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A global value chain perspective on trade, employment, and growth

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Chapter 1

Introduction

1.1 Background on Global Value Chains

In this thesis I study the rise of Global Value Chains (GVCs) in recent decades and its implications for economic research.

A global value chain refers to the globalized production process in which the tasks in producing a final product become unbundled and are conducted in different countries. Due to high transportation and coordination costs, globalized production has been very rare historically. Most goods were made within a country, or just within a workshop. In ancient times, only the most legendary products were made in GVCs. For example the so-called Damascus swords were made from special ores mined in the iron mines of India. The ores were smelted into steel ingots and then shipped to the Middle East, where blacksmiths turn them into mysteriously sharp blades (Sinopoli 2003). India is the only place where this specific sort of iron ore can be found, and a small group of craftsmen in the Middle East were the only ones who mastered the secrets of forging the special blades. Naturally, the blades commanded premium prices.

However, what was once restricted to special goods has proliferated in recent decades. The advancements in (tele-)communication and logistic technology have made it feasible for firms to organize their production internationally and offshore tasks across national borders. If the costs of coordination and shipping of intermediate inputs back and forth between China and the U.S. is smaller than their wage differences, it is more profitable for a U.S. firm to offshore certain production tasks to China (Baldwin 2006). In fact, globalized production has become the norm instead of the exception. As shown in Timmer *et al.* (2016), more than half of global trade flows in 2014 are imports of (non-resources) intermediate inputs. The production of an iPhone provides a well-known example of a GVC. The smartphone and its operating system are developed in Apple's headquarter in the U.S.; the electronic chips are made by various firms in, for instance, the U.S., Japan, Korea, France, and Italy; all components are shipped to China for assembly. GVCs are also pervasive in the production of many other manufacturing products. For example, many tasks in the German automobile industry have been offshored to the Czech Re-

public and China, while the components from Boeing and Airbus planes are produced all around the world. Globalized production appears worthwile for even the most simple products. Figure 1.1 shows the fore and back sides of a simple pencil sharpener. The carbon steel knife carries the inscription "Made in Germany", while the aluminum body says "Made in China". It sells for only 0.99 euro in a Dutch retail store.

Figure 1.1: A Simple Pencil Sharpener

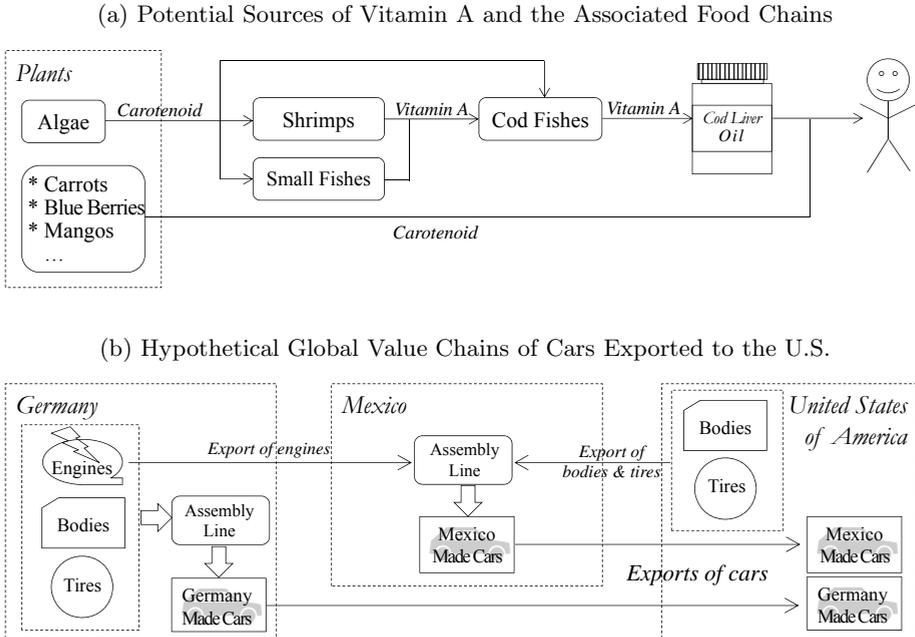(a): Carbon Steel Knife   (b): Aluminum Body

Global value chains have reshaped production patterns as well as international trade, and have deep consequences for our view on the economy. Past studies are largely conducted using country-industry level data, many of which presume a single-stage production perspective, i.e. the production processes are taking place within each country/industry, and trade is mostly in finished goods. This view is, however, no longer true due to globalized production.

