China-EU global value chains:

who creates value, how and where?

– growing linkages and opportunities

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CHINA-EU GLOBAL VALUE CHAINS: WHO CREATES VALUE, HOW AND WHERE?

GROWING LINKAGES AND OPPORTUNITIES

Final Report

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ACRONYMS

BCS	Business Confidence Survey
BEC	Broad Economic Classification
EUCCC	European Union Chamber of Commerce in China
FDI	Foreign Direct Investment
FTA	Free Trade Area
GFCF	Gross Fixed Capital Formation
GVC	Global Value Chain
HS	Harmonised System
ICT	Information and Communication Technologies
JV	Joint Venture
NEV	New Energy Vehicle
OEM	Original Equipment Manufacturer
RCA	Revealed Comparative Advantage
RoAsia	Rest of Asia
RoW	Rest of World
SITC	Standard International Trade Classification
TNC	Trans National Corporation
USD	US Dollar
VAE	Value Added in Exports
WIOD	World Input-Output Database

FOREWORD

This report has been structured to take into account the multifaceted nature of Global Value Chains (GVCs). The first section investigates the nature and evolution of international production, in aggregate and across different sectors, using the World Input-Output Database (WIOD) in an effort to identify and contextualise the bilateral interactions between the EU and China. In the second section we seek to better understand the nature of GVC interactions between Chinese and EU firms in China and to see whether there is any evidence of obstacles or barriers to further or deeper value chain activity between these. The final section of the report then delves into the governance of value chains in China in the electric vehicle and tyre sectors. This in an effort to understand how the regulatory environment conditions firms' organisational and economic activity decisions. This layered approach to the analysis allows us to capture different facets of GVCs and hence to provide a more targeted analysis of the policy implications of their proliferation.

EXECUTIVE SUMMARY

The international fragmentation of production is re-shaping the world economy. Global value chains (GVCs) are at the forefront of this phenomenon with China and the EU emerging as key production hubs. The evidence suggests that value chains are increasingly regional rather than global with three main cross-border production systems emerging: "Factory Europe", "Factory Asia" and "Factory North America" (Baldwin and Lopez-Gonzalez, 2013). In this context, the growing China-EU bilateral linkages embody the global aspect of value chains.

The aim of this report is to provide an analytical assessment of the evolution of GVC activity with a particular focus on the EU and China, and their bilateral interactions. A key objective is to identify some of the practical implications for the design of future policy initiatives to promote the future emergence and development of production networks. The report is divided into three sections. In the first we exploit the World Input-Output Database (WIOD) to derive measures of GVC activity and paint a portrait of the nature and evolution of the linkages at the aggregate level and across sectors.[1] In the second section we draw upon the results of a survey of EU firms with a presence in China and present some descriptive statistics as well as more formal econometric / statistical evidence on the nature of the value chain relationship and the impact of policy variables and barriers on EU firms' activity in China. The final section of the report is based on detailed case studies of two specific sectors – tyres and electric vehicles. These were undertaken using both secondary and primary information sources including face-to-face interviews. They aim to provide more detail to the broader story which emerges from sections one and two of the report.

In this executive summary we highlight some of the key messages which emerge from the report; and the final part of this summary lists some tentative policy recommendations. There is then a more detailed technical summary, which fleshes out some of the results from each of the component parts of the project.

Key messages

Most GVC activity is regional and in its infancy but the growing China-EU relationship is the biggest in the world...

1. China has quickly become a key player in terms of global trade and production; its share of global output has increased from 3.5% to 13.3% between 1995 and 2009. On the other hand, the EU's share has witnessed a relative decline from 30.5% to 27.9%. Jobs associated with exporting activities – 'export jobs' for short, occupy 31 million workers in the EU which is 15% of the total labour force. In contrast 30% (231 million workers) of the Chinese labour force is engaged in exporting activities. At the same time, both have expanded their participation in GVCs. For example, the share of imported intermediate products in total use of intermediates in the EU has gone from 6% in 1995 to 9% in 2009; in China it increased from 9% to 12%.

2. In 2009 bilateral sales and purchases of intermediate products between the EU and China each represented 3% of global intermediate trade flows making EU-China intermediate product trade

[1] Unless specified, we treat the EU as a bloc where intra-EU flows are considered as domestic

as important as that between the EU and the US.[2] While the EU is the largest single foreign source of intermediate products used by the Chinese (representing 2% of Chinese total intermediate inputs, domestic or imported), China is second to the US (with respective shares of 1% and 2%) in Europe in 2009. On average and in 2009, a unit of EU exports requires the use of 2% value added from China whereas a unit of China's exports uses 5% of EU value added.

The vast majority of value added in exports is domestic. This is true for the EU (87%) and for China (76%)...

3. Most countries continue to rely heavily on domestic value added to produce exports - 87% of the value added in EU exports is domestic (counting intra-EU value added as domestic), in China this value is 76%. This indicates that although the Chinese economy is increasingly integrated in international production networks its domestic contribution to exports is higher than often thought; the much cited iPod case study (where China is said to only add 3-4% to the total sales value of an exported iPod) is far from being representative.

4. Although the share of domestic value added in exports is decreasing, evidence suggests that this share is being reaped over a larger volume and hence that countries are getting a slightly smaller share of a much bigger pie. This is particularly true for China and all three focus sectors investigated: 'electrical and optical equipment', 'chemicals', and 'transport equipment'.

China's wider engagement in GVCs is resulting in a slightly decreasing share of a much bigger pie...

5. The preceding indicates that despite the 'momentous' changes linked to globalisation, it is nevertheless the case that, when considered at the aggregate level and across all sectors, the internationalisation of economic activity remains in its relative infancy. Output produced by the EU and China continues to rely overwhelmingly on the use of domestic inputs.

1.1 million jobs in the EU are sustained by Chinese exporting activity with 5.5 million Chinese jobs being supported by EU total exports...

6. Nonetheless it is also true that international production linkages between EU and China have intensified. Their importance is apparent when looking at jobs. In 2009, over 1.1 million jobs in the EU were sustained by Chinese exporting activity with 5.5 million Chinese jobs being supported by EU exports. In terms of employment creation, Chinese GVC jobs associated to EU exports have increased ten-fold since 1995 whilst EU GVC jobs linked with Chinese exports have doubled. Putting these figures in perspective; EU GVC jobs in Chinese exports have grown twice as fast as EU export jobs and nearly 9 times faster than total EU jobs since 1995.

7. In the EU 56% of domestic value added in exports can be associated to returns to high and medium skill labour. In contrast, the largest source of domestic value added in China is capital

[2] excluding intra-EU trade.

(62%) and low-skill labour (21%) compensation.[3] In turn, the EU mainly sources capital value added from abroad (51% of imported value added) whereas 50% of China's imports of value added involve sourcing high and medium skill labour value added. This suggests that the EU and China are highly complementary in their production structures. Moreover, China is the largest foreign source of EU low-skill and capital value added whilst the EU is China's largest supplier of med-skill and high-skill value added.

8. Flows of intermediate products/value-added are only part of the story. The expansion of GVCs has also led to an increase in the use of imported capital goods. Chinese capital goods exports to the EU amounted to 58 billion USD in 2009 representing just over 34% of EU imported capital goods that year. EU capital good exports to China were nearly 48 billion USD, representing 36% of total capital goods imports in China. This is more than the combined share of US and Japan in China.

Given the strong bilateral GVC linkages between the EU and China one could expect there to be larger FDI flows between these. This suggests the presence of untapped potential...

9. Worldwide stocks of FDI have also been growing rapidly - from 3 trillion dollars in 1995 to 23 trillion dollars in 2012. The statistically significant correlation between the changes in inward FDI stocks and changes in GVC participation suggests that the growth in FDI is at least partly linked to wider participation in GVC activity (UNCTAD 2013). Given the widespread participation of China in GVCs documented in this report it is therefore somewhat unexpected that the Chinese share of global FDI stocks has remained relatively stable since 1995 (at around 10% of worldwide stocks).[4]

10. Although it is hard to determine what is driving this, whether increased Chinese rather than foreign investment or the presence of regulatory obstacles stymieing further deployment of foreign investment, the analysis also suggests that China represents a small share of total EU FDI outflows (under 3% in 2009). This, again, is surprising given the wide bilateral production linkages between the EU and China identified herein. This may also be indicative of an important untapped potential.

Sectoral specialisation is positively correlated with a rise in the share of imported value added in exports further suggesting complementarity. Moreover, countries with higher shares of foreign value added in exports tend to be more productive...

11. At the sectoral level and for both China and the EU, we see a positive correlation between the evolution of domestic value added and the use of imported value added. This suggests that the sectors which have internationalised their economic activity the most are also those which have grown faster in terms of domestic value added. On the one hand this is not surprising as it may simply indicate that increased / decreased exports is correlated with both increased / decreased use

[3] The high capital compensation in China is likely to reflect high profit activities.
[4] intra-EU FDI flows are included in global stocks

of domestic and foreign value added and intermediates. However, for China there is also a positive correlation between the change in the share of each sector in total Chinese value added (between 1995-2009), and the change in the import content of exports *within* sectors. This suggests that increased sectoral competitiveness and specialisation is positively correlated with a rise in the share of imported intermediates in exports. Hence there appears to be some complementarity between the growth in imported intermediates and the growth in direct domestic value added; and that outsourcing the less competitive elements of production may allow a country to specialise in higher value adding activities according to their comparative advantage.

12. In addition, we find that countries that have a higher import content of exports typically have higher productivity. While we do not establish causality it nonetheless suggests that engagement in global value chains may lead to higher productivity and therefore economic growth.

The share of services embodied in exports is large and increasing (particularly in the EU)...

13. While direct exports of services are responsible for a relatively small share of gross exports, the contribution of services to the domestic value added embodied in exports is large and increasing. This suggests that there is a strong trend towards the 'servicification' of exports, particularly in the EU. Indeed, when we delve deeper into the value chains of the ‘electrical and optical equipment’, ‘transport equipment’ and ‘chemicals’ sectors we see that the EU’s specialisation is mainly in the medium and high skilled labour value adding service sectors of the value chain. In contrast, China’s specialisation mainly occurs in the capital and low skilled labour spectrum of the manufacturing sectors, again pointing towards the presence of important complementarities in the production structures of China and the EU.

14. Overall the results of the aggregate analysis paint a portrait of increasing inter-dependence and complementarity. Whether it is intermediate products, value added, investment or jobs, the bilateral links between the EU and China are not only important in absolute terms but also growing fast.

Most EU firms operating in China are focused on delivering professional or financial services. They perceive 'market access barriers' as the most costly obstacle...

15. The firm level analysis indicates that, out of the firms surveyed, most EU firms operating in China are focused on professional or financial services. In contrast firms engaging in GVCs are concentrated in manufacturing sectors. The main motivation of firms appears to be either traditional market seeking objectives or engagement in domestic value chains as opposed to participation in international backward or forward linkages.

16. Most EU firms indicate that “market access barriers” are the most costly obstacle for operating in China. For firms with backward linkages with foreign suppliers, those that are more vertically integrated perceive intellectual property rights as the main obstacle in their operations. Bureaucratic obstacles/barriers are also perceived as important for firms engaged in sub-

contracting. For firms with forward linkages, regulatory barriers, in addition to market access barriers, are seen as significant constraints to their activity.

17. The response of EU firms to these barriers appears to have a direct impact on the Chinese economy via changes in prices to consumers and suppliers, constraints on technology diffusion and transfer, and through reductions on investments or procurement of intermediate goods.

Barriers to EU firms in China also affect Chinese producers and consumers through higher prices and reduced investment...

18. Nearly 50% of the full sample of firms perceives that one or more barriers have a significant impact on their operations in China. For firms engaged in GVCs, a back of the envelope calculation of the aggregate impact suggests that the extent to which firms have chosen to relocate their activity away from China corresponds to the equivalent of between 383 million to 1.5 billion Euros. Similarly approximate back of the envelope figure for the extent to which firms have reduced their purchase of intermediate inputs within China is between 30 million to 208 million Euros. Together, these figures represent between 1.2% to 2.8% of the EU firms' turnover. Another way of considering the impact of the barriers faced by the EU firms is the impact on prices. Once again approximate calculations suggest that on average the impact has been for EU firms to increase the prices paid by Chinese businesses and consumers by between 1.5%-3.5%.

19. The case studies on the tyre and electric vehicle sectors give illustrative examples on how regulatory frameworks may lead to lose-lose situations. For example, in the electric vehicle sector we find evidence suggesting that EU firms may be restricting investment in further R&D as a result of the onerous catalogue of requirements required to produce automobiles in China. Moreover, we also find evidence that Chinese firms also seem to be cutting their R&D expenditure once they are paired up with an EU firm. This could be indirectly contributing to the Chinese government not meeting its desired target of having 500k New Energy Vehicles produced in China by 2015.

Policy Implications

The EU and China have vested interests in each other's success...

Whether it is intermediate products, value added, investment or jobs, the bilateral links between the EU and China are important and growing. The EU and China have complementary production structures which should allow firms to exploit the benefits of specialisation and obtain important cost advantages in production. China-EU GVC activity embodies this form of mutually beneficial cooperation and calls for an increasing emphasis on policy coordination aimed at nurturing this relationship. The EU and China have vested interests in each other's success since China's exporting prowess creates jobs in the EU and vice-versa.

For the EU

> *Services are at the heart of EU value added and efforts need to be made to ensure that Services remain competitive through increased liberalisation...*

EU policy needs to be premised on the assumption that both exports and imports are crucial to the evolution of competitiveness. The old maxim “barriers to imports are barriers to exports” needs to be remembered. The EU needs to ensure that trade in intermediates and other sources of imported value added that contribute to EU exports are liberalised/deregulated to allow the EU to maximise returns from specialisation. Promoting competition in domestic services markets is likely to be important in this context.

> *The old maxim "barriers to imports are barriers to exports" needs to be remembered...*

The importance of high skilled labour in EU value added exports emphasises the need to continue to invest in a highly educated/highly trained workforce. That is crucial if the EU is to remain internationally competitive. Such workers can raise their productivity notably in services by benefitting from the complementarity with low cost outsourcing activities. However, there will be workers who find it harder to move into jobs that benefit from positioning in GVCs. The continuing social acceptance of the gains from trade may depend on opportunities for employment, notably in the non-traded sector, for workers with less flexibility.

The importance of EU service sector engagement with China suggests the need to further open up the EU domestic services market. Services are at the heart of EU value added and efforts need to be made to ensure they remain competitive. This underlies the importance of the completion of the Single Market in services.

For China

> *The importance of the objectives spelled out in the new Five Year Plan i.e. "more active strategies for 'opening up'" seem to be validate by this analysis...*

The report provides extensive evidence of the growing engagement of China in global value chains, hence also of the importance of access to imports of intermediates (be they goods or services), as well as foreign investment. The firm level analysis and the case studies suggest that more could be done to facilitate such flows and therefore to enable the consequent gains. For example, China’s tariffs have been lowered since the accession to the WTO (from 16% to 9.5%) but they are still higher than the EU’s (4.2% in 2011).

The observations of this report also highlight the importance of the objectives spelled out in Part XII of the Five Year Plan: "*Mutual beneficial and win-win, improving the opening up"*which seeks *"more active strategies for "opening up" and unceasingly explore the new areas of reform*".

a. Industry

Chapter 51 of the Five Year Plan identifies the need to *"optimize policy measures to promote the transition from processing trade to R&D, design, manufacturing of the key components and logistics etc, to extend the value-added chain in China*."

> *Problems in IPR do not simply reduce willingness to sell, they may also hamper willingness to buy Chinese intermediate goods, thus frustrating the essence of value chains activity ...*

EU FDI in China, though very significant and important to both parties is less than expected given the scale of the GVC relationship. Indeed the survey results indicate that barriers to operating in China have led EU firms to relocate part of their investment away from China. Further it can be seen from tables 2.22 and 2.28 of the report that problems in the IPR area do not simply reduce EU firms willingness to sell, but also their plans to buy intermediate goods from Chinese suppliers. This could be frustrating the strengthening of China's participation in the value creation process. It underlines that there is a clear need to work in the spirit of the aim in Chapter 52 that: "The soft environment of investments will be optimised and the legal rights of investors will be protected."

The electric vehicle case study provides an example of policies that can have less than effective outcomes. The Chinese government strategy to encourage innovation in the nascent electric vehicles sector is riddled with multiple and stringent conditions imposed on foreign investors. [5] The problems of access include the nature of the investment "catalogue" and rules on subsidies and branding. This is possibly hampering the potential for mutually beneficial cooperation between EU and Chinese firms in the sector. It would seem to be in the interests of both the EU and China to facilitate cooperation in this important area given the disappointing headline numbers so far:

- 500,000: the Central government's target number of Electric Vehicles to be produced in China by 2015,;
- 11,500: the number of New Energy Vehicles (NEV) produced in China by the end of 2012;
- 0: the number of European NEVs produced and sold in China so far.

b. Services

> *The competitiveness of manufacturing exports can no longer be separated from that of services sectors. Hence openness in service sectors is important...*

[5] Competitiveness of the EU Automotive Industry in Electric Vehicles (2012) http://ec.europa.eu/enterprise/sectors/automotive/files/projects/report-duisburg-essen-electric-vehicles_en.pdf

Chapter 50 of the Five Year Plan states: *"We will also push for a further "opening up" of the service sector, promote the development of international trade in services, and attract foreign investment in the service sector."* The report underlines the importance of this goal. One of the most striking observations of the report concerns the role of services in the EU's exports. Two issues stand out: first the EU's exports to China incorporate a very high value added coming from services in the EU. One simple illustration of this is that in some industries much modern capital equipment contains digital elements which are controlled by software. This shows up in the "gross" exports simply as equipment sales while the value added may be overwhelmingly in the software. This importance of services inputs for EU exports contrasts sharply with what can be observed in China. Second the EU's investments in China among the surveyed companies are very much in services, mostly professional and financial, where it has to be assumed they have a strong competitive advantage, or else they would not have ventured into the Chinese market.

Putting together these observations leads to the conclusion that the competitiveness of manufacturing exports depends closely on the competitiveness of the service sector serving it. Hence openness in service sectors is not only likely to promote growth of these sectors but also of downstream activities including exports.

SECTION 1: AGGREGATE AND SECTORAL ANALYSIS

1.1. TECHNICAL SUMMARY

The international fragmentation of production is re-shaping global economic activity. Global value chains (GVCs) are at the forefront of this (Baldwin, 2006 and 2011) with China and the EU emerging as key production hubs for the world (Baldwin and Lopez-Gonzalez, 2013).

The aim of this part of the report is to provide an analytical assessment of the general trends in GVC activity with a particular focus on the EU and China and their bilateral interactions. To this end, we exploit the World Input-Output Database (WIOD) to derive measures of GVC activity and paint a portrait of the nature and evolution of interactions, both aggregate and across broad sectors. A principal element to this is the objective of identifying practical implications for the design of future policy initiatives; whether these relate to traditional trade policy instruments (tariffs and non-tariff barriers to trade), investment rules, and/or intellectual property rights. These have played a pivoting role in the emergence and development of production networks.

GVC activity is broadly defined here as the use of imported inputs in any production process.[6] We rely on two key indicators to capture such activity. The first is the most general; it tracks the ***direct inputs used to produce total output***. We refer to direct inputs as i) the factors of production (labour and capital) directly employed by the factories and firms; and ii) the intermediate products (domestic and/or foreign) used as physical inputs into production. For example, a German car manufacturer will directly employ domestic labour and capital to fashion domestically sourced steel and imported car components into a vehicle. By tracking the evolution of the share that each of these direct inputs represent in the final cost of the car we can measure the extent of internationalisation that the German car manufacturing firm is engaged in (or in other words how dependent on the sourcing of imported products this industry is). However, since some of the intermediate products used in production, i.e. the domestically sourced steel and the imported car components, are themselves made by workers and capital located across different domestic or foreign locations, these measures do not give us a full breakdown of the ultimate origin of the value added embodied in the German car. Our other measure of GVC activity does.

The second measure is then the ***value added content of gross exports*** which we shorten to *VAE – Value Added in Exports* (see Koopman et al. 2010 and 2012). This captures the direct and *indirect* origin of the value added embodied in any German car that is exported. The indirect value added refers to that which is contained in the intermediate products that were used in production. Following the above example, when the German car manufacturer exports its output, the VAE measure decomposes the direct inputs (domestic value added and domestic and imported intermediates) that go into its production according to the ultimate origin of their value added. The first input; the direct domestic value added, requires no further calculation since this represents wages, rental of machinery and profits in the German automotive sector. These are all in value added terms and accrue to German factors of production. But if the domestically sourced steel contains Polish value added, in the form of iron ores that were extracted by Polish workers and then sold to the German steel manufacturers, then there is an element of foreign value added embodied in this intermediate product. Similarly, the car parts that the German car manufacturer imports may themselves have been originally designed by German engineers but assembled by Czech workers – thus containing German value added. The VAE

[6] This is a departure from the more traditional literature on GVC which looks at how international networks are organised. Such a broad view of GVCs is taken because we do not have information on the organisational nature of international production networks, but rather on the distribution of flows.

measure assigns value added to its ultimate origin by tallying up all domestic and imported value added in the German exported car.

The distinction between direct inputs and value added is useful. Direct input flows essentially capture what the factories and firms located in a country are doing (i.e. the German car manufacturing factory is buying steel from domestic producers and importing car parts from abroad). The value added measure identifies what the factors of production that are employed in a given country are doing (i.e. German workers). In looking at trade interactions between countries, direct input flows are useful since trade policy, such as tariffs, is applied on the entire value of products entering a customs territory and not their value added components. However, in order to identify the returns to domestic factors of production it is flows of value added that must tracked.

We make one important distinction and two extensions to these measures. The distinction is between a country's *purchases* of foreign intermediates or value added and a country's *sales* of intermediates or value added into other country's production. This helps us identify the backward (purchases) and forward (sales) linkages that tie GVC activity. The first extension is a decomposition of the factor compensation that is embedded in domestic and imported value added in exports. For example, we can decompose the EU's domestic or imported VAE into low, medium and high skill labour compensation as well as remuneration to capital. This allows us to observe how imported value added differs in its composition and to identify the type of specialisation that is taking place along the value chain. The second extension is the identification of the jobs that are associated with GVC activity. We identify 'export jobs' as the number of workers domestically employed to produce exports. A subset of this is 'GVC jobs' which is the number of workers employed domestically that are tied to the exports of other countries through value chain activity. By tracking how these have evolved we capture a measure of engagement in GVCs by way of workers rather than monetary value.

Caveat

We preface this report by noting that the units of analysis employed are the country and at most the country-industry. Whilst this conforms to the traditional approach used in the literature, it is important to note that it is firms and not countries which engage in GVCs. These have diverse and often complex ownership structures involving both domestic and foreign partners. The use of such a unit of analysis implies, for instance, that a European firm operating in China is indistinguishable from a Chinese owned firm in China. Moreover, when we attribute value added to a particular nation, or sector within a nation, we have to bear in mind that the profits of the firm operating in this sector may be repatriated or accrue to a different nation than that were the economic activity is taking place.

Another important issue to bear in mind is that flows of intermediates or indeed value-added are just one approach to analysing the GVC phenomenon. International production networks also involve investment flows, technology transfers, logistic services and complex governance structures. Although we are unable to capture these in this sectoral analysis we will aim, in subsequent sections, to get a better grasp for the fuller GVC picture by delving into EU and Chinese firm level activity in China through a more focused firm level analysis and a set of case studies.

With this in mind, we proceed to enumerating some of the key findings of this section.

There is evidence of growing internationalisation of production activities both in the EU and China but this process is just starting

- Despite the big changes often attributed to globalisation, the internationalisation of economic activity remains in its infancy – only 8% of global output is composed of imported intermediates with 92% being sourced domestically.
- Domestic sales and exports differ quite significantly in their composition. Services dominate domestic output but manufacturing is the most important component of exports. Although this still holds for the EU (manufacturing occupies 61% of total exports), the service sector here has increased significantly both in domestic and export sales. For China, Manufacturing occupies 75% of export sales with services also rising.
- Further looking at the nature of these sales, and in particular whether these are intermediate or final goods, reveals interesting differences between the EU and China. In the manufacturing sector, the EU mainly exports intermediate goods, the reverse is true for China, which may be indicative of China's role as an 'assembler'.
- Differences between the EU and China, are also visible in terms of the composition of their direct domestic value added: for example, EU predominantly relies on high and medium skilled labour value added whereas China is more reliant on low-skill and particularly capital value-added.

China's trade in intermediate products is an increasingly important feature of international production with EU-China bilateral exchanges playing a central role

- In the period 1995-2009 the EU has gone from importing 6% of its intermediates from the rest of the world to 9%. In the same period, China has gone from 9% to 12%.
- During this period the global importance of the EU as an exporter of intermediates to the world (excl intra EU flows) fell from 22% to 20%. Similarly, in terms of global purchases of imported intermediates, the EU saw a 2 percentage point drop to 18%.
- The decline arises from a statistical crowding out effect driven by China's increased participation in intermediates trade; China's global share increased from 3% to 14% in terms of intermediate exports and from 4% to 16% in terms of imports over the period 1995-2009, making China a global GVC hub.
- The EU is China's most important foreign supplier of intermediate products (representing 2% of Chinese total intermediate products used), while China ranks as the second EU foreign supplier, after the US.
- In 2009, EU sourcing from and sales to China each represented 3% of global flows (excl. Intra EU flows) of intermediates, making this bilateral trade with China as important as that between the EU and the US.

On average, a unit of EU exports requires the use of 2% value added from China whereas a unit of Chinese exports uses 5% of EU value added in 2009

- The EU sources 87% of the value added in its exports domestically (counting intra-EU value added as domestic). In China this figure stands at 76%. This suggests that i) China engages more widely in international production networks; and ii) the much cited iPod case study, where China is seen to only add 3-4% of the value of an exported iPod, is far from being representative.
- Globally, the EU emerges as a key supplier of value added into the production of many countries' exports. The other two 'giant' suppliers are China and the US.

- The EU and China have a somewhat asymmetrical dependence on each other's value added. On average, a unit of EU exports requires the use of 2% value added from China whereas a unit of Chinese exports uses 5% of EU value added in 2009.
- The EU is the biggest supplier of value added to China but China ranks fourth in terms of value added used by the EU to produce exports.

There are important differences in the factor content composition of EU and China's exports which suggest a high degree of complementarity

- In the EU, one third of domestic value added embodied in exports is composed of remuneration to capital and another third to remuneration to med-skill labour. High-skill labour remuneration represents 23% of the domestic value added embodied in exports (with the remainder being attributed to low-skill labour).
- In China over 60% of the domestic value added embodied in exports is composed of remuneration to capital. Low-skill labour represents the second largest share of value added with 21% of total value added.
- In terms of imported value added, 51% of EU value added imports are composed of remuneration to foreign capital with a further 24% being remuneration to med-skill labour.
- For China; capital represents 42% of value added imports with med-skill and high-skill value added representing 28% and 22% respectively.
- Differences in the composition of domestic and imported value added between China and the EU suggest elements of complementarity.
- Relative to other partners, China is the largest source of EU low-skill and capital value added. In contrast, the EU is China's largest supplier of med-skill and high-skill value added. But it is important to note that 94% of low skilled value added remains domestic in the EU.

Although China's engagement in GVCs has risen sharply, China has not increased its share of the global stock of inward FDI.

- The EU is China's largest source of imported capital goods representing 48 billion dollars in 2009, more than the combined capital goods imports from Japan and the US. EU imports of capital goods from China represent 58 billion dollars in 2009. However, domestic capital goods in the EU and in China represent 94% of total capital goods used.
- The latest World Investment Report (UNCTAD 2013) suggests that there is a positive correlation between changes in GVC activity and changes in inward stocks of FDI. Given China's growing participation in GVCs (as documented above), one could expect it to attract an increasing share of inward FDI stocks. However the data show that China's share of global inward FDI stocks has remained relatively stable at 10% of global stocks.
- Although increasing, EU outflows of FDI towards China remain relatively low particularly given the importance of production linkages between these two; 2008 FDI outflows to China were around 1% of total outflows, rising to 3% in 2009.

Jobs related to GVC activity are increasingly important and growing fast; EU (China's) exports create jobs in China (EU)

- In 2009, 31 million jobs in the EU were dependent on exporting activities ('export jobs'): this represented nearly 15% of the total labour force of the EU.

- In China this share was even larger: nearly 30% of the labour force (231 million persons) had jobs that were dependent on exports.
- 'GVC jobs' are a subset of 'export jobs' capturing those persons who are indirectly contributing to a foreign country's exports. For example, EU GVC jobs related to Chinese exports are jobs located in the EU which are tied to the intermediates that China imports to produce its own exports.
- In 2009, over 1.1 million jobs in the EU were sustained by Chinese exporting activity while 5.5 million jobs in China were supported by EU exports.
- Chinese GVC jobs associated with EU exports have increased ten-fold since 1995 whilst EU GVC jobs linked with Chinese exports have doubled. Putting these figures in perspective; EU GVC jobs embodied in Chinese exports have grown twice as fast as export jobs and nearly 9 times faster than total EU jobs since 1995.

Bilaterally and globally, EU internationalisation, both in terms of foreign purchases and sales, is most pronounced in the 'renting machinery and equipment and other business services' sector. For China internationalisation is most pronounced in the 'electrical and optical equipment' sector.

- The EU is a significant importer of 'mining and fuel' and 'renting M&Eq (machinery and equipment) and other business services' intermediates. China's imports of intermediates are mainly from the 'electrical and optical equipment' and 'mining and fuel' sectors.
- In terms of exports of intermediate products, the EU has a rather diverse and full sales vector, meaning that it sells across many different sectors and to many nations, however the 'renting M&Eq and other business services' stands out as the biggest sector. China, on the other hand, predominantly exports 'electrical and optical equipment' intermediates.
- China is the largest foreign supplier of 'electrical and optical equipment' intermediates to the EU: it is responsible for 54% of the intermediates that the EU sources from abroad in that sector.
- The EU is the largest foreign supplier of intermediate products to China in the 'machinery nec' sector (46% of total imported intermediate products from this sector); 'transport equipment' (39%); 'financial services' (42%); 'renting and M&Eq' (62%); and 'construction services' (62%).

Within industries, a higher growth in imported value added in exports is associated with positive changes in domestic value added in exports for both the EU and China which suggests that imports may complement the creation of domestic value added. Moreover, countries with higher value added per worker also appear to have a larger aggregate foreign value added content of exports.

- In terms of domestic value added China specialises mainly in manufacturing sectors whilst the EU's specialisation is largely in the service sectors.
- Looking at the joint evolution of domestic value added and imported intermediate products reveals some interesting results; For example, the Chinese domestic value added in the 'electrical and optical equipment' sector rose by 1.7 percentage points from 1995 to 2009. In turn, imported intermediates rose by nearly 7 percentage points. This suggests that there may be some complementarity between the growth in imported intermediates and the growth in value added.
- Indeed, when we look at the correlation between changes in these elements (domestic value added and imported intermediates) across all sectors we find that for the China, the annual

change in imported intermediates is highest in the sectors which have had a larger annual growth in domestic value added.

- Importantly, both in the EU and in China, there is also a positive relationship between domestic and imported value added in exports which in turn suggests that importing to export could be correlated with higher growth rates of domestic value added. This provides some tentative evidence to the thesis that outsourcing the less competitive elements of production allows a country to specialise in higher value adding activities according to comparative advantages.
- On aggregate, countries with higher value added per worker also tend to display higher foreign value added content of export ratios.

There is a growing 'servicification' of exports and the EU is emerging as a strong supplier of service sector value added into other country's production of exports. China's comparative advantage along the value chain remains in the manufacturing sectors which further highlighting the complementarities between the EU and China.

- While services occupy a relatively small share of gross exports, the share of services embodied in exports is large and growing.
- Where comparative advantages along the value chain are concerned, the EU holds advantages in all service sectors but most notably in the 'renting M&Eq and other business services' sector. China's main comparative advantage continues to lie in manufacturing sectors.

A relatively simple story emerges from the analysis of the bilateral interactions between China and the EU in the 'electrical and optical equipment', 'transport equipment' and 'chemicals' value chains; the EU specialises in service value added where it holds a comparative advantage whilst China mainly specialises in manufacturing sector value added.

- We further delve into the value chains in three key sectors; electrical and optical equipment; transport equipment; and chemicals in view of describing how value chain interactions stand.
- We find a relatively simple story that is consistent across these three sectors; the EU tends to specialise in service intermediate inputs/value added where it holds comparative advantages. China on the other hand appears to have strong comparative advantages in manufacturing value added.
- In these three sectors we find evidence that although China's domestic share of exports is diminishing, the value of these is increasing rapidly and hence China is enjoying a marginally smaller part of a substantially bigger pie.
- China's domestic value added is dominated by capital remuneration while that of the EU is mainly derived from medium and high skill labour.
- The results suggest the presence of important complementarities between the production structures of China and those of the EU.
- The results obtained for the electrical and optical equipment sector also suggest that the much used example of the iPhone/iPad is not representative of manufacturing. Indeed the Chinese domestic value added content in this sector is much higher than what is suggested in these case studies.

Whether it is intermediate products, value added, investment or jobs, the bilateral links between the EU and China are not only highly significant but also growing fast. These should be nurtured not frustrated.

- Imports of both goods and services are critical to promote competitiveness and trade policy, on both sides, should reflect this.
- The EU, dependent as it is on a competitive services sector, needs to ensure openness, internally and externally, of the services sector of the economy.
- EU competitiveness also hinges on its high skilled workers and every effort has to be made to ensure an adequate supply of these.
- The question arises of ensuring that the gains from trade are shared in a socially acceptable way with all members of society, a challenge that goes well outside the field of value chain analysis but which is highlighted by it.
- Similarly for China, continuing to promote value chain specialisation through market opening and domestic reform would seem to be a win-win option.

1.2. MOTIVATION AND OBJECTIVES

Global value chains are behind some of the most momentous changes in international economic activity (Baldwin and Lopez-Gonzalez, 2013). The transport and ICT revolution has enabled firms located in developed countries to export their high-tech know-how to emerging economies with lower-wage labour to produce at lower costs. This has re-shaped global economic activity and led to a re-distribution of value added between the North and the South. Three key Factory systems have emerged; Factory Europe, Factory Asia and Factory North America. Although each is differently organised they all share a commonality; China. It has emerged as one of the most dynamic GVC players and is now not only central to Factory Asia but also to the remainder of the Factory systems (Baldwin and Lopez-Gonzalez, 2013).

The aim of this section is to investigate the evolution of GVC participation of the EU and China. To this end, our specific objectives are to:

i) Identify and discuss the nature and evolution of GVC activity across the globe;
ii) locate the EU and China within this global context and highlight how each interacts both bilaterally and with the rest of the world.
iii) To delve deeper into the origin and destination of value-added at the sectoral level and in particular in three key sectors: the automotive, chemical and ICT industries.
iv) To identify the comparative advantages held by the EU and China across different segments of the value chain.

The next section of this report defines the concepts and measures of GVCs that will be used in subsequent sections. Section 4 is then concerned with providing an analysis that situates China and the EU within the global context. Section 5 provides a more focused analysis of the sectoral linkages in the EU and China. Here we focus more readily on three key sectors; the automotive; ICT and chemicals industries. Section 6 then provides an analysis of the determinants of different forms of GVC participation. Section 7 concludes and provides some policy recommendations.

1.3. CONCEPTS AND MEASURES

The rise in GVC activity presents new challenges for economists and policy-makers. For the former these relate mainly to the theoretical implications that underscore this new phenomenon. For policy makers, the challenge lies in understanding the need for new policy prescriptions; to facilitate this process notably by improving the disciplines for the international governance in the emerging trade-investment-service nexus (Baldwin, 2011); and/or to appease its distributional consequences. Common to both is the challenge of capturing the incidence and nature of these linkages which is the focus of the remainder of this section.

Traditional trade statistics are ill suited to identifying the location of value added - the factor that has witnessed the biggest changes with the rise in GVCs (see Timmer et al., 2011, Koopman et al., 2012 and Lopez-Gonzalez and Holmes, 2011).[7] In this section we discuss an array of measures that can help capture the evolution of GVC activity. We then aim to provide an intuitive taxonomy which exposes the multifaceted nature of participation in value chains. To this end we begin with a discussion of the main challenges that arise when trying to identify the use of intermediate inputs in production.

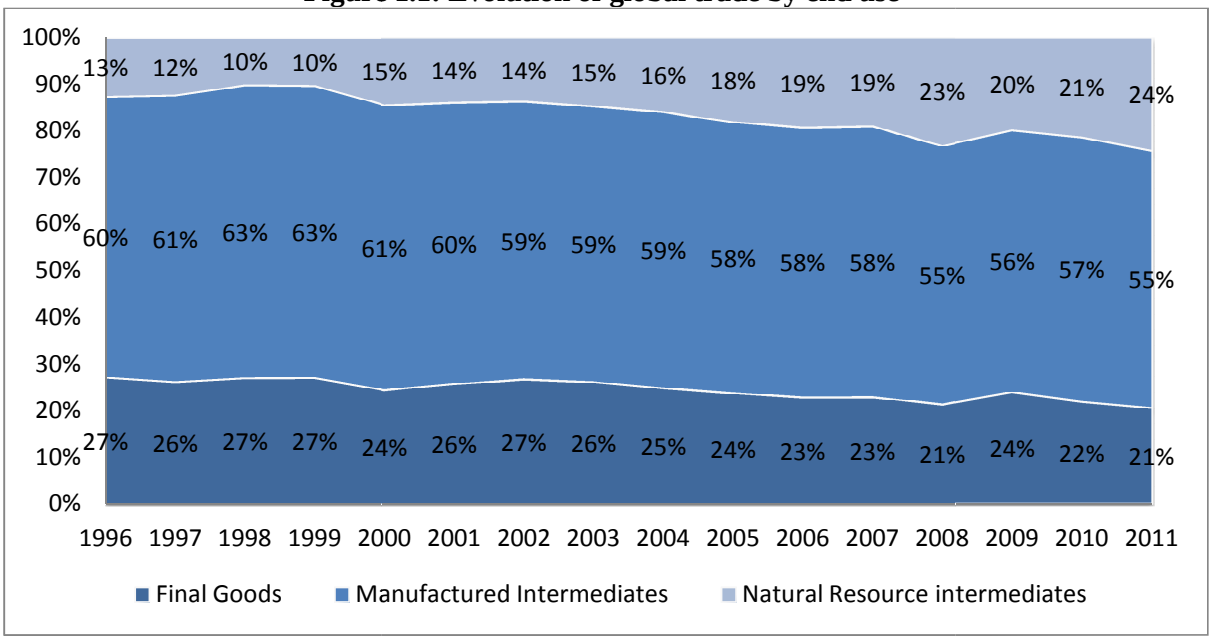
1.3.1. CAPTURING INPUT TRADE

A key symptom of the international fragmentation of production is the geographical dispersion of value added. One might expect to capture this phenomenon through a relative increase in the share of intermediate goods that are traded globally yet the numbers in Figure 1.1 do not support this thesis. They highlight three key points. The first is that the share of manufactured intermediates in global trade has actually declined; the second is the increase in the share of raw material intermediates in global trade; and the third is the relatively low share that final goods represent in global trade (a little over $1/5^{th}$ of global trade). These observations are somewhat out of kilter with the momentous changes that are often highlighted in the literature (see Blinder, 2006, Baldwin, 2006 and Baldwin, 2012).

Several factors explain the discrepancies. First is an increase in the price of natural resources relative to other goods which crowds out increases in the flows in the other categories. Second is the fact that specialisation can lead to price reductions in intermediate inputs which in turn will lead to a fall in the share of manufactured intermediates, in value terms, over time. But a key explanation for the discrepancy between what we think is happening in the world with regards to GVC activity and what we observe from the trade statistics (Figure 1) arises from the way that trade statistics are recorded.

[7] This does not imply that trade statistics are useless in analysing policy implications since these constitute real movement of goods. Moreover, tariffs and trade policy are still guided by these statistics. The implication of the value added trade literature is that one has to refine the trade policy to the changing circumstances. Two points are noteworthy. First, calculating measures of comparative advantage based on these statistics are likely to provide skewed perceptions on the comparative advantages of processes (see Koopman et al. 2012). And second, bilateral trade balances are likely to be less informative since they do not account for own value added (see Johnson and Noguera, 2012 who highlight that the trade imbalance between the US and China is in fact 30 to 40% smaller than gross trade statistics would suggest).

Figure 1.1: Evolution of global trade by end use



Source: Own calculations using UN BEC at HS 6 digits

There are three key measurement challenges that need to be tackled when attempting to capture GVC activity:

i) Identifying intermediate products;
ii) Identifying the production linkages within and between countries; and
iii) Capturing the net rather than gross value of trade

Trade statistics are diligently recorded by customs officials and are thus a relatively precise and rich source of information on the movement of products across countries. However, when it comes to identifying imported intermediates there are some noteworthy drawbacks. The current practice is to use the United Nation's Broad Economic Categories (BEC) nomenclature to identify tariff lines which may reflect intermediates (as in Figure 1). This is done largely by recalling tariff lines with headings beginning with 'parts and components'.[8] While this is likely to capture many intermediates, particularly in the manufacturing sectors, this classification can be misleading since it assigns an exclusive end-use to particular products. The example of milk is instructive. It is a final good when it is consumed in households for breakfast, but it is equally an intermediate product in the production of dairy produce. Similarly, a computer monitor is a component of a desktop computer when bought in a bundle but it is a final good when bought separately by a consumer. The main point here is that products become intermediates in their *use* rather than their characteristics.

Trade statistics do not provide an indication on whether goods are actually being used as intermediates, neither do they convey information on the linkages that arise across industries within and between countries. Hence if we want to look further into the intermediates used in the production of cars we would be tempted to search for the HS 4 digit category 8708 which is defined as "parts and accessories of motor vehicles". Broadly speaking, we would capture imported intermediates such as gear boxes, breaks or radiators but what we would not identify are all the other products that are used to produce a car; namely metal and plastics as well as electronic devices and service inputs. This

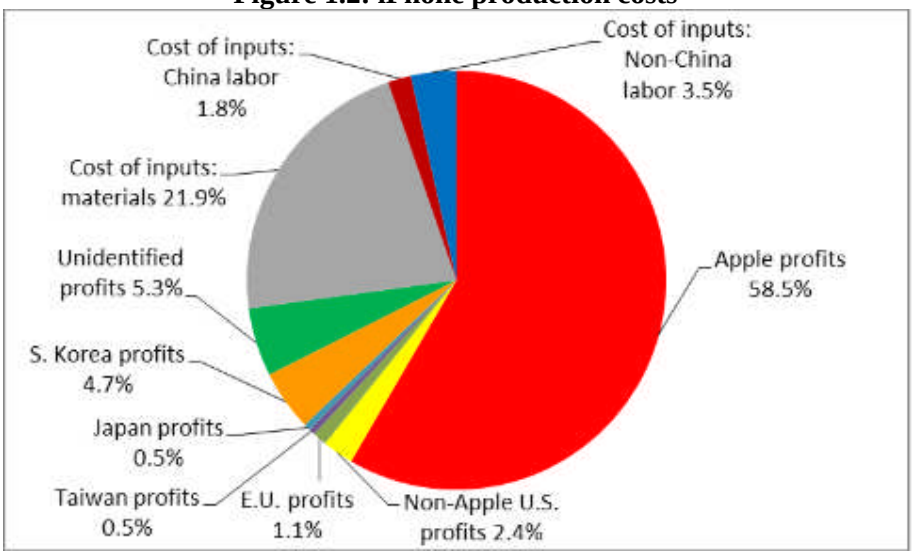
[8] The BEC nomenclature is based on more disaggregate nomenclatures such as the SITC or the HS. It classifies over 5000 products according to their end-use.

implies that associating intermediate products through trade statistics misses the important linkages that arise between industries.

Finally, there is a now well documented issue relating to the way that trade statistics are collected (see Daudin et al. 2011, Johnson and Noguera, 2012, and Koopman et al,2010 and 2012). Each time a product crosses an international border, the entire value of the product is recorded. This means that goods that are produced in sequential stages, with value being added in different international locations, will be 'double counted' in trade statistics. The implication is that recorded gross export flows will overstate the actual amount of value added that is being produced in any reporting country. This in turn can skew measures of comparative advantage calculated using such flows (see Koopman et al. 2010).

This last point can be illustrated by comparing the results from the oft-cited case studies on the iPod (Linden et al., 2009) and iPhone (Xing and Detert, 2010 and Kraemer et al, 2011) against what the trade statistics tell us. These studies suggest that China captures a very small share of the value of the final factory priced iPhone or iPad – around 5%-10% (see Figure 1.2 for an illustration). When looking at mobile phones and tablets/laptops under HS-07 codes 851712 and 847130 respectively we see that they represent, in 2011, 3.3% and 5.5% of total Chinese exports. If the iPhone and iPad case studies are representative of the industry as a whole this would suggest that their importance in total exports in terms of value added retained in China is much lower than what is suggested by the trade statistics. This also implies that measures of China's comparative advantage calculated using these trade statistics can be misleading since one may wrongfully attribute a comparative advantage to China in the production of these products when in fact the comparative advantage lies in the assembly of these products.[9] While the production of the iPhone is likely to be an extreme case, it provides an instructive example showing how trade statistics can offer a distorted view of the distribution of value added across countries.

Figure 1.2: iPhone production costs



Source: Kraemer et al. (2011)

One way of overcoming the above enumerated challenges that arise from the use of trade statistics to analyse GVCs is to use internationally linked input-output tables. These allow one to identify i) the

[9] A Balassa RCA index of 6.5 for tablets and notebooks and one of 3.8 for mobile phones.

use of products; and ii) the production linkages across industries and countries. Consequently one can calculate the domestic value added embodied in production (or any vector of demand). Returning to the iPhone example, it means that we can trace the origin of value added so as to disentangle China's and other partner's contributions. But internationally linked IO tables are fairly aggregate in terms of the sectors covered so that these calculations can only be undertaken at the industry level for very broad industries. The limited country coverage also implies that both origin and destination of inputs and output is only recorded for a small sample of developed and emerging economies. Despite these non-trivial shortcomings, these tables provide a very rich amount of information that is critical for the analysis of GVCs.

One such internationally linked IO table is the World Input Output Database (WIOD), described in Box 1, which we rely on in the remainder of this section in view of investigating the nature and evolution of GVC activity between the EU and China. Before turning to the data, we discuss some preliminary concepts and present the intuition behind their derivation.

Box 1: The World Input Output Database (WIOD)

The WIOD is a sectorally harmonised and internationally consistent input-output table (see Timmer et al. 2012). It was put together by a consortium of 11 institutes led by the University of Groningen and funded by the European Commission. It is constructed from underlying Supply-Use tables and presents data on sales and purchases of 35 sectors across 40 countries and the rest of the world during the period 1995 to 2009.

The geographical coverage includes all EU27 countries as well as Turkey, Canada, Mexico, USA, Japan, Korea, Taiwan, Australia, Brazil, Russia, India, Indonesia and China. The sectoral aggregation captures 35 sectors which can be broadly subdivided into; 4 agricultural and natural resource sectors; 11 manufacturing sectors; and 20 service sectors.

In addition to the internationally harmonised tables, the WIOD also includes socio-economic accounts describing variables such as; employment; labour and capital compensation; price levels; as well as compensation and hours worked by degree of skill (High, medium and low). Since these are sectorally harmonised, they can be used in conjunction with the international input output tables to tease out defining features of GVC activity.

There are some shortcomings relating to the construction of these tables which are worth noting. The first has to do with the timing of the compilation of the underlying 'base' tables. Generally, these are compiled at five year intervals and hence data in between 'base' years is extrapolated. The second has to do with harmonisation; and particularly balancing the external accounts. It requires using some relatively restrictive methodological assumptions leading to an important trade-off between precision and balance. For example, adjustments have to be made to harmonise what country A claims it imports as intermediates from country B and what country B claims it exports to country A. The balancing act can cause changes in recorded inputs within the IO tables which can have consequences for calculated technological coefficients. A final issue relates to missing data, particularly for service inputs and trade. Many of these values are estimated using cross-entropy methods. What this implies is that, in compiling and harmonising these linked input-output tables, much precision is lost.

1.3.2. INDICATORS OF GVC ACTIVITY

We define GVC activity as the use of imported intermediates or value added in any production process.[10] Motivated by the work of Baldwin and Lopez-Gonzalez (2013), we distinguish between two types of GVC engagement; namely the direct inputs used to produce output and the value added content of exports. [11]

The first is the broadest form of GVC activity – it tracks the **direct inputs used to produce output** where we distinguish between three broad elements (see Figure 1.3):

[10] This is a departure from the more traditional literature on GVC which looks at how international networks are organised. Such a broad view of GVCs is taken because we do not have information on the organisational nature of international production networks.

[11] see the Appendix for more formal mathematical derivations of these indicators

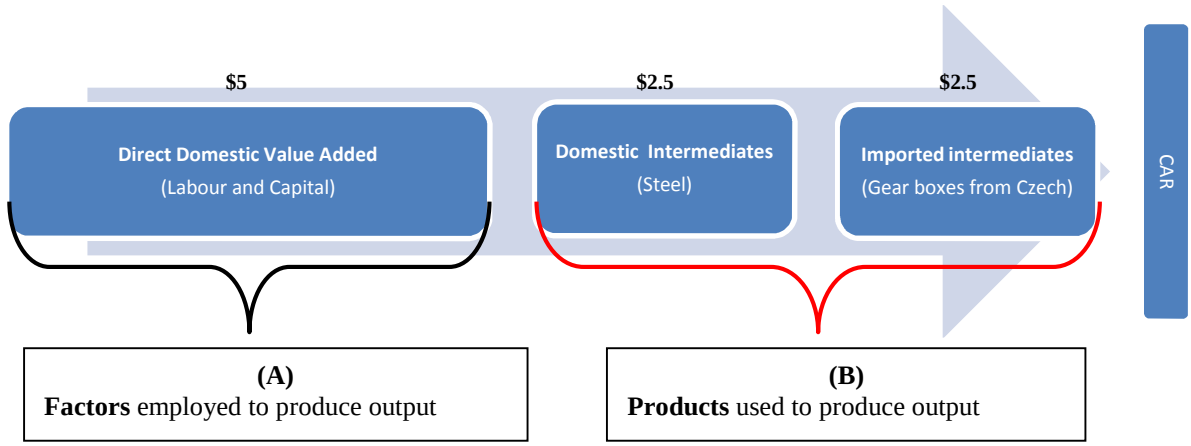
i) *domestic value added*: which captures the direct payments to factors of production such as labour and capital as well as profits earned from these;

ii) *domestic intermediates*: capturing the use of domestically sourced intermediate products – i.e. the domestic backward linkages; and

iii) *imported intermediates*: which are intermediate products sourced from other nations – i.e. the international backward linkages.

We refer to these as direct inputs because they represent the direct costs incurred by an industry or country in the production of a given output. Figure 1.3 shows that, in order to produce a car worth $10 (thousand), a factory in Germany will employ workers and use capital (direct domestic value added) remunerated at $5 to fashion steel – a physical intermediate product; costing $2.5 sourced from a German supplier (domestic intermediates), and gear boxes – another intermediate product, costing $2.5 and originating from the Czech Republic (imported intermediates), into a car. By tracking the value of these inputs we get an indication of the activity that is taking place within the German car factory and the links between domestic and international industries.[12]

Figure 1.3: Decomposition of output of German car manufacturer by direct inputs



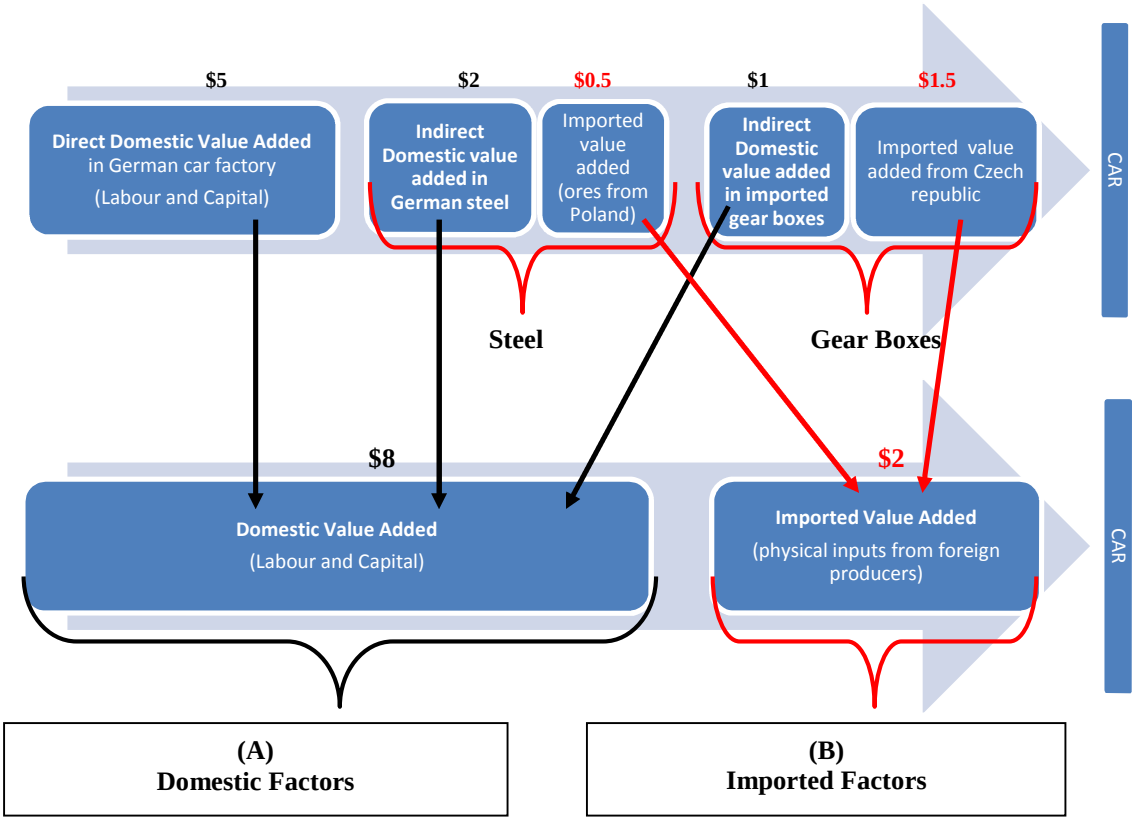
Source: Own elaboration

But this is only part of the story. The intermediate products (B) that are being used as inputs in the production of the car (steel and gear boxes) are themselves subject to similar accounting identities. This is to say that German steel production will use German workers and capital as well as other inputs such as iron ores which may be imported. In Figure 1.4 we show this refinement to capture the ultimate origin of value added embodied in a German car (the direct and indirect inputs). Here we assume that German steel producers use $2 worth of workers and capital (domestic value added) and $0.5 worth of imported ores from Poland – which is ultimately Polish value added. Similarly, the gear boxes that come from the Czech Republic contain $1.5 worth of Czech value added (from workers and capital) and $1 worth of German value added in the form of the design of the gear boxes which is done by German engineers. By assigning the value added to its ultimate origin we can compute measures which allow us to break up production into domestic and foreign value added (see bottom arrow of Figure 1.4). By doing so we effectively eliminate intermediate products and just work in terms of the location of value added.

