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Import penetration from China and its effect on manufacturing employment in the OECD countries

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Abstract

China has ever since the 1990s emerged as a manufacturing superpower, following its liberalized trade reforms and its entrance to the World Trade Organization. This has caused China to expand their exports substantially, in particular to the OECD countries. This has lead to an increasing debate on whether, or to what extent, increasing manufacturing exports from China to the OECD countries has contributed to the decline in manufacturing employment levels seen in the last 20 years. This study examines if and how China's import penetration has affected the employment of manufacturing workers in the OECD countries. The relationship is analyzed using import penetration and employment data from 26 OECD countries between 1997 and 2011 in a regression model. Two different versions of the model are analyzed, namely, one with dummies only for time, and one with both time-dummies and cross-sectional dummies. The results show that, generally, import exposure is connected to lowered employment levels in the sector, until we control for country-specific effects, when the results are the opposite, as Chinese import penetration then has a strong positive effect. This implies that the conditions of trade and employment within a country is crucial in determining how the sector is affected by trade. Additionally, the results contradicts the popular belief that China’s increasing exports to the OECD countries are harmful to their domestic manufacturing industries.

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1. Introduction

China has over the last decades emerged as one of the world's largest manufacturing superpower with a massive increase in foreign exports of manufacturing goods (Autor et al, 2016). Although Chinese manufacturing exports have been distributed worldwide, much attention has been directed to the effect of Chinese exports on the developed world such as the OECD countries and the US in particular. This is because the rapid increase in import penetration following China's increased exports to the OECD countries has sparked a debate on whether, or to what extent, free trade could be harmful towards industries that are the most exposed to foreign competition (Ashournia et al, 2014). Although the consensus that trade is overall welfare improving, basic trade theory also shows that the increase in welfare is not distributed evenly to every industry (Marrewijk, 2017). For the OECD countries, the industries thought to be the most negatively affected by increased imports from China, are the manufacturing industries (Autor et al, 2016).

In recent time the debate surrounding China's impact on the manufacturing industries in the OECD countries has to a large extent been revolving around the massive fall in employment of manufacturing labour experienced in the west in recent decades (Ashournia et al, 2014). Indeed, the demand for low-skilled labour such as manufacturing workers, relative to that of highly skilled labour, has fallen considerably ever since the 1970s in the developed world (Freeman, 1995). The cause for this was according to Sachs and Shatz (1996), due to a demand shift towards more educated workers. They conclude that the demand shift could have had two different explanations. The first suggested that technological change has been favourable towards employment of highly skilled labour. The second suggested that increased international trade with developing countries had lead to the demand for low skilled manufacturing workers in the OECD countries to fall. Further research by Berman et al. (1998) concluded that the manufacturing industries in the developed countries appeared to be shifting their employment, despite rising skill prices, towards high skilled labour. This suggested that skill-biased technological improvements were the main cause for the fall in

employment of manufacturing workers, and that trade did not have a major impact. (Berman et al. 1998)

However, a recent study by Autor et al (2016) argues that China's rise as a manufacturing superpower has caused a “trade shock” which has ultimately changed the patterns of world trade. They argue that China's rise has challenged much of the previous empirical evidence on how labour markets adjust to cope with the new competition. They go on to say that US trade with China has had negative impacts in certain areas, where employment of manufacturing workers has fallen in the US industries more exposed to import competition while offsetting employment gains in other industries have yet to materialize.

The claim that China is negatively affecting manufacturing industries in developed countries has received a lot of attention in recent time. The debate gives rise to interesting questions concerning the actual effects of China’s increased exports to the OECD countries. China’s increasing involvement in international trade has been analyzed to some extent, however, no major research has been conducted on the effects of China's import penetration on manufacturing employment of an aggregate of the OECD countries. By gaining further understanding of the role of China’s import penetration on OECD manufacturing employment, it would be possible to get an indication as to how much trade is causing employment in this industry to fall on a wider scale.

Hence, the aim of this paper is to examine to what extent Chinese import penetration affects the employment of the OECD aggregated manufacturing industry in the short term between 1997-2011. The paper starts out with chapter two, explaining China's emergence as a manufacturing superpower, followed by chapter three which defines and discuss the concept of import penetration and its implications. Chapter four gives a brief explanation of the models and theories used when analyzing the linkages between import penetration and employment. The fifth chapter provides an overview of previous relevant studies on the subject. In chapter six, the data, sample period and method is described and discussed while chapter 7 present the regression along with the regression results. Lastly, chapter 8 concludes with a discussion of the results and concluding remarks.