The pattern of production and trade may lead to confusing and illusionary conclusions when analysed from the "standard" point of view. To see in an intuitive way how problems may arise, I compare a global value chain to a food chain. Figure 1.2(a) illustrates some potential sources of vitamin A for human beings. Cod liver oil is famous for its richness in vitamin A. But vitamin A is also found in some vegetables and fruits, like carrots and mangos. The plant sources of vitamin A are less well-known, and hardly any link can be found between carrots and cods. Are both fishes and vegetables able to produce vitamin A? Based on common knowledge, one may possibly conclude that fishes are more capable in doing so, given the popularity of cod liver oil and its high level of vitamin A. However, the nutritious elements in an animal (plant) may be produced by the animal (plant) itself, but may also come from the food that the animal eats (or are extracted from the environment the plant lives). Without tracing the food chain, it is not possible to identify these two channels. In fact, vitamin A comes from its precursor, carotenoids, which can be found in virtually all plants and some bacteria that performs photosynthesis. Most animals are able to absorb and convert carotenoids to vitamin A, but are not able to produce either of them. Vitamin A in seafood is ultimately produced

by algae that small fishes and shrimps eat, while cods and other big fishes played the role as the concentrators of vitamin A instead of the producers.

Figure 1.2: Global Value Chain and Food Chain

(a) Potential Sources of Vitamin A and the Associated Food Chains

(b) Hypothetical Global Value Chains of Cars Exported to the U.S.

A similar phenomenon exists in global value chains. Consider figure 1.2(b) which illustrates the hypothetical value chains of German and Mexico cars exported to the U.S. A car consists of a body, four wheels and an engine, but the components may not be made in the same country where the cars are assembled and exported. Everything is made within the exporting country as shown in the case of Germany. But the car can also be made in an alternative way, in which the core components are made by various countries including the U.S., and the final assembly takes place in Mexico. It is not possible to tell how values in the car was added without knowing the structure of production. Misleading conclusions and improper policy implications might arise if one only focuses on the export flows of cars. The U.S. may consider, for example, an embargo on Mexican cars to increase its own employment in the automobile sector. If the structure of globalized production is as described in the hypothetical value chain, the only task Mexico performs is assembly. When the production of cars is brought back to the U.S., the U.S. gains the employment in low-skilled assembling tasks, but on the other hand, the total cost of cars is expected to rise due to higher wage. This may in turn lower the demand for cars, which ultimately harms U.S. steel and chemical firms that supply car bodies and wheels.

The chapters in my thesis are motivated by trying to find solutions to potential problems in current studies that fail to account for GVCs. I argue that new analytical perspectives are needed which should precisely mark to specific research questions and

explicitly take globalized production into consideration. For example, when analysing production, one should go beyond the national boundary and account for all tasks performed in all countries that are needed in a GVC. When analysing employment trends in each country, one should focus on the exact tasks that are taking place, as the products a country produces do not convey information on its actual economic activities.

Currently available country-industry level statistics are insufficient in analysing global value chains; many datasets are limited to activities within the national boundary and lack the capacity of tracing internationally fragmented value chains. In this paper I make intensive use of the recently available World Input-Output Database (WIOD, Timmer *et al.* 2015). The 2013 release of the WIOD provides time series of multi-regional input-output tables for 40 countries annually from 1995 to 2011. The multi-regional IO tables report the use of intermediate inputs by each industry that come from both domestic and foreign countries. Importantly, imported intermediates used by domestic industries are linked to the countries-industries where the intermediates are produced, such that offshoring and globalized production structures can be analysed. The WIOD project also includes other supplementary statistics on, for example, the skill content of employment in each country-industry. These data provide a very useful stepping stone for rich analyses for various fields in economics.

1.2 Puzzling Questions and Global Value Chains as the Solution

What are potential problems that may arise if one neglects the rise of offshoring and globalized production? In this thesis I will show that globalization has deep consequences for analyses of trade, employment, and growth. The standard views might be inconsistent, and a global value chain perspective is needed in various fields of economic studies.