[12] When we aggregate these elements across all industries within a nation, we get a decomposition of the nation's total output.

The domestic value added embodied in a German car is then the sum of the direct domestic value added (the German workers employed directly by the German car manufacturer) and the *indirect* domestic value added (the German workers employed by the steel industry and in the engineering of the gear boxes). The imported value added is then the sum of the value added of the Polish iron ore miners and the Czech gear box assemblers. In our example, the direct inputs of a German car manufacturer are 75% domestic and 25% foreign, however, in value added terms, a German car is composed of 80% domestic value added and 20% foreign value added. Since this decomposition allows us to assign value added to its originating country, it gives us a more precise indication on what the factors of production of a country are doing (contrasting with the direct input measures which show the activity of the factory or firm).

Figure 1.4: decomposition of output of German car manufacturer into domestic and foreign value added



Source: Own elaboration

We use this value added approach to derive our second indicator of GVC activity – the ***value added in exports (VAE)*** which decomposes the origin of value added into domestic and foreign elements for products that are subsequently exported (see Koopman et al., 2010 and 2012). This indicator is close to the concept of GVCs since it involves both an importing and an exporting element.

We also distinguish between the ***buying/sourcing*** and ***selling*** elements of GVC participation. For example, Germany's purchases of gear boxes used in the production of a car capture the presence of a backward linkage, in terms of intermediate products, with respect to the Czech Republic. However, from the perspective of the Czech Republic this is a sale into a German value chain: a forward linkage. Similarly Germany's sale of the design of these gear boxes is a German value added forward linkage with respect to the Czech Republic. Baldwin and Lopez-Gonzalez (2013) show that there are important differences between buying and selling activities across nations; large 'headquarter'

economies such as Germany tend to have much more prominent selling and buying elements than surrounding 'factory' economies such as the Czech Republic which mainly source intermediates from headquarter economies.

Since the WIOD Socio-Economic Accounts provide information on how value added decomposes into compensation to labour by skill category and capital, it is also possible to decompose the value added in exports into high, medium and low skill labour as well as returns to capital. This allows us to measure the **factor content** of exports. Further distinguishing between the purchasing and sales elements of factors will then help us determine the *type of processes* that countries are specialising in – if a country is exporting high-skill value-added we can surmise that the country is specialising at the higher skill-end of the value chain.

The final refinement that we make is that we identify the job content of exports. We identify two measures of jobs. The first are the domestic jobs that are used to produce exports. We term these 'export jobs'. The second is a subset of these; the jobs that are associated with value chain activity which we term 'GVC jobs'. These are a nation's jobs which are directly supported by the exporting activities of other nations. For example, EU GVC jobs in China are the jobs located in the EU which are embodied in the intermediate products that China uses in order to produce its exports.

Methodologically, direct input measures can be analysed by reading entries from the WIOD tables, however looking at VAE measures requires working through recursive processes of value added, both within and between countries and industries (see the Appendix for a more formal derivation). The computation of such measures is done on the basis of aggregate international sectoral input-output relations which require taking on board some important assumptions about production structures. One of these is that the technology used in the production of total output is the same than that used in the production of exports. This is problematic because we know, from the theoretical and empirical results of the heterogeneous firm literature (Melitz, 2003), that firms engaged in exporting tend to be more productive than those that are not. Moreover, Koopman et al. (2010) use I-O tables which capture the international linkages apparent in special export processing zones in China and Mexico to show that in these free-zones, which occupy firms only engaged in exporting activities, there are noticeable differences between the calculated GVC measures and those calculated using the national IO tables of the countries where these zones are located. Generally, it appears to be the case that the domestic value added content of the exports produced in these free zones is lower than that perceived for the corresponding economy. The measures that we present in the remainder of this report relate to products produced in mainland China and not those in the export processing zones.

Box 2: GVC terms

The **direct input** content of total output: the inputs used by factories in order to produce output irrespective of whether this output is consumed domestically or exported. Composed of:

- Direct domestic value added: direct remunerations to labour and capital.
- Domestic intermediates: intermediate products sourced from domestic suppliers.
- Imported intermediates: intermediate products sourced from foreign suppliers.

The **value added in exports** (**VAE**):

- The *buying/sourcing* element decomposes the direct and indirect value added embodied in exports according to whether this is domestic or foreign (backward linkage or purchases of VAE).
- The *selling* element captures a country's sales of value added that is subsequently used by a partner country for the production of its exports (forward linkage or foreign VAE sales).

Factor content of exports: decomposes the domestic or foreign value added in exports in to; low, medium and high skilled labour contributions as well as capital compensation.
Export Jobs: identify the number of domestic jobs that are tied to gross exports.
GVC jobs: is the number of jobs that are sustained by other countries' exporting activities.

1.4. AGGREGATE ANALYSIS

This section aims to contextualise the EU and China's global positioning within the world economy so that we can draw out broad observations relating to the nature of their participation in value chains. We set the stage by noting China's impressive growth during the last decades. It has seen its share of global output increase from 3.5% to 13.3% in the 15 years between 1995 and 2009. Consequently China has become one of the most dominant and dynamic players in the global scene. The EU, on the other hand, has witnessed a relative decline with its share of global output falling from 30.5% to 27.9%. This relative decline is mainly due to the fact that China's growth, and that of other emerging nations, has far outpaced the EU's.

1.4.1. CHINA AND THE EU IN THE GLOBAL CONTEXT

To further understand the nature of these changes, in Table 1.1 , we decompose total output into the three direct input elements that were delimited in the section above for the world, the EU and China.

- **Direct Domestic value added** identifies the direct returns awarded to domestic factors of production such as labour and capital (these do not include the indirect value added associated with domestic labour and capital embodied in intermediate products used for production).
- **Domestic intermediates** capture the gross value of intermediates purchased from domestic factories and firms;
- **Imported intermediates** are the purchases of foreign intermediates used to produce total output.

The key message from Table 1.1 is that, in 2009, global total output is 92% domestically sourced (50% domestic intermediates and 42% domestic value added) and only 8% imported intermediates. This suggests that *global production is less internationalised than it is often thought to be* (see Baldwin and Lopez-Gonzalez, 2013). Nevertheless, the trends hint at domestic value-added being replaced by imported intermediates which is a preliminary symptom of the international fragmentation of production unfolding.[13]

Taking the EU as the sum of its parts (i.e. including intra-EU imports)[14], we see that the share of imported intermediates over total output stands at 10% in 2009. This suggests a high degree of internationalisation relative to the world however six of these percentage points represent imports from other EU countries (shown in the table in parenthesis) suggesting that much of this internationalisation is due to the internal market.[15]

In contrast, China appears to be less reliant on imported intermediates than the world in 1995 but on par with world averages in 2009. What is most striking is the low and declining amount of direct domestic value added in China's total output. China is increasingly relying on imported and domestic

[13] It is worth recalling that the figures are direct input measures and hence do not take into account the fact that many domestic and imported intermediates contain further domestic value added. We will turn to this issue in subsequent sections.

[14] The EU is identified here as the sum of its 27 Member State's domestic and imported intermediate matrices as well as the direct value added. This implies that it includes imports from other EU member states in its imported intermediate matrix.

[15] An element that could be driving the higher internationalisation witnessed in the EU is the compositional nature of EU countries. These tend to be small in size and in close proximity. Smaller countries tend to rely more heavily on imported intermediates since they have a smaller domestic market from which to draw inputs (see Lopez-Gonzalez, 2012).

intermediates in order to produce output. This fits two possible scenarios; i) China is in-sourcing more and more intermediate inputs (hence the high domestic intermediate figures); and at the same time ii) it is increasingly specialising in lower value adding processes of production (evidenced by the relatively low domestic value added figures). These observations are broadly in-line with the anecdotal evidence suggesting that China specialises in the assembly of products which is often associated with lower value adding activities.

Table 1.1: Decomposition of total output by direct input

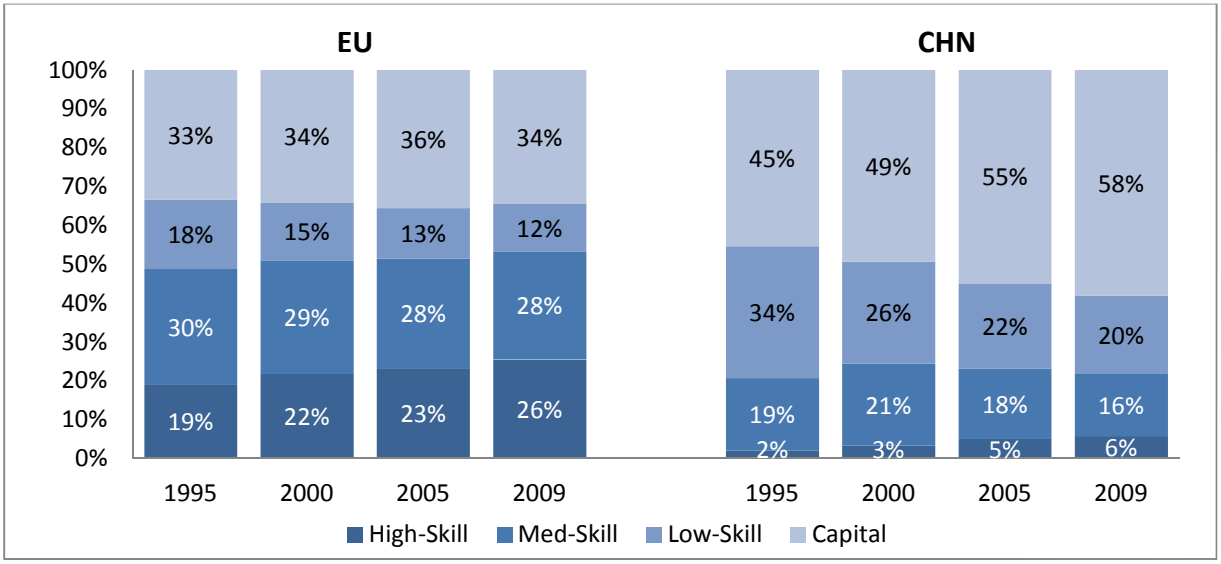
		Domestic		Imported
		Direct Value Added	Intermediates	Intermediates
World	**1995**	53%	41%	6%
	2009	50%	42%	8%
EU	**1995**	53%	39%	8% (of which 5pp is intra-EU)
	2009	51%	38%	10% (of which 6pp is intra-EU)
China	**1995**	39%	56%	5%
	2009	33%	59%	8%

Source: own calculations using WIOD

Notes: Domestic value added is the direct compensation paid to domestic factors of production, Domestic intermediates are purchases of physical inputs from domestic factories and firms. Imported intermediates represent purchases of physical inputs from foreign factories/firms. See Figure 1.3for more detailed definitions of these elements.

Differences between the EU and China's composition of direct domestic value added are better perceived when we decompose the above direct domestic value added figures into low, medium and high skill labour and capital returns and present the figures as a share of total direct domestic value added (Figure 1.5). For China, the biggest change arises from the large increase in the share of value added coming from capital compensation which, in 15 years has gone from 45% to 58%. The decline of low skilled labour compensation is also pronounced as is the increase in the share of value added arising from compensation awarded to high-skilled labour. The EU also witnesses a declining share of value added from the low-skill category with a large increase in the share of value added destined to high-skill labour, group which represents 26% of total direct EU value added in 2009. These figures give us an insight into the specialisation patterns of the EU and China. *The EU's direct value added is increasingly composed of returns to high and med skill labour whereas in China, returns to capital hold the highest share of value added*. However, China's returns to high skilled labour are rising fast and have tripled since 1995.

Figure 1.5: Share of direct domestic value added compensation by type over total compensation 1995-2009



Source: own calculations using WIOD

In Table 1.2 we look at the gross sales element of production across three broad activities; natural resources, manufacturing and services. The first panel, on the left, shows how total output is distributed across these sectors whereas the second, on the right, provides a similar decomposition but exclusively for sales in foreign markets – exports. Turning to the first panel and focusing initially on the world as a whole we see that the composition of total output sales has changed very little in time. There has been a small decline in manufacturing with a corresponding increase in services and natural resources. However, the *figures highlight large differences in the composition of total output and exports*. In particular, *the dominance of services in total output is not reflected in exports where this sector plays second fiddle to the manufacturing sector*.

The entries for the EU and China reveal marked differences in the composition of their sales too. *The EU is more service oriented than China in terms of both total and international sales*. Where exports are concerned, EU manufacturing is still dominant but it has fallen considerably with a consequent rise in EU service exports. China, in contrast, has witnessed a relative decline in natural resources with a small increase in manufacturing and a larger increase in services. Despite this, the manufacturing sector represents, in 2009, over 75% of total export sales.

Table 1.2: Evolution of sectoral output as a share of total output (1995-2009)

		Total Output		Exports	
Region	Sector	1995	2009	1995	2009
World	Natural Resources	12%	13%	16%	19%
	Manufacturing	25%	23%	65%	58%
	Services	63%	64%	19%	23%
EU	Natural Resources	10%	8%	13%	13%
	Manufacturing	25%	21%	70%	61%
	Services	65%	71%	17%	26%
China	Natural Resources	24%	16%	12%	4%
	Manufacturing	42%	45%	75%	76%
	Services	34%	39%	12%	20%

Source: own calculations using WIOD

Table 1.3 shows similar figures but rather than normalising by total output, as was the case in Table 1.2, we normalise by the output of each broad sector. We also make a distinction between intermediate and final sales. The World figures show that, on average, total domestic sales distribute relatively evenly between intermediates and final goods. These occupy around 88% of global output in 2009 with a slight dominance of final sales. Export sales represent but 12% of total output with 8% as intermediates and 4% as final goods. The contrast here is that *in domestic markets, final goods appear to prevail ever so slightly, however in external markets; intermediate goods outpace final goods by a factor of 2.*

The table also reveals marked differences across sectors. As expected, natural resources are generally sold as intermediates with a large domestic bias which is less pronounced than that of total trade as discussed above. *Manufacturing is far more internationalised with exports of this sector representing 32% of output of which 19 percentage points are intermediate sales and the remaining 13 final good exports. Services are predominantly sold as final domestic goods with international sales being relatively small and focused towards intermediates rather than final services.* One big change that has taken place is that whilst intermediate service exports outpaced final service exports by a factor of 2 in 1995, in 2009 the gap widens so that the former are 4 times the size of the latter.

Table 1.3: Evolution of gross sales by broad activity (1995-2009)

		1995				**2009**			
		Domestic Sales		Exports		Domestic Sales		Exports	
Region	Sector	Ints	Final	ints	final	Ints	final	ints	Final
World	Total	41%	49%	6%	4%	42%	46%	8%	4%
	Natural Resources	47%	40%	8%	5%	51%	31%	13%	6%
	Manufacturing	50%	24%	15%	11%	51%	17%	19%	13%
	Services	36%	61%	2%	1%	37%	59%	4%	1%
EU	Total	39%	46%	9%	6%	38%	44%	11%	7%
	Natural Resources	44%	37%	7%	12%	39%	33%	12%	16%
	Manufacturing	36%	22%	24%	18%	33%	15%	30%	22%
	Services	39%	57%	3%	1%	40%	54%	5%	1%
CHN	Total	56%	35%	4%	5%	59%	28%	7%	6%
	Natural Resources	56%	40%	2%	3%	73%	24%	1%	2%
	Manufacturing	66%	18%	7%	9%	68%	10%	10%	11%
	Services	44%	53%	2%	1%	42%	51%	5%	1%

Source: own calculations using WIOD

In the EU the story is similar - domestically, final good shares are slightly higher than intermediate shares but the dominance of intermediates is less pronounced in exports than was the case for the world. External markets represent around 18% of total output in 2009 up from 15% in 1995 which is above the world average. Exported EU natural resources are mainly final rather than intermediates and the gap between intermediate and final manufacturing exports is less pronounced but still tilts in the same direction as that of the world (i.e. towards intermediates). Services, however, are even more skewed towards intermediate export sales and in 2009 overarch final services by a factor of 5. Still, these represent a very small share of total export sales.

China is different in many ways. First, it is intermediate domestic sales that dominate over final sales. Exports represent 13% of total sales with the gap between intermediates and final exports being relatively small. Chinese natural resources are predominantly sold domestically. With regards to manufacturing, most sales are intermediates and sold domestically and, unlike the world and the EU, exports are mainly in final rather than intermediate goods. Services are also largely sold domestically

and mainly as final goods but exports are geared towards intermediate usage, which outpace final exports also by a factor of 5 like in the EU.

1.4.2. AGGREGATE FLOWS OF INTERMEDIATE PRODUCTS

In this section we look at how aggregate intermediate product flows between countries have evolved in time. Figure 1.6 shows global (top) and individual country (bottom) intermediate product flows in 1995 (left panel) and 2009 (right panel) using the global matrices introduced in Baldwin and Lopez-Gonzalez (2013). In the top panel, each entry identifies the row nation's sales of intermediate products to the column nation as a share of global (world) intermediate product trade (flows below 0.5% are zeroed out for readability). Taking the EU row in 1995 as an example, the first 'significant' entry shows that EU *sales* of intermediates to Brazil represent 1% of global intermediate product flows. For the EU column, the first significant entry is also with respect to Brazil and shows EU *purchases* of intermediates from Brazil representing 1% of global intermediate product trade.[16]

In 1995 the EU is a significant supplier of intermediate products to 10 of the 14 regions identified in the WIOD (not counting itself). Its global share of intermediate product sales is 22% and, after the RoW, the US is the most significant single destination market. Where sourcing is concerned, extra-EU flows represent 20% of global intermediate product flows with the US again appearing as the single biggest supplier (after the RoW grouping). The China-EU trade relationship in 1995 is also significant both in terms of purchases and sales which occupy 1% global flows apiece.

China's story in 1995 is relatively straight forward: it is only a significant supplier to the EU and the RoW and its sourcing patterns are only significant with respect to these two as well as Japan. Total Chinese intermediate product sales represented only 3% of global flows with its purchases just 4%.

By 2009 things change drastically. Owing to China's huge economic growth, extra-EU sales are statistically crowded out and become significant only with respect to three partners – down from 10 in 1995. A similar, albeit less extreme, story also applies to the US – it goes from being a significant supplier of intermediate products to 7 partners in 1995 to just 5 by 2009. In the meantime, China increases its share of total intermediate good sales from 3% to 14% and its purchases from 4% to16% supplying significant shares of intermediates to the EU (3%), Japan and Korea (1% each), the US (2%) and the RoW (5%). Where Chinese sourcing patterns are concerned, the EU becomes, by 2009, the most important single foreign source of intermediate products for China. Other globally significant sources are; the RoW, Australia, Taiwan, the US, Japan, and Korea.

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[16] Since the figure omits intra-EU gross input sales it is worthwhile noting that in 1995 these occupied 17.6% of global flows falling to 12.4% by 2009. This decline is largely due to a faster growth in emerging economies; particularly China who saw its share of global gross input trade increase from 2.2% in 1995 to 11.1% by 2009.

Figure 1.6: Global and individual intermediate input matrices 1995 and 2009

1995	Extra-EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
Extra-EU			1%	1%			1%	1%	1%	1%	1%	5%		1%	10%	22%
Turkey																0%
Brazil	1%														1%	2%
Russia	2%															3%
India																1%
Indonesia																2%
Australia															1%	2%
China	1%														1%	3%
Taiwan												1%			1%	3%
Japan	1%							1%	1%		1%	2%			5%	12%
Korea	1%									1%		1%			1%	4%
USA	5%								1%	2%	1%		1%	3%	8%	21%
Mexico												1%				2%
Canada	1%									1%		3%			1%	5%
RoW	7%							1%	1%	3%	1%	4%				19%
TOTAL	20%	1%	2%	1%	1%	2%	2%	4%	3%	9%	4%	18%	2%	4%	28%	100%

2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
EU								3%				3%			11%	20%
Turkey																1%
Brazil															1%	2%
Russia	2%														1%	3%
India																1%
Indonesia																1%
Australia								1%								2%
China	3%									1%	1%	2%			5%	14%
Taiwan								1%								2%
Japan	1%							2%							2%	6%
Korea								1%							1%	4%
USA	3%							2%					1%	1%	5%	14%
Mexico												1%				2%
Canada	1%											2%				4%
RoW	7%		1%		1%			5%	1%	2%	1%	4%				24%
TOTAL	18%	1%	1%	1%	2%	1%	1%	16%	2%	5%	4%	13%	2%	3%	29%	100%

1995	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	94%	7%	3%	5%	3%	5%	4%	1%	5%		3%	2%	3%	4%	9%
Turkey		85%													
Brazil			93%												
Russia		2%		91%											
India					91%										
Indonesia						82%									
Australia							89%								
China								91%							
Taiwan								1%	74%						
Japan						4%	1%	2%	6%	95%	3%		1%	1%	4%
Korea						2%			1%		83%				
USA	2%		1%			2%	2%		5%		3%	92%	15%	15%	7%
Mexico													78%		
Canada												1%		77%	
RoW	2%	3%	2%	3%	3%	3%	3%	2%	6%	1%	4%	2%	1%	2%	76%
Tot imp	6%	15%	7%	9%	9%	18%	11%	9%	26%	5%	17%	8%	22%	23%	24%

2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	91%	6%	3%	3%	2%	2%	2%	2%	4%		3%	2%	3%	3%	10%
Turkey		82%													
Brazil			92%												
Russia		2%		93%											1%
India					85%										
Indonesia						85%									
Australia							89%								
China	1%	1%			3%	3%	2%	88%	5%	1%	4%	2%	4%	2%	5%
Taiwan									68%						
Japan						1%		1%	5%	92%	2%				2%
Korea									2%		78%				1%
USA	2%				1%		1%	1%	3%		2%	91%	11%	10%	5%
Mexico													76%		
Canada												1%		81%	
RoW	4%	6%	3%	1%	7%	6%	4%	4%	11%	4%	7%	3%	2%	2%	73%
Tot imp	9%	18%	8%	7%	15%	15%	11%	12%	32%	8%	22%	9%	24%	19%	27%

Note: Top panel shows row nation sales to column nation as a share of global (all country) sales (not including domestic intermediates) – values below 0.3% are zeroed out for readability. Bottom panel is row nation sales to column nation as a share of column nation total intermediate inputs – values below 1% are zeroed out.

The bottom panel of Figure 1.6 highlights the significance of intermediate products for each individual country in 1995 and 2009. The entries show the row nation's sales to the column nation over the column nation's total use of intermediate products where we now show the use of domestic intermediates (in the diagonal). Values that are less than 1% are zeroed out.

The first entry, for the EU, tells us that 94% of the intermediate products used in 1995 were sourced domestically or from other EU countries and hence that 6% of the intermediates used to produce output were imported from extra-EU sources.[17] In 1995, outside the Single Market, the EU only sourced significantly from the US and the RoW. On the sales side, the EU row is rather full; the EU supplied significant shares of intermediates to all nations except Japan. Where China is concerned we see that it imported a significant amount of intermediates from Japan, the EU and Taiwan. However its sales were not significant inputs into any of the listed countries – meaning that no nation relied on Chinese intermediate products for more than 1% of its total intermediates in 1995.

Moving to 2009 there is a strong trend towards international fragmentation – all save Brazil and Russia significantly increase their share of imported intermediates over total intermediates. The EU increases its extra-EU sourcing by 3 percentage points and China becomes a significant supplier to the EU with a share of over 1% of total intermediates. In fact the biggest changes come from China's increased participation in intermediates trade going from not being an important supplier to any of the nations in 1995 to supplying a significant share of intermediates to 12 of the 15 nations identified (Brazil and Russia being the only two which do not significantly rely on Chinese intermediates). The RoW, followed by the EU, become China's main source of imported intermediates. Importantly the EU becomes, in 2009, a more important supplier to China than Japan or the US.

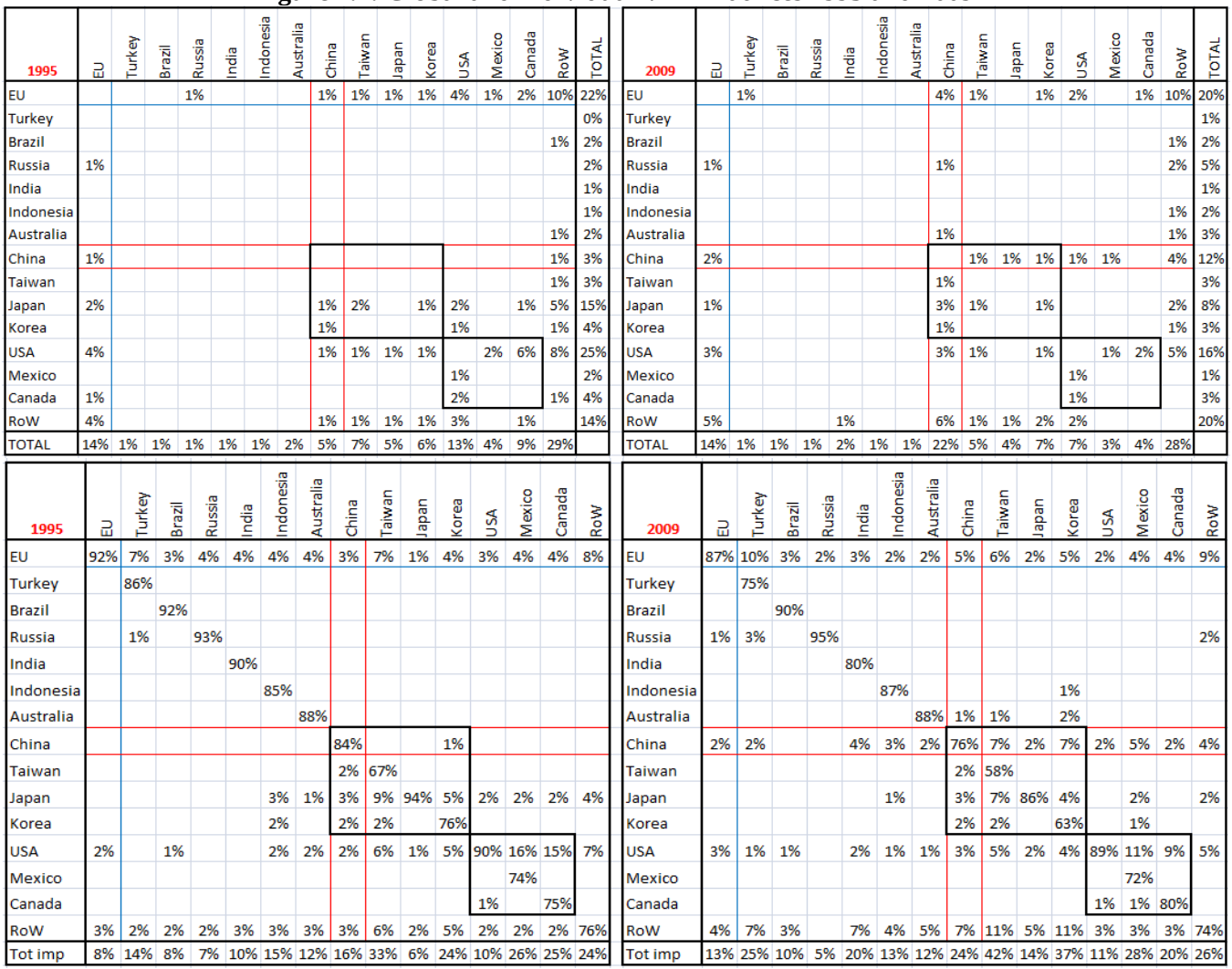
1.4.3. AGGREGATE FLOWS OF VALUE ADDED IN EXPORTS (VAE)

In this section we track the value added which is associated with exporting activities using our value added in export (VAE) measures. Figure 1.7 shows the global (top panel) and individual (bottom panel) VAE matrices for the years 1995 and 2009 using the setup that was introduced in Figure 1.6. Turning to the global matrix first we see that extra-EU sourcing represents 14% for global VAE flows whilst sales are 22%. For China, in 1995, the VAE figures highlighting very little activity as was the case in the previous measures of GVC activity but they also reflect China's role as a global hub for VAE activity by 2009. Where bilateral links between the EU and China are concerned, in 1995, EU sales to and purchases from China represented 1% of global flows respectively, but by 2009 extra-EU sales to China rise to 4% whereas extra-EU purchases from China rise to 2% of global flows.

In the bottom of this Figure we have the individual country VAE matrices for 1995 and 2009. Here, the EU emerges as a dominant supplier of value added to all nations, trend which is growing with all partners except Russia and Taiwan. For China, the figure picks up the impressive increase in the participation of China in GVCs going from supplying significant shares of value added only to Korea in 1995 to being a key supplier to 12 of the 15 nations on the matrix. The figure also picks up the asymmetric relationship between China and the EU. The Chinese value added content of extra-EU exports is 2% whereas the EU value added content of Chinese exports stands at 5%.

[17] Note that these values are not directly comparable to those of Table 1 since they represent inputs only and not value added which is included in the measures of Table 1.

Figure 1.7: Global and individual VAE matrices 1995 and 2009



1995	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
EU				1%				1%	1%	1%	1%	4%	1%	2%	10%	22%
Turkey																0%
Brazil															1%	2%
Russia	1%															2%
India																1%
Indonesia																1%
Australia															1%	2%
China	1%														1%	3%
Taiwan															1%	3%
Japan	2%							1%	2%		1%	2%		1%	5%	15%
Korea								1%				1%			1%	4%
USA	4%							1%	1%	1%	1%		2%	6%	8%	25%
Mexico												1%				2%
Canada	1%											2%			1%	4%
RoW	4%							1%	1%	1%	1%	3%		1%		14%
TOTAL	14%	1%	1%	1%	1%	1%	2%	5%	7%	5%	6%	13%	4%	9%	29%	

2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
EU		1%						4%	1%		1%	2%		1%	10%	20%
Turkey																1%
Brazil															1%	2%
Russia	1%							1%							2%	5%
India																1%
Indonesia															1%	2%
Australia								1%							1%	3%
China	2%								1%	1%	1%	1%	1%		4%	12%
Taiwan								1%								3%
Japan	1%							3%	1%		1%				2%	8%
Korea								1%							1%	3%
USA	3%							3%	1%		1%		1%	2%	5%	16%
Mexico												1%				1%
Canada												1%				3%
RoW	5%				1%			6%	1%	1%	2%	2%				20%
TOTAL	14%	1%	1%	1%	2%	1%	1%	22%	5%	4%	7%	7%	3%	4%	28%	

1995	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	92%	7%	3%	4%	4%	4%	4%	3%	7%	1%	4%	3%	4%	4%	8%
Turkey		86%													
Brazil			92%												
Russia		1%		93%											
India					90%										
Indonesia						85%									
Australia							88%								
China								84%			1%				
Taiwan								2%	67%						
Japan						3%	1%	3%	9%	94%	5%	2%	2%	2%	4%
Korea						2%		2%	2%		76%				
USA	2%		1%			2%	2%	2%	6%	1%	5%	90%	16%	15%	7%
Mexico													74%		
Canada												1%		75%	
RoW	3%	2%	2%	2%	3%	3%	3%	3%	6%	2%	5%	2%	2%	2%	76%
Tot imp	8%	14%	8%	7%	10%	15%	12%	16%	33%	6%	24%	10%	26%	25%	24%

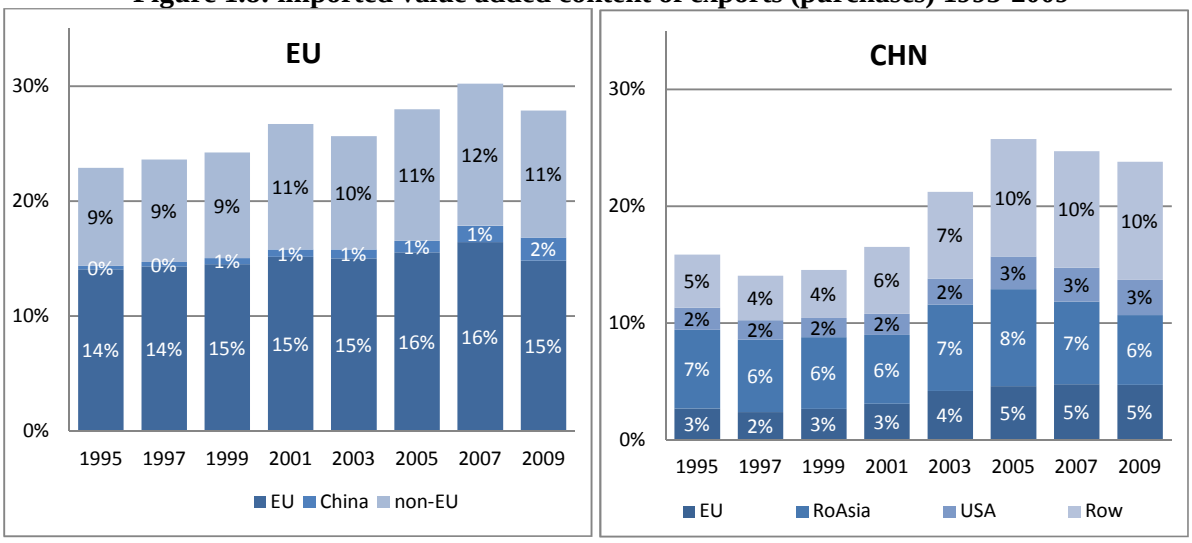
2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	87%	10%	3%	2%	3%	2%	2%	5%	6%	2%	5%	2%	4%	4%	9%
Turkey		75%													
Brazil			90%												
Russia	1%	3%		95%											2%
India					80%										
Indonesia						87%					1%				
Australia							88%	1%	1%		2%				
China	2%	2%			4%	3%	2%	76%	7%	2%	7%	2%	5%	2%	4%
Taiwan								2%	58%						
Japan						1%		3%	7%	86%	4%		2%		2%
Korea								2%	2%		63%		1%		
USA	3%	1%	1%		2%	1%	1%	3%	5%	2%	4%	89%	11%	9%	5%
Mexico													72%		
Canada												1%	1%	80%	
RoW	4%	7%	3%		7%	4%	5%	7%	11%	5%	11%	3%	3%	3%	74%
Tot imp	13%	25%	10%	5%	20%	13%	12%	24%	42%	14%	37%	11%	28%	20%	26%

Note: Top panel shows row nation sales to column nation as a share of global sales (not including domestic value added) – values below 0.3% are zeroed out for readability. Bottom panel is row nation sales to column nation as a share of column nation total value added – values below 1% are zeroed out.

In Figure 1.8 we home in on the EU and Chinese aggregate imported VAE trends over time. For the EU, in the left-hand panel, we distinguish between intra-EU imports and those from China and the RoW. This allows us to investigate the evolution of intra-EU value added imports and their importance in the production of exports. The figure highlights the growing participation of the EU in GVCs. Counting intra-EU trade, the EU has seen the share of foreign value added in exports increase from 23% in 1995 to 28% in 2009 (i.e. the use of imported value added is growing at a faster rate than the use of domestic value added). In terms of the origin of this imported value added, the figures highlight the dominance of other EU countries as a source of value added. The intra-EU imported value added content of exports, i.e. the share of imported value added of EU countries from other EU countries, has risen slightly from 14% in 1995 to 15% in 2009 (peaking at 16% in 2007). The share of non-EU value added also rose throughout this period. Interestingly, the crisis seems to have hit all sources except China who saw its value added share rise from 1% to 2% in the period 2007-2009. Nevertheless, China is still a relatively small source of VAE for the EU as a whole.

China's foreign value added content of exports (right hand panel) has witnessed a dramatic increase since 1995 – it has gone from 16% to 24%. The origin of this imported value added is largely shared between the RoW grouping, the RoAsia (which is the sum of Japan, Korea and Taiwan) and the EU. Where trends are concerned, sourcing from the RoW has doubled since 1995 and there has been a relative decline in sourcing from RoAsia. In contrast both the EU and the US have grown as an origin of VAE. The US value added content of Chinese exports has gone up from 2% to 3% whilst for the EU it has gone from 3% to 5%. Importantly, the EU is nearly twice as significant a source of inputs for China as the US, just behind the RoAsia.

Figure 1.8: imported value added content of exports (purchases) 1995-2009



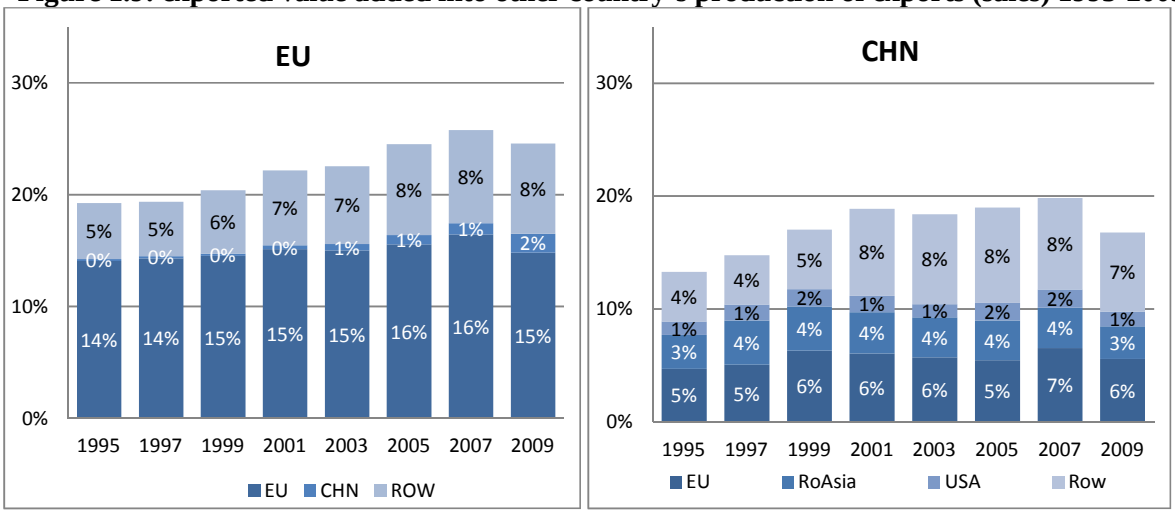
Source: Own calculations using WIOD
Note: RoAsia includes Japan, Korea and Taiwan

Figure 1.9 provides a more in depth investigation of the *sales* element of VAE activity for the EU (left panel) and China (right panel). For the EU entry in 1995, the 19% value represents the share of EU gross exports which are used as intermediate value added by other countries in their production of exports – or, in other words, the sale of value added into international production processes (an indicator of forward linkages in GVC participation). The first important observation is that the sales elements are smaller than the purchasing elements for both the EU and China (comparing Figure 1.8 with Figure 1.9). Or that both the EU and China source more value added from abroad than they sell

as a share of exports. However, this difference is more pronounced for China than for the EU. In terms of the destination of EU VAE, and comparing these figures to the origin of these, we see how the EU remains the top destination with China representing 2% of VAE sales.[18] The EU is selling less to the RoW grouping than it is buying from them. In terms of sales to China, the figures are relatively similar to the purchases although the latter are marginally bigger.

Where China is concerned (right panel), the differences are more pronounced. Sales of VAE to the RoW, RoAsia and US are all smaller than purchases but this is not so with respect to the EU. Chinese sales into EU value chains outpace its purchases and are nearly as important as those to the RoW. Again this figure highlights the asymmetric relationship between the EU and China where, in relative terms - i.e. as a share of their respective gross exports, EU sales to China are relatively small but Chinese sales to the EU are large.

Figure 1.9: exported value added into other country's production of exports (sales) 1995-2009



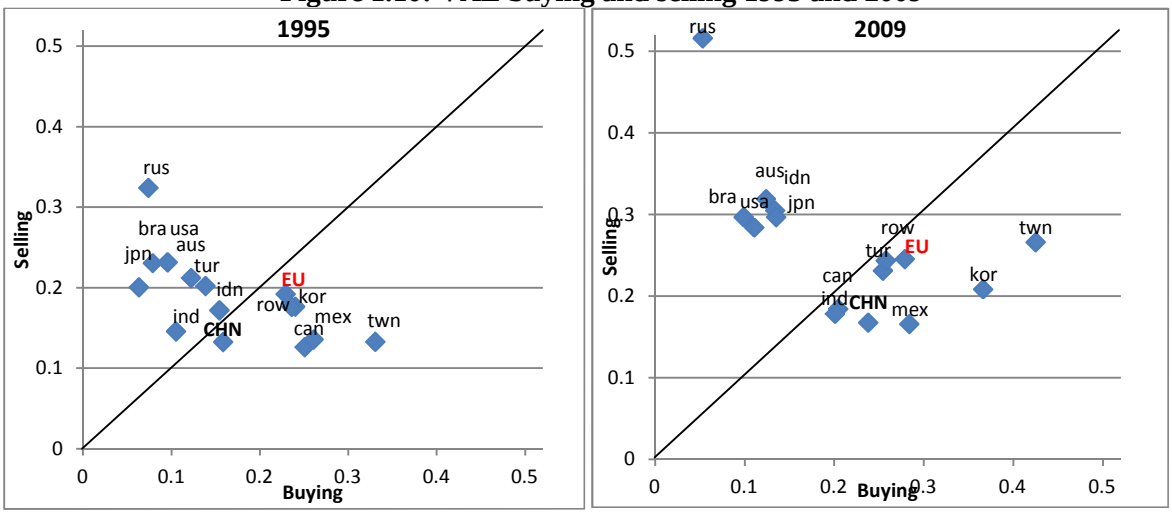
Source: Own calculations using WIOD
Note: RoAsia includes Japan, Korea and Taiwan

Figure 1.10 plots a scatter of the aggregate purchasing and sales elements of foreign VAE for the EU as a whole (including intra-EU linkages) and the remaining countries of the WIOD in 1995 (left panel) and 2009 (right panel). The increased participation in GVC activity is made patent with the move, by all countries, away from the origin. The EU's expansion is relatively uniform albeit more towards the purchasing side. Conversely that of China is taking place on the purchasing rather than the selling side.

Natural resource abundant countries such as Russia, Australia, Brazil and Indonesia have clearly benefited from the natural resource boom and have consequently developed very large selling elements to their GVC activity. At the same time, countries like Korea and Taiwan have vastly expanded their purchasing activities. Amidst the big suppliers of VAE also stand the US and Japan.

[18] Note that since what the EU purchases from other EU countries and what it sells to other EU countries is the same, the share that sales and purchases occupy in total exports is also the same.

Figure 1.10: VAE buying and selling 1995 and 2009

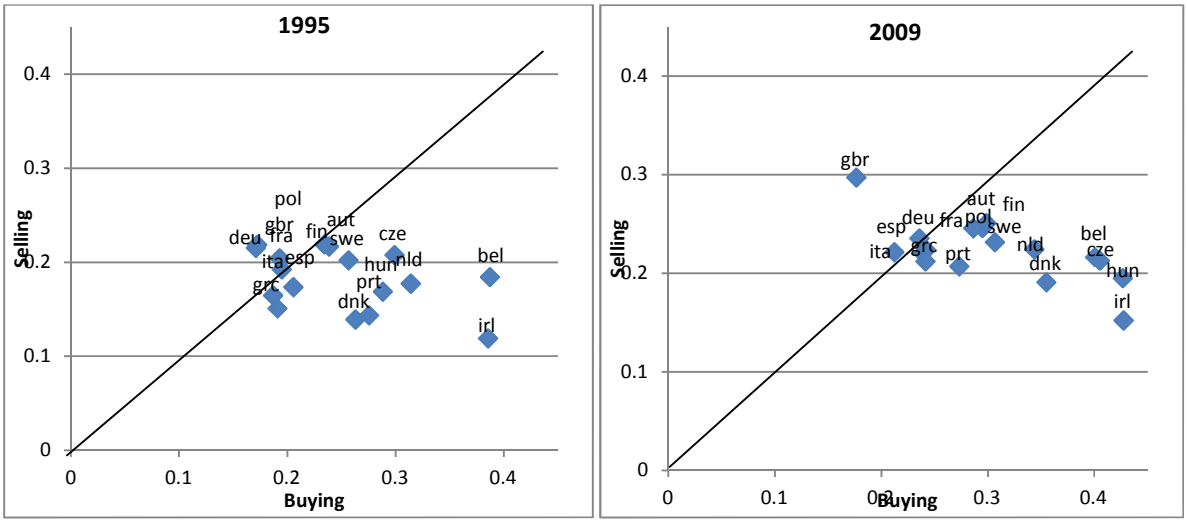


Source: Own calculations using WIOD

Note: Buying identifies the imported value added content of exports, selling is the value added content of exports which other countries use to produce their own exports.

In Figure 1.11 we take a closer look at what is happening within individual EU countries where we consider intra-EU flows as imports (we remove some of the smaller EU members for clarity of exposition). Here too the expansion in GVC activity is noticeable. Most countries experience a move towards the right of the graph indicating greater increases in purchases than in sales. Smaller countries appear to more readily locate closer to the right hand side of the scatter which suggests that size and purchases of imported intermediates used to produce exports may be correlated. The bigger EU countries on the other hand tend to locate near the 45 degree line showing more evenly distributed buying and selling activity.

Figure 1.11: EU VAE buying and Selling 1995 and 2009



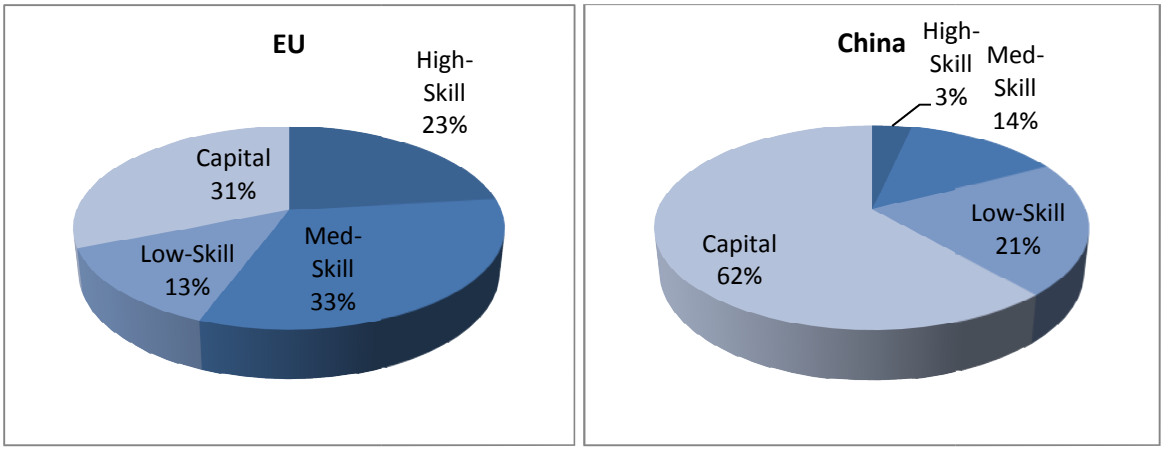
Source: Own calculations using WIOD

Note: Buying identifies the imported value added content of exports, selling is the intermediate value added content of exports which other countries use to produce their own exports.

1.4.4. FACTOR COMPENSATION

We now turn to looking at the factor composition of the value added in exports. We preface this analysis by showing the composition of the EU's and China's domestic value added embodied in exports in 2009 in Figure 1.12.[19] Here we see that China's main components of value added are capital payments and low-skill labour compensation which cumulatively account for 83% of value added in exports. In the EU value added is more evenly spread. Med-skill receives the highest share of compensation followed by capital and then high-skill. It is important to note that the capital element of value added could largely be capturing profits which seem to be particularly important in China.

Figure 1.12: EU and China domestic value added in exports by type embodied in exports 2009

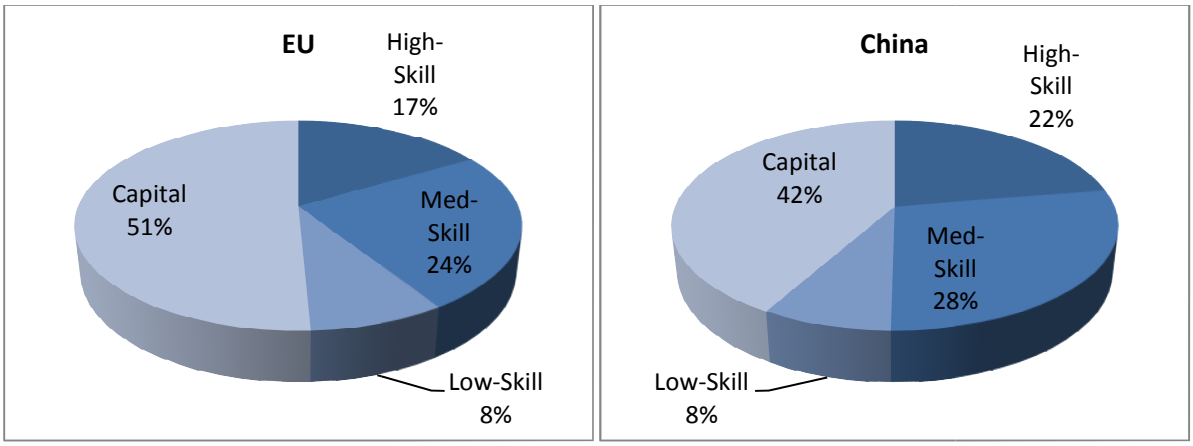


Source: own calculations using WIOD

Where imports of value added used to produce exports are concerned, Figure 1.13 shows that the EU value added imports are mainly in the form of compensation to foreign capital. For China this is important too but the med-skill and high-skill categories are cumulatively more important. Differences in the composition of domestic and imported value added are expected since value chains allow countries to take advantage of different factor endowments across countries in order to produce at lower costs. What transpires from these aggregate figures is that the composition of the EU's domestic value added embodied in its exports is predominantly composed of returns to factors which represent a low share of Chinese domestic value added. This suggests that the EU and China have complementary value added structures.

[19] This figure is different to Figure 5 in that it accounts for the direct and indirect VA embodied in exports where Figure 5 only showed the direct VA in output.

Figure 1.13: EU and China imported value added in export sales to other GVCs in 2009



Source: own calculations using WIOD

In Figure 1.14 we look at the origin of value added for VAE trade according to the different compensation categories. Each matrix identifies the share of row nation sales to column nation in terms of the total factor compensation by category of the column nation in 2009. For example, *the EU low-skill column shows that 94% of the low skill value added used to produce exports comes from within the EU*. The rest is imported with China contributing 3% of low skill value added – the most important extra-EU supplier in this category. The domestic EU value added compensation for capital is lower; standing at 87% which implies that the EU imports 13% of the capital content of its exports from extra-EU sources. Here too China is seen as the main supplier representing 4% of total capital value added inputs. The Chinese medium-skill compensation content of EU exports is much lower and only represents 1% of total medium-skill compensation in the EU. Here the US and Russia are the main sources. Where high-skill labour compensation is concerned, the EU's only significant partner is the US. *EU sales are important in all categories, however these are most pronounced in the low-skill and high-skill categories*.