2. China's rise

The increase in import penetration from China's has come as a result of their large trade expansion that began in 1990, with major political reforms stemming from the economic experiments known as “Special Economic Zones – Sza’s”. These zones allowed foreign investments into export-oriented factories with little interference from the government. These zones proved to be beneficial and the number of SEZ’s went from 20 in 1991 to 150 in 2010, while at the same time, inflows of foreign investment went from averaging 0.7% of China's GDP to 4,2% of GDP (Yu & Tian, 2012). As a consequence of the SZA`s success, many state-owned manufacturing sites were also privatized during this period. This lead to a relocation of capital and labour, turning smaller factories into big size manufacturing plants and thereby increasing both productivity and output (Alder et al, 2013). Studies of China's Revealed Comparative Advantage (RCA) values made by Amiti & Freund (2010) have shown that in 1992 the country went from having a disadvantage to having an advantage in the production of manufacturing goods due to their abundance in low skilled labour supply. At the same time, they also went from having an advantage in the production of primary commodities to instead have a disadvantage.

Apart from economic growth, China spent much of the 1990s adapting to GATT’s, and later the WTO`s policy framework. This required China to terminate their regulations that required all exports to pass through state intermediates which had for long been setting back international trade due to long procedures and excess bureaucracy (Hsieh & Song 2015). After major reforms and adjustments, China became an official WTO member in 2001. The membership granted the country Most Favoured Nation (MFN) tariffs which provided greater access to the international market. This was because the average MFN-tariff in 1999 was 3,4% while Non-MFN tariffs on Chinese goods in the US were prospected to have been at a level of 37% in the same year according to the research by Handley & Limao (2014) and Pierce & Schott (2016). The WTO also offered China increased access to better and cheaper intermediate goods through import which helped boost productivity in the domestic

manufacturing industry with further grew their comparative advantage. All of this lead to China's share of the manufactured goods in the international export to grow from 2,3% to 18,8% between 1991 and 2010, increasing their import penetration rates in some the OECD countries substantially (Brandt & Morrow, 2014).

3. Import Penetration

When analyzing the increased Chinese exports to the OECD countries and its impact on the manufacturing industries, this paper will rely on the framework of import penetration. Import penetration is a type of trade measurement which describes the proportion of domestic consumption that is being satisfied by foreign import rather than domestic supply, either by sector or overall (OECD, 2005). It is measured as:

$$\textit{Import penetration} = \textit{Imports from country J /(Domestic output} + \textit{total imports} - \textit{total exports),}$$

Hence, a country whose domestic consumption is satisfied by a large amount of foreign imports will have a high import penetration ratio, while a country whose domestic consumption is satisfied by domestic goods will have a low import penetration (OECD, 2005). Therefore, a country that can produce goods with high efficiency and international competitiveness will, in turn, see its exports increase while their imports decrease. Because of this, the given country will see their export ratio rise and their import penetration rate fall. In contrast, a country that produces goods with low efficiency and lacking international competitiveness will instead see their exports decrease, imports increase and import penetration rise (Avinash, 1989). In other words, an increase in import penetration from China to any OECD country means that a larger proportion of domestic consumer demand is being satisfied by Chinese products. In this context, increasing imports of goods could have benefits for the consumer as they will be granted access to a larger variety of goods and at lower prices than at their domestic producer. However, large ratios of import penetration within any given industry can have negative effects as both domestic output and employment levels fall.

Import penetration ratios can also be interpreted as indicators of different policies of trade protection (OECD, 2005). A low import penetration ratio can be interpreted as an indication

that a country is relying on extensive trade protection policies such as high import tariffs or other trade barriers in order to protect domestic producers. However, in many cases, other factors such as the size of the economy or geographical distances to other industrialised countries play a large role in determining the ratio of import penetration. Large producer countries like the United States or Japan are less inclined to depend on imports from other countries than small countries like Luxembourg or Ireland. Other countries like Australia who has a relatively open trade regime but long distances to other industrialized countries also have a lower ratio of import penetration (OECD, 2005).

4. Theoretical Framework

A common framework for analyzing the effect of import penetration on a host country is the model of Heckscher-Ohlin and the Stolper Samuelson theorem. The Heckscher-Ohlin model argues that because of China's abundance of low-skilled labour, China will be able to produce manufactured goods at a lower expense than the relatively high skilled labour abundant OECD countries. This is due to the fact that a country's scare factor endowment will be expensive to employ while their abundant factor will be cheap (Marrewijk, 2017). Hence, China's relative abundance of cheap low skilled labour enables them to produce manufacturing goods at a lower expense than the OECD countries, outbidding them on the international market and increasing their import penetration ratios (Jin Xu, 2012).

