, creating a more pronounced U-shape. The result is that a country's position in the value chain (stages in which the country specializes) determines the effect of trade on factors such as wages, employment, and output.

Figure 6: Value chain disaggregation



Source: Mudambi (2008)

4 Explaining the rise of global value chains

This section discusses factors explaining the origins of global value chain. The section will show how theories explaining international trade evolved with changes in trade patterns. Long distance trade is certainly not a new phenomenon. In fact, economic historians trace the origins of global integration or "long distance trade" to the period following the Neolithic Revolution[11] (Helpman 2011). During this period, goods such as spices, silver, textiles, horses and silk were traded between Europe, Asia, Sub-Saharan Africa and the Middle East. Trade in goods consisted primarily of products that were not produced locally. That is, these goods were typically "noncompeting" (Helpman 2011; O'Rourke and Williamson 2002).

Economic historians identify three main periods during which global integration accelerated. The development of the steamship during the 1840s led to a significant decrease in the cost of transporting goods over long distances (Sachs and Warner 1995). North (1958) studies developments in transport between 1750 and 1913 and shows that ocean transport contributed to greater interdependence between countries. By 1913, merchandise trade as a fraction of world output amounted to 11.9 (Krugman 1995). What characterized this period of globalization is that improvements in transportation technology enabled production to be separated from consumption (Baldwin 2012). The decline in transport costs also meant that the composition of international trade shifted away from noncompeting goods towards basic manufactured goods (Helpman 2011).

[11] See Helpman (2011) for an overview of the evolution of world trade. Karlsson, Johansson and Stough (2010) trace different waves of global integration over the last 1000 years starting with the development of city-states in Northern Italy and the Hanseatic League in Northern Europe.

Other developments that increased global integration were the completion of the Suez Canal, the Panama Canal and the growing use of the railway for in-land transportation in countries such as Russia, India, and the U.S.[12] (Donaldson 2010; Sachs and Warner 1995). The 1800s featured significant improvements in the movement of goods. Developments during this period such as the telegram also aided faster communication over long distances (Krugman 1995). These advances enabled countries to specialize according to their comparative advantage and engage in international trade.

The move toward greater integration came to a halt with the outbreak of the World War I. During the interwar period, countries implemented protectionist policies and erected tariff barriers which led to a sharp contraction in international trade (Sachs and Warner 1995). After the Second World War, the GATT came into force which led developed countries to open up their economies once more to trade by reducing tariff barriers. One peculiar development in international trade in the post-war period was noted by Leontief (1953) who observed that the U.S. exported labor intensive goods and imported capital-intensive goods. This observation was at odds with the dominant paradigm in international trade. According to the Heckscher-Ohlin theorem, capital abundant countries such as the United States should specialize in producing and export capital intensive goods. Another development in the post-war period was the growth in intra-industry trade. Countries with similar levels of development produced and traded similar goods. Balassa (1967) reviews developments in trade policy since the end of the Second World War, and discusses the effects of these changes on international trade patterns. One key observation was that the decline in tariffs raised the level of exports of manufacturing goods from developing to developed countries. This change in trading patterns was mainly evident in goods such as textiles and apparels. These developments point to increasing integration during this period and by 1970 the ratio of world trade to production returned to its 1913 level.

Another view on the origins of globalization put forward by Baldwin (2012) maintains that globalization takes place different waves. Baldwin (2012) refers to these periods of global integration as *unbundling* since in each phase, international trade facilitates the separation of consumption from production as well as separating production stages. The first wave occurred in the 19th century when the steam engine was developed. The second wave of globalization came in the wake of the ICT revolution in the 1980s (Baldwin 2012). What distinguished this new wave from the previous one is that ICT-enabled the separation of different production activities while the first unbundling separated production from consumption (Baldwin 2012). The cost of coordinating production activities across countries

[12]Duranton et al. (2013) study the effect of highway complexity on trade patterns between U.S. states. They show that highways influence specialization patterns as well as inter-state exports. States with more complex highway networks specialize in industries producing goods with a lower value to weight ratios.

declined and this triggered another period of rapid integration between countries. This interdependence came about due to firms fragmenting production stages across different countries.

McCann and Acs (2011) identify some institutional changes that led to increasing global integration. These include the fall of the Berlin Wall in 1989, the fall of communism in Eastern Europe and the opening up of China. The creation of the North American Free Trade Agreement as well as the European Union single market also marks a period of increasing global integration (McCann and Acs 2011). Technological advancements also contributed to the growing internationalization. The jet engine enabled the growth of air travel as one of the main modes of travel, which resulted in a drastic reduction in travel times. Another significant technological advancement in during this period was the creation of the World Wide Web. The following factors have been identified as the primary drivers of the 'slicing up' of the global value chain: advances in ICT, declining trade costs and policy. In what follows I discuss these three factors explaining how global value chains emerged.

4.1 Three stories

1. Advances in ICT

The ICT revolution refers to recent advances in the 20th century that have changed how information is transmitted over long distances, enabling an even greater level of interconnectedness between countries. Table 4.1 lists the most significant developments in ICT since the 1930s. The first general-purpose computer was invented in 1945 and less than thirty years later, in 1971, the first email was sent. It is not coincidental that international outsourcing gained momentum in the 1980s as these technologies enabled firms to fragment business function across countries.

Baldwin (2012) pinpoints the ICT revolution as the single most important factor explaining the growth of production sharing since the 1980s. Advances in ICT have enabled firms to separate functions geographically. The availability of this new technology meant that the cost of coordinating activities across large distances declined. For instance, Frankel (2000 p46) reports that "Between 1920 and 1990...the cost of a three-minute telephone call from New York to London fell from $244.65 to $3.32". As such, firms are now able to outsource not just assembly but also a wide range of business services.

Before the 1980s, outsourcing took place primarily in the production of goods and originated with the age-old question whether to 'make or buy' production inputs. Outsourcing of IT functions within firms began in the 1960s when Frito-Lay and Blue Cross outsourced their data processing functions to Electronic Data Systems

Table 1: Table Developments in ICT since 1936

	Computer revolution
1936	modern computer theory begins
1945	first general-purpose electronic computer
1947	invention of the transistor
1970	arrival of microprocessors
	Satellites
1957	launch of world's first satellite
1960	launch of communication satellites
1962	first satellite to transmit live transatlantic television signals & phone calls
	Mobile communications
1960	first fully automated car phone system
1973	first call made from a handheld phone
1979	first automated cellular service
	Internet and World Wide Web
1969	creation of a packet-switched network of computers
1971	first email sent
1990	World Wide Web made freely available

Source: International Telecommunications Union

(Lacity and Hirschheim 1995). The practice gained momentum in the 1980s and 1990s when several large companies such as Eastman Kodak, Xerox, Continental Airlines, among others, outsourced their IT functions.

With the improvement in communication technologies and the integration of world markets through trade liberalization, there has been significant growth in trade in services across international borders (Busi and McIvor, 2008). The Swedish National Board of Trade reports that the share of purchased services as a percentage of total inputs for manufacturing firms has more than doubled since 1970 (Kommerskollegium 2010). Service exports account for approximately 20 percent of world trade in 2007. This share increases to almost 50 percent when trade is measured in value-added terms and rises even further when affiliate sales by multinational firms are taken into account (Francois and Hoekman 2010). Apart from transport and travel, business and ICT account for the largest share of trade in services. For a service to be offshored, this often requires the use of other service inputs such as telecommunications services or IT services to ensure delivery. Hence, services occupy a dual role as both enablers of outsourcing and offshoring as well as the business function that is being offshored. Also, these complementarities often create the need for cross-border movement of people as suppliers may be required to move to a customer's new location.

2. Declining Trade Costs

Since the end of the Second World War, trade costs have decreased substantially. This section surveys research on the evolution of trade costs, focusing on the role of advances in transportation technology. Bernhofen et al. (2015) investigate the contribution of containerization on the growth in world trade since the Second World War. Containerization was developed in the 1950s in the U.S. and adopted worldwide between 1962 and 1990. Perhaps the most important benefit of containerization was that transit times were greatly reduced. Before containerization, it took a total of 70 days to ship cargo between Europe and Asia. Transit times declined to 34 days after containerization technology was adopted (Bernhofen et al. 2015). Transit time is an important determinant of production costs which in turn influences total output and trade. Djankov et al. (2006) show that a one-day delay in transit time is equivalent to being located an additional 85 kilometers from the trading partner and reduces exports of time-sensitive goods.

The advent of containerization also saw the development of an intermodal freight transport system. This system eliminated the need to unload cargo by hand and reduced associated risks such as damage and theft. Intermodal freight transport technology reduced the bottleneck at the point at which cargo needed to be offloaded from trucks and trains to cargo ships. Bernhofen et al. (2015) show that factors such as insurance costs and working capital "locked up as inventory in transit" were reduced dramatically by adopting containerization. In addition, labor productivity of dock workers increased by more than 15-fold. The use of larger ships also helped to increase the capacity of ports. Rodrigue and Slack (2013) find that containerization reduced trade cost by 20 times and reduced the share of retail price attributed to transport costs to 1.5 percent from 10 percent.

The decline in air transport cost is also an important aspect contributing to greater global connectivity. Advances in transport technology have significantly reduced transport times and contributed to a more integrated world. Bel and Fageda (2008) find a direct causal link between the number of intercontinental flights to a city and the number of multinational headquarters located there. In addition to promoting greater mobility of workers, intercontinental flights have become important in cargo transport (Krugman et al. 1995).

Other factors that have contributed to lower trade costs include trade facilitation. Improvements in the regulatory aspects of international trade, as well as improvements in port facilities, have contributed positively to global integration. Behar, Manners, and Nelson (2009) find that there is a 46 percent increase in exports for every one standard deviation increase in logistics performance for developing countries. Blonigen and Wilson (2006) show that there is a positive relationship between port efficiency and bilateral trade. Improving port efficiency augurs well for a country's integration into the world economy.

The discussion above shows that declining trade costs have led to an increase in international trade. One way in which these forces help to explain the rise of global value chains includes the effects of transport costs on firms' organizational form. Advances in transportation technology have facilitated new forms of organizing production. For example, the use of lean manufacturing is made possible due to the existence of faster shipping methods by air, road, rail and sea (MCann and Iammarino 2013). Lean manufacturing and just-in-time production favor a more geographically dispersed supply chain and may encourage firms to participate in global value chains (Levy 1997).

Anderson and van Wincoop (2004) show that even though tariff barriers are low, and that transport costs have declined, total trade costs remain high. Large trade costs partly explain why global value chains tend to be regional in nature and why production activities are unevenly distributed across countries. Costs associated with transportation, marketing, distribution account for a significant share of the price of the final good. These factors help to shape current patterns in the geography of production.

3. The role of policy

The third factor explaining the growth of global value chains since the 1960s concerns the role of institutional changes in the world economy. Changes in economic policy at the global, regional and national levels have helped to create the conditions for the globalization of production. Policy changes such as financial liberalization at the global level, free trade agreements at the regional level, and industrial policy at the national level have increased the pace of global integration. The number of free trade agreements entered into between 1948 and 1994 amounted to 124 while there were an additional 400 since the establishment of the WTO in 1995 (WTO). Among advanced countries, average tariff rates are around 5 percent today (Anderson and van Wincoop 2004). In developing countries, average tariff barriers are between 10 and 20 percent (Anderson and van Wincoop 2004). Political developments such as the fall of communism in the former Soviet Union and ideological shifts towards more free-market policies have also helped to increase the pace of globalization (Antras 2015). In this section, I summarize the major policy and institutional changes that have directly influenced the rise of multinational firms and the fragmentation of production.

Financial integration Sachs and Warner (1995) trace the evolution of financial market openness over the last 200 years. Factors such as geopolitical conflicts in addition to shifts in the dominant political and economic ideology caused bouts of rapid financial market openness followed by periods of less integrated financial markets. Before World War I, the global economy was characterized by open financial markets with convertible currencies as well as low tariffs on traded goods in many countries. With the help of international financial markets, countries

were able to finance large infrastructure projects such as railway building. In the early 20th century, the Great Depression and World War II set off a period where some countries implemented inward-looking policies, and financial markets were no longer open. Countries erected tariff barriers, and international trade declined as a result. Later, in the post-war period, some countries began to favor more open financial markets. Economic policies diverged with some developed countries pursuing greater economic integration while developing countries moved towards implementing protectionist policies. Between the 1950s and the 1960s, developed countries opened up their economies to trade and investment. At the same time, a large number of developing countries pursued development policies based on the idea of self-sufficiency, implementing state-led industrialization policies or import substitution industrialization policies (Sachs and Warner 1995). By the 1990s, many of these policies were reversed, and an increasing number of developing countries liberalized their financial markets.

Trade integration Another significant development that contributed to the growth of global value chains is the reduction of tariffs and non-tariff barriers. The GATT which came into force in 1947 and the WTO which was established in 1995 helped to secure a reduction in tariff barriers. These multilateral agreements have also contributed to changes in economic institutions. For example, the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement protect intangible asset investments across countries. In addition, free trade agreements and bilateral investment treaties have contributed to greater integration through their influence on domestic rules and regulations.

How does global economic integration explain changes in the location of production? "Integration means not only greater market-based trade and financial flows, but also institutional harmonization concerning trade policy, legal codes, tax systems, ownership patterns, and other regulatory arrangements" (Sachs and Warner 1995, p2). Financial liberalization enabled multinationals to operate as integrated units across distant locations (Narula 1996). Before financial liberalization, multinational subsidiaries operated as separate units that replicated activities across locations (Narula 1996). As a result, financial liberalization has opened up the range of possible ways in which multinational firms may choose to serve foreign locations. One effect of financial liberalization is that multinational firms could own financial assets in the host country. Firms could, therefore, access the local capital markets to finance their domestic operations. Foley and Manova (2015) survey the branch of literature showing that the level of financial sector development influences the location of multinational firms, the extent of their operations in the local market, the level of affiliate sales as well as sales to the headquarter locations. Financial sector development also influences the activities of firms along the global value chain.

The effect of economic integration on the growth of global value chains is more

visible when one considers the following cases. Regional trade agreements help to foster the growth in international fragmentation. Gereffi (1996) shows that NAFTA contributed to more fragmented production between Mexico, Canada, and the United States. Trade in parts and components increased after NAFTA came into place. Another example is the effect of EU expansion in 1995 and again in 2004 on the growth of the manufacturing sector in accession countries (Stehrer and Stöllinger 2015). As a result of the enlargement of the EU, there has been an increase in production sharing between the old EU members and countries such as Poland and the Czech Republic. Proximity to Germany and low production costs have made these countries more suitable locations for firms to locate their manufacturing activities. Free Trade Agreements increase the level of bilateral trade flows (Baier and Bergstrand 2007). The effect of trade agreements on trade flows becomes even more apparent when we examine the impact of China's accession to the WTO on global trade.

Industrial policy Industrial policy also played a major role in influencing the rise of global value chains. The Maquiladora industries in Mexico is one example of the importance of industrial policy in shaping patterns in global production sharing. The Maquiladora industries refer to industries producing under an arrangement in which production plants located on the U.S.-Mexico border were permitted to import "duty-free inputs from the United States and thereby only pay taxes on the value added in Mexico" (Gereffi 1998 p157). Under the U.S. tariff codes HS9802, firms in sectors such as the automotive, electronics and textiles industries could save on labor costs by exporting inputs to Mexico for assembly. These goods were then re-exported to the United States, paying duties only on the Mexican value added (Feenstra, Hanson, Swenson 2000). The elimination of tariffs under NAFTA increased the share of production taking place in Mexico's maquiladora industries (Bergin, Feenstra and Hanson 2008). The share of manufacturing employment in Mexico rose to 24.5 percent in 2004 from 4.1 percent in 1980.

Other examples of industrial policy measures that increased production sharing include:

- Export promotion policy

  The regional production network in East Asia started to emerge as early as the 1960s when Japanese multinational firms outsourced manufacturing to these countries. Export-led industrialization policies in Taiwan, Singapore, Hong Kong and Korea have contributed to the growth of *Factory Asia*. The establishment of export processing zones had a direct impact on the growth of global value chains. For example, in the 1980s, China implemented a series of reforms such as abolishing tariffs on imports for processing trade. The establishment of export processing zones in other countries in the region contributed to the growth of production networks (ADB 2013).

- Education policy

  Stiglitz (1996) identifies investment in engineering education as one form of industrial policy that helped to stimulate growth in East Asian countries. During the 1980s and 1990s, governments in Taiwan, Korea and Singapore invested heavily in expanding engineering studies as a means of stimulating growth (Cimoli, Dosi and Stiglitz 2009). Education policy was instrumental in transforming the industrial structure of these countries by facilitating knowledge transfer from foreign MNEs to domestic firms and fostering the development of a domestic IT industry.

  Similar patterns were observed in India. The establishment of technical universities such as the Indian Institute of Technology contributed to a growth in the level of human capital which in turn facilitated the growth of a domestic software services industry (Singh 2008). As a result, India was able to join the software value chain and has become an important player in the supply of software services.

5 Firms in the Global Value Chain

In sections 1.1 and 1.2 I discussed the growth of global value chains and traced the growth of production sharing at an aggregate level. This section shifts the focus towards the internal organization of the firm and discusses two main questions: where does production take place? And why do firms join global value chains? The section will begin with an overview of research examining the location issue. The section will conclude with a discussion of the determinants and effects of global sourcing at the firm level.

5.1 Global value chains and firm location choice

One of the earliest theories explaining why countries produced certain goods and imported others was put forward in the Ricardian theory of comparative advantage. Ricardo (1817) advances that, by specializing in the sector in which they are relatively more efficient, countries could increase consumption by engaging in international trade. In the two-good, two-country framework countries specialize according to their comparative advantage. It is therefore relatively straightforward to predict where production will be located. Almost a century later around the peak of the first wave of globalization, new thinking on international trade and comparative advantage aimed to explain why lagging countries such as Sweden were able to achieve convergence with Britain (Williamson 1996). Heckscher-Ohlin theory proposes that relative factor endowment, not technology, explains differences in trade patterns. A country will specialize in those sectors that use intensively those factors of production with which it is abundantly endowed. Differences

between countries' relative endowments, therefore, explain international trade patterns.

These theories did not square well with observed patterns of international trade in the post-war period. In the 1950s Wassily Leontief evaluated the relative skill and capital intensity of U.S. imports and exports. He found that contrary to the predictions of the Heckscher-Ohlin model, the U.S. exported labor abundant goods and imported capital abundant goods (Leontief 1953). Further, Balassa (1967) observed that trade flows were mainly intra-industry rather than inter-industry and that countries with similar technologies and similar factor endowments traded more intensively with each other. These observations sparked a debate among researchers (See Neary (2009) for a review of the origins of new trade theory). In the 1970s and 1980s, new trade theory showed that scale economies explained much of the observed patterns of international trade. The Heckscher-Ohlin and Ricardian theories of comparative advantage assumed perfectly competitive markets and constant returns to scale.

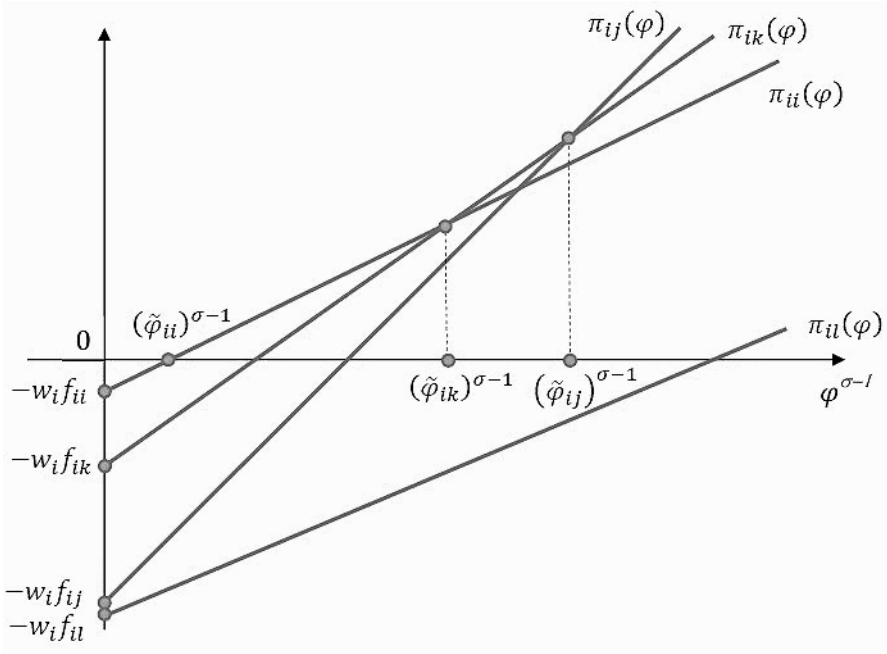
The monopolistic competition revolution in international trade theory allows for trade between similar countries in similar goods by accounting for factors such as increasing returns to scale, imperfect competition, and product differentiation. Allowing for increasing returns to scale explains intra-industry trade since exporting increases sales while decreasing average costs. Developed countries no longer specialize in different goods. Instead, they specialize in differentiated varieties of the same good (Helpman and Krugman 1985). This new approach allowed for foreign direct investment to be integrated into trade models.

The model by Helpman and Krugman (1985) treats all firms symmetrically which contradicts empirical observations in the 1990s (Antras 2015; Bernard et al. 2010; Bernard and Jensen 1999). Another drawback of the model proposed by Krugman (1980) is that it predicts that all firms will export to all countries in the world. This prediction is inconsistent with observation, as empirical studies show that not all firms become exporters. For instance, Bernard and Jensen (2004) find that, in 1992, only 31 percent of firms in the United States sold their products in foreign markets. Their findings also show that domestic sales exceed export sales and that there is a significant amount heterogeneity among firms that export. In particular, the top 1 percent of exporters accounted for 78.2 percent of trade in 1993 and 80.9 percent in 2000. Another critical insight from Bernard et al. (2009) is that exporters are more productive than non-exporters. These patterns are observed in other countries such as Germany (Bernard and Wagner 2001), Sweden, (Andersson and Lööf 2009) France (Bellone et al. 2009) among others (ISGEP 2007). These inconsistencies call for a new model that reflect the role of multinational firms in international trade.

Firms in international trade In a seminal paper, Melitz (2003) accounts for

heterogeneity among producers and incorporates this insight into the Krugman (1980) model to produce a new model of international trade. This model assumes that there are fixed costs associated with production as well as fixed costs of entering into exports. These fixed costs are identical across firms. In this model, a firm's ability to cover fixed costs of entry will determine whether it start to produce. Having entered the market, a firm's ability to cover the sunk cost of exporting then determines whether it will begin to serve foreign markets through exporting. Melitz (2003) assumes that firms draw their productivity from a Pareto distribution. A high productivity draw means that firms can charge lower prices, produce higher levels of output, capture a larger share of the market and earn more profits. In the model, there exist two productivity cutoff levels that determine whether firms produce and whether they will export. The main insights from Melitz (2003) are that opening up to trade raises the threshold productivity level for exporting which forces some firms to exit exporting. In addition, the least productive firms will be forced out of the domestic market entirely as increased labor demand by exporters drives up wages in the domestic market. Finally, Melitz (2003) shows that international trade raises aggregate welfare through its impact on productivity. Melitz (2003) does not account for multinationals, but the model has been extended by several researchers to analyze various features of multinational production and their effect on international trade.

Figure 7: Selection into offshoring



Source: Antras (2015)

Figure 7 illustrates the sourcing decisions of firms across four countries based

on the model by Antras (2015). Antras (2015) extends Melitz (2003) to model a multi-sector framework in which firms fragment production geographically into headquarter activities (skill-intensive services) and manufacturing activities. Antras (2015) relaxes the assumption that there are fixed costs associated with exporting and focuses instead on the decision to offshore production. There are, however, fixed costs associated with locating production abroad and these fixed costs are higher than the cost of producing domestically. As in Melitz (2003), firms first observe their productivity levels and then decide whether to start producing. Among market entrants, only the most productive firms will be able to offshore production. The model predicts that the least productive firms will choose to source manufacturing in the home market (country i) since the fixed costs for sourcing domestically are lower. Conversely, no firm will choose to outsource to country l since both fixed and marginal costs are high. The fixed costs of producing in-country j ($-w_i f_{ij}$) are higher than production in country i and country k. However, country j also offers lower marginal costs of production. Therefore, the most productive firms will gain by offshoring to country j. Firms with intermediate productivity levels (greater than the cutoff for country i but less than the cutoff for country j) will offshore to country k where marginal costs are lower than domestic sourcing and despite the slightly higher fixed costs.

What determines the international location of production? There is a rich body of literature exploring the location decision of multinational firms. The model by Antras (2015) assumes that production costs are the only consideration when deciding among locations. Theories explaining the location decision of the multinational firm date back to the 1960s. The Product Life Cycle Hypothesis is one of the first attempts to account for the role of geography in explaining why multinationals arise. Vernon (1966)'s Product Life Cycle Hypothesis was an attempt to explain some developments in the world economy. These include increasing economic integration in the developed world as well as development policies by developing countries. The Product Life Cycle also aimed to reconcile the inconsistencies in trade patterns exposed by the Leontief paradox. Vernon (1966) advances that multinationals often originate in the U.S. as factors such as high per capita incomes, high labor costs provide the incentives for entrepreneurs in the U.S. to invest in developing new products that are capital intensive. During the introduction phase (Phase I), entrepreneurs will choose to locate in the home markets to remain close to consumers, suppliers and competitors as well as to sources of knowledge.

Vernon (1966) then proceeds to explain why multinational firms arise. Factors such as growing demand for the new product in foreign markets provides incentives for firms to serve these markets by exporting. Firms compete on product differentiation. As production processes mature and a dominant design emerges, firms start to pursue cost savings and shift the location of production abroad. From this location, the firm serves the local market, the home market (the U.S.) and may even serve

third countries. To maintain their market share, competitors follow by relocating production overseas. This is referred to as the second phase of the product life cycle. Vernon (1966) argues that this generates a pattern of international trade in which the U.S. is a net exporter of more products whose production processes are still in the early phases of the product life cycle. Vernon (1966) argues that the product life cycle hypothesis answers the puzzles raised by Leontief (1953).

During the third and final phase of the product life cycle, production is more standardized. Firms compete on the basis of price rather than product differentiation. As a result, firms are concerned with lowering production cost during this phase. Developing countries have a competitive advantage in the manufacture of standardized goods due to lower factor costs. These cost differences provide incentives for firms to vertically integrate production in low-cost countries and serve the home market using exports (Vernon 1966).

Another well-known theory explaining the location choice of multinational firms is the OLI paradigm (Dunning 1977, 1981). The OLI paradigm identifies three factors that together shed light on the organization *and* location question. **O**wnership advantages refer to firm-specific assets such as technological know-how that are sources of market power for the firm. **L**ocation advantages describe specific features of a country, region, or city that offer benefits for locating abroad rather than at home. These may include access to natural resources or benefits from co-location with other firms (agglomeration economies). The third and final aspect, **I**nternalization advantages, refers to factors that motivate firms to choose vertical integration in foreign locations. This theory has formed the basis for future work on the location pattern of multinational firms.

The knowledge-capital model combines insights from the OLI paradigm with two main trade theories explaining multinational location choice (Markusen 2002). These include the horizontal theory of FDI (Markusen 1984; Brainard 1997) and the vertical theory of FDI (Helpman 1984). The horizontal theory of FDI predicts that multinational firms will locate where transport and trade barriers costs are high. Geographical dispersion often involves a trade-off between economies of integration foregone and gaining access to large markets (Navaretti and Venables 2004). In this framework, low plant-level scale economies and high firm-level scale economies help to explain gains from replicating operations in foreign countries (Markusen 2002). Finally, in the Horizontal theory of FDI, firms will locate in countries with similar factor costs as the home country.

The vertical theory of FDI posits that cost considerations explain why firms locate overseas. In this setup, there are differences in factor cost intensities between stages of production. Firms will, therefore, choose to locate a particular stage in a country that offers cost advantages. Therefore, multinationals' location patterns are based on differences in factor endowments. Trade costs are important in this theory in

that low trade barriers and transport costs are favorable for firms wishing to ship inputs between countries (Helpman 1984). The knowledge-capital model argues that scale economies at the firm-level help to influence its chosen organizational form. These scale economies are derived from fixed costs or ownership advantages (firm-specific assets). Two additional assumptions of the model are that knowledge capital is a public good and that the firm can separate knowledge production from its other activities and exploit knowledge across locations. Finally, the model assumes that multinational firms' headquarter operations are skill intensive and will locate in countries where skilled labor is abundant.

Table 2: Theories explaining multinational location choice

Theory	**Motive**	**Optimal Location**
Product Life Cycle (Vernon 1966)	Phase I: Introduction Phase II: Expansion Phase III: Cost saving	Home market (U.S.) Large foreign markets Low cost locations
OLI paradigm (Vernon 1977)	Resource-seeking Market seeking Strategic asset seeking	Natural resource-rich locations Large markets Technologically advanced countries
Horizontal FDI (Markusen 1984)	Market access	Large markets with High tariffs and/or High transport costs
Vertical FDI (Helpman 1984)	Low factor costs	Low-cost locations Locations with low trade barriers and low transport costs Comparative advantage in low-skilled activities
Proximity-concentration hypothesis (Brainard 1997)	Increase subsidiary sales Economies of scale	Locations with high trade costs High transport costs Home market

The knowledge capital model predicts that vertical multinationals will arise when it is possible to fragment activities and when factor intensities and factor costs differences are important (Markusen 2002). Horizontal MNEs, on the other hand, will arise when knowledge is a public good within the firm which the firm then exploits across locations. The proximity-concentration hypothesis is an empirical test of the horizontal and vertical theories of FDI that weighs the relative cost of being located close to large markets (proximity) with the cost of serving the market using exports (Brainard 1997). The predictions of each of these location models are summarized in Table 2.

Based on the prediction of each of the theories presented in Table 2, Navaretti and Venables (2004) summarize the factors influencing multinational location choice in the following expression:

$$Y_{ij}^{h} = f(X^{h}, X_{j}, X_{ij}, X_{ij}^{h}, X^{h} \times X_{i}, X^{h} \times X_{j}) + \varepsilon_{ij}^{h} \quad (1)$$

Expression (1) shows the relationship between home and host market characteristics and multinational location for firms headquartered in country i located in country j and operating in industry h. Factors typically captured by the variable X^h include: characteristics of the home country such as factor intensity or R&D intensity of the operations. The variable X_j represents host country characteristics such as market size, factor endowments, tariff rates, or government policies. Bilateral features such as proximity or cultural affinity are captured by X_{ij}. The specification also accounts for the role of country-industry interactions. This is captured by the terms $(X^h \times X_j)$ and $(X^h \times X_i)$.

Empirical research on the location patterns of multinational firms shows that FDI follows the predictions from gravity equation. That is, bilateral FDI flows vary positively with between GDP similarity and negatively with bilateral distance. Chen (2011) studies the location patterns of French multinational firms and finds that the location of MNE production networks depends on the relationship between trade costs and distance to final consumers. Multinational firms produce intermediate inputs in locations where trade costs are relatively low (vertical fragmentation). On the other hand, high trade costs motivate firms to locate final good production close to consumers. Multinational location behavior, therefore, reflects a more network-like structure rather than strictly vertical or horizontal patterns. Another empirical study on the location patterns of MNEs finds that multinationals tend to agglomerate in space (Alfaro and Chen 2014). Alfaro and Chen (2014) find that multinationals tend to cluster together, and these agglomerations patterns are not driven by the location patterns of domestic firms. They show that headquarter firms in particular show strong tendencies to co-locate. Alfaro and Chen (2014) attribute these patterns to "vertical production linkages... technology diffusion and capital market externality." (Alfaro and Chen 2014, p 36).

5.2 Global value chains and the organization of firms

One main weakness with the theories discussed in this section is that they address only one aspect of global production. The PLC, OLI and knowledge-capital model focus on explaining where multinationals will locate subsidiary plants. To gain a complete picture of the location of production, one that explains more complex patterns of trade, a new class of models combines industrial organization theories with theories of international trade.

The use of organizational theory to study multinationals dates back to Hymer (1960) who broke away from traditional trade theory by arguing that market failures, not interest rate differentials were responsible for the development of the multinational firm (Dunning and Rugman 1985). Hymer (1960) put forward a theory that

emphasized the role of market failures in the development of multinational firms who leverage their size to supplant the market and eliminate the competition. The international business literature has since built on this hypothesis by framing the question through a transaction cost economics lens (Dunning and Rugman 1985). Internalization theory posits that market failures arise because of asset specificity, opportunism and bounded rationality and not for structural reasons as proposed by Hymer (Hennart, 2001). Market failure often leads to small numbers bargaining which provides an incentive for opportunistic behavior (Erramilli and Rao 1993). Thus, internalization theory extends Coase (1937) question and asks why do multinational firms exist? The theory has since been used to examine some issues including the entry modes of international firms using transaction costs economics framework (Teece 1986).

Transactions Cost Economics Analyzing how firms choose between integration and outsourcing in an international setting is the primary focus of the thesis and transaction cost economics provide useful tools to understand this issue by framing it in a "make versus buy" setup. In this framework, the firm and the market are seen as alternative governance structures. Firms are faced with a trade-off between production costs and governance costs associated with each transaction (Williamson 1985). That is, while market procurement may reduce production costs, these cost savings may be offset by cost related to establishing and maintaining a contractual relationship with a supplier. Firms make their organization decision based on the sum of production and governance costs associated with each form, in this case, vertical integration and outsourcing. Firms will outsource an activity only if the costs of outsourcing are lower than those associated with executing the transaction within the firm.