The Chinese figures show that most of the low-skill compensation content of exports is local (91%) with imported low-skill value added from the EU being the highest external source (3%) followed by Taiwan (1%). Capital compensation is also largely domestic (87%) with the EU as the main external supplier followed by the US and the other Asian neighbours. However domestic medium skill labour compensation value added is much lower at 69%, with, in order of importance, inputs from the EU, Japan and the US being highest. It is however the high-skill compensation which is most revealing. The domestic content of high-skill value added is only 45% implying that China imports 55% of its high-skill compensation. The EU is the main source (18%) with the US (13%), Japan (8%) and Korea (7%) being the other main external sources.

The EU remains the biggest source of value added for China in all categories but particularly the medium and high skill ones where compensation to these factors represent 10% and 18% of total med and high skill compensation. China, on the other hand is the EU's main external source of low-skill and capital value added with a share of 3% and 4% of total compensation in these categories.

Figure 1.14: Individual Factor Content of Gross Export matrices 2009

Low-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	94%	7%	2%	11%	3%	1%	2%	3%	6%	4%	11%	8%	10%	20%	43%
Turkey		89%													2%
Brazil			96%										1%	2%	3%
Russia				81%											2%
India					88%									3%	2%
Indonesia						93%			1%	2%	3%				4%
Australia							95%		2%	2%	4%			2%	4%
China	3%	2%	1%	5%	6%	3%	2%	91%	9%	8%	18%	9%	17%	16%	27%
Taiwan								1%	76%	1%	2%		2%	1%	3%
Japan									3%	81%	3%		2%	2%	3%
Korea											55%				2%
USA									1%		2%	77%	6%	12%	5%
Mexico													59%	1%	
Canada														37%	
Tot imp	6%	11%	4%	19%	12%	7%	5%	9%	24%	19%	45%	23%	41%	63%	

Capital	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	87%	6%	2%	2%	2%	1%	1%	3%	5%	1%	5%	2%	2%	3%	26%
Turkey		85%													1%
Brazil			93%												2%
Russia	2%	3%		96%					1%		1%				8%
India					87%										2%
Indonesia						93%			2%	1%	2%				3%
Australia							92%	1%	2%	1%	3%				2%
China	4%	3%	1%		6%	3%	2%	87%	11%	3%	13%	3%	6%	2%	23%
Taiwan								1%	65%		1%				2%
Japan								2%	7%	89%	5%		1%		7%
Korea								1%	2%		63%				3%
USA	3%	1%	2%		2%		1%	2%	5%	2%	4%	90%	7%	9%	17%
Mexico												1%	82%		2%
Canada												2%		83%	2%
Tot imp	13%	15%	7%	4%	13%	7%	8%	13%	35%	11%	37%	10%	18%	17%	

Medium-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	93%	22%	4%	2%	7%	5%	4%	10%	10%	2%	7%	3%	7%	3%	39%
Turkey		59%													
Brazil			91%												2%
Russia	2%	10%		97%				2%	2%		2%				12%
India					81%										
Indonesia						82%									
Australia							89%	1%	1%		1%				1%
China	1%	2%			4%	3%	1%	69%	5%	1%	4%		4%		9%
Taiwan								2%	56%						1%
Japan		1%			1%	3%	1%	6%	13%	94%	6%		3%		9%
Korea						1%		2%	2%		73%		1%		3%
USA	2%	3%	2%		4%	2%	2%	6%	8%	1%	5%	93%	17%	8%	20%
Mexico													63%		
Canada												2%	2%	86%	2%
Tot imp	7%	41%	9%	3%	19%	18%	11%	31%	44%	6%	27%	7%	37%	14%	

High-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	93%	24%	4%	5%	6%	7%	5%	18%	9%	2%	5%	2%	12%	6%	45%
Turkey		61%													
Brazil			92%					1%							2%
Russia		5%		93%				1%							5%
India					85%										1%
Indonesia						78%									
Australia							88%	1%							1%
China					1%	1%		45%	2%		1%		3%		4%
Taiwan								4%	65%				1%		2%
Japan		1%				3%		8%	8%	92%	3%		4%		7%
Korea		2%				2%		7%	3%		83%		4%		5%
USA	3%	4%	2%		5%	4%	3%	13%	10%	2%	5%	95%	34%	16%	26%
Mexico													39%		
Canada													2%	75%	1%
Tot imp	7%	39%	8%	7%	15%	22%	12%	55%	35%	8%	17%	5%	61%	25%	

Note: Panels shows column nation factor compensation inputs from row nation as a share of total compensation for each factor - values below 1% are zeroed out.

Another way of looking at the same data is to normalise by total value added rather than the value added in each category. We do this in Figure 1.15 where each entry identifies the category's flow of value added which are higher than 0.3% of global value added in export flows (with the remainder of entries zeroed out for readability). Turning to the aggregate figures which can be found in the bottom right hand corner of each category's matrix we see that low-skill labour flows occupy 9% of global VAE flows with capital being the largest component with a 47% share. It is followed by med-skill flows which are 26% of global flows and then High-skill flows at 19%.

Where EU-China interactions are concerned, in 2009 extra-EU low-skill exports to China represented 1% of global flows with Chinese low-skill flows also being above 0.3% of global flows. The EU and China are the only countries that show significant global flows of low skill value added. Turning to capital value added we see that the links between the EU and China are most important occupying 2% of global value added flows apiece (i.e. extra-EU exports of capital derived value added to China and extra-EU imports from China both represent 2% of global flows). But it is in the med and high skill categories that differences begin to emerge. For example, the share of med-skill flows from China to the EU are much smaller, just over 0.3% of global flows, than the share of med skill flows from the EU to China which represent over 2% of global value added in export flows. Where high-skill value added flows are concerned, China is not a significant supplier of these to the EU which sources its extra-EU high-skill value added mainly from the US. In contrast, the flow of high skill value added from the EU to China is globally significant at 1% of global flows, similarly sized to the Chinese imports of high-skill value added from Japan, Korea and the US.

Overall, the results from this figure confirm those that were earlier observed. The global links between the EU and China are significant but asymmetrical. The EU's role as a supplier of value added to China is larger than China's in all categories except capital where the link is similarly sized.

Figure 1.15: Global Factor Content of Gross Export matrices 2009

Low-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	Total
EU								1%							1%	3%
Turkey																
Brazil																0%
Russia																
India																
Indonesia																0%
Australia																1%
China	0%														1%	2%
Taiwan																0%
Japan																0%
Korea																
USA																1%
Mexico																
Canada																
Total	1%							2%	0%	0%	1%	1%			3%	9%

Capital	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	Total
EU								2%			0%	1%			4%	8%
Turkey																1%
Brazil															0%	1%
Russia	1%							0%							1%	3%
India															0%	1%
Indonesia								0%							0%	1%
Australia								1%							0%	2%
China	2%				0%				1%	1%	1%	1%	0%		4%	10%
Taiwan								1%							0%	2%
Japan	0%							1%	0%		0%				1%	4%
Korea								1%							0%	2%
USA	1%							1%			0%		1%	1%	3%	8%
Mexico												1%			0%	1%
Canada	0%							0%				1%			0%	2%
Total	6%	1%	0%	0%	1%	0%	0%	8%	2%	2%	3%	3%	1%	2%	16%	47%

Medium-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	Total
EU								2%			0%	1%			4%	8%
Turkey																
Brazil																0%
Russia	1%														1%	2%
India																
Indonesia																
Australia																1%
China	0%														1%	2%
Taiwan																1%
Japan								1%	0%		0%				1%	3%
Korea								0%								1%
USA	1%							1%					0%	1%	2%	6%
Mexico																
Canada												0%				1%
Total	3%	0%			0%			5%	1%	1%	1%	2%	1%	1%	9%	26%

High-Skill	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	Total
EU								1%			0%	1%			3%	6%
Turkey																
Brazil																0%
Russia															0%	1%
India																
Indonesia																
Australia																0%
China																1%
Taiwan																1%
Japan								1%							0%	2%
Korea								1%							0%	1%
USA	1%							1%					0%	1%	2%	6%
Mexico																
Canada																0%
Total	2%							4%	1%	0%	1%	1%	1%	1%	6%	19%

Note: Entries show the factor content of traded value added over global value added – values below 0.3% are zeroed out for readability

1.4.5. CAPITAL GOODS AND INVESTMENT FLOWS

The previous sections highlighted the determining role that returns to capital play in terms of value added flows, in this section we explore this further by looking first at the origin of capital goods. Thereafter we investigate how foreign direct investment (FDI) has evolved.

1.4.5.1. CAPITAL GOODS

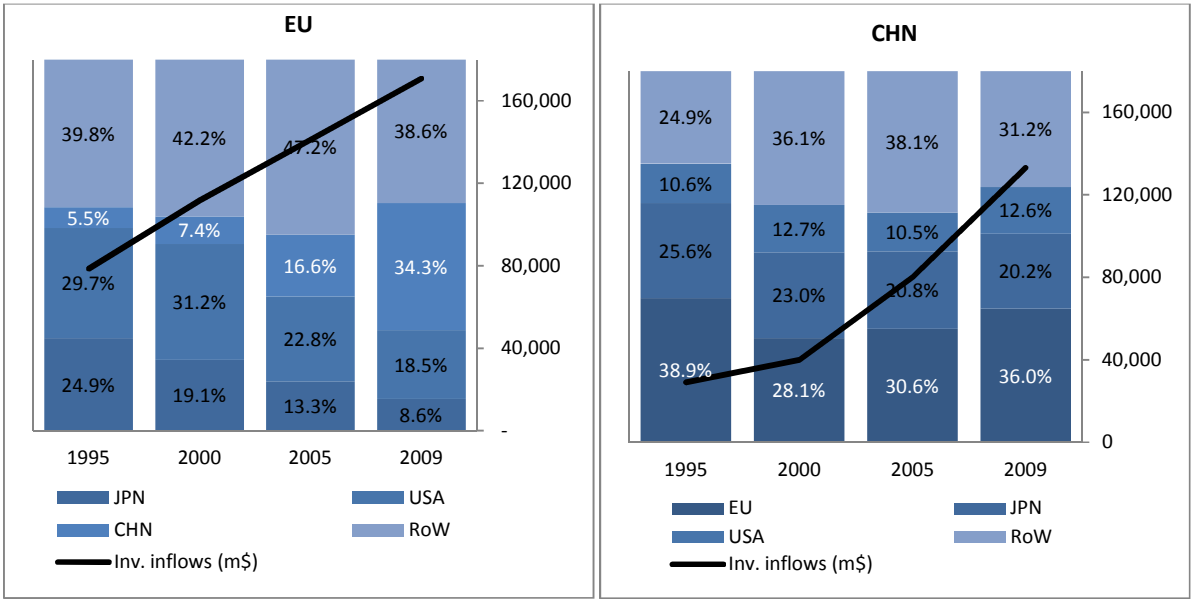
Since imported capital goods contain foreign technologies or knowledge that is ultimately embedded in the products sold either domestically or abroad or in the processes companies engage in, tracking the value of capital goods can help us better understand how countries engage in GVCs.

Using gross fixed capital formation (GFCF) data from the WIOD, the left panel of Figure 1.16 shows the evolution of the EU's share of imported capital goods by origin country from 1995 to 2009. [20] It also shows the value of the total imports of capital on the right hand axis. The data shows that the largest single foreign source of capital goods in the EU in 1995 is the US supplying nearly 27% of total capital goods imports. Things change drastically by 2009. The US' share falls by over 10 percentage points in comparison to 1995, giving way to a huge increase in capital goods from China. These rise from 5% to nearly 35% of imported capital goods between 1995 and 2009 to reach over 58 billion dollars.

The story for China is somewhat different (right panel of Figure 1.16). The EU remains the single largest source of imported capital goods in China throughout the period of analysis but flows have been somewhat erratic. Overall the EU's share of imported capital goods in China has gone down by nearly 3 percentage points (from 39% to 36%) but it still represents 48 billion dollars in 2009, more than the combined capital goods imports from Japan and the US. The key message is that there is an important dependence of both the EU and Chinese in capital goods from each other. However, these flows mask the fact that most capital goods are sourced domestically. The share of EU domestic capital goods in total capital goods in 2009 is 94%. Similarly China sources domestically 94% of total capital goods.

[20] Gross Fixed Capital Formation refers to the value of new fixed assets. It is a measure of investment to the extent that it captures the dollar value used to replace or increase productive capacity.

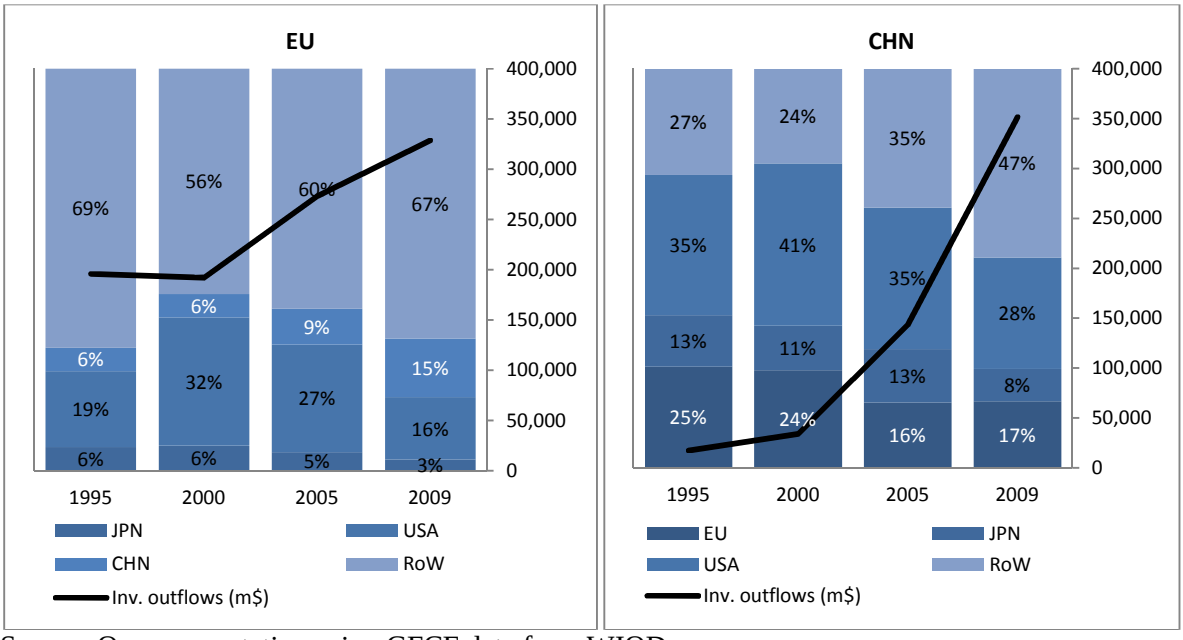
Figure 1.16: Share of foreign capital goods purchases by origin by the EU and China 1995 to 2009



Source: Own computation using GFCF data from WIOD

In Figure 1.17 we show the share of exported capital goods by destination for the EU and China. The first noticeable observation is that exports, from both the EU and China, dwarf imports. The 48 billion dollar capital good flow from the EU to China in 2009 represents 15% of the EU's total exports of capital goods. This is just under the 16% destined to the US. On the other hand, the EU represents 17% of Chinese capital good exports with the US being the largest single destination with 28% of Chinese Capital good exports.

Figure 1.17: Share of exported capital goods from the EU and China by destination 1995 to 2009



Source: Own computation using GFCF data from WIOD

1.4.5.2. FOREIGN DIRECT INVESTMENT

The increase in the use of foreign value added in production is one dimension of the GVC story; another is the surge in transnational corporation (TNC) activity evidenced by the rise in foreign direct investment (FDI) – worldwide inward FDI stocks have increased from 3 trillion dollars in 1995 to 23 trillion dollars in 2012.[21] The link between FDI and GVC activity is made in the most recent World Investment Report (UNCTAD 2013) which shows a statistically significant positive relationship between changes in inward FDI stocks and changes in participation in GVCs.[22]

We begin, in Figure 1.18, by looking at the evolution of the global shares of inward (left panel) and outward (right panel) stocks of FDI across different locations. Turning to inward stocks (FDI stock receiving country) first; the left panel shows the EU (including intra-EU FDI stocks) as the largest recipient of FDI stocks in 2012 (34% of worldwide FDI stocks) with the US following (17%) giving these a cumulative share of over half of the world's FDI and pointing to a strong concentration in inward FDI stocks. Noteworthy is the 12 percentage point decline in the US share of inward FDI stocks and the 13 percentage point rise of the RoW grouping. In contrast, China has retained a relatively stable participation with a low of 7% of world inward FDI stocks in 2005 and a high of 10% in 2012.

The right panel of Figure 1.18 then shows outward stocks of FDI (the country of ownership of the FDI stocks). Again, the EU and the US appear as the biggest players occupying 42% and 22% of global outward stocks in 2012. As was the case with the inward FDI stock figures, the US has lost importance going from a high of 36% in 1995 to a low of 22% in 2012. The EU shows a humped evolution peaking at 46% in 2005 but then subsequently falling to 42% in 2012. China, on the other hand has witnessed an important rise in its outward FDI stock as a share of global stocks going from 3% of global outward stocks in 1995 to 8% in 2012 placing it as one of the biggest risers in terms of foreign ownership.

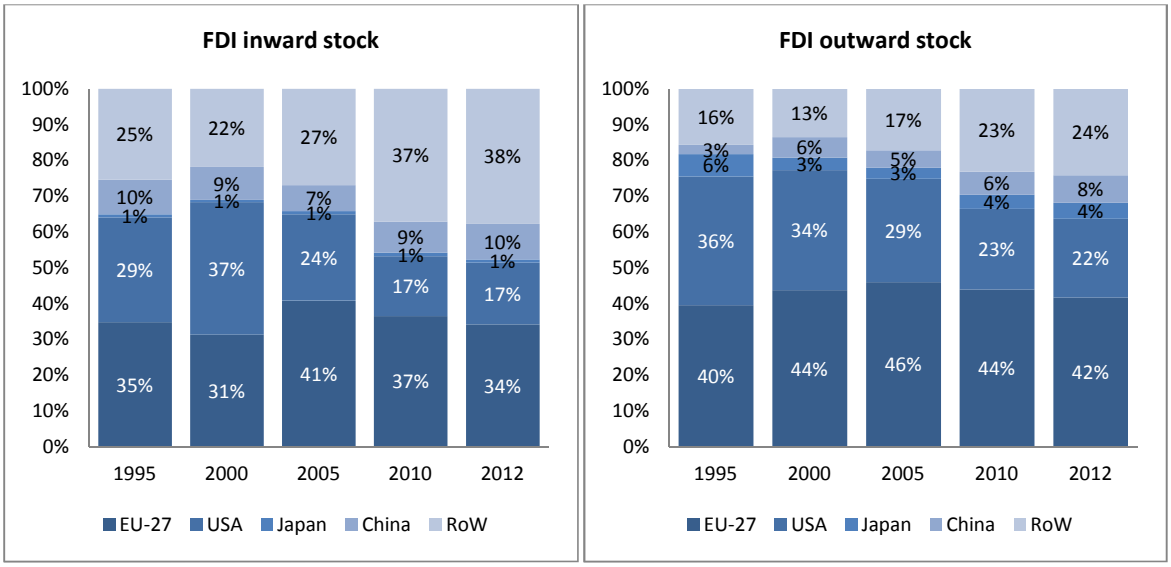
Two interesting observations emerge from this analysis. The first is the concentration of both outward and inward FDI stocks in the EU and in the US. The second is the role of China. The analysis in the previous sections highlighted China's impressive transformation into a global GVC hub, however it seems that its global share of inward FDI stocks has remained relatively stable in time. This is surprising even more so given the strong positive association between changes in GVC participation and changes in inward FDI stocks as shown in UNCTAD (2013). While it is indeed the case that inward FDI stocks in China have been growing, they appear to have done so at a similar pace to those of the rest of the world despite China increasing its GVC engagement at a faster pace (see Figure 1.7).

There are many explanations that are consistent with what we observe, but identifying which is driving this is not possible without more targeted research. This may arise from increased Chinese rather than foreign investment, but it might also be due to the presence of regulatory obstacles which limit foreign investment in China. Nevertheless, it is surprising that inward FDI stocks have not grown even faster in China. FDI is often associated with increased productivity and diffusion of

[21] UNCTAD (2013)
[22] Participation in GVCs is measured as the import content of exports although calculated using a different database to that used in this report.

technology and it seems that China's engagement in GVCs has progressed in spite of less than expected foreign investment.

Figure 1.18: Share of global inward and outward stocks of FDI 1995-2012



Source: adapted from WIR 2013 annex tables, includes intra-EU FDI stocks

To further understand the evolution of global investment patterns, we show, in Table 1.4, other FDI metrics over time. Where the distribution of FDI inflows and outflows are concerned; the main players are similar to those witnessed in the figure above, however, turning to the cross-border M&A activity we see that China, although increasing its participation remains well below 10%.[23] This hints at the presence of possible difficulties in engaging in M&A activity in China.

Table 1.4: Distribution of Global Investment by type 1995 and 2009

	FDI Inflows		FDI Outflows		Cross-border M&A by seller*		Greenfield FDI by destination	
	1995	2012	1995	2012	1995	2012	2003	2012
EU	38%	19%	44%	23%	47%	40%	17%	21%
USA	17%	12%	25%	24%	25%	21%	3%	10%
Japan	0%	0%	6%	9%	0%	0%	1%	1%
China	13%	15%	7%	12%	1%	4%	18%	14%
RoW	32%	54%	17%	32%	26%	34%	60%	54%

Source: adapted from WIR 2013 annex tables, China includes Hong-Kong and Macao. EU includes intra-EU flows * M&A sales identify origin of acquired company.

Overall, the FDI figures suggest that the EU is a key FDI hub. China is increasingly important in terms of outflows but seems to be attracting less FDI than what might be suggested by its economic size and its strong engagement in GVCs.

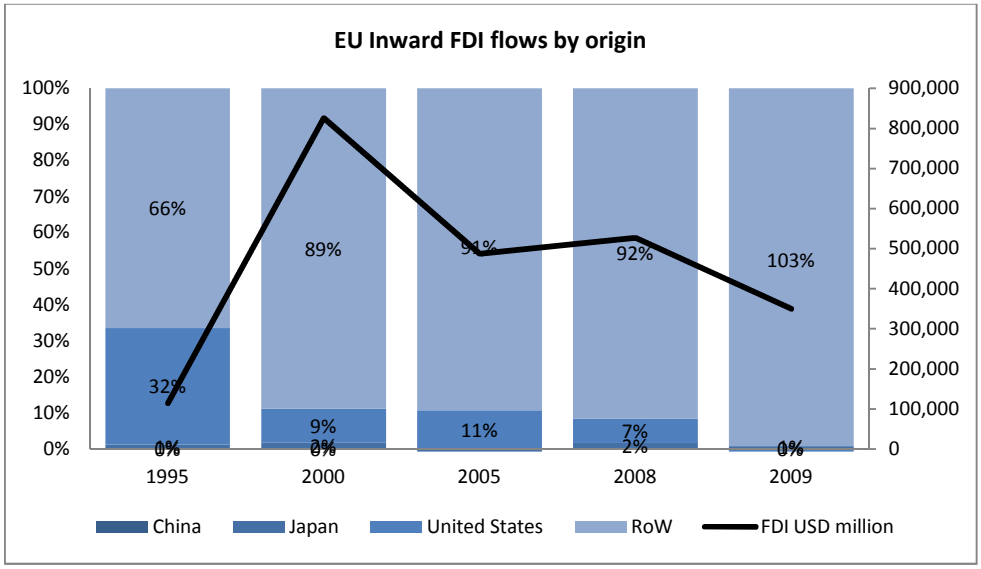
The bilateral relationship between the EU and China in terms of FDI is hard to trace because bilateral FDI data is scarce. We have obtained data for EU inward and outward investment by origin/destination from the UNCTAD FDI/TDC database which we map in Figure 1.19 for the period 1995-2009. Where inflows are concerned (top panel), the RoW (which is defined here as all countries except China, the US and Japan and therefore included intra-EU FDI flows), is the largest grouping. Looking at other partners reveals the relative decline of US inward FDI towards the EU. Where China

[23] 10% is also the share that China occupies in global trade.

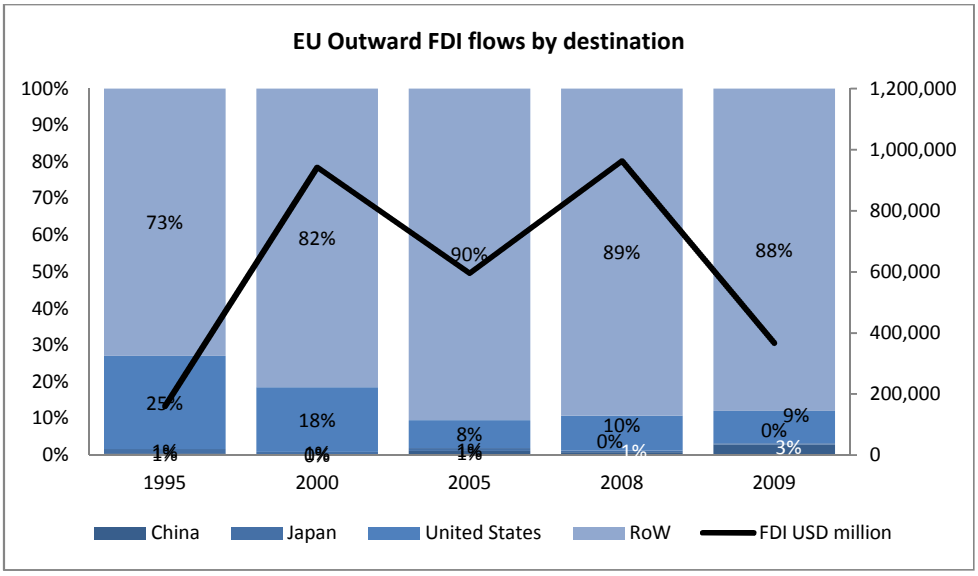
is concerned, inward FDI flows represent less than 0.1% of total flows highlighting a very small Chinese participation in the EU.

The bottom panel then looks at EU outward FDI flows by destination. The US is identified as the largest non-EU FDI destination. Outflows to China remain small but gained importance in 2009 reaching just under 3% of total EU outflows. It is however important to note that from 2008 to 2009 EU FDI outflows fell by 60% but actually rose with respect to China; evidence of resilient EU investment in China. Nevertheless in 2008, which might be considered as a more representative 'normal' year for FDI in the EU, outflows to China represented just under 1% of total outflows. Clegg and Voss (2011) also highlight, citing official Chinese statistics, that the share of EU FDI in China has been falling (from 12% during the 80's to around 5% in 2008). Overall, the figures suggest that bilateral FDI activity between the EU and China is lower than one might expect (see also Sunesen et al., 2010).[24] This is particularly surprising given the wide bilateral engagement in GVCs between these as highlighted in previous sections of this report. It implies that there may be important untapped potential for both the EU and China.

Figure 1.19: EU inward and outward FDI flows by origin/destination



[24] Sunesen et al. (2010) highlight that the share of EU outward FDI towards the African continent is larger than the combined share of EU outward FDI to China and India.



Source: UNCTAD, FDI/TNC database

Note: Shares above 100% arise from negative inward FDI flows

1.4.6. EXPORT JOBS AND GVC JOBS

In this section we take a closer look at the jobs that are associated with exporting activities. We do this using the WIOD's data on employment by country and a similar method to that which is used to calculate our value added measures of GVC activity.

For the period 1995 to 2009, Table 1.5 shows; i) the amount of jobs associated with exporting activities – 'export jobs' for short; ii) the total number of persons employed; and iii) the share of 'export jobs' in total employment. The importance of 'export jobs' in the EU is clear. In 2009 31 million persons are engaged in jobs that sustain exporting activities, this represents nearly 15% of total persons employed in the EU. For China this share is even larger, in 2009 nearly 30% of the labour force is engaged in 'export jobs', this is just over 231 million persons. The change in 'export jobs' seems to outpace that of total jobs. In the EU export jobs have grown by 55% since 1995 whilst total jobs have only grown by 12%. This suggests that job creation is more pronounced in export related activities than it is for the non-export activity.

Table 1.5: 'Export jobs' in the EU and China 1995 – 2009

	1995	2000	2005	2009	
	***jobs in exporting activities* ('000)**				Change 1995-2009
EU	21,269.56	26,713.86	29,771.40	32,895.66	55%
China	123,692.60	125,421.61	197,625.80	231,674.39	87%
	***Total Jobs* ('000)**				
EU	200,729.82	213,664.64	219,242.08	224,653.26	12%
China	680,650.00	720,850.00	758,250.00	779,950.00	15%
	share of jobs in exporting over total employment				
EU	10.6%	12.5%	13.6%	14.6%	38%
China	18.2%	17.4%	26.1%	29.7%	63%

Source: Own calculations using WIOD

With the proliferation of production networks, domestic jobs are increasingly being sustained by the exporting activities of other countries. For example, in order to produce a unit of exports, China will import intermediates from the EU which are produced by workers in the EU. Consequently the production of Chinese exports indirectly sustains jobs in the EU – we term this phenomenon 'GVC jobs'. It is the subset of export jobs that are engaged in the production of exports of other countries. The left panel of Table **1.6** shows the amount of EU GVC jobs reliant on the exports of each column nation. In 1995, 91,000 jobs in the EU were sustained, or indirectly used, in the production of Chinese exports, by 2009 this figure rises to over 1.1 million jobs. Overall, more than 5.5 million persons were engaged in GVC jobs in the EU, China represented over 20% of these. In China nearly 30 million persons are engaged in GVC jobs with the EU sustaining the employment of over 5.6 million of these which represents around 19% of GVC jobs. Both are each other's main external source of GVC jobs highlighting the importance of GVC activity between these. In terms of employment creation, Chinese GVC jobs in the EU have increased ten-fold since 1995 whilst EU GVC jobs in China have doubled. Putting these figures in perspective; EU GVC jobs in China have grown twice as fast as export jobs and nearly 9 times as fast as total jobs.

Table 1.6: EU and Chinese 'GVC jobs' 1995 – 2009

	EU GVC Jobs ('000)					China GVC jobs ('000)			
	CHN	**USA**	**JPN**	**RoW**		**EU**	**USA**	**JPN**	**RoW**
1995	91.93	404.04	101.55	1,966.67	**1995**	2,832.53	1,190.13	910.98	7,108.16
2000	182.62	590.19	136.76	3,308.43	**2000**	3,457.27	1,580.83	1,005.15	10,409.36
2005	542.40	487.17	157.17	4,222.75	**2005**	4,535.63	2,647.61	1,643.04	19,975.92
2009	1,146.19	399.06	128.35	3,888.57	**2009**	5,663.12	2,637.34	1,461.89	20,130.14
Change	1,054.27	- 4.98	26.81	1,921.90	**Change**	2,830.59	1,447.21	550.91	13,021.98

Source: Own calculations using WIOD. Figures represent the amount of jobs from the EU and China used by the column nation in their production of exports.

1.5. SECTORAL ANALYSIS

In this section we explore the sectoral distribution of GVC activity in view of complementing the above analysis by picking out the sectors where internationalisation has been most pronounced. This will allow us to gain additional insights into how the EU and China's international specialisation patterns have evolved. For this exercise, we aggregate the 35 WIOD sectors into a more manageable 15 sectors (see Appendix 1 for table showing sectors included in each new category). We then trace the evolution of trade in intermediate products, direct domestic value added as well as the sectoral value added in exports.

1.5.1. SECTORAL PROFILE OF TRADE IN INTERMEDIATES

In Table 1.7 we map global imports of intermediates, by sector, for the EU, China, Japan, the US and the Rest of the World in 1995 and in 2009. Each entry identifies the column nation's imports of intermediates from each row sector as a share of global traded intermediate products. Two very clear messages emerge. First, the EU is a significant global purchaser of intermediates – predominantly in 'mining and fuel' and 'renting M&Eq and other business services' (M&Eq stands for machinery and equipment) representing over 4% and 3% of global intermediate product flows respectively in 2009.[25] Second, China did not source any globally significant shares of intermediates in 1995 but by 2009 its purchases of 'electrical and optical equipment' and 'mining and fuel' are globally significant occupying 4% and 3% of global flows.

Table 1.7: global imports of intermediates by sector 1995 and 2009

	1995						2009				
	EU	CHN	JPN	USA	RoW		EU	CHN	JPN	USA	RoW
Agriculture and Food	1%				2%						2%
Mining and Fuel	3%		2%	2%	4%		4%	3%	2%	3%	6%
Light Manufacturing (textile, leather, wood, paper)	2%		1%	2%	5%						4%
Chemicals	2%			2%	5%		1%	2%		1%	4%
Rubber and Plastics					1%						1%
Basic metals	2%		1%	2%	5%		1%	1%		1%	5%
Machinery nec					2%						2%
Electrical and Optical Equipment	2%			3%	6%		2%	4%		2%	6%
Transport Equipment				1%	4%						3%
Transport and logistics services	1%				5%		1%				5%
Telecom services											
Financial services					2%						3%
Renting M&Eq and other business services	2%			2%	1%		3%			2%	2%
construction services											
other services	2%				5%		2%				5%
Total Buying	20%	4%	9%	18%	49%		18%	16%	5%	13%	48%

Source: own calculations using WIOD

Note: entries show the share of column nation purchases of imported intermediates from row sector over global (world total) purchases of imported intermediates.

[25] 'Renting M&Eq and other business services' (ISIC rev 3 sectors 71-74) includes; i) renting of transport, machinery and personal equipment; ii) Hardware and software consultancy; data and database processing; other computer related activities; iii) Research and development in natural sciences, engineering, social sciences and humanities; and iv) Legal, accounting, book-keeping and auditing activities; tax and business management consultancy; advertising; recruitment; other business activities.

Where sales of intermediates are concerned, Table 1.8 presents the figures. Here the entries show the share of the column nation's exports of intermediates over global intermediate exports by sector. The first important observation is the dominance of the RoW as a purveyor of 'mining and fuel' intermediates – occupying 16% of global flows in 2009. The EU shows a diverse and rather full sales vector, its global importance is however declining in all sectors except in 'renting M&Eq and other business services', for which in 2009 it was responsible for over 3% of global flows (up one percentage point since 1995). China's exports of intermediates have significantly grown in importance; most markedly in 'electrical and optical equipment' which in 2009 occupied 4% of global intermediate exports.

Overall, for the EU the 'renting and M&Eq' sector appears to be the one with the largest internationalisation both in terms of sourcing and selling. For China, it is the 'electrical and optical equipment' sector which is most internationalised.

Table 1.8: global exports of intermediate products by sector 1995 and 2009

	1995					2009				
	EU	CHN	Japan	USA	RoW	EU	CHN	Japan	USA	RoW
Agriculture and Food				1%	3%					3%
Mining and Fuel	1%				10%					16%
Light Manufacturing (textile, leather, wood, paper)	3%			2%	5%	2%	1%			2%
Chemicals	3%		1%	2%	4%	2%			1%	4%
Rubber and Plastics										
Basic metals	2%		2%	1%	5%	2%	1%	1%		4%
Machinery nec	2%					1%				1%
Electrical and Optical Equipment	2%		3%	3%	5%	2%	4%	1%	2%	5%
Transport Equipment	2%		2%	2%	1%	1%			1%	1%
Transport and logistics services	3%		1%	2%	2%	2%	1%		1%	2%
Telecom services										
Financial services				2%		2%			2%	
Renting M&Eq and other business services	2%			1%	2%	3%	1%		2%	2%
construction services										
other services	1%		1%	3%	3%	1%	1%		2%	3%
Total Selling	22%	3%	12%	21%	43%	20%	14%	6%	14%	47%

Source: own calculations using WIOD
Note: entries show the share of column nation sectoral sales over global sales

In Table 1.9 we then look at the origin of imported intermediates in the EU in 2009 so as to identify the main suppliers. Each row shows the share that each origin country occupies in total imported intermediates. For example, the first entry in the first row of the table tells us that 4% of EU imports of 'agriculture and food' intermediates are sourced from China. The far right column then identifies the share that each sector represents in total imported intermediates. Where bilateral interactions between the EU and China are concerned, we see that China is by far the most significant single supplier of 'construction services' and 'electrical and optical equipment' intermediate products to the EU. It is also a significant supplier of 'rubber and plastics', 'light manufacturing' and 'machinery nec'.

Table 1.9: EU main suppliers of imported intermediates, 2009

	China	USA	Japan	RoW	Share of sector in total Imports
Agriculture and Food	4%	4%	0%	92%	4.1%
Mining and Fuel	0%	2%	0%	97%	23.3%
Light Manufacturing (textile, leather, wood, paper)	29%	15%	2%	55%	4.7%
Chemicals	12%	20%	4%	65%	7.4%
Rubber and Plastics	35%	11%	9%	46%	1.5%
Basic metals	16%	7%	5%	72%	6.5%
Machinery nec	25%	22%	10%	43%	2.7%
Electrical and Optical Equipment	54%	12%	6%	28%	9.8%
Transport Equipment	14%	31%	15%	39%	3.8%
Transport and logistics services	17%	22%	4%	58%	6.6%
Telecom services	24%	33%	0%	42%	1.9%
Financial services	3%	69%	3%	26%	2.9%
Renting M&Eq and other business services	16%	33%	1%	50%	13.9%
construction services	72%	1%	0%	27%	0.4%
other services	15%	15%	1%	69%	10.5%

Source: Own calculations using WIOD

The figures for China are in Table 1.10. Here we identify the EU as the most important supplier of 'renting M&Eq and other business services', 'construction services', 'financial services', 'machinery nec' and 'transport equipment' intermediates. Other significant sectors are 'telecom services' and 'transport and logistics services'. The asymmetry of dependence between the EU and China is made patent here with the EU being one of the most significant suppliers to China in many sectors (more so than Japan and the US in many sectors). The US is another important source, but Japan is only supplying significant shares of intermediate products in 'rubber and plastics' and 'transport equipment'. It is however important to stress that these figures capture flows of imported intermediates. With our data, we do not capture the operations of Japanese firms located in China which can be important.

Table 1.10: China main suppliers of imported intermediates, 2009

	EU	USA	Japan	RoW	Share of sector in total Imports
Agriculture and Food	5%	19%	0%	75%	5%
Mining and Fuel	1%	1%	1%	97%	20%
Light Manufacturing (textile, leather, wood, paper)	17%	12%	12%	59%	5%
Chemicals	14%	9%	13%	64%	11%
Rubber and Plastics	18%	8%	32%	41%	1%
Basic metals	14%	7%	18%	61%	9%
Machinery nec	46%	10%	17%	27%	6%
Electrical and Optical Equipment	13%	9%	16%	63%	26%
Transport Equipment	39%	19%	29%	13%	3%
Transport and logistics services	28%	20%	7%	45%	3%
Telecom services	38%	19%	1%	42%	1%
Financial services	42%	25%	2%	31%	0%
Renting M&Eq and other business services	62%	12%	1%	25%	6%
construction services	62%	0%	0%	38%	0%
other services	23%	27%	2%	47%	4%

Source: Own calculations using WIOD

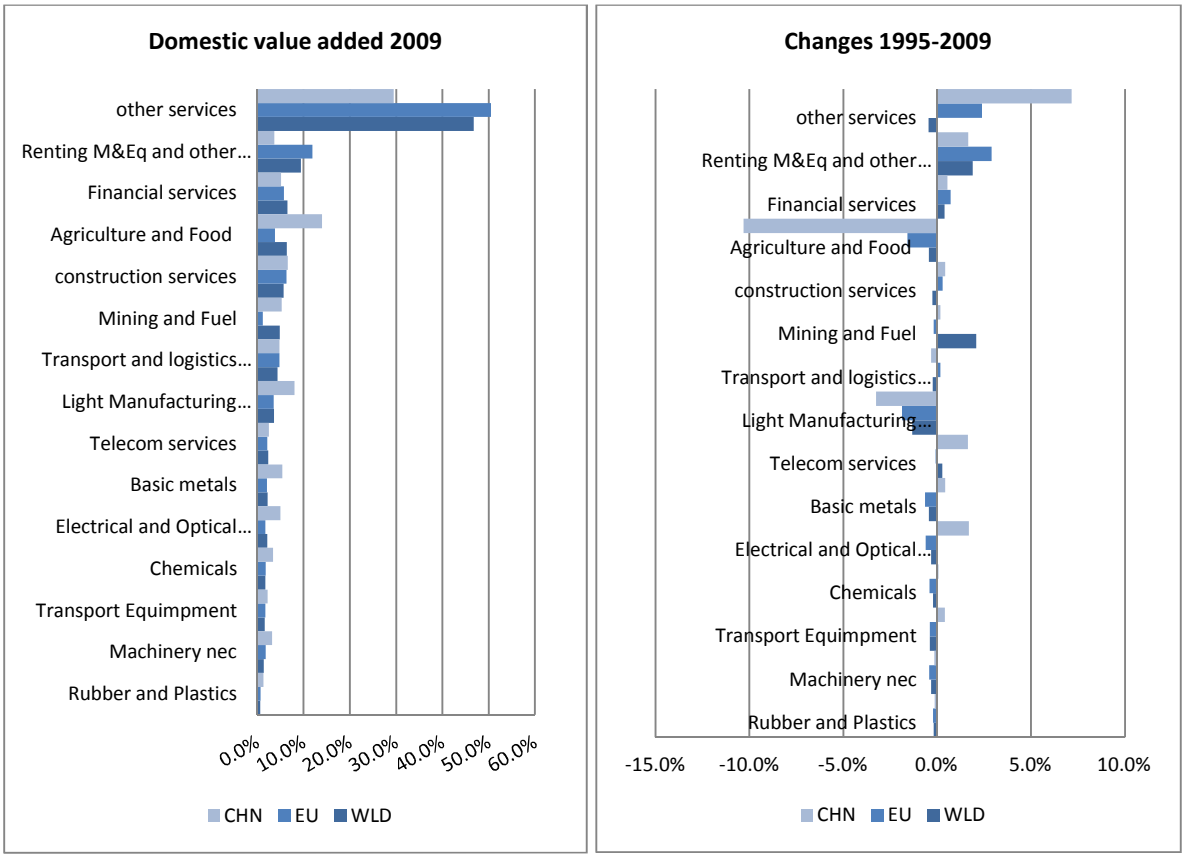
1.5.2. SECTORAL CO-EVOLUTION OF DIRECT DOMESTIC VALUE ADDED AND IMPORTED INTERMEDIATES

One important facet of GVC activity is the interplay between direct domestic value-added and imported intermediates. By outsourcing the segments of production where countries hold comparative disadvantages, they can dedicate resources towards greater specialisation in the sectors where comparative advantages are most apparent. In this section we investigate whether there is any evidence of direct domestic value added being replaced by imported intermediates or if imported intermediates act as a complement to domestic value added.

In Figure 1.20 we map the share of world, EU and Chinese direct domestic value-added, by sector, over their respective total direct domestic value added in 2009 (left panel) as well as the changes that have taken place since 1995 (right panel). Direct domestic value added refers to the direct remuneration paid to workers and capital across the different sectors. The figures for 2009, which are ranked by order of importance according to world (aggregate) direct domestic value-added, show the 'other services' sector occupying most economic activity in the world, the EU and China (this sector category captures wholesale and retail trade; electricity, hotels and restaurants, real estate, public administration, defence as well as health and education). 'Renting of M&Eq and other business services' and 'financial services' rank second and third respectively.

Since 1995, China has witnessed huge increases in the direct domestic value added of 'other services' and more modest growth in 'renting M&Eq and other business services', 'telecom services' and 'electrical and optical equipment'. In contrast 'agriculture and food' and 'light manufacturing' have shown relative declines (although it is worth noting that these sectors are still comparatively large in China). The EU's direct domestic value added has increased in 'renting M&Eq' and 'other services' and declined in 'agriculture and food' and 'light manufacturing'.

Figure 1.20: Sectoral direct domestic value added over total direct domestic value added 1995 and 2009

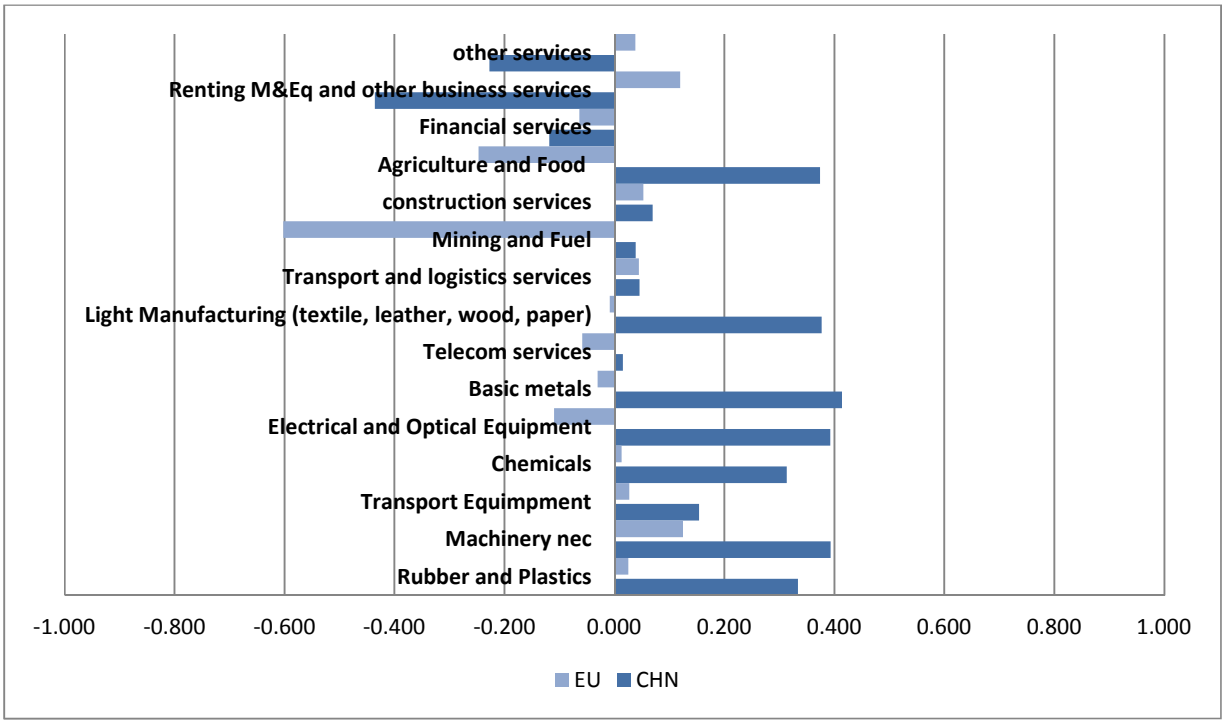


Source: Own calculations using WIOD
Note: entries show sectoral share of domestic value added over total domestic value added

To gauge the degree of specialisation that is taking place in the factories and firms located in the EU and China we can compare the EU and China's respective domestic value added shares against world averages. This allows us to calculate a measure of comparative advantage in terms of direct domestic value added. We do this in Figure 1.21 where positive values indicate a relative degree of specialisation; for example, the EU's direct domestic value added share in 'other services' (50.5%) is relatively higher than that of the world (46.8%) and hence firms located in the EU are relatively more specialised in this sector. China, on the other hand, has a large comparative deficit in 'other services' implying that its specialisation follows a different path.

As expected, China's specialisation is mainly in the manufacturing sectors and particularly in 'light manufacturing'; 'basic metals'; 'electrical and optical equipment'; 'chemicals'; 'transport equipment', 'machinery nec'; and 'rubber and plastics'. It also shows specialisation in transport and logistics, telecom, and construction services. In contrast, the EU is much more specialised in the service sectors such as 'renting and M&Eq and other business services'; 'construction services'; and 'transport and logistics services' but it also shows relative specialisation in some manufacturing sectors such as 'machinery nec', 'transport equipment', 'rubber and plastics' and 'chemicals'.

Figure 1.21: Direct domestic value added specialisation 2009



Source: Own calculations using WIOD

Note: entries show the sectoral share of direct domestic value added over total direct domestic value added divided by the world's sectoral share of direct domestic value added. Values are normalised so that positive values identify sectors where the country's share of direct value added is larger than that of the world.

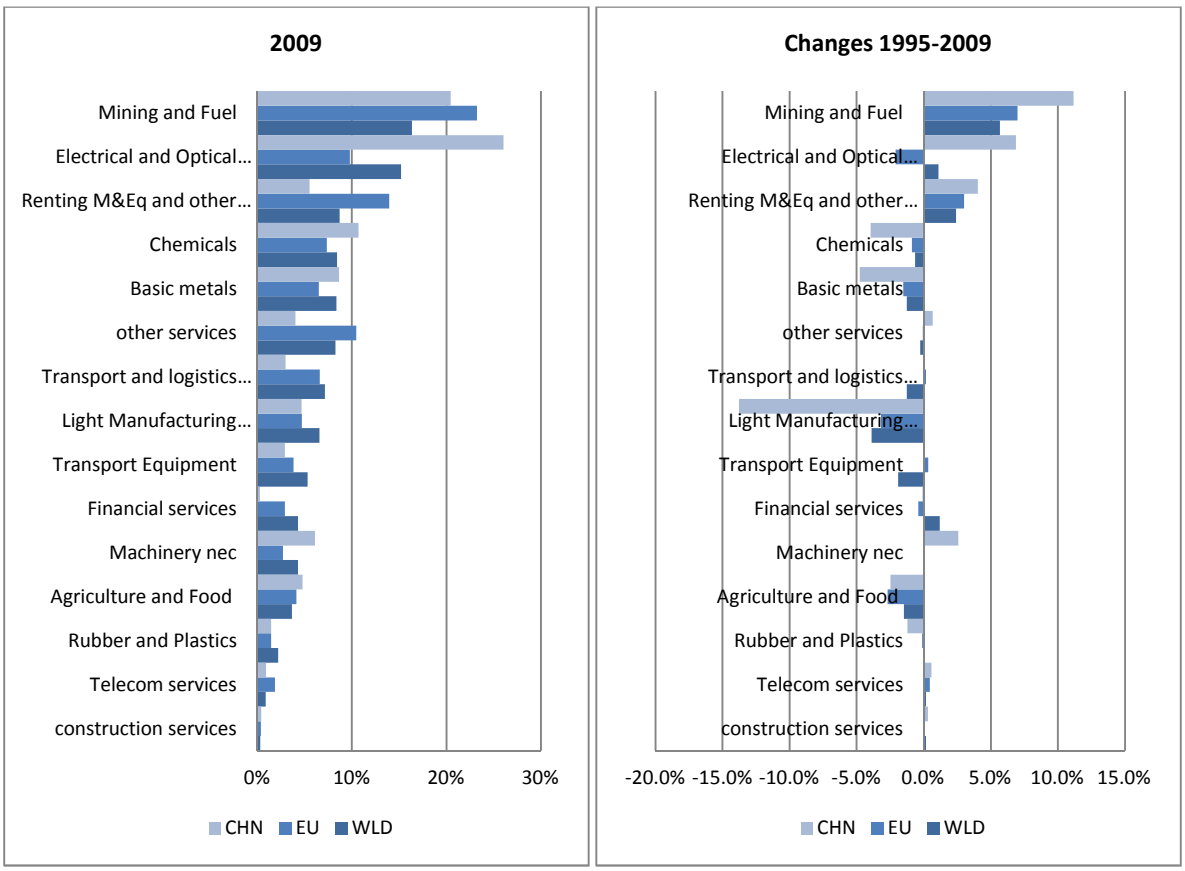
In Figure 1.22 we show the share of imported intermediates by sector over total imported intermediates across the 15 sectors for the world, the EU and China using a similar set-up as in Figure 1.20. In contrast to the direct domestic value added figures we see that imported intermediates at the global level are dominated by the 'mining and fuel', 'electrical and optical equipment' and 'renting M&Eq' sectors. What is striking about China is the importance of 'electrical and optical equipment' intermediate imports which is almost twice the world average and nearly three times that of the EU. China's imported intermediates from the 'mining, fuels'; 'chemicals'; and 'Machinery nec' sectors also outpace world averages suggesting that, in China these are the most internationally fragmented sectors. In the EU it is the 'mining and fuels'; 'renting M&Eq and other business services'; and the 'other services' sectors that show the highest degree of internationalisation.

Where changes over time are concerned, the key trends in China are; the huge increase in imports of intermediate products from the 'mining and fuels'; 'electrical and optical equipment'; and 'renting M&Eq' sectors and the big declines in 'light manufacturing'; 'basic metals'; 'chemicals'; and 'rubber and plastics'. Comparing these changes with the direct domestic value added changes reported above is very revealing. For example, the Chinese direct domestic value added in the 'electrical and optical equipment' sector rose by 1.7 percentage points from 1995 to 2009, while imported intermediates rose by nearly 7 percentage points. Although this implies that this sector is internationalising rapidly, the accompanying increase in direct domestic value added suggests that imports may be enabling domestic value adding activities. And this is not the only sector where this is occurring: indeed the 'renting and M&Eq and other business services' sector bears similarities with domestic value added rising by 1.7 percentage points and imported intermediates by 4 percentage points.