Recovering the Link Between Endowments and Bilateral Trade

Most economic theories agree that a country's export pattern should reflect its structure of factor endowments. However, recent gross trade statistics show a puzzling picture that seems to be contradictory to theoretical predictions. The observed exported products depart substantially from the trade patterns that would be predicted based on each country's factor endowments. Many developing countries have surpassed the developed world in exporting technology intensive products. For instance, electronic products have a higher share in the bilateral exports from China to the U.S. compared with the exports from the U.S. to China. Why do developing countries abundant in low-skilled labour rapidly turn into exporters of advanced products? It is hard to explain if one takes a conventional view of trade and production, which presumes that exported products are largely made by the exporting country itself. In chapter 2, I argue that globalized production is a major cause for the "mismatch" between endowments and product trade patterns. When offshoring is possible the products that a country produces and exports may not be aligned with the actual tasks it performs. As a result, trade theories should be tested with measures of factors that underlie the trade in products.

Chapter 2 contributes to the literature by introducing a precisely defined and accurately calculated new measure of bilateral factor exports. My new measure is based on identifying the country of origin of values added by each factor and the final destination of consumption; it accounts for traded intermediates and is robust under complex forms of globalized production. Using this new measure, I find that bilateral factor exports are closely in line with countries' factor endowments. Not only the direction of net bilateral factor trade can be largely explained by the endowment structures of country pairs, but also their volume.

Offshoring, Biased Technical Change, and the Changing Skill Structure of Employment

In recent decades, developed countries' labour markets have witnessed a rapid increasing wage premium for higher education, as well as the so-called job polarization where employment in middle middle-skilled jobs grows more slowly relative to both high- and low-skilled ones. What are the possible causes for the changing skill demand of employment? The consensus in the literature is that both offshoring and biased technical change (BTC) are important drivers, but until now it has not been possible to disentangle the effects of BTC and offshoring. The effects of offshoring may look observationally the same as BTC in domestic labour markets. To see this, suppose that there is no change in the production technology, but the firm decides to re-allocate unskilled production tasks abroad. The use of unskilled worker declines in the domestic labour market, which looks identical as a BTC against the use of unskilled workers, for example through automation. Current studies identify the two effects by using specific indicators that measure each job's vulnerabilities to offshoring and technical change. However, empirically the proxies for offshoring and BTC appear to be highly correlated. For instance, developments in information and communication technology (ICT) give rise to specialised software that automatizes accounting tasks, which reduces the demand for clerks. However, ICT at the same time also enables cheap, timely, and secure transmission of financial and accounting information, such that many tasks performed by clerks can be offshored to low-wage countries. Given the high correlation between offshoring and BTC measures, their effects cannot be sharply disentangled and the estimates are usually sensitive to exact indicators being used.

In chapter 3 we present a novel approach to measure BTC in global value chains. Instead of analysing one-stage production within each country-industry, we investigate production in GVCs such that the final output is mapped to labour and capital employed at any stage of production, in any country. When a task is offshored, the decline in domestic employment must appear in other countries, and the GVC factor usage remains unchanged. But if a task becomes obsolete due to new technology, the disappeared employment will not be found in any country in the GVC. This difference allows us to first neutralize the effects of offshoring before estimating technical changes. We find evidence of BTC in favour of college-educated workers and capital, and against non-college workers. Simulations suggest that offshoring and BTC contribute quantitatively equally to the decline in employment of non-college workers in advanced countries. By decomposing non-college workers into medium- and low-skilled, we find that the use of ICT capital has significantly polarized labour demand away from medium-skilled.