In explaining the organizational structure of firms, transaction cost economics goes beyond traditional neoclassical economic theory and analyzes the internal workings of the firm. Thus, the basic unit of analysis in this framework is the transaction, or as stated by Williamson (1985) p 19, "the economic equivalent of friction within the physical system". Williamson (1981) defines a transaction as having occurred "when a good or service is transferred across a technologically separable interface". Problems associated with the organization of firms are reinterpreted as primarily contracting issues. By framing organizational questions as contractual questions, transaction cost economics reduces the analysis to a fine level of detail, assessing the governance and production costs associated with each alternative (Williamson, 1989).

In this thesis, we evaluate the relative importance of production and transaction costs for the organizational decisions of multinational firms. Large multinational firms outsource to low-wage countries such as India, Bangladesh, and China, indicating that economizing on labor costs influence the location choice. Surely transaction costs must play a role in influencing the choice between equity invest-

ments and subcontracting functions within the firm to external parties. Williamson (1981, 1985) present an analysis of the various types of transaction costs inherent in commercial contracting. These costs together with the institutional environment of the host country help to determine the most efficient governance structure.

Drawing on organization theory, transaction cost economics takes into account human factors such as cognitive limitations and opportunistic behavior that may increase the complexity of a transaction. This represents a significant departure from neoclassical economics in which agents are assumed to be perfectly rational (Gravelle and Rees, 2004). Transaction cost economics does away with this notion and instead assumes that individuals are merely boundedly rational. The contractual man is rational to the extent that his objective is to choose the best alternative, but cognitive limitations impair his ability to consistently and accurately determine which option is most favorable (Williamson 1985). To this end, transaction cost economics assumes that all contracts are inherently incomplete as parties are not able to foresee all possible contingencies related to the transaction.

Despite the severe constraints presented by agents' bounded rationality, it does not in itself does prohibit the enforcement of comprehensive contracts (Williamson, 1981). Another human factor which represents a source of transaction costs is opportunism or unfair or dishonest behavior by either party. In the absence of opportunistic behavior, weaknesses in the contractual agreement (brought about by limited rationality) can be rectified when agents act in good faith and deliver on their promises. Opportunism in the transaction cost framework is similar to the neoclassical assumption that individuals act in their self-interest but differs in the sense that it allows for cases in which there is "self-interest seeking with guile" (Williamson 1981, p554). Opportunism may take the form of information asymmetry as a result of one party providing incomplete or deliberately misleading information. Transaction cost economics aims to analyze how opportunism can be reduced if not eliminated by implementing preventative measures such as choosing the most appropriate organizational structure whether contracting or integration. The threat of opportunism by external contractors makes internal organization a more attractive (less costly) option. Market competition in the form of large numbers bidding also greatly diminishes the threat of opportunistic behavior by suppliers (Williamson 1981).

Williamson (1985) identifies three factors which help to determine the transaction costs related to the nature of the contract. These include the frequency with which a transaction takes place and the ease with which a particular governance structure can respond or adapt to unforeseen events. Williamson (1989) refers to the latter as simply, uncertainty. The third and perhaps most important characteristic of contracts identified in the literature is the level of asset specificity. Williamson (1989) describes asset specificity as the degree to which parties to a contract invest in "durable, transaction-specific assets". These assets typically have greater value

inside than outside the contractual relationship which in effect changes the nature of a transaction from a large-to-small- numbers bidding (Lafontaine and Slade, 2007; Williamson, 1981b). Williamson (1985) discusses four categories of asset specificity: site specificity, physical asset specificity, dedicated assets and human capital specificity.

Asset specificity is all the more important as it in effect creates the need for private ordering between firms. Henisz and Williamson (1999) argue that while the institutional environment is important to define property rights[13] and establish a well-functioning judicial system, the existence of transaction-specific investment often results in a situation in which a buyer and a seller enter into an agreement that is not enforced by the courts. Thus, the main contribution of the theory is the recognition that not all agreements will take place within the institutional framework of the country due to shortcomings in human behavior and contractual incompleteness. Another advantage of using a transaction cost framework is that it allows us to study how contracts adapt over time to changing environments. Contractual duration and enforcement mechanisms provide clues into the ways in which firms respond to and safeguard against contractual hazards.

The relatively low costs of integration might suggest that vertical integration is always feasible; however, there are other concerns such as how to measure the quality of suppliers (Erramilli and Rao 1993). Search costs heavily impact the choice of organizational form for multinational firms. Hennart (2001) discusses the role of information assymetry between the firm and its suppliers and how this determines the choice of organization form. Firms seeking to purchase knowledge intensive services will find it difficult to evaluate the quality of suppliers since the only way a supplier can reveal its quality is by divulging valuable information free of charge. Hennart (2001) argues that the market for services displays characteristics similar to the market for lemons discussed in Akerlof (1970). When suppliers do not divulge information about their know-how, the purchasing firm will underbid. This makes a case for vertical integration as the efficient flow of knowledge between the firm and its subsidiary is rewarded. Neither party has an incentive to cheat.

Ex-post considerations are likely to influence organizational structure. The multinational firms faces additional costs related to monitoring the performance of overseas subsidiaries or suppliers – whichever organizational structure it so chooses. As the output of services is uniquely difficult to measure, the firm faces a problem with creating incentives to optimize output in the most cost-effective way. Moreover, the issue of contract duration is particularly relevant in the case of outsourcing (Crocker and Masten 1988). The firm is faced with the responsibility of evaluating

[13]One stream of literature argues that the property rights view of the firm when analyzing the interaction between multinationals and its affiliates and subcontractors. Antras (2005) proposes that, consistent with the property rights view of the firm, the boundaries of the multinational firm will be determined by the party that owns the residual rights to the most valuable asset.

the length of time for which a specific task will be valuable to the firm. Rapid technological change increases the importance of this issue. Firms will then have to, using sequential bargaining, assess at each period the value of a particular contract to determine the correct course of action. This evaluation will require the firm to determine the value of the contract relative to the costs of a breach (Masten, Meehan and Snyder 1991).

Empirical research on the effect of transaction costs on the organization firms across country borders spans the fields of industrial organization, international business and international trade. There are some papers showing that factors such as the role of political hazards (Henisz 2000), cultural proximity (Brouthers and Brouthers 2003), and judicial system (Nunn and Trefler 2007) influence the organizational form of firms. A cross-country study by Nunn and Trefler (2007) examines how differences in the institutional environment affect the occurrence of vertically integrated firms within the country. The authors make use of the property rights approach and find that an improvement in the institutional environment causes firms to integrate instead of outsourcing. This is, of course, contrary to transaction cost theory. Where institutions are weak, integration is more suitable (Henisz and Williamson 1999). Institutions do in fact matter for cross-border investments and in particular for services. One such example is the existence and enforcement of intellectual property rights laws. This is particularly relevant for knowledge intensive services such as research and development.

5.3 Global value chains and firm performance

Section 5.1 showed that being more productive is a pre-condition for entering into exporting or other more complex forms of internationalization. We now consider the reverse question: what is the effect of internationalization on firm performance? There has been much debate surrounding the effects of international trade on firm performance. This discussion dates back to the 1960s when proponents of the infant industry argument maintained that exposure to international trade would be harmful to infant industries in developing countries. On the other hand, supporters of export-oriented industrialization saw international trade as one way to secure technology transfer from technology-rich countries. In the context of global value chains, there are a number of ways in which a firm can gain from internationalization. The most obvious channel through which firms may benefit from fragmentation is by reducing the cost of production. Further, firms may gain access to a wider range of intermediate inputs which in turn may lead to higher productivity (Goldberg et al. 2013). Firms may also benefit from access to better technology and as a result become more innovative. Firms may also 'upgrade' along the value chain and produce more sophisticated products. This section surveys the

literature on the effects of global value chains on firm performance[14].

Productivity One of the earliest papers establishing a causal link between exposure to international trade and firm productivity was Pavcnik (2002). Using trade liberalization in Chile as a natural experiment, Pavcnik (2002) finds a positive effect of trade on plant-level productivity. At the aggregate level, opening up to trade results in a reallocation of market share towards more productive firms as less productive firms exit the industry. What is the specific channel through which trade induces productivity improvements? De Loecker (2007) reports that Slovenian firms that start exporting become more productive as a result. This supports the hypothesis that firms learn by exporting. However, this hypothesis does not find broad support in the literature. In a study on the effects of exports on Swedish firms, Andersson and Lööf (2009) find no evidence supporting the learning-by-exporting hypothesis.

In addition to learning by exporting, there may be a direct relationship between gaining access to intermediate inputs and firm-level productivity. Goldberg et al. (2013) find that trade liberalization increased Indian firms' imports of intermediate inputs and that this, in turn, resulted in higher productivity. Trade may have a positive effect on firms performance due to the presence of technology transfer which encourages firms to innovate (Colantone and Crinò 2014; Bustos 2011). Other studies examining the effects of trade on performance include Bloom et al. (2016) who find that import competition from China induces European firms to become more innovative.

The effect of participating in the global value chains varies across firms. Görg and Hanley (2004) find that only larger firms experience an increase in profitability as a result of sourcing intermediate inputs from external suppliers. Kohler and Smolka (2009) take the analysis one step further and examine the relationship between the productivity level of the firm and the chosen sourcing strategy (domestic versus international sourcing). They rank firms according to the productivity premia associated with each sourcing strategy. Firms that source internationally within the affiliate group are the most productive, followed by firms that pursue foreign outsourcing, domestic insourcing and domestic outsourcing, respectively (Kohler and Smolka, 2009). Görg et al. (2008) find that there is a positive relationship between international sourcing and productivity for exporters while sourcing has no effect on firms that do not export.

Innovation More direct evidence of the impact of global value chains on firm performance is presented in Iacovone et al. (2015) who study the effect of Walmart's entry into Mexico on the performance of Mexican suppliers. They find

[14]There is a large literature on the spillovers from FDI. These studies focus on the effect of multinationals on the host economy. This will not be addressed in this section. See for example Görg and Strobl (2001) for a review of this literature

that Walmart's Mexican suppliers invested in product improvement in response to the firm's entry into the Mexican market. Alcacer and Oxley (2012) investigate a so-called *Learning by Supplying* hypothesis that states that suppliers to large firms in the mobile technology industry learn from this buyer-supplier relationship. Their results show that outsourcing does indeed have a positive effect on the number of patents granted to supplier firms.

MacPherson (1997) examines the effect of service outsourcing on product innovation of manufacturing firms. The author distinguishes between firms located in metropolitan areas with a high concentration of service suppliers and those located in peripheral regions. He finds that manufacturing firms that purchase services from external suppliers introduce more new products to the market than vertically integrated firms. This, however, depends on the specific activity that is outsourced; outsourcing industrial design is positively related to the level of product innovation while outsourcing advertising has no such effect. This result was consistent across regions.

This section has traced the origins and growth of global value chains and examined existing research on the factors influencing firms' decision to enter foreign markets, where they locate and the consequences of globalization for firm performance. The remainder of the thesis comprises four essays on developments in global value chains and their implications for the organization of firms. The following section summarizes the main contribution of each paper. Section 7 then discusses of the major limitations of the thesis and suggests how future research can address these concerns.

6 Summary of Papers 1-4

This section presents the four research questions answered in this thesis. Each research question is addressed separately in the four papers found in Part II of this thesis. The section includes an overview of certain key aspect of each of the papers and summarizes the main findings. Paper 2 is co-authored with Martin Andersson and Paper 3 is co-authored with Shahid Quoreshi.

6.1 Paper 1

International Outsourcing and the Global Value Chain: Evidence from Sweden

In section 3, I discussed the importance of measuring trade in terms of value added rather than using gross exports. The section also discussed major breakthroughs in documenting and analyzing the extent of global production

sharing. Paper 1 is set against the background of the recent push to measure trade flows in terms of value added rather than gross exports. The paper aims to study patterns in Sweden's domestic value added as a ratio of total export ratio over time. The paper uses the method set out in Koopman et al. (2012) to determine the the extent to which Swedish firms are integrated in global value chains. Paper 1 then analyzes the how the international orientation of Swedish industries have changed over time. To this end, the main research question is: What is the effect of global value chains on the pattern of Swedish imports and exports?

Purpose and Contribution

The paper analyzes the contribution of foreign value added to Swedish export growth between 1995 and 2011 to shed light on recent developments in the geography of production of Swedish manufacturing firms. The paper analyzes how this change then influences the Swedish trade patterns by examining importing and exporting behavior of Swedish firms in the manufacturing sector.

The main contribution of this paper is that it is able to give a detailed picture of global value chain participation at the level of the firm. By analyzing the contribution of foreign value added to Swedish export growth, the paper also contributes current understanding of how the changing geography of production influences Sweden's specialization patterns.

Main Findings

Paper 1 shows that Swedish industries have become more integrated in the world economy since 1995. The share of foreign value added in gross export has increased over the period, which implies that a greater share of exports is attributed to imported inputs. Another important finding is that Swedish firms have become more specialized in downstream stages of the value chain. The import and export behavior of manufacturing firms shows that global production fragmentation is associated with a shift towards downstream activities for Swedish manufacturing firms. This ties back to the discussion on the distribution of value added across regions. Advanced economies increasingly specialize in very early or very late stages of the global value chain where the value added tends to be higher. Finally, the paper shows that trade costs continue to shape the pattern of trade flows. High trade barriers have a negative effect on industries that are located upstream the value chain.

6.2 Paper 2

Global Sourcing and Technical Efficiency: a firm-level study on the ICT industry in Sweden

In section 5.3, I discussed the effects of internationalization on firm performance. Papers in this stream of literature find that there are heterogeneous effects of globalization on firm performance. Paper 2 focuses on the ICT manufacturing sector and investigates the effects of global sourcing on firm peformance. This paper builds on the findings presented in Paper 1 showing that that the Swedish ICT sector is one of the most globalized sectors in terms of the share of foreign value added in total exports. Paper 2 examines how the global sourcing patterns of Swedish ICT manufacturing firms influence their performance. To answer this broad question, the following issues are addressed: Does global sourcing increase the efficiency level of ICT manufacturing firms? Does global sourcing explain differences in firm performance?

Purpose and Contribution

To measure performance, Paper 2 estimates the technical efficiency levels of manufacturing firms in the ICT sector using Stochastic Frontier Analysis (SFA). This method measures each firm's deviation from its optimum output and computes where a firm lies in relation to the frontier. The paper then investigates the effect of global sourcing on the performance of firms in the ICT sector. A firm is said to be deeply integrated in the global value chain if it imports a greater number of intermediate inputs from a greater the number of source countries. Paper 2 uses two main measures of import diversification. These include the Herfindahl index and the entropy measure of diversification, which capture the dispersion in a firm's sourcing networks as well as the relative importance of each source country in a firm's production.

Main Findings

We find that ICT manufacturing firms that are more heavily involved in international sourcing are indeed more efficient than their peers. We decompose our measure of imports to capture the effects of importing from a greater number of source countries (across-country entropy) and a greater number of products from each country (within country entropy). All measures indicate that being more deeply integrated into global value chains is associated with better performance. The second aspect of this paper relates to industry-wide heterogeneity. We find that firms that are closer to the industry frontier tend to import a higher number of inputs.

6.3 Paper 3

Do Global Value Chains Make Firms More Vulnerable to Trade Shocks? Evidence from manufacturing firms in Sweden

The third paper in this thesis focuses once more on the effects of global value chains on firm performance. However, Paper 3 differs from Paper 2 in that this paper examines the effect of the financial crisis on firm performance. An emerging stream of literature shows that global value chains have contributed to greater business cycle synchronization between countries. Global value chains can therefore transmit business cycle conditions across countries by influencing the demand for imported inputs along the value chain. This paper examines the effect of the Global Financial Crisis of 2008-2009 on the performance of Swedish manufacturing firms.

Purpose and Contribution

The Global Financial Crisis of 2008-2009 resulted in the steepest decline in international trade since the Great Depression. Studies on the effect of the crisis on international trade argue that international production fragmentation helped to worsen the effect of the crisis on trade flows. However, there is a paucity of studies addressing the consequences of the falloff in trade from the perspective of the firm. This paper examines the response of Swedish firms to the global financial crisis and studies how global value chains influence the relationship between firm performance and trade shocks.

Main Findings

We find that firm performance –measured as domestic and foreign sales growth as well as value-added growth– declined during the crisis. Our findings also reveal that the crisis had a more adverse effect on firms operating in industries with stronger trade linkages. We interpret this to mean that greater business cycle synchronization implies that Swedish manufacturing firms may become more responsive to external risks as a result.

6.4 Paper 4

Institutional Quality, Knowledge Intensity and Multinational Location Choice: Evidence from Developing Countries

Section 3 discusses the distribution of value added across stages of pro-

duction and how this works together with the location patterns of multinational firms to determine the distribution of value creation across space. Paper 4 studies the location aspect of global value chains by investigating the factors influencing multinational location behavior across developing countries. The paper sheds new light on the question: Why do firms locate in some countries and not others? The paper focuses on the role of institutions in determining where multinationals locate and addresses the following question: What is the effect of institutions on the number of multinational entries in developing countries?

Purpose and Contribution

Since the mid-to late 1990s the share of FDI invested in developing countries has grown tremendously. However in recent times there have been some important changes in the pattern of FDI globally. Developing countries are becoming important sources of FDI flows and currently account for more than 50 percent of outward FDI. The number of multinational firms headquartered in developing countries has also grown.

This paper is one of a few papers documenting and analyzing the growth of FDI flows from developing countries. The paper analyzes the effect of institutional quality on the location patterns of multinational firms in developing countries. In addition, the paper compares the location behavior of multinationals from advanced economies and those from developing economies. A final contribution of the paper deals with the effect of knowledge intensity on the location decision.

Main Findings

Paper 4 shows that there is a negative relationship between institutional quality on the number of multinational entries in developing countries during the period 2005-2013. However, this effect differs according to the income level of the source country. Multinational firms from the global North choose to locate in countries with better institutions. In contrast, multinationals from the global South are less sensitive to institutional quality. Firms operating in knowledge intensive industries also prefer to locate in countries with higher institutional quality. These findings relate to the discussion in sections 5.1 and 5.2 that considers factors influencing multinational entry mode.

7 Suggestions for future research

One caveat to the findings in each of the four papers is that they apply to the specific cases considered. Paper 1 shows the evolution in Swedish manufacturing firms' participation in global value chains. The results pertain to the specific effects of value chain position on the types of goods a firm imports and exports.

However, the paper assumes away simultaneity in the relationship between firm characteristics and the value chain position of the goods a firm imports and exports. That is, the paper does not consider how the value chain position of Swedish firms affects factors such as investment in capital, investment in R&D or firm profitability. The excerpt at the beginning of this chapter alluded to investment in 3D printing as a way for firms in advanced countries to compete with low-cost locations. It is left up to future research to investigate possible simultaneity in this relationship between the globalization of production and investment in new technology.

Paper 2 studies the effect of global sourcing on technical efficiency of manufacturing firms in the ICT industry in Sweden. The paper considers the six-year spell between 2003 and 2008, which excludes the volatile years in early 2000s as well as the global financial crisis. Choosing a period of stability helps eliminate the effects external shocks. One caveat is that China acceded to the WTO in 2001 which potentially has long- term effects on international trade patterns. Future research could examine the effects of this policy change on firm-level technical efficiency.

Paper 3 studies the effect of trade exposure on the performance of manufacturing firms in Sweden during the global financial crisis of 2008-2009. The paper focuses on sales and value added growth as the key measures of firm performance. The main limitation is that the paper does not include information on the specific markets to which firms export. In addition, the paper does not consider the role of financial constraints in explaining the decline in firm performance during the crisis. On the other hand, bank health in Sweden did not deteriorate during the crisis. Therefore, the effect of finance on firm performance is not straightforward. Future research could try to untangle the relative effects of trade and finance on firm performance during the crisis.

Another caveat of Paper 3 is that it does not study the effect of trade exposure on firm performance in the period following the financial crisis. International trade flows returned to their pre-2009 levels as early as 2010. This provides another avenue for future research – how does exposure to trade influence firms' sales growth in the aftermath of the crisis? What are the major factors explaining firms' ability to recover from the downturn?

The final paper in this thesis focuses on a recent development in the location behavior of multinational firms. The growth in the number of multinationals located in developing countries challenges the dominant theories explaining multinational location choice. Using data on the number of multinational entries across all developing countries, Paper 4 studies how host country institutional quality influences multinational location choice. A limitation is that the paper does not consider the size of the investment in each country and therefore treats all observations equally. In addition, the paper does not take into account the specific mode of entry.

One avenue for future research is to examine the internal organization of MNEs in

order to determine how multinationals organize production in developing countries. There is a large literature on the factors influencing multinational firms' entry mode. However, the recent surge in the number of multinationals headquartered in developing countries warrants a re-examination of existing knowledge on multinational location behavior. Another direction for future research is to examine the effect of the increase in multinational investment in developing countries on trade flows. Is there a relationship between the growth in multinational entries and the composition of a country's trade flows? In addition, are there spillovers from FDI from developing countries?

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Part II

Papers 1 – 4

Paper 1

International Outsourcing and Global Value Chains: Evidence from Sweden

Trudy-Ann Stone

ABSTRACT

This paper uses input-output analysis to study the effects of global value chains on changes in bilateral trade patterns in Swedish firms and industries. Specifically, the paper quantifies the share of foreign value-added in Swedish production and exports. The findings show that industries have become more deeply embedded in global value chains. One important implication of this change is that the level of domestic production embodied in exports has declined. The paper uses firm-level data to examine how the position of Swedish firms in global value chains has evolved over time. The findings reveal that Swedish firms have shifted towards specializing in more downstream stages of the value chain and that Swedish imports are more upstream than its exports. These results indicate that global value chains have enabled firms to specialize in high value-added activities closer to final consumers. The final aspect of this paper deals with the effect of value chain participation on the pattern of trade flows and finds that trade frictions (distance) have a greater impact on international trade flows when industries are located upstream the value chain.

Keywords: International Trade, Exports, Globalization, Input-Output
JEL classification: F60, F14, R150

1 Introduction

International production fragmentation has given rise to new patterns of international trade in which intermediate inputs account for an increasing share of global trade flows (Hummels, Ishii and Yi 2001). Hummels et al. (2001) find that intermediate inputs account for 30 percent of the increase in world trade between 1970 and 1990. This growth in intermediate input trade is the result of broader changes in the way in which firms organize production. For instance, as companies continue to slice up the value chain across plants located in different countries, a product may cross country borders at various stages during the manufacturing process before reaching the final consumer. International outsourcing and offshoring have led to the rise of global value chains or global supply chains and have transformed the geography of production globally (Baldwin and Lopez-Gonzalez 2015). This paper examines the effect of global value chains on Swedish trade flows at the industry as well as at the firm-level. The paper analyzes how participating in global value chains have influenced the specialization patterns of Swedish firms and industries.

The internationalization of production has received a significant amount of attention in the media, and its effects are extensively debated (Blinder 2006). Global value chains allow firms to separate business functions along the value chain and spread these activities across several locations. One consequence is that firms in advanced countries increasingly specialize in high-skilled, non-manufacturing activities (Timmer et al. 2013). Global value chains may, therefore, alter specialization patterns and the industrial structure of countries and also help to shape factors such as the demand for skilled and unskilled labor. Additionally, participating in global value chains may influence firm performance. Firms may become more productive through learning-by-exporting (Bernard and Jensen 1999) or by gaining access to more advanced inputs (Goldberg et al. 2013). Therefore, analyzing the effect of global value chains on specialization patterns may help to inform policymakers on current trends in the structure of international trade and its effects on domestic production. Understanding the extent to which Swedish firms engage in value-chain trade can also yield insight into issues such as the changes in the skill composition of firms.

The purpose of the paper is three-fold. First, the paper analyzes the extent to which domestic production in Sweden depends on value-added produced abroad. That is, the paper examines production sharing between Swedish industries and foreign industries and analyzes whether changes in international fragmentation has influenced the growth in Swedish exports. To determine the role of global value chains, the paper focuses on the share of foreign value-added that is embodied in Swedish exports.

Second, the paper focuses on the international activities of firms and analyzes changes in the participation of Swedish firms in the global value chain. More than 70 percent of Swedish manufacturing firms export goods to foreign markets in a

given year, a remarkably high share that exceeds the export participation rate of most countries in the OECD (ISGEP 2007). The total share of firms in international trade is even higher when we account for firms that import. Andersson, Johansson, and Lööf (2007) find that 76 percent of Swedish manufacturing firms engage in international trade. Against this background, the paper investigates how the importing and exporting activities of Swedish firms determines their position in the global value chain. The paper uses product-level data on firms' imports and exports to analyze patterns in the participation levels of firms in the global value chain.

The increasing importance of global value chains in world trade demands a new approach to studying and measuring trade flows between countries (OECD and WTO 2013) since measuring trade flows in gross exports terms understates the level of interdependence among countries. In addition, gross export flows 'double count' foreign value-added embodied in the production of final goods (Johnson and Noguera 2012). Double counting occurs, for instance, when the production of a single good spans two or more countries. When the final good is exported for final use, customs data records the value of the good without accounting for the value of its constituent parts that were produced in countries that lie further upstream the value chain. As a result, the value of a production input manufactured in upstream countries is counted in trade statistics when it is first exported as an intermediate input and then as part of the final good. Johnson and Noguera (2012) and Koopman et al. (2014) develop two new methods to account for double counting and accurately attribute the value of exports to the appropriate country of origin. These methodological improvements propose that measuring international trade flows in value-added terms instead of gross export terms eliminates double counting. They also help to analyze the interlinkages between industries located in different countries and shed light on the importance of global value chains in driving the growth in international trade (Timmer et al. 2013; Johnson and Noguera 2012; Koopman et al. 2010; Hummels et al. 2001).

Previous research on global value chains has focused primarily on documenting broad patterns at the global level (Baldwin and Lopez-Gonzalez 2013; Koopman et al. 2010). Other papers look at the integration of developing countries like Mexico and China in the global value chain (Koopman et al. 2009; Koopman et al. 2008; Pula and Peltonen 2011). This paper instead focuses on Sweden: a small open economy in the European Union and analyzes how changes in the organization of production are reflected in the country's trade patterns. The paper is most closely related to a recent report documenting broad patterns in the skill composition of the Swedish labor force (Swedish Agency for Growth Policy Analysis 2014). Using detailed data at the firm-level, I analyze the specialization patterns of Swedish firms and show that Swedish firms increasingly import and export towards high value-added products. These findings may explain observed changes in the skill composition of the Swedish workforce.

The findings reveal that only 70 percent of Swedish exports are produced domestically– or that 30 percent of the value of Swedish exports is attributed to imports from abroad. Since 1995, there has been a steady increase in the share of foreign value-added in Swedish exports. Moreover, the share of Swedish imports that is embodied in the exports of third countries is also increasing, indicating a deeper level of trade integration. More importantly, Swedish firms have become more specialized in downstream activities. The findings also show that firms increasingly import and export products that lie downstream the value chain.

Quantifying the rise in international outsourcing is only the first step in understanding new trade patterns. The third and final purpose of this paper is to analyze the effect of participating in global value chains on the sensitivity of trade flows to trade costs. Yi (2010) puts forward that production fragmentation magnifies trade costs so that increases in trade barriers at upstream stages affects all other stages and produces a "home bias" in international trade. Accordingly, the effect of trade costs on total exports for an industry depends on whether the industry lies upstream or downstream the global value chain. The paper uses physical distance as a proxy for barriers to trade and international outsourcing. Distance captures the effects of direct trade costs such as transport costs, tariffs and non-tariff barriers to trade (Anderson and van Wincoop 2004). Distance also captures other frictions such as search costs and transactions costs that may decline with geographic proximity (Irarrazabal and Moxnes 2013; Keller and Yeaple 2013). Lawless (2010) finds that using country fixed effects, physical distance, and GDP sufficiently capture the effect of trade costs on exports. This paper, therefore, analyzes how these costs influence trade flows in the presence of global value chains. The results show that the effect of trade barriers depends on whether the industry lies upstream or downstream the value chain. In particular, upstream industries are more distance-sensitive than downstream industries.

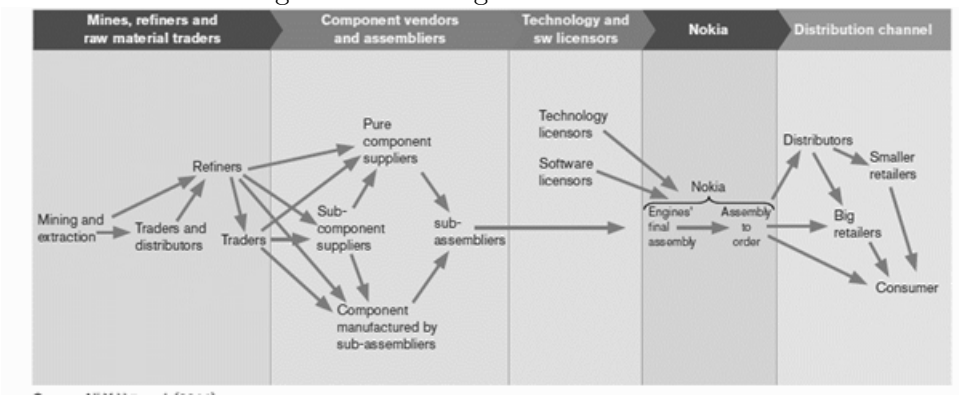
The rest of the paper proceeds as follows: Sections 2 and 3 show how we use input-output analysis to study international production fragmentation. Using the method described in Section 2, Section 4 studies the importing and exporting behavior of Swedish industries. Section 4 decomposes Swedish exports to show the share of exports that rely on production in other countries and what share of exports is domestically produced. Section 7 of this paper evaluates the effect of trade costs (distance) on trade patterns and how global value chains influence this relationship. The paper concludes with a discussion and analysis of the findings.

2 Measuring International Outsourcing

To illustrate the importance of international outsourcing in modern production systems, consider the case of Nokia by Ali-Yrköö et al. (2011) who provide a breakdown of the sequence of production and non-production activities that go into creating mobile phones by Nokia. Specifically, the authors identify five stages of

value creation that comprise the firm's value chain. These are illustrated in Figure 1. Remarkably, Nokia is only directly involved in assembly. All other upstream and downstream activities are carried out by third parties located both inside the home country, Finland, and abroad. The first stage of value creation consists of mining and extraction activities, and the dominant players are mines, refiners and distributors, and traders. Next, component vendors produce and supply electronic components to sub-assemblers. The third stage of value creation consists of service activities such as technology licensing. At the downstream stages, the handsets are assembled and subsequently delivered to consumers through distribution and retail channels.

Figure 1: Five stages of value creation



Source: (Kommerskollegium 2013)

Product level studies such as Ali-Yrkööet al. (2011) are informative in that they disassemble goods to show where the various stages of production take place. However, measuring international outsourcing at a more aggregate level is complicated by data limitations. An ideal dataset would contain information at the product level for all products and services to determine the location of production for all final goods and their inputs (Sturgeon et al. 2013). Examples of relevant data items include information on the cost of assembly, labor, materials and other inputs; the price consumers pay for final product; and the number of units produced as well as the location of each activity in the value chain. Such an extensive description of the production process would shed light on the geographical orientation of value-added trade (Sturgeon et al. 2013). In the absence of detailed data on global value chains, the international trade literature proposes several measures to approximate trade in value-added. This section presents three main methods for measuring production fragmentation between countries.

Recent research on production fragmentation argues that using intercountry input-output models provides a wealth of information on international production linkages. This class of models has been used to supplement data on bilateral trade flows to create inter-country input-output tables such as the World Input-Output

Database (WIOD)[1] Hummels, Ishii, and Yi (2001) is the first paper to use input-output analysis to quantify international outsourcing. They develop a measure termed "vertical specialization" (VS) that quantifies the share of a country's exports that is accounted for by imported intermediate inputs. Johnson and Noguera (2012) build on Hummels et al. (2001) and construct a ratio of value-added to gross exports (VAX ratio). Johnson and Noguera (2012) cite several drawbacks to using vertical specialization as a measure of production fragmentation. First, vertical specialization does not account for the situation in which a sector uses imported intermediate inputs but does not export. Second, vertical specialization does not account for value-added in a country that is absorbed by a third country. Hence, by assuming that a country's exports are entirely absorbed in the destination country, vertical specialization does not fully capture the interdependence in international trade. Also, the VS measure does not distinguish between final and intermediate goods in gross exports. The VAX ratio takes these concerns into account and measures the share of a country's exports that is produced domestically. A low value-added to exports ratio is evidence of international outsourcing as it indicates that the country relies on imported intermediate inputs to produce the goods it exports.

Koopman et al. (2014) combine the vertical specialization and VAX measures to decompose gross exports into domestic and foreign components. Specifically, they break down gross exports to capture the following five elements of value-added exports. These include domestic value-added in a foreign country's imports, domestic value-added in a foreign country's imports that is used to produce goods for third countries, domestic value-added in a country's imports that is then re-imported, and foreign value-added in a country's exports. Koopman et al. (2014) then define two important concepts: value chain participation and value chain position. The rest of this section will describe the method proposed by Koopman et al. (2014). Section 6 will then apply this method to analyze the growth of value chain participation by Swedish firms.

2.1 Implementation

This section illustrates how interregional input-output analysis can be used to measure production fragmentation between two countries. Interregional input-output tables have been used to answer questions such as how factor demand, economic growth or environmental degradation is influenced by patterns of international trade (Lenzen et al. 2012; Trefler and Zhu 2010). This paper focuses on the composition of Swedish exports by accounting for the share of foreign versus domestic value-added. The following example illustrates how the share of domestic versus foreign value-added in exports is measured using a two-country setting. This

[1]The OECD inter-country input-output tables and the Global Trade Analysis Project also provide data on inter-country production linkages.

method is then extended to account for the multiple-country setting as proposed by Koopman et al. (2014).