There is also evidence that China is increasingly insourcing some of its economic activity. For example, imports of intermediates from the 'basic metals' sector fell 4.8 percentage points but the direct domestic value added of this sector rose by 0.4 percentage points. In contrast, 'machinery nec' imported intermediates rose 2.6 percentage points but the direct value added in this sector fell modestly by 0.1 percentage points which in turn suggests switching sources of inputs.

For the EU, the changes are less dramatic: international sourcing has expanded in 'mining and fuels' and 'renting M&Eq' as well as in 'transport equipment' and in 'telecom services' (albeit more moderately). Declines in imported intermediate product sourcing have occurred in 'light manufacturing', 'electrical and optical equipment', 'basic metals' and 'chemicals'. Looking at these changes in conjunction with the direct domestic value added figures is also useful. Imports of intermediates in 'Renting and M&Eq and other business services' rose by 2.9 percentage points whilst domestic value added increased by 3 percentage points. This again suggests that imports did not substitute domestic value added.

Figure 1.22: Sectoral imported intermediates over total imported intermediates (%), 1995 and 2009



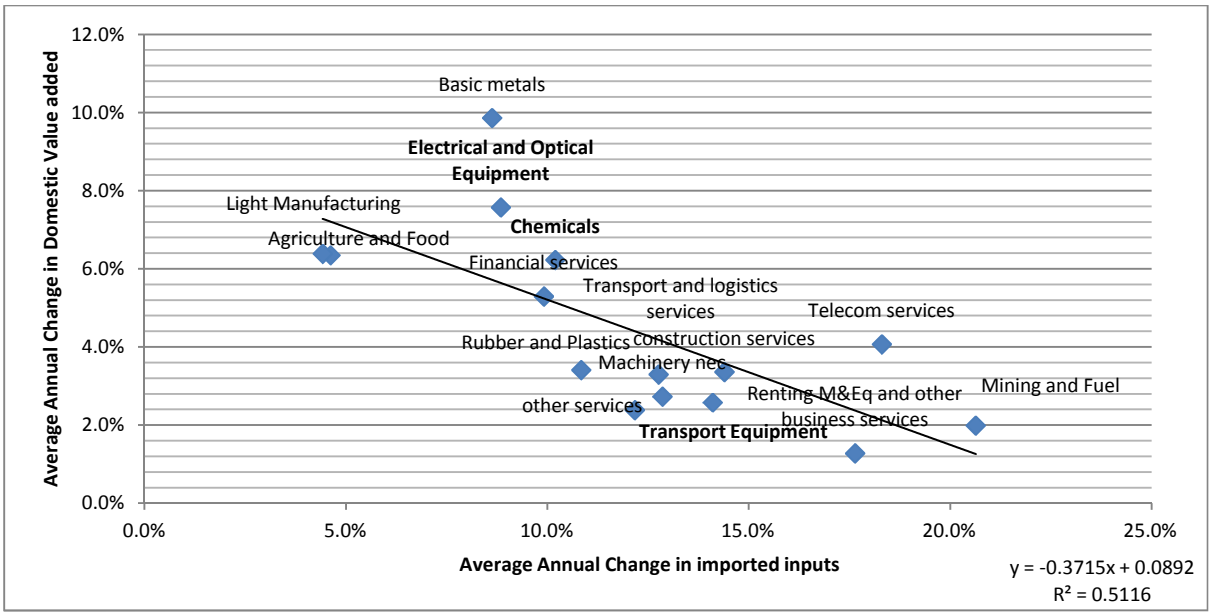
Source: Own calculations using WIOD

Note: Bars show the sectoral share of imported intermediates from originating sector over total imported intermediates.

In view of understanding how intermediate imports and direct domestic value added have jointly evolved, we present, in Figure 1.23 and Figure 1.24 scatter plots, for the EU and China respectively, showing annual changes in the direct domestic value added of each sector against annual changes in

imports of intermediates from each sector.[26] For the EU, in Figure 1.23, two observations are of note; first, all changes are positive so there has been no absolute contraction in terms of direct domestic value added or imported intermediates. Second, the relationship in the EU is downward sloping. This indicates that imported intermediates appear to have grown at a faster rate, in most sectors, than domestic value added. This implies that there might be some replacement of domestic value added for imported intermediate. It is however worth noting that this is not the case for all sectors. For example, 'basic metals', 'light manufacturing' and 'agriculture and food' have seen bigger changes in direct domestic value added than in imports. However sectors such as 'mining and fuel', renting M&Eq' and 'telecom services' have witnessed very large increases in imports with more modest increases in direct domestic value added. In a subsequent part of this report we look at the relationship between domestic and imported value added in exports where we find that this relationship changes.

Figure 1.23: EU changes in domestic value added against changes in imported intermediates 1995-2009

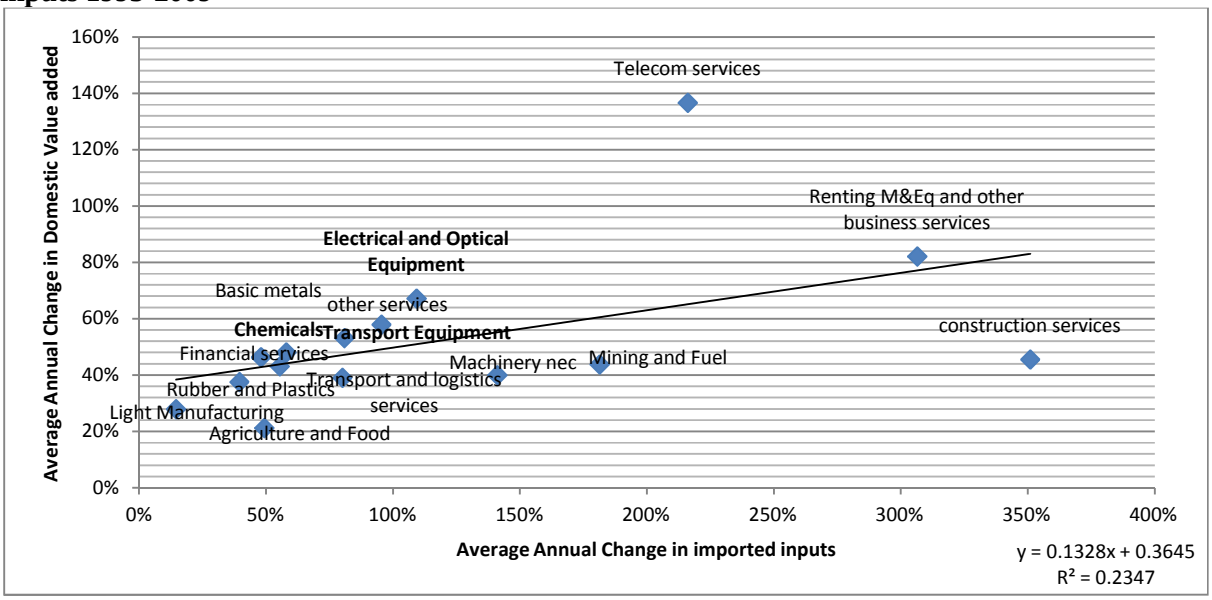


Source: Own calculations using WIOD,
Note: annual rates calculated as the percentage change in absolute VA divided by the amount of years.

For China the picture is completely different (Figure 1.24). Here there is a clear positive correlation between growth in direct domestic value added and growth in imported intermediates. This suggests that international expansion in outsourcing may be supportive of direct domestic value added creation. Since the growth in imported intermediates outpaces the growth in domestic value added, it seems that China has to import a lot in order to increase its domestic value added.

[26] This is a narrow concept of outsourcing in which we are trying to capture whether there is evidence of replacement taking place between direct domestic value added and imported intermediates.

Figure 1.24: China changes in domestic value added against changes in imported intermediate inputs 1995-2009



Source: Own calculations using WIOD,
Note: annual rates calculated as the absolute change in VA divided by the amount of years

1.5.3. SECTORAL VALUE ADDED IN EXPORTS

In this section we turn to the evolution of the sectoral value added content of exports (VAE). We begin by looking at how gross export sales distribute across sectors in the EU and China in Table 1.11 where we see that the dominance of 'other services', which was by far the largest component of domestic value added (Figure 1.21), is greatly diminished. For the EU, in 2009, the chief export sector is 'mining and fuel' (17%) whereas for China it is the 'electrical and optical equipment' sector (26%).

Since 1995 China's exports of 'mining and fuels' and 'electrical and optical equipment' have gained momentum – increasing by 10 and 5.6 percentage points respectively. The importance of 'light manufacturing' and 'machinery nec' has however waned with declines of 10 and 4.6 percentage points each. In the EU it is the 'electrical and optical equipment' and the 'light manufacturing' sectors which have declined the most, 2.8 percentage points apiece. Increases were most pronounced in 'mining and fuels' (5.2pp) and 'renting M&Eq' (2.2pp).

The table also shows the revealed comparative advantages (RCAs), calculated using gross export flows, held by each sector in the EU and China.[27] In 1995, the EU holds a comparative advantage in many of the services sectors and in 'agriculture and food', 'mining and fuels', 'light manufacturing' and 'chemicals'. By 2009, the structure of EU comparative advantage remained similar although the EU appears to have lost the comparative advantage it held in 'financial services'. China's comparative advantage profile, in 1995, was largely geared towards the manufacturing sectors and 'construction services', while it had a comparative disadvantage in 'mining and fuel', 'transport equipment' and most other service sectors. By 2009 China managed to retain its comparative advantage in 'chemicals', 'basic metals', 'electrical and optical equipment' and 'machinery nec' but lose it in 'light

[27] The RCAs are calculated, following the balassa index, as the share that each sectors occupies in the gross exports of a country over the sectoral share of world exports. Values above 1 indicate a comparative advantage whereas values below 1 show comparative disadvantages.

manufacturing' and 'rubber and plastics'. It, however, gained advantage in 'mining and fuels' and 'telecom services'.

Table 1.11: Gross export shares and comparative advantages in the EU and China 1995 and 2009

	1995				2009			
	EU		China		EU		China	
	Export Share	RCA	Export Share	RCA	Export Share	RCA	Export Share	RCA
Agriculture and Food	8.7%	1.1	7.4%	1.0	6.9%	1.1	5.8%	1.0
Mining and Fuel	12.0%	1.7	6.5%	0.9	17.3%	1.5	17.1%	1.4
Light Manufacturing	12.6%	1.0	15.2%	1.2	9.9%	1.0	4.7%	0.5
Chemicals	7.3%	1.0	11.2%	1.5	7.8%	1.0	10.1%	1.3
Rubber and Plastics	1.4%	0.7	2.2%	1.2	1.4%	0.7	1.4%	0.8
Basic metals	5.9%	0.8	10.3%	1.5	4.8%	0.7	7.4%	1.1
Machinery nec	4.6%	0.6	12.8%	1.7	4.4%	0.7	8.2%	1.3
Electrical and Optical equipment	15.0%	0.9	21.2%	1.3	12.2%	0.8	26.7%	1.7
Transport Equipment	5.7%	0.6	4.6%	0.5	6.5%	0.8	4.8%	0.6
Transport and logistics services	5.2%	0.8	2.3%	0.4	5.4%	0.9	2.8%	0.5
Telecom services	1.1%	2.1	0.3%	0.6	1.5%	2.3	0.9%	1.4
Financial services	2.6%	1.2	0.3%	0.2	2.3%	0.7	0.3%	0.1
Renting M&Eq and other business services	8.2%	2.0	1.2%	0.3	10.4%	1.8	5.0%	0.9
construction services	0.3%	1.8	0.9%	4.5	0.4%	1.4	0.5%	1.9
other services	9.2%	1.3	3.7%	0.5	9.1%	1.2	4.3%	0.6

Source: Own calculations using WIOD

Note: RCAs calculated using Balassa Index (i.e. share of sector in country total exports over share of world exports of that same sector over total world exports). Values above 1 suggest a comparative advantage.

Table 1.12 then shows how the domestic value added in exports (VAE), rather than gross exports, have evolved. Taking the EU 1995 column as an illustrative example on how to interpret the table; the first entry tells us that 4.9% of the EU's total domestic value added in exports is in the 'Agriculture and food' sector.

Something that comes out very clearly in this table is the importance of service sector domestic VAE. While services were seen to occupy a relatively small share of gross exports (see above), in terms of domestic VAE it is a large and growing sector. The key driver of this is the 'servicification' of manufacturing where the service value added in manufactured products is growing. Where comparative advantages are concerned, the EU holds advantages in all service sectors and particularly in 'renting M&Eq and other business services', sector which occupies the second largest share in domestic VAE. China's main advantage continues to lie in manufacturing sectors. An interesting result is that the 'light manufacturing' and 'rubber and plastics' sectors in China exhibited a comparative disadvantage in the gross export table but in terms of domestic VAE China seems to hold a comparative advantage. This suggests that China is increasingly adding domestic value added in these sectors which is embodied in the exports they sell globally.

Table 1.12: Domestic VAE shares and comparative advantages in the EU and China 1995 and 2009

	1995				2009			
	EU		China		EU		China	
	DVAE Share	RCA	DVAE Share	RCA	DVAE Share	RCA	DVAE Share	RCA
Agriculture and Food	4.96%	0.8	16.86%	2.6	3.76%	0.6	10.41%	1.7
Mining and Fuel	2.80%	0.3	6.68%	0.8	2.46%	0.2	6.53%	0.4
Light Manufacturing	9.11%	1.0	20.25%	2.3	6.11%	1.0	12.45%	2.0
Chemicals	6.36%	1.2	4.44%	0.8	5.85%	1.1	5.21%	1.0
Rubber and Plastics	2.00%	1.1	2.83%	1.5	1.64%	1.0	2.43%	1.5
Basic metals	7.05%	1.0	7.36%	1.0	5.79%	0.9	7.41%	1.2
Machinery nec	7.05%	1.7	3.15%	0.7	5.59%	1.6	3.96%	1.2
Electrical and Optical equipment	7.22%	0.8	8.29%	0.9	5.81%	0.7	11.86%	1.5
Transport Equipment	5.48%	1.1	1.38%	0.3	4.29%	1.2	2.38%	0.7
Transport and logistics services	8.69%	1.2	7.22%	1.0	9.14%	1.4	6.38%	1.0
Telecom services	1.72%	1.0	0.93%	0.5	1.79%	1.1	1.86%	1.1
Financial services	4.84%	0.9	4.50%	0.8	7.38%	1.3	4.75%	0.8
Renting M&Eq and other business services	12.84%	1.4	1.39%	0.2	18.61%	1.7	5.32%	0.5
construction services	1.14%	1.8	0.33%	0.5	1.31%	2.0	0.26%	0.4
other services	18.74%	1.0	14.39%	0.7	20.48%	1.1	18.79%	1.0

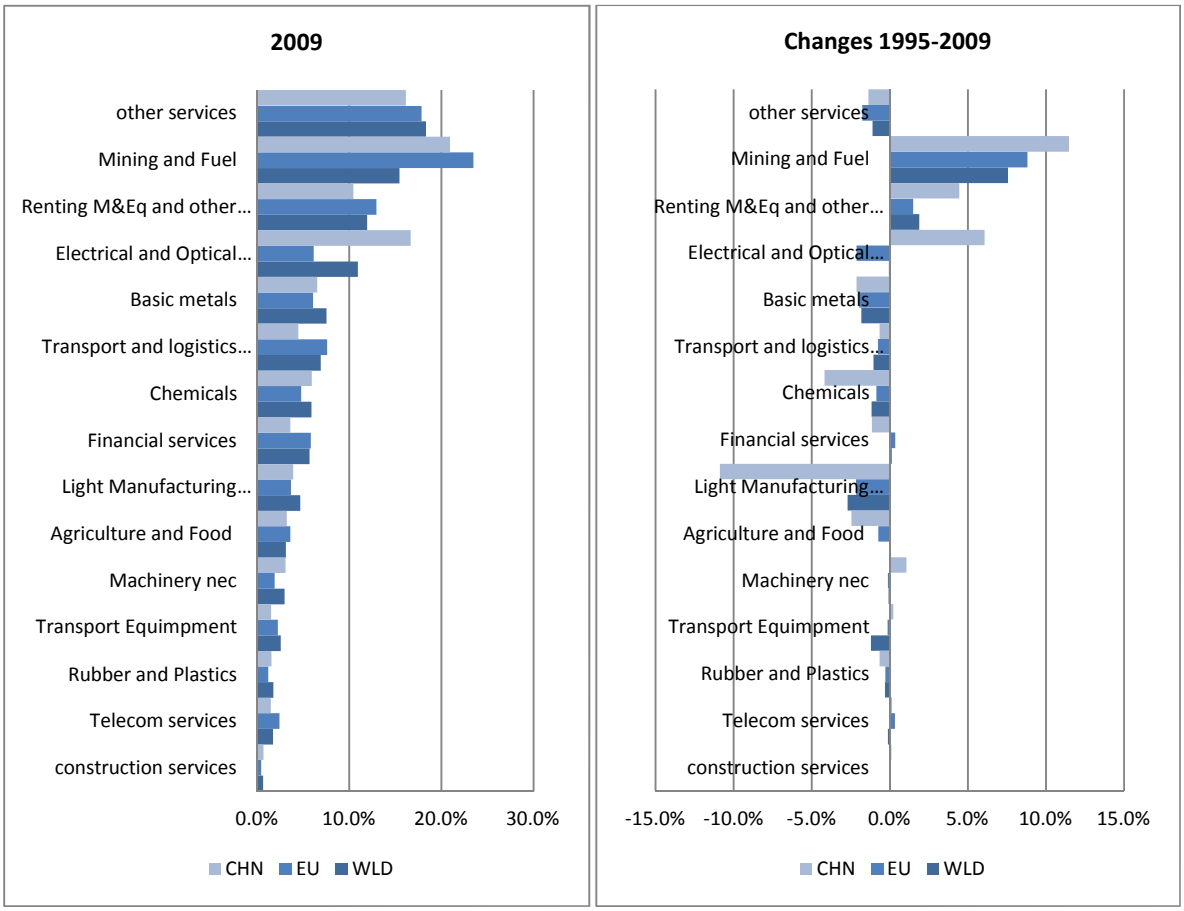
Source: Own calculations using WIOD

Note: RCAs calculated using Balassa Index (i.e. share of sector DVAE in country total DVAE over share of world DVAE of that same sector over total world DVAE). Values above 1 suggest a comparative advantage.

In Figure 1.25 we then look at the evolution of the foreign value added embodied in exports (imports of VAE) of the world, the EU and China. The left panel is ranked according to descending world shares and the right panel identifies changes in time (1995 to 2009). In Figure 1.25 we see that in 2009 the EU's second import VAE sector is 'other services'; this identifies not only direct imports of value added from this sector but also indirect 'other service' value added embodied in other products which the EU imports in order to produce exports. The fact that this sector is not identified as a top sector in the intermediates charts of Figure 1.22 suggests that many imported intermediates that the EU uses to produce exports contain 'other services' inputs.

In 2009 China's main import of VAE is 'mining and fuel' followed by 'electrical and optical equipment'. These are the sectors that have exhibited the greatest growth since 1995. Other notable growing sectors are 'renting M&Eq' and 'machinery nec'. The biggest declines are in 'light manufacturing', 'chemicals' and 'basic metals' which is in-line with the results from the previous table which suggested that China has gained a comparative advantage in the sales of these products. The foreign VAE purchases story for the EU is simple. Most sectors have been declining except for 'mining and fuel' and 'renting and M&Eq'.

Figure 1.25: Share of sectoral imported VAE over total imported VAE 1995 and 2009

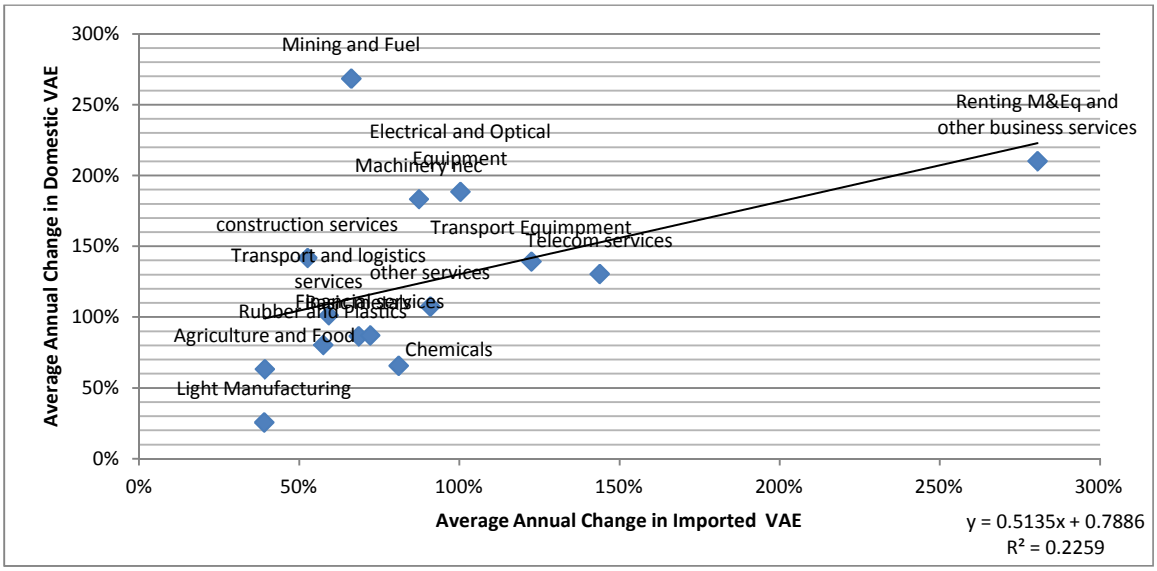


Source: Own calculations using WIOD

In the figures that follow, we chart the annual change in domestic VAE versus the annual change in imported VAE for the EU (Figure 1.26) and China (Figure 1.27). Here we aim to identify whether there is any evidence of imported value added in exports replacing domestic value added in exports. As can be seen there is a positive relationship between these which in turn suggest that importing to export could be correlated with higher growth rates of domestic value added in exports. This provides some preliminary evidence to the thesis that outsourcing the less competitive elements of production allows a country to specialise in higher value adding activities according to comparative advantages.

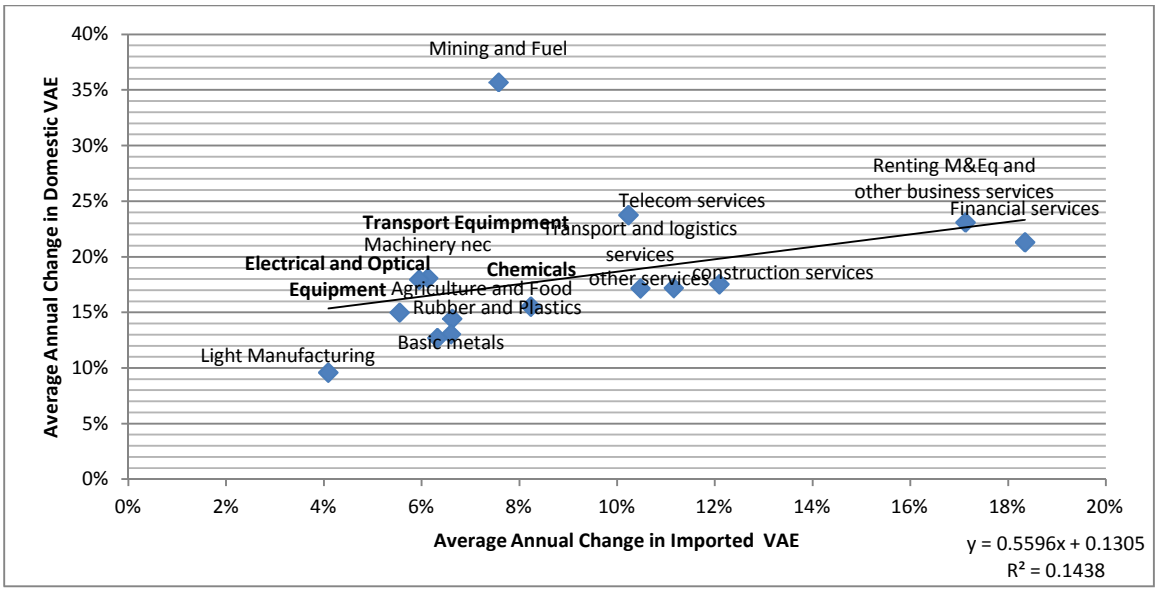
One interesting result arises from comparing these VAE figures to those that were obtained using intermediate products shown in Figure 1.23. Contrary to what is observed in Figure 1.26, Figure 1.23 showed the presence of a negative relationship between changes in direct domestic value added used to produce output and changes in the use of imported intermediate inputs to produce output in the EU. What this suggests is that, although imported intermediate inputs are associated with a lower growth in direct domestic value added, the EU content of these imported intermediates is relatively high. Once we account for the domestic value added content of imported intermediates we see that the relationship is reversed. This means that even if the EU is importing more of its intermediates, it is also increasingly indirectly contributing to these (due to returning domestic value added embodied in these) through its wide engagement in GVCs.

Figure 1.26: EU domestic and imported VAE annual growth rates 1995 to 2009



Source: Own calculations using WIOD,
Note: annual rates calculated as the absolute change in VA divided by the amount of years

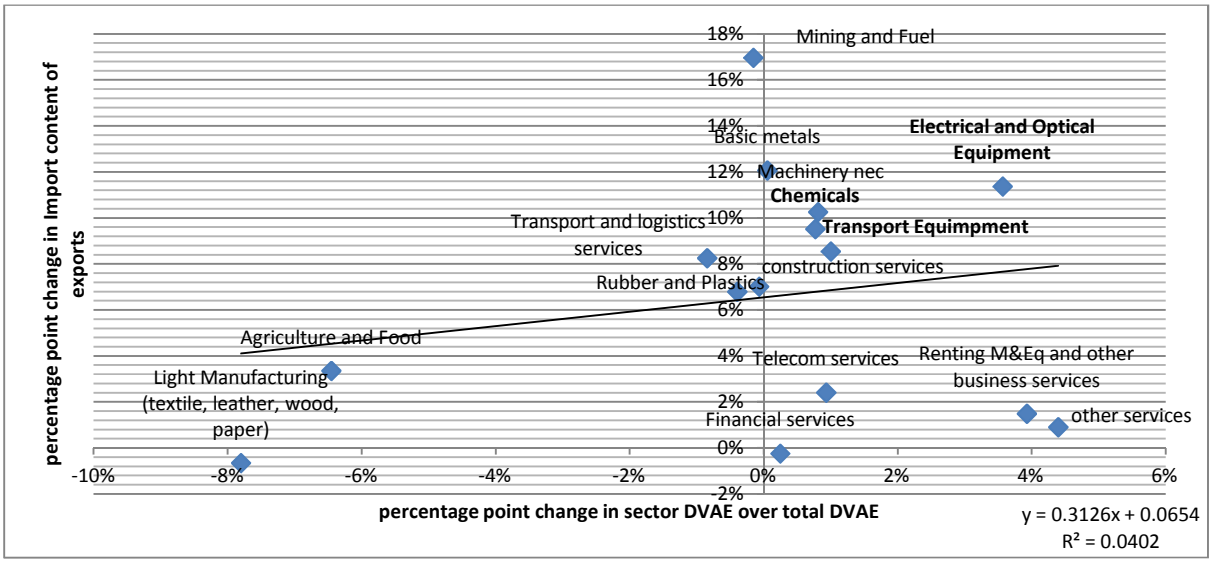
Figure 1.27: Chinese domestic and imported VAE annual growth rates 1995 to 2009



Source: Own calculations using WIOD,
Note: annual rates calculated as the absolute change in VA divided by the amount of years

On the one hand, the above exposed relationship is not surprising as it may simply indicate that increased / decreased exports is correlated with both increase / decreased use of domestic and foreign value added. However, for China there is also a positive correlation between the sectoral change in the share of domestic value added over total value added (between 1995-2009), and the change in the share of the import content of exports *within* each sector (Figure 1.28). This suggests that increased sectoral competitiveness and specialisation is positively correlated with a rise in the use of imported intermediates. Hence there appears to be some complementarity between the growth in imported intermediates and the growth in domestic value added.

Figure 1.28: Changes in the sectoral share of domestic VAE versus changes in the import content of exports between - China 1995 and 2009

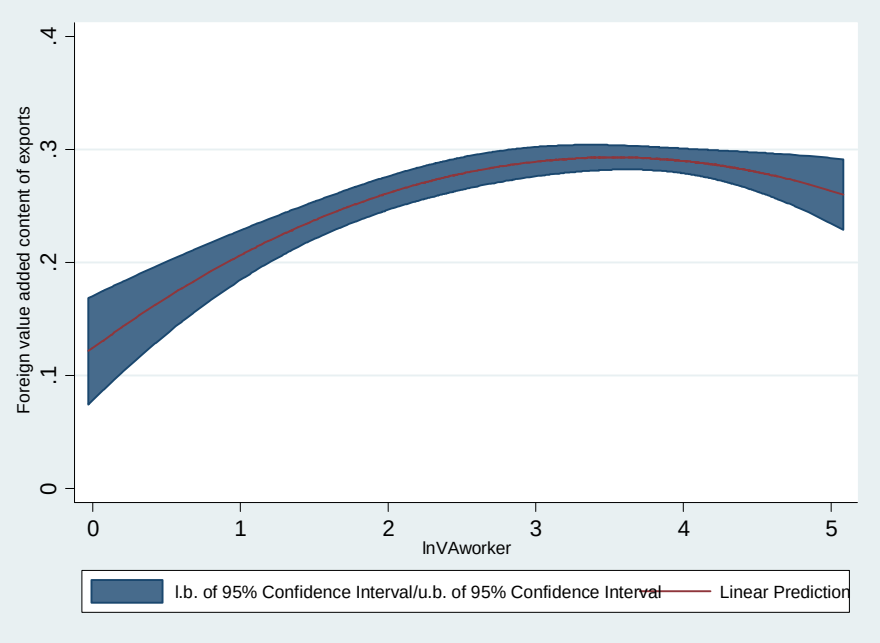


Source: Own calculations using WIOD,

Note: The sectoral share of domestic VAE is the share of domestic VAE of sector i over total domestic VAE in the economy. The percentage point change is then 2009 values minus 1995 values. The import content of export is the share of sector i imports needed to produce a unit of exports in sector i.

In Figure 1.29 we plot a regression line between the foreign value added content of exports and the average value added per worker across countries. We find that countries that have a higher share of foreign value added in their exports typically have higher productivity. There are of course unresolved issues of causality, but this is indicative that engagement in global value chains may lead to higher productivity and hence economic growth.

Figure 1.29: Foreign value added content of exports and value added per worker across countries



Source: Own calculations using WIOD,

1.5.4. FOCUS SECTORS

In this section we focus our attention on the three sectors that have been highlighted in the ToRs – 'Electrical and optical equipment'; 'Chemicals'; and 'Transport equipment'. Here we aim to give a value chain perspective by considering the origin of the intermediate products used as inputs or domestic value-added used in producing a unit of output or exports. We also provide a comparative analysis by showing how different country value chains compare to the EU and China's.

Much of the analysis that follows is descriptive. It aims to provide a portrait of the main characteristics of EU and Chinese value chains. There is a small caveat that must be noted before we proceed with the analysis. In much of what will be presented we compare the use of domestic or imported intermediates /value-added embodied in a unit of output/export. To the extent that the EU and China export different products within these broad categories the comparison of the input vectors is not straight-forward. For example, the EU's chemical sector exports may largely be composed of pharmaceutical products whilst those of China may concentrate in other base chemicals. Since the inputs/value added used to produce base chemicals are likely to be different to those used to produce pharmaceuticals the comparison between China and the EU's input structures may not be entirely straightforward.

1.5.4.1. ELECTRICAL AND OPTICAL EQUIPMENT

We begin with Table 1.13 by mapping the flows of intermediate products used in the production of electrical and optical equipment across the world in 2009. Each column identifies the origin of intermediates, from any sector, used in the production of a unit of the column nation's electrical and optical equipment output. Here we see that intermediate input structures differ quite a bit across countries. For example, Mexico is the single country that uses the least amount of domestic intermediates in the production of its electrical and optical equipment output (38%). 78% of the intermediates used by China are domestically sourced and hence 22% are imported whereas the EU uses 83% domestic and 17% imported intermediates. In terms of the origin of China's imported intermediates, we see that Taiwan is the largest direct supplier with Japan, Korea and the EU following closely and the US trailing with only 2% of intermediate inputs being supplied by this country. For the EU, the main source of imported intermediates is China with 7% and then the US with 3%.

Table 1.13: Origin of intermediates used in the production of electrical and optical equipment 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	83%	15%	3%	4%	3%	5%	4%	3%	5%		3%	2%	5%	5%	23%
TUR		70%													
BRA			82%												
RUS				89%											
IND					85%										
IDN						70%									
AUS							75%								
CHN	7%	7%	6%	4%	4%	9%	6%	78%	14%	4%	10%	8%	23%	9%	20%
TWN								4%	47%		2%				4%
JPN						3%		3%	9%	90%	4%		3%		6%
KOR								3%	4%		72%		4%		4%
USA	3%						2%	2%	6%		3%	78%	18%	17%	13%
MEX												3%	38%	3%	
CAN														59%	
RoW	3%	4%	3%		5%	9%	8%	6%	14%		5%	3%	5%	3%	25%
Imported	17%	30%	18%	11%	15%	30%	25%	22%	53%	10%	28%	22%	62%	41%	75%

Source: own calculations using WIOD.

Note: entries identify column nation purchases of intermediate products as a share of total purchases of intermediates. Values below 2% are zeroed out.

Where the above figure highlights the use of intermediate products, below, in Table 1.14, we take a closer look at the origin of value added in exports (VAE). Here we perceive some key differences which hint at how GVCs in this sector are structured. For example, China's domestic value added in electrical and optical equipment exports is of 67% which is comparatively low. This suggests that many domestic intermediates used to produce exports contain foreign value added and hence that the value chain in this sector is much more internationalised than what the intermediate product figures would suggest. For China, the US, which occupied only 2% of intermediates, now is seen to supply 5% of the value added in this sector which is as big as Japan's contribution suggesting that US value added in this sector enters China through indirect routes (third countries). A similar story arises with EU value added. Intermediates represented 3% of Chinese inputs but *in terms of value added the EU is the single largest source of imported value added for this sector* (6%). Again, this shows that a lot of EU value added enters China's value chains through indirect routes.

Another key difference that arises between the intermediate product and the value-added flows is that China is seen as having a smaller role as a supplier of inputs into other country's production of electrical and optical equipment exports. For example, China was seen to contribute 7% of intermediate products into the production of EU electrical and optical equipment output however the value added figures are 2 percentage points lower (5%). This reflects a high foreign content of value added embodied in the intermediates imported from China.

Table 1.14: Origin of value-added in the production of electrical and optical equipment exports 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	83%	13%	4%	4%	4%	5%	4%	6%	7%		6%	2%	7%	5%	18%
TUR		70%													
BRA			82%												
RUS				89%											
IND					82%										
IDN						73%									
AUS							81%								
CHN	5%	5%	4%	2%	4%	6%	4%	67%	10%	3%	9%	3%	15%	5%	12%
TWN								3%	53%						2%
JPN						3%		5%	8%	87%	5%		4%		5%
KOR								3%	3%		63%		3%		3%
USA	3%		2%			2%	2%	5%	7%		5%	89%	17%	13%	11%
MEX													44%		
CAN														68%	
RoW	3%	5%	4%		6%	6%	5%	8%	9%	3%	7%		5%	3%	42%
Imported	17%	30%	18%	11%	18%	27%	19%	33%	47%	13%	37%	11%	56%	32%	58%

Source: own calculations using WIOD.

Note: entries identify column nation purchases of value-added as a share of total value-added

We now turn to looking at the sectoral intermediate input content of electrical and optical equipment output in 2009 for the world, the EU and China in Table 1.15. Each column in the table identifies the source of intermediate inputs needed to produce a unit of output and hence they each sum up to 100%. In the first panel (WLD) we identify the average intermediate product (technological) requirements needed to produce a unit of electrical and optical equipment output in the world. For example, the TOT entry tells us that, on average, 43% of the intermediates needed to produce a unit of electrical and optical equipment output come from the electrical and optical equipment sector itself. The second

largest contributing sector is 'basic metals' (14%) followed by 'other services' (12%). We then compare these requirements across the EU and China in the other panels.

Differences in the intermediate input structures of the EU and China come out very clearly in this table. For example, 34% of intermediates to produce a unit of output in the EU come from the electrical and optical equipment sector (own sector intermediates) whereas China uses 48%. Although own sector intermediates are largest in terms of domestic intermediates, the second intermediate input sector in China is 'basic metals' whereas in the EU it is 'other services'. What this suggests is that the EU's use of service intermediates is much bigger than China's who largely uses manufacturing sector intermediates (see entries for 'renting M&Eq' and 'other services').

Table 1.15: Sectoral intermediates product used in the production of electrical and optical equipment output 2009.

	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	0%	0%	0%	0%	0%	0%	1%	1%	0%
Mining and Fuel	1%	1%	1%	1%	1%	1%	1%	1%	1%
Light Manuf. (textile, leather, wood, paper)	4%	5%	2%	3%	3%	2%	4%	5%	1%
Chemicals	4%	4%	3%	2%	2%	3%	4%	5%	3%
Rubber and Plastics	4%	5%	2%	3%	3%	1%	5%	6%	1%
Basic metals	14%	17%	8%	11%	12%	7%	17%	21%	6%
Machinery nec	3%	3%	3%	2%	3%	2%	3%	3%	3%
Electrical and Optical Equipment	43%	33%	70%	34%	28%	65%	48%	39%	79%
Transport Equipment	1%	1%	1%	1%	1%	1%	1%	1%	1%
Transport and logistics services	3%	3%	2%	3%	4%	1%	2%	2%	1%
Telecom services	1%	1%	0%	1%	1%	1%	1%	1%	0%
Financial services	2%	3%	1%	2%	2%	0%	2%	3%	0%
Renting M&Eq and other business services	8%	9%	4%	14%	15%	9%	3%	4%	3%
construction services	0%	0%	0%	1%	1%	0%	0%	0%	0%
other services	12%	16%	3%	20%	23%	5%	8%	10%	1%
Share		72%	28%		83%	17%		78%	22%

Source: Own calculations,

note: entries show the use of intermediate product. All columns sum to 100% and show us how the composition of intermediate product use differs across the categories. Intra EU imports are classified as EU domestic intermediates.

In Table 1.16 we present a similar table but with the VAE figures which show us the total, domestic and imported value added that is needed to produce a unit of electrical and optical equipment exports. For China, we see that 34% of the value added in the production of a unit of exports of electrical and optical equipment comes from the electrical and optical equipment sector itself share which is lower than that of the EU (46%) and the world (42%). This is because much of the value added in this industry comes from different sectors. Indeed, when we look at the domestic value added vector we see that 15% comes from 'other services' and 10% from 'basic metals'. In contrast, the EU's domestic value added is again higher in 'other services' and 'renting and M&Eq' giving further evidence to the increasing service content of EU electrical and optical equipment production. Where imported value added is concerned, we see that the imported vectors are more dispersed across the sectors. China imports a higher share of value added from the electrical and optical equipment sector than the EU but less from the renting and M&Eq sector.

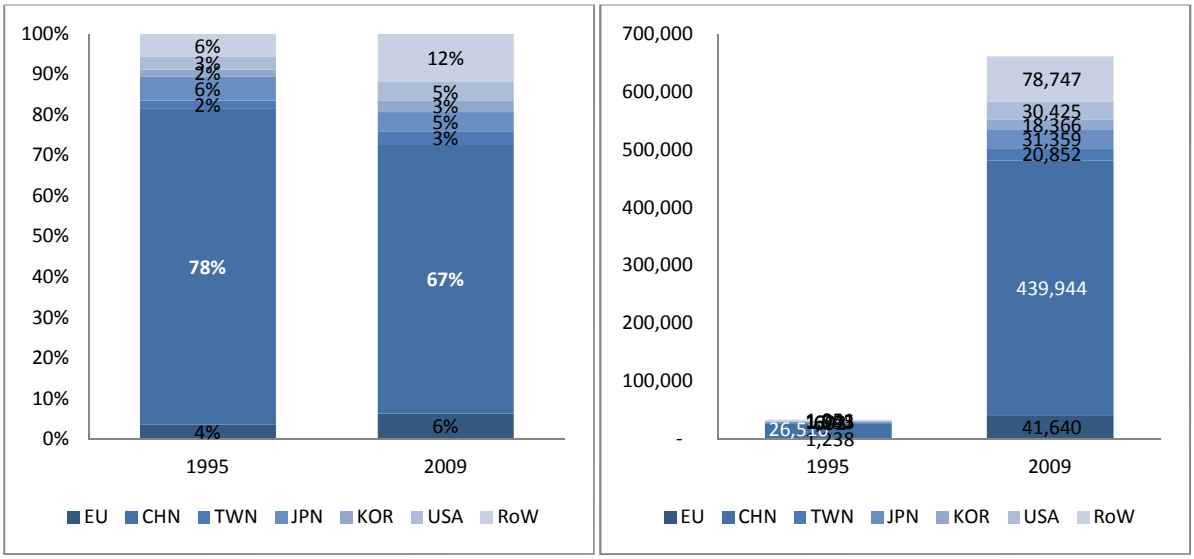
Table 1.16: Sectoral value added in the production of electrical and optical equipment exports 2009.

	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	2%	2%	2%	1%	0%	2%	3%	4%	1%
Mining and Fuel	6%	3%	12%	3%	1%	12%	9%	6%	15%
Light Manuf. (textile, leather, wood, paper)	3%	3%	4%	2%	2%	4%	4%	4%	3%
Chemicals	3%	2%	4%	2%	1%	4%	4%	4%	5%
Rubber and Plastics	2%	2%	2%	1%	1%	2%	2%	3%	2%
Basic metals	7%	6%	8%	5%	5%	8%	9%	10%	7%
Machinery nec	2%	1%	3%	1%	1%	2%	2%	2%	3%
Electrical and Optical Equipment	42%	50%	26%	46%	50%	23%	34%	37%	27%
Transport Equipment	1%	0%	1%	1%	0%	1%	1%	1%	1%
Transport and logistics services	3%	3%	5%	3%	3%	5%	4%	3%	4%
Telecom services	1%	1%	1%	1%	1%	2%	2%	2%	1%
Financial services	4%	4%	4%	3%	3%	5%	5%	6%	4%
Renting M&Eq and other business services	8%	7%	10%	14%	14%	13%	6%	4%	10%
construction services	0%	0%	1%	1%	1%	0%	0%	0%	1%
other services	15%	15%	17%	17%	17%	18%	16%	15%	16%
Share		69%	31%		83%	17%		67%	33%

Source: Own calculations,
note: entries show the value added content of exports, intra EU value added imports are classified as EU domestic.

In Figure 1.30 we look at how the value added in exports in the electrical and optical equipment sector has evolved in time. In the left-hand panel we report this as a share of total value added whereas in the right-hand panel we look exclusively at values. What transpires is that although the domestic value added content of Chinese exports is falling (from 78% in 1995 to 67% in 2009), the value over which this is reaped is increasing rapidly and hence that China is getting a slightly smaller share of a much bigger pie ($26 billion in 1995 and $439 billion in 2009). Noteworthy is also the EU's increasing participation in this sector, it has seen its share rise from 4% in 1995 to 6% in 2009. This makes the EU the single largest external source of value added in Chinese electrical and optical equipment (more than Japan and the US).

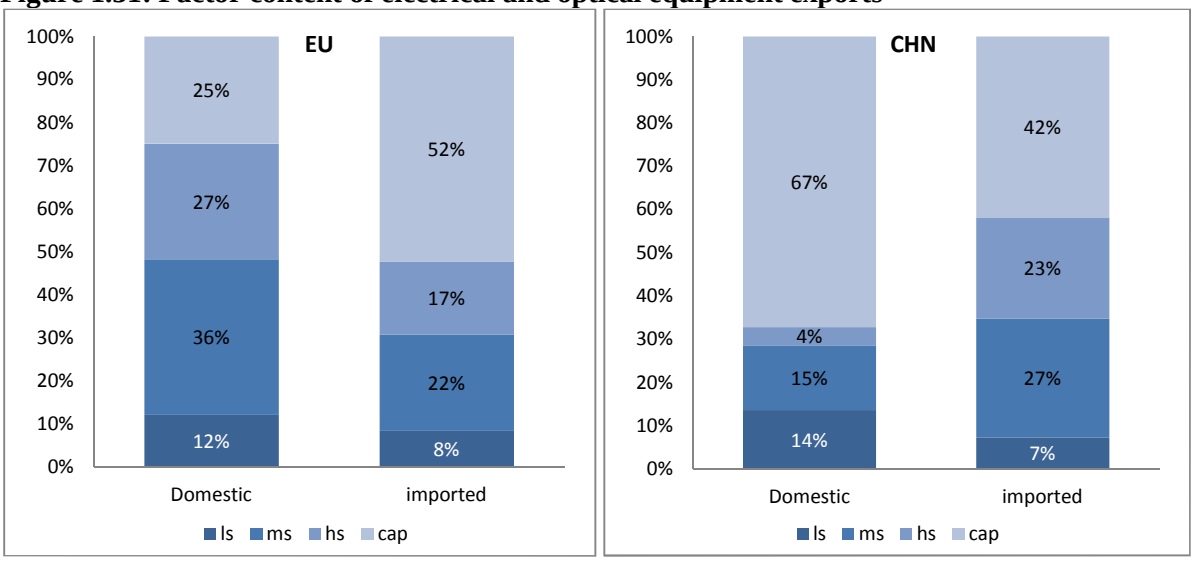
Figure 1.30: Evolution of the value added content of electrical and optical equipment exports in China 1995 and 2009



Source: Own calculations,
note: Left-panel: value added share of one unit of electrical and optical equipment exports by origin. Right hand panel: dollar value of content of Chinese electrical and optical equipment exports by origin (values in $ billion).

Finally we look at the factor content of exported electrical and optical equipment. The left panel in Figure 1.31 shows how domestic and imported value added differ in terms of their factor composition for the EU (left) and China (right). In the case of the EU, the factor composition of domestic value added is predominantly medium and high skill labour which jointly occupy over 60% of domestic value added in electrical and optical equipment exports. Imported value added is predominantly capital value added (52%) followed by medium skill value added (22%). In China, the domestic value added in electrical and optical equipment exports is largely composed of capital returns (which occupies 67% of total domestic value added). In contrast, returns to domestic high-skill labour contributes very little to value added (4%). As expected, the import shares reflect a more evenly distributed composition of value added. In China med and high skill labour value added imports combined occupy 50% of imported value added. The figures further suggest that the EU is specialising in medium and high skill labour value added all the while outsourcing capital value added production. China shows the mirror image, it specialises in capital value added and outsources the high and medium skill processes abroad.

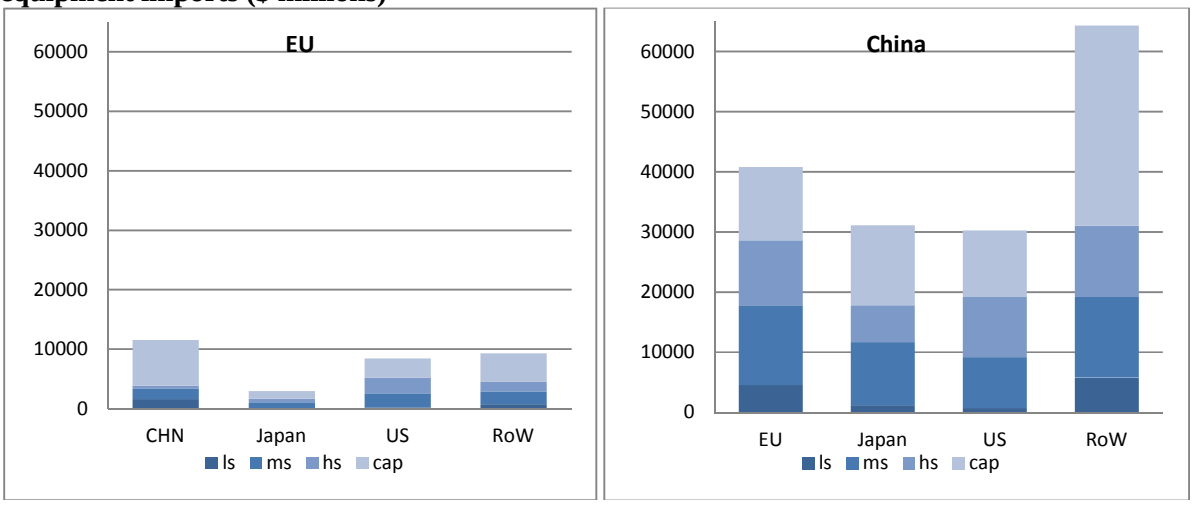
Figure 1.31: Factor content of electrical and optical equipment exports



Source: Own calculations,
note: ls= low skill, ms= medium skill, hs= high skill, cap=capital value added. Intra-EU imported value added is classified as EU domestic.

Figure 1.32 shows how the origin of foreign value added distributes across different partners for the EU (left panel) and China (right panel), and across categories in 2009. First we note the much higher absolute participation of China as a user of foreign value added. Second, we see that the composition of these imports, in terms of factor content, is much more high-skill intensive than what was seen from the domestic figures presented above. Indeed the EU and China appear to be outsourcing tasks which are intensive in the content which they do not have a domestic advantage in.

Figure 1.32: Origin and factor content of foreign value added in exports of electrical and optical equipment imports ($ millions)



Source: Own calculations.
note: ls= low skill, ms= medium skill, hs= high skill, cap=capital value added.

To further investigate the patterns of specialisation in the EU and China in the production of electrical and optical equipment exports, we provide, in Table 1.17, a decomposition of the EU's and China's domestic comparative advantages across different sectors and categories of value added in exports in the production of electrical and optical equipment exports (sectors showing a comparative disadvantage are not shown for readability).[28] For example, the low-skill column suggests that the EU has a comparative advantage in the low-skill service sector value added inputs, such as 'renting and M&Eq and other business services' or the 'financial services', in the production of electrical and optical equipment exports. The indicator therefore gives us an insight into the comparative advantages of countries across a given value chain.

Overall, the table very clearly shows that China has a comparative advantage in low-skill manufacturing value added and in capital value added in most sectors. The EU on the other hand is more specialised in high and medium skilled processes and particularly in the service sectors although its low-skill comparative advantage in service sectors is also of note. In many ways, these figures tell us that the EU and China have very complementary production structures, they hold comparative advantages in different segments of the production of electrical and optical equipment which in turn suggests that they can gain widely from further bilateral specialisation.

[28] The comparative advantage by categories is calculated as; the domestic share of country-factor value added in total sector domestic value added divided by the equivalent share of world domestic value added. Values above 1 indicate a comparative advantage in the value chain segment. The intuition of the indicator is as follows. If a country has a larger share of a given sector-factor domestic value added than the average seen in the world, it reveals itself as having a comparative advantage in this particular process of the value chain. Unlike more traditional comparative advantage indicators, here we take the share relative to all domestic value added to capture differences in the composition of countries value added.

Table 1.17: Comparative advantages across sector and value added category in Electrical and optical equipment exports, 2009

	Low-skill		Medium-skill		High-skill		Capital	
	EU	CHN	EU	CHN	EU	CHN	EU	CHN
Agriculture and Food		27.8		2.0	1.3			14.6
Mining and Fuel		23.2		9.3		2.4		12.2
Light Manufacturing		3.1	1.0		1.6			5.6
Chemicals		4.1		2.2				6.2
Rubber and Plastics		3.1			1.7			7.3
Basic metals		1.9	1.3		2.3			7.7
Machinery nec		2.1	1.4		1.9			6.2
Electrical and Optical Equipment	1.7		1.7		1.3			3.2
Transport Equipment		2.4	1.3		2.0			8.6
Transport and logistics services	1.4		1.4		1.8			2.6
Telecom services	2.6		1.3			1.1		2.3
Financial services	2.5			1.4				3.8
Renting M&Eq and other business services	2.1		1.9		1.9		1.8	
construction services	2.2		2.2		1.8		2.4	
other services	1.8		1.5		1.6			1.7

Source: Own calculations,
note: Comparative advantage calculated as country-sector-type of value added divided by total sector value added which is then divided by world equivalent. Values above 1 identify an input sector / factor comparative advantage in the production of electrical and optical equipment exports. Values below 1 (comparative disadvantage) omitted for readability.

1.5.4.2. TRANSPORT EQUIPMENT

Here we take a closer look at the transport equipment value chain. In Table 1.18 we show the origin of intermediate products in the production of transport equipment output in 2009. In this sector the EU imports 9% of its intermediates with no single country supplying more than 2% of intermediates. China sources 90% of its intermediates domestically, 4% from the EU and 2% from Japan. The international value chains in North America seem to be more fragmented, as suggested by Mexico and Canada's relatively low use of domestic intermediate inputs (at around 60%). Both countries are highly reliant on the US which supplies around 20% of the intermediates they use to produce transport equipment. A similar relationship emerges between the EU and Turkey. Where main suppliers of intermediates are concerned, the big players are; the EU, China, Japan, the US and to a lesser extent Korea. Mexico and Canada are important but only in Factory North America.