Due to China's production efficiency, their import penetration in the OECD markets will force domestic producers with lower efficiency to compete with a much more efficient producer, resulting in layoffs of workers or market exit (Autor et al, 2013). Because of this, the less efficient industries within the OECD countries will be forced to relocate to an industry where their comparative advantage and efficiency are higher, resulting in an overall improvement of welfare (Marrewijk, 2017). However, the relocation of industries in the OECD countries towards sectors characterized by higher comparative advantages, would not benefit low-skilled manufacturing workers, since these industries are characterised by the employment of labour with a higher skill set (Sachs and Shatz, 1996).

In the longer run, the Stolper Samuelson theorem suggests that since free trade will lower the prices of manufacturing goods, it will also lead to a decrease in the reward to the factor

endowment that is used intensively in producing manufacturing goods, while simultaneously increasing the return to the other factor (Marrewijk, 2017). Hence, large scale, cheap manufacturing imports from China would force the prices of domestically produced goods in the OECD countries to fall, resulting in lower employment and lower wages for low-skilled workers. At the same time, demand for higher skilled workers would increase as the OECD countries would focus more on the production of high skill-intensive goods (Marrewijk, 2017).

There is a vast amount of research on the subject that has been made by many economists. Looking at trade liberalization in Mexico, Hanson and Harrison (1999) concluded that trade liberalization in Mexico (a country relatively abundant of high-skill labour) where tariffs and other trade barriers were removed, led to a rise in the prices of skill-intensive goods while it decreased the price of low-skill intensive goods. The price changes then reduced demand for low skilled workers while at the same time demand for high skilled workers increased. However, even though some empirical evidence supports framework of the Stolper Samuelson theorem and the Heckscher Ohlin model, many researchers like Krugman (2000), Grossman (1987) and Grossman, Rossi-Hansberg (2008) contributes the fall in employment and wages for low-skilled manufacturing workers to skill-biased technological improvements. They concluded that improved communications and better transport have helped larger firms to split their operations by allocating more low-skilled-intensive parts of the overall production to countries where the wages for unskilled workers are low. They also argue that better technology has made high skilled workers more effective in their production and vice versa for low skilled workers.

5. Previous studies of Import Penetration

As previously mentioned, Chinese import penetration on the OECD countries has risen substantially since the beginning of the 1990s. However, the ratios of import penetration, differ widely among the OECD countries since their differences in size, geographical location, and political regime are all factors that influence their economies (OECD, 2005). Hence, the OECD countries have experienced dissimilar consequences of China's expansion.

Hence, this chapter of the paper will summarize some of the key research made on import penetration and its effects on employment levels, while also present the outlines of the methodology. The aim of this review is to be exemplary rather than exhausting as the number of studies made on the subject is simply too big to reasonably cover. Instead, this paper will review a set of studies that is believed to make up a fair representation of the research made thus far. The review is also limited to studies concerning the trade shock of China and its effect on employment levels on domestic OECD markets to keep relevance towards the purpose of this paper. The first part of the review will be aimed towards the paper "China Syndrome" by Autor et al (2012), which makes up a key part of the more extensive China Shock literature. We make a more in-depth review of this study because of its' significance to recent research and the inspiration it has given the methodology used in the study of this paper. The chapter then continues to go through the findings of further research, some that build on Autor et al.'s conclusions and some that contrast them.

5.1 Research of Import Penetration in the US

In the paper China Syndrome (2012) Autor et al. examine import penetration on the US manufacturing market over the time period 1992 to 2007. They find that industries that experience higher exposure to Chinese imports do experience a greater loss in employment levels than the ones less exposed and that these effects are rather large and long-lasting. Their research is largely inspired by earlier studies that use local labour markets to study the effects of trade, which the authors also apply in their research. When analyzing whether trade with China has affected the domestic labour markets, the authors divide the US manufacturing market into smaller local labour markets which they treat as sub-economies subjected to the Chinese import penetration in different ways. They then estimate a regression explaining the change in employment with the change in import penetration from China and a set of control variables. They include time dummies for each 10-year period and use Chinese import growth in other countries as an instrument for its growth in the US. Through this instrumental variable strategy, Autor et al. aim to identify the Chinese productivity and "trade-shock-component" of the growth in US imports from China and leave out the demand-driven part of the process. To confirm that the decline in employment and rise of Chinese imports are causally connected, and not due to a common-causal variable, they also

conduct a falsification exercise by regressing changes in employment share on future import penetration.