Two-country case

Assume there are two countries j and k and N sectors each producing one differentiated tradable good. In the two-country framework, all goods are used to satisfy consumer demand or as intermediate inputs in either country j or k. This can be expressed as follows:

$$X_{ij} = A_{jj}X_j + A_{jk}X_k + F_{jj} + F_{jk} \quad j,k = 1,2 \tag{1}$$

where the $N \times 1$ vector X_j refers to total output in country j , A_{jj} is an $N \times N$ matrix of intermediate input coefficients for all sectors in country j while A_{jk} is an $N \times N$ matrix of intermediate input coefficients for goods produced in country j that are delivered to k. The last two terms F_{jj} and F_{jk} are $1 \times N$ vectors of final demand for goods produced in j and consumed in countries j and k, respectively. Equation (1) above can be re-written more compactly in matrix form as:

$$\mathrm{x} = \mathbf{A}\mathrm{x} + \mathrm{f} \tag{2}$$

To solve the system of equations for total output in each country, rewrite (2) as:

$$\mathrm{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathrm{f} \tag{3}$$

where the Leontief inverse $M = (I - A)^{-1}$ measures the share of output in sector i necessary to satisfy a one unit of increase in consumer demand f. In a two-country setting, the Leontief inverse captures share of output in one country necessary to satisfy a one unit increase in final demand at home or abroad.

To obtain value-added for country j, subtract total intermediate inputs used in country j from total output. The result, v, is a 1xN vector where each element v_i measures total output minus intermediate inputs. The share of value-added in a country's gross output is, therefore:

$$\mathrm{vx} = \mathrm{v}(\mathbf{I} - \mathbf{A})^{-1}\mathrm{f} = \mathrm{v}\mathbf{M}\mathrm{f} \tag{4}$$

To obtain the share of value-added in a country's exports, define total exports as the sum of intermediate inputs and consumer goods produced in j and consumed in k or:

$$E_{jk} = \sum_j (A_{jk}X_j + F_{jk}) \quad j,k = 1,2 \tag{5}$$

The share of country j's value-added embodied in its exports to country k can, therefore, be expressed as the product of the value-added vector, v, the matrix of Leontief inverse, $\mathbf{M}$, and the vector of gross exports from country j, E.

Hummels, Ishii and Yi (2001), Johnson and Noguera (2012) and Koopman et al (2014) measure value-added in a country's exports according to the following matrix:

Value-added share of exports =

$$\begin{pmatrix} V_1 & 0 \\ 0 & V_2 \end{pmatrix} \begin{pmatrix} M_{11} & M_{12} \\ M_{21} & M_{22} \end{pmatrix} \begin{pmatrix} E_1 \\ E_2 \end{pmatrix} = \begin{pmatrix} V_1 M11 E_1 & V_1 M_1 2 E_2 \\ V_2 M21 E_1 & V_2 M_2 2 E_2 \end{pmatrix}$$

Extending the two country case to three or more countries

To analyze value-added trade in a more realistic setting, the three country case developed by Koopman et al.(2014) is used. The distinction is important as the interpretation changes when there are three or more countries since value-added produced in country j can be used in country k's production for export to a third country (Koopman et al. 2014). Extending the analysis to include three or countries makes it possible to measure value-added exported from j to k that is then re-imported by country j. This is crucial as production processes are not necessarily sequential. Baldwin and Venables (2013) argue that the pattern of production sharing between countries can be described as either 'spiders' or 'snakes.' Snakes describe sequential links in the value chain while spiders tend to feature complex inter-linkages between several stages of production. The case of Nokia discussed above is an example of a spider-like pattern of production. Other measures of fragmentation such as Hummels et al. (2001) assume a vertical structure in international production fragmentation and do not account for exports to third countries. The approach by Johnson et al. (2012) measures value-added as a share of exports but does not consider value-added from indirect sources.

Koopman et al. (2014) measure the share of value-added in a country's gross exports using the following expression:

Value-added share of exports=

$$\begin{pmatrix} V_1 M_1 1 E_1 & V_1 M_1 2 E_2 & V_1 M_1 3 E_3 \\ V_2 M_2 1 E_1 & V_2 M_2 2 E_2 & V_2 M_2 3 E_3 \\ V_3 M_3 1 E_1 & V_3 M_3 2 E_2 & V_3 M_3 3 E_3 \end{pmatrix}$$

The 3x3 matrix above allows us to separate value-added from domestic and foreign sources as well as indirect value-added from third countries. The clear advantage is that value-added in a country's exports can be decomposed into domestic, foreign and indirect value-added. Domestic value-added in a country's own production and consumption is given by the diagonal terms. For example, $V_1\ M_{11}\ E_1$ measures country 1's value-added as a share of its total exports. The remaining two sources

of value-added tell us where the value-added was produced and where the exports are absorbed. The first measure, foreign value-added as a share of total exports, is given as the sum of the off-diagonal columns of matrix. This tells us the share of a country's exports that is accounted for by value-added imported from foreign countries. For instance, the sum of $V_2\ M_{21}\ E_1$ and $V_3\ M_{31}\ E_1$ measures the share of country 1's gross exports that is attributed to value-added produced in countries 2 and 3, respectively. Finally, indirect value-added captures value-added in country j embodied in country k's exports to third countries. Indirect value-added is given by the sum of off-diagonal rows. To illustrate, the sum of the elements $V_1\ M_{12}\ E_2$ and $V_1\ M_{13}\ E_3$ gives country 1's value-added embodied in countries 2 and 3's gross exports to other countries. This measure also captures value-added that is re-imported by country 1.

3 Data

Data on the input-output structure of global production come from the World Input-Output Database (WIOD). This database covers 40 countries covering the EU27, North American Free Trade Agreement, (NAFTA), Brazil, India, Indonesia, Russia and China and the rest of the world for the period 1995-2011 and covers 85 percent of global output (Dietzenbacher et al. 2013). The data is aggregated to cover 35 industries in the manufacturing and service sectors. The WIOD distinguishes between intermediate and final goods traded between countries and this makes it possible to determine what share of Swedish exports is used as inputs abroad. The socio-economic accounts of the WIOD provide data on national income, and labor and capital compensation. Data on physical distance and gross domestic product (GDP) come from Centre d'Études Prospectives et d'Informations Internationales (CEPII). Finally, data on firms' imports and exports are obtained from Statistics Sweden (SCB). This data set is combined with data on firms' balance sheet which also come from SCB. Trade data are recorded using the Swedish Standard Classification of Products by Activity 2007 (SPIN 2007). This classification makes it convenient to match imports and exports to their source industries. Finally, firm-level trade data is matched with corresponding NACE industry categories used in the WIOD. Table 1 shows some descriptive statistics on firms included in the sample.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Year	2,340,211	2005.55	3.455	2000	2011
Industry	2,340,211	25.124	9.983	1	35
Upstreamness	2,340,211	2.018	0.744	1	3.914
Downstreamness	2,340,211	1.922	0.413	1	2.918
Number of employees	2,333,717	462.382	1,644.134	1	27,972
High skilled/total employment	2,333,717	0.281	0.190	0	1
Labor market area	1,918,979	16.457	15.615	1	75
Ownership type	2,340,211	2.180	0.901	1	4
Size	2,340,211	1.723	0.803	1	3
Import upstreamness	2,340,211	0.598	0.799	0	20.969
Export upstreamness	2,340,211	0.487	0.818	0	18.518
Export-import upstreamness	2,340,211	-0.0018	0.242	-3.914	3.914
Log(exports)	2,126,608	16.324	3.342	0	25.063
Log(imports)	2,320,575	17.449	2.510	0	25.059
Log(capital per worker)	2,314,977	11.571	1.457	-4.454	19.613
Log (average wages)	2,340,211	17.053	1.656	8.590	23.095
Log(sales)	2,340,211	19.245	1.820	0	25.515
Log(employment)	2,340,211	4.351	1.613	2.303	10.574
Log(value added per worker)	1,752,156	13.278	0.627	4.022	18.010

Source: Author's calculation using data from SCB

4 The Position of Swedish Industries in the Global Value Chain

Section 2 presents several measures used to evaluate changes in international outsourcing by analyzing how the share of Sweden's exports relying on imports has evolved over time. Section 2 also provides an outline of two measures of value chain position. This section implements these methods to analyze changes in the patterns of international outsourcing in Sweden by evaluating the contribution of foreign value-added to Swedish export growth. The results are presented in Column 1 of Table 2. In line with previous research on global value chains, the findings show that foreign value-added as a percentage of Swedish exports has increased over time (Swedish Agency for Growth Policy Analysis 2014). Between 1995 and 2011 the ratio of foreign value-added to gross exports increased steadily from 25.66% to 31.66%, indicating a deeper level of integration between Swedish industries and the world economy.[2]

[2]Appendix I shows the contribution of each of the 39 other countries in the WIOD to the growth in the share of foreign value-added in total exports by Swedish manufacturing industries. Germany, Russia, the United States, Denmark and the United Kingdom are the main sources of foreign value-added in gross exports from Sweden for the year 2011. Looking at the relative contribution of each manufacturing sector, one can see that mining, basic metals, electronics and account for the greatest share of foreign value-added (see Appendix).

The results in Table 2 reveal another interesting pattern: the share of Swedish production that is embodied as intermediate inputs in third countries is also rising. In particular, the share of indirect value added in gross exports has increased between 1995 and 2010. An increase in the share of indirect value-added in total exports represents a greater level of interconnectedness between Swedish industries and foreign industries and implies a growth in reflected value added (Swedish value added that is re-imported) as well as Swedish value added embodied in third countries' exports. Therefore, in addition to importing a larger proportion of their inputs (foreign value added), Swedish industries also produce output that is later used by households and firms in third countries (indirect value added). Figure 2 depicts recent trends in international outsourcing more clearly. There is a clear downward trend in the share of domestic production in total exports, and conversely, a rise in the share of foreign value-added.

Table 2: Value-added to gross export ratio

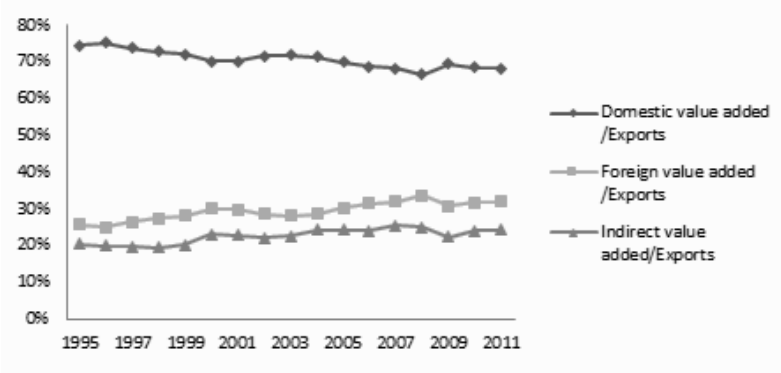
Year	Foreign Value-added in Gross Exports	Indirect Value-added in Gross Exports
1995	25,66%	20,24%
2000	29,83%	23,02%
2005	30,08%	24,08%
2010	31,66%	23,94%

Source: Author's calculation using WIOD data

It is important to point out that these changes in the ratio of value-added to gross exports are not due solely to volatility in export growth. That is, the rise in the ratio of foreign value-added to gross exports is due to a larger numerator and not a smaller denominator. One can think of this ratio as adjusting trade data for double counting. Table 2 shows that more than 30 percent[3] of the value of Swedish exports is due to double counting. Naturally, the extent/severity of double counting varies with the share of foreign value-added embodied in Swedish exports. Therefore, accounting for double counting in international trade statistics gives a more accurate depiction of the geography of international production – that is, accounting for double counting enables us to determine whether Swedish industries rely primarily on foreign inputs or produce inputs for further processing abroad? To fully understand the relative importance of foreign value-added in Swedish exports, the next section will analyze the position of Swedish firms and in the global value chain.

[3]Double counting is equal to the sum of foreign value added in gross exports and reflected domestic value added i.e. the portion of domestic value added that is re-imported as a final good

Figure 2: Changes in Domestic versus Foreign Value-added 1995 - 2011



Source: Author's calculation using WIOD data

5 Value chain Position and Participation

One of the main advantages of using inter-country input-output tables is that they allow us to determine the position of each industry in the global value chain. That is, it is possible to determine whether Swedish industries are located closer to suppliers or final consumers. The "upstreamness" of an industry indicates that the share of indirect foreign value-added exceeds direct foreign value-added in total exports. A country lies upstream the value chain for example if the country produces primarily raw materials for further processing in foreign countries. "Downstreamness" on the other hand means that direct foreign value-added is more important than indirect sources of value-added in a country's exports. That is, the country largely relies on inputs from foreign countries. The position of an industry in the value chain position is measured using the method put forward by Fally (2012):

$$\text{Input upstreamness } = \mathrm{x}^{-1}\mathbf{M}\mathrm{xi} \tag{6}$$

$$\text{Output downstreamness} = \mathrm{i}'\mathbf{M} \tag{7}$$

Where i refers to a vector of ones and, as before, **M** represents the Leontief matrix and x the vector of inputs. According to this measure, the "upstreamness" of an industry describes the distance between an industry and its suppliers while downstreamness measures the distance to the final consumer. Measuring the position of Swedish industries in the global value chain indicates whether Swedish industries produce output that is used mainly as parts and components for future assembly or goods that are ready for final use.

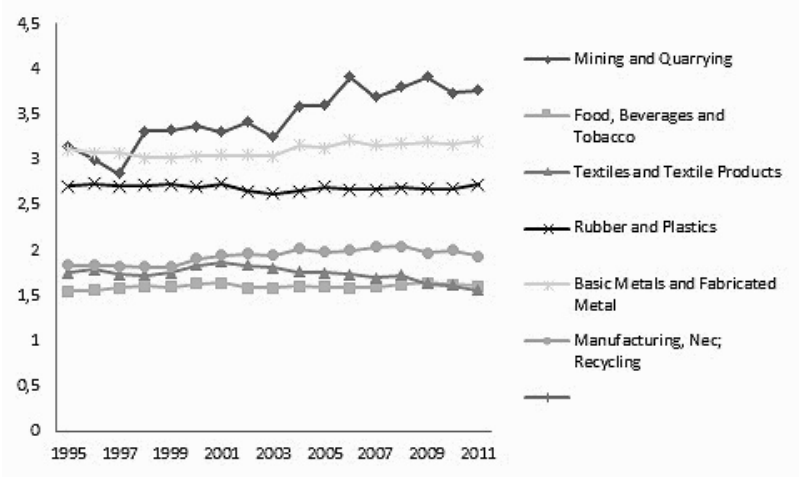
Comparing the relative contribution of foreign value-added and indirect value-added shows the value chain position of Swedish industries. This simple measure reveals whether an industry lies upstream or downstream the value chain. In the present terminology, downstreamness implies that foreign value-added is relatively

more important than indirect value-added. Table 2 shows that at the aggregate level, direct sources of foreign value-added play a greater role than indirect sources in Swedish gross exports for the years 1995-2011. In other words, Swedish industries are located downstream the global value chain. These findings are confirmed by Antras et al. (2011) and Miller and Temurshoev (2015) who show that more advanced economies tend to be located downstream the value chain while countries that lie upstream the value chain are mainly located in the global South. The findings reported in Table 2 reveal another important feature of international outsourcing by Swedish industries. The gap between foreign value-added and intermediate value-added is getting somewhat larger. This can be interpreted as evidence that Swedish industries are becoming even more downstream. That is, the results indicate that the role of imported intermediate inputs is becoming even more important in Swedish production.

While Swedish industries are located downstream the global value chain, there are significant differences between industries. For instance, for industries with strong supplier linkages, their position on the global value chain will be determined by the extent to which their output is used by final consumers in foreign countries. On the other hand, industries with strong forward linkages in the domestic market may lie downstream the value chain depending on whether they import a large share of their intermediate inputs. Comparing the share of foreign value-added to indirect value-added at the industry level tells us whether an industry lies upstream or downstream the value chain according to equation (7). At the industry level, the Swedish industries that lie upstream the global value chain include the services sectors, and within the manufacturing sector only the agricultural sector and the mining and quarrying sectors. All other manufacturing industries lie downstream the global value chain according to this measure.

Another way to analyze the position of Swedish industries is by calculating the distance to suppliers and the distance to final demand using the method proposed by Fally (2012). Equations (6) and (7) define input upstreamness and output downstreamness, respectively. A high value for output downstreamness indicates that the final product passes through a large number of production stages before reaching the consumer. Conversely, a high value for input upstreamness reflects the fact that a significant share of the industry's output is used as intermediate inputs further down the value chain. Figure 3 illustrates the three manufacturing industries with the highest and lowest upstreamness measures, respectively for the year 2011. The manufacturing industries that are closest to their suppliers are mining and quarrying, basic and fabricated metals and rubber and plastics. This is intuitive as these industries rely heavily on raw materials in the production processes, and their output is predominantly used as production inputs. The food and beverages and the textile industries have the lowest upstreamness measures, implying that these industries are furthest away from raw material suppliers.

Figure 3: Industries with the highest and lowest upstreamness measures 1995-2011

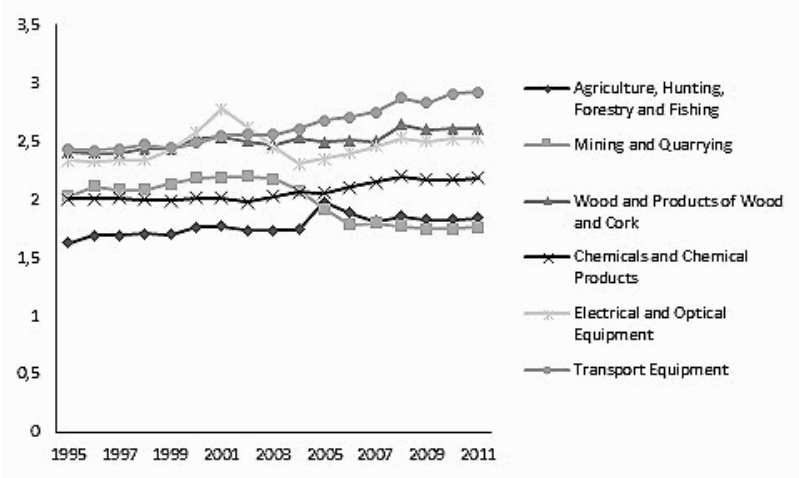


Source: Author's calculation using WIOD data

Figure 4 shows the three industries with the lowest and highest downstreamness measures, respectively for the year 2011. A large downstreamness measure means that the industry is located closer to the final consumer. The industries with the highest downstreamness measures are wood and wood products, electrical equipment and transport equipment. These three industries mainly produce final goods rather than inputs to production. In contrast to these consumer-oriented industries, the agricultural, mining and chemicals industries have the lowest downstreamness measures – that is, their output is predominantly used by other industries as inputs and not as final products.

These findings are consistent with expectations. Swedish industries have become more deeply integrated into global value chains since 1995. To get a more detailed picture of the developments in Sweden's trade patterns, the paper will examine how firms' imports and export patterns have changed over time. Specifically, the paper will examine the evolution in the value chain position of Swedish imports and exports as well as analyze the relationship firm characteristics and value chain position. For example, it is possible to determine whether larger firms or more productive firms find it profitable to become integrated into global value chains and whether they become more deeply integrated over time.

Figure 4: Industries with the highest and lowest downstreamness measures 1995-2011



Source: Author's calculation using WIOD data

6 Firm-level Evidence

The discussion above shows that Swedish industries have become more integrated into global value chains. This section builds on the industry-level analysis by highlighting the participation of firms in global value chains. This section evaluates the upstreamness of firms' imports and exports over time using detailed information on firms' import and export activities. Data on firms' imports and exports at the product level are mapped into the corresponding upstreamness/downstreamness measure for the industry. This is possible as Swedish trade flows are recorded using the SPIN 2007 classification while firms are categorized according to the Swedish Standard Industrial Classification 2007 (SNI 2007). The SNI classification describes the activities or production processes of firms while SPIN describes the types of goods and services that are produced. Each SPIN code is identical to the corresponding SNI code at the 5 digit level. To illustrate, SNI 17.111 refers to the "manufacture of mechanical or semi-chemical pulp" while SPIN 17.11.1 refers to products in the category "mechanical or semi-chemical pulp" (SCB)[4]. It is, therefore, possible to map each product code to the corresponding industry code and then use the relevant concordance table to assign Swedish SNI codes to NACE Rev.1 codes used by WIOD.

Following Chor et al. (2014), the position of a firm's exports in the global position as a weighted average of the firm's export upstreamness across industries can be expressed as follows:

$$U_{ft}^{X} = \sum_{i=1}^{N} \frac{X_{fit}}{X_{ft}} U_{it} \tag{8}$$

[4]See: http://www.sni2007.scb.se/

Where X_{ft} refers to firm f's total exports in year t; X_{fit} represents the firm's exports in industry i and period t. the variables U_{ft}^{X} and U_{it} represent firm and industry upstreamness, respectively. Similarly, the position of a firm's imports can be written as

$$U_{ft}^{M} = \sum_{i=1}^{N} \frac{M_{fit}}{M_{ft}} U_{it} \tag{9}$$

Where upstreamness at the firm-level U_{ft}^{M} is a weighted average industry upstreamness, U_{it}, of firm f's imports from industry i, M_{fit}, in total imports, M_{ft}.

The share of a particular product in a firm's total imports (exports) tells us the relative importance of that product in a firm's imports (exports). The share of each product is multiplied by its corresponding upstreamness score to get a weighted average upstreamness for each firm. To analyze trends in firm-level upstreamness over time, equation (10) is estimated.

$$Upstreamness_{ft} = \alpha + \beta_t Year + \gamma Z_{ft} + \delta_r Region + \delta_i industry + \varepsilon_{ft} \tag{10}$$

Where the dependent variable $Upstreamness_{ft}$ is defined in equations (9) and represents export upstreamness or import upstreamness for firms for the year 1995-2011. The variable Z_{ft} captures firm characteristics such as size and ownership structure. The variable $Year$ represents year dummies and captures trends in firms' value chain position over time. The variable $Region$ represents region dummies for local labor market areas[5]. Finally, firm dummies control for time invariant firm-specific characteristics.

Table 3 shows the findings when we estimate equation (10) using the upstreamness score for Swedish imports and exports. The findings show that Swedish firms' imports and exports have become more concentrated in downstream products since 1995. Columns 1 – 3 and 4 – 6 show that both exports and imports have become less upstream since 2000. The point estimates for the year dummies are negative and statistically significant, indicating a decline in the upstreamness score for each period reported. Column 1 shows the results when year and municipality dummies are included. The results indicate that within regions, the upstreamness measure of firms' exports decreased over the period 2000 to 2011. In Column 2, industry level dummies are included. The results are comparable to Column 1 and show that within industries the exports of firms became increasingly concentrated in downstream products. Column 3 then includes firm fixed effects to control for firm-specific characteristics that are not directly included in the specification. As in

[5]Koenig and Mayneris (2010) show that there are regional spillovers in firms' export patterns. Similar results were found by (Patelli 2015) who uses Swedish data to show that there are import spillovers at the sectoral and regional levels.

columns 1 and 2, the results indicate that both imports and exports have become less upstream over time as the point estimate for each period become much smaller compared to the results in Columns 1 and 2. In addition, when controlling for firm fixed effects, the size of the coefficients for each year dummy becomes less negative. However, the general pattern remains consistent: the exports of Swedish firms have shifted to downstream stages of the value chain.

So far, the discussion has focused on the value chain position of Swedish exports. However, a more detailed picture of firms' value chain position can be obtained by comparing the relative position of imports and exports. If both import and export upstreamness scores decline then this implies that firms' activities are concentrated in downstream stages. Comparing the results in Columns 3 and 6 reveals that export upstreamness has declined more rapidly than import upstreamness. This implies a shift towards exporting goods that are closer to final demand as well as importing inputs that are at more advanced stages of production (further away from raw materials). Columns 7-9 compare changes in exports and import upstreamness and reports the results when the dependent variable in equation (10) is equal to the difference in export and import upstreamness. The findings reveal that, for firms that both import and export, their imports tend to be more upstream than their exports. This is evident in the negative coefficient for the year dummies, indicating that import upstreamness declines more slowly than export. In addition, Table 3 shows that the gap between import and export upstreamness is larger for firms with high export volumes. These findings are consistent with the idea that Swedish firms are positioned closer to final demand. These results differ from Chor et al. (2014) who study the value chain position of Chinese firms. They show that Chinese firms' imports became increasingly upstream over time. This shift upstream indicates that Chinese firms increasingly participate in more stages of production (Chor and Manova 2014).

Table 3: The position of Swedish Firms in Global Value Chains

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Exports	Exports	Exports	Imports	Imports	Imports	Exports-Imports	Exports-Imports	Exports-Imports
Log(exports)	-0.008***	-0.009***	0.011***	-0.019***	-0.018***	-0.005***	0.0004***	0.0006***	0.0005***
	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.001)	(9.93e-05)	(0.0001)	(0.0002)
Swedish multinational	-0.093***	-0.079***	0.017	-0.069***	-0.058**	0.016	0.0003	0.001*	-0.004
	(0.027)	(0.026)	(0.020)	(0.026)	(0.026)	(0.013)	(0.0008)	(0.0008)	(0.008)
Foreign multinational	-0.136***	-0.133***	0.075***	-0.102***	-0.102***	0.033*	-0.001	-0.0007	0.006
	(0.026)	(0.025)	(0.026)	(0.026)	(0.025)	(0.018)	(0.0008)	(0.0008)	(0.010)
Unaffiliated firm	0.061	0.063*		0.018	0.022		-0.0007	-0.001	
	(0.040)	(0.038)		(0.039)	(0.039)		(0.002)	(0.002)	
2001	-0.004	-0.007	0.006	0.003	0.003	0.006*	-0.0003	-0.001*	-0.0006
	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.004)	(0.0005)	(0.0006)	(0.0005)
2002	-0.009	-0.002	-0.0006	-0.006	2.59e-05	-0.002	-0.0006	-0.001*	-0.0009*
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)	(0.004)	(0.0006)	(0.0005)	(0.0005)
2003	-0.027***	-0.029***	-0.014**	-0.012*	-0.013*	-0.009**	-0.001**	-0.002***	-0.001**
	(0.009)	(0.009)	(0.006)	(0.007)	(0.007)	(0.004)	(0.0006)	(0.0006)	(0.0006)
2004	-0.030***	-0.028***	-0.012*	-0.017**	-0.015*	-0.011**	-0.001**	-0.002***	-0.002***
	(0.010)	(0.009)	(0.006)	(0.008)	(0.008)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2005	-0.032***	-0.034***	-0.006	-0.019**	-0.024***	-0.003	-0.002***	-0.002***	-0.002***
	(0.010)	(0.010)	(0.007)	(0.009)	(0.009)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2006	-0.027***	-0.032***	-0.008	-0.010	-0.016*	-0.003	-0.001*	-0.001**	-0.001**
	(0.011)	(0.010)	(0.007)	(0.009)	(0.009)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2007	-0.038***	-0.046***	-0.012	-0.015	-0.024***	0.002	-0.001**	-0.002***	-0.002***
	(0.011)	(0.011)	(0.008)	(0.009)	(0.009)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2008	-0.037***	-0.045***	-0.004	-0.012	-0.021**	0.010*	-0.002***	-0.002***	-0.002***
	(0.012)	(0.011)	(0.008)	(0.010)	(0.010)	(0.006)	(0.0006)	(0.0006)	(0.0006)
2009	-0.035***	-0.043***	-0.007	-0.012	-0.021**	0.007	-0.002***	-0.009***	-0.002***
	(0.012)	(0.011)	(0.008)	(0.010)	(0.010)	(0.006)	(0.0006)	(0.0007)	(0.0006)
2010			-0.012			0.001			-0.001**
			(0.009)			(0.006)			(0.0006)

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Table 3 – *Continued from previous page*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2011			-0.019**			-0.005			-0.002***
			(0.009)			(0.006)			(0.0006)
Constant	0.779***	0.785***	0.340***	0.925***	0.903***	0.605***	-0.007***	-0.0104***	-0.008
	(0.047)	(0.048)	(0.036)	(0.045)	(0.048)	(0.021)	(0.002)	(0.00197)	(0.006)
Observations	1,750,198	1,750,198	2,126,608	1,750,198	1,750,198	2,126,608	1,750,198	1,750,198	2,126,608
R-squared	0.023	0.116	0.497	0.024	0.101	0.543	0.000	0.007	0.081

Note: Dependent variable is upstreamness of firm-level exports (Cols 1-3), upstreamness of firm-level imports (Cols 4-6) and upstreamness of exports-imports (Cols 7-9). All specifications include year fixed effects. Robust standard errors in parenthesis are clustered at the firm-level where * denotes p<0.10, ** denotes p<0.05 and *** denotes p<0.01

What is the effect of firm size and productivity on the firm's value chain position? There is a direct link between productivity and firms' participation in international trade. Previous research shows that productivity is a precondition for entering international markets and that exporters tend to be more productive than non-exporters (Melitz 2003; Wagner 2007). What then is the relationship between firm performance and the value chain position of its imports and exports? Table 4 reveals that, controlling for firm characteristics such as export sales and ownership type, firms exporting larger volumes also export and import more downstream products. The table also shows that firms that pay higher wages tend to import and export products that lie downstream the value chain. In contrast, capital intensive industries both export and import products that lie upstream the value chain. Table 4 presents the results when additional firm characteristics are included. Specifically, the table shows the results when value added per worker, and capital and skill intensities are included. Column 1 shows that firms that are more productive import more downstream products and export more upstream products. However, these results are not robust across specifications. When firm fixed effects are included, the variables capturing performance are no longer significant.

Table 4: The position of Swedish Firms in Global Value Chains

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Exports	Exports	Exports	Imports	Imports	Imports	Exports-Imports	Exports-Imports	Exports-Imports
Ln(VA/worker)	0.076***	0.054***	0.005	0.015	0.029***	0.005	0.0001	-0.0002	0.0009***
	(0.011)	(0.010)	(0.004)	(0.012)	(0.011)	(0.003)	(0.0003)	(0.0003)	(0.0003)
Log(avg wage)	-0.053***	-0.039***	-0.009	-0.074***	-0.063***	-0.028***	-0.0002	0.0002	-0.0001
	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)	(0.0002)	(0.0002)	(0.0005)
Log(cap/worker)	0.012**	0.004	-0.004	0.009	0.005	-0.006***	0.0005**	0.0001	-0.0003
	(0.006)	(0.006)	(0.003)	(0.006)	(0.006)	(0.002)	(0.0002)	(0.0002)	(0.0002)
Swedish multinational	0.037	0.011	0.013	-0.098***	-0.084***	0.013	0.001*	0.002***	-0.007
	(0.023)	(0.023)	(0.018)	(0.026)	(0.026)	(0.013)	(0.0007)	(0.0008)	(0.008)
Foreign multinational	-0.033	-0.059***	0.071***	-0.152***	-0.142***	0.034**	-0.0004	4.06e-05	0.007
	(0.023)	(0.022)	(0.023)	(0.026)	(0.026)	(0.017)	(0.0007)	(0.0007)	(0.009)
Unaffiliated firm	-0.078**	-0.060**		0.114***	0.096**		-0.0004	-0.001	
	(0.031)	(0.030)		(0.044)	(0.044)		(0.002)	(0.002)	
2001	5.20e-05	-0.0005	0.010	-0.0001	0.001	0.004	-0.0003	-0.0008	-0.0004
	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.003)	(0.0005)	(0.0005)	(0.0005)
2002	-0.006	0.0007	0.0053	-0.012*	-0.010	-0.006	-0.0005	-0.0007	-0.0009*
	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)	(0.004)	(0.0005)	(0.0005)	(0.0005)
2003	-0.028***	-0.027***	-0.008	-0.026***	-0.030***	-0.012***	-0.001*	-0.001**	-0.001**
	(0.009)	(0.008)	(0.007)	(0.008)	(0.007)	(0.004)	(0.0005)	(0.0006)	(0.0005)
2004	-0.032***	-0.025***	-0.006	-0.026***	-0.030***	-0.015***	-0.0010*	-0.001**	-0.001**
	(0.009)	(0.009)	(0.007)	(0.008)	(0.008)	(0.004)	(0.0005)	(0.0006)	(0.0005)
2005	-0.035***	-0.032***	-0.001	-0.023**	-0.035***	-0.004	-0.002***	-0.002***	-0.002***
	(0.010)	(0.010)	(0.008)	(0.009)	(0.009)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2006	-0.033***	-0.032***	-0.004	-0.014	-0.029***	-0.004	-0.0008	-0.001*	-0.0010
	(0.010)	(0.010)	(0.008)	(0.010)	(0.010)	(0.005)	(0.0006)	(0.0006)	(0.0006)
2007	-0.041***	-0.044***	-0.005	-0.009	-0.026**	0.002	-0.001	-0.001**	-0.001**
	(0.011)	(0.010)	(0.008)	(0.010)	(0.010)	(0.006)	(0.0006)	(0.0006)	(0.0006)
2008	-0.043***	-0.046***	-0.003	-0.004	-0.019*	0.012*	-0.001**	-0.002***	-0.001**

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Table 4 – *Continued from previous page*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	(0.012)	(0.011)	(0.009)	(0.011)	(0.011)	(0.006)	(0.006)	(0.0006)	(0.0006)
Constant	0.269	0.437**	0.591***	1.650***	1.316***	1.070***	-0.005	-0.004	-0.007
	(0.173)	(0.171)	(0.126)	(0.175)	(0.170)	(0.101)	(0.005)	(0.005)	(0.010)
Observations	1,713,249	1,713,249	1,734,782	1,713,249	1,713,249	1,734,782	1,713,249	1,713,249	1,734,782
R-squared	0.028	0.116	0.495	0.049	0.122	0.589	0.000	0.006	0.081

Note: Dependent variable is upstreamness of firm-level exports (Cols 1-3), upstreamness of firm-level imports (Cols 4-6) and upstreamness of exports-imports (Cols 7-9). All specifications include year fixed effects. Robust standard errors in parenthesis are clustered at the firm-level where * denotes p<0.10, ** denotes p<0.05 and *** denotes p<0.01

7 Value Chain Position and Trade Costs

The preceding sections show that Swedish firms and industries have become more integrated into global value chains. They also show that firms' imports and exports are primarily confined to downstream products. Additionally, imports tend to be more upstream than exports indicating that Swedish firms position themselves closer to the final consumer by importing intermediate inputs and exporting final goods. This is especially true for more productive firms that specialize in activities located downstream the value chain. In this section, the paper investigates whether the value chain position of Swedish industries makes them more or less sensitive to trade frictions. In particular, this section estimates the relationship between industry-level imports and value chain position using the gravity equation.