Table 1.18: Origin of intermediate products used in the production of Transport equipment output 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	91%	22%	4%	11%	3%		4%	4%	3%		3%	4%	6%	5%	28%
TUR		66%													
BRA			88%												
RUS				77%											
IND					86%										
IDN						84%									
AUS							83%								
CHN		2%			3%	3%	4%	90%	7%		4%	4%	6%	2%	12%
TWN									70%						
JPN				4%		3%		2%	11%	95%	3%		2%	3%	8%
KOR				2%					2%		88%				5%
USA			2%				2%		2%			82%	18%	21%	11%
MEX												3%	60%	3%	
CAN												3%		63%	
RoW		5%	2%		5%	5%	5%		3%						27%
Imported	9%	34%	12%	23%	14%	16%	17%	10%	30%	5%	12%	18%	40%	37%	73%

Source: own calculations using WIOD.
Note: entries identify column nation purchases of intermediate products as a share of total purchases of intermediate. Values below 2% are zeroed out.

Table 1.19 then shows the origin of value added in the production of exports. There are some interesting observable differences between the values reported here and those above. For example, China's domestic sourcing is now lower (75% of value added) and the US emerges as an important supplier. The EU also has a lower contribution from domestic sourcing than was observed above; China and the US appear as important suppliers of value added with 2% and 3% shares respectively.

Table 1.19: Origin of value-added in the production of transport equipment exports 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	87%	16%	5%	10%	4%	3%	5%	7%	5%		5%	5%	6%	6%	23%
TUR		70%													
BRA			84%												
RUS		2%		77%											
IND					81%										
IDN						83%									
AUS							80%								
CHN	2%	2%			3%	3%	4%	75%	6%	2%	6%	4%	5%	3%	9%
TWN									64%						
JPN				4%		3%		4%	10%	88%	5%		2%	3%	7%
KOR											70%				3%
USA	3%		3%		2%		3%	3%	3%		3%	81%	13%	19%	10%
MEX													67%		
CAN												2%		62%	
RoW	3%	5%	3%	2%	6%	4%	5%	5%	6%	3%	6%	2%	2%	2%	40%
Imported	13%	30%	16%	23%	19%	17%	20%	25%	36%	12%	30%	19%	33%	38%	60%

Source: own calculations using WIOD.
Note: entries identify column nation purchases of value-added inputs as a share of total purchases of value-added.

Table 1.20 maps the intermediate input use of the transport equipment sector in 2009. Here we see that, on average, it is composed of 'transport equipment' intermediates (40%) followed by 'basic metals' (14%) and 'other services' (13%). In terms of foreign sourcing of intermediates, imports of 'electrical and optical equipment' also appear important, much more so than across any other sector suggesting that many countries outsource intermediates from this sector. Output production in the EU is relatively similar to world averages although the EU uses more service inputs and fewer inputs from the 'transport equipment' sector itself. The contrary is seen for China: its industry relies more on

own sector inputs, on intermediates from the 'machinery nec' and 'basic metals' sector and less on service inputs.

Table 1.20: Sectoral intermediates products used in the production of transport equipment output 2009.

	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	0%	0%	0%	0%	0%	0%	1%	1%	0%
Mining and Fuel	1%	1%	1%	1%	0%	1%	1%	1%	2%
Light Manuf. (textile, leather, wood, paper)	3%	3%	3%	3%	3%	4%	4%	4%	2%
Chemicals	2%	2%	2%	2%	1%	4%	2%	2%	4%
Rubber and Plastics	5%	5%	4%	4%	5%	4%	5%	5%	3%
Basic metals	14%	14%	13%	14%	14%	15%	15%	15%	11%
Machinery nec	5%	5%	7%	4%	4%	5%	11%	10%	17%
Electrical and Optical Equipment	6%	5%	13%	5%	5%	13%	7%	6%	20%
Transport Equipment	39%	38%	44%	33%	33%	40%	40%	41%	33%
Transport and logistics services	3%	3%	2%	3%	3%	3%	2%	2%	1%
Telecom services	0%	1%	0%	0%	0%	1%	0%	0%	0%
Financial services	2%	2%	1%	2%	2%	1%	1%	1%	0%
Renting M&Eq and other business services	7%	7%	4%	9%	9%	6%	4%	4%	5%
construction services	0%	0%	0%	1%	1%	0%	0%	0%	0%
other services	13%	15%	4%	18%	20%	4%	8%	9%	2%
Share		83%	17%		91%	9%		90%	10%

Source: Own calculations,

note: entries show the use of intermediate product. All columns sum to 100% and show us how the composition of intermediate product use differs across the categories. Intra EU imports are classified as EU domestic intermediates.

In Table 1.21 we report the value added embodied in the exports of transport equipment in 2009. Differences between these values and those reported above are not huge but the greater indirect contribution of the 'mining and fuel' sector and the 'renting M&Eq and other business services' stands out. For example, in terms of intermediate products 'mining and fuel' only represented 1% of intermediates but their contribution in terms of value added goes up 4%, and it is a particularly important sector in terms of imported value added. The figures also confirm that service sector value added is much larger in the EU than in China. Another interesting observation is that the import profiles of the EU and China are relatively similar which in turn suggests that they source similar inputs from foreign suppliers to use into the production of transport equipment exports.

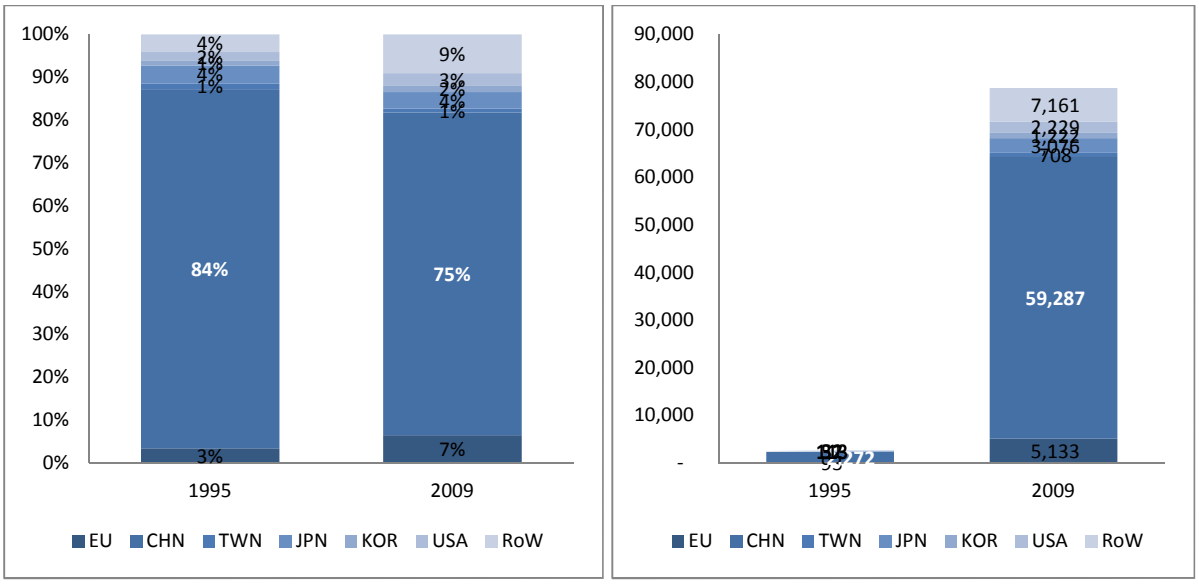
Table 1.21: Sectoral value added in the production of transport equipment exports 2009.

	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	1%	1%	2%	1%	0%	2%	3%	4%	2%
Mining and Fuel	4%	2%	14%	3%	1%	16%	9%	5%	19%
Light Manuf. (textile, leather, wood, paper)	3%	2%	4%	3%	2%	4%	4%	4%	3%
Chemicals	2%	1%	4%	2%	1%	4%	3%	3%	5%
Rubber and Plastics	2%	2%	3%	2%	2%	2%	2%	2%	2%
Basic metals	8%	7%	11%	8%	7%	11%	9%	9%	9%
Machinery nec	2%	2%	4%	2%	2%	3%	5%	5%	6%
Electrical and Optical Equipment	4%	2%	8%	3%	2%	7%	5%	3%	10%
Transport Equipment	38%	45%	12%	35%	39%	10%	31%	38%	7%
Transport and logistics services	4%	3%	5%	4%	4%	6%	4%	3%	4%
Telecom services	1%	1%	1%	1%	1%	2%	1%	1%	1%
Financial services	4%	3%	4%	3%	3%	4%	4%	4%	3%
Renting M&Eq and other business services	10%	9%	10%	13%	13%	11%	6%	4%	11%
construction services	1%	1%	1%	1%	1%	0%	0%	0%	1%
other services	17%	17%	17%	20%	21%	18%	15%	15%	16%
Share		79%	21%		87%	13%		75%	25%

Source: Own calculations,
note: entries show the value added content of exports. Intra-EU imported inputs are classified as EU domestic.

In Figure 1.33 we look at the evolution of the origin of value added in exports of transport equipment exports in China. The panel on the left identifies the share of total value added in a unit of exports of transport equipment whereas in the right-hand panel shows values. Although the domestic value added content of Chinese exports is falling from 84% in 1995 to 75% in 2009, the value over which this is reaped is increasing, from $2.2 billion in 1995 to $59 billion in 2009 again, much like in the electrical and optical equipment sector, showing that China is getting a slightly smaller share of a much bigger pie. The rising importance of EU value added in Chinas exports of transport equipment is also made patent in the figure where the EU's share is almost as high as that of the US and Japan combined.

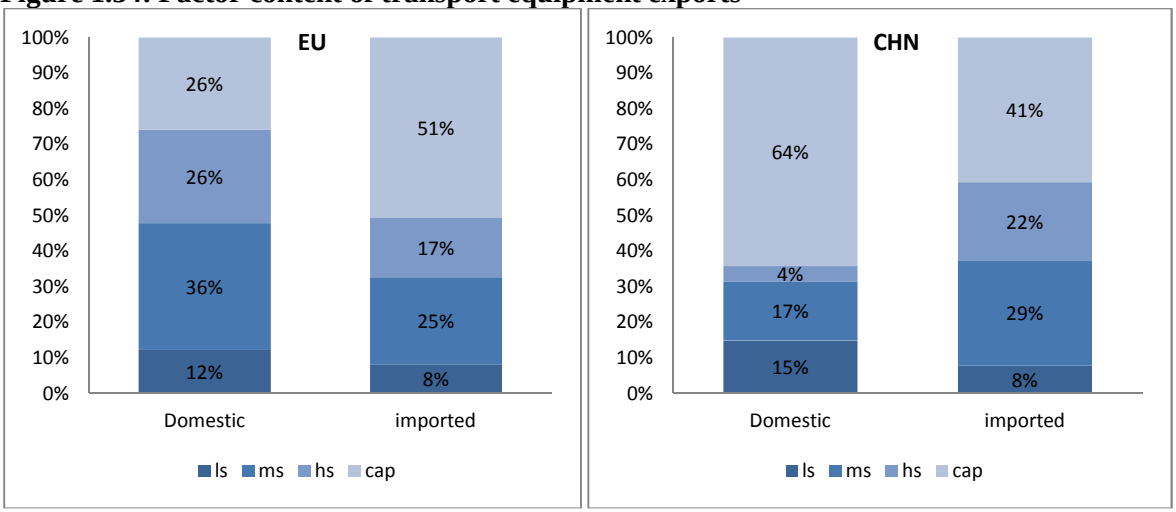
Figure 1.33: Evolution of the value added content of transport equipment exports in China 1995 and 2009



Source: Own calculations,
note: Left-panel: value added share of one unit of transport equipment exports by origin. Right hand panel: dollar value of content of Chinese transport equipment exports by origin (values in $ billion).

We then turn to the factor composition of transport equipment exports in Figure 1.34. The EU's largest contributor is med-skilled labour value added (36%) followed by high-skilled labour (26%) and capital (26%) value added. Where imports are concerned, it is capital value added which occupies the largest share of imported value added – 51%. For China, and similar to what we saw for the electrical and optical equipment sector, the largest domestic contribution to transport equipment exports comes from capital and then medium skill labour. The domestic high-skill labour value added is particularly low representing only 4% of domestic value added.

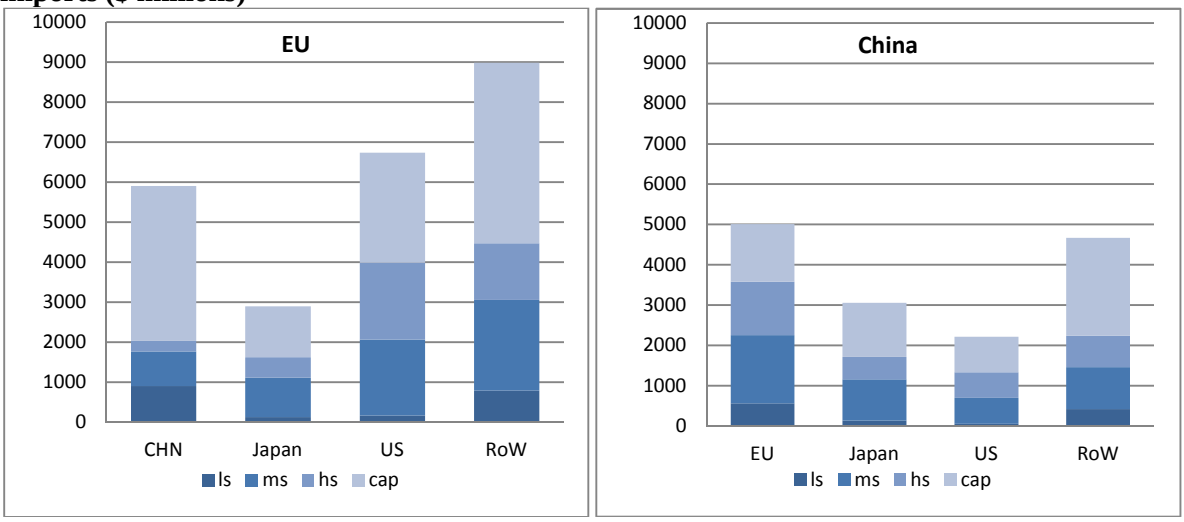
Figure 1.34: Factor content of transport equipment exports



Source: Own calculations, **note:** ls= low skill, ms= medium skill, hs= high skill, cap=capital value added. Intra EU imported value added is classified as domestic

In Figure 1.35 we look at the factor content of transport equipment imports. For the EU (left panel) we see that most imports from China embody capital value added, and to a lesser extent high and medium skilled labour value added, particularly from Japan and the US. China's imports are much less geared towards capital value added. The EU is mainly supplying China with value added created by medium and high skilled labour. A similar story emerges for the US but at lower absolute values.

Figure 1.35: Origin and factor content of foreign value added in exports of transport equipment imports ($ millions)



Source: Own calculations, **note:** ls= low skill, ms= medium skill, hs= high skill, cap=capital value added.

Finally, in Table 1.22 we show the EU and China's comparative advantage profile in the production of transport equipment exports across production factors and sectors. China very clearly has a comparative advantage in low-skill and capital value added processes where this is mainly in the natural resource and manufacturing sectors. The EU, in contrast is largely specialised in the provision of labour value added with important comparative advantages in most sectors across the spectrum of type of value added. It however shows little comparative advantage in capital value added except in some service sectors. Here too the figures suggest quite a bit of complementarity between the EU and China in that where the EU does not have a comparative advantage, China does, and vice-versa.

Table 1.22: Comparative advantages across sector and value added category in transport equipment exports, 2009

	Low-skill		Medium-skill		High-skill		Capital	
	EU	CHN	EU	CHN	EU	CHN	EU	CHN
Agriculture and Food		22	1.2	1.6	1.1			15.7
Mining and Fuel		17		6.1		1.7		8.8
Light Manufacturing	1.2	2.2	1.0		1.2			4.0
Chemicals	1.3	2.8		1.5				4.7
Rubber and Plastics	1.4	1.5	1.0		1.3			3.3
Basic metals	1.6	1.1	1.2		1.6			4.3
Machinery nec	1.6	2.4	1.4		1.4			7.2
Electrical and Optical Equipment	1.9	1.1	1.3					6.1
Transport Equipment	1.4	1.1	1.1		1.2			4.7
Transport and logistics services	1.6		1.1		1.4		1.0	1.9
Telecom services	2.2		1.1		1.0			1.5
Financial services	2.0		1.2					2.3
Renting M&Eq and other business services	2.1		1.3		1.3		1.6	
construction services	1.9		1.5		1.4		1.9	
other services	1.9		1.3		1.4		1.0	1.3

Source: Own calculations, **note:** Comparative advantage calculated as country-sector-type of value added divided by total sector value added which is then divided by world equivalent. Values above 1 identify an input sector / factor comparative advantage in the production of transport equipment exports. Values below 1 (comparative disadvantage) omitted for readability.

1.5.4.3. CHEMICALS

Finally we turn to the Chemicals' sector where, in Table 1.23, we show how the use of intermediates distributes across locations in 2009. Three key world suppliers can be identified: the EU, China and the US. The EU mainly relies on domestic intermediates (87%) with the only significant foreign source of intermediates being the US - providing 3% of intermediates. For China we see a similar structure of production overwhelmingly grounded on domestic suppliers of intermediates (87% of total). Interestingly in this sector the EU does not play a significant role as a supplier of intermediates into China (i.e. the share of the EU in the use of intermediates in China is below 2%).

Table 1.23: Origin of intermediate products used in the production of the Chemical sector's output 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	87%	11%	3%	6%	2%		4%		4%		4%	5%	3%	7%	21%
TUR		75%													
BRA			88%												
RUS				89%											5%
IND					85%										
IDN						82%									
AUS							83%								
CHN					3%		3%	87%	5%		4%				5%
TWN									72%						
JPN									6%	92%	4%				3%
KOR									2%		78%				3%
USA	3%								2%		2%	86%	11%	14%	9%
MEX													82%		
CAN												2%		72%	
RoW	6%	8%	4%		7%	12%	5%	6%	8%	3%	7%	4%		4%	46%
Imported	13%	25%	12%	11%	15%	18%	17%	13%	28%	8%	22%	14%	18%	28%	54%

Source: own calculations using WIOD.

Note: entries identify column nation purchases of intermediate inputs as a share of total purchases of intermediates. Values below 2% are zeroed out.

The values for the EU are not very different when we look at the origin of value added in exports in Table 1.24. However, they are quite different for China which has a lower use of domestic value added than was suggested when looking at the sourcing of intermediates (75% versus 87% above). Moreover, the EU now stands out as the single most important source of foreign value added embodied in China's exports of Chemicals. This implies that a significant amount of EU value added is embedded in the intermediates sourced by China's chemicals exporters. The table also shows that the RoW is a very large supplier of inputs into all countries; for example, it supplies 10% of China's inputs and 19% of Korea's.

Table 1.24: Origin of value-added in the production of the chemical's sector exports 2009

	EU	TUR	BRA	RUS	IND	IDN	AUS	CHN	TWN	JPN	KOR	USA	MEX	CAN	RoW
EU	86%	10%	4%	5%	3%		4%	4%	6%	2%	6%	5%	3%	7%	14%
TUR		76%													
BRA			86%												
RUS		2%		90%											4%
IND					80%										
IDN						83%									
AUS							83%								
CHN					3%		3%	75%	5%		5%				4%
TWN									57%						
JPN								2%	6%	84%	4%				2%
KOR											56%				
USA	3%		2%				2%	2%	4%		4%	84%	9%	12%	7%
MEX													83%		
CAN												2%		72%	
RoW	5%	6%	4%		8%	10%	5%	10%	17%	7%	19%	4%	2%	4%	62%
Imported	14%	24%	14%	10%	20%	17%	17%	25%	43%	16%	44%	16%	17%	28%	38%

Source: own calculations using WIOD.

Note: entries identify column nation purchases of value-added inputs as a share of total purchases of value-added.

Table 1.25 identifies the sectoral intermediate product purchasing profile for the world, the EU and China in the chemical sector in 2009. Here we see that the top three intermediate inputs in the world

are: ‘chemicals’ (36%), ‘other services’ (17%); and ‘mining and fuel’ (16%). In terms of imported intermediates we note the higher importance of ‘chemicals’ and ‘mining and fuel’, and the lower use of ‘other services’. As has been the case for the “transport equipment” and “electrical and optical equipment” sectors, also in the “chemicals” sector the EU tends to rely more on services intermediates than the average (notably from the ‘renting M&Eq’ sector. China, on the other hand relies more on ‘mining and fuel’ domestic intermediates than the average but much less on service intermediates.

Table 1.25: Sectoral intermediate products used in the production of the chemical’s sector output 2009.

	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	3%	4%	2%	2%	2%	1%	7%	8%	3%
Mining and Fuel	16%	15%	19%	7%	6%	14%	19%	18%	30%
Light Manuf. (textile, leather, wood, paper)	3%	4%	3%	4%	4%	2%	4%	4%	2%
Chemicals	36%	33%	49%	29%	26%	48%	38%	38%	45%
Rubber and Plastics	2%	3%	2%	2%	2%	1%	4%	4%	2%
Basic metals	2%	2%	2%	2%	2%	2%	2%	2%	1%
Machinery nec	1%	1%	2%	1%	1%	1%	2%	2%	2%
Electrical and Optical Equipment	1%	1%	3%	1%	1%	1%	1%	1%	4%
Transport Equipment	0%	0%	0%	0%	0%	1%	0%	0%	0%
Transport and logistics services	4%	4%	4%	5%	5%	4%	3%	3%	2%
Telecom services	1%	1%	0%	1%	1%	1%	1%	1%	0%
Financial services	3%	3%	2%	2%	3%	1%	2%	2%	0%
Renting M&Eq and other business services	10%	10%	7%	17%	17%	16%	4%	4%	5%
construction services	0%	1%	0%	1%	1%	0%	0%	0%	0%
other services	17%	19%	6%	26%	29%	6%	12%	13%	3%
Share		83%	17%		87%	13%		87%	13%

Source: Own calculations,

note: entries show the use of intermediate product. All columns sum to 100% and show us how the composition of intermediate product use differs across the categories. Intra EU imports are classified as EU domestic intermediates.

Table 1.26 then shows the same information as above but on the basis of the origin of value added. The story that emerges is very similar. The EU is more reliant on service sectors’ value added whilst China is more reliant on mining and fuel.

Table 1.26: Sectoral value added in the production of the chemical’s sector exports 2009.

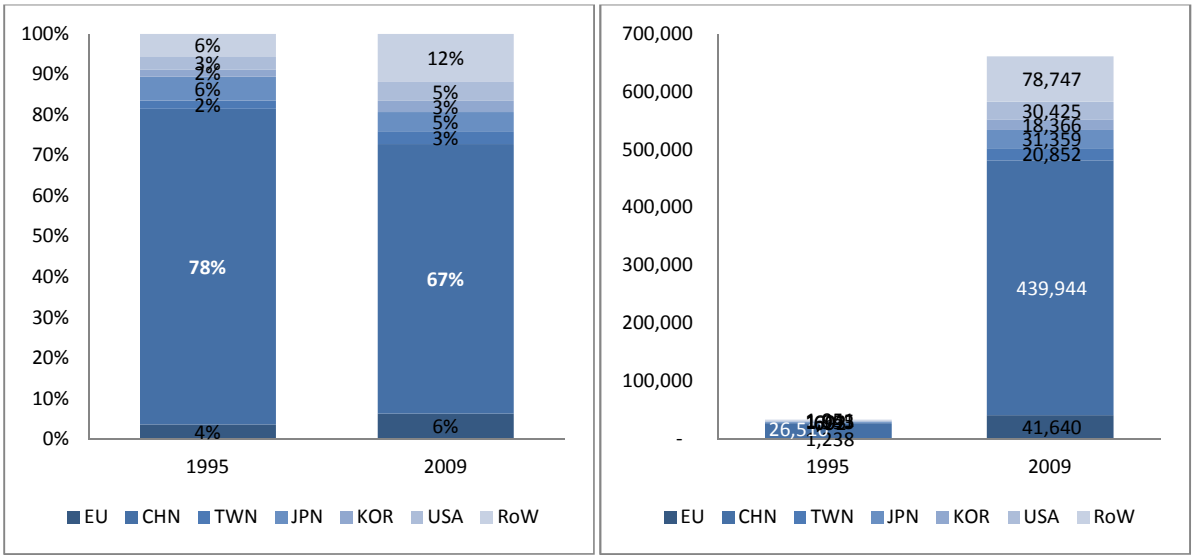
	World			EU			CHN		
	TOT	DOM	IMP	TOT	DOM	IMP	TOT	DOM	IMP
Agriculture and Food	2%	2%	3%	1%	1%	3%	8%	9%	3%
Mining and Fuel	14%	11%	23%	5%	2%	25%	18%	13%	34%
Light Manuf. (textile, leather, wood, paper)	2%	2%	3%	2%	2%	3%	3%	3%	3%
Chemicals	41%	50%	16%	43%	48%	15%	33%	40%	13%
Rubber and Plastics	1%	1%	1%	1%	1%	1%	2%	2%	1%
Basic metals	2%	1%	3%	2%	1%	3%	3%	2%	3%
Machinery nec	1%	0%	1%	1%	1%	1%	2%	1%	2%
Electrical and Optical Equipment	1%	1%	3%	1%	1%	2%	2%	1%	5%
Transport Equipment	0%	0%	1%	0%	0%	1%	1%	1%	1%
Transport and logistics services	4%	3%	7%	4%	4%	6%	4%	4%	5%
Telecom services	1%	1%	2%	1%	1%	2%	1%	1%	1%
Financial services	4%	3%	5%	3%	3%	4%	4%	5%	3%
Renting M&Eq and other business services	10%	9%	12%	15%	15%	16%	5%	3%	10%
construction services	1%	1%	1%	1%	1%	0%	0%	0%	1%
other services	16%	15%	19%	19%	20%	18%	15%	14%	15%
Share		76%	24%		86%	14%		75%	25%

Source: Own calculations,

note: entries show the value added content of exports. Intra-EU imported value added is classified as EU domestic.

In Figure 1.36 we investigate the evolution of the origin of value added in exports of the Chemical sector in China. The panel on the left identifies the share of total value added in a unit of exports of the chemical sector whereas in the right-hand panel shows the values. What transpires is that although the domestic value added content of Chinese exports is falling (from 78% in 1995 to 67% in 2009), the value over which this is reaped is increasing rapidly and hence that China although having a lower overall participation is reaping a large value ($26 billion in 1995 and $439 billion in 2009). The EU is also identified as the single largest supplier of value added in exports to this sector.

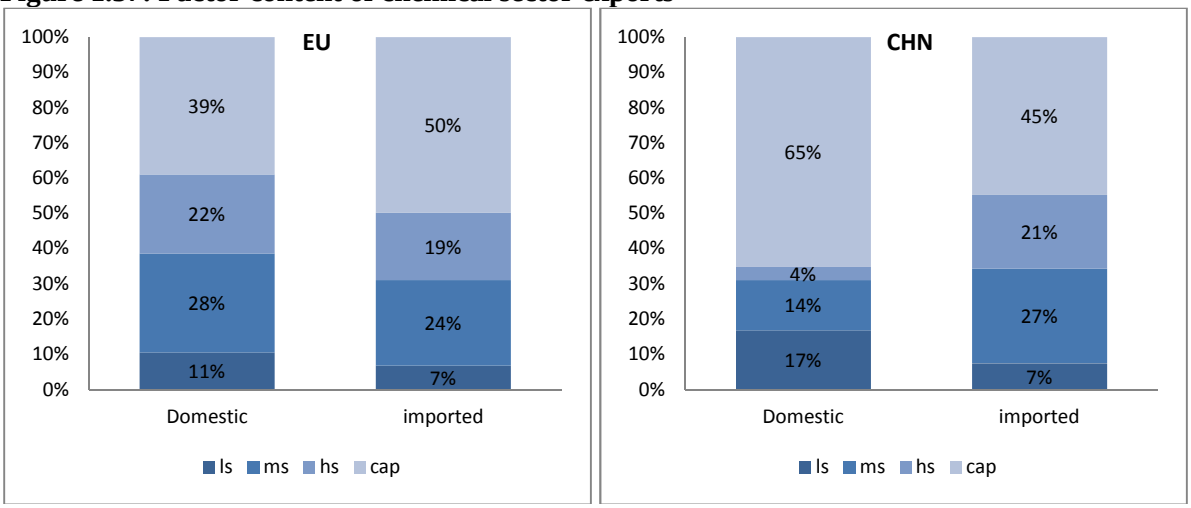
Figure 1.36: Evolution of value added content of chemical exports in China 1995 and 2009



Source: Own calculations,
note: Left-panel: value added share of one unit of chemical sector exports by origin. Right hand panel: dollar value of content of Chinese chemical sector exports by origin (values in $ billion).

The factor content of chemical sector's exports is charted in Figure 1.37. It shows that, for the EU the returns to capital are the main component of domestic value added in chemical sector's exports. This also holds for China but it is much more pronounced. In the EU, returns to medium-skilled labour and high-skilled labour together make up 50% of the domestic value added embodied in the Chemical sectors' exports. In terms of foreign sourcing, 50% of imported value added embodied in EU chemical sector exports arises from capital returns. China's imports also contain a large part of capital value-added. High and med skilled labour make 48% of imported value added while returns to low skilled-labour contribute only 7%.

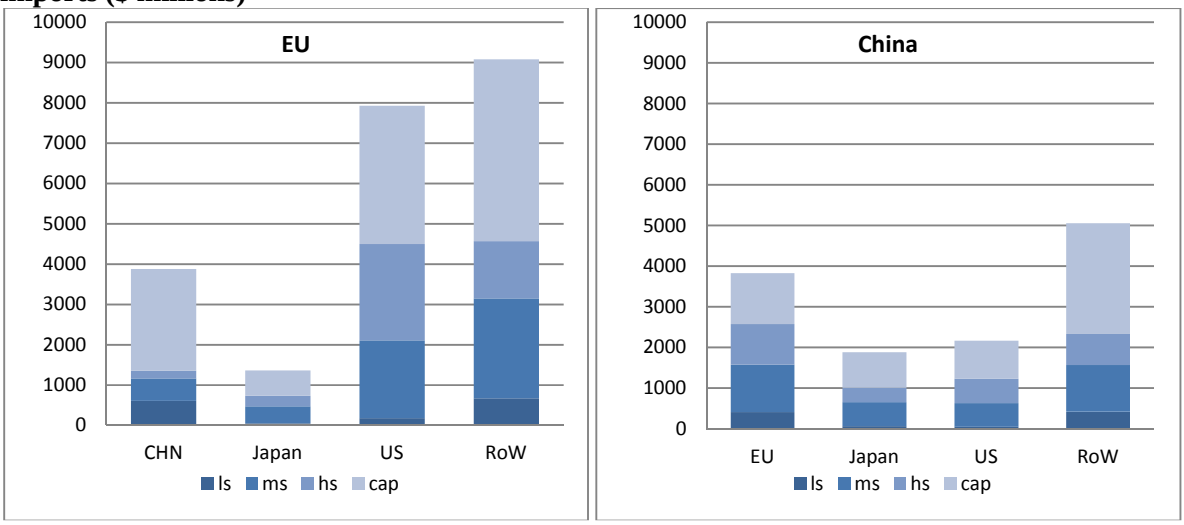
Figure 1.37: Factor content of chemical sector exports



Source: Own calculations, **note:** ls= low skill, ms= medium skill, hs= high skill, cap=capital value added. Intra EU imported value added is classified as EU domestic

Figure 1.38 shows the origin of imported chemical value added across the different factors where, for the EU, we see the large capital content of imported value added from China. From the US, high-skilled labour value added is nearly as large as capital. Chinese imports of value added from the EU are relatively evenly distributed across the capital, high and med skilled labour value added categories.

Figure 1.38: Origin and factor content of foreign value added in exports of chemical sector imports ($ millions)



Source: Own calculations, **note:** ls= low skill, ms= medium skill, hs= high skill, cap=capital value added.

Finally, in Table 1.27 we show the domestic comparative advantages held across different segements of production of chemical sector exports. The EU largely specialises in low, medium and high-skill value added in manufacturing and services. China on the other hand is more specialised in low skill and capital natural ressources and manufactures.

Table 1.27: Comparative advantages across sector and value added category in chemical sector exports, 2009

	Low-skill		Medium-skill		High-skill		Capital	
	EU	CHN	EU	CHN	EU	CHN	EU	CHN
Agriculture and Food		31		2.0	1.2			10.9
Mining and Fuel		19		9.4		2.0		8.6
Light Manufacturing	1.1	2.2	1.1		1.3			4.3
Chemicals	1.4		1.2		1.1			1.4
Rubber and Plastics	1.1	2.5	1.0		1.3			6.7
Basic metals	1.3	1.5	1.2		1.6			6.1
Machinery nec	1.2	2.3	1.4		1.6			7.0
Electrical and Optical Equipment	1.5	1.4	1.3		1.1			7.4
Transport Equipment	1.1	2.6	1.2	1.2	1.5			12.1
Transport and logistics services	1.4		1.1		1.3			2.3
Telecom services	1.9		1.1		1.0			1.6
Financial services	1.7		1.1	1.1				2.7
Renting M&Eq and other business services	1.7		1.3		1.3		1.5	
construction services	1.5		1.2		1.2		1.6	
other services	1.6		1.2		1.3			1.3

Source: Own calculations, **note:** Comparative advantage calculated as country-sector-type of value added divided by total sector value added which is then divided by world equivalent. Values above 1 identify an input sector / factor comparative advantage in the production of chemical sector exports. Values below 1 (comparative disadvantage) omitted for readability.

1.6. CONCLUSIONS AND POLICY IMPLICATIONS

Whether it is intermediate products, value added, investment or jobs, the bilateral links between the EU and China are important and growing fast. The EU and China have highly complementary production structures with the EU specialising in high and medium skill value added and China increasingly orienting its GVC participation towards low-skill and capital value added. These complementarities allow firms to exploit the benefits of specialisation and obtain important cost advantages in production. China-EU GVC activity embodies this form of mutually beneficial cooperation and calls for an increasing emphasis on policy coordination aimed at nurturing this relationship. The EU and China have vested interests in each other's success since China's exporting prowess creates jobs in the EU and vice-versa. With this in mind, we highlight some key policy conclusions.

EU External policy

EU policy needs to be premised on the assumption that both exports and imports are crucial to the evolution of competitiveness. The EU needs to ensure that trade in intermediates and other sources of imported value added that contribute to EU exports are liberalised/deregulated to allow the EU to reap the maximum export gains from specialisation. Opening of the domestic services market both internally and externally is likely to be important in this context. The old maxim “barriers to imports are barriers to exports” needs to be remembered.

EU domestic policy

Competitiveness begins at home; the importance of high skilled labour in EU value added exports emphasises the need to maximise the production of highly educated/highly trained workers if the EU is to remain internationally competitive. But we must be honest about the possible distributional implications of the gains to be had. Remaining globally competitive depends on high skilled labour and the continuing focus on ensuring a high skilled labour force is important. Such workers can raise their productivity by benefitting from the complementarity with low cost outsourcing activities. There will however be workers who find it harder to move into jobs that benefit from positioning in GVCs. The continuing social acceptance of the gains from trade with China reaped by consumers and high skilled workers may depend on opportunities for employment, notably in the non-traded sector, for workers with less flexibility.

The importance of EU service sector engagement with China suggests the need to further open up the EU domestic services market, both to ensure the lowest possible cost of services to be embodied in EU exports and the need to have service providers able to compete in China. Services are at the heart of EU value added trade and efforts need to be made to ensure that Services remain competitive. On the face of it that requires investment on the provision of skills necessary to produce high value added services. It also underlines the importance of the completion of the single market in services so that domestic competition drives productivity gains and the size of the markets allows realisation of economies of scale.

Chinese policy

The study results emphasise the gains to China from the liberalisation of imports of goods and services intermediates. China’s tariffs have been lowered since the accession to the WTO but they are

still higher than the EU's.[29] Again a tax on imports is a tax on exports. The scope for increasing inward FDI with consequent increases in GVC formation should also be emphasised. The apparent relatively low levels and growth of bilateral FDI suggests that a bilateral investment agreement may help to further increase/nurture GVC activity between the EU and China. The latter would imply deregulation of remaining ownership restrictions and rights of establishment. IPR enforcement is another perennial issue, it is in principle tractable and there is a constituency in China with IPRs to defend. Further services deregulation would also improve the possibility of expanding GVC formation, issue which we will touch upon in subsequent sections.

[29] Chinese unweighted (weighted) tariffs in 2001 were 15.9% (14%). In 2011 the unweighted (weighted) average Chinese MFN tariff was 9.5% (4%) whereas that of the EU was 4.2% (2.4%).

SECTION 2: FIRM LEVEL ANALYSIS ON THE IMPACT OF MARKET BARRIERS ON EU FIRMS OPERATING IN CHINA

2.1. TECHNICAL SUMMARY

In this section we exploit the European Business Confidence Survey in China (BCS) to describe European firms' activity in China, especially that which is related to participation in Global Value Chains (GVCs). In addition to describing firms' activity we focus on understanding the impact that different regulatory barriers in China may have on European firms and their response to these obstacles.

A value chain is defined as the set of production processes and services required to develop a product from its inception to its commercialization. When the processes and services required are implemented in more than one country, we use the term Global Value Chains (GVCs). Firms can be involved in different aspects of any given GVC. However the dataset that we are using is based on EU firms operating in China. This implies that we are unable to observe all the stages of the GVC or all the different firms participating in the entire value chain. Instead, we can determine whether EU firms in China participate in some stage of the GVC. This could be that they are either buyers (importers) or suppliers (exporters) of intermediate goods to other firms located abroad. Using the information available on the exports and imports of intermediate goods, we distinguish between two types of GVC activity. We use the term "backward linkages" to capture the use of imported intermediates by EU firms based in China; and the term "forward linkages" to capture the supply of intermediate products by EU firms based in China to firms outside of China.

In addition, given the information available in the BCS we also explore two additional dimensions of GVC activity. The first one relates to the degree of contractual rigidity, or value chain governance of the backward linkages. This is based on the nature of the contractual relationship of the EU firms in China with their suppliers of intermediates. In the literature on global value chains, forward and backward linkages are also used to reflect linkages with domestic firms. In our sample we can only identify such domestic linkages for the firms that are already also engaged in international linkages. For these firms, therefore, the second dimension explored is the difference between international GVC activities and firms engaging in domestic (China) linkages.

This section of the report is composed of a descriptive statistical analysis of the responses of the firms, and a formal econometric analysis. In the descriptive statistical analysis we seek to identify:

i) The characteristics of firms that operate in global value chains in China (GVC firms) in comparison to those that do not participate in GVCs (non-GVC firms).
ii) The impact that barriers have on the intensity of the backward and forward linkages of GVC firms.
iii) The responses that the firms make when faced with barriers.

For the formal econometric analysis we address the following specific questions:

i) Do GVC firms experience a larger incidence of these barriers than non-GVC firms?
ii) Do the barriers impact on the intensity of GVC activity?
iii) What is the impact of these barriers on the probability of firm-level responses such as relocating production away from China?

The key results are:

GVC and non-GVC firm characteristics:

- EU firms in the sample operating in China are concentrated in Shanghai and Beijing, and more than 50% have been operating in China for over 10 years. The majority of firms have less than 250 workers, and for the majority of these their proportion of global revenue generated in China is less than 15%.
- GVC firms reveal fairly similar characteristics to the average EU firm in China, but tend to be slightly less concentrated in Beijing, more vertically integrated, employ more people, a higher proportion have been in China for more than 10 years, and their activities represent a slightly higher share of global operations.
- Across the whole sample the most common forms of legal status are fully owned foreign entity (54%), representative office (18%), and joint venture (14%). There is a higher proportion of GVC firms that are either wholly foreign owned (61%) or joint ventures (16%).
- Linked to this, most EU firms in China invest by adopting stricter contractual forms with Chinese subsidiaries (mainly FDI and joint-ventures), relationships with suppliers are more flexible and concentrate mainly on subcontracting inputs, and to a lesser extent on spot market purchases.
- While overall most EU firms operating in China concentrate on providing services (primarily professional or financial services), firms engaging in GVCs are significantly more concentrated in manufacturing.
- The main motivation of firms appears to be either traditional market seeking objectives, or for engagement in domestic value chains as opposed to participation in international backward or forward linkages. 75% of both GVC and non-GVC firms indicated that the provision of goods and services to the Chinese markets is their principal strategic reason to be in China. For the GVC firms these are therefore largely firms with backward linkages with foreign suppliers.
- The focus on market seeking can also be seen from the fact that 63% of firms do not carry out any import or export activity, and almost 13% of firms are two way traders. Out of the firms engaging in GVCs, these are equally distributed between those that are engaged in importing, exporting, or are two-way traders.

Backward and forward linkages:

- International backward linkages are prevalent in around 25% of firms in the survey, mainly in manufacturing. These backward linkages are typically established using more flexible contractual relationships and focus on the sub-contracting of inputs and on spot market purchases. This contractual flexibility with suppliers is observed for all type of products (standard of customised), sectors and destinations.
- Around 19% of all firms in the survey engage in international forward linkages and 29.5% of all firms engage in supplying intermediates to Chinese firms. Around 59% of firms with international forward linkages have been in China for more than 10 years, while 76% of firms producing inputs for local firms have been in China more than 10 years. Firms engaging in forward linkages tend to be larger and generate more revenues, especially those oriented to provide inputs to China.

Barriers / Obstacles for firms' activities:

- Overall, most firms indicate market access barriers as the most costly obstacle for EU firms operating in China. The incidence of these barriers appears quite consistent in terms of

importance across GVC and non-GVC firms. However, for firms that do not trade internationally, administrative barriers are also important, while for trading firms other key barriers are regulatory barriers and bureaucracy.

- Other barriers, such as discrimination faced by Foreign Invested Enterprises in accessing public procurement and restrictions in access to financing appear to be the barriers with lower incidence.
- Regarding firms with backward linkages with foreign suppliers; firms that vertically integrate perceive intellectual property rights as the main obstacle in their operations, which may indicate that vertical integration and tighter control of suppliers is the result of a desire for property rights control.
- Firms with forward linkages with foreign buyers perceive regulatory barriers, in addition to market access barriers, as significant constraints to their activity.
- In general, about 50% of the full sample of firms perceives that one or more barriers have a significant impact in their operations in China. For 65% of the GVC firms the barriers impact on less than 25% of their revenues, but for nearly 21% the impact is greater than this. The corresponding figures for non-GVC firms are 50% and 26%.
- The response of EU firms to these barriers appears to have a direct impact on the Chinese economy via changes in prices to consumers and suppliers, constraints on technology diffusion and transfer, and through reductions on investments or procurement of intermediate goods
- A ball park figure of the aggregate impact suggests that the extent to which firms have chosen to relocate their activity away from China corresponds to the equivalent of between 383 million to 1.5 billion Euros. Similarly an approximate figure for the extent to which firms have reduced their purchase of intermediate inputs within China is between 30 million to 208 million Euros. Together, these figures represent between 1.2% to 2.8% of the EU firms' turnover. Another way of considering the impact of the barriers faced by the EU firms is the impact on prices. The responses suggest that on average the impact has been for EU firms to increase the prices paid by Chinese businesses and consumers by between 1.5%-3.5%.

Econometric Analysis

- While the descriptive analysis indicated differences in the perceived incidence of regulatory barriers between GVCs and non-GVCs, these are not statistically significant in the sample for market access or administrative obstacles. Statistically the barriers that appear to be most important for GVC firms are: restrictions in access to financing, registration processes for companies/products and discretionary enforcement of regulation. IPR protection seems a more important barrier for non-GVC firms. This last result might be explained by the fact that GVCs may be more likely to use vertical integration and joint-ventures, which is in part a mechanism for the protection of their intellectual property rights.
- The results regarding the impact on the intensity of forward and backward linkages are not very robust in terms of statistical significance. Only some barriers affect the intensity of the international backward linkages - mainly market access, regulatory requirements and tax obstacles. Interestingly, while tax obstacles may reduce the intensity of these linkages, market access and regulation appear to increase global sourcing of inputs by discouraging domestic sourcing. If this is the correct explanation this would suggest that such barriers may impact negatively on the deepening of linkages with Chinese firms along the value chain.
- The results confirm some of the findings of the descriptive statistics section and show that the impact of the different barriers in China is not only on EU firms via increasing their costs and

reducing sales, but also on the Chinese economy via increasing prices to consumers and firms, reducing investment and decreasing the sourcing of domestic intermediates.

- Most of the regulatory barriers analysed trigger significant "negative" responses from firms in terms of either reductions in investment, reductions in purchases of intermediates, increases in their prices, or the relocation of activity away from China. This was especially the case with respect to IPR infringement; but interestingly, not with respect to regulatory barriers. With regulatory barriers, it appears that the presence of barriers is negatively correlated with the relocation of production and investment. If overcoming regulatory barriers requires firms to incur sunk costs this could discourage firms from subsequently relocating production by making it unprofitable. An alternative explanation is that once the costs of complying with the regulatory frameworks have been met, firms may find themselves in a more comfortable market position consequently reducing the probability of reallocation. Of course the regulatory barriers may have also impacted on the initial decision to invest and plausibly could discourage investment, but our data does not allow us to address this issue.

2.2. INTRODUCTION

This section is based on the European Business Confidence Survey (BCS) carried out by the EU Chamber of Commerce in China (EUCCC).The objective of the section is twofold. First, we aim to describe key characteristics of European firms operating in China and in particular with regard to their Global Value Chain (GVC) activity. Second, we examine the possible impact of obstacles, such as regulatory barriers or market access barriers, as perceived by European firms, on their activities, and once again in particular on their value chain activity in China.

A value chain is defined as the set of production processes and services required to develop a product from its inception to its commercialization. When the processes and services required are implemented in more than one country, we use the term Global Value Chains (GVCs). Hence we define a *GVC firm*, as a firm that has any intermediate linkage with foreign firms. In contrast, non-GVC firms are those that do not engage in any international sourcing or selling of intermediates. This definition is analogous to that used in earlier sections of this report where we identify the importing and exporting of intermediates as the determinant of participation in GVCs.

Specifically, we distinguish between two aspects of GVC activity:

(i) Backward linkages– where firms participate in GVCs by purchasing intermediate inputs from foreign firms. With regard to backward linkages the BCS survey also provides information as to the nature of the contractual relationship that firms have with their intermediate suppliers, and the associated degree of control that this implies (see Box 1). We therefore also explore this additional dimension of GVC activity.

(ii) Forward linkages – where firms sell intermediate goods to other firms abroad.

Box 1. Contractual relationships along the value chain

Firms may adopt different contractual relationships with suppliers in the value chain depending on the type of control that they want to exert over suppliers, based on the type of product that is being produced, control over property rights or different business strategies.

In the BCS, we can observe that firms can adopt one or more of the following contractual relationships with suppliers:

- FDI or vertically integrated suppliers – where buyers "own" suppliers and value chain relationships are totally controlled by buyer and occur intra-firm. This may be explained by the desire of the parent company to keep residual rights or protect intellectual property rights during the production process
- Joint ventures- joint investments between suppliers and other local investors, where while significant control of the production process is kept by buyers, some rights are transferred to local investors.
- Franchising – local investments where know-how and technology is transferred to local investors under rigid usage rights.
- Subcontracting – flexible form of relationship with suppliers where intermediates are subcontracted under flexible contracts for suppliers, with little control from buyers and also little or no transfer of technology or know-how.
- Procurement in spot markets – no contractual relationships between buyers or suppliers in the short or long-run. Buyer purchase standardised intermediates to suppliers, and can change procurement in the short run.

As suggested above, these types of contractual relationships represent different degrees of rigidity in terms of the governance of inter-firm transactions. FDI / vertical integration provides a high degree of control; whereas with spot market transactions there is considerably less control of suppliers.

In the literature forward and backward linkages are also used to reflect linkages with domestic firms. Hence while this report primarily focuses on linkages with foreign firms (GVCs), there is also a possible 'domestic' element to global value chains. We refer to this as Domestic Global Value Chains (DGVCs). A DGVC is where an EU firm based in China is mainly supplying or purchasing intermediate inputs to/from another firm in China. For example, an EU firm selling service inputs to another firm in China represents a transaction whereby the other firm is using foreign know-how to enhance its production capabilities. Note, that the 'other' firm here could either be a Chinese firm, or another foreign firm.

In our sample, we can identify DGVC activities only for those firms that also engage in international GVCs i.e. for those firms that are engaged in either the import or export of intermediates from abroad. Here we can identify whether intermediates are also being purchased from or sold to another business in China, but we cannot identify whether it is to a Chinese firm or to another foreign firm. Therefore with regard to both forward and backward linkages we also explore, in the empirical section, the differences between firms that buy and sell intermediates from/to abroad from those that do so in the domestic market

The dataset we have, which is based only on EU firms operating in China, comes with certain limitations. First, we cannot observe all the stages of the GVC or provide a complete description of the degree and types of inter-firm integration, coordination or contractual relationship across the chain. Secondly, it is possible and indeed likely that some of the firms that do not engage in GVCs, may be engaged in business-to-business (B2B) transactions in China (i.e. DGVCs), by either supplying / purchasing intermediates to/from Chinese firms. However, our sample does not enable us to identify such firms. Thirdly, the survey does not allow us to easily distinguish between goods and service activities along the value chain. In most cases therefore our results and definitions of GVCs refer to goods rather than services.

This section is structured into seven parts. In the next part, we characterise EU firm activity in China and analyse some of the differences between GVC and non-GVC firms. Part 4 focuses more specifically on describing EU firm GVC activity in China and the types of GVC activity that are more prevalent. Given that one of the objectives of this report is to analyse the impact of different policy obstacles on GVC activity in China, in part 5 we describe the incidence of obstacles for each type of GVC activity group using the information provided in the survey. This is complemented in part 6 with an econometric analysis that focuses on understanding whether regulatory barriers have a larger impact on GVC firms than on non-GVC firms, whether barriers affect VC intensity and what the response of EU firms to some of these obstacles has been. The last section, part 7, concludes and gives some policy implications.

2.3. DESCRIBING EU FIRM ACTIVITY IN CHINA

2.3.1. THE SURVEY

The survey used in the analysis is the European Business Confidence Survey in China administered by the European Union Chamber of Commerce in China. The EUCCC invited its members to take part in the 2013 Business Confidence Survey over a two-week period during March 2013. The survey was conducted in cooperation with Roland Berger Strategy Consultants and was published in May

2013. There were 1,403 eligible entities.

The core survey comprised 47 questions, grouped under four key themes:

- Company Profile and Statistics
- Outlook on China, Competition, Company Strategy and Regulation
- Human Resources
- Financial Performance

It was agreed, with the EUCCC, that a GVC component, comprising 18 additional questions, be annexed to this survey. A concern of the EUCCC was that the addition of a GVC section to the BCS would overburden firms and hence jeopardise the response rate to the overall survey. In order to mitigate this we agreed that a 'trigger question' be introduced, which, when answered affirmatively, would bring up the GVC component for firms to respond to at the end of the survey. The trigger question asked firms whether they were engaged in either the buying or selling of products outside of China.

Out of the 1,403 eligible entities affiliated to the EUCCC 760 firms responded to the BCS 2013 survey. Of these 205 indicated that they were engaged in some form of international as opposed to purely domestic activity, and were then asked to respond to the GVC component. The response rate was, therefore, 54.17% of the known universe of EUCCC member firms in China and the more detailed GVC questionnaire was implemented to 14.6% of the firms.

Some of the empirical limitations related to the use of the BCS are worth noting. First, we do not know how representative the firms that are members of the EUCCC are of the universe of EU firms in China.[30] Since membership to the EUCCC is voluntary there is 'self-selection' which may or may not be correlated with; sector of activity, size of firms and time in China, factors which may also be correlated with participation in GVCs. We cannot formally control for this in the econometric analysis. Second, and as mentioned above we are not able to capture the interaction between those EU firms who do not engage in international GVC activities and other firms in China. Hence, for non-GVC firms we cannot control for the degree of value chain interaction with domestic firms. Third, although the BCS has been administered annually for a number of years we were unable to use the longitudinal dimension of the data since both firm identifiers and questions vary by year. Our econometric analysis is therefore restricted to the cross-sectional dimension and to a relatively limited amount of firms. Finally, there is a lack of continuous variables in the dataset since firms are reluctant to divulge what they consider may be commercially sensitive information. This means that many variables (e.g. with regard to turnover) are defined in ranges, in turn requiring the use of more restrictive econometric models.

2.3.2. GENERAL CHARACTERISTICS OF EU FIRMS IN CHINA

In this section we describe European firms' activity in China and their main characteristics. We distinguish between firms engaging in GVCs and firms that do not engage in GVCs (Non-GVC). As described above, we define a GVC firm as any firm that has either a backward or a forward linkage in the international market. For all tables, the values in parenthesis correspond to column percentages unless specified differently.