From their findings, the authors conclude that while most trade flows are due to forces of supply and demand, the rise in Chinese imports stems more from changes in supply from China, driven by productivity, political reforms and the lowering of trade barriers. Their study also suggests that approximately a quarter of all losses in US manufacturing work opportunities can be derived to the import penetration from China, making up close to a million jobs. The authors find evidence that trade can have, and in the case of the US and China does have, negative effects on wages and employment on smaller groups within the economy, both in the short and medium-run timeline, while still recognizing the general gains from trade on a national level supported by theory and numerous empirical studies.

Other studies on the US market by Bernard et al. (2006) also used the idea of import penetration to examine the consequences of increased US exposure to trade from low-wage countries. They found that over five-year intervals, industries facing greater increases in exposure to trade and foreign competition are subject to higher rates of plant exit while those that survive have larger reductions in employment. Acemoglu et al. (2016) provide a complementary analysis to Bernard et al.'s (2006) that moves the focus to the industry level and cover the period 1991 to 2011. They too found that the import penetration variable is negative and highly significant, consistent with the hypothesis that rising import exposure lowers domestic industry employment.

However, Edwards and Lawrence (2013) come up with what they define as contradicting results to the work of Autor et al, Bernard et al, and Acemoglu. In their paper, they argue that the decline in US manufacturing jobs is mostly due to faster productivity growth in the manufacturing sector, and partly due to a shift in domestic demand away from consumption of goods. While studying the relationship between the US trade balance and manufacturing employment, they conclude that even with a balanced trade throughout the entire China boom, the manufacturing employment decline would still be of considerable extent. While examining an aggregate of imports and employment they find a strong positive relationship between the two and even find evidence for import growth-boosting domestic employment in

economic downturns. Although recognizing that some imports have had a disruptive effect for some workers, they strongly emphasize that the evidence blaming trade for manufacturing employment decline is highly exaggerated.

In line with the general message of Edwards and Lawrence authors Graetz and Michaels relates manufacturing job losses to the implementation of robots in production in their paper Robots At Work (2015), where they let robots represent the height of new technology. The results are applicable to developed nations as they use cross-country and industry data and the findings are strong for middle- and especially low-skill workers. Correspondingly, the work of Acemoglu and Restrepo (2017) find evidence that regions in the US with the type of manufacturing production predisposed to adapting robots into production experience a relatively large employment decline compared to other types of production.

5.2 Research of Import Penetration in other OECD countries

While most studies on import penetration from China and its effects have been directed towards the US, there are also a number of studies highlighting its impact on other OECD countries. Research on countries such as Norway by (Balsvik et al. 2015) and for Spain by (Donoso et al. 2014), which covered the periods between 1990-2007, found that import penetration from China held similar results found within the US. As both Norway and Spain experienced higher import penetration from foreign competition they also witnessed a fall in manufacturing employment. In Norway, lower manufacturing employment has lead primarily to increased unemployment while Spain experienced a reallocation of labour outside the manufacturing sector. Another study conducted in Germany between 1988 and 2008 by Dauth et al. (2014) found that Chinese import competition had also lead to a negative impact on manufacturing employment. However, the impact of rising Chinese import competition was offset by a large growth of German manufacturing exports to Eastern Europe which followed in the removal of the Iron Curtain. Hence, in contrast to the case of the US, the gain in manufacturing employment related to the exports to Eastern Europe offset the loss of employment from Chinese import penetration.

However, other studies of Danish firms by Ashournia et al (2014) showed dissimilar results. While imports from China has increased substantially, rising from 2% of all imports in 1997 to almost 7% in 2009, and industries more exposed to increasing Chinese import penetration experience a reduction in domestic sales, the authors showed that low-skilled workers did not experience increased unemployment. Instead, low-skilled workers would lose around 0.48% of their wages for each percentage point increase in Chinese import penetration.