Previous research on the relationship between the share of foreign value-added in a country's exports and trade costs shows that accounting for value chain participation produces a higher distance coefficient compared to gross bilateral exports (Johnson and Noguera 2012b). In other words, value chains tend to be highly localized among groups of neighboring countries, reducing the role of trade frictions. Moreover, industries located further up the global value chain may suffer from a "magnification effect" brought about by changes trade costs. When production is fragmented, the cost of shipping inputs between countries multiplies with the distance to final demand when trade costs increase. As a result, shipping costs increase even more for industries that lie upstream the value chain. An increase in trade costs may, therefore, reduce the volume of international trade for these industries (Yi 2010). To test the effect of trade costs on Swedish trade in the presence of international outsourcing, this section analyzes the relationship between industry upstreamness and physical distance in explaining current patterns of Swedish imports. This is expressed in the hypothesis:

> **Hypothesis:** The imports of upstream industries are more distance-sensitive than the imports for downstream industries (due to the magnification effect).

To test the hypothesis, the log of industry-level imports is regressed on the interaction between industry position and distance, along with industry and country dummies. This approach has been used previously in Romalis (2004), Levchenko (2007) and Fally (2012). Starting with Romalis (2004), a long line of research has investigated sources of comparative advantage using an interaction variable specification. Nunn and Trefler (2013) review this stream of literature that uses the following specification:

$$y_{gi} = \alpha_i + \alpha_g + \beta(f * e) + \gamma X_{gi} + \varepsilon_{gi} \tag{11}$$

where the main parameter of interest β measures the interaction between, in the present case, the log of distance and value chain position, α_{gi} refers to industry i's exports from country g, α_i and α_g industry and country fixed effects and X_{gi} a vector of controls. X also includes standard gravity variables such as sharing a common border and membership in regional trade agreements. Equation (11) is estimated for the year 2005:

$$log(M_{ic}) = \beta_1 U_i log(distance_c) + \beta_2 D_i * log(distance_c) + \alpha_i + \gamma_c \qquad (12)$$

where M_{ic} represents imports by industry i from country c, the terms U_i and D_i represent industry up- or downstreamness while α_i and γ_c capture industry and country dummies, respectively. The main parameters of interest are β_1 and β_2 which capture the effect of the interaction between industry value chain position and physical distance on imports at the industry level. A negative coefficient for the interaction between physical distance and upstreamness, β_1 would confirm the hypothesis that trade costs have a greater effect on downstream industries. Also, a negative coefficient for the interaction between distance to final consumers (downstreamness) D_i and physical distance to trading partners supports the hypothesis that industries that are less downstream are more responsive to trade costs.

In addition to the specification in equation (12), value chain position also depends on a country's level of development. Thus, two additional terms capturing the effects of GDP on value chain position using the interaction variable specification described above are included in the regression equation (12). This specification has been used previously by Fally (2012) who finds that developed countries specialize in more downstream industries. Table 5 reports the results of equation (12).

Table 5 shows that the coefficient for the interaction between distance and downstreamness is negative and significant. This indicates that distance has a negative effect on industries that are further away from final consumers. This confirms the hypothesis that upstream industries are more distance sensitive. The findings also show that the interaction term between distance and upstreamness is positive and significant. This means that physical distance has a greater effect on industries that are closest to suppliers.

The regression results in Table 5 also show that there is a positive coefficient for the interaction between GDP and downstreamness indicating that richer countries produce goods that are closer to final demand which is consistent with expectations. Accounting for the effect of comparative advantage on trade flows changes the results only slightly: the interaction between distance and upstreamness is no longer significant. Overall, these results confirm that the rise of global value chains has helped to shape the pattern of trade flows for Swedish industries.

Table 5: The effect of trade costs on upstream and downstream imports

	(1)	(2)	(3)	(4)
Log(distance)* Upstreamness	0.106**		0.090*	0.086
	(0.048)		(0.053)	(0.071)
Log(distance)* Downstream	-0.282*		-0.550***	-0.529***
	(0.146)		(0.138)	(0.076)
GDP* upstreamness		0.041	0.019	0.014
		(0.025)	(0.029)	(0.036)
GDP*downstreamness		0.201**	0.335***	0.410***
		(0.078)	(0.076)	(0.039)
Skill abund* skill intensity				0.203**
				(0.096)
Cap. abund* Cap. intensity				0.004*
				(0.002)
Constant	-4.511*	5.073	1.020	-1.879***
	(2.464)	(3.230)	(3.539)	(0.442)
Observations	1,400	1,400	1,400	1,326
R-squared	0.779	0.776	0.785	0.687
Country FE	YES	YES	YES	NO
Industry FE	YES	YES	YES	YES

Note: Dependent variable is the log of imports for the year 2005. Robust standard errors in parenthesis where * denotes p<0.10, ** denotes p<0.05 and *** denotes p<0.01

8 Summary and Conclusions

This paper analyzes the evolution of Swedish trade in value-added using inter-country input-output tables. Using measures of production sharing that decompose the share of production that relies on imported intermediate inputs, the paper investigates whether Swedish industries have become more integrated into global value chains. This enables us to ask new questions about the relationship between international trade and a country's production structure. The findings reveal that Swedish industries are mainly located downstream the global value chain and that the level of integration with the world economy steadily increased between 1995 and 2011. That is, Swedish industries import inputs from other countries and produce output that is closer to final use. The main implication is Swedish industries largely specialize in high value-added activities downstream the value chain.

This paper also analyzes the position of Swedish exports and imports at the level of the firm. It is not unusual that a firm imports and exports a wide range of inputs and analyzing the relative contribution of these products to the firm's overall value chain position has shed new light on the participation of firms in international trade. The paper shows that the growth in foreign value-added in Swedish exports can be attributed to firms importing products that are more downstream the value chain. Such products tend to embody more value-added.

Previous research has long identified falling trade costs as one of the main explanations for the growth in production fragmentation. One of the weaknesses of this stream of literature was the inconsistent way in which fragmentation was measured. A final goal of this paper is to study the effect of trade costs on the pattern of trade in the presence of global value chains. To do this, the paper tests whether distance sensitivity of an industry is related to its position in the global value chain. The findings reveal that more upstream industries are indeed more sensitive to trade costs.

Despite the growing importance of global value chains in world trade, factor endowments are still a major driver of trade. Future research could unpack the determinants of outsourcing and identify the relative contributions of labor costs, access to inputs and access to knowledge and technology to changes in trade patterns.

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Appendix I

Figure 5: Decomposing foreign value-added by source country

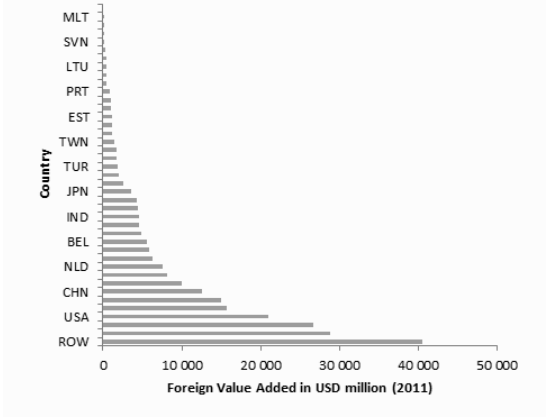
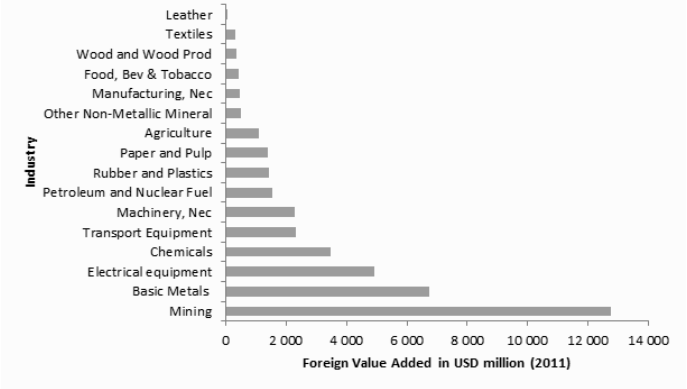


Figure 6: Decomposing foreign value-added by industry



Appendix II

Table 6: List of countries in the WIOD

	Country Code	Country Name
1	AUS	Australia
2	AUT	Austria
3	BEL	Belgium
4	BGR	Brazil
5	BRA	Bulgaria
6	CAN	Canada
7	CHN	China
8	CYP	Cyprus
9	CZE	Czech Republic
10	DEU	Germany
11	DNK	Denmark
12	ESP	Spain
13	EST	Estonia
14	FIN	Finland
15	FRA	France
16	GBR	United Kingdom
17	GRC	Greece
18	HUN	Hungary
19	IDN	India
20	IND	Indonesia
21	IRL	Ireland
22	ITA	Italy
23	JPN	Japan
24	KOR	Korea
25	LTU	Lithuania
26	LUX	Luxembourg
27	LVA	Latvia
28	MEX	Malta
29	MLT	Mexico
30	NLD	Netherlands
32	POL	Poland
33	PRT	Portugal
34	ROU	Romania
35	RUS	Russia
36	SVK	Slovak Republic
37	SVN	Slovenia
38	SWE	Sweden
39	TUR	Turkey
40	TWN	Taiwan
41	USA	United States

Paper 2

Global Sourcing and Technical Efficiency: a firm-level study on the ICT industry in Sweden

Martin Andersson
Trudy-Ann Stone

ABSTRACT

This paper employs stochastic frontier analysis to analyze the relationship between international sourcing, measured as imports of intermediate inputs, and the technical efficiency of firms in the Swedish ICT manufacturing industry. The main hypothesis is that global sourcing raises firms' capabilities to combine and re-combine inputs in productive ways, thereby increasing technical efficiency. We find a robust relationship between technical efficiency and international outsourcing. First, firms deeply engaged in global sourcing are closer to their own frontier (maximum output level). Second, firms engaged in international sourcing are also closer to the industry efficiency frontier. These findings are consistent with the hypothesis that a strategy to source globally stimulates firms' capabilities, for example, because of improved abilities to identify 'better' inputs and adoption of more efficient production and management practices.

Keywords: technical efficiency, outsourcing, offshoring, globalization, variety, learning, capabilities, recombinant capabilities, technology transfer, import
JEL codes: D22, F61, L63

1 Introduction

International outsourcing has grown considerably in importance in recent decades. Falling transportation costs, as well as reductions in costs associated with coordination and control of internationally fragmented production structures, have enlarged firms' possibilities to source inputs globally. By sourcing inputs from abroad, firms exploit global differences in comparative advantages across stages of production. These trends leave clear footprints in global trade patterns. Hummels et al. (2001) show that vertical specialization, defined as trade in intermediate goods that are imported and used to make goods that are later exported, is a key feature of recent globalization. Vertical specialization is indicative of a wider trend of the global disintegration of production and is one of the main factors driving growth in trade worldwide (Hummels et al. 2001).

Closely related to the growth in global sourcing is the evolution of the internal organization of firms since around the 1970s. Many firms have become less vertically integrated, resulting in increasingly fragmented production processes. Firms do not produce complete final goods, but rather modules that seamlessly integrate into a larger system. Aided by codification and standardization of tasks and routines, modular production systems are organized such that a good may be produced in stages by different firms (Baldwin and Clark 2000). For example, the production process for a personal computer can today be described as modular, where computer design, chip production, operating systems and final assembly are all carried out by different firms (Dedrick et al. 2007). Modular production systems have several advantages relative to more vertically integrated organizational forms. First, modularity eliminates the need to specialize in all stages of the production chain by enabling firms to benefit from the scale economies of their suppliers. Second, modularity gives rise to a greater degree of standardization which ensures that firms can access the right components or inputs for their needs (Sturgeon 2002).[1]

These developments have naturally led to an interest in economic consequences of global sourcing and internationally fragmented production.[2] A large literature has focused on issues concerning firm-level productivity and efficiency gains associated with the global sourcing and modularity. Even though there are several arguments in favor of a positive effect, empirical evidence is limited and has so far produced

[1] One of the earliest examples of a modular computer was the IBM System/360 (Baldwin and Henkel 2015; Ferguson and Morris 1993). The IBM System/360 was characterized by a high degree of flexibility so that devices such as disk drivers were interchangeable with other components. The IBM System/360 used a 'mixed and matched catalog of peripheral equipment' (Ferguson and Morris 1993) so that an entire family of computers could share the same components and software.

[2] Issues are broad and span, for example, "home" employment effects from international (or offshore) outsourcing (e.g Becker, Ekholm, and Muendler 2013) and the extent to which knowledge and technology spillovers, as evidenced for instance by patent citations, are mediated by global production networks (e.g. (Piermartini and Rubinova 2014).

rather mixed results (Amiti and Konings 2007; Bas and Strauss-Kahn 2014). There is still a dearth of empirical papers in this strand that focuses on the effects of global sourcing using firm-level data, and even fewer consider the role played by the characteristics and nature of import flows (van den Berg and van Marrewijk, 2013)van den Berg and van Marrewijk (2013).

This paper contributes to the literature with an analysis of the influence that global sourcing has on firms' efficiency. Drawing on the international business literature as well as recent literature on the origins of firms' capabilities, we argue that global sourcing stimulates efficiency because it influences firms' capabilities to combine and re-combine inputs in productive ways. We put forth two main reasons for this.

The first is that exposure to as well as interaction with a foreign supplier may stimulate knowledge and information spillovers, which help firms to expand and improve their capabilities. The strategic management literature argues that differences in firm performance can be attributed to differences in firm capabilities, as firms vary in their ability to recombine resources to create new products or to address new problems (Mahmood, Zhu and Zajac 2011; Dutta, Narasimhan and Rajiv 2005; and Gulati, Norita and Zaheer 2000). Capabilities refer to a firm's routines and internal coordination that enable the firm to "combine a number of resources [efficiently] to engage in productive activity and attain a certain objective" (Dutta et al. 2005, p278). Global sourcing can influence such capabilities because buyer-supplier interaction induces knowledge transfers. Such interaction may, for example, stimulate identification and adoption of 'best practice' in production processes and design, as well as putting firms in a better position to identify 'good' inputs that match their needs. Recent literature points to that suppliers play an important role in explaining firms' performance. Todo et al. (2016) find that that a more extensive and varied network of suppliers stimulates knowledge diffusion which improves the buying firm's productivity and innovation capabilities. Likewise, buyer-supplier relationships, such as joint problem-solving, have been found to constitute an important source of firms' capability-building as well as spillovers of knowledge between buyers and suppliers (Mahmood et al. 2011; McEvily and Marcus 2005).

Our second argument is that global sourcing increases the returns to capabilities to combine and re-combine inputs, i.e. so-called *recombinant* capabilities. The ability to combine inputs and other resources in new ways distinguishes more efficient firms from their lagging counterparts. The international business literature proposes that one of the main advantages of multinational firms is their ability "to augment in a productive fashion the [firm's] existing resource base with newly accessible resources" (Rugman, Verbeke and Nguyen 2011). We extend this argument and put forward that global sourcing makes firms more efficient when firms can recombine inputs so as to achieve even higher levels of production.

Engagement in global sourcing often implies that the production system of firms becomes more modular. Modular production systems increase flexibility and enable firms to combine inputs in new ways. Because of this, the returns, and hence incentives, to develop and strengthen recombinant capabilities grow. The experiences of the computer industry epitomize this interplay between modularity and returns to recombinant capabilities. In the 1980s, new entrants to the computer industry were able to take advantage of the modular design and imitated these individual modules or components to capture a significant share of the market. New firms such as Compaq were able to build their own computer by combining components from many different producers and erode the market share of the dominant firm, IBM (Baldwin and Henkel 2015; Ferguson and Morris 1993). Modularization thus raises the importance of recombinant capabilities. This discussion shows that the relationship between global sourcing and firm performance is not a mechanical one. Instead, the extent to which a firm becomes more efficient as a result of global sourcing depends, at least in part, on how it influences capabilities that are unique to each firm. The growth in international trade and the simultaneous modularization of production suggest that companies can access a wide variety of inputs from suppliers located in distant countries and that these inputs can be easily integrated into firms' manufacturing processes.

To test these ideas, we employ Stochastic Frontier Analysis (SFA) and analyze the effects of global sourcing on firms' efficiency. While most empirical studies measure firms' performance by conventional productivity measures, we examine firms' ability to combine inputs to attain a given level of output. That is, we estimate the efficiency with which firms can convert inputs to outputs, i.e. *technical efficiency*. Technical efficiency and productivity, though closely related, describe different aspects firm performance. Productivity refers to the ratio of output to input usage while technical efficiency relates to the level of output a firm manages to attain for a given input level.

Our use of technical efficiency is motivated by the theoretical arguments linking global sourcing to firms' capabilities. Technical efficiency has, for example, been used in recent studies in the strategic management literature as a way to quantify firms' capabilities (see Dutta et al. 2005; Mahmood 2011). In these studies, capabilities are conceived of as "the efficiency with which a firm employs a given set of resources (inputs) at its disposal to achieve certain objectives (outputs)" (Dutta et al. 2005, p.277). This is exactly what the technical efficiency of a firm aims to capture. Moreover, within industries, there tends to be a high degree of variation in firm performance as not all firms achieve the maximum level of output attainable (Kumbhakar and Lovell 2000). Sources of such efficiency heterogeneity include differences in the way firms organize and manage their production, as well as differences in terms of firms' ability to match characteristics of their inputs to their needs. These examples of firm-level attributes ultimately reflect differences in 'managerial capability.'

We employ firm-level data for the Swedish ICT manufacturing industry which allow us to, in quantitative terms, describe each firm's import network of inputs. The empirical analysis focuses on analyzing whether the variety and extent of firms' global sourcing network influence their technical efficiency. The findings reveal that there is a robust relationship between the global sourcing and technical efficiency for firms in Swedish ICT manufacturing. A greater variety of intermediate products imported as well as a larger number of source countries is associated with a smaller deviation from a firm's production frontier. This finding is consistent with the hypothesis that global sourcing improves firm-level technical efficiency. Similar effects are found when we measure the extensive margin of imports flows using alternative measures of diversification such as the Herfindahl index and the Entropy measure of diversification. These results highlight that imports alone may not be all that matters. We argue that our measures of extensive margin capture the 'deepness' by which a firm is integrated into the global economy and take part in global production networks. We conclude that firms have much to gain from integrating with the global economy and exploiting global patterns of specialization. A second result is that global sourcing appears to reduce a firm's distance to the industry frontier, defined according to the efficiency level of the most efficient firm in the industry. We also find that factors such as firm size and human capital influence distance to the frontier. Large firms as well as firms with a high share of skilled workers are closer to the industry frontier.

2 International trade and the performance of firms

There is a wide disparity in firm performance even in narrowly defined industries (Bloom, Sadun, and Van Reenen 2009). Identifying the factors explaining this disparity has been at the forefront of research in fields such as international trade theory, international business and organizational economics (Melitz 2003; Syverson 2010). A wealth of research has shown that there is a causal link between participating in international trade and firm productivity and that causality runs in both directions. Only the most productive firms can overcome the fixed and sunk costs associated with initiating trade with foreign markets (Melitz 2003), and, in turn, participating in international trade induces firms to become more productive (Pavcnik 2002; Andersson and Lööf 2009). Organizational economics argues that factors such as differences in management practices across firms account for much of the heterogeneity in firm performance (Bloom et al. 2009) Strategic management scholars focus on these specific practices and investigate, for example, how firms' sourcing strategies affect performance. In what follows, we review these three branches of literature to understand how managerial practices such as global sourcing explains not only firms' ability to produce on their productivity frontier but also the position of a firm relative to the industry frontier.

One of the most robust findings in the recent literature is that there is a great

deal of self-selection that determines which firms participate in international trade (Bernard et al. 2010; Melitz 2003). Since there are fixed costs associated with entering international markets, only the most productive firms can engage in international trade. Antras and Helpman (2004) model the choice between outsourcing, foreign direct investment and exporting to understand the factors determining how firms organize production across countries. The authors show that it is the combination of (1) productivity differentials between firms and (2) the differences in intermediate input intensity that generates different cross-border organizational forms. The model by Antras and Helpman (2004) predicts that in "component-intensive industries" outsourcing will be the dominant organizational form since the fixed costs associated with outsourcing is lower than FDI or integration. Whether firms will outsource to domestic or foreign companies depends on differences in variable costs abroad and fixed costs in the home country. The most productive firms will choose to import intermediate inputs from suppliers in the foreign country; the model also predicts that less productive firms obtain their inputs from domestic suppliers while the least productive firms exit the industry (Helpman 2006). In this model when there is a wide disparity in firms' productivity levels then firms will choose to outsource production to foreign suppliers.

Empirical tests of the relationship between importing intermediate inputs and firm performance show that there are positive effects associated with access a greater variety of inputs in terms of technology transfer, knowledge spillovers or lower production costs. Kasahara and Rodrigue (2008) find that Chilean plants that start importing intermediate goods become more productive as a result. Other papers show that firms who are deeply engaged in the international division of labor by both exporting and importing (so-called two-way traders) perform better than firms who only export (Serti and Tomasi 2014; Muûls and Pisu 2009; Andersson, Lööf, and Johansson 2008). Bas and Strauss-Kahn (2011) analyze whether importing inputs globally raises a firm's productivity and exports. They find that using foreign intermediate goods is associated with higher productivity for French manufacturing firms. Their estimates suggest that doubling the number of varieties of foreign inputs increases total factor productivity (TFP) by 4%. Their findings also show that firms using more imported inputs, and/or a more diversified set of inputs, export a larger number of varieties.

How does trade influence firm performance?

So far, we have seen that importing may contribute to productivity improvements for firms. However, what are the mechanisms through which international trade influences firm performance? The international trade literature identifies three main channels through which sourcing inputs globally may improve firms' performance. These include the quality, learning and variety effects. The quality effect suggests that sourcing inputs worldwide may allow firms to identify and employ higher quality intermediate inputs that are closer to the global technological frontier

(Imbruno 2015; Lööf and Andersson 2010)Imbruno (2015); Lööf and Andersson (2010). [3] The quality effect stimulates efficiency in production as global sourcing enables firms to identify and adopt inputs that better match their needs. By sourcing better inputs, firms may then adapt their production processes to increase output for a given level of inputs.

The learning effect refers to knowledge spillovers that occur when firms interact with foreign suppliers (Coe et al. 1997). Knowledge transfer may occur when buyers and supplier interact, coordinate and adapt activities. Knowledge transfer induces learning which is then manifested in the way in which firms organize production.[4] One example along these lines is that suppliers of advanced intermediate inputs and machinery often "train" buyers on how best to incorporate their product into production processes (Rebolledo and Nollet 2011). Suppliers may also impart knowledge on best practices which may translate into higher performance.

Finally, the variety effect implies that importing inputs increases firm productivity through a so-called "love-of-variety" effect in production (Ethier 1982). Van den Berg and van Marrewijk (2013) identify three dimensions of the import variety that relate to firms' performance: (i) the geographical dimension (which countries a firm imports from), (ii) the character of the imported goods (what types of goods are imported) and (iii) the extensive dimension (the number of source countries and imported goods). Todo et al. (2016) find that transaction linkages with distant suppliers improve the productivity of Japanese firms. They attribute these productivity improvements to the fact that intermediate inputs from more distant firms may embody more diversified knowledge than inputs from neighboring suppliers. Their results emphasize the importance of diversified partners in knowledge diffusion through supply chain networks.

In this paper, we will account for the character of goods dimension by focusing on imports of intermediate goods. We then consider the geographical dimension by directing our attention to the role of the extensive margin of imports in explaining firms' technical efficiency. This margin is measured in terms of imported inputs as well as source countries.

We argue that the potential for information and knowledge transfers that may influence the capability of a firm is directly related to the extensive margin of imports. The extensive margin reflects the 'depth' with which a firm is integrated into the global economy on the supply-side. The strength of the quality, variety and learning effects discussed above may depend on these dimensions. For example,

[3] This associates to the main idea of embodied (Rebolledo and Nollet, 2011) technological change, i.e. that advances in technology are embodied in capital goods (Sakellaris and Wilson 2004).

[4] The learning effect is often claimed to be related to both the quality- and variety-effect, as firms with richer import networks and more advanced imports are more likely to be subject to learning effects.

learning that influence firms' capabilities is more probable for a firm deeply embedded in global trade with rich import networks to many different source countries compared to a firm that just imports from a few nearby countries. Indeed, in a recent study, Todo et al. (2016) find that a more extensive and varied network of suppliers stimulates knowledge diffusion, which improves productivity and innovation capability.

ICT manufacturing – a globally important goods-producing sector

Our context in this paper is the ICT manufacturing industry, which warrants a discussion of its key features. Since the late 1980s the electronics industry, a major component of ICT manufacturing, has dominated trade in intermediate goods accounting for the largest share of trade in parts and components, followed by the automotive sector (Sturgeon and Kawakami 2010)). East Asia accounts for the bulk of world trade in intermediates in the electronics sector followed by the United States, Germany and the Netherlands. These patterns reflect the fact that the electronics global value chain is more geographically dispersed because there is less need for face-to-face contact than in other knowledge-intensive industries.

The ICT manufacturing industry sector is a unique and interesting case for a variety of reasons. Sturgeon and Kawakami (2010) argue that the electronics hardware sector, an important part of ICT manufacturing, is "...the world's most important goods-producing sector" citing the fact that the industry "employs more workers and generates greater revenue than any other sector, its products also enhance productivity in other activities and stimulate innovation across entire economies" (ibid pp. 269). The ICT industry is also unique as it is only of the most highly globalized industries, accounting for one of the largest shares of intermediate inputs trade (Sturgeon and Kawakami 2010).

In Sweden, ICT manufacturing is one of the most important industries regarding export shares, accounting for 15 percent of total exports in 2011. It is highly integrated into the global economy with the vast majority of firms exporting a proportion of their output (Giertz et al. 2013). In fact, as much as 42 percent of exports and 37 percent of imports by the ICT manufacturing firms is attributed to intermediate goods (Giertz et al. 2013). The ICT manufacturing industry thus constitutes a relevant industry case for an analysis of efficiency effects of global sourcing, from a Swedish as well as international perspective.

3 Data and Descriptives

3.1 Data and Variables

We employ audited full-population register data on Swedish firms that are maintained by Statistics Sweden (SCB).[5] The basic firm-level data include information on firms' sales, capital expenditure, labor expenditure and value added. These data are complemented with additional data on firm-level characteristics drawn from several sources. One is individual-level register data, also obtained from SCB, which provide information on individuals' place of work and job classification. We use individual-level data together with firm-level data to categorize different types of workers in firms and separate knowledge workers from production workers. In particular, we use four categories of workers when estimating the production frontier: knowledge workers, skilled workers, unskilled workers, and managers.

As our focus is on firms in the ICT manufacturing industry, a key issue is to delineate that industry. We follow Giertz et al. (2013) who analyze recent trends and dynamics in the information and communications technology industry in Sweden. They define the scope of the ICT industry to include firms that develop and manufacture computer and electronic equipment, firms that develop and update software as well as firms that conduct system maintenance. Among firms with 5 or more employees, the authors find that service firms account for the largest share (74%) of employment in 2011. Manufacturing firms in the ICT sector are divided into two broad categories: manufacturers of complete products and systems and manufacturers of parts and components. Each sub-sector is characterized differently with large firms dominating the former while the latter is comprised of many small firms. Following this definition, we arrive at a total of 1,910 firms in the ICT industry in 2008, of which 16 percent were manufacturing firms.

The industry consists of mainly small firms with fewer than 50 employees while approximately 47% of firms belong to multinational enterprises. The share of manufacturing firms declined by four percentage points over the period 2003-2008. After removing observations that only appear in one period, our final sample includes an unbalanced panel of approximately 280 firms over a six-year period 2003-2008. Table 1 provides descriptive statistics for the sample and our variables.

To measure each firm's level of participation in international trade we use trade data recorded at the firm level. In addition, the dataset provides information on country of origin, the total value of each transaction in Swedish kronor and the volume (measured in kilograms) traded. We classify goods as intermediate or final using the guidelines provided by the UN Broad Economic Categories that classify

[5]These data are accessed through a remote desktop connection to SCB's microdata online access system. See http://www.scb.se/mona-en/

Table 1: Descriptive statistics for sample of ICT manufacturing firms with 10 or more employees

Variable	No.Obs.	Mean	Std.Dev.	Min	Max
Log(Capital)	1,523	14.714	1.873	7.902	21.558
Log(Knowledge workers)	1,523	1.056	1.415	0	8.983
Log(skilled production workers)	1,523	1.908	1.423	0	8.654
Log(Unskilled production workers)	1,523	2.901	1.294	0	8.720
Log (Managers)	1,523	1.274	1.060	0	7.434
Log(Number of employees)	1,523	3.592	1.132	2.303	9.916
Share of high skilled workers	1,523	.3482	0.229	0	1
Log (value added)	1,523	16.827	1.342	11.898	24.117
Time	1,523	4.681	1.420	2	6
Year	1,523	2005	1.709	2003	2008
Log (import value)	1,523	13.769	4.908	0	23.539
Number of products imported	1,523	61.779	123.949	0	1577
Number of source countries	1,523	12.519	12.663	0	126
Domestic firm	1,523	0.396	0.489	0	1
Swedish MNE	1,523	0.279	0.449	0	1
Foreign MNE	1,523	0.194	0.395	0	1
Unaffiliated firm	1,523	0.131	0.338	0	1
10-50 employees	1,523	0.679	0.467	0	1
51-250 employees	1,523	0.254	0.435	0	1
>250 employees	1,523	0.067	9.250	0	1
Herfindahl index	1,523	0.513	0.282	0	0.936
Herfindahl index (products)	1,523	0.426	0.290	0	0.970
Across country entropy	1,523	0.160	0.132	0	0.368
Within country entropy	1,523	0.873	1.582	0	16.707
Total entropy	1,523	1.033	1.599	0	16.710

Note: The descriptive statistics are based on unbalanced panel firms in Swedish ICT manufacturing industry observed over a period of six years (2003-2008).

imports according to their end use.

Global sourcing patterns of the firms in our data are calculated using several different measures of dispersion. First, we include count values for the number of countries a firm sources from as well as the number of products imported from each country. We then use a Herfindahl index across all imports as well as at the product level. The Herfindahl index is a measure of dispersion defined as the sum of the squared share of each product in a firm's imports. The Herfindahl index ranges between zero and one, so that values close to zero indicate that the firm's imports are evenly distributed among many "small" products. Large values (close to 1) suggest that the variety of inputs imported by a firm is dominated by a few main products. One drawback of this measure is that firms that import just one

product also have a high value for the Herfindahl index.[6] We, therefore, specify the Herfindahl index as one minus the sum of squared shares so that large values correspond with greater diversification (Jacquemin and Berry 1979).

Our final measure of the role of imported inputs in a firm's performance level is the entropy measure of industrial diversification. This measure enables us to account for the relative importance of each source country as well as the level of diversification at the product level. Large values indicate a greater level of diversification. We use three measures of entropy that capture different margins of diversification: total entropy, across country entropy, and within country entropy. We define our first measure, total entropy, as the sum of the share of each product multiplied by the natural logarithm of the inverse share. We follow the method proposed in Jacquemin and Berry (1979) to decompose the variety of channels through which a firm sources its input by taking into consideration the country and product dimensions. That is, we measure the dispersion of imports across source countries as well as the dispersion of imports across products within source country. This can be expressed as:

$$E_T = \sum_{i=1}^{n} P_i ln \frac{1}{P_i} = \sum_{s=1}^{s} P_s(E_w) + E_A \tag{1}$$

Where P_i denotes the share of product i in a firm's total imports, P_s represents the share of each source country s in a firm's total imports and the variables E_w and E_A capture within and across entropy, respectively.

Our second measure, within-entropy focuses on the product level. Here, we take advantage of the fact that we can disaggregate imports from country s into imports of product i from country s to determine the relative contribution of diversification across countries and within countries to total entropy. This within-country entropy measure is defined as:

$$E_w = \sum_{i \in s} \frac{P_i}{P_s} ln \frac{P_s}{P_i} \tag{2}$$

Finally, across country entropy is defined as the share of imports from country s multiplied by the log of the inverse, or:

$$E_A = \sum_{s=1}^{s} P_s ln \frac{1}{P_s} \tag{3}$$

The entropy measure is equal to zero if all imports are concentrated in one product

[6] Fewer than 5 percent of firms in our sample import only 1 product.

or are sourced from just one country. Conversely, the measure is maximized when imports are evenly distributed across products and countries. Hence, we expect to find that firms vary in terms of their maximum entropy value and that this variation helps to explain variation in efficiency between firms.

3.2 Imports of intermediate inputs of ICT manufacturing firms in Sweden

Nearly all manufacturing firms in this sector imported some fraction of their intermediate inputs during this period. The mean ratio of imports to total sales for manufacturing firms in the ICT sector import amounted to 15% over the period. To get a more meaningful description of the activities of firms in this sector, we look at the dispersion of products imported. Figure 1 shows the variation in the number of imported intermediate inputs among firms that import, and Figure 2 shows the same pattern for the number of source countries from which firms source inputs. In each figure, the horizontal axis measures the number of intermediate inputs imported (or number of source countries), while the vertical axis measures number of firms. Each dot thus represents the number of firms (vertical axis) that import a given number of intermediate inputs (horizontal axis). It is clear from the figures that there is rather substantial heterogeneity across firms in terms of their sourcing pattern. Only a few firms source a large number of products from abroad. The same applies to the number of source countries. That is, these patterns show that within the group of importing firms, the 'depth' of firms' integration in the global economy varies substantially across firms. This finding is consistent with previous research on the patterns of internalization among firms (Eaton, Kortum, and Kramarz 2011; Andersson et al. 2008).