[30] Some back of the envelope estimates from the EUCCC suggest the possibility of there being around 20,000 in total. The national membership manager of the EUCCC counts around 7000 but it is important to note that many of these can be duplicates as there is a tendency to register affiliates across different provinces.

There is relatively little difference between GVC and non-GVC firms in terms of the location of their HQ (Table 2.1). Each of these (70% and 78% respectively) is primarily located in Beijing and Shanghai, with more non-GVC firms being in Beijing than GVC firms (34% versus 26%). There are also more GVC firms operating in Guangzhou (14%) in comparison to non-GVC firms (9%). In terms of the time operating in mainland China (Table 2.2), on average 52% of firms have been operating for more than 10 years, with this applying to 57% of GVC firms, and 51% of non-GVC firms.

Table 2.3 shows the legal entity under which EU firms operate in China. The categories are not mutually exclusive since in some cases firms may have more than one legal entity, and therefore, the percentage represents the share in the total number of existing legal entities rather than firms. The most common legal status is fully owned foreign entity (53.63%) followed by a representative office, join venture, and regional office. Interestingly, firms engaging in GVCs tend to have legal entities that represent more stringent control from European investors; 77% of firms are either wholly foreign owned (61.3%) or joint-venture (15.7%); compared to 65.4% of non-GVC firms. In general, European firms investing in China, both GVCs and non-GVCs, appear to look for tighter control of Chinese subsidiaries.

Table 2.1: Firms HQ location

	Non-GVC	**GVC**	**Total**
Beijing	169	44	213
	(33.87%)	(26.19%)	(31.93%)
Shanghai and lower Yangze River Delta	218	74	292
	(43.69%)	(44.05%)	(43.78%)
Nanjing and middle Yangze River Delta	18	13	31
	(3.61%)	(7.74%)	(4.65%)
Guangzhou, Shenzhen, and the Pearl River	45	24	69
	(9.02%)	(14.29%)	(10.34%)
Chengdu, Chongqing and Western China	21	3	24
	(4.21%)	(1.79%)	(3.6%)
Other	28	10	38
	(5.61%)	(5.95%)	(5.7%)
Total	499	168	667

Table 2.2: Time operating in mainland China

	Non-GVC	**GVC**	**Total**
< 2 years	27	3	30
	(5.41%)	(1.79%)	(4.5%)
2-5 years	73	23	96
	(14.63%)	(13.69%)	(14.39%)
6-10 years	144	47	191
	(28.86%)	(27.98%)	(28.64%)
11-20 years	149	67	216
	(29.86%)	(39.88%)	(32.38%)
>20 years	106	28	134
	(21.24%)	(16.67%)	(20.09%)
Total	499	168	667

Table 2.3: Legal entity under which company is registered

	Non-GVCs	GVCs	Total
Wholly owned foreign	312 51.91%	133 61.29%	451 53.63%
Representative Office	124 20.63%	20 9.22%	148 17.60%
Regional Branch/Office	51 8.49%	10 4.61%	64 7.61%
Joint-venture	81 13.48%	34 15.67%	121 14.39%
Holding	14 2.33%	8 3.69%	26 3.09%
Foreign Invested Commercial Enterprise (FICE)	12 2.00%	10 4.61%	22 2.62%
Foreign Invested Partnership Enterprise (FIPE)	7 1.16%	2 0.92%	9 1.07%

Regarding size, around 59% of all firms operating are small and medium sized enterprises with less than 250 employees in China. Only around 11% are large companies employing more than 5000 people. GVC firms tend to be bigger in terms of number of employees. Around 27% of them have more than 1000 employees in Mainland China, compared with 19% of non-GVC firms. At the other end of the scale, nearly 42% of Non-GVC firms have less than 50 employees, compared to just over 21% of GVC firms. Of course in good part this could be driven by the different sectors of activity between GVC and non-GVC firms (see also Table 2.6 below). The more formal econometric analysis later in this section controls for such sectoral factors.

Table 2.4: Firm size- Number employees in mainland China

	Non-GVC	GVC	Total
<50	209	36	245
	(41.88%)	(21.43%)	(36.73%)
51-250	105	44	149
	(21.04%)	(26.19%)	(22.34%)
251-1000	89	41	130
	(17.84%)	(24.4%)	(19.49%)
1001-5000	46	28	74
	(9.22%)	(16.67%)	(11.09%)
>5000	50	19	69
	(10.02%)	(11.31%)	(10.34%)
Total	499	168	667

In terms of revenues generated in Mainland China, 20% of the firms had total revenues in 2012 between 11 and 50 million Euros and 8.9% of the firms generated more than a billion Euros in total revenues. GVC firms tend to generate larger revenues in China than non-GVC firms, with 11.3% generating more than 1 billion Euros.

In order to look at the importance of China for EU firms, Table 2.5 shows the proportion of the revenues mainland China represents out of total revenue. For around 54% of the firms in the sample the revenue generated in China was less than 10% of total global revenues; and for only 26% do revenues represent more than 25% of global revenues. For the majority of firms their proportion of global revenue generated in China is less than 155. This suggests that the importance of operating in China for most EU firms in the sample is relatively low when considering global revenues. The importance for GVC firms appears slightly higher in terms of global share of China operations as

compared to non-GVC firms, where for 48% of GVC firms revenues from Chinese operations account for more than 10% of global revenue. For non-GVC firms the corresponding figure is 45%.

Table 2.5: Proportion of global revenues produced in mainland China in 2012

	Non-GVC	GVC	Total
<5 %	129	41	170
	(33.16%)	(27.15%)	(31.48%)
5-10 %	86	38	124
	(22.11%)	(25.17%)	(22.96%)
11-15 %	39	26	65
	(10.03%)	(17.22%)	(12.04%)
16-25 %	26	14	40
	(6.68%)	(9.27%)	(7.41%)
>25 %	109	32	141
	(28.02%)	(21.19%)	(26.11%)
Total	389	151	540

Summing up, EU firms in the sample operating in China appear to be concentrated in Shanghai and Beijing, and more than 50% have been operating in China for more than 10 years. The majority of firms have less than 250 workers, and for the majority of firms their proportion of global revenue generated in China is less than 15%.The most common forms of legal status are fully owned foreign entity, representative office, and joint venture GVC, with more GVC firms being fully foreign owned or joint-ventures in comparison to non-GVC firms. Firms reveal fairly similar characteristics to the average EU firm in China, but tend to be slightly less concentrated in Beijing, more vertically integrated, employ more people and their activities represent a slightly higher share of global operations.

2.3.3. SECTOR, CUSTOMER SEGMENT, SUPPLIERS

In terms of the sector of activity, Table 2.6 shows a significant difference between GVC and non-GVC firms.71% of non-GVC firms are in the services sector, in comparison to 32% of the GVC firms. Conversely, 25% of the non-GVC firms are in manufacturing, in comparison to 65% of the GVC firms. Only around 4% of firms declare extraction and raw materials to be their sector of operation, and this proportion is similar for both GVC and non-GVC firms.

Table 2.6: Main broad sector of activity [a]

	Non-GVC	GVC	Total
Services	376 (70.54%)	59 (32.24%)	437 (60.11%)
Manufacture	136 (25.52%)	118 (64.48%)	261 (35.9%)
Extraction/Raw materials	21 (3.94%)	6 (3.28%)	29 (3.99%)
Total	533	183	727

[a]Some firms are multi-sector and operate in more than one broad sector

Table 2.7 outlines the sub-sectors of operation. In aggregate, the sectors with the biggest shares are "other" (22.7%), professional services (21.2%), followed by financial services (9.2%), machinery (7.1%), transportation and logistics (5.1%). All other sectors have a share of less than 5%. In contrast, firms engaging in GVCs operate mainly in "other" (27.4%), automotive (11.3%), machinery (11.3%), chemicals (10.7%), pharmaceutical (8.93%) and food & beverages (6.6%). On the other hand, 40% of

non-GVC firms are mainly concentrated in two services sectors, professional and financial services and with 21.1% of the firms in the sector "other".

Table 2.7: Sub-sector of activity

	Non-GVC	GVC	Total
Automotive	15	19	34
	(3.11%)	(11.31%)	(5.22%)
Chemicals and Petroleum	16	18	34
	(3.31%)	(10.71%)	(5.22%)
Civil engineering and construction	12	4	16
	(2.48%)	(2.38%)	(2.46%)
Fashion and textile	3	2	5
	(0.62%)	(1.19%)	(0.77%)
Food and Beverage	12	11	23
	(2.48%)	(6.55%)	(3.53%)
Machinery	27	19	46
	(5.59%)	(11.31%)	(7.07%)
Utilities, primary energy and other	8	12	20
	(1.66%)	(7.14%)	(3.07%)
IT and telecom	22	7	29
	(4.55%)	(4.17%)	(4.45%)
Pharmaceuticals and healthcare	15	15	30
	(3.11%)	(8.93%)	(4.61%)
Financial services	60	0	60
	(12.42%)	(0%)	(9.22%)
Other professional services	132	6	138
	(27.33%)	(3.57%)	(21.2%)
Media and publishing	8	1	9
	(1.66%)	(0.6%)	(1.38%)
Retail and hospitality	25	1	26
	(5.18%)	(0.6%)	(3.99%)
Transportation, logistics and distribution	26	7	33
	(5.38%)	(4.17%)	(5.07%)
Other	102	46	148
	(21.12%)	(27.38%)	(22.73%)
Total	483	168	651

Overall the majority of firms surveyed (75%) have as the main strategic reason to be in China the provision of goods and services to the Chinese market. This, therefore, suggests that the main motivation of these firms is either traditional market seeking objective, or for engagement in DGVCs, as opposed to participation in international backward or forward linkages. The picture does not change whether we look at firms involved in GVCs or not, a majority of which are firms with backward linkages with foreign suppliers. Nevertheless 14.3% of firms have as their strategic reason the aim of supplying to markets outside of China, mainly those with forward linkages with foreign buyers.

Table 2.8: Strategic reason to operate in China

	Non-GVC	GVC	Total
To provide goods or services for Chinese market	358	126	484
	(74.27%)	(75%)	(74.46%)
To provide goods or services for the EU market	52	20	72
	(10.79%)	(11.9%)	(11.08%)
To provide goods or services for other markets	2	4	6
	(0.41%)	(2.38%)	(0.92%)
Access to the supply of goods or services from Chinese firms	10	9	19
	(2.07%)	(5.36%)	(2.92%)
Use local intellectual and R&D resources	12	4	16
	(2.49%)	(2.38%)	(2.46%)
Request from European customers / partner to enter China	48	5	53
	(9.96%)	(2.98%)	(8.15%)
Total	482	168	650

The importance of the Chinese market for EU firms is also clear when looking at trading status. Around 63% of the firms in the survey do not carry out any import or export activity, while almost 13% of firms are two-way traders. By definition, GVC firms perform some trading activities, and GVC firms are evenly distributed across the three trading groups, only importers, only exporters and two-way traders. Most EU firms operating in China have, therefore, a market seeking orientation.

Table 2.9: Trading status

	Non-GVC	GVC	Total
Two-way trader	27	57	84
	5.61%	33.93%	12.94%
Exporter	15	54	69
	3.12%	32.14%	10.63%
Importer	30	57	87
	6.24%	33.93%	13.41%
no trader	409	0	409
	85.03%	0.00%	63.02%
Total	481	168	649

The largest customer segment for EU firms is business-to-business - i.e. to privately owned companies (55%) and around 20% of the sample operates in the business to consumer segment. These figures are similar for both GVC and non-GVC firms in terms of market segments. This in turn suggests that non-GVC firms are engaged in DGVC either through the provision of services or goods.

Overall most EU firms operating in China concentrate on providing services (primarily professional or financial services). Firms engaging in GVCs are significantly more concentrated in manufacturing as opposed to services with 75% of these aiming primarily to serve the Chinese market.This suggests that the main motivation is either traditional market seeking objective, or for engagement in DGVCs, as opposed to participation in international backward or forward linkages.Interestingly the nature of the GVC engagement is equally distributed between firms that are engaged in importing, exporting, or both of these.

2.4. GVC FIRMS IN CHINA

The previous section analysed EU firms operating in China and compared GVC and non-GVC firms. In order to further understand GVC activity, an additional questionnaire was administered to a sub-sample of firms involved in either export or import activities of intermediates. This additional

questionnaire was aimed at obtaining information on the nature of firms' internationalization and participation in global value chain activities, as well as on the possible impact of regulatory barriers which may be present in China. In this section we provide an overview of additional characteristics of these firms in areas which builds on the information available from the general questionnaire.

Most of the EU companies operating in China also operate in the EU, Asia and North America; and around half of these firms have been in business with these countries for more than 10 years. This suggests that our survey is capturing mainly well-established EU firms with a significant history of operations in different countries, including China. This also implies that there may be a significant lack of new investors in the survey, hence when analyzing the impact of regulatory barriers the analysis is de facto focusing on the impact on existing firms rather than on entry of new firms.

According to the economic literature the type of product produced (e.g. whether it is a standard or customized product) influences the type of GVC governance and contractual relationship within the GVC. For example, when products are highly customized, firms may want more control of suppliers in order to guarantee the quality of the process or to protect IPRs. Also, firms might want to produce some processes in countries with more production capabilities and with a higher degree of contractual enforcement.

The survey allows us to look at different cross-tabulations related to the type of product produced. Table 2.10 shows the tabulation of the type of product for inputs and final products and the market destination and origin. The type of product is almost evenly split between customised and standard types across all locations.

Table 2.10: Type of product by market destination and input source

With regard to your principal product what type of product is this and in what destination is it being sold?	**Customised**		**Other**		**Standard**		**Total**
China	83	42.35%	9	4.59%	104	53.06%	196
Asia	63	45.00%	3	2.14%	74	52.86%	140
EU	68	47.89%	4	2.82%	70	49.30%	142
North America	60	47.24%	5	3.94%	62	48.82%	127
Elsewhere	39	45.88%	6	7.06%	40	47.06%	85
Total	313	45.36%	27	3.91%	350	50.72%	690
Relating to your top input: What type of product is this and what is its origin?							
China	64	34.41%	13	6.99%	109	58.60%	186
Asia	39	32.23%	6	4.96%	76	62.81%	121
EU	55	37.93%	6	4.14%	84	57.93%	145
North America	36	33.03%	6	5.50%	67	61.47%	109
Elsewhere	26	28.26%	7	7.61%	59	64.13%	92
Total	220	33.69%	38	5.82%	395	60.49%	653

The type of inputs is instead more concentrated on standard products, which suggests less need for very rigid contractual relationships with suppliers. Indeed, as shown in Table 2.11 flexible contractual relationships with suppliers, such as spot market purchases or subcontracting activities, are the most prevalent forms of contractual relationships between EU GVC firms and their input supplier. Out of these two contractual forms, subcontracting, which involves a significantly larger degree of control than spot market procurement, is the main contractual form, in 61.2% of cases overall. What is perhaps surprising is that a significant number of cases of customized products also use more flexible contractual relationships (i.e. spot market and sub-contracting) with suppliers. Therefore, in general

the type of product does not seem to impact on the type of contractual relationship with suppliers, which appears to be largely flexible.

The duration of the relationship with suppliers varies across locations with less durable relationships (less than 10 years) prevailing in China and Asia while the opposite happens in the EU and North America.

Table 2.11: Type of product and contractual relationship with suppliers

	Spot		subcontract		franchising		Joint-venture		FDI		Total
custom	20	28.57%	45	64.29%	0	0.00%	0	0.00%	5	7.14%	70
standard	21	29.58%	42	59.15%	1	1.41%	2	2.82%	5	7.04%	71
other	0	0.00%	2	50.00%	1	25.00%	1	25.00%	0	0.00%	4
Total	41	28.28%	89	61.38%	2	1.38%	3	2.07%	10	6.90%	145

2.4.1. TRADING FIRMS

In this section we compare firms that have different degrees of participation in international markets. We focus on exporters, importers and two-way traders. Trading is not necessarily a direct measure of participation in GVCs, since firms could export a final product totally produced in-house and without any foreign participation in the production process. However, trading is a first approximation to GVC when the good traded is an intermediate.

Trading is not a common activity in the full sample; 62.2% of firms do not engage in trading activities, which is consistent with the primary focus of EU firms in China, focusing on services and supplying the Chinese market. For the remaining firms, 13.7%only import, 10.5% only export and 13.5% are two-way traders.

Table 2.12 shows the sector decomposition for each group: trading status (importer, exporter or two-way trader), backward linkage and forward linkage. This table is based on the full sample of firms (i.e. not just the GVC firms). In the left hand panel of the table, the first two columns give, for each sector, the distribution between firms that trade and those that do not. Sectors where trading predominates are: automotive, chemicals, food and beverage, machinery, and utilities. The next three columns then show the distribution between importers, exporters and two way traders for each sector. Recall (Table 2.9) that in aggregate firms were evenly distributed across these categories. At the sectoral level, however, there are significant differences. Most importing only firms operate in pharmaceuticals followed by the automotive sector and then petroleum and chemicals. On the other hand, exporting firms tend to operate in the machinery and utilities sectors. Two way traders are more prevalent in the chemicals and petroleum sector but also in machinery and in the automotive sectors

In the right hand panel of the table, we then distinguish between backward and forward linkages and for each of these, we also differentiate between engagement in Domestic Global Value Chains (DGVCs), and international GVCs. This discussed more in the sections below.

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Table 2.12: Sector decomposition of GVC groups (share of firms)

Sector	Trading status					Backward Linkages		Forward Linkages		total number firms
	no trader	Trader (total)	Importer	Exporter	Two-way trader	Global	Domestic	Global	Domestic	
Automotive	35.29%	64.71%	32.35%	8.82%	23.53%	52.94%	52.94%	35.29%	58.82%	34
Chemicals and Petroleum	14.29%	85.71%	31.43%	2.86%	51.43%	48.57%	54.29%	37.14%	62.86%	35
Civil engineering	68.75%	31.25%	6.25%	18.75%	6.25%	18.75%	31.25%	25.00%	25.00%	16
Fashion and textile	60.00%	40.00%	20.00%	20.00%	0.00%	40.00%	40.00%	0.00%	40.00%	5
Food and Beverage	33.33%	66.67%	41.67%	12.50%	12.50%	45.83%	37.50%	29.17%	50.00%	24
Machinery	42.55%	57.45%	17.02%	19.15%	21.28%	38.30%	46.81%	34.04%	48.94%	47
Utilities, primary	25.00%	75.00%	25.00%	35.00%	15.00%	45.00%	60.00%	45.00%	65.00%	20
IT and telecom	58.62%	41.38%	13.79%	13.79%	13.79%	20.69%	34.48%	24.14%	37.93%	29
Pharmaceuticals	21.88%	78.13%	46.88%	9.38%	21.88%	46.88%	56.25%	18.75%	68.75%	32
Financial services	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	60
Other professional se	93.43%	6.57%	0.73%	4.38%	1.46%	2.92%	2.92%	4.38%	4.38%	137
Media and publishing	88.89%	11.11%	0.00%	0.00%	11.11%	11.11%	11.11%	11.11%	11.11%	9
Retail and hospitality	80.77%	19.23%	15.38%	0.00%	3.85%	3.85%	7.69%	0.00%	7.69%	26
Transportation, logistics	72.73%	27.27%	3.03%	15.15%	9.09%	21.21%	18.18%	12.12%	21.21%	33
Other	53.33%	46.67%	12.00%	16.00%	18.67%	24.67%	30.00%	26.67%	32.67%	150
All sectors	62.25%	37.75%	13.70%	10.50%	13.55%	22.68%	26.33%	19.03%	29.53%	657

Almost half of the firms that do not take part in international trade activities are small firms (in terms of their operations in China) with less than fifty employees. This figure is much lower for firms taking part in international trade. Almost half of the firms doing both import and export operations are large companies with more than one thousand employees.

Table 2.13: Employment size by trading status (number of firms and share of firms)

Employees in mainland China	None	Importer	Exporter	Import/export	Total
<50	193	23	18	8	242
	47.19%	25.56%	26.09%	8.99%	36.83%
51-250	81	20	24	19	144
	19.8%	22.22%	34.78%	21.35%	21.92%
251-1000	66	25	17	20	128
	16.14%	27.78%	24.64%	22.47%	19.48%
1001-5000	30	13	7	23	73
	7.33%	14.44%	10.14%	25.84%	11.11%
>5000	39	9	3	19	70
	9.54%	10%	4.35%	21.35%	10.65%
Total	409	90	69	89	657
	62.2%	13.7%	10.5%	13.5%	

A similar pattern can be observed if we look at total revenues generated in China. Non-trading firms tend to be smaller and have lower revenues, while trading firms tend to generate higher revenues. These two findings confirm an established empirical fact that firms actively operating in global markets have bigger size both in term of number of employees and revenues in mainland China. Surprisingly, however, importers only appear to have very similar revenue levels as two-way traders; while in the literature most two-way traders that engage in exports and imports tend to be larger and more productive than only importers, since exporting requires large sunk costs and, therefore, higher productivity levels to face these than importing.

2.4.2. BACKWARD LINKAGES AND GVC GOVERNANCE

Table 2.12 shows that only 22.7% of firms engage in global backward linkages and 26.3% in domestic backward linkages. The distribution across sectors is similar for global and domestic backward linkages. Backward linkages are more prevalent in manufacturing sectors such as Automotives where it applies to 52.9% of firms, Pharmaceuticals (51.6%), Chemicals and Petroleum (50%) or Food and Beverages (47.8%). Interestingly, the share of firms engaged in backward linkages in the machinery sector is smaller than in other sectors.

Another dimension of GVCs is to look at the nature of the backward linkages with suppliers. For these firms the additional questionnaire provides information on the type of contractual relationship that firms have. We can rank this type of relationship in terms of ownership and control from forms with a higher degree of control such as vertical integration[31]or joint-ventures, to lower control relationships such as the purchase of inputs in spot markets or sub-contracting.

[31] Firms were asked whether their ownership was in the form of FDI/shared ownership, and in this report we refer to this as vertical integration.

Table 2.14 shows the decomposition across types of contractual relationships with suppliers. For firms with backward linkages, 27.3% of them purchase inputs in spot markets, 62% through subcontracting, 1.33% via franchising, 2.67% via joint-ventures and 6.67% via vertically integrating with suppliers. These, more flexible contractual modes are prevalent across all sectors. *Thus, while most EU firms in China invest by adopting very stringent contractual forms with Chinese subsidiaries, mainly vertical integration and joint-ventures, relationships with suppliers are more flexible and concentrate mainly on subcontracting inputs, and to a lesser extent on spot market purchases.*

Table 2.14: Sector decomposition of supplier governance (share of firms with global backward linkages)

	GVC governance				
sector	**Spot**	**subcontract**	**franchising**	**JV**	**vertical integration**
Automotive	11.11%	88.89%	0.00%	0.00%	0.00%
Chemicals and Petroleum	35.29%	52.94%	0.00%	0.00%	11.76%
Civil engineering	33.33%	66.67%	0.00%	0.00%	0.00%
Fashion and textile	100.00%	0.00%	0.00%	0.00%	0.00%
Food and Beverage	27.27%	45.45%	0.00%	18.18%	9.09%
Machinery	38.89%	55.56%	0.00%	0.00%	5.56%
Utilities, primary	33.33%	55.56%	0.00%	0.00%	11.11%
IT and telecom	16.67%	83.33%	0.00%	0.00%	0.00%
Pharmaceuticals	25.00%	56.25%	6.25%	0.00%	12.50%
Financial services	0.00%	0.00%	0.00%	0.00%	0.00%
Other professional services	50.00%	25.00%	0.00%	0.00%	25.00%
Media and publishing	0.00%	100.00%	0.00%	0.00%	0.00%
Retail and hospitality	0.00%	0.00%	0.00%	100.00%	0.00%
Transportation, logistics	0.00%	85.71%	0.00%	0.00%	14.29%
Other	27.03%	64.86%	2.70%	2.70%	2.70%
All sectors	27.33%	62.00%	1.33%	2.67%	6.67%

Firms that have larger control over suppliers through vertical integration or joint ventures have been in mainland China for longer. In terms of employment, larger firms are those who engage with suppliers via joint ventures, while those that engage via vertical integration tend to be medium size firms, which is somehow surprising.

Table 2.15: Employment by type of governance of suppliers

Employees in	**No GVC**	**Spot**	**Subcontracting**	**Franchising**	**JV**	**V.Int**	**Total**
<50	205	14	22	0	0	4	245
	43.62%	24.56%	18.49%	0%	0%	28.57%	36.68%
51-250	98	19	29	0	1	2	149
	20.85%	33.33%	24.37%	0%	16.67%	14.29%	22.31%
251-1000	81	8	34	0	2	6	131
	17.23%	14.04%	28.57%	0%	33.33%	42.86%	19.61%
1001-5000	38	11	21	1	1	2	74
	8.09%	19.3%	17.65%	50%	16.67%	14.29%	11.08%
>5000	48	5	13	1	2	0	69
	10.21%	8.77%	10.92%	50%	33.33%	0%	10.33%
Total	470	57	119	2	6	14	668
	70.4%	8.5%	17.8%	0.2%	0.9%	2.1%	

Looking at the distribution of contractual relationship of suppliers by country of input origin suggests that the most widely used contractual arrangements with the main supplier in all locations are subcontracting and spot markets. We also see that vertical integration and subcontracting relationships are proportionately the highest with the EU, and correspondingly spot market transactions are the

lowest. This indicates that the backward linkages of EU firms in China tend to require low levels of VC governance.

Table 2.16: Governance of VC relationship with supplier by origin

	Vert.	JV	Spot	Franchising	Subcontracting	Total
China	8	9	58	1	110	186
Asia	5	4	42	1	70	122
EU	15	6	28	3	93	145
North America	6	3	37	1	62	109
Elsewhere	9	2	33	2	46	92
Total	43	24	198	8	381	654

In summary, backward linkages are only prevalent in around 25% of firms in the survey, mainly in manufacturing. These backward linkages are typically established using more flexible contractual relationships and focus on the sub-contracting of inputs and on spot market purchases. This contractual flexibility with suppliers is observed for all type of products, sectors and destinations.

2.4.3. FORWARD LINKAGES

The final dimension of GVC activity that we explore looks at firms' forward linkages - firms whose main production segment is to produce inputs for other firms. We distinguish between domestic and world market linkages depending on whether they sell only in China or also to other destinations.

The information in Table 2.12 suggests that around 19% of all firms in the survey engage in global forward linkages and 29.5% of all firms engage in supplying intermediates to Chinese firms. Around 59% of firms with international forward linkages have been in China for more than 10 years, while 76% of firms producing inputs for local firms have been in China more than 10 years.

Most forward linkages, both global and domestic, occur in the machinery, automotive and chemicals and petroleum sectors. Looking at the sectors where a larger share of the firms in the sector engage in forward linkages suggest that the utilities and primary products sector (45%) for global linkages and the pharmaceuticals (69%) for domestic linkages, are the sectors where more firms operating in the sector engage in such linkages. Firms engaging in forward linkages tend to be larger and generate more revenues, especially those oriented to provide inputs to China.

Finally, Table 2.17 shows the tabulation of forward linkages by type of product. Interestingly, for both types of forward linkages, there is a significant amount of firms producing either customized or standard inputs. In the case of global linkages, 54.6% of firms produce customized inputs and 43.8% standardized inputs. On the other hand in the case of domestic forward linkages 43.62% produce customized inputs and 51.60%standardized ones.[32]

Table 2.17: Forward linkages and type of product

	customized	standard	Other[33]	Total
Global forward linkage	66	53	2	121
Domestic forward linkage	82	97	9	188

[32] Note that the survey did not provide information on the nature of the governance relationship for firms engaged in forward linkages.
[33] Other reflects the option given to BCS respondents to identify other types of products.

2.5. PERCEIVED INSTITUTIONAL, MARKET AND REGULATORY OBSTACLESIN CHINA

2.5.1. BARRIERS INCIDENCE

The BCS survey provides information on the institutional and regulatory business environment, and asks firms about the perceived severity and importance of the barriers they face. Specifically, firms have been asked which institutional and regulatory constraints, from a list of ten possible obstacles, represent the main barrier for doing business in mainland China. Each firm had the option of indicating the top three obstacles in order of importance. This data has certain limitations. First the responses relate to the *perceptions* of the firms who may not be able to differentiate between regulatory measures and regulatory barriers. Second is the fact that some of the categories firms were asked about are imprecise. For example, firms were asked about "market access barriers" but these were not clearly defined in the survey. Hence it is hard to distinguish how these relate to regulatory measures or indeed precisely what these encapsulate.

With this in mind, Figure 2.1 summarizes the incidence of the main (perceived) barriers for all firms, non-GVC and GVCs. Market access difficulties appears as the most prevalent barrier, with 25% of all firms indicating the negative impact of such barriers. This is followed by administrative issues, discretionary enforcement of regulation and bureaucracy. On the other hand discrimination against Foreign Invested Enterprises in public procurement and restrictions in access to financing appear the barriers with lower incidence.

The incidence of these barriers appears quite consistent in terms of importance between GVC and non-GVC firms. The main difference lies in the importance of market access barriers, which are more important for GVC firms and administrative issues which are more important for non-GVC firms.

In order to summarise the information in a single indicator according to which we can then rank the main obstacles to doing business in mainland China, we construct a single score from the three options chosen by firms. We give a score of three for each time the obstacle is identified as the first main obstacle by a firm. We then give a score of two if the obstacle is identified as the second most important obstacle and a score of one in case where it is identified as the third main obstacle.

The overall ranking of barriers is reported in the Table 2.18 below and suggests an incidence of obstacles similar to Figure 2.1. Market access is the most important obstacle followed by the discretionary enforcement of regulation and bureaucracy.

Figure 2.1: Incidence of regulatory barriers

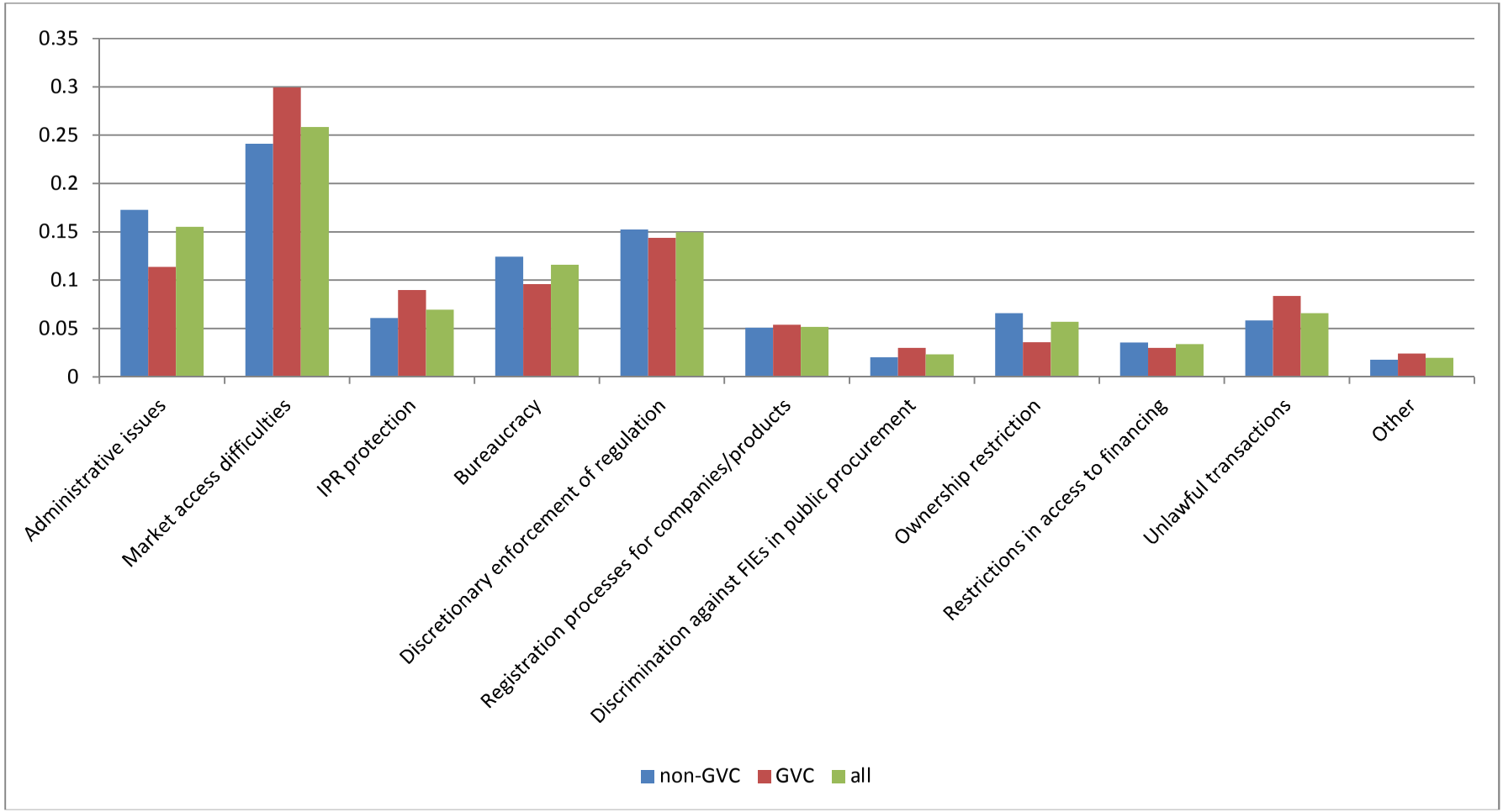

Table 2.18: Ranking of main perceived obstacles (all firms)

	Score
Market access difficulties (MAB)	656
Discretionary enforcement of regulation (REG)	501
Bureaucracy (BUR)	481
Administrative issues (ADM)	444
Unlawful transactions (LAW)	293
Registration processes for companies/processes (REGP)	250
IPR protection (IPR)	233
Ownership restrictions (OWN)	203
Restrictions in access to financing (FIN)	149
Discrimination against FIEs in public procurement (DIS)	122
Other (OTH)	57

We further disaggregate the scores regarding obstacle incidence by the type of GVC group. This sheds light on the perceptions different categories of firms have with regard to the obstacles they face. For each category (rows of the table) the highest scores are represented in red; and the second highest scores are in blue.

The results show that market access barriers (MAB) tend to be the main perceived obstacle across all types of firms. For non-traders the second most important obstacle relates to administrative barriers, whereas for trading firms the key barriers are regulatory. Unfortunately, understanding in more detail what are the forms of market access, regulatory, and administrative barriers that firms perceive that they face is not possible with this data.

Regarding backward linkages, market access is not the main perceived barrier only for those firms with stringent governance relations with suppliers via vertical integration and joint-ventures. Interestingly, for firms that vertically integrate with suppliers intellectual property rights appear as the main obstacle in their operations. This may indicate that vertical integration and tighter control of suppliers is the result of a desire for intellectual property rights control. It is also interesting to note the relative importance bureaucratic obstacles/barriers for firms engaged in subcontracting. With regard to forward linkages, in addition to market access barriers we also see the importance of regulatory barriers. Finally, the obstacles with a lower score and perception of acting as barriers across firm groups are discrimination against FIEs in public procurements and restrictions in access to financing. This could be either because these are barriers are genuinely less of an issue, or could arise from the nature of the sample whereby firms that could be hurt by such barriers are not in the sample.

Overall, most firms indicate market access barriers as the most costly obstacle for EU firms operating in China. For non-trading firms administrative barriers are also important, while for trading firms other key barriers are: regulatory barriers and bureaucracy.

Table 2.19: Importance of main perceived obstacles by type of GVC (scores)

	ADM	MAB	IPR	BUR	REG	DIS	OWN	FIN	LAW	REGP	OTH
	BY TRADE EXPOSURE										
None	**314**	**387**	103	315	299	66	145	100	161	154	31
Importer	42	**108**	51	59	**68**	18	23	13	39	45	8
Exporter	46	**69**	45	55	**59**	20	15	14	41	21	10
Import/export	42	**92**	34	52	**75**	18	20	22	52	30	8
	BY GOVERNACE OF BACKWARD LINKAGES										
No backward linkage	**332**	**408**	117	324	306	69	150	106	168	152	37
Backward linkage											
Spot	38	**76**	32	35	**60**	16	12	15	28	24	6
Subcontracting	62	**139**	60	**109**	106	32	27	24	80	52	13
Franchising	0	**6**	**4**	0	0	0	0	0	1	0	1
JV	0	4	3	3	**7**	0	**6**	2	**6**	5	0
FDI	7	11	**15**	9	**14**	2	7	2	9	8	0
	BY FORWARD LINKAGES										
No forward linkage	345	**473**	145	**358**	347	78	158	113	198	187	40
Forward linkage											
Domestic linkage	15	**27**	23	15	**24**	2	12	5	18	7	2
Global linkage	76	**137**	57	97	**119**	39	30	29	71	50	14

2.5.2. BARRIERS IMPACT

While the previous analysis in relation to barriers is very much based on identifying the main type of obstacles from the perceptions of firms, the survey allows us to explore the issue of the impact of these barriers a little further by asking firms to quantify how these have impacted on their economic activity. For example, firm managers are asked whether the firm feels that it loses business opportunities due to market access and regulatory barriers. In a majority of cases (54%) the answer is negative, and this percentage does not change depending on whether firms are involved in GVC or not.

For firms that answer that these barriers limit their business opportunities, a follow up questions asks what percentage of revenues they estimate these missed opportunities represent. Most of these firms suggest that this loss is less than 25%, with between 10 and 25% as the most repeated answer. The incidence seems lower among GVC firms with a higher percentage of them quoting losses of less that 25% of annual revenue. Nevertheless it is interesting that nearly 8% of non-GVC firms and over 10% of GVC firms report that these barriers represent over 50% of their revenues.

Table 2.20: Firm level estimates of the % of annual revenue that the obstacles listed in Table 2.19 represent

	non-GVC	GVC	Total
<10%	31	17	48
	(17.61%)	(22.08%)	(18.97%)
10-25%	57	33	90
	(32.39%)	(42.86%)	(35.57%)
25-50%	33	8	41
	(18.75%)	(10.39%)	(16.21%)
>50%	14	8	22
	(7.95%)	(10.39%)	(8.7%)
Don't Know	41	11	52
	(23.3%)	(14.29%)	(20.55%)
Total	176	77	253

In general, these barriers impact on about 50% of the full sample of firms. For 65% of the GVC firms the barriers impact on less than 25% of their revenues, but for nearly 21% the impact is greater than this. The corresponding figures for non-GVC firms are 50% and 26%.

To further analyze the impact of barriers on EU firms' performance in China, the additional questionnaire to GVC firms explores the costs of additional barriers such as IPR, environmental regulations or legal or tax treatment. Again, the most important barrier in terms of costs appears to be market access; since more than 20% of firms claim that these barriers trigger costs above 10% of revenue. This is followed by regulatory barriers with around 18%. On the other hand, IPR infringement and environmental regulations are the obstacles that translate into less perceived costs to firms.

Table 2.21: What percentage of revenues would you estimate the costs from the following barriers represent(GVC firms only)?

	0%	<1%	1-5%	5-10%	10-20%	>20%	Total
IPR infringement	68	31	58	26	8	6	197
	34.52%	15.74%	29.44%	13.20%	4.06%	3.05%	
Market access barriers	45	23	49	39	20	21	197
	22.84%	11.68%	24.87%	19.80%	10.15%	10.66%	
Environmental regulations	68	37	46	30	8	8	197
	34.52%	18.78%	23.35%	15.23%	4.06%	4.06%	
Regulatory barriers	37	27	52	45	20	16	197
	18.78%	13.71%	26.40%	22.84%	10.15%	8.12%	
Differential legal/tax treatment	40	30	68	36	16	7	197
	20.30%	15.23%	34.52%	18.27%	8.12%	3.55%	

Most firms in the survey have been operating in China for more than 10 years and, therefore, we cannot identify whether barriers are having an impact on the location decision of other EU firms. However, we can identify the response of these firms to the costs associated with these barriers.

According to the survey, 41.6% of GVC firms have reallocated some production outside of China as a response to these barriers, around half of which have reallocated production with a value higher than 5% of turnover. Also, 59.4% of firms have passed these costs via higher prices to other firms and 52% via higher prices to consumers. In addition 40.6% have reduced sales in China as a result of the barriers, and more importantly 39% of firms have reduced the purchase of domestic inputs and 44.6% have restricted investment. A ball park figure of the aggregate impact suggests that the extent to which firms have chosen to relocate their activity away from China corresponds to the equivalent of

between 383 million Euros to 1.5 billion Euros.[34] Similarly an approximate figure for the extent to which firms have reduced their purchase of intermediate inputs within China is between 30 million to 208 million Euros. Together, these figures represent between 1.2% to 2.8% of the EU firms' turnover. Another way of considering the impact of the barriers faced by the EU firms is the impact on prices. The responses suggest that on average the impact has been for EU firms to increase the prices paid by Chinese businesses and consumers by between 1.5%-3.5%. *This suggests that the costs of these barriers are not only internalized by EU firms but may also have a significant impact on the Chinese economy.*

Table 2.22: Action taking as a response to barriers (GVC firms only)

	0%	**<5%**	**5-10%**	**10-20%**	**>20%**	**Total**
Relocated economic activity outside of China by (share of turnover %):	115	47	26	4	5	197
	58.38%	23.86%	13.20%	2.03%	2.54%	
Passed on the higher costs to the firms you supply by increasing prices by:	80	78	29	7	3	197
	40.61%	39.59%	14.72%	3.55%	1.52%	
Passed on the higher costs to consumers by increasing prices by:	94	70	28	3	1	196
	47.96%	35.71%	14.29%	1.53%	0.51%	
Reduced your sales in China by:	117	42	27	9	2	197
	59.39%	21.32%	13.71%	4.57%	1.02%	
Reduced purchase of intermediates from China by:	119	45	24	3	4	195
	61.03%	23.08%	12.31%	1.54%	2.05%	
Restricted the amount of investment in China by:	108	43	32	6	6	195
	55.38%	22.05%	16.41%	3.08%	3.08%	
Other: (specify %)	50	2	16	12	0	80
	62.50%	2.50%	20.00%	15.00%	0.00%	
Total	683	327	182	44	21	1,257

Finally, when questioned about the overall response to all these barriers, around 44% of firms claim that they have foregone bringing technological know-how to China, while only 14% suggest that they have been forced to transfer technology to a Chinese partner. *Therefore, an additional cost of these barriers to the Chinese economy may be a significant constraint on technology transfer from EU firms.*

Table 2.23: Response to challenges of operating in China (GVC firms only)

	NO	YES	Total
Been forced to transfer technology to a Chinese partner	168	28	196
Decided to engage in a joint venture with a Chinese Partner	148	48	196
Foregone bringing technological knowhow to mainland China	111	86	197
Other (specify %):	33	10	43
Total	460	172	632

[34] This is calculated by multiplying the upper and lower bounds of the share of turn-over that would be affected by the barriers as stated by the firms by the upper and lower bounds of the turnover of the firm generated in China and then adding across firms. For example, Firm A claims that the presence of barrier 1 reduces turn-over by 5-10% and that its China turnover is between 51-250 million Euros. The firm is therefore expected to make a loss between 2.55 million (5% of 51 million) and 25 million (10% of 250 million). Adding up across all firms gives us an indication of the total impact of the barrier. Similar calculations are done for the other amounts presented in this paragraph.

In general, the impact of the barriers appears to be concentrated similarly across all firms, GVCs and non-GVCs, mainly in relation to market access. The impact is significant for half of the firms, but for those firms the costs are relatively high. While market access and other regulatory issues are perceived as important barriers, other barriers such as environmental regulations and IPR infringement appear less costly for firms. One important element of the impacts of these barriers is the fact that the response of EU firms to these barriers has an impact on the Chinese economy via changes in prices to consumers and suppliers, constraints on technology diffusion and transfer, and through reductions on investments or procurement of intermediate goods.

2.6. MEASURING THE IMPACT AND INCIDENCE OF OBSTACLES ON EU FIRMS'GVC ACTIVITY IN CHINA

In this section we analyse more formally the impact of the different categories of obstacles and barriers on EU firms GVC activity. In order to do so we exploit the information in the BCS survey and its cross-section structure to control for firms characteristics and answer empirically the following questions:

(i) Do GVC firms experience a larger incidence of these barriers than non-GVC firms?
(ii) Do the barriers impact on the intensity of GVC activity?
(iii) What is the impact of these barriers on the probability of firm-level responses such as relocating production away from China?

2.6.1. DO GVC FIRMS EXPERIENCE LARGER INCIDENCE OF BARRIERS THAN NON-GVC FIRMS?

The descriptive statistical analysis in the previous part did not reveal significant discrepancies between GVC and non-GVC firms regarding the importance of specific regulatory barriers. Since it is possible that group averages may mask important differences across firms and that the incidence of these barriers could be correlated with specific firm or sector characteristics, we look more formally at this issue using propensity score matching (PSM) methods.

Ideally, one would like to observe whether the perception of a specific regulatory barrier is similar when the same firm engages in a GVC and when it does not have any linkages. However, the cross-section nature of the survey and the fact that firms rarely change their GVC status, imply that the counterfactual status is not observed. PSM methods allow one to build a counterfactual by matching firms with different GVC status according to their characteristics. Intuitively, for each GVC firm we approximate a counterfactual firm from the pool of non-GVC firms that has the most similar characteristics with its GVC counterpart. Then for each matched pair we can look at differences in the perception of the different obstacles and calculate the average treatment effect; the average difference in perceptions between GVC and non-GVC firms. Specifically, for each regulatory barrier we match non-GVC and GVC firms and look at differences on whether matched firms claim the same barrier as one of the three main barriers in terms of negative impact.

For an individual firm *i* the importance of a barrier related to participating in a GVC is the difference in the importance of the barrier when the firm engages in GVC Y_1 and does not engage Y_0. The

perception of the barrier here is defined as in Table 2.1 earlier. Thus, one can define the average impact on a GVC firms as the average treatment on the treated (ATT) as shown in equation (2).

$$\delta_i = Y_{1i} - Y_{0i} \quad (1)$$

$$ATT = E(Y_1 - Y_0 | D=1) \quad (2)$$

The problem in (2) is that the parameter Y_0 is the counterfactual and not observable. But it can be shown that the ATT can be expressed as the difference in outcomes between treated (GVC) and non-treated (non-GVC) plus a selection bias parameter that measures the bias arising from the fact that firms' characteristics explain self-selection on participating or non-participating in GVCs.

$$ATT = E(Y_1 | D=1) - E(Y_0 | D=0) + Sel \quad (3)$$

Intuitively, we seek to create a counterfactual for each GVC firm based on the most similar non-GVC firm in the sample; defining similarity in terms of what would be predicted given a set of firm characteristics. The more similar are each match of firms, the lower is the potential selection bias, since the matched firm is a closer fit to the counterfactual; this is what the GVC firm would have perceived as a barrier if it was not engaging in GVC activity.[35]

To match firms we use a logistic regression where the probability of participating in GVCs is explained by whether the firm is foreign owned, firm size in terms of employment and revenue generated, and the trading status; an index that ranges from 0 (no trader), to 1(only importer), 2 (only exporter) and 3 (two-way trader). The choice of specification is implemented using balancing tests on these determinants and including variables that reduce the risk of bias significantly.

Table 2.24 shows the results for the unmatched (GVC and non-GVC simple averages) and the matched samples between GVC and non-GVC firms (comparing firms matched by characteristics)[36]. In cases where the difference between group means is positive and statistically significant, the importance of the barrier is larger for the GVC firms. On the other hand when the difference is negative the importance of the barrier is larger for non-GVC firms. For example, for administrative issues the ATT difference is 0.013, suggesting higher incidence of this barrier on GVC than on non-GVC firms when these are matched. However, the difference is not statistically significantly different from zero.

In the preceding section (see Fig 1 earlier) we described the average difference in the perception of the barriers between GVC and non-GVC firms. The PSM methodology allows us to explore these differences more formally, though as previously noted the size of our sample is small and hence the econometric results should be interpreted as indicative only. The PSM results suggest that there are statistically significant differences in the perceived incidence of some of the regulatory barriers between GVCs and non-GVC firms. Interestingly, where Fig. 1 earlier suggested that there was a

[35] In order to eliminate the selection bias (*Sel=0*) we match firms using the nearest neighbour matching methods with analytical standard errors implemented by the psmatch2 command in Stata in Leuven, Edwin and Barbara Sianesi (2003) "PSMATCH2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing," Statistical Software Components S432001, Boston College Department of Economics, revised 19 Jul 2012

[36] The information in the first row for each entry (unmatched) corresponds closely to the information in Fig.1, except that Fig 1 is based on each firms principal trade barrier, whereas in Table 24 we take into account the three main barriers that each firm identified.

noticeable difference between GVC and non-GVC firms with regard to administrative obstacles and market access difficulties, the average treatment effect on the matched samples (ATT) does not appear as statistically significant. Note, that this does not mean that these barriers are unimportant, but that formally there is no difference in the importance of these barriers between GVC and non-GVC firms.. On the other hand the results do suggest that the following barriers are more important for GVC firms: restrictions in access to financing, registration processes for companies/products, discretionary enforcement of regulation and other barriers. Conversely, IPR protection appears to be a more important barrier for non-GVC firms. This result might be explained by the fact that GVCs may be more likely to use vertical integration and joint-ventures (as seen earlier), in part as a mechanism for the protection of their intellectual property rights. However, it is worth underlining that this is a hypothesis which future research could explore, and we do not have direct evidence in support of this.

Table 2.24: Average treatment effect incidence of barriers –GVCs

Barrier	Sample	Treated	Controls	Difference	S.E.	T-stat
Administrative issues	Unmatched	0.2581	0.4063	-0.1483***	0.0466	-3.18
	ATT	0.2581	0.2452	0.0129	0.1297	0.10
Market access difficulties	Unmatched	0.5032	0.4825	0.0207	0.0491	0.42
	ATT	0.5032	0.6323	-0.1290	0.1369	-0.94
IPR protection	Unmatched	0.2323	0.1937	0.0386	0.0398	0.97
	ATT	0.2323	0.5226	-0.2903**	0.1352	-2.15
Bureaucracy	Unmatched	0.4387	0.4476	-0.0089	0.0489	-0.18
	ATT	0.4387	0.4323	0.0065	0.1338	0.05
Discretionary enforcement of regulation	Unmatched	0.4968	0.4032	0.0936*	0.0485	1.93
	ATT	0.4968	0.2903	0.2065*	0.1232	1.68
Registration processes for companies/products	Unmatched	0.2258	0.2444	-0.0186	0.0419	-0.45
	ATT	0.2258	0.0581	0.1677*	0.1005	1.67
Discrimination against FIEs in public procurement	Unmatched	0.1677	0.0984	0.0693**	0.0319	2.17
	ATT	0.1677	0.1935	-0.0258	0.1077	-0.24
Ownership restriction	Unmatched	0.1032	0.1841	-0.0809**	0.0356	-2.27
	ATT	0.1032	0.1484	-0.0452	0.1063	-0.42
Restrictions in access to financing	Unmatched	0.1677	0.1365	0.0312	0.0348	0.90
	ATT	0.1677	0.0452	0.1226**	0.0588	2.09
Unlawful transactions	Unmatched	0.3484	0.3111	0.0373	0.0460	0.81
	ATT	0.3484	0.4065	-0.0581	0.1306	-0.44
Other	Unmatched	0.0387	0.0540	-0.0153	0.0212	-0.72
	ATT	0.0387	0.0000	0.0387***	0.0155	2.49

In Table 2.25 we perform the same matching exercise but this time we match firms engaging in domestic VCs and firms not participating in domestic VCs. In this case, however, we find that with regard to many of the barriers there is no statistically significant difference when looking at the matched samples (i.e. when looking at the ATT rows). This suggests two important things. First, that matching helps reducing any biases related with observable characteristics; and, second, that the perceived incidence of barriers is not statistically different between firms engaging in domestic value chains and firms not engaging in VCs. Once again this does not mean the barriers are not important, it means that there is no statistically discernible difference between the two categories of firms in their perceptions of these barriers. Hence from the point of view of policy making – to the extent that barriers impact on firm level activity this applies equally to GVC and non-GVC firms and therefore

there is no evidence from these results for the distinguishing of policy between these two categories of firms.

Therefore, these results suggest that while some obstacles are perceived as more important among GVC firms, perceptions on the importance of barriers are similar between firms participating in domestic VCs and not participating in domestic VCs.