The vast amount of research on the effects of import penetration has come up with many different types of conclusions as to how these consequences manifest in different countries. Therefore, a conclusion to the phenomenon has been hard to find. In an attempt to summarize the current state of the general economic analysis of trade and jobs, Paul Krugman published a letter on his New York Times blog called "Trade and Manufacturing Employment: No Real Disagreement" (2016). Motivated by clearing up the misunderstanding that economists are disagreeing on the relationship between employment and trade, Krugman shows that much of the research that has been conducted conclude in very similar conclusions and differs mostly in how these conclusions are expressed. The studies that emphasize the impact of trade on employment levels, with the China Shock literature as the prime example, does *not* disprove the fact that the manufacturing employment decline of the last two decades "is basically about productivity "(Krugman, 2016). The reality is that most research, either emphasizing the importance of trade or technology, concludes that trade is hardly accountable for the manufacturing share of total employment that has gone down from circa 25% in the 1970s to less than 9% in 2015 in the US. Additionally, researchers also, more or less, concluded that trade accounts for approximately a fifth or one million of all manufacturing jobs lost 2000-2015. Krugman suggests that, although these numbers are not insignificant, it is reasonable to believe that the shift away from manufacturing does not have much to do with either trade or trade policy.

6. Empirical Study of OECD Trade With China

This chapter covers the empirical research part of the paper which tests the effects of Chinese import penetration on manufacturing employment in an aggregate of OECD countries. The chapter is divided into four main sections; the first and second section presents the collected data sample as well as the data period. The third section presents the methodology and the fourth section presents an econometric discussion.

6.1 Sample Data

Following chapter will look more closely into the data chosen for the regression model, comment on difficulties attributed to the data and present some descriptive statistics. A general trend in the data is that for almost every country, import penetration has risen more or less constantly throughout the time period. Similarly, manufacturing employment levels has generally fallen with varying degrees, depending on the country. The dataset consists of data collected for five different variables in 26 different OECD countries. The variables that will be used are summarized in the following table:

Table 1. *List of variables.*

Variable	Definition	Source
Employment	**The yearly average of the number of people working in the manufacturing industry.**	**FRED**
IP	**Index on import Penetration of Chinese imports on domestic manufacturing market, measured in percentage of the total domestic market.**	**WITS,** constructed by authors (see closer description in Methodology chapter)
Human Capital	**Index based on the average years of schooling and an assumed rate of return to education.**	**Penn World Tables 9.0**
RnD	**Resources put towards research and development in a nation as percentage part of GDP.**	**OECD**
High-Tech Exports	**Percentage of nations GDP consisting of exports of advanced technology.**	**The World Bank**

The employment data for all countries is collected from the Organization for Economic Co-operation and Development in turn retrieved from the Bureau of Labour statistics. The data is the yearly average, not seasonally adjusted, of the number of people working within the manufacturing industry. The manufacturing industry is here defined as comprised of "establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products" (Bureau of Labour Statistics). The data used to construct the Import Penetration index are each country's total value of manufactured goods imports from the world, total value of manufactured goods exports to the entire world, total value of manufactured goods imports specifically from China, and output of value-added manufacturing production, all for each year, measured in dollars from January 1st to December 31th. Manufactured goods here are defined as goods that are not agricultural or raw material. Is has been collected from the World Bank's WITS – World Integrated Trade Solution and all data is based on reported data and is not gap filled. Research and development (RnD) data comes from the OECD's 2018 edition of Research and Development Statistics and is based on surveys conducted on the units carrying out the research and development and national estimates. The data consists of expenditures put towards research and development as percentage part of GDP for each country and each year. The Human Capital Index comes from the Penn world table by Feenstra et al. and is an index based on the nations average years of schooling and expected return to education, with data for each country and each year. Lastly, a percentage measurement of how much of the countries GDP consists of exports of advanced technology is used in the regression as an indication of the level of the country's technological advancement. This data is collected from The World Bank. An overview of the descriptive statistics of the data follows below:

Table 2. *Descriptive statistics*

Variable	N	Mean	Median	Sd	Min	Max
Employment	381	3577426	1056475	4670245	106650	17560000
IP	382	7,36	4,68	7,35	0,36	33,93
Human capital	390	3,19	3,25	0,32	2,07	3,71
RnD	385	1,81	1,65	0,94	0,42	4,43
High-tech Exports	385	16,56	15,55	9,53	2,58	47,49

With this type of detailed analysis of trade and employment within a large specific industry, the problem with missing data was expected and dealt with in the following way: countries that lacked more than 90% of all data for all variables in total were excluded from the panel data in order to construct a reliable regression, this left 26 of 36 OECD countries to be part of the analysis. It is important to note that the results from the regression must be seen in the light of this limitation. We cannot exclude the possibility that this group of excluded countries to carry specific characteristics or have common features, that are more or less prominent in this group compared to the included 26 countries, which the results of the research does not take into account. This problem is however not defeating for the research as the group is at large heterogeneous in its composition of countries, containing economies of vastly different sizes and compositions, spread out all over the world and with major differences in production types, which should minimize the risk of their exclusion making up a critical misrepresentation in the research. Furthermore, some of the countries in the sample group do still have missing data for one or several years in one or several of the variables, and this is, of course, a general problem. The judgment has however been called to leave these missing values in the panel data as the problem that would occur from excluding all countries with incomplete data would be much larger. The 90% limit is thought to be a sound limit to where any less would harm the regression more than adding to its reliability. The 26 countries chosen are all part of the 36 OECD countries. The countries included in the research must have at least 90% of the relevant data available which left 10 countries out of the group. Details on countries included and excluded can be found in the appendix.