Multinational firms that by definition have affiliates abroad may be more likely to source inputs from foreign countries. This is one potential explanation of the variation that we see in Figures 1 and 2.We therefore calculate the ratio of imports in total sales (import intensity) for multinationals and non-MNEs in our sample of ICT manufacturing firms. Multinationals do report a higher import intensity than non-MNEs. However, domestic firms also import a substantial share of their inputs relative to total sales. In the next section, we analyze the extent to which these differences help to explain differences in firms' efficiency levels relative to the frontier.

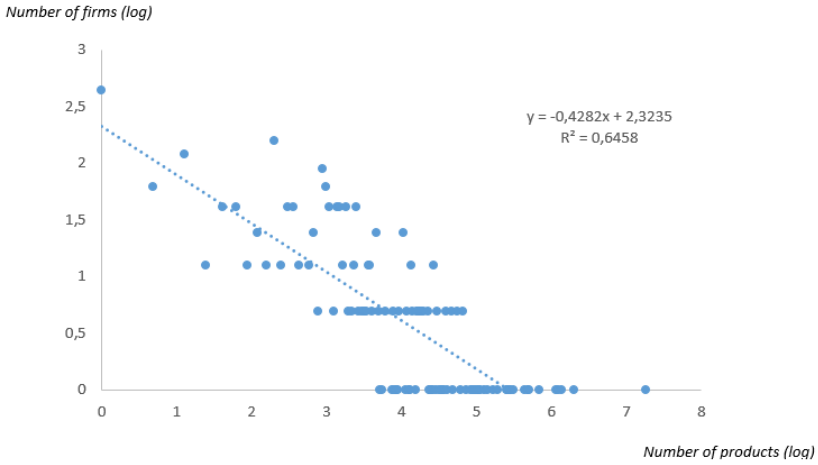


Figure 1: Distribution of manufacturing firms in the ICT sector according to the number of intermediate inputs that firms import. In the figure a dot denotes the number of firms importing a given number of intermediate inputs. (authors' calculation based on data from SCB).

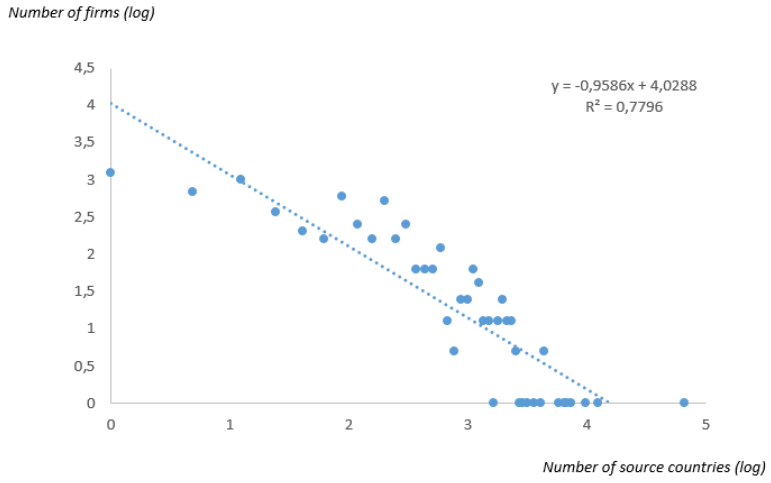


Figure 2: Distribution of manufacturing firms in the ICT sector according to the number of source countries from which firms source inputs. In the figure a dot indicates the number of firms importing from a given number of source countries. (authors' calculation based on data from SCB).

4 Empirical Strategy and Estimation

4.1 Estimating Technical Efficiency

To estimate the influence that sourcing intermediate inputs from abroad has on efficiency we use Stochastic Frontier Analysis (SFA).[7] This method has been

[7]For a review of various applications of Stochastic Frontier Analysis see Fried et al (2008).

widely used in the productivity and efficiency literature as a way to measure firm performance relative to some benchmark (Aigner, Lovell, and Schmidt 1977). SFA is a parametric approach to the estimation production frontier models and allows for the fact that firms may not always make full use of their production inputs and are therefore inefficient (Del Gatto, Liberto, and Petraglia 2011; Van Biesebroeck 2007).[8] It estimates the level of efficiency of a firm based on the deviation between a firm's output level and the maximum output attainable using a given set of inputs. Because this associates to managers' capacity to utilize firms' resources efficiently, SFA has recently been employed to quantify and measure firms' capabilities (Dutta et al. 2005, Mahmood et al. 2011).

To illustrate, we define the production frontier for a firm as follows:

$$y_i = f(x_i; \beta) * TE_i \tag{4}$$

where y_i represents firm i's output and x_i represents the same firm's inputs. The term $f(x_i; \beta)$ describes the firm's production function where β captures technology. The second term on the right hand side, TE_i, is the technical efficiency of firm i and is equal to 1 if the firm is fully efficient. If the firm is inefficient TE_i is less than one and the firm is producing at a level that is below its optimum output level. We can rewrite the production frontier as:

$$lny_i = x_i'\beta + v_i - u_i \tag{5}$$

where technical efficiency is now decomposed into two stochastic terms u_i and v_i, whereas $x_i'\beta$ is the deterministic component. By decomposing the error component into firm-specific random noise, v_i, and a stochastic component reflecting inefficiency, u_i, we transform the production function from a deterministic one to a stochastic one. In this specification, a firm is technically inefficient if $u_i \geq 0$. That is, technical efficiency is estimated as the component of the error term that is unaccounted for by random shocks. Figure 3 illustrates the production frontier and explains the intuition of inefficiency in the context of SFA.

A firm's output level may deviate from the deterministic frontier in two ways. At point A, the firm's output level lies above the frontier but this deviation is due solely to the noise effect. In contrast, at point B, the output level lies below the frontier and this deviation is attributed to both a noise component and an

[8] Van Biesebroeck (2007) compares the performance of parametric, semi-parametric and non-parametric techniques for measuring productivity under different scenarios. He concludes that SFA fares well, and that it is primarily preferred in cases where we can assume that firms share the same technology and where we believe we have a rather accurate measure for firms' output levels. At the macro-level, SFA has been used to explain differences in productivity across countries with the same technology, but is typically employed to explain efficiency differences between firms in the same industry (Del Gatto 2011).

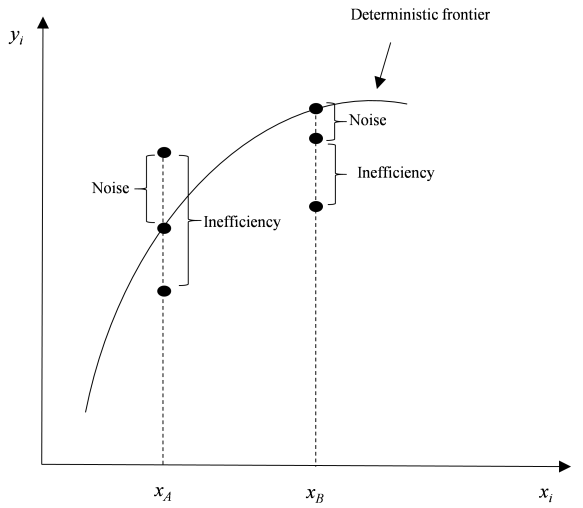


Figure 3: The Stochastic Production Frontier (adapted from Lovell et al. 2008).

inefficiency component. The figure shows that by using SFA, a firm's performance is measured as the deviation from the frontier attributed to inefficiency while accounting for the deviation caused firm-specific random shocks, i.e. noise.

We use SFA to estimate a firm-specific production frontier, from which each firm's level of inefficiency is computed. This means that a firm's inefficiency is determined relative to its own frontier. In estimating the frontier, we use the Translog specification because it brings several advantages. First, we avoid making assumptions on returns to scale in production. Second, the Translog specification does not restrict elasticity of substitution or homotheticity. Our empirical implementation of SFA is given by:

$$lnY_{it} = \beta_0 + \frac{1}{2}\sum_i \sum_j \beta_1 ln(X_{it} lnX_{jt} + ownership + \frac{import}{sales}_{it} + v_{it} - u_{it} \quad (6)$$

$$u_{it} = \delta_1 size + \delta_2 skill + \delta_3 import_diversification + W_{it} \quad (7)$$

where we measure output Y_{it} as log value added. The variables X_{it} and X_{jt} represent factors of production, i.e. capital and labor. The third and fourth term in the equation represent the composite error term. u_{it} represents technical inefficiency and v_{it} represents the "noise" term. By definition, the technical inefficiency term u_{it} is non-negative since it measures deviation from the production frontier. The random component of the composite error term, v_{it}, is normally distributed independently of u_{it} and X_{it}.

A key issue for our empirical analysis concerns selection effects. Firms that for some reason are well managed and productive are in a better position have the resources needed to source globally and develop richness in import flows. This implies that a positive association between efficiency and global sourcing could reflect such a selection effect, i.e. efficient firms source more globally than inefficient ones, rather than an effect from global sourcing to firm-level efficiency.

We deal with this identification problem in two main ways. First, we specify our Translog function such that it includes several characteristics of firms' that may influence its production frontier. This specification ensures that the estimation of each firm's production frontier accounts for relevant production characteristics of firms, and are not erroneously picked up as technical efficiency. We decompose labor into the following five categories: (i) knowledge workers, (ii) skilled production workers, (iii) managerial workers, and (v) unskilled workers. This decomposition allows us to capture the nature and human capital intensity of firms' production. There is a large literature studying the role of human capital in determining a firm's capacity to absorb, assimilate and develop new knowledge and technology. Human capital, therefore, may influence firms' production frontier (Bartel and Lichtenberg 1987; Cohen and Levinthal 1990).

We also account for firm size by including size dummies, as well as dummies representing foreign ownership. The motivation for including size dummies is that firm size is usually claimed to reflect firms' internal resources. Similarly, the inclusion of dummies for ownership account for the fact that individual firms belonging to company groups, and multinationals, in particular, are likely to gain from the corporation's internal knowledge and technology resources as well as production routines. For example, MNEs typically have established links to several markets and thereby a coupling to several knowledge sources (Dachs, Ebersberger, and Lööf 2007), and they also tend to have strong internal capabilities pertaining to the development of proprietary information and knowledge (Pfaffermayr and Bellak 2002). Being part of a corporation, in particular, MNEs, is therefore expected to influence a firm's production frontier.

Time dummies are included to account for temporal shocks that may influence firms' production frontier. Finally, we include firms' import intensity directly in the estimation of the production frontier. The reason for this is that our main focus is not on imports per se, but on the influence that the variety and extent of global sourcing have on firms' efficiency. Since firms that engage in international trade tend to be larger and more productive than other firms (Andersson et al. 2008; Wagner 2007; Bernard et al. 2007; Bernard and Wagner 1997), accounting for import intensity may capture characteristics of firms that directly influence their production frontier.

Second, when estimating the influence that our measures of the variety and extent

of global sourcing have on efficiency, we implement a number of procedures to account for confounding factors. We allow for changes in efficiency over time and estimate time varying inefficiency using the Battese and Coelli (1995) stochastic frontier model. This model assumes that the inefficiency term follows a truncated normal distribution and has two distinct advantages: it allows us to estimate the frontier and the inefficiency term simultaneously. We are therefore able to determine the shape of the frontier term y_{it} and the inefficiency term u_{it} in one single step. The model also allows us to estimate the effect of firm characteristics on mean inefficiency. We include our main explanatory variables and controls for confounding factors directly in the technical inefficiency term to determine their contribution to mean inefficiency (Kumbhakar and Lovell 2003).

Following Battese and Coelli (1995), we estimate mean technical efficiency using the specification in Equation (7) where W_{it} ensures than u_{it} remains non-negative. While our main interest is on the influence that our measures of global sourcing have on mean inefficiency, which is expected to be negative, we control for a number of confounding factors. Specifically, we control for firm size as well as whether or not the firm is a multinational firm. We further control for the fraction of workers in the firms that has a long university education (≥ 3 years), which is supposed to reflect human capital employed in the firm.

Distance to the Industry Frontier

In addition to analyzing the influence that global sourcing has on a firm's efficiency relative to its own frontier, we also evaluate the contribution of a firm's sourcing strategy to its performance relative to the most efficient firm in the industry. The decision (or possibility) to import intermediate inputs is related to a firm's distance to the industry efficiency frontier. Acemoglu et al. (2007) find that a firm's organizational form – whether the firm is vertically integrated or more decentralized – depends on the firm's distance to the frontier. Distance to the frontier in this instance refers to the firm's position in relation to the most technologically advanced firm in the industry. We also interpret the findings of the paper by Acemoglu et al. (2007) in terms of distance to the productivity frontier as the authors find that firms are more likely to be decentralized – that is they are more likely to purchase their inputs — when they operate in industries where there is a wide variation in productivity levels. In particular, they show that three main characteristics influence whether firms' are more likely to be decentralized: young firms, firms that operate in more "heterogeneous environments" and firms that are closer to the technological frontier tend to have a more decentralized organizational structure.

To this end, we compute the firm's efficiency level relative to the benchmark as a measure of the "distance to the industry frontier" and calculate:

$$distance_{it} = ln\frac{u^*_{it}}{u_{it}} \tag{8}$$

where u^*_{it} represents the efficiency score for the benchmark firm. We then calculate the absolute value of the distance so that large values imply that firms are closer to the frontier. Using this distance to the frontier as our measure of relative efficiency, we then estimate Equation (9):

$$distance_{it} = \alpha + \beta_1 import + \beta_2 skill + \beta 3 size_d + \mu_t + \varepsilon_{it} \tag{9}$$

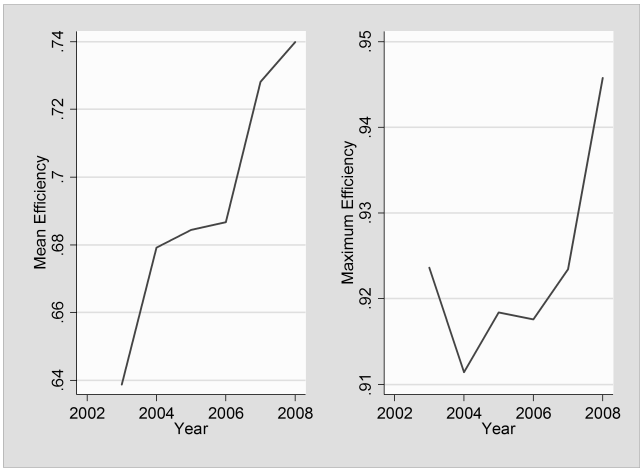
where the dependent variable is our distance measure defined above. The right-hand side variables are the same as in the equation we use to explain a firm's efficiency, u_{it}, i.e. import diversification, high skill share as well as year and size dummies. Our coefficient of interest is β_1, which tells us the relationship between the extensive margin of imports and firms' distance to the industry frontier. We expect to find a negative relationship between import diversification and our distance measure. A negative and statistically significant value for each β_1 confirms our hypothesis that greater import diversification is associated with being closer to the industry frontier. That is, more efficient firms are more deeply integrated in international markets and source a greater range of inputs internationally.

Trends in efficiency

Before we turn to the results, we first examine broad patterns in firm efficiency levels between 2003 and 2008. In Figure 4 we plot the trend in mean efficiency for all firms in the industry as well as the efficiency level for the most efficient firm in each year. We see that there is a steady increase in the average level of efficiency over the period. Mean efficiency levels increased from 0.66 to around 0.76. It can be argued that the increase in mean efficiency is due to exogenous technical change. To check this, we measure the effect of exogenous technical change over the period as the first derivative of the frontier function with respect to time. This measure yields a positive derivative of 0.32, which implies that the frontier has shifted outward over the period. This can be seen by looking at the efficiency score of the best performing firm in each year. The maximum efficiency score increased between 2004 and 2008, after declining slightly between 2003 and 2004. In other words, there has been an increase in efficiency level of the "benchmark firm" over this period.

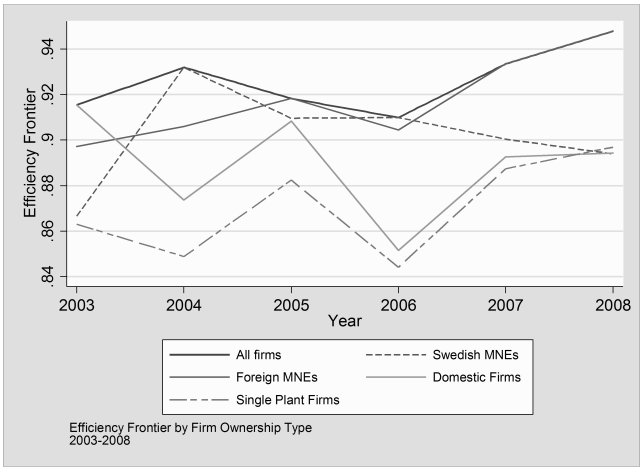
Decomposing efficiency growth by firm type, we find that multinational firms consistently show a higher efficiency frontier than non-multinationals (Figure 5). A particularly striking result is that Foreign MNEs are more efficient than Swedish MNEs. This is consistent with previous research on the relative performance of

Figure 4: Trends in mean efficiency and maximum efficiency (2003-2008).



foreign and domestic firms. For example, Griffith et al. (2004) find that multinational firms operating in the UK are more productive than domestic firms. Our analysis also shows that single plant firms perform worse than multinationals or firms that are part of a company group. Finally, our analysis indicates that in 2008, the efficiency levels of the benchmark firm converged to around the same score (0.88) across ownership types. The only exception was foreign MNEs, which continued to outperform domestic firms.

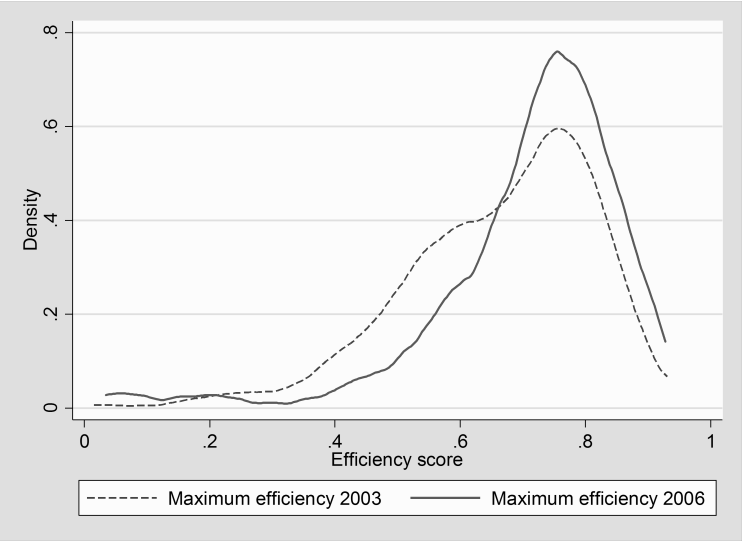
Figure 5: Trends in mean efficiency by firm type (2003-2008).



These trends are indicative of a broader pattern in the ICT industry. Figure 6 plots the estimated Kernel density of efficiency scores for the period 2003 to 2008. It is evident that the distribution has shifted to the right, indicating that firms in the ICT manufacturing industry have become more efficient. The figure also shows

that the level of heterogeneity across the industry has decreased. The spread of the distribution decreased in 2008 relative to 2003.

Figure 6: Maximum efficiency for ICT manufacturing firms between 2003-2008.



5 Results

In this section, we employ SFA as described above to estimate the influence that the variety and extent of global sourcing have on firms' efficiency. We estimate the production frontier given in Equation (6) using SFA and report the results of the second-stage in Table 2 where we estimate the influence that firm-level characteristics have on firms' inefficiency. We present the results obtained when we estimate the frontier with several measures of import margins. The results of the Translog estimation are presented in the Appendix.

The effect of global sourcing on firms efficiency level

Column 1 of Table 2 shows the results when we use the number of imported inputs as our measure of global sourcing. We find that there is a negative relationship between the number of inputs imported and the mean level of inefficiency. That is, importing intermediate inputs has a positive effect on mean efficiency. These results are in line with the idea that firms who import a wider variety of inputs may be more flexible in the way their production is organized. As a result, firms that are more deeply integrated into global value chains tend to be more efficient.

We also examine the role of import variety along another dimension: the breadth of countries from which firms import. These results are reported in Column 2. We find that the greater number of source countries, the higher the level of mean

efficiency. Firms that source a wider range of inputs from more source countries can exploit differences in comparative advantage across countries to gain access to the best quality inputs.

So far our measures of import diversification amount to simple product and source country counts which may not capture the full effect of global sourcing on efficiency levels. We therefore also study the influence of our measures of diversification: the Herfindahl index and an entropy measure of diversification. Our first index, the Herfindahl index, shows that there is a strong negative relationship between greater import diversity and inefficiency. This result is shown in Column 3. We obtain a negative and statistically significant coefficient for the Herfindahl index. These results are consistent with our previous findings that global sourcing is positively related to greater levels of efficiency. We repeat the analysis using a more restricted definition of the Herfindahl index: a firm's diversification across products.

Our third and final measure of import diversification is the entropy measure. Using total entropy as our measure of value chain integration, we analyze the relationship between importing a wider range of inputs and technical efficiency. These results are reported in Column 5. We obtain a negative and significant coefficient for total entropy, indicating that importing inputs has a negative effect on inefficiency. We then decompose entropy to reveal two things: the number of countries from which a firm imports as well as the number of products sourced from each country. Across country entropy describes the dispersion of a firm's network while within country entropy describes the depth of a firm's integration in global value chains. In Column 6 we show the results when we decompose entropy into across- and within-country entropy. We find that both margins have a significant effect on technical efficiency.

Turning to the control variables we see that medium-sized firms with 51-250 employees are most efficient. The relationship between firm size and efficiency is often not clear-cut. One argument is that larger firms should be more efficient since they can take advantage of economies of scale and produce a higher level of output more cheaply. However, production processes are often very complex, and there might be other factors at play that are idiosyncratic to larger firms that make them less efficient. Our findings are similar to Castiglione (2011) who finds that medium-sized firms in the Italian manufacturing sector are more efficient than large firms. As regards human capital, in Table 2 measured as the fraction of employees with a long university education (>3 years), we see that it is statistically insignificant in the first three specifications but negative and significant in Columns 4, 5 and 6. We interpret this as that firms employing larger fractions of educated workers are more efficient, which is in line with our expectations, but that counts of products and source countries as well as the HHI for source countries capture this effect[9].

[9]Indeed, when excluding the global sourcing indicators in columns 1-3, then the human capital

Table 2: The influence of global sourcing on firms' inefficiency.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Ln(# of inputs)	-0.617***					
	(0.143)					
Ln(# of source countries)		-0.733***				
		(0.154)				
HHI (countries)			-1.271***			
			(0.339)			
HHI (products)				-0.865***		
				(0.300)		
Total entropy					-0.142***	
					(0.053)	
Within country entropy						-0.137**
						(0.054)
Across country entropy						-0.873*
						(0.519)
Share of high skilled workers	0.198	0.138	-0.302	-0.695*	-0.639*	-0.620*
	(0.452)	(0.376)	(0.351)	(0.382)	(0.337)	(0.359)
51-250 employees	-0.037	0.042	-0.377*	-0.605***	-0.605***	-0.644***
	(0.314)	(0.279)	(0.225)	(0.225)	(0.200)	(0.216)
>250 employees	-0.609	-0.256	-0.565	-0.797	-0.841*	-0.909*
	(0.835)	(0.654)	(0.515)	(0.509)	(0.441)	(0.473)
Observations	1,400	1,400	1,400	1,400	1,399	1,399
Number of firms	360	360	360	360	360	360

Note: The reports estimate on the influence of firm-level characteristics on firms' inefficiency using SFA. The underlying data are 360 firms in the ICT manufacturing industry in Sweden. Inefficiencies are based on a Translog estimation of each firm's production frontier (see equation 6). Results from this model are presented in Appendix. Standard errors in parentheses. *** p<0.01, ** p< 0.05, * p<0.1.

Global sourcing and distance to the industry frontier
In addition to studying the relationship between global sourcing and a firm's output relative to its own production frontier, our analysis also examines the position of a firm relative to the benchmark firm in the industry. In Figure 5 we saw that multinational firms are more efficient than non-MNEs while Figures 4 and 6 show that firms in the ICT sector are becoming more efficient over time. We now turn our focus to understanding these differences in firm efficiency. That is, we estimate Equation (9) to analyze whether differences in firms' sourcing behavior are related to differences in relative firm-level efficiencies.

Table 3 shows the effect of imports on heterogeneity in the ICT industry. Starting with the control variables, we see that firms with a greater fraction of employees that have a long university education (> three years) have a smaller distance to the most efficient firm in the industry. It is also clear that medium-sized as well as large firms show a smaller gap to the most efficient firms in the industry. Both results are in line with expectations.

Turning now to the variables of main interest, we see that column 1 reveals that there is a negative relationship between import variety using the Herfindahl index along the product dimension and the distance to the industry frontier. This indicates that the more diversified a firm's imports, the lower the distance to the industry frontier. However, we do not find that the relationship is statistically significant.

We repeat the analysis using other measures of import variety. These include total diversification using the Herfindahl index, the number of products, the number of source countries, and our entropy measure of diversification. Column 2 shows that there is a negative and statistically significant relationship between import diversification and distance to the industry frontier. These results hold when we use count measures of diversification: importing a higher number of products from a wider range of countries is associated with better performance relative to the most efficient firm. This confirms our hypothesis that being deeply integrated into the global value chain augurs well for a firm's performance level.

variables becomes significant and negative.

Table 3: Global sourcing and distance to the industry frontier

Variables	(1)	(2)	(3)	(4)	(5)	(6)
HHI (products)	-0.011					
	(0.049)					
HHI		-0.155***				
		(0.053)				
Ln(number of inputs)			-0.054***			
			(0.013)			
Ln(number of source countries)				-0.090***		
				(0.017)		
Across country entropy					-0.025	
					(0.105)	
Within country entropy					-0.011	
					(0.009)	
Total entropy						-0.011
						(0.009)
Share of high skilled workers	-0.348***	-0.312***	-0.300***	-0.270***	-0.346***	-0.346***
	(0.071)	(0.072)	(0.073)	(0.074)	(0.071)	(0.071)
51-250 employees	-0.261***	-0.223***	-0.178***	-0.156***	-0.267***	-0.267***
	(0.033)	(0.034)	(0.039)	(0.037)	(0.032)	(0.032)
>250 employees	-0.375***	-0.332***	-0.236***	-0.226***	-0.382***	-0.382***
	(0.063)	(0.063)	(0.073)	(0.070)	(0.061)	(0.061)
Observations	1,400	1,400	1,400	1,400	1,399	1,399
Number of firms	360	360	360	360	360	360

Note: The reports estimate on the influence of firm-level characteristics on relative efficiency (see equation 9). The underlying data are 360 firms in the ICT manufacturing industry in Sweden. Inefficiencies are based on a Translog estimation of each firm's production frontier (see equation 6). Results from this model are presented in Appendix. The estimations include time dummies. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

In Column 6, we present the estimation results of Equation (9) when we use total entropy as our measure of value chain integration. We find that there is a negative relationship between our entropy variable and distance to the frontier. In Column 5, we decompose entropy into its constituent parts – across - and within-country entropy. The results are similar to our previous findings when total entropy is used as our measure of import diversification. However, while the direction of the relationship and the size of the coefficient are similar to other measures of diversification, using entropy does not yield statistically significant results.

6 Summary and Conclusions

The main conclusion of this paper is that a strategy to source globally and having networks to a variety of suppliers in different countries put firms in a better position to improve their capabilities. This is consistent with the argument that global sourcing is not only about exploiting differences in costs across different countries and regions of the world, thereby providing firms with 'static' gains from cost reductions. It is also about building networks to foreign suppliers that may act as vehicles for knowledge and information transfers which benefit the capability development of firms. Thereby, the paper adds to the growing literature emphasizing foreign suppliers and global import networks as an important source of firms' capabilities and productivity (Todo et al. 2016, Mahmood et al. 2011, Rebolledo and Nollet 2011).

The analyses in the paper focus on the influence that global sourcing of inputs has on firms' performance. We put forth that the influence of global sourcing is not a mechanical one. Instead, the extent to which a firm becomes more efficient as a result of global sourcing depends, at least in part, on how it influences capabilities that are specific to each firm. Using Stochastic Frontier Analysis (SFA) on firms in Swedish ICT manufacturing, we test this idea by estimating the influence that global sourcing has on firms' technical efficiency. Technical efficiency is a major component of firms' productivity growth, and is typically regarded as a relevant indicator of firms' capabilities (Dutta et al. 2005, Mahmood et al. 2011). We decomposed our measure of imports along two dimensions: the product dimension and the country dimension. The analyses then evaluated the effects of sourcing inputs from a greater number of source countries as well as the effect of sourcing a larger number of products from each country.

We find that firms that are more involved in sourcing and have a more diversified import network are indeed more efficient than their peers. These results hold across all measures of import diversification and are consistent with the argument that a more extensive import network (involving a variety of foreign suppliers) improves the potential for knowledge and information spillover that benefit the capabilities of firms. For example, interaction with and exposure to foreign suppliers may allow firms to identify 'better' inputs and to adopt of more efficient production and

management practices.

Our findings also reveal that foreign multinationals are the most efficient firms, followed by Swedish multinational firms. These findings point to the potential for knowledge spillovers from abroad that are mediated by international sourcing and help to stimulate the capabilities of firms, as evidenced by increased technical efficiency of firms engaged in global sourcing. We also analyzed the relationship between a firm's performance level relative to the most efficient firm in the industry and firms' sourcing behavior. We find that firms that engage in global sourcing are closer to the industry frontier. Firms that are closer to the frontier source a greater number of products globally to exploit differences in specialization across countries.