Globalized Production and New Paths of Structural Upgrading

For a long time, structural change in developing countries is understood as a shift of employment across sectors, from agriculture to industry, and from less skill-intensive industries to more sophisticated and high-skill intensive ones. This typology is, however, under challenged in the presence of offshoring and globalized production. Nowadays, most manufacturing products are produced in global value chains, with different stages of production taking place in different countries in the world. Underdeveloped countries may participate in the global value chains of high-tech products, like mobile phones, by performing low-skilled tasks like assembly and packaging. Highly developed countries may still keep an important stake in the GVCs of so-called low-skilled products, like cloths, handbags and shoes, by performing high-skilled tasks such as design, marketing, and the management of their international material supply chains. When offshoring is possible the name of an industry can be very different from the actual tasks that are carried out. This has major consequences for our understanding of growth and development, and raises the need to identify two types of upgrading, horizontal and vertical. Offshoring seems to open up plenty of opportunities for horizontal upgrading in developing countries, which refers to the re-allocation of their current low-skilled employment towards sophisticated GVCs, for example from making T-shirts to the assembly of electronics. At the same time, it is also increasingly important to study the propensity of vertical upgrading withing each industry towards higher-skilled tasks, for example from assembly to R&D within the electronics industry. However, our knowledge on the latter type of structural upgrading is yet limited.

How do countries upgrade under globalized production and what are the propensities of horizontal and vertical upgrading? Chapter 4 contributes by using the WIOD dataset, which provides new data on the tasks carried out in GVCs by a large set of countries. Following Hidalgo *et al.* (2007), I study the possible paths of structural upgrading based on the bilateral relatedness of tasks in various industries at different skill levels. The relatedness between two tasks is measured by the probability that a country has a revealed comparative advantage in both tasks, calculated on the basis of value-added export contributed by each task. I find a task is in general more related with other tasks at the same skill level, while the relatedness is low between low- and higher-skilled tasks even within an industry. Participation in GVCs is easy, but vertically climbing up is a very different process that may require a different set of stimulation policies. I also find that tasks in business service sectors, especially in utility and logistics, have a strong complementarity with manufacturing tasks and may play an important role in structural upgrading.

1.3   Overview of Future Research Directions

In this thesis I study the effects of globalization on trade, employment, and growth. I show that many misleading and confusing results may arise if one takes a conventional view on production and trade that fails to recognize offshoring and production fragmentation. The puzzles can be solved, if we take a global value chain perspective and properly account for the new paradigm of globalized production. Global value chains are a quite new phenomenon in history, and our knowledge is still limited. It has deep consequences

on various fields of economic research. This thesis is a preliminary exploration, and many research directions can be put on the agenda for the future.

In my studies the patterns of offshoring are taken from actual data. Offshoring has been controlled for, but remains unexplained. It will be interesting and important to explain the dynamics in offshoring, which opens new research questions, both empirically and theoretically. For empirical studies, one may consider to explore multinationals' behavior of offshoring and investigate how international production is organized, namely why certain tasks are offshored to particular countries. The match between socioeconomic conditions of countries and requirements of tasks should be a key element, but the research also relates to various other aspects like the choice of technology in production, trade costs of different intermediate goods and services, agglomeration and regional economic integration, international politics, and environmental concerns and business ethnics.

From a theoretical point of view, the fraction of tasks that can be offshored is viewed as exogenous in my research. In the long run, however, offshoring technology may develop endogenously. Acemoglu (2002) models the development of factor biased technological change as an directed process in which the direction of R&D effort is dependent on economic incentives. He shows that the long-run technological change is directed towards a more intensive use of factors that are abundant in the economy. Theoretical models on globalized production may be developed, in which offshoring technology is endogenized in a similar way. As important developing countries like China and India integrate in the world economy, the potential supply for cheap low-skilled labour increases for firms located in developed countries. In order to benefit from globalization, R&D expenditures may be spent on making production processes more standardized and modular, such that a larger share of tasks can be offshored. In addition, due to the increasing availability of the labour supply from developing countries, production technology in the long run may also be biased towards a higher usage of tasks that are offshorable.

I have emphasised that for many studies it is important to pinpoint the actual tasks that each country performs in global value chains. Due to data availability I cannot observe exact tasks, and a tasks is identified in this thesis based on the industry and educational attainment of employees. This may not be the optimal way, as the years of schooling an employee received may not align with the skill requirement of his task. Efforts from various research institutes in the world have been put in constructing new datasets on the occupation composition in each country-industry, which are expected to be available in the near future. Using occupation data in global value chain analysis has important advantages. Occupations have a tigher link with the tasks being performed and are expected to improve empirical analysis. More importantly, new research with GVC-occupation data is capable to reveal detailed types of skills that are most affected by offshoring and technical changes. It goes beyond the single dimensional years of schooling and has policy implications not only on whether more education is needed, but also on what types of education is most helpful in preparing the future generation for globalization and technological development.