6.2 Sample Period

The sample period chosen for the regression are the years 1997 to 2011 and this specific time period has been found suitable for two main reasons other than the benefits of examining recent time. The first being that it is in line with most of the key research mentioned in the literature review segment making comparisons between findings more relevant. Secondly, the chosen time period captures the biggest movements of Chinese international trade in recent history with the country starting to partake in the international market in the early ’90s, becoming members of the World Trade Organisation in 2001 and the boom of Chinese international trade in the years after. The years 1997 to 2011 is hence believed to contain the key parts of the Chinese international trade development. Although a period stretching to 2018 would be optimal, the choice was made to stop at 2011 for the data set to remain adequately complete and for the regression results to be as adequate as possible. This is however not a major problem since the most important aspect of this analysis is to include a few years before and a few years after China’s entry into the World Trade Organisation. Working with a time sample of 15 year also gives the analysis some advantages in terms of estimating a regression. Panel data of this time-length typically does not suffer from some of the issues that arise when working with longer time series data, i.e. spurious regression results. Working with longer time series hence requires a different level of econometric detail and with the time restrictions of this paper, the 15 years included is the most suitable time length.

6.3 Methodology

The following section elaborates on the method used for identifying what component of the change in the employment of the OECD countries’ manufacturing sector in the short term, is due to import penetration from China. This relationship will be analyzed using an OLS regression model on panel data collected from the OECD countries. The chosen strategy is underlined with the assumptions that 1) rising Chinese imports affect the domestic market employment through comparative advantages and the general economic gains of trade, and 2) technological advancement affects productivity in manufacturing market so less labour is needed at every output level, i.e. substituting labour for capital. These are the two

mechanisms most extensively referred to as the main causes of employment losses in the manufacturing sector in the developed world, thus, these are the two factors this study will consider.

An index measuring Chinese import penetration of each country's manufacturing market will be constructed to measure the import competition, and further details on this follows later in this chapter. Three variables connected to technological advancement will then control for productivity changes connected to technology. More specifically, high-technology exports, RnD and the human capital index will be used to measure how developed a nation is in respect to the three factors high-technology production, development of high technology and readiness to apply it to production, respectively. The variable high-technology exports also capture how the manufacturing industry is divided, i.e. the sector with frontier technology production and the sector with more traditional or mechanical low technology production. It is reasonable to expect these two types of sectors to be affected differently by trade, most importantly because the former typically is characterized as value-added production, i.e. uses plenty of intermediate goods in production, whilst the latter one less so. Additionally, the high-technological industry is assumed to have a different connection to the labour market than the low-technological industry, as it generally requires a higher level of high-skilled workers in its production. Hence, this variable is likely to provide some interesting information on the effects of an economy shifting towards more advanced types of production.

These are the variables we found most closely captures the conditions suitable for an economy to adopt technology into production to make it more efficient but, ideally, more precise variables would be a benefit. Intuitively some sort of manufacturing productivity index would be best suited but including such a variable would give the OLS regression some major problems. This is because indexes measuring productivity are generally constructed as some function of employment level and output (Scott 2015). Hence, such a measurement would create severe multicollinearity problems for the regression since the output is included in the IP index while employment is the dependent variable. The variable would also become almost completely endogenous. Instead, we have used other variables explaining this process to serve as instruments, i.e. our three control variables. Due to our limited access to data, these control variables also have their limitations. First off, it would of course be optimal to

use an index measuring to what extent the manufacturing sector *produces* and not how much is *exported*, but since no such data was available the export index had to serve as an estimator of how much is actually produced. Likewise, the human capital index is an index covering the whole population, and this must here serve as an estimator of the level of human capital within the manufacturing labour force.