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Appendices

Table 4: Production frontier estimates using stochastic frontier analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Frontier 1	Frontier 2	Frontier 3	Frontier 4	Frontier 5	Frontier 6	Frontier 7	Frontier 8
Ln (capital)	-0.500***	-0.464***	-0.417***	-0.408***	-0.385**	-0.397***	-0.458***	-0.508***
	(0.154)	(0.154)	(0.153)	(0.153)	(0.152)	(0.152)	(0.154)	(0.154)
Ln(Knowledge workers)	0.596***	0.575***	0.536***	0.513***	0.504***	0.512***	0.576***	0.596***
	(0.146)	(0.146)	(0.147)	(0.147)	(0.147)	(0.147)	(0.146)	(0.146)
Ln(Skilled workers)	0.678***	0.669***	0.643***	0.654***	0.633***	0.637***	0.667***	0.686***
	(0.145)	(0.146)	(0.147)	(0.147)	(0.146)	(0.146)	(0.145)	(0.145)
Ln(Unskilled workers)	0.427**	0.393**	0.350**	0.357**	0.376**	0.379**	0.405**	0.424**
	(0.172)	(0.171)	(0.170)	(0.169)	(0.168)	(0.168)	(0.171)	(0.172)
Ln(Managerial workers)	-0.651***	-0.689***	-0.641***	-0.599***	-0.576***	-0.569***	-0.699***	-0.642***
	(0.194)	(0.194)	(0.194)	(0.195)	(0.195)	(0.195)	(0.194)	(0.195)
Time dummy	0.153	0.131	0.189	0.217*	0.216*	0.202	0.128	0.153
	(0.123)	(0.124)	(0.124)	(0.123)	(0.123)	(0.124)	(0.124)	(0.123)
Capital x Knowledge workers	-0.026**	-0.024**	-0.022*	-0.021*	-0.020*	-0.021*	-0.024**	-0.026**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Capital x Skilled workers	-0.019*	-0.019*	-0.018	-0.018	-0.015	-0.016	-0.019*	-0.020*
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Capital x Unskilled workers	-0.013	-0.012	-0.008	-0.006	-0.006	-0.007	-0.012	-0.013
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Capital x managers	0.051***	0.054***	0.051***	0.045***	0.043***	0.043***	0.054***	0.051***
	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)
Knowledge workers x Skilled workers	0.019	0.019	0.023*	0.025*	0.027**	0.027**	0.019	0.018
	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
Knowledge workers x unskilled workers	-0.063***	-0.064***	-0.064***	-0.065***	-0.067***	-0.067***	-0.065***	-0.063***
	(0.015)	(0.015)	(0.016)	(0.015)	(0.016)	(0.016)	(0.015)	(0.015)
Knowledge workers x managers	0.023	0.021	0.021	0.021	0.021	0.022	0.021	0.023
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Skilled workers x unskilled workers	-0.085***	-0.084***	-0.087***	-0.090***	-0.092***	-0.092***	-0.083***	-0.085***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)

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Table 4 – *Continued from previous page*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Skilled workers x Managers	-0.118***	-0.119***	-0.119***	-0.116***	-0.119***	-0.119***	-0.119***	-0.117***
	(0.018)	(0.019)	(0.019)	(0.019)	(0.019)	(0.018)	(0.019)	(0.018)
Unskilled workers x managers	-0.018	-0.017	-0.014	-0.014	-0.003	-0.003	-0.016	-0.019
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Capital x time	0.001	0.003	0.001	-0.001	0.000	0.001	0.003	0.001
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Knowledge workers x time	0.004	0.002	0.002	0.002	0.003	0.003	0.002	0.003
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Skilled workers x time	-0.028***	-0.029***	-0.027***	-0.026***	-0.026***	-0.026***	-0.029***	-0.027***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Unskilled workers x time	-0.018	-0.016	-0.016	-0.020*	-0.022**	-0.022**	-0.017	-0.018
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Managers x time	0.052***	0.051***	0.050***	0.055***	0.055***	0.053***	0.053***	0.052***
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Capitalˆ2	0.042***	0.038***	0.034***	0.034***	0.032***	0.033***	0.037***	0.042***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Knowledge workers ˆ2	0.066***	0.065***	0.059***	0.057***	0.055***	0.055***	0.066***	0.066***
	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.019)
Skilled workers ˆ2	0.163***	0.167***	0.167***	0.162***	0.159***	0.161***	0.165***	0.164***
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Unskilled workers ˆ2	0.166***	0.164***	0.162***	0.159***	0.156***	0.158***	0.163***	0.167***
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
Managers ˆ2	0.070**	0.063**	0.064**	0.073**	0.068**	0.068**	0.064**	0.072**
	(0.032)	(0.031)	(0.030)	(0.030)	(0.029)	(0.030)	(0.030)	(0.032)
Time ˆ2	-0.031*	-0.033**	-0.038**	-0.039**	-0.040**	-0.040**	-0.033**	-0.031*
	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.016)
Swedish MNE	0.129***	0.122***	0.123***	0.131***	0.123***	0.125***	0.122***	0.131***
	(0.034)	(0.034)	(0.034)	(0.035)	(0.035)	(0.035)	(0.034)	(0.034)
Foreign MNE	0.179***	0.171***	0.186***	0.194***	0.190***	0.192***	0.168***	0.181***
	(0.037)	(0.037)	(0.039)	(0.039)	(0.039)	(0.039)	(0.037)	(0.037)
Unaffiliated firm	-0.088*	-0.080*	-0.101**	-0.119**	-0.121**	-0.119**	-0.077	-0.092*
	(0.048)	(0.048)	(0.048)	(0.047)	(0.047)	(0.047)	(0.049)	(0.047)

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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Import Intensity	-0.165***	-0.167***	-0.112*	-0.105*	-0.117**	-0.111*	-0.180***	-0.159***
	(0.054)	(0.054)	(0.059)	(0.059)	(0.059)	(0.059)	(0.054)	(0.054)
Constant	17.633***	17.530***	17.160***	16.981***	16.813***	16.909***	17.490***	17.675***
	(1.088)	(1.089)	(1.082)	(1.080)	(1.072)	(1.074)	(1.091)	(1.088)
Mean Inefficiency								
Ln(number of inputs)	-0.617***							-0.617***
	(0.143)							(0.144)
Ln(number of source countries)		-0.733***					-0.919***	
		(0.154)					(0.203)	
HHI			-1.271***				0.820*	
			(0.339)				(0.486)	
HHI (products)				-0.865***				-0.398
				(0.300)				(0.405)
Total entropy					-0.142***			
					(0.053)			
Within country entropy						-0.137**		
						(0.054)		
Across country entropy						-0.873*		
						(0.519)		
share of high skilled workers	0.198	0.138	-0.302	-0.695*	-0.639*	-0.620*	0.122	0.187
	(0.452)	(0.376)	(0.351)	(0.382)	(0.337)	(0.359)	(0.369)	(0.477)
51-250 employees	-0.037	0.042	-0.377*	-0.605***	-0.605***	-0.644***	0.060	-0.041
	(0.314)	(0.279)	(0.225)	(0.225)	(0.200)	(0.216)	(0.274)	(0.332)
>250 employees	-0.609	-0.256	-0.565	-0.797	-0.841*	-0.909*	-0.233	-0.623
	(0.835)	(0.654)	(0.515)	(0.509)	(0.441)	(0.473)	(0.648)	(0.859)
Observations	1,400	1,400	1,400	1,400	1,399	1,399	1,400	1,400
Number of orgnr	360	360	360	360	360	360	360	360
lambda	2.974	2.765	2.491	2.446	2.295	2.371	2.738	3.049
sigma_u	1.010	0.933	0.841	0.830	0.777	0.803	0.923	1.038
sigma_v	0.340	0.337	0.338	0.339	0.339	0.339	0.337	0.340

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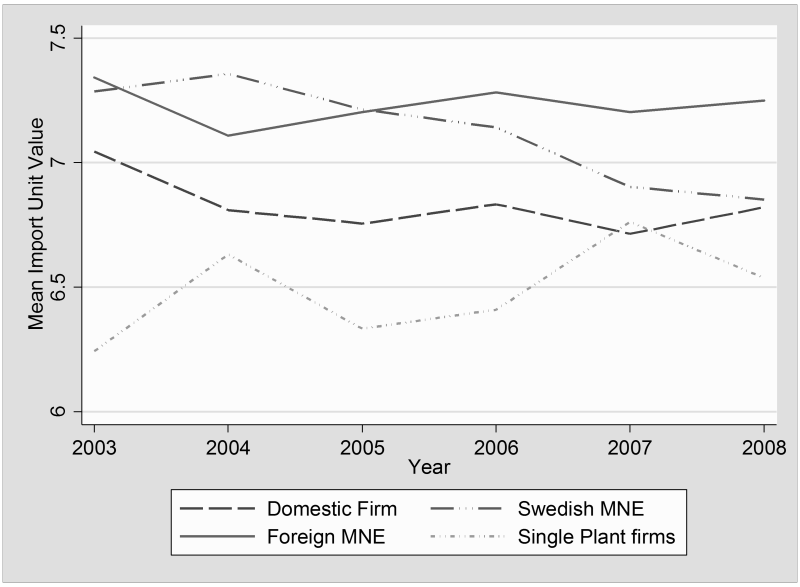
Table 4 – *Continued from previous page*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	0.397	0.409	0.428	0.429	0.441	0.434	0.410	0.393
SD	0.348	0.348	0.341	0.337	0.334	0.335	0.348	0.348
Min	0.0552	0.0565	0.0573	0.0589	0.0552	0.0548	0.0568	0.0554
Max	4.543	4.537	4.418	4.419	4.329	4.337	4.538	4.568
ll	-972.5	-973.9	-992.9	-998.4	-998.2	-997	-972.4	-972
chi2	6829	6370	5679	5823	5601	5700	6422	6927
N	1400	1400	1400	1400	1399	1399	1400	1400

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

Figure 7: Mean import value by firm type (2003-2008)



Paper 3

Do Global Value Chains Make Firms More Vulnerable To Trade Shocks? Evidence from Manufacturing Firms in Sweden

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ABSTRACT

This paper examines the effect of the Global Financial Crisis on manufacturing firms in Sweden by analyzing the effect of trade exposure on firm performance. We measure trade exposure at the firm and industry levels to assess direct and indirect effects of the crisis on firm performance. We find robust evidence of a negative relationship between trade exposure and firms' sales and value added growth during the crisis. In addition, we find that higher export dependence is associated with lower sales growth during the crisis. Our results also show that the effect of the decline in external demand on firm performance depends on international input-output linkages. In particular, industries that are upstream the value chain experienced a less severe decline in performance during the crisis.

Keywords: financial crisis, firm performance, exports, global value chains
JEL codes: F14, F44, F6, L25

1 Introduction

The Global Financial Crisis of 2008-2009 resulted in one of the most severe economic downturns in recent times and triggered economic recessions in many countries across the world. During this period, global trade experienced the steepest decline since the Great Depression (Bussière et al. 2013, Brakman, van Marrewijk and Partridge 2014). One distinguishing feature of the 2008-2009 crisis is that the contraction in trade was more severe than the initial decline in output (Bussière et al. 2013). The decline in world exports was four times larger than the initial decrease in aggregate demand, as imports and exports deteriorated simultaneously across all countries (Bems, Johnson, and Yi 2011; Baldwin 2009). These developments have led to renewed interest in understanding the relationship[1] between trade flows and business cycle synchronization between countries, with particular emphasis being placed on the role of global production linkages in explaining why the crisis resulted in an even greater decline in trade (Levchenko, Lewis and Tesar 2011; Behrens, Corcos and Mion 2013; Baldwin and Evenett 2009). One key finding is that production linkages may transmit business cycle downturn across countries as a decline in demand for final goods in one country suppresses demand for foreign intermediate goods[2] along the value chain (Baldwin and Evenett 2009; Freund 2009). In this paper we examine one aspect of the decline in international trade during the Global Financial Crisis by focusing on the relationship between global production linkages and firm performance.

We put forward that by being more integrated in global value chains, firms are more exposed to fluctuations in foreign demand and are expected to be more sensitive to external shocks. The precise effect of the crisis on firms' imports and exports may vary according to the extent to which a particular industry is dependent on a globally dispersed supply chain (di Giovanni and Levchenko 2010). For instance, the automotive and the electronics manufacturing industries account for the largest share of trade in intermediate input trade and these two industries experienced the steepest decline in trade flows during the crisis years (Baldwin 2009; Sturgeon and Kawakami 2010).

The literature on the 2008-2009 Global Financial Crisis focuses on macroeconomic effects such as understanding the causes of business cycle synchronization (Baldwin and Evenett 2009; Bussiere et al 2013; di Giovanni and Levchenko 2009). However, the microeconomic effects of the global recession is less well understood. Macroeconomic models predict that, under certain conditions, exchange rate depreciations following financial crises may lead to either an expansion or reduction in exports

[1] Early research on the relative contribution of finance and trade to business cycle synchronization includes Van Rijckeghem and Weder (2001), Glick and Rose (1999) and Frankel and Rose (1998).

[2] Intermediate inputs make up the largest share of total trade flows, which suggests that a decline in the demand for final goods may, in turn, reduce the demand for imported parts and components from abroad (Yi 2009).

(Kim, Tesar and Zhang 2015). However, these models do not account for the role of global production linkages between firms. This paper finds that evidence supporting the claim that global production linkages is one key mechanism through which the sudden decrease in external demand resulted in a decline in firms' sales and export performance.

To investigate the effect of external shocks on relationship between global production linkages and firm performance, we test the effect of the recent economic crisis on three main measures on firm performance: export growth, domestic sales growth and value added growth.

By using export growth and domestic sales growth as our main measures of firm performance, our paper can shed light on the direct and indirect effects of the Global Financial Crisis on firms. We argue that the the crisis directly influences firm performance through its impact on export sales. Export sales may decline on two margins: the volume of export sales within each market (intensive margin[3]) and the number of markets a firm serves (extensive margin[4]). The crisis may also have a direct effect on firm performance by influencing the price of imports. A decline in the price of imported inputs may affect firm outcomes since a reduction in import prices can lower the cost of intermediate goods and boost performance for firms relying on imported inputs. Alternatively, lower import prices[5] for final goods may raise competition in the domestic market and reduce the market share of import-competing domestic firms (Forbes 2002).

The indirect effect of the crisis is manifested in the domestic market and operates through input-output linkages between domestic firms and exporters. (Acemoglu et al. 2015; Cravino and Levchenko 2016; Levchenko et al. 2011). The indirect effect may also occur as a result of the complementary effect of a firm's foreign operations on domestic sales. Berman et al. (2015) find a positive effect of exports on domestic sales. In this paper, we focus on the importance of input-output linkages and how they influenced firm performance during the 2008-2008 crisis.

[3]Behrens et al. (2010) show that Belgian exports declined more noticeably on the intensive margin, and this decline was more visible for firms that are more heavily indebted. Similarly, Paravisini et al. (2014) find that, in Peru, the intensive margin of exports declined more severely for firms more sensitive to credit shocks.

[4]Research on the effect of the crisis on the extensive margin of exports shows that export sales decline as firms exited certain markets during the 2008-2009 period. Berman et al. (2012) find that there was a higher rate of exit from exports to markets more severely affected by the crisis. Martin et al. (2009) show that firms were less resilient during the crisis as both export survival and export growth rates declined during 2008-2009.

[5]Looking at Argentine exports, Chen and Juvenal (2015) investigate the effect of the crisis on the quality composition of Argentine exports. They find that the composition of exports shifted towards lower quality products during the crisis. In a similar vein, Bems and di Giovanni (2016) use scanner-level data from Latvia to document changes in consumption and find that consumers substituted imported goods for domestic goods and that this change accounts for 26 percent of the observed decline in imports.

We analyze the effect of global production linkages by regressing firm export and domestic sales growth on pre-crisis measures of trade exposure. We construct three main variables measuring the extent to which firms are exposed to trade. These include firm-level trade intensity, industry-level exposure to trade and a measure of Swedish industries' position in the global value chain. In addition, we control for a host of firm and industry characteristics such as the skill level of workers, firm size, and the degree of industrial concentration using the Herfindahl Hirschman index as well as industry dummies. We use data on Swedish firms' monthly exports, sales and value added for the period 2007-2014. The dataset covers all firms in the Swedish manufacturing sector that declare monthly value added tax (VAT) and payroll taxes. We combine firm-level data with industry measures of global value chain participation to investigate the role of input-output linkages between Swedish and foreign industries and how these linkages influence firm performance during the crisis period.

The estimation results support our argument that global production linkages are a key mechanism through which the Global Financial Crisis affected firms' export, sales and value added growth. First, we find that the crisis had a negative effect on firms' export and sales growth. Moreover, the decline in firms' export growth was more severe than the decline in domestic sales growth. This indicates that greater exposure to trade through deeper participation in global value chains may make firms more sensitive to changes in external demand. Second, we find that firms that operate in upstream industries experienced a lower decline in export growth, domestic sales growth and value added growth.

While vertical linkages explain much of the decline in trade, the extent to which these linkages account for the observed reduction in trade in the wake of the global recession is widely debated (Duval et al. 2016; Ng 2010). There are two competing hypotheses explaining this falloff. One branch of literature argues that global trade collapsed as the crisis led to a decline in the demand for imports during the 2008-2009 period (Bems et al. 2011). Alessandria, Kaboski, and Midrigan (2011) examine the effect of changes in demand on trade flows and put forward that inventory adjustments during the crisis led to a decrease in the demand for imports. The crisis resulted in a decline in consumer demand which encouraged firms cut inventory on hand and fill orders from their existing stock of inventories in response (Alessandria et al. 2011). This then led to a decline in the demand for imports during the global economic recession.

Another branch of literature identifies financial market contagion as the primary channel through which the crisis stimulated a downturn in trade flows. Mollah, Quoreshi, and Zafirov (2016) investigate whether contagion spread via equity or credit markets by studying the correlation in financial returns for each country with U.S. financial returns. The authors show that bank risk transfer was responsible for the spread of the crisis from the U.S. to other countries. The crisis also meant that

industries and firms that are more reliant on external credit were more adversely affected. A number of studies investigate this hypothesis (Foley and Manova 2015). In a seminal paper, Chor and Manova (2012) study the impact of the crisis on the export performance at the industry level. They find that industries that on external credit fared worse during the crisis period. Chor and Manova (2012) also show that this decline was worse in industries exporting to countries with less developed financial markets. The crisis resulted in tightening credit conditions in exporting countries, making it more difficult for firms to secure working capital needed to produce as well as export (Chor and Manova 2012).

This paper contributes to the current debate by highlighting the effect of production linkages in determining the effect of external shocks on firm performance. Most micro-level studies examine the relationship between firms' reliance on external finance and firm performance during the crisis (Amiti and Weinstein 2007). These studies also typically test the effect of exchange rate depreciations on firm performance (Ekholm, Moxnes, Ulltveit-Moe 2012; Forbes 2002). Our paper differs from existing studies in that, while we acknowledge the importance of financial vulnerability during economic recessions, we argue that the increasing interconnectedness in global production adds a new dimension to firms' responsiveness to financial crises. Our paper is most closely related to Claessens, Tong and Wei (2012) who find that trade linkages explain much of the decline in firm performance during the Global Financial Crisis and that financial vulnerability is a less compelling explanation. Claessens et al. (2012) use data on publicly listed manufacturing firms in their analysis. Our paper examines the case for all manufacturing firms in Sweden, which allows us to analyze the heterogeneous effects of the decline in trade on firms.

In Section 2, we present our empirical analysis and discuss these results in Section 3. Finally, in Section 4 we present our main conclusions.

2 Data and Empirical Approach

2.1 Empirical approach

In this section, we present our main empirical approach. We begin by expressing our baseline specification in Equation (1) which estimates the relationship between the effect of international linkages on firm performance and how this was affected by the crisis.

$$\Delta y_{ijt} = \alpha + \beta_1 \Delta trade_{ij1} + \beta 2 crisis_t + \beta 3 \Delta trade_{ij1} \times crisis_t + \delta \Delta Z_{ijt} + \mu_t + \varepsilon_{ijt} \quad (1)$$

Our dependent variable, Δy_{ijt}, represents changes in performance for firm i in industry j at time period t. We measure firm performance using sales growth and

value added growth. The independent variable $trade_{ij1}$ denotes denotes firm-level pre-crisis exposure to international trade during 2007 and is defined as:

$$trade_{ij1} = \frac{(import_{ij1} + export_{ij1})}{sales_{ij1}}$$

Equation (1) also controls for firm characteristics, denoted by Z_{ijt}, such as firm size, a dummy variable indicating whether the firm is a multinational as well as a dummy variable indicating whether the firm has ever exported during the period 2007-2014. We also include monthly wage growth per worker as a measure of the skill level of the firm's workforce which controls for certain firm-specific characteristics such as productivity that may be correlated with firm performance and may therefore disguise the true effect of the crisis. Finally, we include the variable μ_t, which represents year dummies to control for factors such as changes in input prices that are common to all firms during a particular year.

Equation (1) answers the following question: what is the average effect of the crisis across firms in an industry? Our main purpose is to analyze whether value chain integration, measured at the industry level, influences the effect of the financial crisis on sales and value added growth. Using data on the firm's international activities may underestimate the true effect of trade exposure since the activities of other firms within each industry should also be taken into account. We test two main predictions: during the global financial crisis, firms in sectors with stronger production linkages experienced larger declines in total sales growth. The second prediction states that during the global financial crisis, firms in sectors with stronger global production linkages experienced larger declines in value-added growth. To this end, we include the interaction between trade exposure at the industry level and the financial crisis dummy. Our new specification is set out in Equation (2).

$$\Delta y_{ijt} = \alpha + \beta_1 \Delta trade_{j1} + \beta_2 crisis_t + \beta 3 \Delta trade_{j1} \times crisis_t + \delta \Delta Z_{ijt} + \mu_j + \mu_t + \varepsilon_{ijt} \quad (2)$$

where the dependent variable Δy_{ijt} denotes changes in firm performance as in Equation (2). We include the variable $trade_{j1}$, which represents pre-crisis trade exposure at the industry-level and is measured using the natural logarithm of industry-level imports or exports. Alternatively, we construct a measure of industry-level exposure to trade defined as:

$$trade\,exposure_{j1} = Total\,Production_{j1} - Exports_{j1} + Imports_{j1}$$

This measure of trade exposure accounts for changes in each industry's business cycle by accounting for monthly total sales at the industry level. Using pre-crisis

variables as an independent variable helps us overcome potential problems associated with endogeneity (Kim, Tesar, and Zhang 2015; Desai, Foley, Forbes 2008). We therefore control for pre-crisis characteristics using data for the corresponding 12 month period up to September 2008. We also include the industry's Herfindahl index to control for the degree of concentration in each industry. The variable Z_{ijt} denotes firm characteristics such as wage per employee, firm size, and dummies indicating MNE and exporter status. We also include the lag of the dependent variable as a regressor to account for serial correlation. μ_j represents one-digit industry fixed effects to control for the effect of unobserved industry characteristics. Finally μ_t represents year fixed effects. As in Equation (1), including sector and year fixed effects controls for factors such as changes in input prices.

Equation (2) analyzes the effect of the crisis on the relationship between firm performance and global production linkages. This specification helps us understand the relationship between trade exposure and sales (value-added) growth at the firm level and how this relationship was influenced by the crisis. Our coefficient of interest is β_3 which measures how trade exposure influences the impact of the crisis on firm performance. A negative and statistically significant point estimate for β_3 suggests that there is a negative relationship between trade exposure and firm performance during the crisis.

2.2 Data Description

To estimate the effects of the crisis on firm performance we use a unique dataset on monthly tax returns for Swedish firms. The dataset covers all firms in Sweden (over 1,500,000 firms) and is obtained from Statistics Sweden (SCB) and the Swedish tax agency for the period 2007–2014. The dataset includes monthly values for sales, value-added, imports and exports. Other firm-level data available in the dataset include data on firm characteristics such as size, ownership type as well as the municipality in which the firm is located. We use data on monthly financial returns for the following reasons. First, high-frequency data provides a richer, more detailed level of analysis on the responses of firms to external shocks. More aggregate data at the annual level may wipe out periodic variation in firm performance. Second, monthly financial returns data also allows us to analyze how variation in macroeconomic variables such as exchange rates help to shape firm-level outcomes. These effects are more difficult to detect using aggregate data. Finally, our dataset also includes variables such as interest payments which allow us to analyze the effect of the crisis on firms' cost of capital.

In this paper, we define the crisis period as the period from September 2008 to December 2009. All financial variables are deflated using the appropriate industry price deflator. We use the domestic price index for each Swedish Industry Code (SNI) three-digit industry to deflate the variables domestic sales and wages. These data on industry-level domestic, import and export price indices also come from

SCB. We use the corresponding export and import indices for each SNI three-digit industry to deflate data on firms' exports and imports, respectively. We restrict our analysis to manufacturing firms and remove firms with zero sales for the entire period. The final sample consists of an unbalanced panel of 56,422 firms. Finally, our analysis uses data on the value chain position Swedish industries. These measures are calculated based on data from the World Input-Output Database and are obtained from Stone (forthcoming).

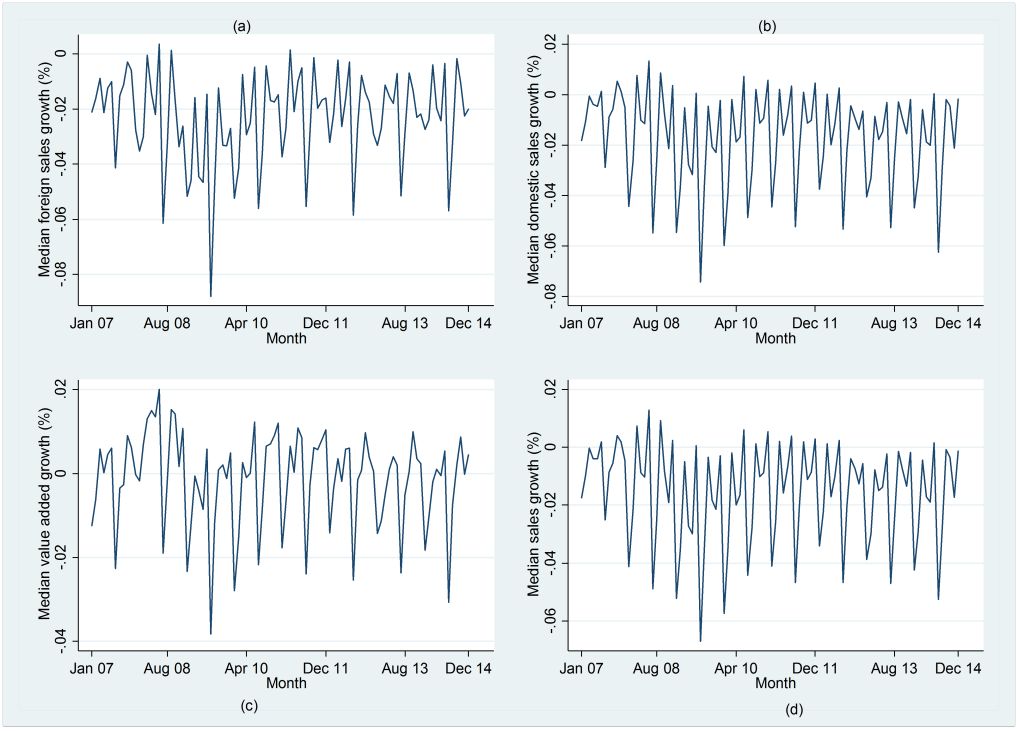
Table 1 summarizes basic descriptive statistics for firms in our sample. Approximately 60% of all manufacturing firms exported at least once between 2007 and 2014. Multinationals make up 7% of all firms in the sample. We aggregate firms into 13 industries.

Table 1: Descriptive Statistics

Variable	Number of Observations	Mean	Std. Dev.	Min	Max
Log exports	1,474,129	3.887	6.127	0	23.177
Log imports	418,566	12.159	2.509	-0.193	22.216
Log value added	1,110,482	11.591	1.857	0.128	26.00
Log sales	1,474,129	10.083	6.065	0	23.404
Log wage/worker	1,474,131	9.190	2.554	0	15.06
No. workers	1,474,132	31.170	277.23	1	19,072
Industry	1,474,133	7.969	3.88	1	13
Foreign MNE	1,474,134	0.065	0.247	0	1
Exporter	1,474,135	0.60	0.48	0	1

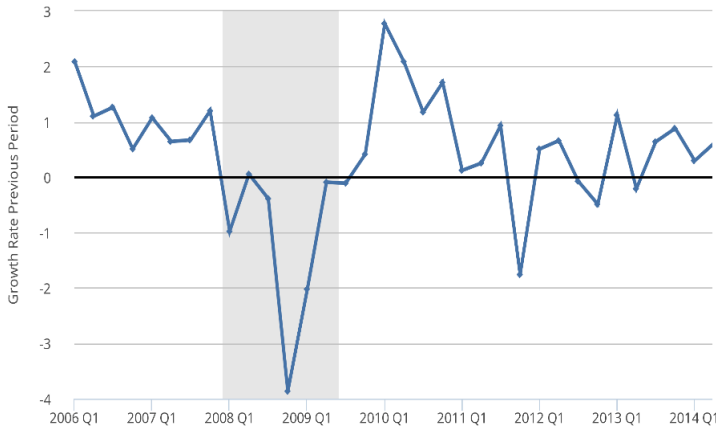
Figure 1 shows trends in median sales and value added growth for all manufacturing industries. Both foreign and domestic sales growth declined during the period July 2008-January 2010, with the steepest decline occurring between June and August 2009. These trends are comparable to GDP growth for Sweden, which declined between the first quarter of 2008 and the third quarter of 2009. Figure 2 shows quarterly GDP growth between 2006 and 2014. The grey bar indicates the recession period. During the fourth quarter of 2008, quarterly GDP fell by approximately 3.8 percent. These patterns in foreign sales growth also are comparable to trends in world trade flows. In Appendix I (Figure 3) we see that 2009 features a steep decline in trade flows across the world and more so for Sweden. In 2009, world trade declined by 10% while Swedish trade flows decreased by 15% on an annual basis. As discussed in the introduction, the decline in GDP brought about an even steeper decline in world trade.

Figure 1: Median monthly sales and value added growth for manufacturing firms (2007-2014)



Note: Figures 1(a)and 1(b) show the median foreign sales growth and median domestic sales growth. Figure 1(c) shows median value added growth while Figure 1(d) shows median total sales growth.

Figure 2: Quarterly GDP Growth for Sweden (2007-2014)



Source: Federal Reserve Bank of St. Louis (FRED)

3 Results

In this section, we discuss the results of our regression analysis. We begin by discussing the results of the baseline specification. To analyze the effect of the crisis on firm performance, we estimate Equation (1) by regressing changes in sales and changes in value-added on a crisis dummy and lagged firm characteristics. Table 2 compares the results for the two measures of firm performance - sales growth and value added growth. Columns 3 and 4 show that there is a negative relationship between our crisis variable and monthly sales and value-added growth, respectively. The results in Table 2 indicate an average decline in monthly sales and value added growth by between 2 and 4% during the crisis. We decompose the variable total sales growth into foreign and domestic sales growth and find that there is a larger decline in domestic sales growth (3.4%) than foreign sales growth (1.6%).

Table 2: Monthly sales and value added growth for manufacturing firms

VARIABLES	(1) Δ Foreign Sales	(2) Δ Domestic Sales	(3) Δ Total Sales	(4) Δ Value Added
Crisis	-0.016***	-0.034***	-0.036***	-0.019***
	(0.004)	(0.006)	(0.006)	(0.002)
1-9 employees	0.081***	0.419***	0.427***	0.028***
	(0.008)	(0.008)	(0.008)	(0.003)
10-49 employees	0.191***	0.367***	0.375***	0.007**
	(0.008)	(0.009)	(0.009)	(0.003)
50-249 employees	0.024***	0.024**	0.026***	-0.001
	(0.009)	(0.009)	(0.009)	(0.003)
Δ Wage per worker	0.013***	0.057***	0.057***	0.025***
	(0.002)	(0.004)	(0.004)	(0.001)
HHI	-2.175***	-5.351***	-5.412***	-0.252***
	(0.115)	(0.257)	(0.260)	(0.021)
Constant	0.077***	0.191***	0.187***	0.019***
	(0.008)	(0.010)	(0.010)	(0.003)
Observations	1,198,584	1,198,584	1,198,584	762,764
R-squared	0.221	0.214	0.213	0.220

Note: The sample includes all manufacturing firms with at least one employee. Lagged dependent variables are included in estimation but not reported in the table. Robust standard errors clustered at firm x year level where *** denotes p<0.01, ** p<0.05, and * p<0.1

Turning to the full results for Equation (1), we include the interaction variable for three measures of trade exposure and present the results in Table 3. Columns 1-3 show the effect of trade exposure on a firm's monthly foreign sales growth. We obtain a negative coefficient for the interaction term between monthly import growth at the firm level and the crisis dummy. The results suggests that there is a positive relationship between higher monthly import growth in the pre-crisis period and foreign sales growth overall. However, higher import growth is not a strong predictor of firm performance during the crisis. Column 2 shows the

results when export growth is used as the measure of trade exposure. The results show that higher pre-crisis export exposure is positively related to foreign sales growth. However, firms with stronger export linkages in the pre-crisis period also experienced lower foreign sales during the crisis. This is seen in the negative and statistically significant coefficient for the interaction between the interaction between the crisis dummy and firms' monthly pre-crisis export growth and firm's overall foreign sales growth.

Column 3 reports the results when we use our measure of firm trade exposure presented in Section 3.1. The interaction between the crisis dummy and firm exposure to trade is negative and significant. We interpret this result as follows. Firms with a higher import and export intensity (import and exports as a share of total sales) in 2007 are more likely to experience a decline in export growth during the crisis. Our results also suggest that export growth is one of the main factors driving the negative impact of trade exposure on foreign sales growth.

Columns 4, 5 and 6 present the results for domestic sales growth. Here, we can see that foreign sales and domestic sales growth show similar responses to the crisis. Column 4 shows that import dependence at the firm level is negatively related to firms' domestic sales growth. Similar results are obtained when export growth is used as our measure of trade exposure. In Column 6 we obtain a positive coefficient for our interaction variable. This suggests that firms with higher import and export intensity are more likely to report positive domestic sales growth during the crisis. In Columns 10, 11 and 12, we report the results for value added growth. We find that a positive effect of trade exposure in 2007 and value added growth during the crisis.

Table 3: The financial crisis and firm performance using firm's own exposure to trade

VARIABLES	(1) Foreign Sales	(2) Foreign Sales	(3) Foreign Sales	(4) Domestic Sales	(5) Domestic Sales	(6) Domestic Sales	(7) Total Sales	(8) Total Sales	(9) Total Sales	(10) Value Added	(11) Value Added	(12) Value Added
Crisis	0.012	-0.040	-0.028	0.020	0.024	0.025	0.016	0.015	0.018	0.012	-0.017***	-0.016***
	(0.022)	(0.025)	(0.025)	(0.029)	(0.025)	(0.024)	(0.028)	(0.026)	(0.025)	(0.022)	(0.006)	(0.006)
HHI	-10.544**	-12.731**	-13.122**	-15.848**	-15.074**	-15.373**	-15.933**	-15.250**	-15.414**	-10.544**	-1.034***	-1.083***
	(4.667)	(5.343)	(5.153)	(7.041)	(6.475)	(6.136)	(7.035)	(6.570)	(6.193)	(4.667)	(0.224)	(0.244)
Wage per worker	0.064***	0.078***	0.081***	0.074***	0.074***	0.078***	0.084***	0.073***	0.073***	0.064***	0.022***	0.022***
	(0.015)	(0.016)	(0.019)	(0.015)	(0.015)	(0.018)	(0.016)	(0.016)	(0.019)	(0.015)	(0.004)	(0.005)
Import 2007	0.023*			0.023			0.011			0.023*		
	(0.013)			(0.023)			(0.020)			(0.013)		
Crisis x import 2007	-0.018			-0.085***			-0.065***			-0.018		
	(0.015)			(0.019)			(0.015)			(0.015)		
Exports 2007		0.202***			0.022			0.052*			0.054***	
		(0.029)			(0.027)			(0.027)			(0.006)	
Crisis x Exports 2007		-0.157***			-0.037*			-0.080***			0.004	
		(0.028)			(0.021)			(0.022)			(0.007)	
Exposure 2007			0.079**			-0.033			-0.006			-0.043***
			(0.036)			(0.038)			(0.037)			(0.005)
Crisis x Exposure 2007			-0.046**			0.065***			0.033*			0.027***
			(0.023)			(0.019)			(0.018)			(0.005)
											(0.005)	(0.004)
Constant	0.089	0.382	-0.298	1.019***	1.120***	1.209***	1.332***	1.121***	1.197***	0.089	0.237***	0.462***
	(0.492)	(0.453)	(0.996)	(0.341)	(0.347)	(0.271)	(0.300)	(0.321)	(0.247)	(0.492)	(0.046)	(0.055)
Observations	230,165	251,690	210,356	230,165	251,690	210,356	230,165	251,690	210,356	230,165	198,648	169,988
R-squared	0.245	0.228	0.232	0.143	0.241	0.246	0.252	0.240	0.244	0.245	0.242	0.243
INDUSTRY FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Note: The sample includes all manufacturing firms with at least one employee. Lagged dependent variables and a categorical variable representing four firm size groups are included in estimation but not reported in the table. Robust standard errors clustered at 3-digit SNI industry level where *** denotes p<0.01, ** p<0.05, and * p<0.1

The results in Table 3 also reveal that firms that pay higher wages are more resilient. This is seen in the positive point estimate for the variable wage per employee. These results suggest that having a higher share of skilled employees is positively with associated higher sales and value-added growth. In addition, the results show that operating in more concentrated industries is negatively related to firm performance.