Table 2.25: Average treatment effect incidence of barriers – Domestic VCs

Barrier	Sample	Treated	Controls	Difference	S.E.	T-stat
Administrative issues	Unmatched	0.2556	0.4207	-0.165***	0.0449	-3.68
	ATT	0.2556	0.2222	0.0333	0.1534	0.22
Market access difficulties	Unmatched	0.5000	0.4828	0.0172	0.0475	0.36
	ATT	0.5000	0.4611	0.0389	0.1732	0.22
IPR protection	Unmatched	0.2667	0.1690	0.0977***	0.0382	2.56
	ATT	0.2667	0.2833	-0.0167	0.1693	-0.10
Bureaucracy	Unmatched	0.4333	0.4517	-0.0184	0.0472	-0.39
	ATT	0.4333	0.4222	0.0111	0.1640	0.07
Discretionary enforcement of regulation	Unmatched	0.4889	0.4000	0.0889*	0.0470	1.89
	ATT	0.4889	0.2944	0.1944	0.1545	1.26
Registration processes for companies/products	Unmatched	0.2333	0.2414	-0.0080	0.0405	-0.20
	ATT	0.2333	0.0833	0.1500*	0.0903	1.66
Discrimination against FIEs in public procurement	Unmatched	0.1556	0.1000	0.0556*	0.0309	1.80
	ATT	0.1556	0.1667	-0.0111	0.1523	-0.07
Ownership restriction	Unmatched	0.1167	0.1828	-0.0661*	0.0345	-1.92
	ATT	0.1167	0.0111	0.1056	0.0879	1.20
Restrictions in access to financing	Unmatched	0.1444	0.1483	-0.0038	0.0337	-0.11
	ATT	0.1444	0.1222	0.0222	0.1182	0.19
Unlawful transactions	Unmatched	0.3500	0.3069	0.0431	0.0444	0.97
	ATT	0.3500	0.2722	0.0778	0.1541	0.50
Other	Unmatched	0.0389	0.0552	-0.0163	0.0205	-0.79
	ATT	0.0389	0.2222	-0.1833	0.1161	-1.58

2.6.2. DO BARRIERS IMPACT ON THE INTENSITY OF GVC ACTIVITY?

The perceptions on the importance of some of the barriers appear to differ between GVC and non-GVC firms and in this section we explore whether there is any evidence that this may have impacted on the intensity of GVC activity. Note that the data does not allow us to determine the extent to which the barrier may have impacted on the initial location decision. However, it is perhaps unlikely that these obstacles were the key determinant of the decision to locate in China for the firms in the survey and therefore whether or not they participate in GVCs. These decisions are more likely the result of firms' decisions with regard to headquarters, product characteristics and technological elements.[37] In addition, most firms in the survey have been in China for more than 10 years, which implies that we are working with a sample of already established firms. Hence we are not able to analyse issues of entry and exit in the Chinese market. It is, however, likely that these obstacles might affect the intensity of value chain relationships. For example, some regulatory barriers may limit the extent to

[37] We ran some tests to see whether barriers are a statistically significant determinant of GVC linkages using a selection model and found that none of the barrier variables were statistically significant in explaining participation in value chains.

which firms can engage in forward linkages with other firms. As a result, in this section we explore this issue econometrically.

One advantage of the additional questionnaire of the BCS is that at least for almost 200 firms there is some information on the estimated costs as a proportion of revenues of some regulatory barriers. Although this information is only available in ranges, it allows us to define an index of cost intensity of these barriers (where no cost is 0, <1% is 1, <5% is 2, 5-10% is 3, 10%-20% is 4 and >20% is 5). Therefore, we use these indices of cost intensity for each of the barriers (see the Appendix for more details) as explanatory variables to estimate a reduced form equation for the determinants of both forward and backward linkage intensity. Forward and backward linkage intensity is measured as the proportion of revenues associated with both types of linkages. Since the answer to this question is structured in ranges, for each firm we take the mid-range as the linkage intensity.

Estimating this equation on the reduced sample is, however, problematic since firm characteristics are likely to affect both the intensity of the linkage and the decision to have or not to have the linkage. This implies that the reduced sample is not likely to be random, and some of the coefficients may be biased. In order to correct for this sample selection bias, we implement a standard Heckman two-stage procedure.

In the first stage, we estimate a selection equation as in equation (5) and (6) using a Probit, where the probability of a firm having a forward or a backward linkage depends on structural characteristics of the firm (*Str*); such as size (number of workers), type of ownership (if foreign owned), the broad sector of activity (whether firm operates mainly in services sector) and the trade status (importer, exporter or two-way trader). Although the cost barriers variables described above are not available for non-GVC firms, we also tried dummy variables reflecting firms' perception of the impact of barriers in both stages, given the fact that these are defined for the whole sample. However, none of the coefficients associated to the dummy barriers were statistically significant in any of the specifications and hence these are not reported here. This suggests that these barriers might not impact on the establishment of linkages for those EU firms already established in China, while they may in turn impact on the intensity of the linkages.

To identify the second stage equation we use an identification variable (*Ident*) which captures whether the Chinese market is the main strategic market for the firm. The assumption is that this market strategy determined the type of linkages but not its intensity.[38]

Then, in a second stage, following equation (4), we estimate a similar equation by OLS on the intensity of the linkages, but adding the inverse Mills ratio and the perceived intensity of the following barriers: IPR infringement, market access barriers, environmental regulations, regulatory barriers and differential legal/tax treatment. We also expand the equation and add two additional specifications that capture whether the type of contractual relationship with suppliers affect backward linkages and also the type of product produced, whether customized or standard. We estimate the model for backward linkages, global or domestic, and for forward linkages, also global and domestic.

$$Link\_\text{int}_i = \alpha + \sum_n \beta_n Str_{ni} + \sum_k \delta_k Bar_{ki} + \lambda + u_i \qquad (4)$$

[38] We have tried other identification variables, time in mainland China and type of customer segment, with similar results, for the inverse mills ratio and the coefficients of interest.

$$Linkage_i^* = \alpha + \sum_n \beta_n Str_{ni} + \delta ident_i + u_i \quad (5)$$

$$Linkage \begin{cases} 1 if Linkage_i^* > 1 \\ 0 otherwise \end{cases} \quad (6)$$

Table 2.26 shows the results of the estimates for backward linkages. We report the selection equation in columns (4) and (8) for only two specifications since the results are very similar. In both cases trade status and the sector of activity affect the probability of establishing a backward linkage global or domestically. Firms with more trade intensity and that do not operate in the services sector are more likely to establish backward linkages.

Table 2.26: Determinants of Backward Linkages intensity

	(1) Second stage Backward intensity GVC	(2) Second stage Backward intensity GVC	(3) Second stage Backward intensity GVC	(4) First stage Selection Backward linkage GVC	(5) Second stage Backward intensity Domestic VC	(6) Second stage Backward intensity Domestic VC	(7) Second stage Backward intensity Domestic VC	(8) First stage Selection Backward linkage Domestic VC
employees	6.654**	7.815**	7.340**	-0.00825	2.470	2.009	2.567	0.139
	(3.361)	(3.425)	(3.612)	(0.105)	(2.856)	(2.621)	(2.885)	(0.105)
foreign	-0.195	-2.216	-2.415	-0.0541	-5.062	-4.701	-5.773	0.283
	(6.553)	(6.656)	(6.851)	(0.188)	(5.602)	(4.990)	(5.740)	(0.190)
services	-3.178	-0.898	-2.258	-0.457**	0.502	0.124	1.364	-0.319*
	(10.02)	(10.28)	(11.76)	(0.179)	(4.957)	(4.425)	(5.114)	(0.183)
Trade status	13.56	9.552	11.96	0.954***	-10.08	-8.254	-9.431	1.038***
	(17.49)	(17.80)	(19.26)	(0.0878)	(10.89)	(9.465)	(10.50)	(0.0919)
IPR_prop	2.365				-0.685			
	(1.738)				(1.084)			
MAB_prop	3.174*				-0.895			
	(1.910)				(1.384)			
env_prop	1.173				0.556			
	(1.924)				(1.193)			
reg_prop	3.594*				-0.0645			
	(2.148)				(1.608)			
tax_prop	-5.556***				-1.081			
	(2.141)				(1.472)			
Contract suppliers		-0.402				0.713		
		(2.176)				(1.578)		
custom			-2.781				3.126	
			(5.107)				(3.141)	
Strategy in China				0.250				0.250
				(0.192)				(0.199)
mills	30.12	25.47	29.55		-22.62	-20.33	-22.05	
	(32.64)	(33.59)	(36.30)		(20.70)	(18.10)	(20.17)	
Constant	-38.48	-14.88	-20.39	-1.590***	54.11	41.93	44.59	-2.150***
	(54.47)	(54.76)	(59.25)	(0.330)	(40.66)	(34.64)	(39.06)	(0.355)
Observations	510	510	508	508	510	510	507	507

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

Note: IPR_prop, MAB_prop, env_prop, reg_prop and tax_prop represent the percentage of revenues that barriers represent according to EU firms (see Table 2.21)

Looking at the intensity of the linkage (specifications (1) (2) and (3) for GVCs; and (5), (6) and (7) for domestic VCs) suggest that larger firms have more intensive backward linkages, for the case of GVCs but not in the case of domestic VCs. The results for the impact of the barriers are interesting. While tax barriers have the expected sign of decreasing the intensity of the linkages; market access and regulatory barriers appear to increase the intensity of backward linkages, although the coefficients are only marginally significant. This suggests that firms that perceive these barriers as larger obstacles tend to use more global backward linkages. One hypothesis is that if these obstacles imply additional costs in the Chinese market, this may encourage GVC firms to expand outsourcing of intermediates from abroad (this is also consistent with the findings shown in Table 2.22).

The coefficients for the specifications for domestic value chains are not statistically significant. None of the covariates appear to explain the determinants of domestic value chain intensity, including the costs of barriers, the type of contract with suppliers or the type of product produced. In the case of the barriers intensity, this might indicate that while market access, regulatory and tax barriers appear to affect the intensity of GVC backward linkages, it does not impact on domestic backward linkages. This suggests that as described in the previous section some barriers appear to have more incidence on GVC firms, and also that the barriers may be more specifically related to linkages with foreign suppliers of intermediates as opposed to domestic.

Table 2.27: Determinants of Forward Linkages intensity

	(1) Second stage Forward intensity GVC	(2) Second stage Forward intensity GVC	(3) Second stage Forward intensity GVC	(4) First stage Selection Forward linkage GVC	(5) Second stage Forward intensity Domestic VC	(6) Second stage Forward intensity Domestic VC	(7) Second stage Forward intensity Domestic VC	(8) First stage Selection Forward linkage Domestic VC
employees	0.625	-0.127	0.422	-0.136	0.525	0.0726	0.504	0.0641
	(3.471)	(0.112)	(3.569)	(0.113)	(1.742)	(0.106)	(1.479)	(0.106)
foreign	-5.860	-0.0803	-5.244	-0.0860	2.034	-0.0291	0.877	-0.0420
	(5.345)	(0.190)	(5.324)	(0.190)	(3.222)	(0.188)	(2.653)	(0.187)
services	6.145	-0.324*	6.687	-0.336*	4.908	-0.372**	3.775	-0.423**
	(7.181)	(0.185)	(7.278)	(0.185)	(3.266)	(0.183)	(2.792)	(0.182)
Trade status	10.11	0.950***	6.019	0.951***	-7.345*	1.222***	-5.897	1.200***
	(17.97)	(0.0887)	(17.49)	(0.0885)	(4.271)	(0.104)	(3.662)	(0.103)
IPR_prop	0.471				0.751			
	(1.753)				(0.879)			
MAB_prop	0.597				-0.526			
	(1.756)				(1.027)			
env_prop	0.916				0.318			
	(1.626)				(0.926)			
reg_prop	3.078				-1.748			
	(1.962)				(1.155)			
tax_prop	-1.538				1.119			
	(1.836)				(1.073)			
custom			-0.771				-0.559	
			(4.233)				(2.106)	
strategy		0.259		0.255		0.828***		0.756***
		(0.192)		(0.192)		(0.225)		(0.220)
mills	11.90		4.464		-17.68**		-14.99**	
	(31.75)		(30.75)		(8.154)		(6.963)	
Constant	-1.356	-1.608***	23.48	-1.583***	32.88**	-2.222***	29.15***	-2.091***
	(56.44)	(0.333)	(52.74)	(0.333)	(13.82)	(0.366)	(10.95)	(0.353)
Observation	512	512	512	512	510	510	510	510

Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1
Note: see Table 2.21 for definition of IPR_prop, MAB_prop, env_prop, reg_prop and tax_prop

Table 2.27 shows similar estimates for forward linkages. Columns (4) and (8) show the coefficients from the selection equation, selling intermediates to foreign buyers (4) or Chinese buyers (8). As before, trade intensity and the operating sector of the firm predict establishing linkages. However, none of the other variables appear statistically significant in affecting forward linkage

Summing up, the results regarding the impact on the intensity of linkages do not appear very robust in terms of statistical significance. Only some barriers affect the intensity of linkages for the backward linkages of GVCs - mainly market access, regulatory and tax obstacles. Interestingly, while tax obstacles may reduce the intensity of these links, market access and regulation may increase global sourcing of inputs by discouraging domestic sourcing. To the extent that this is the correct explanation for what we observe than this would suggest that such barriers impact negatively on the deepening of (inter) linkages with Chinese firms along the value chain, and therefore in turn may impact on the position of both EU and Chinese firms in terms of their position along the value chain.

2.6.3. WHAT IS THE IMPACT OF BARRIERS ON THE PROBABILITY OF DIFFERENT FIRM LEVEL RESPONSES SUCH AS RELOCATING PRODUCTION AWAY FROM CHINA?

While barriers might impact on the intensity of GVC activity, it is also likely that they may trigger a response from firms arising from the additional costs associated with such regulatory barriers. In this section we explore this issue by exploiting the information from the additional BCS survey on the type of response typically followed by firms.

Since each dependent variable is ordered in terms of impact, as a percentage of revenue we estimate an ordered Probit model for these firms with information on the impact of these barriers as in equation (7).[39] As before, since the response to the impact question is formulated as a range, we use an index from 1 to 5 to capture the following impacts on revenue 0%, 0%-5%, 5%-10%, 10%-20% and >20%.

In terms of impact, we use as dependent variables (*Impact_int*) the information available in the survey, which focuses on the following GVC firm responses: the probability that the firm reallocates production elsewhere, passes costs into consumers or firms, reduces sales of final products or the purchase of inputs, changes investment decisions or other.

$$impact\_\text{int}_i = \alpha + \sum_n \beta_n Str_{ni} + \sum_k \delta_k Bar_{ki} + u_i \qquad (7)$$

Table 2.28 shows the ordered Probit estimates. We focus on the impact of barriers; IPR infringement, market access barriers, environmental regulations, regulatory barriers and differential legal/tax treatment. Firms increase the relocation of production away from China in response to IPR infringement, market access and environmental regulation obstacles; but reduce the extent of relocation as a response to regulatory obstacles. One hypothesis to explain the response to regulatory

[39] There is no selection correction term defined for ordered probit models. Therefore, the results need to be interpreted with caution since the sample of firms with response is not random and some of the coefficients could be biased.

obstacles is that if overcoming such obstacles requires firms incurring sunk costs this could discourage firms from subsequently relocating production by making it unprofitable. An alternative explanation is that firms perceive regulations as costly obstacles, but if these regulatory frameworks are effective instruments protecting the market environment, then having met the regulation (and overcome the obstacle) strengthens the position of the firm in the market and consequently reduces the probability of reallocation. Once again these are hypotheses which we cannot explicitly test nor confirm with the available data. It is also worth pointing out that our data enables us to examine the extent to which regulatory obstacles impact on firms' behaviour given that they have chosen to have a presence in China. Regulatory barriers clearly involve additional costs to firms, and may therefore impact on the initial decision whether or not to undertake the initial investment decision in China. This also is not an issue that could be addressed here, but is an important issue which would be worth exploring in more detail in future research.

Table 2.28: Impact of barriers on firm behaviour (probit - GVC firms only)

	(1) Relocation production	(2) Price consumers	(3) Price to other firms	(4) Reduction sales	(5) Reduction purchase of intermed.	(6) Reduction investment
employees	0.198	0.137	0.0459	0.0263	-2.44e-05	0.0791
	(0.130)	(0.141)	(0.129)	(0.136)	(0.138)	(0.151)
Foreign	0.329	-0.0663	0.128	-0.129	-0.0698	-0.242
	(0.244)	(0.221)	(0.233)	(0.220)	(0.262)	(0.274)
Services	0.515**	0.350*	0.274	-0.375	-0.229	-0.0988
	(0.234)	(0.202)	(0.205)	(0.231)	(0.230)	(0.233)
Trade status	-0.121	0.229	0.0439	-0.145	-0.0672	0.0140
	(0.132)	(0.142)	(0.134)	(0.139)	(0.151)	(0.139)
Strategy	-0.0385	-0.252	-0.405*	0.379	-0.0984	0.206
	(0.237)	(0.218)	(0.218)	(0.236)	(0.245)	(0.256)
IPR_prop	0.271***	0.116	0.0556	0.175**	0.252***	0.258***
	(0.0842)	(0.0802)	(0.0799)	(0.0864)	(0.0850)	(0.0870)
MAB_prop	0.317***	0.0613	0.262***	0.0399	0.163	0.226**
	(0.106)	(0.0845)	(0.0891)	(0.120)	(0.110)	(0.0937)
env_prop	0.253***	0.202**	0.136*	0.0627	0.0966	0.193*
	(0.0931)	(0.0861)	(0.0826)	(0.0831)	(0.0942)	(0.101)
reg_prop	-0.274**	-0.0173	-0.132	-0.0382	-0.195	-0.293**
	(0.117)	(0.101)	(0.110)	(0.139)	(0.133)	(0.122)
tax_prop	0.139	0.124	0.163	0.134	0.302***	0.360***
	(0.109)	(0.0966)	(0.107)	(0.107)	(0.105)	(0.110)
Constant	4.948***	4.694***	3.796***	3.319***	3.819***	4.473***
	(0.674)	(0.694)	(0.689)	(0.592)	(0.608)	(0.650)
Observations	140	140	140	140	139	138

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

Note: IPR_prop, MAB_prop, env_prop, reg_prop and tax_prop represent the percentage of revenues that barriers represent according to EU firms (see Table 2.21)

Firms increase prices to consumers in the case of environmental barriers and increase prices of intermediates to other firms in the case of market access barriers. Firms change (reduce) sales as a response to IPR infringement and reduce the purchase of inputs as a response to IPR infringement and differential tax treatment. Finally, firms reduce investment as a response to all the barriers considered with the exception of regulatory barriers, As before, the impact of regulatory obstacles might be related to the fact that regulatory barriers require larger sunk costs and investments, or to the fact that these perceived obstacles create regulatory frameworks that increase investment in mainland China.

These results confirm the findings of the descriptive statistics section and show that the impact of these barriers is not only on EU firms via increasing costs and reducing sales, but also on the Chinese economy via increasing prices on consumers and firms, reducing investment and decreasing the sourcing of domestic intermediates. Most of the regulatory barriers analysed trigger significant "negative" responses from firms, especially IPR infringement. On the other hand, given the decision to have a presence in China, regulatory barriers may subsequently increase investment and reduce relocation of production by increasing the sunk costs for firms or by providing a positive regulatory framework that improves the business environment for the firm that have already entered the market.

2.7. CONCLUSIONS

In this section we describe not only European firms' GVC activity in China but also the impact that different barriers have on these and their response to these obstacles.

In general, we find that EU firms operating in China are concentrated in Shanghai and Beijing, typically have been operating for more than 10 years, and are primarily either vertically integrated or in a joint-venture. The majority of firms have less than 250 workers and their operations in China constitute less than 15% of their global revenues.

The firms engaging in GVC activity show similar characteristics to the average EU firm in China, but tend to be slightly less concentrated in Beijing, more vertically integrated, employ more people and activities in China represent a slightly higher importance in global operations. A higher proportion of GVC firms are either wholly foreign owned or in a joint venture. We also find that GVC firms are significantly more concentrated in manufacturing as opposed to services, and that 75% of firms indicate that provision of goods and services to the Chinese market is the principal strategic reason for their operations in China.

The analysis of the impact of barriers suggests that their perceived impact is significant for half of the firms, and for those firms affected, the costs are relatively high (between 10-25% of revenue). The econometric analysis then suggests that there are differences in the perceived incidence of regulatory barriers between GVCs and non-GVCs. Specifically, restrictions in access to financing, registration processes for companies/products and discretionary enforcement of regulation. IPR protection seems a more important barrier for non-GVC firms. We find evidence of a statistical impact of regulatory barriers on the extent of the international backward linkage that a firm engages in but not on the depth of the domestic linkage.

More importantly, the econometric analysis shows that EU firms respond to the additional costs incurred by barriers by increasing the prices faced by Chinese consumers and firms. Additionally we find evidence that firms relocate production away from China, reduce investment and decrease sourcing from Chinese firms as a result of these obstacles. Most of the regulatory barriers analysed trigger significant "negative" responses from firms on one or more of these dimensions, especially IPR infringement. The results suggest, therefore, that such barriers negatively impact not just European firms' activity in China, but also the Chinese economy. The main exception to the above concerns the role of 'regulatory obstacles' where the response was negative with regard to the relocation of production and investment. A plausible explanation is that, *given* the decision to have a presence in China, regulatory barriers may subsequently increase investment and reduce relocation of production by increasing the sunk costs for firms. It is also possible that regulatory frameworks, although costly to comply with, may be associated with improvements in the business environment for the firm. Our data does not allow us to address this issue nor the possibility that the regulatory barriers may impact on the initial decision to invest and plausibly discourage new investment.

SECTION 3: TYRE AND ELECTRIC VEHICLE SECTOR CASE STUDIES

3.1. TECHNICAL SUMMARY

The aim of this section is to further delve into the participation of EU firms in value chains in China in the tyre and electric vehicle sector. The analysis of this section is therefore complementary to that of the previous section and aims to provide illustrative examples of the types of barriers that are faced by EU firms operating in these sectors and investigate how these may be impacting on Chinese economic activity. The key results are:

Tyres

- Demand for automotive tyres in China can be confidently expected to grow significantly over the next decade driven both by the increasing production of new vehicles and by the demand for replacement tyres.
- EU and Chinese producers in China target different segments of the market. The former mainly supply premium tyres whereas the latter mainly provide value or budget tyres. Both seem to operate independently of each other and we have uncovered very little by way of value chain activity between EU and Chinese producers in China.
- China's indigenous supplies of natural rubber are relatively small and hence the tyre industry is heavily reliant on imports. But natural rubber is subject to a 6% tariff in 2013. One possible immediate policy prescription could be to reduce tariffs on natural rubber so as to reduce costs for both Chinese and European manufacturers in China. Since it appears that EU and Chinese firms compete in different segments of the market this move would help consolidate Chinese tyre manufacturers without widely increasing the competitive pressures from EU producers. Moreover, it could also provide a competitive boost to the thriving export market where Chinese manufacturers are increasingly important.
- An important characteristic of tyre manufacture is that the value chains of many of the large international companies are often highly integrated. There seems to be a trend towards even greater vertical integration both downstream (with many of the major firms expanding their own distribution networks) and upstream. For instance, Michelin owns and operates several rubber plantations (*inter alia* in Vietnam, Brazil and Nigeria). These moves reflect increased concerns about price volatility and guaranteed supplies of essential raw materials at a time when tyre production is increasing.
- A real opportunity is offered by the fact that China's 12th Five Year Plan (2011-2015) highlights *inter alia* the objectives of lower energy consumption, better environmental protection, and improved road safety. The EU tyre manufacturers have significant advantages in the development and production of tyres with lower rolling resistance (and hence better fuel efficiency, and lower emissions) and better safety features. Any policy measures that encourage and facilitate these broad objectives should thus provide mutual benefit both to the Chinese economy (and population) and to the EU tyre manufacturers.
- For example, tyre product standards and specifications in China are typically different than in the European Union, are subject to frequent changes, and may vary within China across provinces. This can be frustrating for foreign tyre manufacturers, particularly if they are given little or no advance warning of impending changes. It would benefit all in the industry if all tyre manufacturers (foreign and Chinese alike) were consulted in advance on proposed changes to specifications and other regulatory matters.

- One of the future challenges for the Chinese tyre industry is chronic over-capacity, notwithstanding the predicted growth in tyre demand. At the end of 2012, there were 500+ enterprises in the Chinese domestic tyre industry, but many were small-scale with little R&D capability and also unable to reap the benefits of economies of scale. China's 12th Five-year Plan envisages the consolidation of the industry and financial support for upgrading and expanding operations will be provided though the Bank of China. The larger firms should survive the consolidation, particularly if they can raise their product standards though collaboration with foreign manufacturers, but the smaller firms may become targets for acquisition.
- This process of consolidation may well be stymied by local protectionism as provincial governments try to subsidise and maintain local firms. It is to be hoped that such local protectionism does not hold sway, and moreover that there is no discrimination against foreign firms wishing to acquire some of these small tyre businesses. The tyre industry in China will only thrive, to the benefit of the companies concerned and of automobile manufacturers, if market forces are allowed to drive the restructuring of the industry.

Electric Vehicles

- In an effort to reduce dependence on oil and lower emissions, the Chinese Government has set a target of 500k New Energy Vehicles (NEVs) to be produced in China by 2015. However, by the end of 2012 only 11.5k had been produced with EU firms in China selling no NEVs to date.
- Our research suggests that this shortfall is caused by a combination of low private consumer demand for NEVs, a buoyant market for Internal Combustion Engine (ICE) vehicles and a restrictive regulatory environment.
- Foreign car manufacturers in China are required to enter into Joint Ventures (JVs) with Chinese partners in order to produce any vehicles. The ownership split is to be at least 50% Chinese owned. For ICE vehicles, where the technology is ubiquitous and the 'charging' infrastructure is abundant in the shape of petrol stations, it seems that the JV requirement has not prevented both foreign and Chinese companies taking advantage of the business opportunities offered by a market that has expanded manifold over the last decade. However, this is not the case for NEVs.
- In general, the current regulation with regards to JVs in 'key sectors' such as cars and particularly NEVs may be restricting or delaying further investment from European OEMs.
- The regulatory framework is still perceived by European Original Equipment Manufacturers (OEMs) as ambiguous (at best) or unsupportive (at worst) for the production of EVs. EU firms appear to be restricting their R&D activity in China as a result of this therefore delaying a more rapid deployment of production of EVs. Moreover, the Chinese partners also seem to be cutting their R&D expenditure when in a JV and this is causing an impasse in terms of moving forward jointly.
- Interview material suggests that the new NEV incentive policy is perceived as a step in the right direction but questions remain as to whether it is still too biased in favour of local producers. European OEMs may need more guarantees that they (or at least the JVs where they participate) will not be disadvantaged by the subsidies policy.

- These perceptions may jeopardise the attainment of the Chinese government’s goals with regards to the expansion of the EV sector.
- This is a clear example of a lose-lose situation which could be turned into a win-win solution.

3.2. INTRODUCTION

The aim of this section is to further delve into the mechanisms that underscore the participation of EU firms in value chains in China. Here we seek to provide a more qualitative narrative focusing on the governance structures of the value chains in two key sectors; tyres and electric vehicles. To this end, we use a case study approach designed to complement the earlier segments of this report. Having established the general trends in GVC activity (Section 1) as well as the particular role that barriers play in the decisions of EU firms to engage in value chain activity in China (Section 2), in this section we discuss the organisational choices of EU firms in China paying particular heed to how the governance of the value chain is conditioned by the policy environment.

The sectors that are the subject of this section are not only appealing individually, they also provide interesting contrasts. For example, the tyre sector is relatively well established and EU firms compete with Chinese firms along the quality spectrum through varying cost and technology inputs. In contrast, the electric vehicle sector is nascent; value chains are not yet established and there is a strong element of IP ownership both in terms of inputs and output. Although we largely focus on these sectors individually, we will also aim to provide a discussion of how these differ and what we can learn from this.

We take a case study approach to this analysis so as to draw out the more qualitative and nuanced elements of value chain participation that eluded us in the previous more quantitative sections. The analysis is based on a combination of secondary literature, face-to-face and phone interviews administered to firms within the selected sectors as well as other key informants (experts) and carried out in October 2013. The aim is then to provide some examples of how EU firms have reacted to some of the impediments that they face in China thus complementing the analysis of the previous sections.

We begin by discussing some of the aims of the case studies as well as the common methodology that it used throughout. We then proceed with the two case studies where we provide, for each of these; a literature review, the key findings and the preliminary conclusions. We conclude in the final part by providing some tentative policy issues that arise from the analysis.

3.3. METHOD

Value chains are complex; they involve an array of value addition activities dispersed across many different segments and often located in different countries. Their analysis often involves several dimensions ranging from mapping exercises to looking at coordination elements or *governance*. It is beyond the scope of this study to undertake an exhaustive analysis of the entire value chain of our selected sectors. Instead, we focus on a particular node of activity that involves EU firms in China and on the governance dimension. We do this through a set of case studies geared towards identifying how EU firms condition their economic activity in the context of the policy environment they face in China.

Contact with the firms active in each of the sectors under investigation was established through the European Chamber of Commerce in China (EUCCC). For the tyre sector, only one firm was interviewed; Continental, although Pirelli and Michelin are also very active in China. The electric vehicle sector in China has around 10 large EU firms. Although in principle most firms were happy to cooperate there was some reluctance from their part related to the degree of this cooperation. Given

the nascent nature of this sector, firms are concerned about revealing important strategic information which can be used against them by other competitors in the Chinese market. To appease these concerns, in addition to ensuring anonymity of key respondents and firms, we have committed to i) providing our bona fides through a letter from the European Commission; ii) giving them a sample of the questions that we are likely to ask; and iii) giving them first refusal on the draft of the case study related to their sector.

The successful completion of these case studies depends on the cooperation of firms with the process. While we did our utmost to ensure that firms were comfortable talking to us by being very transparent both in terms of our goals and our results, many firms remained reluctant to engage more widely.

3.4. TYRES

The world tyre industry comprises several segments, including *inter alia* automotive tyres, bicycle tyres, motorcycle tyres, and aerospace tyres. This part will focus on the automotive tyre segment, which may be further divided into passenger vehicles, light commercial vehicles, and heavy trucks & buses – and each of these comprises two distinct markets: the original equipment (OE) market (the tyres supplied with new vehicles) and the replacement market. New passenger and commercial vehicles are typically equipped with five new tyres, and tyre demand is closely related to new vehicle sales. Tyres typically last for c.4 years, and hence typically need to be replaced during the vehicles' useful life. Replacement tyre demand thus typically reflects the size of the automotive vehicle population, and customers often replace tyres with the same OE brand. Truck tyre demand is closely related to industrial activity, and truck tyres need to be replaced more frequently. Automotive tyres do not all offer the same level of performance, and tyres are typically classified as premium (highest performance), value, or budget (lowest price).

Tyres for the OE market are supplied direct to the vehicle manufacturers, whilst tyres for the replacement market require a network of dealers to effect sales to customers. In mature markets, replacement tyres typically account for about 80% of total automotive tyre demand, although in China the figure is currently closer to 60%.

3.4.1. THE WORLD TYRE INDUSTRY

The industry worldwide is currently dominated by the major international manufacturers (i.e. Bridgestone, Michelin, Goodyear, Continental, Pirelli, Sumitomo Rubber, Yokohama Rubber, and Hankook Tire), whose combined global market share was over 60% in 2012 – see Table 3.1. But Chinese tyre manufacturers now account for 26 of the top 75 tyre manufacturers (by sales) in the world, with the largest (Hangzhou Zhongce Rubber) ranking in tenth place. The combined market share of these Chinese manufacturers has risen from 15.9% in 2009, to 16.4% in 2011. In total, there were 500+ enterprises in the Chinese domestic tyre industry at the end of 2012, but many were small-scale and they tend to specialise in the value and budget segments of the market (unlike the European manufacturers which specialise in premium tyres). Most of these small companies concentrate on the low-end of the market, lack significant R&D capability and so produce few innovative products. The four main Chinese tyre companies are Hangzhou Zhongce Rubber, Triangle Group, Shandong Linglong Rubber, and Double Coin Tyre Holdings – all currently produce tyres for the mid-low end of the market.

Table 3.1: The Top Tyre Manufacturers in the World, Ranked by Global Sales (million USD)

Company	HQ country	2010 sales	2011 sales	2012 sales
Bridgestone	Japan	28,200	28,593	30,397
Michelin	France	23,696	26,829	27,590
Goodyear	US	18,832	22,767	20,992
Continental	Germany	10,460	11,529	12,418
Pirelli	Italy	6,326	7,559	7,749
Sumitomo Rubber	Japan	5,838	6,716	7,463
Hankook Tire	South Korea	4,943	5,692	6,242
Yokohama Rubber	Japan	4,691	5,081	5,357
Cheng Shin Rubber	Taiwan	3,526	4,268	4,908
Zhongce Rubber	China	3,345	4,286	4,871
Giti Tire	Singapore	3,870	4,189	4,498
Cooper Tire & Rubber	US	3,360	3,908	4,201
Kumho Tire	South Korea	3,026	3,435	3,595
Toyo Tire & Rubber	Japan	2,506	2,969	3,088
Triangle Group	China	2,262	2,601	2,709
Shandong Linlong Rubber	China	1,429	2,324	2,678
Apollo Tire	India	1,943	2,271	2,448
MRF	India	1,740	2,408	2,455
Nokia Tire	Finland	1,402	1,967	2,071
Double Coin	China	1,344	1,692	1,921
	World	154,000	187,000	

Source: *Global and China Tire Industry Report, 2012-2013*. (www.researchinchina.com)

China is the premier location for tyre manufacturing in the world - see Table 3.2- accounting for over one-third of all tyres (in terms of rubber) manufactured worldwide in 2012. The major international manufacturers began to enter China in the 1990s, and all of the non-Chinese manufacturers in the top-20 list have wholly-owned subsidiaries or joint ventures in China – see Table 3.3 - with most having plans for capacity expansion over the next few years.

Table 3.2: Tyre Production Worldwide 2008-2012 (000's tons of produced rubber)

Country/Region	2008	2009	2010	2011	2012
Asia & Oceania	7565	7365	8673	8899	9289
China	3817	4090	4849	4961	5261
Japan	1325	998	1208	1225	1160
South Korea	519	457	588	614	633
Europe	2830	2310	2586	2794	2653
North America	1707	1398	1671	1732	1653
South & Central America	886	761	890	905	905
Middle East & Africa	247	202	201	224	231
Total	13235	12036	14021	14554	14711

Source: JATMA (2013)

Note: The figures include all types of tyres (automobile, bicycle etc), and are expressed in thousands of tons of produced rubber.

Table 3.3: Tyre Manufacturing Capacity in China by Foreign Companies

Company	Location	Current capacity	Future capacity	Notes
Bridgestone	Tianjin Wuxi Shenyang	9.2m PV 6m PV	 1.8m truck + bus by 2014	
Michelin	Shenyang Shanghai Wuwei	2.6m PV/light truck + 850000 truck 5.4m PV/light truck	 5m PV by 2017	 JV with Double Coin
Goodyear	Pulandian	5.4m PV	+ 1m truck	Dalian plant opened in 1995, but closed in 2011
Continental	Hefei	3m PV	8m PV by 2017	
Pirelli	Yanzhou Yanzhou	4.1m PV + 700000 truck + 1m motorcycle Steel cord	10m PV + 850000 truck by 2014	Acquisition of RoadOne Tyre JV
Sumitomo Rubber	Changshu Changsha	2.2m PV 5.5m PV in 2014	 11.0m PV in 2017	Opened in 2004 To open in 2014
Hankook Tire	Jiaxing Huaian Chongqing	29m PV + truck in 2013 860000 in 2013	 10m PV + 1.6m truck/bus by 2015	Opened in 1999 Opened in 1999 Opened in 2013
Yokohama Rubber	Hangzhou Suzhou	PV tyres Truck + bus tyres		Opened in 2003 Opened in 2008
Cheng Shin Rubber	Kunshan Xiamen Chongqing Xiamen	PV and light truck tyres Truck tyres 11m PV 11m PV		Previous JV with Toyo Tire Previous JV with Toyo Tire

China is the largest tyre exporting country in the world with exports amounting to $15.9bn, or 19% of the world total, in 2012 – see Table 3.4. Much of China's total tyre exports are comprised of tyres for trucks and buses ($8.1bn) and for passenger vehicles ($5.9bn) – see Table 3.5. These two categories accounted for almost 90% of the total and, whilst China is also a major exporter of bicycle tyres, the value of this trade ($248m) is small in comparison. Total EU tyre exports only account for 10% ($7.9bn) of the world total, and the aggregate value of the EU exports of passenger vehicle, truck and bus tyres was less than half that of China in 2012. The EU was the leading exporter of aircraft tyres – a segment in which China was an insignificant player – but the total value of this trade ($151m) was small.

Table 3.4: Tyre Exports (US$m) 2010-2012

		2010	2011	2012
China	Total Exports	10,388	14,762	15,884
	Share in world	16%	17%	19%
EU	Total Exports	5,326	6,589	7,924
	Share in world	8%	8%	10%
Japan	Total Exports	6,928	8,246	8,086
	Share in world	11%	10%	10%
Korea	Total Exports	3,294	4,152	4,507
	Share in world	5%	5%	6%
USA	Total Exports	3,990	4,971	5,378
	Share in world	6%	6%	7%
World	Total Exports	65,320	86,163	81,693

Source: Comtrade (HS 4011: new pneumatic tyres, or rubber)

Table 3.5: Tyre Exports by Type (US$m) 2012

Product	Product Name	China	EU	Japan	Korea	USA	RoW	World
401110	...used on motor cars (incl. Station wagons& racing cars)	5,879	4,174	3,316	2,884	2,010	22,871	41,135
		14%	10%	8%	7%	5%	56%	100%
401120	...used on buses/lorries	8,056	2,099	1,969	1,572	2,350	11,012	27,058
		30%	8%	7%	6%	9%	41%	100%
401130	...used on aircrafts	9	151	108	180	0.00	211	479
		2%	31%	23%	0%	0%	44%	100%
401140	...used on motorcycles	263	131	105	24	24	905	1,452
		18%	9%	7%	2%	2%	62%	100%
401150	...used on bicycles	248	53	4	0	4	477	787
		32%	7%	0%	0%	1%	61%	100%
401161	...used on machinery (401161-401199)	1,428	1,315	2,585	26	990	4,439	10,782
		13%	12%	24%	0%	9%	41%	100%
	Total	15,884	7,924	8,086	4,507	5,378	39,915	81,693
		19%	10%	10%	6%	7%	49%	100%

Source: UN Comtrade

World tyre production is increasingly concentrating in China. Although European manufacturers have a global strong-hold in the sector, particularly in the premium tyre market, Chinese firms are increasingly becoming important. However, the large number of Chinese firms operating in China suggests that there has been little by way of consolidation in the industry. This in turn could mean that firms are not currently exploiting important economies of scale which may be hindering their competitiveness.

3.4.2. THE TYRE VALUE CHAIN

Tyres are sophisticated engineering products, and the value chain consists of three broad elements: raw material procurement; manufacture; and distribution.

The main raw materials come from a variety of industries, viz: rubber plantations (for natural rubber), textile industries (cords), chemical industries (synthetic rubber, sulphur, carbon black, and other additives), and steel industries (beads & cords). China's indigenous supplies of natural rubber are relatively small (c800 tonnes per year, or about 6% of total world supply in 2011) so the tyre industry is heavily reliant on imports. Natural rubber imports into China are subject to import tariffs, these were reduced from 7.5% to 6% in early 2013. Thailand (32%) and Indonesia (27%) are the two

biggest rubber-producing countries, with significant production also in India (9%), Malaysia (8%) and Vietnam (7%). Some international tyre producers (e.g. Michelin) have vertically-integrated their natural rubber supplies by owning and operating several rubber plantations (inter alia in Vietnam, Brazil and Nigeria) – this not only assures supplies of an essential raw material, but also provides some protection against volatility in the world price of natural rubber. Other manufacturers (e.g. Pirelli and steel cord manufacturing) have internalised some of their raw material supplies.

The main synthetic rubbers are polybutadiene, styrene-butadiene rubber, and butyl rubber, and their roles are to improve abrasion resistance, reduce heat build-up, and enhance the mechanical properties of the tyres. Rubber accounts for 50-60% of the total raw material cost in the production of tyres. More synthetic rubber is used in car tyres, whilst more natural rubber is used in truck tyres. The synthetic rubber manufacturing industry in China grew at an annualised rate of 27% over the 2007-12 period, with the industry dominated by four main firms (i.e. China Petrochemical Corporation, China National Petroleum Corporation – Shenhua Chemical Industrial Group and Shandong Yuhuang Chemical) which accounted for 57% of sales in 2012. Michelin provide the following average raw material cost breakdown for 2011: natural rubber (36%); synthetic rubber (27%); fillers (15%); chemicals (10%); steel cord (7%); textiles and other materials (5%). Given this cost breakdown, the price of rubber clearly has a major impact upon the cost of tyre manufacture, and upon tyre manufacturers' profit margins.

The tyre manufacturing process consists of various activities, including mixing the raw materials, fabric manufacture, bead construction, extrusion and ply formation, tyre building, and curing – see Appendix A.3. These activities typically take place within the same factory, or cluster of factories.

As noted above, the finished tyres may then be distributed to indigenous vehicle manufacturers for use on new vehicles, to the replacement tyre market, or exported. Many of the tyre companies manufacturing in China have long-standing supply arrangements with indigenous vehicle manufacturers, whilst sales in the replacement market may be effected either through specialist dealers (who also sell competitors' tyres) or though franchised dealers (who offer exclusive distribution).

3.4.3. Demand for Tyres Manufactured in China

In China, automobile sales increased dramatically from 5.8m units (4.0m passenger vehicles + 1.8m commercial vehicles) in 2005 to 19.3m units (15.5m passenger vehicles + 3.8m commercial vehicles) in 2012, though annual growth rates slowed between 2010 and 2012. Future demand is expected to be more modest with most analysts forecasting single-digit growth rates through the next few years, though the growth figures are still expected to comfortably surpass those in European markets. However, as the Automotive Working Group (2013/2014, p.134) point out, "in the long term prospects for growth remain immense in China since the ratio of car ownership per thousand people is still only a fraction of what it is in Europe or the United States" though "what the double-digit yearly increases in car ownership have all too clearly demonstrated in recent years is that China's cities have not been able to cope with such rapid development in the automotive sector". Nevertheless, it appears as though there will be a steady increase in OE demand for tyres though the next five years.

The ever-increasing vehicle population in China will also give rise to an increasing demand for replacement tyres, albeit with a time lag given the average replacement period of four years. It is also likely that the average tyre life span will shorten, as more cars are sold in rural areas and as safety

awareness increases. Analysts thus predict that domestic demand for replacement tyres should rise at double-digit annual rates over the next decade, and that replacement demand should account for over 70% of the total tyre market by 2020.

About 60% of domestic Chinese tyre manufacture is currently destined for the local market. It has been estimated that the international manufacturers account for about 70% of the Chinese passenger vehicle OE tyre market as the Chinese tyre manufacturers suffer from lower quality and weaker brand image. This high percentage is encouraging for the international manufacturers given the likelihood that customers typically favour their OE brand when replacing tyres. However, Chinese manufacturers are making strenuous efforts to improve the quality of their tyres, spurred in part by growing local consumer awareness of the safety and fuel efficiency merits of better tyres and in part by the more stringent EU requirements on tyre performance (see below). The new EU tyre labelling regulations have raised the technical threshold for tyres imported from China, and have had a significant impact upon exports from many Chinese tyre manufacturers. In response, several Chinese firms have sought to establish partnerships with foreign firms to upgrade their products technical capabilities. One prominent example is the joint venture between Double Coin and Michelin under which the Chinese firm will gain access to French technology to improve tyre quality to EU standards. Another example is provided by the Triangle Group has an agreement with the German chemicals group Lanxess to develop new tyre products. Such collaborations have the potential to benefit both partners, with the Chinese firms improving the quality of their tyres and the European firms increasing their revenues from the Chinese market.

Direct exports of tyres currently account for about 40% of the demand for tyres manufactured in China. Total tyre exports were 159.2m in 2008 and 159.1m in 2009, rising to 187.0m in 2010, to 193.1m in 2011, and c200m in 2012. The United States has historically been the largest export market for Chinese tyres, accounting for over 35% over the period 2007-9. However, the US Government announced "safeguard measures" on imported Chinese passenger vehicle and light truck tyres in September 2009. These "safeguard measures" raised the original import tariffs from c.4% in 2009 to c35% in 2010, to c30% in 2011, and to c25% in 2012. As a result[40], the United States only took 23.4% of Chinese tyre exports in the first half of 2012 - the policy did not reduce aggregate US tyre imports, but simply diverted imports to other Asian (particularly South Korean) suppliers. The "safeguard measures" expired on September 26th 2012, and US tyre imports from China should return to their previous levels, given the cost advantages enjoyed by tyres produced in China. Meanwhile, EU imports as a percentage of total China tyre exports rose from 15.5% in 2009 to 18.4% in 2011.

EU-China trade in tyres is very unbalanced. EU imports of car and light truck tyres from China rose from 24.3m in 2007 to 29.2m in 2009 and to 50.8m in 2011, whilst imports of truck and bus tyres rose from 0.74m in 2007 to 1.52m in 2009 and to 2.57m in 2011. Meanwhile, EU exports of car and light truck tyres to China rose from 1.5m in 2007 to 2.1m in 2011, and exports of truck and bus tyres rose from 0.06m in 2007 to 0.13m in 2011. In November 2012, the EU introduced the first stage of new tyre labelling regulations[41], grading tyres according to rolling resistance, wet grip, and noise level[42].

[40] There is some evidence that Chinese tyre manufacturers circumvented the tariffs by transhipping tyres to the US market via third countries, though no reliable data are available to confirm this suggestion.
[41] Regulation EU/1222/2009. EU regulations will introduce further mandatory reductions in rolling resistance an external noise by November 2016.
[42]Rolling resistance is expressed in A-G grades for cars, and A-F grades for trucks. An A grade represents the highest level of fuel efficiency, and the differences between each grade represent differences in fuel consumption of 2.5-4.5% for passenger vehicles, and 5-8% for trucks.

Tyres which fail to meet the lowest EU standards are banned from sale in the European Union. Most Chinese PV tyres meet the lowest EU labelling standard, whilst about 70% of Chinese truck tyres do so. Thus the introduction of the first stage of labelling standards should not have a major impact on Chinese tyre exports in the short-term, though it is expected that the pending introduction of the second stage of regulations in 2016 will prompt indigenous Chinese tyre manufacturers to upgrade their products in the medium-term.

In addition, more tyres are likely to be exported in the future as a result of Chinese automotive manufacturers establishing overseas assembly facilities in many export markets. These manufacturers are likely to equip the vehicles with Chinese tyres to maintain their cost competitiveness.

3.4.4. THE EUROPEAN TYRE MANUFACTURERS IN CHINA

All three main European tyre manufacturers (i.e. Michelin, Continental and Pirelli) operate in China, though their market shares are well below their global market shares. Michelin had an estimated China market share of 9% in 2011, and Continental an estimated share of 2-3%.

Michelin has two wholly-owned manufacturing plants: in Shenyang (annual output ≈ 2.6m passenger vehicle and light truck tyres + 850,000 truck tyres), and in Shanghai (annual output ≈ 5.4m passenger vehicle and light truck tyres). Current 2012 capacity is about 130,000 tonnes, but Michelin intends to increase capacity to 255,000 tons by 2017 based on an expansion of the capacity of the Shenyang facility. In addition, Michelin is in the process of building a new plant in Wuwei (Anhui province) with a target capacity of 5m passenger vehicle tyres) as part of a joint venture with the Chinese firm, Double Coin (Michelin 40%, Double Coin 60%). Michelin's strategy in China is to focus on the passenger vehicle replacement tyre market, and it has limited sales to the local automobile OE market. It has a major "TyrePlus" distribution network, with 840 outlets in 2012 and plans to increase the number of outlets to 1700 by 2017.

Continental started exporting tyres to China in 1997, supplying replacement tyres to clients such as BMW Ag and DaimlerChrysler AG. The German firm opened its first China office in 2006, and later added some franchised distribution outlets. But Continental was late (relative to Michelin and other foreign manufacturers) in establishing production facilities in China, and it was not until May 2011 that it opened a production plant in Hefei (Anhui province). Production was c3m passenger vehicle tyres in 2012, and Continental intends to expand output to c8m tyres by 2017. Meanwhile Continental had increased the number of its franchised stores to 2500 by the end of 2012, with plans to "deepen its footprint" in second-tier and third-tier cities with a further 1000 new outlets in 2013. Currently 90% of Continental's output in China is destined for the replacement market, but the firm hopes to increase its OE business with the future establishment in China of long-established EU partners (e.g. Volvo and Jaguar Land Rover) and the development of local Chinese car brands. The medium-term objective is a 65-35 split between the replacement and OE markets. Continental imports truck tyres from its facilities in Modipuram (India) and Petaling Jaya (Malaysia) to supply the Chinese truck market, and premium car tyres from Germany.

Pirelli established its tyre production facility in China in 2005, when it acquired a stake in RoadOne Tyre Co. Ltd in Yanzhou (Shandong province). Initially production was of truck tyres only, but a PV tyre production line was added in 2007. Pirelli subsequently increased its ownership stake from 75% to 90% in 2011. Production was 4.1m passenger vehicle tyres in 2011 (+ 700,000 truck tyres), but

Pirelli announced plans in early 2013 to increase capacity to c10m PV tyres (+ 850000 truck tyres) by 2014. In addition, the plant has an annual capacity of 1m motorcycle tyres. Pirelli's focus is on premium tyres, and it intends to export up to 40% of its Chinese PV tyre production to Europe but also to cater for increasing demand within China from the luxury car segment. Pirelli is also a minor partner in a steel tyre cord manufacturing facility, also in Yanzhou. Furthermore, Pirelli also wants to expand its distribution network in China from 1100 outlets in 2011 to more than 3,000 points of sale in 2014, also with an emphasis on second- and third-tier Chinese cities.

3.4.5. OPPORTUNITIES AND CHALLENGES FOR THE EUROPEAN TYRE MANUFACTURERS IN CHINA

- Demand for automotive tyres in China can be confidently expected to grow significantly over the next decade, driven both by the increasing production of new vehicles and by the demand for replacement tyres. In particular, strong growth is predicted for luxury cars. For all three major European tyre manufacturers, there is the challenge of increasing their market shares within China to levels comparable to their global market shares – but they will face strong competition from other foreign manufacturers (notably Hankook and Cheng Shin) which have more extensive facilities in China.
- An important characteristic of tyre manufacture is that the value chains of many of the large international companies are often highly integrated, with many companies not only undertaking tyre manufacture but integrating both downstream activities (with many of the major firms expanding their own distribution networks) and/or upstream activities. For instance, Michelin owns and operates several rubber plantations (*inter alia* in Vietnam, Brazil and Nigeria), Goodyear has recently invested in two new synthetic rubber manufacturing plants, and Pirelli has become a minor partner in a steel cord manufacturing facility. These moves reflect increased concerns about price volatility and guaranteed supplies of essential raw materials at a time when tyre production is increasing.
- A particular challenge is for EU companies to increase sales to the vehicle manufacturers located in China, given that customers often replace tyres with the same OE brand. There are currently restrictions on investment by foreign automobile manufacturers in China. The only permissible ownership structure is a joint venture with a Chinese partner, with the foreign investor's maximum shareholding limited to 50%. Furthermore, any foreign investor is restricted to establishing no more than two such Sino-foreign joint ventures for the production of passenger cars, and two for commercial vehicles (the '2+2' regulation). If these restrictions were relaxed, then the possible growth in EU vehicle production in China might well lead to a growth in demand for tyres produced by EU manufacturers within China.
- Increased sales of replacement tyres require the presence of a substantial dealership network, preferably offering exclusive sales. It is interesting to note that all three EU tyre manufacturers are currently making significant investments to their Chinese distribution networks, including reaching out to second-tier and third-tier cities.
- One possible immediate policy prescription could be to reduce tariffs on natural rubber thus reducing costs for both Chinese and European manufacturers in China. Since it appears that EU and Chinese firms compete in different segments of the market this move would help consolidate Chinese manufacturers without increasing the competitive pressures from EU firms. Moreover, it could also provide a competitive boost to the thriving export market where Chinese manufacturers are increasingly important.

- A real opportunity is offered by the fact that China's 12th Five Year Plan (2011-2015) highlights *inter alia* the objectives of lower energy consumption, better environmental protection, and improved road safety. The EU tyre manufacturers have significant advantages in the development and production of tyres with lower rolling resistance (and hence better fuel efficiency, and lower emissions) and better safety features. Any policy measures that encourage and facilitate these broad objectives should thus provide mutual benefit both to the Chinese economy (and population) and to the EU tyre manufacturers.
- Tyre product standards and specifications in China are typically different than in the European Union, are subject to frequent changes, and may vary within China across provinces. This can be frustrating for foreign tyre manufacturers, particularly if they are given little or no advance warning of impending changes. It would benefit all in the industry if all tyre manufacturers (foreign and Chinese alike) were consulted in advance on proposed changes to specifications and other regulatory matters. The manufacturers would thus not only have time to redesign and adapt their products, but might also be able to contribute constructively to any changes in the regulatory environment.
- One of the future challenges for the Chinese tyre industry is chronic over-capacity, notwithstanding the predicted growth in tyre demand. At the end of 2012, there were 500+ enterprises in the Chinese domestic tyre industry, but many were small-scale with little R&D capability and also unable to reap the benefits of economies of scale. China's 12th Five-year Plan envisages the consolidation of the industry: small (< 500K capacity) plants will be shut down; no new bias tyre factories will be built; authorisation will only be given to large (i.e. > 6m PV tyres, or > 1.2m truck tyres) new plants; and financial support for upgrading and expanding operations will be provided through the Bank of China. The larger firms should survive the consolidation, particularly if they can raise their product standards through collaboration with foreign manufacturers, but the smaller firms may become targets for acquisition.
- The Chinese Government appointed the Triangle Group as the host company for a joint-funded facility - the National Engineering Laboratory for Radial Tire Design and Manufacturing Technologies (NEL) - in August 2011. The NEL is envisaged as an "open platform" for innovation within the tyre and rubber sector and, as such, is available for use by all Chinese tyre manufacturers. We do not currently have information as to whether or not foreign tyre manufacturers will be welcome to participate, but this is clearly an area where there might well be mutual benefits.
- This process of consolidation may well be stymied by local protectionism as provincial governments try to subsidise and maintain local firms. However, the tyre industry in China will only thrive, to the benefit of the companies concerned and of automobile manufacturers, if market forces are allowed to drive the restructuring of the industry. This will inevitably require some of the small companies either being acquired by larger (Chinese or foreign) firms, or going out of business.