Our research follows the general methodology of previous research in the field, but broadening the approach to analysing an aggregate of manufacturing industries within several countries as panel data individuals. This is in contrast to most previous studies, such as The China Syndrome (2012), who instead analyzes industries or sub-industries within a specific country. The first step in our analysis is to calculate China's import penetration (IP) rate in the manufacturing market for each country and each year. The method used here is largely inspired by the one used in the China shock literature by Autor et al (2016), with the exception of our index being expressed as a percentage of full domestic market size instead of the *change* in the same measurement. This is done in order to make the interpretation more intuitive. The subsequent method is illustrated below.

$$IP_{jt} = Manufactured\ Imports\ From\ China_{jt} / (Manufactured\ Output_{jt} + Manufactured\ Imports_{jt} - Manufactured\ Exports_{jt})$$

Each variable is for country j in the year t. This calculation makes import penetration a measurement of the relative size of Chinese imports to the entire domestic market. This index has been calculated for every year from 1997 to 2011 for each country in the regression, with the exception of cases with missing data. Since it is reasonable to believe that firms take time to react to new levels of competition the analysis will include import penetration as a variable lagged two years. That is, any damage done to firms due to increased competition is assumed to result in layoffs only some time after the initial import exposure, since many other strategies to combat competition is presumably tried before workers are laid off. The response to new levels of productivity and any shift in the production within the manufacturing sector is in our model assumed to be much quicker and hence, no lag has been included for the three control variables. Furthermore, one must consider the possibility of rising imports being a response to a shrinking domestic market, instead of the relationship going the other way, as assumed in our model. In an ideal scenario, instrumental variables

would be used to solve this problem of reverse causation or perhaps simultaneity (in case they are both causing each other). However, due to time restrictions of this paper as well as our limited advancement level, this procedure can unfortunately not be executed and has to be left for further research. Fortunately the inclusion of import penetration as a lagged variable addresses this issue at least to some extent.

To combat the general problem of the data available not being perfect and to gain as much information about the relationship as possible, the regression analysis will be made in two versions. Both are slight variations of the same fundamental regression equation formulated as follows:

$$Employment_{jt} = \alpha + \beta_1 IP_{jt-2} + \beta_2 HumanCapital_{jt} + \beta_3 RnD_{jt} + \beta_4 High\text{-}TechExports_{j\tau} + \varepsilon_{jt}$$

Employment is employment level for country j at time t, IP is import penetration with for country j time t-2, HumanCapital is the human capital index of country j at time t, RnD is percentage of GDP put towards research and development for country j at time t and High-TechExports are value of high-technology exports as part of GDP for country j at time t and $\varepsilon_{j\tau}$ is the error term. α is the OLS intercept and an interpretation of intercept is of no value to the analysis and will therefore not be discussed in results. β_1, β_2, β_3, and β_4 are the sensitivity of employment level in manufacturing due to; market import penetration from China, human capital level, amount of resources put towards research and development and technological advancement, respectively. All beta coefficients are interpreted as the units of change in employment when independent variable changes one unit. The first analysis will be performed using the exact equation above with dummy variables for each year, making it a fixed effects model with respect only to time. The time dummies are used to capture the influence of aggregate international trends such as inflation, economic growth and population growth. The motivation behind only fixating the time effects is that the regression does indeed include some country-specific control variables and it might be the case that too much information might be "controlled away" from the results. The second analysis will be identical to the first except this one will be including cross-sectional dummies additionally to the time dummies. The cross-sectional dummies control for the variation related to unobserved country-specific effects such as preferences, conditions for firms and labour market regulations. With the fixed effects model for both time and cross-section, only the

relevant variation we need to identify the casual relationships remain. It is our hope that when combining the results from these two regressions we will get a broader understanding of the trade-employment relationship than if we were only to approach the question from a single standing point.

The aim of this regression is to investigate how these specific variables, and in particular import penetration from China, affect employment in the OECD countries, leaving the question of what other variables might affect the dependent variable to further research as these are assumed to be sorted out by dummies and fixed effects method.

6.4 Econometric discussion

This portion comments on the econometric weaknesses and possible problems with the regression model and how these issues are dealt with. Firstly, residual normality tests show that the residuals are normally distributed, meaning that our data is well behaved, which is one of the basic assumptions needed for the OLS regression model to work. Furthermore, after performing a Durbin-Watson test and an Augmented Dickie-Fuller test, the data shows some signs of both autocorrelation and non-stationarity, respectively. This implies that the estimations are not optimal but as tests show that the problems are around normal limits for panel data we do dot expect this to be an issue for inference. Also, because of the time period examined being only 15 years, the problem of unit roots in the data, as well as the problem with spurious results that can follow, should not be a major issue, as this is a problem often associated with longer time series. One of the problems with estimating regressions with panel data is that it often has autocorrelation as observations tend to have resemblances amid them as a function of the time lag between them, and this one is not assumed to be an exception. The problem of autocorrelation is dealt with using robust standard errors, more precisely Whites diagonal standard errors, which makes standard errors consistent but are likely to make them larger than normal. This also combats any possible issues regarding heteroscedasticity that the data might have.