We compare the effect for exporters and non-exporters to determine whether international linkages influence firm performance during the crisis. These results are provided in the Appendix (Tables 6-7). A wealth of research shows that exporters are larger and more productive than non-exporters (Bernard et al. 2007). This productivity advantage may make exporters more resilient to adverse macroeconomic conditions. A decline in demand in one market may influence firms to reorganize internally and increase sales in other markets, thereby making firms less responsive to recessions. The results show that exporting manufacturing firms were negatively affected by the financial crisis. That is, the decline in sales growth was more severe for exporters. Similar results are obtained when we use value-added growth as our dependent variable. These results suggest that greater trade exposure negatively influenced firm performance during the crisis.

3.1 Industry exposure to trade and firm performance

The baseline specification confirms our hypothesis that the decline in firm performance during the crisis varies between firms according to the extent to which the firm participates in international trade. In this subsection, we explore this heterogeneity in firm performance and examine the effect of the crisis on the relationship between trade linkages and sales growth. To investigate the effect of value chain integration on the responsiveness of firms to trade shocks, we estimate Equation (2) and report the results in Table 4. We use industry level trade exposure defined in Section 3.1 since a firm's exposure to trade depends to a large extent on the industry in which it operates. Column 1 shows that there is a negative relationship between sales growth and the interaction between industry trade exposure and the crisis dummy. Columns 3 and 4 show the results for domestic and foreign sales growth, respectively. We find that greater trade exposure in 2007 is negatively related to export growth during the crisis. This is evidenced by the negative point estimate for the interaction between the crisis dummy and industry level exposure. The findings reveal that industry-level exposure has a greater effect on export growth than on domestic sales growth. While these results are intuitive, they also provide evidence that a firm's performance on the domestic market is influenced by its exposure to international trade.

In Column 2, we see that value added growth is positively related to firm exposure to trade. These result may indicate that firms that are more exposed to trade may be able to reorganize internally during the crisis. Ekholm et al. (2012) find

Table 4: Firm performance and industry exposure to trade

	(1)	(2)	(3)	(4)
VARIABLES	Δ Total Sales	Δ Value Added	Δ Domestic Sales	Δ Foreign Sales
Crisis	-0.147***	-0.039***	-0.133***	-0.072***
	(0.019)	(0.005)	(0.019)	(0.013)
Foreign MNE	-0.139***	-0.002	-0.133***	-0.046***
	(0.014)	(0.002)	(0.014)	(0.008)
Δ Wage per worker	0.051***	0.025***	0.051***	0.011***
	(0.003)	(0.001)	(0.003)	(0.002)
Δ Industry exposure (t-1)	0.988***	-0.045***	0.965***	0.248***
	(0.012)	(0.004)	(0.012)	(0.009)
Crisis x Industry Exposure	-0.461***	0.066***	-0.459***	-0.140***
	(0.026)	(0.011)	(0.026)	(0.022)
1-9 employees	0.290***	0.028***	0.284***	0.050***
	(0.021)	(0.003)	(0.021)	(0.010)
10-49 employees	0.272***	0.010***	0.267***	0.168***
	(0.022)	(0.003)	(0.022)	(0.011)
50-249 employees	-0.032	0.001	-0.032	0.002
	(0.022)	(0.003)	(0.022)	(0.011)
HHI	-4.219***	-0.115***	-4.192***	-1.347***
	(0.027)	(0.002)	(0.027)	(0.014)
Constant	-16.142***	-0.420***	-16.033***	-5.207***
	(0.109)	(0.009)	(0.108)	(0.055)
Observations	1,198,584	762,764	1,198,584	1,198,584
R-squared	0.298	0.223	0.298	0.242
YEAR FE	YES	YES	YES	YES
INDUSTRY FE	YES	YES	YES	YES
FIRM FE	NO	NO	NO	NO

Note: Lagged dependent variable included but not reported. Robust standard errors clustered at the firm x year level in parentheses where *** denotes p<0.01, ** p<0.05, * and p<0.1

that sudden shocks such as real exchange rate changes are associated with higher productivity for firms that are relatively more exposed to trade.

Indirect effects of the crisis on firm performance

So far our findings point to a negative relationship between trade exposure and sales growth during the Global Financial Crisis. Our findings also suggest that the decline in firms' export sales contributed to most of the observed reduction in firm performance. We now consider the role of interfirm linkages during the crisis and argue that sales and value added growth also depends on the firm's backward and forward linkages[6]. We investigate the effect of the value chain position of Swedish industries on firms' sales and value added growth. We argue that value chain position may determine firms' ability to adjust output, sell existing stock

[6]Levchenko et al. (2010) find that value chain linkages between countries contributed to a significant share of the decline in trade.

Table 5: The effect of the global financial crisis on firm performance: the role of value chain position

VARIABLES	(1) Foreign sales	(2) Domestic Sales	(3) Value added	(4) Foreign sales	(5) Domestic sales	(6) Value added
Crisis	-0.177***	-0.467***	-0.047***	-0.301***	-0.944***	-0.062***
	(0.016)	(0.015)	(0.007)	(0.019)	(0.018)	(0.008)
HHI	-0.318***	-0.806***	-0.022***	-0.313***	-1.215***	-0.028***
	(0.005)	(0.007)	(0.001)	(0.006)	(0.015)	(0.001)
Δ Wage per worker	0.012***	0.056***	0.027***	0.014***	0.058***	0.022***
	(0.002)	(0.005)	(0.001)	(0.002)	(0.006)	(0.002)
1-9 employees	0.114***	0.496***	0.038***	-0.236***	-0.869***	-0.010
	(0.011)	(0.018)	(0.004)	(0.021)	(0.064)	(0.006)
10-49 employees	0.203***	0.402***	0.013***	-0.091***	-0.830***	-0.022***
	(0.012)	(0.018)	(0.004)	(0.021)	(0.064)	(0.006)
50-249 employees	0.021	0.021	0.005	-0.118***	-0.586***	-0.023***
	(0.013)	(0.020)	(0.004)	(0.023)	(0.068)	(0.007)
Constant	-1.520***	-3.976***	-0.096***	-1.096***	-4.123***	-0.087***
	(0.025)	(0.039)	(0.006)	(0.029)	(0.078)	(0.008)
Observations	729,634	729,634	473,354	468,950	468,950	289,410
R-squared	0.223	0.225	0.216	0.229	0.247	0.228
YEAR FE	YES	YES	YES	YES	YES	YES

Note: Lagged dependent variable included but not reported. Robust standard errors clustered at the firm x year level Robust standard errors clustered at the firm x year level reported in parentheses where *** denotes p<0.01, ** p<0.05, * and p<0.1

or to find new markets. Firms that specialize in upstream industries produce goods that are used as production inputs and may be constrained by the lack of alternative markets. For instance, if their output is tailored to the purchasing firm's requirements, a decline in demand may leave the firm with excess capacity and limited options to seek new market. On the other hand, since Swedish firms produce output that is closer to the final customer (i.e. downstream the value chain), a decline in demand may have a strong effect on industries that are downstream the value chain.

To test the effect of value chain postion, we control for each industry's upstreamness in the global value chain in 2007 using the measure proposed in Fally (2012). We divide firms into two samples: industries with upstreamness scores above the median and industries with upstreamness scores below the median. A high upstreamness score implies that the firm produces outputs that are used as inputs to production processes. The results are reported in Table 5. Columns 1-3 report the results for sales and value added growth for industries with a high upstreamnesss score (greater than the median). We find that firms that operate in upstream industries report a less severe decline in sales and value added growth during the crisis. These findings suggest that the effect of trade shocks on firm performance depends not only on the extent to which a firm is exposed to trade, but also the on firm's position in global value chains.

4 Conclusions

Global production linkages have led to an increase in business cycle synchronization between countries and is one of the main factors explaining why the 2008-2009 financial crisis resulted in a collapse in world trade and severe economic recessions across many countries. However, most studies focus on the aggregate effect of the crisis on international trade level. By studying how firms respond to external shocks, our paper is one of a few establishing a direct link between international production linkages and changes in firms' exports and domestic sales during financial crisis.

We argue that global value chains make firms more vulnerable to external shocks and consider the following dimensions of firm performance: domestic sales growth, foreign sales growth and value added growth. We also use several measures of trade exposure at the firm and industry levels. Our main finding points to a positive relationship between trade exposure and firm performance. However, during the crisis, firms with greater exposure to trade experienced a more severe decline in sales and value added growth. This finding is robust across measures of export exposure. The results also show that the effect of the crisis on export sales growth was greater for firms that operate in industries that are more reliant on export sales as well as industries that rely on imports. Another important result points to the role of value chain position. Our results also show that Swedish industries that are closer to final demand report a larger decline in sales and value added growth during the crisis.

This paper shows that the coordinated decline in demand across many countries led to adverse outcomes for Swedish manufacturing firms' export and domestic sales growth. One interpretation of these findings is that exporters were less able to re-direct sales from weak markets to stronger ones. The results also point to indirect effects of the crisis as domestic sales decreased during this period. Traditional research on the effect of financial crises on firm performance often focuses on the effect of exchange rate volatility on exports. Our findings show that, in the current era of globalized production, factors such as production linkages may raise the responsiveness of firms to external shocks. One suggestion for future research on the role of trade linkages is to analyze how the decline in exports influence factors such as the demand for labor. This will improve understanding of the mechanisms through which the crisis led to a decline in domestic sales.

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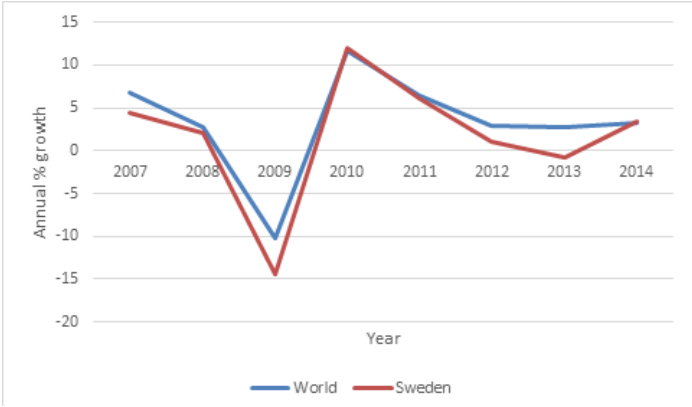
Appendices

Figure 3: Annual Percentage growth in trade (2007-2014)



Source: World Bank

Figure 4: Real effective exchange rate index (2007-2014)

Source: International Monetary Fund

Table 6: Firm sales and value added growth

(1)	(2)	(3)	(4)	(5)	(6)	
VARIABLES	Total Sales	Total Sales	Total Sales	Value Added	Value Added	Value Added
Crisis	0.017	0.007	0.006	-0.017***	-0.019***	-0.018***
	(0.016)	(0.015)	(0.016)	(0.004)	(0.004)	(0.004)
Import 2007	0.009			0.022***		
	(0.010)			(0.002)		
Crisis x Import	-0.064**			0.011**		
	(0.026)			(0.006)		
Exporter	-0.137***			-0.032***		
	(0.026)			(0.006)		
Exports 2007		0.051***			0.052***	
		(0.012)			(0.003)	
Crisis x Exports 2008		-0.076**			0.004	
		(0.030)			(0.007)	
Exposure			-0.024*			-0.044***
			(0.014)			(0.003)
Crisis x exposure 2007			0.037			0.027***
			(0.035)			(0.007)
Wage per worker	0.084***	0.072***	0.070***	0.030***	0.024***	0.022***
	(0.015)	(0.014)	(0.017)	(0.004)	(0.004)	(0.004)
HHI	-13.294***	-12.861***	-13.019***	-0.760***	-0.893***	-0.932***
	(1.099)	(0.837)	(0.909)	(0.082)	(0.085)	(0.098)
Constant	0.715***	0.556***	0.535***	0.094***	0.060***	0.058***
	(0.039)	(0.027)	(0.029)	(0.007)	(0.004)	(0.004)
Observations	230,165	251,690	210,356	183,709	198,648	169,988
R-squared	0.208	0.201	0.202	0.221	0.224	0.225
INDUSTRY FE	YES	YES	YES	YES	YES	YES

Note: Lagged dependent variable included but not reported. Robust standard errors clustered at the firm x year level reported in parentheses where *** denotes p<0.01, ** p<0.05, * and p<0.1

Table 7: Firm sales and value added growth

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Domestic Sales	Domestic Sales	Domestic Sales	Foreign Sales	Foreign Sales	Foreign Sales
Crisis	0.023	0.014	0.012	0.008	-0.051***	-0.039**
	(0.016)	(0.015)	(0.016)	(0.014)	(0.015)	(0.016)
Import 2007	0.011			0.022***		
	(0.010)			(0.008)		
Crisis x Import	-0.065**			-0.018		
	(0.026)			(0.021)		
Exporter	-0.137***			0.209***		
	(0.026)			(0.008)		
Exports 2007		0.021*			0.202***	
		(0.012)			(0.011)	
Crisis x Exports 2008		-0.033			-0.155***	
		(0.030)			(0.029)	
Exposure			-0.052***			0.067***
			(0.014)			(0.013)
Crisis x exposure 2007			0.070**			-0.045
			(0.035)			(0.033)
Wage per worker	0.082***	0.072***	0.075***	0.063***	0.079***	0.081***
	(0.015)	(0.014)	(0.017)	(0.011)	(0.013)	(0.015)
HHI	-13.214***	-12.779***	-13.035***	-8.757***	-10.756***	-11.099***
	(1.091)	(0.823)	(0.900)	(0.747)	(0.712)	(0.791)
Constant	0.712***	0.540***	0.522***	0.175***	0.508***	0.502***
	(0.039)	(0.026)	(0.029)	(0.022)	(0.024)	(0.027)
Observations	230,165	251,690	210,356	230,165	251,690	210,356
R-squared	0.209	0.203	0.204	0.215	0.201	0.200
INDUSTRY FE	YES	YES	YES	YES	YES	YES

Paper 4

Institutional Quality, Knowledge Intensity and Multinational Location Choice: Evidence from Developing Countries

Trudy-Ann Stone

ABSTRACT
The aim of this paper is to analyze the location behavior of multinational firms across developing countries by focusing on the role of institutional differences between countries in influencing the number of multinational entries. Recent developments in world investment patterns have seen a significant increase in the number of multinational subsidiaries located in developing countries. Using plant-level data, the paper analyzes the effect of host country institutional quality on the number of multinational entries. The findings point to the importance of institutional distance between the home and host countries in influencing the location decision of multinational firms. First, the findings reveal that there is a positive relationship between home and host country institutional similarity and the number of South-South multinational entries. Second, the paper finds that knowledge intensive industries are more sensitive to institutional distance between the home and host countries.

Keywords: FDI, multinational firms, institutions, knowledge intensity
JEL codes: F6, F23, O1

1 Introduction

This paper studies the growth in foreign direct investment (FDI) across developing countries and examines the effect of host country institutional quality on the number of multinational entries. A new pattern of FDI flows is emerging in which developing countries are now a major source of outward FDI flows. Outward FDI from developing countries increased from around 180 million U.S. dollars in 1970 to more than 400 billion in 2013 (UNCTAD 2015). Another emerging feature of FDI is that that more than half of total FDI flow worldwide is invested in developing countries, a pattern first observed in 2013. Furthermore, the number of multinational firms headquartered in developing countries has increased dramatically since the mid-2000s. Multinational firms from developing countries accounted for 37 percent of cross-border merger and acquisitions worldwide in 2013 (Cogman, Jazlowitzer, and Rapp 2015). This sudden growth in the number of multinational subsidiaries located in developing countries calls for a re-examination of current understanding of the factors that influence the location choice of multinational enterprises (MNE). The purpose of this paper is to unpack the role of host country institutional quality in determining the number of multinational entries across developing countries.

Empirical research on the influence of institutional quality on the multinational location choice shows that factors such as the protection of property rights, the enforcement of contracts and labor market flexibility positively influence multinational entry (Antras 2014; Bilir 2014; Delbecque, Mejean and Patureau 2014). However, most studies focus on explaining early trends in multinational location in which advanced economies accounted for the majority of FDI flows and invested disproportionately more in other developed countries. The growing importance of developing countries in FDI challenges the notion that institutional quality varies positively with the number of multinational entries, not least because developing countries receive less favorable ratings on a number of international indices (Kaufmann, Kraay and Zoidi 1999). Recent research questioning the role of institutional quality finds that developing countries undercut each other by weakening standards and regulations in order to attract multinational firms (Olney 2013; Davies and Vadlamannati 2013). These results support the 'race to the bottom hypothesis' and suggest that institutional quality varies negatively with the number of multinational entries into developing markets. Furthermore, it can be argued that as MNEs are often larger, more productive firms "[t]hey... can circumvent national regulation and policies more easily than can national firms" (Navaretti and Venables 2004, p1). As such, the role of institutions in informing the location behavior of multinationals is complex.

This paper focuses on three main features of host country institutions and examines how these features influence the number of multinational entries. The paper builds on previous research on the effect of host country institutions on multinational location behavior by focusing on the number of multinational entries into developing countries (Cezar and Escobal 2015; Demir and Hu 2015; Arregle et al 2013). First,

the paper examines the role of institutional quality in the host country and analyzes how this determines the number of multinational entries. Host country institutional quality influences multinational location choice through its impact on transaction costs (Dunning 1977). Transaction costs are particularly relevant for firms entering foreign markets given the increasing importance of services and intangible assets such as intellectual property in the modern economy. The quality of governance and public administration, legal enforcement of contract and the regulatory quality of a country are a few examples of economic institutions which affect the cost of entering a foreign market (Kaufmann, Kraay, and Zoido 1999).

The second goal of this paper is to determine whether differences between host and home country institutional quality promote or impede international investment by multinational firms. This distinction is important since institutional distance between the home and host economies may influence adaptation costs for firms entering new markets as well as the level of bilateral FDI flows (Cezar and Escobal 2015). For instance, for multinationals headquartered in developing countries, prior experience with weak institutions in the home country may make multinationals more resilient to poor institutional quality in foreign countries (Azemar et al. 2012; Cuervo-Cazurra and Genc 2008). This resilience may partly explain the growth in the South-South FDI flows. The paper therefore compares the effect of host country institutional quality on firms' location choice for two types of firms: multinationals from developed countries investing in developing countries (North-South FDI) and multinational from developing countries investing in other developing countries (South-South FDI). According to the Uppsala internationalization model, firms enter foreign markets sequentially, starting with the market that is most similar to the firm's home country. The model argues that firms deciding to establish a foreign presence begin by using the organizational form that requires the least commitment– for example by exporting or using an agent. As the level of familiarity with foreign markets increases, the firm then gradually increases its level of commitment to equity ownership (Johanson and Vahlne 2009). This sequential approach to internationalization helps firms to effectively manage the risks associated with being an outsider.

Institutional distance between the home and host countries influences not only the decision to enter a market but also the type of activity that the firm will choose to carry out there. The Uppsala model posits that the effect of institutional distance varies across industries according to the level of knowledge intensity. "[T]he less structured and well defined the activities and the required knowledge are, the more important is experiential knowledge... [e]specially in the marketing of complex and software intensive products" (Johanson and Vahlne 1977 p.28). This paper examines how knowledge intensity influences the entry decision by analyzing the interplay between institutional distance between the home and host countries and knowledge intensity at the industry level and how this relationship influences the number of multinational entries. Institutional similarity (low institutional distance)

may arise in cases where countries share a common language and legal framework, past colonial linkages, or diaspora networks (Rauch 1999; Head, Mayer, and Ries 2010; Azemar et al. 2012). These linkages may help to reduce transaction costs and promote entry by firms in knowledge intensive sectors.

As firms increasingly 'slice up' the value chain and relocate production to foreign countries, the activities of a parent firm in third countries may have a direct effect on multinational entry in a specific market. Moreover, the footloose nature of FDI suggests that firms may substitute away from a particular host country in favor of countries with more suitable conditions (Navaretti and Venables 2004; Olney 2013). Olney (2013) finds strong evidence that countries compete for FDI by weakening labor market regulations in response to more liberal labor market policies in competing countries. Thus, the final aspect of the paper considers institutional quality in 'competing' countries. That is, I analyze whether differences in institutional quality among host countries have a complementary or a substitution effect on the number of multinational entries into each market. The institutional quality of a country's neighbors may have a complementary effect on multinational location behavior when countries gain from having (competitors) neighbors with high institutional quality. On the other hand, there is a substitution effect taking place when competing countries' institutional quality negatively influence the number of multinational entries into a particular market.

The paper departs from the previous literature in two respects. First, the paper uses establishment-level data on the universe of MNE affiliates across developing countries. Research on MNE location patterns often uses financial flows between countries as a proxy for the level of multinational activity. While informative, using financial flows as a proxy for MNE activity provides an incomplete picture of multinational location strategy. This is because bilateral FDI flows include various types of transfers such as loans between firms or investment financing and cannot be used study MNE activity at the level of the individual firm (Navaretti and Venables 2004). Second, most studies on multinational location choice focus on MNEs headquartered in developed countries. This paper uses data on over 150,000 multinational affiliated located in developing countries to analyze the role of institutional quality and compares the effect of institutional quality and distance for North-South FDI and South-South FDI. This paper is most closely related to Azemar et al. (2012) and Darby, Desbordes and Wooton (2010) and Demir and Hu (2015) who analyze the relationship between institutional quality and multinational location choice in developing countries.

The findings reveal that institutional quality has a significant impact on the number of multinational entries. Furthermore, the direction and magnitude of the effect of institutions depend on the nationality of the MNE. These findings indicate that institutional distance between the home and host countries is a crucial factor determining the number of multinational entries. MNEs from developed countries

are more sensitive to lower institutional quality and institutional distance than those headquartered in developing countries. The results also show that firms in knowledge-intensive sectors are more sensitive to institutional distance between the home and host countries. In addition, the paper examines the effect of third countries' institutional quality on the number of multinational entries and sheds light on the role of institutional distance from another perspective. The paper demonstrates that firms substitute away from countries with low institutional quality and choose to locate in physically proximate countries with higher quality institutions.

This paper is organized as follows: Section 2 reviews the literature on the determinants of FDI, Section 3 then presents the empirical strategy. Section 4 consists of an analysis of the main findings and Section 5 discusses these results and presents the key findings.

2 Multinational Location Choice – The Role of Formal Institutions

This section reviews previous research on the determinants of multinational location choice as well as the literature on FDI and institutions. Throughout the rest of the paper, the term *institutions* is used to refer to economic institutions. Specifically, the paper focuses on aspects of economic institutions commonly used in the literature to explain differences in income level as well as differences in industrial structure across countries. The paper focuses on "the specific innovations and particular institutional instruments evolved from the interplay between two fundamental economic forces: the economies of scale associated with a growing volume of trade, and the development improved mechanisms to enforce contracts at lower costs" (North 1991 p.107). Examples of such institutions are property rights, the rule of law and the existence of markets (See Acemoglu, Johnson, and Robinson (2005) for a comprehensive review of the literature on the origins of the concept in the economics literature).

In line with previous research, this paper argues that cross-country differences in institutional quality may help to explain differences in FDI flows between countries since institutions are a source of comparative advantage (Nunn and Trefler 2014). The literature on the relationship between trade and institutions argues that institutions have an indirect effect on comparative advantage and operate through the following channel: a country's institutions influence its rate of capital accumulation which then influences trade patterns. Institutions, therefore, confer a comparative advantage by determining the industrial structure of countries (Acemoglu et al. 2005; Nunn and Trefler 2014). A related stream of literature on the determinants of comparative advantage puts forward that, in addition to influencing human and physical capital accumulation, institutions can also have a

direct effect on comparative advantage (Linders and de Groot 2005; Acemoglu et al 2005; Nunn 2007; Levchenko 2007). This paper builds on this reasoning to argue that institutions help to determine the level of FDI flows to developing countries both directly and indirectly. By shaping countries' industrial structure, institutions indirectly determine countries' ability to attract international investment.

Previous research in international business and international trade has shown that there is a positive relationship between a country's host country institutional quality and the level of inward FDI. These studies overwhelmingly focus on various features of developed country institutions and study their effect on FDI flows originating from advanced economies. Henisz (2000) is the first paper to study the relationship between multinational firms' entry mode and institutions using transaction-level data. Henisz (2000) examines the effect of political risks on the choice to enter a market using majority or minority-owned subsidiaries and how these factors depend on the specific portfolio mix of the firm. Ascani, Crescenzi, and Iammarino (2015) conduct a similar analysis using data on European mergers and acquisition deals. They estimate the effect of institutional differences between European Union (EU) regions on mergers and acquisitions by firms headquartered in EU-15 countries and investing in new EU member states and report that regions with higher (economic) institutional quality tend to attract more investments by multinationals.

Specific features of institutional quality such as the strength of intellectual property rights protection (Antràs 2011; Bilir 2014) and the contractual environment (Feenstra and Spencer 2005) determine whether a firm will enter a foreign market. Bilir (2014) finds evidence that multinational subsidiaries that specialize in manufacturing are indeed sensitive to the strength of a country's patent laws. Moreover, the effect varies across products according to the length of the product cycle. Dewit, Görg, and Montagna (2003) find that strong labor market protection deters inward FDI in OECD countries. Delbecque et al. (2014) conduct a similar analysis using data on MNEs headquartered in France and find that strict labor market laws in the host country deter multinational entry. Javorcik and Spatareanu (2005) and Haaland and Wooton (2007) find that greater labor market flexibility is associated with an increase in FDI flows. Other institutional factors such as the level of financial sector development influence the decision to enter a market as well as the level of multinational activity abroad (di Giovanni 2005; Portes and Rey 2005; Foley and Manova 2015).

Developing country institutions and FDI

The traditional literature argues that MNEs prefer to locate in countries with higher institutional quality and that these firms choose vertical integration in foreign markets to internalize risks associated with less developed institutional environments (Dunning 1977; Dunning 2001). However since developing countries

have a comparative disadvantage (Nunn and Trefler 2014) in institutional quality, how does this influence the number of multinational entries into these countries? Javorcik and Wei (2009) find that higher levels of corruption in transitioning countries deter foreign firms from entering a market. They find that not only does corruption influence the location choice, it also determines the specific ownership form. Multinational firms will choose to enter transitioning countries using joint ventures when the host market performs relatively poorly on a range of corruption indices. The paper by Javorcik and Wei (2009) studies multinational activity in Central and Eastern European countries, which may explain these findings.

Other papers on South–South FDI find that multinationals originating from developing countries are more resilient to low institutional quality, and are more likely to invest in other developing countries with low institutional quality (Azemar et al. 2012). The authors argue that institutional familiarity may help firms overcome traditional sources of uncertainty associated with entering a foreign market. Demir and Hu (2015) examine the effect of institutional distance on bilateral FDI flows and find evidence supporting the claim that institutional distance matters more for North-South FDI than for South-South FDI.

Each of the studies discussed shows that host country institutional quality is an important determinant of multinational location choice. In general, these studies indicate that higher institutional quality is associated with a greater number of multinational entries. This paper considers multinational entries across developing countries and argues that, in line with the Uppsala internationalization model, institutional quality has a positive effect on the number of multinational entries. Likewise, the paper argues that the difference between home and host country institutions – measured as institutional distance – has a negative effect on the number of multinational entries. The final line of inquiry pertains to the specific activity that the firm performs in the host country. The paper uses a measure of knowledge intensity to evaluate the relationship between institutional quality and knowledge intensity in influencing where a firm chooses to locate.

3 Empirical Specification

This section presents the empirical model used to test the relationship between host country institutions and multinational location behavior across developing countries by estimating the effect of institutions on the number of multinationals entries in each host country-industry pair. If the level of institutional quality has a positive effect on firm entry, then countries with high institutional quality will attract more multinationals than others. The empirical specification also accounts for differences between firms by including industry-level variables such as task routineness in the main regression equation. This measure of task routineness is a proxy for knowledge intensity and has been used in the international trade literature to determine which jobs are more easily standardized and can therefore

be relocated to other countries (Oldenski 2012). This is also in line with the stream of literature showing that industries' sensitivity to institutions depends on factors such as the level of product complexity (Berkowitz, Moenius, and Pistor 2006), product cycle length (Bilir 2014), reliance on external credit (Foley and Manova 2015), or the contract intensity of the industry (Nunn 2007; Antras and Helpman 2008). Hence, industries that are less routine intensive are expected to be more sensitive to low institutional quality and that this will have a negative impact on the choice to enter a particular market.

Following Alfaro and Chen (2015), the effect of institutions on multinational location choice can be specified as:

$$E_{ijk} = \alpha + X_{ij}\beta + \gamma Y_j + \mu_k + \varepsilon_{ijk} \tag{1}$$

where the dependent variable E_{ijk} represents the number of affiliates in industry k headquartered in country i and located in host country j . The independent variables X_{ij} capture country characteristics including physical distance between the host and home economies, human capital, market potential and GDP. The main variable of interest, Y_j, denotes the quality of institutions for each destination country in the sample. The variable μ_k represents industry dummies that capture the effect of omitted variables that affect all firms in industry k. Finally, ε_{ijk} is the residual term that accounts for all other omitted variables affecting multinational entry in country i in industry k. Equation (1) is estimated for the full sample of firms entering foreign markets in the period 2005 to 2013 and then for North-South and South-South FDI, separately. The sign of the coefficient for the variable measuring institutional quality, γ, indicates the effect of institutional quality for both types of FDI.

3.1 Institutional distance

Institutional similarity between the host and home countries may influence the number of multinational entries across developing countries. To test the effect of institutional differences, the Kogut and Singh (1988) measure of distance is included among the regressors in Equation (1). This index is defined as:

$$Dist_{ij} = \frac{1}{n}\frac{\sum_{a=1}^{n}(Y_{ai} - Y_{aj})^2}{V_a} \tag{2}$$

where Y_{ai} captures headquarter country i's score on indicator a, Y_{aj} captures host country j's score on indicator a, V_a represents the variance of country score on indicator a, and n is the total number of institutional indicators.

Equation (1) above can be re-written to include the Kogut and Singh (1988) institutional distance index:

$$E_{ijk} = f(\alpha + X_{ij}\beta + \gamma_1 Y_j + \gamma_2 Dist_{ij} + \delta Dist_{ij} \times Z_k + \mu_k + \varepsilon_{ijk}) \tag{3}$$

where, as in Equation (1) above, E_{ijk} represents the number of affiliates headquartered in country i investing in country j whose main activities are concentrated industry k. The independent variables X_{ij} capture country characteristics and Y_j represents host country institutional quality. $Dist_{ij}$ denotes institutional distance index and, μ_k, industry fixed effects, while Z_k represents the level of industry routineness. The interaction term $Dist_{ij}$ x Z_k captures heterogeneous effects of institutions according to the level of routine intensity of the industry in which the affiliate operates. A negative and statistically significant value for δ confirms the hypothesis that institutional distance has a greater effect on the location decision of firms in less routine intensive (more knowledge intensive) industries. The main coefficients of interest are the parameters γ_1, γ_2 and δ, which capture the effect of institutions on multinational entry behavior.

In addition to the effect of domestic institutional quality on the number of multinationals entering a particular market, third country institutional quality may influence multinational location choice across countries. That is, institutional quality in neighboring countries may positively or negatively affect multinational entry in a particular market. To account for the effect of third country institutions, the paper uses two measures of competitor institutional quality. The first variable is a distance-weighted measure of competitor institutional quality measured as:

$$\sum_{j \neq l} \frac{Institutional\, quality_j}{Distance_{jl}}$$

The second measure used to estimate the effect of competitor institutions is constructed by taking the average number of entries across competing countries. That is, the average excludes data on institutional quality for the specific host country in question. Following Olney (2013), this measure is standardized so that countries with a greater number of multinationals receive a higher weighting. Each third country variable is included in equation (3) individually. A positive coefficient for this variable indicates that there is some degree of complementarity between host country institutional quality and its competitors' institutional quality. On the other hand, a negative coefficient suggests that MNEs opt for host countries with relatively better institutions.

4 Data and Variable Definition

Data on multinational firms' affiliates in developing countries come from the International Trade Center (ITC). The ITC[1] publishes data on multinational investments across developing countries. This dataset comprises establishment-level data for over 150,000 multinational affiliates in 110 developing countries[2] and

[1]Website: http://legacy.intracen.org/marketanalysis/default.aspx

[2]See Appendix for a list of countries covered in the sample

comes from Dunn and Bradstreet, one of the most comprehensive sources of data on multinational activity. The ITC Investment Map dataset records information on multinational subsidiaries located developing countries from as early as 1950 up to 2013. The dataset includes information on the location of the headquarter establishment, the address of each affiliate in the respective host countries as well as financial data on total sales and employment. The dataset also lists the three main activities of each subsidiary at the four digit ISIC[3] Revision 3 level. All subsidiaries are classified into over 900 different industries. Earlier versions of this dataset have been used by Darby, Desbordes, and Wooton (2010) who show that the Investment Map data very closely reflects the level of multinational activity across countries. One weakness of the Investment Map dataset is that no information is provided on shareholder information and therefore it is not possible to determine whether these subsidiaries are wholly-owned by foreign companies.