3.5. ELECTRIC VEHICLES

The Chinese Government has set very ambitious goals to promote green technologies aimed at reducing emissions. To meet these targets they have enacted regulatory frameworks aimed at compelling foreign firms to produce electric vehicles (EVs) in China in partnership with domestic manufacturers. Evidence suggests that these regulatory frameworks may not only be hindering EU firms but also contributing to the current below target production of EVs in China. This is a clear example of a lose-lose situation which could be turned into a win-win solution.

Mapping the electric vehicle (EV) value chain in China is a very difficult task given that this is a nascent sector where global value chains are only just emerging. This makes it is hard to predict the future role of specific technologies, firms, and even countries. Additionally challenging is defining EVs. Producers emphasise the 'electric' characteristics of the engine even when a combustion engine is working in parallel (hybrid vehicles or HEV) in order to enhance their low-carbon credentials. Some car manufacturers produce different types of EVs with different technologies at the same time, and with the real possibility of different kinds of hybrids being counted as EVs it becomes clear that the real story behind the production challenges in EV value chains will only emerge by interviewing key stakeholders.

This case study draws on information obtained from some of the 10 European firms operating in China that may be involved in the production of EVs. It is worth noting that at the moment of carrying out this study no EVs were being produced in China by European firms (although EU firms have indeed produced EVs for other markets and have even exported these to China). We focus on Battery Electric Vehicles (BEVs) and PHEV (Plug-in Hybrid Electric Vehicle).[43] These two types of vehicles correspond with the definition of New Energy Vehicles (NEV) used by the Chinese government in their regulatory framework for this sector.

Since the EV value chain in China is only just emerging, this case study looks at the challenges and opportunities that EU firms face in setting up EV production in China.

3.5.1. BACKGROUND

Production data on EVs is hard to come by but trade data may give us some guidance on the focal production points of EVs. Using HS-2012 code 870390 to identify electric vehicles, Table 3.6 highlights the dominance of the US in EV exports (38% of total trade EVs).[44] Japan follows closely with a 24% market share and then the EU with 8%. What transpires from this data is i) the EV sector is nascent and only occupies 3.5 billion dollars; ii) The US and Japan are the key players; iii) The EU is a more significant exporter of EVs than China.

[43] non-plug-in HEVs are not to be included in this analysis

[44] The tariff code 870390 which appears in the HS2012 nomenclature seems to include hybrid cars. What is revealing is that earlier revisions of the HS system did not provide a breakdown for non-piston engine internal combustion vehicles which is testament to the nascent status of this industry..

Table 3.6: Electric Vehicle Exports - total (million USD) 2012

	Export value	Export share
China	38.3	1%
European Union	278.3	8%
Japan	846.4	24%
Korea, Rep.	1.1	0%
United States	1,309.8	38%
World	3,458.5	100%

Source: Comtrade (HS-2012 code 870390)
Note: This code identifies vehicles with engines other than spark-ignition internal combustion reciprocating piston engine "diesel or semi-diesel"

Although the EV sector is wrought with challenges, a recent study (ECORYS, 2012) suggests that the rewards may be plentiful. They estimate that by the year 2020, 10-20% of all vehicles sold will be EVs. According to this study, one key feature of the organisational structure of the sector is the vertical integration involving battery producers and traditional car manufacturers which often involve firms headquartered in different nations (they cite the alliance between Audi AG and Sanyo electric Co. and that of Volkswagen with Toshiba). This is a clear indication of cross border cooperation between multinational enterprises where each is *lending* its comparative advantage in view of realising future profits.

However, while car manufacturers operate in all three 'world factories', battery manufacturers concentrate in 'factory Asia': Japan (57% market share), Korea (17%) and China (13%). This suggests that the advantages of locating in China may arise not just from cheaper labour force and access to the Chinese market, but also from proximity to battery suppliers. However, the development of the EV sector is also tied to the industrial policy enacted across different countries and the incentives it can provide for producers. The infrastructure element is also likely to be determinant. As it stands, EVs have a relatively low mileage-per-charge and require charging for over ten hours to replenish batteries. Since these cars will require petrol-pump-like infrastructure and there is yet to be a common standard for these, the choice made by particular countries is likely to determine the type of technology that EV manufacturers choose.

3.5.2. EVs IN CHINA - MARKET AND THE REGULATORY REQUIREMENTS

The EV market in China is currently dominated by domestic firms. Recent reports indicate that 80% of the market share for EV and PHEV belongs to Chery, JAC and BYD. There is also a large scope for future growth given the size of the Chinese market and the new incentives that the Chinese government is providing. However uptake of EVs has been slow paced. At the end of 2012, only 11.4k units of BEV and 1.4k units of PHEV had been sold in China, mostly to government fleets and taxi customers (ADL, 2013).

The private consumer market for EVs in China is highly underdeveloped and has mainly been served by domestic firms and imports. The latter tend to be at the top end of the price scale and, according to interviewed firms, are aimed at 'testing' the market in order to plan for future offerings that might be produced locally. Therefore, plans to service the Chinese markets through imports are not likely. But local private demand for EVs has been stifled by concerns related to cost, driving range and ease of recharge. Local supply for the private market has also been slow to take off due to challenges with charging infrastructure and low consumer interest but perhaps most importantly because the traditional ICE (Internal Combustion Engine) car market is still very profitable both for domestic and foreign players alike. Hybrid cars that are not plug-in have also seen an increase in their market share,

with the leader being a foreign company (Toyota). However the more 'electric' the car, the less attractive the Chinese market looks at the moment vis-a-vis the more traditional (and burgeoning) ICE and non-plug-in Hybrid cars.

The current regulatory framework in China foresees that, in order to produce vehicles of any kind, foreign car manufacturers in China have to engage in joint ventures (JVs) with domestic companies under at least a 50-50 share split. Although it is theoretically possible for a foreign company to manufacture in China, in order to sell its products it will require a license. These are rarely obtained unless a Chinese partner is involved. This makes JVs the only feasible route for foreign firms to produce and sell cars, electric of not, in China. This suggests that the organisational structure of the value chain is guided not by market forces but by the imposed regulatory requirements. For ICE vehicles, where the technology is ubiquitous and the 'charging' infrastructure is abundant in the shape of petrol stations, JVs do not seem to have been an insurmountable barrier for foreign companies as the market has expanded manifold over the last decade with China's increasing economic growth. For EVs, which require the use of new technologies the impact of the enforced JV structure remains to be seen.

The Chinese government has also made it a condition that any future expansion by foreign firms into the coveted ICE car market in China is tied to a commitment to produce EVs in partnership with local companies. The new EVs are to be the result of jointly developed R&D and are required to bear a new brand name (belonging to the JV) different from the foreign firm's brand name.

These requirements are usually communicated to the foreign firms directly and negotiated (one interviewee called it 'interpreted') by the staff of the department of government relations in each foreign firm. The role of these departments is to make sure that there are no misunderstandings with regards to what the regulatory framework (and additional requirements) is asking from foreign firms. Even though the domestic partner in the JV communicates the government's requirements to their foreign partners, some interviewees explained that it is better to corroborate that what they are hearing from their JV partner is what the central government meant and in which specific way they are expecting to see these requirements implemented. A recent report from an equity analysis firm calls these requirements part of the 'cost of doing business in China' (See Macquairie, 2013)

The rationale behind these requirements and conditions is linked to the realisation (by the Chinese government) that technological and market leadership in the EV sector is still possible to attain (as opposed to the ICE and Hybrid sectors) for new entrants and they have designed a series of policies which support their domestic companies' aim to leapfrog into this leadership position.

So far, the regulatory framework does not seem to have swayed foreign companies in China to produce NEVs within JVs for the Chinese market. Under this backdrop, we now turn to looking at why this might be the case for European producers in China.

3.5.3. EUROPEAN CAR MANUFACTURERS (OEMS) IN CHINA

Although European BEVs and PHEVs are known in China via imports, European OEMs (Original Equipment Manufacturers) have yet to produce a single EV in China (our interviews suggest that plans are afoot to begin production in the next couple of years).

Issues of technology sharing and branding in JVs have been mentioned as potential explanations for these delays, and other views point to the extreme attractiveness and profitability of the traditional ICE and non-plug-in Hybrid car market as a factor. Both European and Chinese producers can claim a win-win arrangement in those markets but it has been less clear which advantages (beyond market access, which isn't trivial) European OEMs will have if and when they decide to produce EVs in China.

Some interviewees explained that there is little incentive for foreign firms to 'give their technology' to their 'future competitors' (i.e. the JV brand and their domestic partners). In the same vein, one European firm in particular emphasised the high sunk costs of launching a new brand in the market and how foreign firms do not relish the prospect of investing large sums on a new brand that might compete with their own.

Even amongst those not concerned with the 'nurturing our own competitors' risk, another perception is that once a domestic company is paired with a foreign one within a JV, the domestic company stops investing in their own R&D trusting that their foreign partner will provide the latest designs and technology. Foreign firms feel that this type of behaviour does not inspire confidence in the partnership. This can lead to an impasse which is slowing the production of EVs.

According to one interviewee, foreign firms are not the only ones to resent this lack of R&D investment by domestic firms. Apparently the Chinese government is also dissatisfied with their performance and has been trying to come up with incentives and policies to entice local champions to make the most of the opportunity offered by a NEV value chain without clear governance patterns and few established lead firms (e.g. BYD, a domestic firm). The government has tried to help local firms with regulations around JVs with foreign firms and also with subsidies to make the price of NEVs more attractive to consumers.

Both the previous and the new NEV policies by the Chinese government have been aimed at domestic companies, which is not surprising given the importance of decreasing oil-dependency, lowering emissions and the unlikelihood of achieving a technological lead in the ICE and non-plug-in Hybrid car sectors. The new NEV incentive policy, launched in September 2013, extends its coverage to all cities (provided their application succeed) and requires that public fleets in sample cities/regions be more than 30% made up of NEVs. The new policy also restricts the purchase of local brand NEVs in sample cities in order to promote a more 'national' market instead of a more city or province-based one where local government fleets only buy NEVs from the local (regional) manufacturer. Subsidies for electric buses will increase whilst those for passenger vehicles will reduce gradually over the next couple of years which puts more pressure on Chinese firms to join forces with European firms (and other foreign firms) in order to provide quick offerings to the market whilst the subsidies are in place.

A few of those offerings coming from Foreign-Chinese JVs between 2013 and 2016 are: Shouwang EV (Beijing Hyundai) and the Leaf (Nissan). Daimler and BYD plan to launch the DENZA EV and Smart (Smart EV), Mercedes (Benz B EV), Audi (A3 e-tron).

3.5.4. RESULTS

Given the political importance of the New Energy Vehicle (NEV) sector for China's future energy security (reducing dependence on oil) and pollution control (by lowering emissions) the expectation

would be to see large numbers of NEVs being produced in the country by both domestic and foreign firms, as in the case of ICE cars. However, NEVs production is still low and participation by foreign firms (including those from Europe) is limited. Given that there is no established value chain in this sector, and that its governance is imposed by the strict regulatory frameworks, we now turn to explaining the current absence of European NEVs produced in China and whether this is likely to change in the near future.

During our interviews with key informants in China, we specifically sought to understand the background behind three main figures that may summarise this study's focus on EU-China NEV value chains (ADL, 2013):

500,000: the target number of NEVs to be produced in China by 2015, set by the Chinese central government;

11,500: the number of NEVs produced in China by the end of 2012;

0: the number of European NEVs produced and sold in China so far.

It will be extremely challenging to reach the target of 500K NEVs by 2015 when starting from a number as modest as 11.5K in 2012 and without greater involvement of European and other foreign OEMs in this value chain. However, most interviewees concurred that it was not a matter of 'if' but 'when' European involvement in the local NEV value chain would be intensified and become part of the 'business as usual' context of auto making in China. Some factors that are contributing to this change are:

1) Expansion of OEM operations in China is conditioned to investment in NEVs

Foreign companies (operating in JVs, the only way to produce and sell vehicles in the country) aiming to benefit from the seemingly ever-increasing ICE car market in China must comply with several written (and unwritten) rules: i.e. develop an EV, launch a vehicle that is fully developed and produced in China with local R&D and create new brands with their JV partners (i.e. using their foreign brand names is not allowed for these new offerings).

An example of this is BMW-Brilliance (a JV between BMW and Brilliance Auto) which has complied with all these rules by creating the Zinoro brand. It is expected to sell by the end of 2013 by some estimates (Macquaire Research, 2013) although other reports provide a more conservative date of 2015. However, the new Zinoro is not going to be distributed in BMW showrooms but rather through alternative distribution channels so BMW can still sell their high-end vehicles without direct competition from this lower-priced EV.[45] Another example is Denza, the JV formed by Daimler and BYD with the specific purpose of producing an EV which media reports have suggested will be launched in 2014.

However, most European OEMs are adopting a 'wait and see' approach even at the risk of expansion opportunities. Interview material shows that this 'wait and see' view to developing NEVs is widespread. From the interviewed OEMs, two had developed a full prototype for an EV. One of them did not have plans to put it in the market for at least two years whilst the other made an announcement on the 25th of October (Volkswagen) that they would import PHEVs and BEVs as 'early as the end of 2013' but production in China is only expected after 2016 . A third company was planning to import

[45] We were unfortunately not able to interview BMW to understand what determined their choices.

the EVs they sell in Europe in order to test how the car would be received in the Chinese market, with no current plans to develop EVs of their own. A fourth company explained that unless the regulatory framework and support structure for foreign-led (but locally produced) EVs is clearer, they would postpone the decision of investing in the development of a local EV. This suggests that the regulatory framework is still perceived by European OEMs as ambiguous (at best) or unsupportive (at worst) for the production of EVs. This perception may jeopardise the attainment of the Chinese government's goals with regards to the expansion of the EV sector.

2) China has been working on harmonising charging standards for three years.

Whereas in Europe the debate continues as to which kind of charging standard will be followed when designing charging stations, China has settled this matter since 2010. This is welcome by the EU firms and could facilitate the expansion of charging infrastructure all over China which in turn could support the development of the NEV industry in general. The state grid has been using these standards in procurement processes but there are still some important actors (i.e. CNOOPC) operating in large cities which are not following these standards. Interviewees mentioned that European OEMs would favour re-charging options which are based on plug-in rather than battery-swapping systems (whereby they would lose ownership of the most important part of the value chain: the battery pack) which would suggest that their support to the diffusion of standards for charging stations would be a win-win situation for both OEMs and the state grid. Since standards are currently being negotiated in the EU, it is hard to tell whether there are likely to be compatibility issues in the future due to different standards.

3) The new NEV incentive policy is considered an improvement over its predecessor

Launched in September 2013, the new NEV incentive policy will be implemented in a wider area which could support NEV manufacturers to expand their sales all over China. EU and foreign firms can access these subsidies indirectly via their domestic JV partner. The new policy allows any city to apply to become a 'sample city' receiving subsidies for NEV manufacturers. The policy has been hailed as 'more realistic' given its stronger emphasis on government fleet purchases of NEVs; the proportion of NEVs vis-a-vis total vehicle government purchases should be more than 30%. The incentive policy targets NEVs that are produced in China only and therefore discriminates against imports of EVs which is the only current type of EU engagement in China at the moment.

Additionally, the policy provides a disincentive for local governments to favour local NEV manufacturers: there should be more than 30% NEV purchases of other non-local brands, including foreign brands. Since the policy has only come into force a month before this report was written it is hard to tell whether this will be widely enforced.

Another adjustment which reveals an acceptance of the leadership role of public transportation in the development of a NEV industry is the fact that the new policy stipulates lower and decreasing subsidies for NEV passenger vehicles and higher subsidies for NEV buses. The subsidies for NEV passenger vehicles are due to stop by 2015, when they will be 20% lower than those offered in 2013 (60K RMB per vehicle). Local government subsidies can still match the central government's subsidies per vehicle as they did in the previous NEV policy.

Interview material suggests that the new NEV policy is perceived as a step in the right direction but questions remain as to whether it is still too biased in favour of local producers.[46] European OEMs may need more guarantees that they (or at least the JVs where they participate) will not be disadvantaged by the subsidies policy. This reluctance to engage in EV production may ease after the new policy is better explained and is seen to be operating fairly, but this will further delay plans to reach the 500K NEV goal by 2015.

4) Regulations and subsidies (depending on location) could make NEVs more attractive

Total cost of ownership (TCO) is a useful measure to compare ICE cars and NEVs. TCO includes other items beyond the vehicle's price tag that make car ownership less or more expensive over a given period of time. These items include: central government subsidies, local government subsidies, the cost of obtaining a license plate (or the benefit of being exempted), energy cost and insurance. Some comparisons between EVs and ICE cars in Shanghai and Hangzhou show that with all the subsidies and regulations the TCO over three years of a JAC iEV could be between 21K and 25 K RMB lower than its peer ICE model, the JAC Tongyue.

Beijing has already proposed to exempt NEVs from the license plate lottery. The lottery, which has delayed many Chinese consumers' plans for car ownership may make owning a NEV the only chance for many people to have their first city car and this may increase demand for charging stations/solutions. Many Beijing dwellers would also see the benefit of having a second car (a NEV) with a license plate with a different ending from the car they currently own, given the current policy of prohibiting the circulation of odd and even-ended license plates on alternate days to help with reducing pollution and traffic.

Alongside the opportunities mentioned above, it was clear that a number of obstacles are also present which are delaying / impeding stronger collaboration between EU and Chinese companies in the NEV sector:

5) Concerns about sharing proprietary technology within JVs

As mentioned elsewhere, foreign OEMs can only produce and sell vehicles in China as part of a JV with a domestic firm. For NEVs, the domestic partners should have at least 51% percent of the shares, making them the lead partner in the JV. Sharing knowledge which has taken high investment is usually a concern for firms operating in China particularly because the government has made it clear that they expect domestic firms to 'leapfrog' to the vanguard of NEV technology now that is clear that closing the technological gap in the ICE market is unlikely. Some analysts have suggested that European firms should not bring their latest technologies to China and should continue to innovate abroad but that keeping away from joining JVs is not an option either. Being left out of the Chinese market for EVs (and consequently, of ICE cars) is not something the OEMs are prepared to do. In general, the current regulation with regards to JVs in 'key sectors' such as cars and particularly, NEVs, may be restricting or delaying further investment from European OEMs. However, it is difficult to imagine how China would forfeit the opportunity of using access to its vast market as a lever to incentivise foreign participation and technology sharing in JVs.

6) The ICE market will continue to grow over the next few years

[46] It is too early to tell whether this will be properly enforced

Most interviewees seem to agree that the ICE market will continue to be the 'main car market' in China for years to come. Hopes for e-mobility have been tempered with caution and expectations for NEVs now range from 2-5% according to some analysts to 10-20% of the car market in China by 2020 in other estimates. The consensus view is that NEVs will not become the dominant mode of transportation in the next few years.

7) Customer concerns with safety and range, lack of charging stations

Chinese customers have not been enthusiastic about purchasing NEVs. Interview material with OEMs and other key informants confirmed that it has been a challenge to convince customers of the advantages of NEVs. A couple of widely reported incidents in the media where EV batteries caught fire after a collision have not inspired confidence on NEVs. Lack of a suitable and ubiquitous charging infrastructure has also affected demand. Many potential Chinese consumers live in flats and those buildings may not provide adequate plug-in facilities. Lastly, in a country with continental dimensions like China, the short range (up to 160 km) provided by a charge (which could be overnight) is not satisfactory. Extended range PHEVs which also include a small petrol-run engine allow for a 500Km driving range which is a great improvement but many consumers remain undecided.

8) OEM's concerns with costs (investment of 200 million euro)

Interviewees mentioned that 'an EV project' could mean an investment of between 100 and 200 million Euro by an European OEM. It is a considerable amount particularly when demand for NEVs is not a straightforward assumption. To allocate resources for expansion in the lucrative ICE market seems a safer bet than investing in the NEVs sector.

9) OEM's concerns with local battery suppliers

With over 100 battery producers in China, the NEV sector should have many suppliers of this key input to choose from, but unfortunately there are still concerns about the quality and reliability of Chinese battery producers (with the exception of BYD, which was described in complimentary terms during interviews with their European counterparts).

3.5.5. CONCLUSIONS

The Chinese Government has set itself the ambitious target of promoting the deployment of 500k NEVs by 2015. Currently, production of NEVs is well below target at 11.5k (2012) and EU firms have yet to sell a locally produced EV in China. There is an array of factors explaining this shortfall but the most determining, according to our research, seem to be a mix of the current regulatory framework with low consumer demand for NEVs.

The current regulatory frameworks appear to be hindering a more rapid deployment of EV production by European firms who have taken a 'wait and see' approach. The ICE market remains most lucrative due to thriving consumer demand whilst demand for NEVs has not yet picked up. Furthermore, there is evidence pointing to EU firms possibly restricting their R&D activity in China as a result of the requirement to form JVs in this sector (where the European partner cannot have a majority stake)

therefore delaying a more rapid deployment of EU firm production of EVs. This suggests that the current regulatory framework could be impeding the achievement of the Chinese target of deploying 500k EVs by 2015.

Other issues that may be affecting the more rapid deployment of EV production in China relate to; i) Charging standards; and ii) the current incentive policy. Charging standards are likely to be determinant to the further deployment of EV production in China. Although standards have been agreed there remains some issues to be resolved - for example, how compatible these will be with standards chosen in different markets (such as the EU and the US). Once issues have been ironed out we should witness less uncertainty and therefore an environment more conducive to the deployment of EV production capacity. Concerns remain about measures that favour local producers (over foreign competitors), which affect the incentives of EU firms in producing EVs in China.

3.5.6. POLICY IMPLICATIONS

Other regulations such as conditioning the expansion of any ICE project by foreign firms to a commitment to develop a locally produced and branded NEV also show the Chinese government's desire to ramp up NEV production. Those regulations are being perceived as 'sticks' by foreign firms. The main incentive at the disposal of the Chinese policymakers should be the vast domestic market for ICEs, HEVs and eventually, NEVs as well as good and reliable network of suppliers notably of batteries. Foreign firms may want to suggest ways in which more positive incentives can be found to entice their participation in NEVs.

One possibility would be to allow for some flexibility with regards to the 'no-foreign-branded NEV' rule. European brands enjoy a wide appeal in China and abroad and by not allowing them to sell their NEVs under their brands their large investments in NEVs become less attractive. If the European and Chinese firms could come to an agreement about allowing certain models to be sold under the European brand perhaps the return to their R&D sharing will be clearer. What is clear is that currently the policies in place do not seem to be ensuring the attainment of the ambitious goal of 500K NEVs by 2015.

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OVERALL CONCLUSIONS

China has emerged as one of the most dynamic players in the Global Value Chain (GVC) scene. Not only does it play a central role in 'Factory Asia', it also truly embodies the Global part of value chains through its bridging role between 'Factory Europe' and 'Factory North America'. But this is especially important for the EU. EU GVC engagement with China is strong relative to both main advanced country competitors in region (Japan, Korea) and the USA. Increasingly trade between the EU and China displays complementarity not just rivalry. The EU specialises in high and medium skill value added in the service sectors whilst China's comparative advantage lies in the low-skill and capital value added manufacturing segments of the value chain. It is this complementarity which allows countries to engage in mutually beneficial specialisation. Indeed, the sectors which have witnessed larger positive changes in imported value added are also those which have seen their domestic value added increase the most.

The importance of the bilateral interactions between the EU and China is also highlighted when looking at the jobs associated with GVCs. In 2009, over 1.1 million jobs in the EU are sustained by Chinese exporting activity with 5.5 million Chinese jobs being supported by EU exports. In terms of employment creation; Chinese GVC jobs associated to EU exports have increased ten-fold since 1995 whilst EU GVC jobs linked with Chinese exports have doubled. Putting these figures in perspective; EU GVC jobs in Chinese exports have grown twice as fast as EU export jobs and nearly 9 times faster than total EU jobs since 1995.

We see an apparent paradox, however. At the same time as China is one of the most highly active in GVC activity – especially with Europe - and China's share of world output is of the order of 13% and rising, its share of global inward investment stocks has remained relatively stable at around 10%. Even though inflows of EU FDI in China are high relative to other investors and China is one of the largest recipients of FDI, having in some recent years surpassed the US as a destination, its inward FDI stocks are neither as high nor growing as fast as we might expect from its widespread engagement in GVCs. This also seems to be true of its relations with the EU. China is a large and unique economy so we cannot simply extrapolate, but given the close relationship found in the rest of the world between GVC activity and FDI we tentatively suggest that this may imply that there is scope for significant increases in FDI to China.

Relating to EU firm activity in China, we find preliminary evidence suggesting the presence of barriers for EU firms in China which range from administrative barriers, to those concerned with intellectual property. The empirical results suggest that some of these barriers may be stifling further GVC activity between EU and Chinese firms. Indeed, EU firms report that as a result of these they have either; relocated some of their economic activity outside of China; passed on higher costs to consumers; reduced purchases of intermediates from China; or restricted the amount of investment in China. This indicates that there is indicative evidence that these barriers may impact not only on the EU firms themselves but also on the level of economic activity in China, and on the prices faced by both Chinese consumers and producers. This would appear to be an example of the barriers leading to lose-lose situations which may be turned to win-win solutions provided policy coordination between the EU and China can tackle these.

More concrete examples of these lose-lose situations arise from the case studies. Indeed in order to meet the ambitious Chinese Government target of 500k New Energy Vehicles (NEVs) being produced

in China, the Chinese will need to consider how the current regulatory framework affects the collaboration between foreign and domestic firms. Evidence suggests that the catalogue of rules currently in place are not currently conducive to meeting this target.

The results of this report paint a portrait of dependence and complementarity with respect to the linkages between the EU and China. Whether it is intermediate products, value added, investment or jobs, the bilateral links between the EU and China are not only important in absolute terms but also growing fast. The logic of the study is that this should be nurtured not frustrated. Imports of both goods and services are critical for continuing competitiveness and trade policy, on both sides, should reflect this. For both, the policy implications will have to do with domestic policy as much as trade policy. The EU, dependent as it is on a competitive services sector, both to supply inputs to its industry and to supply China directly, needs to proceed with ensuring the opening, internally and externally, of the Services sector of the economy. Trade with China is highly dependent on the importance of the EU's high skilled workers and every effort has to be made to ensure an adequate supply of high skilled workers. Despite the high volume of China's technical graduates the EU still has an edge in quality that it must maintain to remain globally competitive. This is not a new insight but for the first time we can quantify the contribution of different levels of skills precisely.

The question arises of course of ensuring that the fruits of the mutual cooperation are shared in a socially acceptable way with all members of society, a challenge that goes well outside the field of value chain analysis but which is highlighted by it. Similarly for China, continuing to promote GVC specialisation through market opening and domestic reform would seem to be a win-win option.

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APPENDIX

A.1.1. MATHEMATICAL DERIVATION OF INDICATORS

In this section we present a more formal mathematical derivation of the GVC measures described in the main body of the text.

A. 1.1.1. DIRECT INPUTS USED TO PRODUCE OUTPUT

We begin with the simplest – the direct inputs which are used to produce output. This allows us to introduce the notation that will be used subsequently to derive the more complex value added measures which are recursive. We can capture the direct inputs used to produce output by following the traditional one country Leontief I-O model decomposed along two accounting frameworks which respectively capture the sales and input elements of economic activity. The first is the decomposition of total output into intermediate and final demand.

$$X = AX + Y + E \quad (1)$$

X is an *n x 1* vector with elements x_i identifying the value of total output of sector *i* (where n=1,2,..,35, i, our WIOD sectors, and i=j). A is an *n x n* technology coefficient matrix describing the linkages between industries within a country. Its elements - a_{ij}, capture the share of inputs that are used by sector *i* from sector *j* to produce a unit of output in sector *i*. Y and E are *n x 1* vectors of final domestic and foreign demand. This accounting framework shows how *sales* distribute into intermediate and final demand where one can further decompose exports into intermediate and final good sales which we will do later.

The second accounting framework shows the *purchasing* or *input* perspective; total output is the sum of domestic and imported intermediate products as well as domestic value added:

$$X = A^D X + A^M X + VX \quad (2)$$

here A^D , A^M and V represent the domestic, imported and value added share of output. The sum of these matrices is equal to unity since all output must be created using these inputs. The elements of these *n x n* matrices are our gross input measures; the A^M matrix is particularly interesting as it identifies the share of imported intermediates over output which can give us an indication of how input trade has evolved. Since this matrix can be broken down by origin, through the use of the WIOD, we can track originating and destination country information.

This accounting framework is also useful to investigate whether there is any evidence of imported inputs replacing domestic value added – a key sign of production sharing. Moreover, since the WIOD contains information on the compensation to labour by skill category – low, medium and high, as well as capital compensation, we can further decompose the domestic value added term to observe how the use of different factors has evolved in time.

Restricting the analysis to the direct inputs embodied in total output would be short-sighted since, with the internationalisation of production, both imported and domestic intermediates contain elements of domestic and imported value added. This implies that there is an element of recursiveness

which leads to a miss-allocation in the actual location of value added. The subsequent measures that we present aim to resolve this issue.

A.1.1.2. VALUE ADDED CONTENT OF DOMESTIC CONSUMPTION

Using an internationally linked I-O table such as the WIOD allows us to work out the full recursions and obtain net measures of trade in value added. We formalise the exposition using a similar framework to that presented in Koopman et al. (2010 and 2012).

We begin with a two country model. The EU and China produce goods in *n* differentiated sectors which can be i) consumed directly in the domestic economy or exported for final consumption abroad; and ii) used as intermediate inputs domestically or abroad to produce further output. The total output of the EU, on the sales side, is basically an extension of equation (1) across different origins and destinations:

$$X_{EU} = A_{EU,EU}X_{EU} + A_{EU,CH}X_{CH} + Y_{EU,EU} + Y_{EU,CH} \quad (3)$$

X_{EU} is the *n x 1* vector of total output produced in the EU, $Y_{EU,EU}$ and $Y_{EU,CH}$ are *n x 1* vectors showing the final demand for EU products in the EU and EU products in China respectively. $A_{EU,EU}$ is the *n x n* input-output coefficient matrix with elements $m_{i,j}^{EU.EU}/x_i^{EU}$, where $m_{i,j}^{EU.EU}$ is the value of EU inputs used by EU sector *i* from sector *j* and x_i^{EU} is the value of output produced by the EU in sector *i*. This technical requirements matrix delimits the underlying domestic technology of a country. The $A_{EU,CH}$ matrix is similar although it identifies the intermediate products that China sources from the EU. Since this is an accounting framework, all output must fall within these categories. Applying the same decomposition to China's total output we obtain the following equation.

$$X_{CH} = A_{CH,CH}X_{CH} + A_{CH,EU}X_{EU} + Y_{CH,CH} + Y_{CH,EU} \quad (4)$$

Combining Equations (3) and (4) gives us the following input-output relationship between the EU and China.

$$\begin{bmatrix} X_{EU} \\ X_{CH} \end{bmatrix} = \begin{bmatrix} A_{EU,EU} & A_{EU,CH} \\ A_{CH,EU} & A_{CH,CH} \end{bmatrix} \begin{bmatrix} X_{EU} \\ X_{CH} \end{bmatrix} + \begin{bmatrix} Y_{EU,EU} + Y_{EU,CH} \\ Y_{CH,EU} + Y_{CH,CH} \end{bmatrix} \quad (5)$$

We can then solve for the output that is needed to satisfy the vectors of final demand:

$$\begin{bmatrix} X_{EU} \\ X_{CH} \end{bmatrix} = \begin{bmatrix} I - A_{EU,EU} & -A_{EU,CH} \\ -A_{CH,EU} & I - A_{CH,CH} \end{bmatrix}^{-1} \begin{bmatrix} Y_{EU,EU} + Y_{EU,CH} \\ Y_{CH,EU} + Y_{CH,CH} \end{bmatrix} = \begin{bmatrix} B_{EU,EU} & B_{EU,CH} \\ B_{CH,EU} & B_{CH,CH} \end{bmatrix} \begin{bmatrix} Y_{EU} \\ Y_{CH} \end{bmatrix} \quad (6)$$

The first term, after the first equality sign, is the *2n x 2n* international Leontief inverse. It captures the direct and indirect inputs needed to produce any unit of demand and represents the production linkages, domestic and international, across all countries. The second term is then the sum of domestic output absorbed at home and domestic output absorbed abroad, which is equal to the total final sales of output for each country.

Using the international Leontief inverse we can start analysing how value added distributes across countries. We first define the direct value added coefficient matrix V:

$$V = \begin{bmatrix} \hat{V}_{EU} & 0 \\ 0 & \hat{V}_{CH} \end{bmatrix} \quad (7)$$

Its diagonal elements are the diagonalised *n x 1* direct value added coefficient matrices of the EU ($\hat{V}_{EU}$) and China ($\hat{V}_{CH}$) making this a *2n x 2n* matrix. Each element in these sub-matrices captures the share of direct value added of each industry in each country over its total output. By combining these with the international Leontief we get the *2n x 2n* VB matrix which captures the direct and indirect value added shares:

$$VB = \begin{bmatrix} \hat{V}_{EU} & 0 \\ 0 & \hat{V}_{CH} \end{bmatrix} \begin{bmatrix} B_{EU,EU} & B_{EU,CH} \\ B_{CH,EU} & B_{CH,CH} \end{bmatrix} = \begin{bmatrix} V_{EU}B_{EU,EU} & V_{EU}B_{EU,CH} \\ V_{CH}B_{CH,EU} & V_{CH}B_{CH,CH} \end{bmatrix} \quad (8)$$

The first element of the matrix, $V_{EU}B_{EU,EU}$, is an *n x n* matrix which shows the value added share of each EU sector *i* to EU sector *j*. Below it is the value added share of Chinese sector *i* to EU sector *j* - $V_{CH}B_{CH,EU}$. Since these two matrices decompose the value added of all industries, domestic and foreign, into the production of sector i, the sum of their columns must add up to one.

This VB matrix can then be used to capture the value added content of any vector of demand. We define Y as the *2n x 2n* matrix of final demand. Its diagonal elements represent final domestic demand for domestic goods whilst the off-diagonal elements are final foreign demand for domestic goods (see last terms in equations (3) and (4)):

$$Y = \begin{bmatrix} Y_{EU,EU} & Y_{EU,CH} \\ Y_{CH,EU} & Y_{CH,CH} \end{bmatrix} \quad (9)$$

Post-multiplying this matrix by our VB matrix gives us a value added decomposition of final demand (VAFD):

$$VAFD = \begin{bmatrix} V_{EU}B_{EU,EU} & V_{EU}B_{EU,CH} \\ V_{CH}B_{CH,EU} & V_{CH}B_{CH,CH} \end{bmatrix} \begin{bmatrix} Y_{EU,EU} & Y_{EU,CH} \\ Y_{CH,EU} & Y_{CH,CH} \end{bmatrix} = \begin{bmatrix} V_{EU}\sum B_{EU,G}\,Y_{G,EU} & V_{EU}\sum B_{EU,G}\,Y_{G,CH} \\ V_{CH}\sum B_{CH,G}\,Y_{G,EU} & V_{CH}\sum B_{CH,G}\,Y_{G,CH} \end{bmatrix} \quad (10)$$

The diagonal elements of this final matrix capture the value added embodied in products ultimately consumed in the domestic economy. These include the direct value added content of products consumed domestically as well as the domestic value added that returns from importing a final good from the partner country. The off diagonal elements capture the domestic value added embodied in final exports as well as the value added that the partner country uses as intermediates to produce final domestically consumed products. Decomposing this last matrix into its elements gives us a better understanding of what is included in each entry above.

$$VAFD = \begin{bmatrix} V_{EU}B_{EU,EU}Y_{EU,EU} + V_{EU}B_{EU,CH}Y_{CH,EU} & V_{EU}B_{EU,EU}Y_{EU,CH} + V_{EU}B_{EU,CH}Y_{CH,CH} \\ V_{CH}B_{CH,EU}Y_{EU,EU} + V_{CH}B_{CH,CH}Y_{CH,EU} & V_{CH}B_{CH,EU}Y_{EU,CH} + V_{CH}B_{CH,CH}Y_{CH,CH} \end{bmatrix} \quad (11)$$

The first term is composed of two elements; ($V_{EU}B_{EU,EU}Y_{EU,EU}$) is the EU's value added that is used to produce final products ultimately absorbed in the EU. The second, ($V_{EU}B_{EU,CH}Y_{CH,EU}$), is EU value added that is returned to the EU as an import of a final good from China. Turning to the second term, there are also two important elements. The first ($V_{EU}B_{EU,EU}Y_{EU,CH}$) is EU value added embodied in the EU's exports to China. The second ($V_{EU}B_{EU,CH}Y_{CH,CH}$) is the EU's value added that China uses as

intermediates to produce final domestic goods. By decomposing these elements we can arrive at measures that identify the origin of value added consumed in each country. This is a measure used by Timmer et al. (2013) to capture GVC activity.

A.1.1.3. VALUE ADDED IN EXPORTS (VAE)

The composition of total output (Y) of a country and that of its exports (E) differs significantly. Output concentrates in service sectors whereas exports were mainly skewed towards the more tradable manufacturing sectors of the economy (see Baldwin and Lopez-Gonzalez 2013 and Table 1.2). This is why it is important to distinguish between different measures of GVC activity. We define the *2n x 2n E* matrix which contains the diagonalised gross export vectors of the EU ($\hat{E}_{EU}$) and China ($\hat{E}_{CH}$):

$$E = \begin{bmatrix} \hat{E}_{EU} & 0 \\ 0 & \hat{E}_{CH} \end{bmatrix} \tag{12}$$

By post-multiplying E by the VB matrix we obtain a measure of the value added content of exports (VAE):

$$VAE = \begin{bmatrix} V_{EU}B_{EU,EU} & V_{EU}B_{EU,CH} \\ V_{CH}B_{CH,EU} & V_{CH}B_{CH,CH} \end{bmatrix} \begin{bmatrix} \hat{E}_{EU} & 0 \\ 0 & \hat{E}_{CH} \end{bmatrix} = \begin{bmatrix} V_{EU}B_{EU,EU}E_{EU} & V_{EU}B_{EU,CH}E_{CH} \\ V_{CH}B_{CH,EU}E_{EU} & V_{CH}B_{CH,CH}E_{CH} \end{bmatrix} \tag{13}$$

The diagonal elements of this VAE matrix show the domestic content of gross exports and the off-diagonal elements represent the foreign content of exports. By virtue of using the international IO table they incorporate international production linkages arising from trade in intermediates (see Koopman et al. 2012). The term $V_{EU}B_{EU,CH}E_{CH}$ simultaneously captures Chinese *purchases* of European value added embodied in its gross exports (or the EU content of Chinese exports) as well as EU *sales* into the production of Chinese exports. By presenting these values as a share of total EU exports we can begin telling a story about the nature of the EU's linkages with respect to China. In particular, if the sales element is larger than the purchasing element, we can infer that the EU has stronger forward rather that backward linkages with respect to China, hence conveying information on how China and EU locate within their respective value chains.

A.1.1.4. SKILL COMPOSITION OF EXPORTS OR OUTPUT

Since the WIOD Socio-Economic Accounts give information on labour and capital compensation we can further decompose value added into low, medium and high skill compensation as well as capital compensation. Total value added is the sum of these components so that:

$$V = \begin{bmatrix} \hat{V}_{EU} & 0 \\ 0 & \hat{V}_{CH} \end{bmatrix} = \begin{bmatrix} \hat{V}_{EU}^{LS} & 0 \\ 0 & \hat{V}_{CHN}^{LS} \end{bmatrix} + \begin{bmatrix} \hat{V}_{EU}^{MS} & 0 \\ 0 & \hat{V}_{CHN}^{MS} \end{bmatrix} + \begin{bmatrix} \hat{V}_{EU}^{HS} & 0 \\ 0 & \hat{V}_{CHN}^{HS} \end{bmatrix} + \begin{bmatrix} \hat{V}_{EU}^{CAP} & 0 \\ 0 & \hat{V}_{CHN}^{CAP} \end{bmatrix} \tag{14}$$

Replacing the V matrix in the VAFD and VAE equations by any of the matrices above will allow us to calculate i) the origin of the skill and capital content of gross exports; and ii) the origin of the skill and capital content of final consumption:

$$VAFD^{comp} = \begin{bmatrix} V_{EU}^{comp} \sum B_{EU,G}\, Y_{G,EU} & V_{EU}^{comp} \sum B_{EU,G}\, Y_{G,CH} \\ V_{CH}^{comp} \sum B_{CH,G}\, Y_{G,EU} & V_{CH}^{comp} \sum B_{CH,G}\, Y_{G,CH} \end{bmatrix} \tag{15}$$

$$VAFD^{comp} = \begin{bmatrix} V_{EU}^{comp} \sum B_{EU,G}\, E_{G,EU} & V_{EU}^{comp} \sum B_{EU,G}\, E_{G,CH} \\ V_{CH}^{comp} \sum B_{CH,G}\, E_{G,EU} & V_{CH}^{comp} \sum B_{CH,G}\, E_{G,CH} \end{bmatrix} \quad (16)$$

This is useful for two reasons. The first is that it allows us to delve deeper into the type of specialisation that is taking place across countries i.e. whether countries are buying high-skill intensive products and adding low skill intensive processes. The second is that we can differentiate across comparative advantages held in different processes of production. For example, our earlier iPhone example suggested that China's activity was predominantly in the assembly of parts and components. We would expect that this sort of activity occupy mainly low-medium skill workers as well as capital. We would further expect imported inputs to be high-skill intensive. Decomposing value added into these categories will allow us to tell a story about the processes of production that are taking place in each country. In turn, we can then use these figures to look at comparative advantages in processes within the same industry.

A.1.2. DIRECT VALUE ADDED BY TYPE AS A SHARE OF TOTAL OUTPUT

In Table A.1 we decompose the domestic value added figures presented in the first column of Table 1.1into four components; high-skill, medium-skill and low-skill labour compensation as well as capital compensation. This allows us to gauge differences between the EU and China in the composition of their direct value-added (recalling that these indentify payments made to factors of production). We turn first to the aggregate world grouping to benchmark the EU and China figures. Here capital compensation is the largest element of value-added followed by med-skill and then high-skill compensation. High-skill and capital compensation have witnessed increases in time whilst med-skill has fallen with low-skill remaining relatively stable.

The overall importance of each of these components of value-added in the EU is similarly distributed.[47] What stands out is the higher share of high and med skill compensation in the EU in 2009 when compared with the world as well as the lower importance of capital compensation. China shows a very different composition of direct value added. Here, although increasing, the high-skill group is much smaller and the low-skill, although declining, is bigger. The med-skill group is also falling and is significantly smaller than that seen in the EU. Overall, this table suggests that *China's production is more reliant on unskilled labour than the EU who uses higher-skill labour to produce output*.

Table A.1.1. Decomposition of direct value-added by type

		High-Skill	Med-Skill	Low-Skill	Capital
World	**1995**	10%	15%	7%	18%
	2000	11%	14%	6%	19%
	2005	11%	13%	6%	19%
	2009	11%	13%	7%	20%
EU	**1995**	10%	16%	9%	18%
	2000	11%	15%	8%	17%
	2005	12%	14%	7%	18%
	2009	13%	14%	6%	18%
China	**1995**	1%	7%	13%	18%
	2000	1%	8%	10%	19%
	2005	2%	6%	8%	19%
	2009	2%	5%	7%	19%

Source: own calculations using WIOD

Note: The World in this table represents the sum of all WIOD countries but does not include the RoW grouping since there is no aggregate data available for compensation in non-WIOD countries. This is why the sum of the rows is not the same as the value added in total output presented in Table 1.1

[47] This is unsurprising given that the world values are largely dominated by the large players in the sample, namely the EU, the US and Japan

A.1.3. AGGREGATE FLOWS OF VALUE ADDED IN CONSUMPTION (VAC)

In this section we look at the value added content of domestic final consumption (VAC). Using the same set-up as in Figure 1.6, Figure A.1 presents the individual and global VAC matrices for the years 1995 and 2009. The first important observation is that these matrices are relatively similar to the intermediate input matrices presented earlier.[48] Differences between intermediate input and VAC flows arise from i) differences between the domestic output and consumption vectors; and ii) indirect value added linkages arising from GVCs where value added produced in one country undergoes a transformation in a third country before reaching final domestic consumers. The more fragmented the world economy, the bigger the differences between these measures. Since imported intermediates still represent a small fraction of global production (Table 1.1), it is unsurprising that intermediate input and VAC flows are quite similar. Nevertheless, there are some notable observations that emerge from comparing these measures.

First we compare the global matrices (top panels) which track international flows and not domestic ones. For the EU, intermediate input exports represented 20% of global intermediate input flows in 2009 (Figure 1.6). In contrast, extra-EU global VAC sales were 23% of total VAC flows. This indicates that a significant share of extra-EU value added consumed by other countries is embodied in products imported by these from third countries. For China the story is similar; its gross input exports represented 14% of global flows in 2009, its VAC exports were 17% - again highlighting China's role as an important supplier into other country's GVCs.

Differences are more apparent when we turn to the bilateral matrices (bottom panels) which normalise the flows by column nation inputs/value added. In 2009 imported gross inputs represented 12% of total Chinese inputs, in this same year VAC imports were 20% of total value added consumed in China.

[48] This is not surprising since the final consumption vector of a country tends to be very similar its output vector.

Figure A.1.1: Global and individual VAC matrices 1995 and 2009

1995	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
EU		1%	1%	1%			1%	1%	1%	2%	1%	6%		1%	11%	26%
Turkey																1%
Brazil	1%															2%
Russia	1%															2%
India																1%
Indonesia																1%
Australia															1%	2%
China	1%									1%		1%			1%	4%
Taiwan												1%				3%
Japan	2%							1%	1%		1%	3%			4%	13%
Korea	1%									1%		1%			1%	3%
USA	5%									2%	1%		1%	2%	7%	19%
Mexico												1%				2%
Canada	1%											3%				5%
RoW	6%							1%		2%	1%	4%				16%
TOTAL	19%	1%	2%	2%	1%	1%	2%	3%	2%	10%	3%	21%	2%	4%	26%	100%

2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW	TOTAL
EU		1%	1%	1%				3%		1%		4%		1%	11%	23%
Turkey																1%
Brazil	1%														1%	2%
Russia	1%														1%	3%
India	1%														1%	2%
Indonesia																1%
Australia															1%	2%
China	4%									1%		4%			5%	17%
Taiwan																2%
Japan	1%							1%				1%			2%	6%
Korea	1%							1%							1%	3%
USA	3%							1%		1%			1%	2%	5%	14%
Mexico												1%				2%
Canada	1%											2%				3%
RoW	6%				1%			3%		2%	1%	4%				19%
TOTAL	19%	1%	2%	2%	2%	1%	2%	11%	1%	6%	2%	18%	2%	3%	28%	100%

1995	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	92%	7%	3%	10%	4%	5%	6%	4%	7%	1%	5%	3%	3%	4%	10%
Turkey		86%													
Brazil			92%												
Russia		1%		81%											
India					89%										
Indonesia						82%									
Australia							83%		1%						
China								84%							
Taiwan								1%	72%						
Japan					1%	4%	2%	4%	7%	94%	5%	1%	1%	2%	4%
Korea						1%		1%			79%				
USA	2%	1%	2%	2%	1%	2%	3%	2%	5%	1%	4%	91%	10%	13%	6%
Mexico													84%		
Canada												1%		76%	
RoW	2%	2%	2%	4%	3%	2%	3%	3%	4%	1%	4%	2%	1%	2%	75%
Tot imp	8%	14%	8%	19%	11%	18%	17%	16%	28%	6%	21%	9%	16%	24%	25%

2009	EU	Turkey	Brazil	Russia	India	Indonesia	Australia	China	Taiwan	Japan	Korea	USA	Mexico	Canada	RoW
EU	89%	7%	3%	8%	3%	3%	4%	5%	6%	1%	5%	2%	3%	4%	11%
Turkey		82%													
Brazil			90%												
Russia		2%		82%											
India					85%										
Indonesia						83%									
Australia							83%				1%				
China	2%	2%	1%	3%	3%	3%	4%	80%	3%	2%	5%	2%	2%	3%	5%
Taiwan									73%						
Japan						2%	1%	2%	5%	90%	3%				2%
Korea								1%			74%				
USA	2%	1%	1%	1%	2%	1%	2%	3%	4%	1%	3%	90%	8%	10%	5%
Mexico													82%		
Canada												1%		77%	
RoW	3%	4%	3%	4%	5%	5%	4%	5%	6%	3%	6%	2%	2%	2%	71%
Tot imp	11%	18%	10%	18%	15%	17%	17%	20%	27%	10%	26%	10%	18%	23%	29%

Note: Top panel shows row nation sales to column nation as a share of global sales (not including domestic inputs) – values below 0.3% are zeroed out for readability. Bottom panel is row nation sales to column nation as a share of column nation total inputs – values below 2% are zeroed out.

A.1.4. SECTORAL AGGREGATION

Table A.1.2. Aggregated sectors

Agriculture and Food	Mining, Fuel	Light Manufacturing (textile, leather, wood, paper)	Transport and logistics services	other services
Agriculture, Hunting, Forestry and Fishing	Mining and Quarrying	Textiles and Textile Products	Inland Transport	Electricity, Gas and Water Supply
Food, Beverages and Tobacco	Coke, Refined Petroleum and Nuclear Fuel	Leather, Leather and Footwear	Water Transport	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
		Wood and Products of Wood and Cork	Air Transport	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
		Pulp, Paper, Paper , Printing and Publishing	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods
		Other Non-Metallic Mineral Manufacturing, Nec; Recycling		Hotels and Restaurants
				Real Estate Activities
				Public Admin and Defence; Compulsory Social Security
				Education
				Health and Social Work
				Other Community, Social and Personal Services
				Private Households with Employed Persons

Table A.1.3. Unchanged sectors

Chemicals
Rubber and Plastics
Basic metals
Machinery nec
Electrical and Optical Equipment
Transport Equipment
Telecom services
Financial services
Renting M&Eq and other business services
construction services

A.2. DESCRIPTION OF VARIABLES USED IN ECONOMETRIC MODEL

Table A.2.1. Variables Description

Variables	Description
employees	Firm number of employees; 1 if firm SME <250; 2 if medium 250 - 1,000; and 3 if firms are large >1000 employees.
foreign	Dummy with value 1 if firms is fully foreign owned; and 0 otherwise.
services	Dummy with value 1 if firms operate in services sector; and 0 otherwise.
Trade status	Trade intensity. Index with value 0 if firm does not trade; 1 if only importer, 2 if only exporter, and 3 if both importer and exporter
IPR_prop	IPR infringement costs as proportion of revenue; 1 if0%, 2 if<1%, 3 if1-5%, 4 if5-10%, 5 if10-20% and 6 if>20%.
MAB_prop	Market access barriers costs as proportion of revenue; 1 if0%, 2 if<1%, 3 if1-5%, 4 if5-10%, 5 if10-20% and 6 if>20%.
env_prop	Environmental regulations costs as proportion of revenue; 1 if0%, 2 if<1%, 3 if1-5%, 4 if5-10%, 5 if10-20% and 6 if>20%.
reg_prop	Regulatory barriers costs as proportion of revenue; 1 if0%, 2 if<1%, 3 if1-5%, 4 if5-10%, 5 if10-20% and 6 if>20%.
tax_prop	Differential legal/tax treatment costs as proportion of revenue; 1 if0%, 2 if<1%, 3 if1-5%, 4 if5-10%, 5 if10-20% and 6 if>20%.
Contract suppliers	Contract with suppliers' intensity. Index with value 0 if no backward linkage, 1 if sourcing in spot markets, 2 if subcontracting, 3 if franchising, 4 if in a joint-venture with suppliers, and 5 if supplier is vertically integrated
custom	Customized product. Dummy with value 1 if firms' main product is customized; and 0 otherwise.
Strategy in China	Strategy in China. Dummy with value 1 if firms' main strategy in China is to supply the Chinese market; and 0 otherwise.

A.3. TYRE VALUE CHAIN