Table 1: Descriptive Statistics

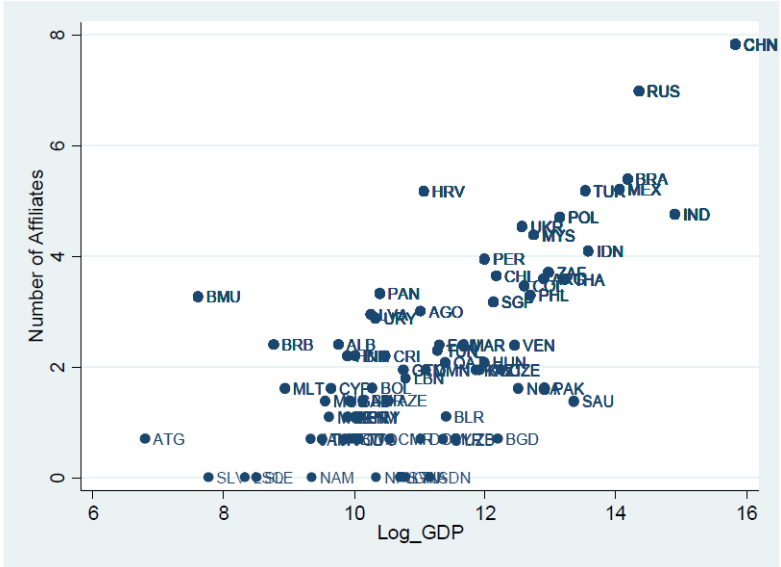
Variable	No. Observations	Mean	Standard Deviation	Max
Number of entries after 2005	35,273	1.80	5.973	99
Year	35,273	2008	2.202	2013
Nonroutineness index 2002	35,273	0.004	0.0004	0.0056
Nonroutineness index 2012	35,273	0.0118	0.002	0.014
Contiguity	35,174	0.174	0.3793	1
Common Language	35,174	0.187	0.3897	1
Distance	35,174	4,134.57	3,681.137	19,369.97
Population	12,577	555.327	597.523	1,311.798
GDP per capita (host)	34,507	24,175.71	18,811.57	89,563.63
Former Colony	35,174	0.0655	0.2474	1
Simple Average Tariffs	26,756	5.987	4.254	33
Weighted Average Tariffs	26,756	3.930	3.876	55.15
Ln (Real Market Potential)	33,982	19.982	1.327	23.491
South-South dummy	35,273	0.360	0.480	1
Economic Freedom index	26,870	6.517	0.499	8.73
Corruption index	31,187	-0.411	0.454	2.195
Stability index	31,187	-0.521	0.589	1.418
Regulation index	31,187	0.012	0.349	1.796
Rule of law index	31,187	-0.402	0.462	1.764
Trade index	27,185	6.617	0.737	9.39
Labor market index	27,185	5.504	0.854	9.24
Property rights index	27,126	5.185	1.344	9.018
Legal system index	27,162	6.112	1.474	8.479
Ownership index	27,126	5.745	1.213	9.135
Compliance index	27,162	6.650	1.241	9.558
Licensing index	27,162	4.572	2.547	9.998

The paper focuses on multinational entries between 2005 and 2013. In addition, only firms operating in the manufacturing and business services sectors are included

[3]International Standard Industrial Classification of All Economic Activities

in the final sample. All other establishments such as nonprofit and governmental organization are removed as well as observations where information on the year of entry was not provided. The final sample includes approximately 35,000 firms entering developing countries over the period 2005-2013. Figure 1 plots the relationship between host country GDP and the level of multinational activity for the year 2005 and shows that multinationals tend to locate in larger markets with higher GDP levels.

Figure 1: Number of multinational entries by host country – industry pair for the year 2005



Source: Author's calculation using ITC data

Variable Definition

The dependent variable is the number of affiliates at the country-industry level for the period 2005 -2013. Using firm-level data has two main advantages. First, firm-level data is a better measure of real activity in the domestic economy since it is possible to identify the specific parent firm, the source country as well as the industry in which the subsidiary operates. The second advantage is that it is possible to observe the simultaneous behavior of the parent firm across destination countries. This will improve current understanding of the importance of differences between countries in determining multinational location choice along the value chain. For example, the data shows that Nestlé established more than 400 subsidiaries across all developing countries. This dataset enables us to chart the firm's activities across countries and identify what stages of the value chain are located in a particular country. The firm's subsidiaries participate in more upstream activities such as growing and harvesting raw material, as well as intermediate activities including

manufacturing food products. Similarly, FDI by auto companies may be devoted to manufacturing parts and components or they may specialize in wholesale and retail trade or even loan financing.

This paper uses data on subsidiaries according to their main activity to test the relationship between institutional features of the host economy and the location choice of multinational firms. Furthermore, the paper argues that knowledge intensity is a key factor determining the effect of host country institutions on the choice to enter a market. This is because knowledge intensive sectors may be more sensitive to institutional quality in the host country. Factors such as intellectual property protection and the enforcement of contracts reduce the cost of entering foreign markets and positively influence the location choice of multinationals specializing in knowledge intensive activities (Bilir 2014). To analyze the effect of institutional quality on multinational entry, the paper employs various indicators that rate countries' economic institutions. Emphasis is placed on indicators that can be used as a proxy for transactions costs. These include the protection of property rights, freedom to trade internationally and labor market flexibility. These indicators will be explained in detail in the next subsection.

4.1 Country Characteristics

Institutions

Cross-country data on institutional quality come from the World Bank World Governance Indicators and the Fraser Institute. The Fraser Institute publishes cross-country data on the level of economic freedom for 157 countries from as early as 1970. This dataset has been used previously by Delbeque et al (2011) and Ascani et al. (2015) to measure the effect of cross-country institutional differences on multinational location behavior. The Economic Freedom index captures differences between countries' institutions on a number of measures. This paper focuses on indicators measuring the quality of governance, labor market restrictions, freedom to trade internationally and the business environment. The paper uses the 2005 values for each institutional indicator discussed below.

Governance: The World Bank's World Governance Indicators provide information on a range of governance measures for 215 developing countries over the period 1996-2014 (Kaufmann, Kraay, and Zoido 1999). In particular, the World Governance Indicators includes information on control of corruption, political stability, regulatory quality, and the rule of law. This paper uses data on these four indicators as a measure of the quality of governance across host countries.

Freedom to trade internationally: This indicator comes from the Fraser Institute and measures among other things restrictions to foreign ownership, tariff and nontariff barriers to trade, regulatory barriers to trade as well as costs asso-

ciated with complying with customs regulation. The paper measure the effect of restrictions to trade on firms' decision to enter a foreign market. The horizontal theory of FDI hypothesis puts forwards that firms choose to become multinational in order to overcome costs associated with serving foreign markets via exports.

Labor market regulations: The Fraser Institute publishes an index of labor market regulation cost based on five different measures. They include: hiring regulations, regulation of working hours, firing costs, the level of collective bargaining and the presence of mandatory military conscription. These measures are then used to construct an index of labor market protection.

Business environment: Data on the business environment come from the Fraser Institute. The World Bank Doing Business Index is often used by researchers when comparing business environment across countries. However, this paper uses the Fraser Institute's dataset as it offers a wider coverage for more countries and for a longer time period. This dataset includes indicators such as the costs associated with starting a business as well as the costs associated with dealing with government institutions. The paper includes indicators on the level of protection of property rights, licensing restrictions and legal protection of property rights.

Other Controls

Other country-level characteristics may influence the location decision of the firm. Data on GDP (in 2005 U.S. dollars) comes from The Penn World tables. Following Cezar and Escobar (2015) an index of GDP similarity between the parent (i) and destination (j) country is included. GDP similarity is measured using the following expression: $(GDP_i GDP_j)/(GDP_i + GDP_j)^2$. Physical and cultural distance between countries may also influence where multinational firms choose to locate. The paper controls for these factors using data from Centre d'Études Prospectives et d'Informations Internationales (CEPII). Data on bilateral distance between the host economy and the parent country and a dummy variable indicating whether country pairs share a common border are used to measure the effect of geography on firm location behavior. Cultural variables including whether countries share a common language or colonial ties also come from the CEPII dataset. The paper controls for host country market potential to account for the effect of host country market size on FDI. Finally, data on the simple average bilateral tariffs at the 3 digit level come from the World Integrated Trade Solution (WITS) database on bilateral tariff rates. Tariff values used in paper correspond to average between 1999-2004 values to account for missing values between reporting periods.

4.2 Industry Characteristics

To estimate the role of institutions in influencing multinational entry choice the paper takes into consideration industry characteristics that shape the decision. Specifically, the paper measures the routine intensity of each industry to estimate whether the impact of institutions on multinational entry varies with the product complexity or knowledge intensity. To measure routine intensity, the paper examines the employment composition of industries. An industry is routine intensive if the share of workers performing more routine tasks is higher than in other industries. Following Costinot, Oldenski and Rauch (2011) and Oldenski (2012), jobs with a high rating for the skill "making decision and solving problems" are assumed to be less routine intensive. Data on the skill requirements for different occupations comes from the U.S. Bureau of Labor Statistics O*NET database. This data is then combined with data on the share of workers in each occupation employed in each industry to obtain an industry-level routineness index. A high value for this index indicates that an industry employs relatively more workers whose jobs require a high degree of problem solving. That is, the industry can be classified as specializing in non-routine or more knowledge intensive activities. Table 1 provides descriptive statistics on variables used in the estimation.

5 Results

This section presents and discusses the results of the empirical analysis, starting with the baseline specification. Equation (1) is estimated using a negative binomial count model and the results are presented in Table 2. The results of the baseline specification are largely consistent with previous research. The findings reveal that the number of multinational entries declines with physical distance between the host and home countries and increases with measures of similarity such as sharing a common official language.

Table 2: The position of Swedish Firms in Global Value Chains

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Log(Distance)	-0.642***	-0.620***	-0.639***	-0.581***	-0.603***	-0.639***	-0.629***	-0.615***	-0.570***	-0.508***	-0.558***	-0.572***	-0.540***	-0.524***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
Simple avg tariffs	0.035***	0.023***	0.035***	0.022***	0.028***	0.030***	0.030***	0.025***	0.027***	0.035***	0.030***	0.024***	0.025***	0.025***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
GDP per capita	0.260***	0.270***	0.255***	0.270***	0.292***	0.294***	0.280***	0.303***	0.280***	0.253***	0.263***	0.282***	0.264***	0.280***
	(0.016)	(0.018)	(0.016)	(0.017)	(0.016)	(0.017)	(0.016)	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.016)	(0.017)
ln(Real Market Potential)	0.445***	0.330***	0.432***	0.465***	0.395***	0.483***	0.434***	0.458***	0.572***	0.312***	0.517***	0.528***	0.443***	0.433***
	(0.009)	(0.012)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.018)
GDP Similarity	-1.982***	-1.818***	-1.993***	-1.474***	-1.834***	-1.748***	-1.972***	-1.818***	-1.801***	-1.245***	-1.417***	-1.494***	-1.592***	-1.172***
	(0.096)	(0.106)	(0.097)	(0.090)	(0.092)	(0.091)	(0.094)	(0.091)	(0.091)	(0.092)	(0.092)	(0.091)	(0.094)	(0.090)
Contiguity	-0.256***	-0.105***	-0.234***	-0.186***	-0.253***	-0.257***	-0.234***	-0.301***	-0.236***	-0.276***	-0.179***	-0.161***	-0.150***	-0.234***
	(0.031)	(0.033)	(0.031)	(0.031)	(0.030)	(0.031)	(0.030)	(0.030)	(0.031)	(0.031)	(0.031)	(0.031)	(0.030)	(0.032)
Common Language	0.537***	0.432***	0.510***	0.613***	0.607***	0.635***	0.525***	0.643***	0.678***	0.846***	0.621***	0.566***	0.592***	0.786***
	(0.027)	(0.030)	(0.027)	(0.028)	(0.027)	(0.027)	(0.026)	(0.026)	(0.028)	(0.028)	(0.027)	(0.027)	(0.027)	(0.028)
Colony	-0.449***	-0.449***	-0.479***	-0.461***	-0.475***	-0.414***	-0.470***	-0.498***	-0.462***	-0.392***	-0.440***	-0.471***	-0.480***	-0.427***
	(0.030)	(0.035)	(0.030)	(0.032)	(0.030)	(0.031)	(0.030)	(0.029)	(0.031)	(0.032)	(0.031)	(0.032)	(0.031)	(0.032)
Num affiliates pre 2005	0.010***	0.009***	0.009***	0.009***	0.009***	0.010***	0.009***	0.008***	0.009***	0.009***	0.009***	0.008***	0.008***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Institutional Quality		-0.605***												
		(0.034)												
Labor market index			-0.039***											-0.170***
			(0.010)											(0.015)
Trade index				-0.481***										-0.147***
				(0.012)										(0.015)
Corruption index					-0.623***									-0.227***
					(0.024)									(0.034)
Stability index						-0.527***								-0.161
						(0.017)								(0.131)
Regulation index							-0.472***							0.325***
							(0.030)							(0.050)
Rule of law index								-0.659***						0.458***
								(0.020)						(0.108)
Property rights									-0.218***					-0.155**
									(0.006)					(0.061)
Legal system index										0.305***				0.004

Continued on next page

Table 2 – *Continued from previous page*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
										(0.007)				(0.010)
Ownership											-0.256***			0.121***
											(0.007)			(0.013)
Compliance												-0.280***		-0.023**
												(0.007)		(0.011)
Licensing													-0.117***	-0.075***
													(0.003)	(0.015)
Constant	-5.894***	0.132	-5.648***	-5.418***	-3.301***	-5.636***	-7.198***	-5.851***	-7.060***	-7.970***	-6.343***	-6.602***	-6.203***	-2.840***
	(0.237)	(0.429)	(0.243)	(0.256)	(0.245)	(0.235)	(0.238)	(0.236)	(0.234)	(0.245)	(0.235)	(0.238)	(0.235)	(0.507)
Observations	23,993	21,358	23,408	23,718	23,718	23,993	23,993	23,993	23,993	23,676	23,714	23,676	23,714	23,322
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Pseudo R-squared	0.190	0.197	0.200	0.191	0.199	0.195	0.196	0.192	0.197	0.196	0.201	0.197	0.199	0.206
Log Likelihood	-82555	-73231	-79985	-81790	-80901	-82110	-81996	-82392	-81911	-81161	-80733	-80986	-80913	-79169

Table 2 also reveals that, over the period 2005-2013, multinational firms chose to locate new subsidiaries in markets where other multinationals operating in the same industry were already present. The point estimate for the variable measuring the number of affiliates operating in industry k present in host country i prior to 2005 is positive and statistically significant coefficient and suggests that there are agglomeration effects taking place. The positive coefficient on real market potential suggests that developing countries with large internal markets and relatively better access to foreign markets are more attractive locations for multinational firms. Similarly, there is a positive relationship between tariff rates and the number of multinational subsidiaries located in these countries. This suggests that for countries with high tariff rates, firms choose to serve these markets using FDI rather than exports.[4] The following subsection discusses the main findings.

The Role of Institutions

Equation (1) is estimated using a number of institutional indicators to analyze the effects of institutional quality on the number of affiliates located in developing countries. Column 2 of Table 2 shows the results for the overall Fraser Institute institutional quality index. The coefficient for this indicator negative and statistically significant coefficient, which suggests that countries with relatively weaker institutions tend to attract a larger number of multinational firms. Repeating this exercise using other measures of institutional quality confirms these findings. These measures include: trade restrictiveness, labor market regulation, and governance indicators such as the rule of law, control of corruption and the level of political stability. The results are largely unchanged – there is a negative relationship between the quality of a country's institutions and the number of foreign affiliates it hosts. These findings are consistent with those reported by Darby, Desbordes, and Wooton (2010). Column 14 reports the results when all indicators are included simultaneously. To account for the high degree of correlation in the institution indicators used in Table 2, an index of institutional quality will be used throughout the rest of the analysis. This index is constructed by taking the arithmetic mean of the seven[5] institutional indicators used in Table 2. This index has been used previously by (Linders and de Groot 2005) who study the effects of institutions on international trade flows. To account for similarities between countries the Kogut and Singh (1988) measure of institutional distance is included and equation (3) is estimated. These two variables measuring institutional quality and institutional distance are used throughout the rest of the paper to compare the differential impacts of institutions on North-South and South-South FDI. Table 3 shows the effect of institutional quality of the number

[4]The results of the baseline specification provide broad support for market-seeking motive of FDI advanced by various theories of FDI.

[5]The index comprises the following indicators: freedom to trade internationally; labor market regulations; protection of property rights; legal enforcement of contracts; restrictions to foreign ownership; compliance costs of international trade and licensing restrictions.

of multinational entries using this institutional index. A one standard deviation increase in a country's score is associated with an decrease in the expected number of entries by 27.

Table 3: Institutional Distance and Multinational Entries

	(1)	(2)
VARIABLES		
Log (Distance)	-0.533***	-0.533***
	(0.011)	(0.011)
Simple avg tariffs	0.018***	0.018***
	(0.002)	(0.002)
GDP per cap	0.345***	0.345***
	(0.020)	(0.020)
ln(Real Market Potential)	0.523***	0.524***
	(0.009)	(0.009)
GDP Similarity	-1.560***	-1.558***
	(0.095)	(0.095)
Contiguity	-0.064*	-0.064*
	(0.034)	(0.034)
Common Language	0.621***	0.617***
	(0.028)	(0.028)
Colony	-0.543***	-0.540***
	(0.032)	(0.032)
No affiliates pre 2005	0.008***	0.008***
	(0.001)	(0.001)
Institution quality index	-0.753***	-0.752***
	(0.027)	(0.027)
Institutional distance Index	-0.051***	-0.639***
	(0.008)	(0.240)
Institution distance x routineness		-0.107**
		(0.044)
Constant	-6.303***	-6.309***
	(0.239)	(0.238)
Observations	23,533	23,533
Industry FE	YES	YES
Pseudo R-squared	0.201	0.201
Log Likelihood	-80306	-80304

So far, the results have shown that there is a negative relationship between institutional quality and multinational activity across developing countries, even after controlling for industry fixed effects. These results suggest that countries with relatively weaker institutions are generally more favorable destinations for multinational firms. The fact that the sample of destination countries includes only developing countries potentially explains a significant portion of these results. Darby, Desbordes, and Wooton (2010) and Azemar et al. (2012) obtain similar results showing that countries with weaker institutions attract a greater number

of multinational subsidiaries.

Another way to assess the role of institutions in influencing the number of multinational entries is by estimating the effect of institutional distance on the number of multinational entries across countries in the sample (Equation 3). Table 3 shows that institutional distance has a negative effect on the number of multinational entries. These results suggest that, while countries with relatively weaker institutions account for a larger share of multinationals entries, firms are more likely to invest in countries with a similar level of institutional quality. These results hold even after controlling for GDP similarity between countries, overall institutional quality and industry effects. These findings confirm the hypothesis that there is a positive relationship between institutional similarity and the level of multinational investment within country pairs.

North-South versus South-South FDI

The results presented so far consider the aggregate impact of institutions on MNE location behavior. Equation (3) is estimated using a negative binomial model and the results are presented in Table 4. To test the hypothesis that institutional differences have a greater impact on North-South than South-South FDI, equation (3) is estimated separately for North-South and South-South FDI. Table 4 shows that institutional quality has a positive effect on multinational entry for firms headquartered in advanced countries and a negative effect on South-South FDI. These findings confirm the hypothesis that institutional distance has a weaker effect on South-South FDI than on North-South FDI. These results are consistent with the hypothesis that South-South FDI is more resilient to weak institutional environment.

Table 4 also shows that market potential in the host economy has a larger effect on North-South FDI. This is in line with the horizontal theory of FDI that predicts that MNEs choose to locate in countries that provide access to large markets. Cultural variables such as sharing a common language exert a positive effect on North-South FDI flows. For South-South FDI, sharing a common language with the host country has a weaker effect on the number of multinationals entries from developing countries. Table 4 reveals that multinationals from advanced countries invest more in large emerging markets as the coefficient for GDP similarity is large and positive for North-South FDI. Conversely, South-South FDI varies negatively with GDP similarity.

Industry-specific Effects

The effect of institutional quality on multinational location choice may also depend on the specific industry in which the firm operates. To test the hypothesis that

Table 4: The effect of institutional Quality on North-South versus South South FDI using Negative Binomial Model

	(1)	(2)	(3)	(4)
VARIABLES	North -South	North -South	South-South	South-South
Log (Distance)	-0.563***	-0.563***	-0.286***	-0.287***
	(0.012)	(0.012)	(0.040)	(0.040)
Simple avg tariffs	0.026***	0.026***	0.015***	0.015***
	(0.002)	(0.002)	(0.003)	(0.003)
GDP per cap	-0.421***	-0.421***	0.593***	0.592***
	(0.046)	(0.046)	(0.045)	(0.045)
ln(Real Market Potential)	0.541***	0.541***	0.219***	0.220***
	(0.010)	(0.010)	(0.022)	(0.022)
GDP Similarity	2.457***	2.457***	-9.742***	-9.741***
	(0.130)	(0.130)	(0.346)	(0.346)
Contiguity	-0.199***	-0.199***	1.504***	1.502***
	(0.037)	(0.037)	(0.068)	(0.068)
Common Language	0.547***	0.548***	-0.485***	-0.486***
	(0.056)	(0.056)	(0.072)	(0.072)
Colony	-0.094**	-0.095**	-2.391***	-2.392***
	(0.042)	(0.042)	(0.117)	(0.117)
Number of affiliates pre 2005	0.005***	0.005***	0.005**	0.005**
	(0.001)	(0.001)	(0.002)	(0.002)
Institution quality index	0.215***	0.215***	-0.815***	-0.814***
	(0.035)	(0.034)	(0.051)	(0.051)
Institutional distance Index	0.180***	0.212	-0.105***	-0.315
	(0.010)	(0.278)	(0.016)	(0.582)
Institution distance x routineness		0.006		-0.038
		(0.051)		(0.106)
Constant	-3.351***	-3.352***	-1.420**	-1.410*
	(0.480)	(0.481)	(0.719)	(0.721)
Observations	15,249	15,249	8,284	8,284
Industry FE	YES	YES	YES	YES
Pseudo R-squared	0.239	0.239	0.236	0.236
Log pseudolikelihood	-45440	-45440	-30482	-30482

firms in knowledge intensive industries may be more sensitive to low institutional quality Equation (1) is estimated for the manufacturing and services sectors, separately. The sign and magnitude of the coefficient for the interaction term between institutional distance and the level of industry routineness tells us whether knowledge intensive industries are more sensitive to institutional quality. Table 5 shows that for firms operating in industries that are more knowledge intensive, institutional distance between the source and destination countries has a negative effect on multinational activity. Firms that specialize in more knowledge intensive activities are less likely to establish plants in more institutionally distant locations.

In the second step, the effect of institutions on the level of multinational entry is estimated for the manufacturing and services industries, separately. Table 5 shows

Table 5: The effect of institutional Quality on North-South vs South South Multinational Entries in the Manufacturing Sector

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All firms	North-South	North-South	South-South	South-South
Log (Distance)	-0.381***	-0.482***	-0.483***	-0.331***	-0.332***
	(0.016)	(0.016)	(0.016)	(0.071)	(0.070)
Simple avg tariffs	0.017***	0.016***	0.016***	0.018***	0.018***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
GDP per cap	0.364***	-0.042	-0.041	0.776***	0.777***
	(0.033)	(0.082)	(0.082)	(0.076)	(0.076)
ln(Real Market Potential)	0.453***	0.511***	0.512***	0.360***	0.361***
	(0.014)	(0.016)	(0.016)	(0.047)	(0.048)
GDP Similarity	2.556***	3.618***	3.607***	-5.405***	-5.413***
	(0.161)	(0.192)	(0.192)	(0.561)	(0.560)
Contiguity	0.963***	0.245***	0.246***	1.891***	1.890***
	(0.048)	(0.055)	(0.055)	(0.077)	(0.077)
Common Language	0.434***	-0.006	-0.003	-0.746***	-0.748***
	(0.049)	(0.096)	(0.096)	(0.102)	(0.102)
Colony	-0.463***	-0.006	-0.012	-1.651***	-1.651***
	(0.083)	(0.101)	(0.100)	(0.210)	(0.210)
Number of affiliates pre 2005	0.008***	0.004***	0.004***	0.007*	0.007*
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
Institution quality index	-0.293***	0.225***	0.221***	-0.485***	-0.484***
	(0.050)	(0.060)	(0.060)	(0.068)	(0.068)
Institutional distance Index	0.018	0.105***	-1.616**	-0.040***	-0.509
	(0.014)	(0.018)	(0.638)	(0.009)	(0.771)
Institution distance x routineness			-0.311***		-0.085
			(0.116)		(0.139)
Constant	-9.620***	-7.693***	-7.532***	-10.290***	-10.254***
	(0.462)	(0.900)	(0.908)	(1.765)	(1.757)
Observations	8,583	5,225	5,225	3,358	3,358
Industry FE	YES	YES	YES	YES	YES
Pseudo R-squared	0.264	0.274	0.274	0.386	0.386
Log Likelihood	-23700	-12022	-12021	-9076	-9075

that there is a positive relationship between institutional quality and North-South FDI for manufacturing firms. The effect of institutional quality on South-South FDI in the manufacturing sector is negative and statistically significant. Repeating this analysis firms operating in the services sector, Table 6 shows that multinationals headquartered in the advanced economies generally establish operations in countries with stronger institutions. The coefficient for the effect of institutional quality on North-South FDI in the services sector is positive and significant. The reverse is true for South-South FDI—there is a negative relationship between institutional quality and the number of foreign affiliates located in developing countries.

To ensure that these findings are not distorted by outliers, Equation (3) is estimated when China is dropped from the list of destination countries. These results are reported in Table 7. The results are largely unchanged. Table 7 shows that institutional quality is negatively related to the number of multinational entries across developing countries. In addition, institutional similarity has a positive effect

Table 6: The effect of Institutional Quality on North-South versus South South Multinational Entries in the Services Sector

	(1)	(2)	(3)	(4)	(5)
VARIABLES	All firms	North-South	North-South	South-South	South-South
Log (Distance)	-0.629***	-0.617***	-0.617***	-0.264***	-0.263***
	(0.015)	(0.016)	(0.016)	(0.051)	(0.051)
Simple avg tariffs	0.017***	0.030***	0.030***	0.014***	0.014***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
GDP per cap	0.327***	-0.522***	-0.523***	0.527***	0.525***
	(0.024)	(0.056)	(0.056)	(0.052)	(0.052)
ln(Real Market Potential)	0.622***	0.581***	0.581***	0.226***	0.225***
	(0.012)	(0.012)	(0.012)	(0.034)	(0.034)
GDP Similarity	-2.513***	2.053***	2.053***	-10.565***	-10.566***
	(0.112)	(0.172)	(0.171)	(0.413)	(0.414)
Contiguity	-0.541***	-0.426***	-0.424***	1.482***	1.484***
	(0.042)	(0.044)	(0.044)	(0.099)	(0.099)
Common Language	0.663***	0.672***	0.670***	-0.404***	-0.404***
	(0.032)	(0.068)	(0.068)	(0.093)	(0.093)
Colony	-0.431***	-0.098**	-0.097**	-2.515***	-2.519***
	(0.033)	(0.048)	(0.048)	(0.135)	(0.135)
Number of affiliates pre 2005	0.007***	0.006***	0.006***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
Institution quality index	-0.794***	0.236***	0.238***	-0.907***	-0.906***
	(0.032)	(0.041)	(0.040)	(0.065)	(0.065)
Institutional distance Index	-0.039***	0.212***	-0.110	-0.130***	-0.552
	(0.010)	(0.012)	(0.314)	(0.021)	(0.680)
Institution distance x routineness			-0.059		-0.077
			(0.057)		(0.124)
Constant	-5.391***	-0.733	-0.737	-2.491***	-2.470***
	(0.312)	(0.617)	(0.616)	(0.869)	(0.872)
Observations	14,287	9,642	9,642	4,645	4,645
Industry FE	YES	YES	YES	YES	YES
Pseudo R-squared	0.174	0.207	0.207	0.198	0.198
Log Likelihood	-53693	-32398	-32397	-18950	-18949

on the level of FDI activity between countries. Columns 2 and 3 report the results for the manufacturing and service sectors, respectively. The coefficient for the variable institutional distance is not statistically significant for the manufacturing sector, while there is a negative effect of institutional distance on the number of multinational entries in the services sector. Finally, the paper analyzes the effect of institutional quality in competing countries on the number of multinational entries in a particular destination country. The results are reported in Table 8. Column 1 reports the results when competition is measured using a distance-weighted index. The findings reveal that higher institutional quality in neighboring countries varies negatively with the number of multinational entries in country i. Column 2 reports the results when competition is measured using an activity-weighted index. The results are largely similar to those obtained using the distance-weighted index. These findings suggest that competition in terms of better institutional quality from neighboring countries reduces a country's ability to attract multinational firms.

Table 7: Institutional Distance and Multinational Entries (Excluding China)

	(1)	(2)	(3)
VARIABLES	Number of entries	Manufacturing	Services
Log (Distance)	-0.319***	-0.146***	-0.377***
	(0.0161)	(0.0233)	(0.0196)
Simple avg tariffs	-0.000840	-0.00256	0.00130
	(0.00182)	(0.00303)	(0.00209)
GDP per cap	0.525***	0.170***	0.585***
	(0.0256)	(0.0303)	(0.0311)
ln(Real Market Potential)	0.579***	0.269***	0.630***
	(0.0197)	(0.0225)	(0.0235)
GDP Similarity	-1.536***	-0.155	-1.522***
	(0.132)	(0.178)	(0.162)
Contiguity	-0.633***	0.288***	-0.891***
	(0.0360)	(0.0531)	(0.0414)
Common Language	0.153***	-0.115**	0.216***
	(0.0424)	(0.0462)	(0.0520)
Colony	0.0339	-0.226***	0.139***
	(0.0358)	(0.0662)	(0.0408)
No affiliates pre 2005	0.00872***	0.0164***	0.00637***
	(0.00136)	(0.00334)	(0.00144)
Institution quality index	-0.621***	-0.121***	-0.659***
	(0.0277)	(0.0395)	(0.0329)
Institutional distance Index	-0.0281***	0.0115	-0.0173*
	(0.00898)	(0.0146)	(0.0105)
North-South dummy	-0.709***	-0.0186	-0.838***
	(0.0403)	(0.0537)	(0.0496)
Constant	-10.68***	-5.461***	-11.70***
	(0.415)	(0.516)	(0.503)
Observations	14,886	3,600	11,286
Industry FE	YES	YES	YES
Pseudo R-squared	0.207	0.196	0.180
Log Likelihood	-43886	-6329	-36837

6 Conclusions

This paper investigates the effect of institutions on multinational location behavior across developing countries using plant-level data on multinational affiliates. The results show that the effect of institutions on the number of multinational entries varies across source countries. North-South FDI is greater in host countries with relatively stronger institutions. The opposite effect holds for South-South FDI. This paper is one of few papers examining South-South MNE location behavior. One novel feature of the paper is that it exploits information on the main activities of firms to show that the relationship between institutions and multinational behavior depends on the type of industry in which the firm operates. Institutional differences have a greater impact on firms operating in less routine intensive industries. These findings suggest that firms in knowledge intensive industries are

Table 8: The Effect of Competitor Institutions

	(1)	(2)
VARIABLES	Distance-weighted index	Activity-weighted index
Log(Distance)	-0.458***	-0.547***
	(0.0116)	(0.0111)
Simple Average Tariffs	0.022***	0.022***
	(0.002)	(0.00176)
GDP per capita (home)	0.253***	0.257***
	(0.016)	(0.0157)
Log (Real Market Potential)	0.227***	0.475***
	(0.017)	(0.020)
GDP similarity	-1.432***	-1.608***
	(0.090)	(0.090)
Contiguity	-0.101***	-0.145***
	(0.029)	(0.030)
Common language	0.587***	0.549***
	(0.025)	(0.026)
Colony	-0.451***	-0.456***
	(0.030)	(0.030)
Number of affiliates pre-2005	0.008***	0.009***
	(0.001)	(0.001)
Distance-weighted Ins. Qual	-0.065***	
	(0.003)	
Institutional quality	-0.331***	-0.444***
	(0.016)	(0.016)
Activity-weighted Ins. Qual		-0.008**
		(0.004)
Constant	0.585	-5.550***
	(0.411)	(0.387)
Observations	23,993	23,993
Industry FE	YES	YES
Log pseudolikelihood	-82473	-82626

more sensitive to institutional distance. This is largely consistent with previous research showing that the combination of firm characteristics such as contract intensity and financial dependence and country features such as legal enforcement of contracts and financial development influence international trade and investment patterns. Finally, the paper finds evidence of a substitution effect among developing countries. Better institutional quality in competing or neighboring countries has a negative effect on the number of multinational entries.

Future research could employ data that identify not only the existence of a subsidiary but also the size of the initial investment as well as accounting data over time to analyze firm location behavior across countries. In addition, further investigation into the substitution effect of neighboring countries' institutional quality on multinational location choice could improve understanding of the

relationship between developing country institutions and multinational location patterns.

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ABSTRACT

This thesis deals with the globalization of production, a salient feature of the modern economy. The development of international outsourcing as a widespread business practice and the simultaneous decrease in trade and transport costs have contributed to the growth of a phenomenon known as global value chains. The main aim of the thesis is to understand how global value chains alter the location of economic activity. The thesis also studies the extent of firms' participation in global value chains and its consequences for firm performance.

The thesis consists of four papers studying the behavior of firms in global value chains. Paper 1 analyzes how production fragmentation influences the importing and exporting behavior of Swedish firms in the manufacturing sector. Paper 2 focuses on manufacturing firms in the ICT sector and analyzes the effect of global sourcing on firm performance. In Paper 3, the thesis examines deeper implications of global production by investigating whether exposure to trade raises firms' sensitivity to external shocks. The final paper in the thesis studies the location patterns of multinational firms and analyzes the effect of institutional distance on the number of multinational entries in developing countries.

A number of patterns emerge from these studies. The first is that Swedish manufacturing firms increasingly participate in global value chains by sourcing production inputs from overseas to create products for local and foreign customers. As a result, global value chains help to alter the specialization patterns of manufacturing firms. The second finding is that firms reap benefits from global sourcing in the form of greater efficiency. However, global sourcing may also raise the responsiveness of firms to negative external shocks. The final key result points to a developing trend in the location of activity in which emerging market multinational firms are becoming significant sources of foreign direct investment flows and their investment patterns challenge existing theories of multinational location choice.

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