Multicollinearity, i.e. correlation between variables, gives high variance and thus gives the OLS-model a hard time estimating the beta values. The control variables in this regression are assumed to be highly correlated, but not to the extent that inference becomes impossible.

Two issues of endogeneity also have to be addressed, i.e. simultaneity and omitted variables. If the two models turn out to have large differences in the result (fixed/not fixed country-specific effects) this indicates that there is a problem with omitted variables. There could possibly be a problem with simultaneity as well, as it might be the case that the decline in manufacturing employment, indicating a shrinking manufacturing sector, is what causes the rise in imports, instead of the other way around. One must also consider the possibility of this model suffering from some other causality problems, especially concerning the question of variables being causally connected to employment levels or if any significant beta values are mere correlations. By using an instrumental variable one could solve these issues but unfortunately, this is not possible due to the level of advancement required. But the problems are dealt with partially through the inclusion of the lagged IP-variable.

7. Regression Results

The following section presents the results from the regression. The results of the two versions of the analyses will be presented in table 3 and then go on to be discussed separately.

In table 3, the results for Model 1 and 2 are presented. The robust standard errors are shown in parentheses below each variable's coefficient. The R^2 values tells how much of the variance in the dependent variable in each model is explained by the different explanatory variables. In Model 1 the explanatory variables explain 26,5 % while the variables in Model 2 explains 98,7 % of the variance of their respective dependent variable. This implies that the variables have the highest degree of explanation on the dependent variable in Model 2. This is expected since the second model includes dummy variables for both time specific and country-specific effects that evidently explains large parts of the employment levels.

Table 3. *Results.*

Variable	**Model (1)** Fixed effects Time **Beta value**	**Model (2)** Fixed effects time & cross-section **Beta value**
IP(-2)	-153340,3*** (30503,5)	412329*** (10348,9)
Human capital	1096166** (491617,6)	-89211,6 (569630,5)
RnD	1275373*** (316790,1)	54837,4 (165948,7)
High-technology exports	119042,5*** (26118,5)	63548,8*** (16553,8)
R2	0,265	0,987
N	390	390

*Significance Level: *p<0.10, **p<0.05, ***p<0.01*
Robust standard errors in parentheses

7.1 Model 1

The results from model 1 show that import penetration from China has a negative effect on manufacturing employment, with strong statistical significance. It suggests that for every unit (i.e. percent since this is how IP is measured) import penetration rises, approximately 150 000 jobs are lost in the domestic manufacturing market. Expressed more explicitly international competition tends to lower employment level in the import exposed industry at an aggregate level. This fits the outcome one would expect following the model of Heckscher Ohlin and Samuelson as the scarcity of low-skilled labour in OECD countries makes them more vulnerable to competition.

Moreover, the model shows that the control variables do a decent job of explaining the employment level as they are all significant. Any un-observed variables affecting employment level are collected in the error term. More precisely, from looking at the R^2 value we see that 73,5% of the true variables explaining employment lie within the error term. One should also note that since model 1 is a fixed effects model in respect to time, this means that there is also explanations related to trends in time that are scooped up by the time dummies, and this is part of the 26.5% that is explained by the model. All control variables have a strong positive effect and are significant at a three- or two star level. This result is somewhat unexpected as these are the variables predicted to boost productivity and hence promote the trade-off between labour and capital (i.e. machines and robots). Rather, this model suggests that the more developed a nation is in respect to high-technology production, development and readiness to apply it to production, the more job opportunities they see in the manufacturing industry. Here one can assume that the aggregate level in which the market is examined is hiding differences in results *within* the sector. The employment level in the manufacturing sector as a whole does however not seem to suffer from technological advancement.

7.2 Model 2

When controlling for country-specific effects, the results are vastly different. Most notably import penetration now is positively correlated with employment levels. Furthermore, two of the control variables, human capital and research and development, has now no significance, revealing that there are omitted variables that the fixed model scoops up. This means that there is most likely some country-specific variable other than the control variables that are directly affecting employment levels.

The lagged IP variable is significant at two-star level. Since IP is measured in percentage this suggests that one percentage change in import penetration from China actually is correlated with a rise in manufacturing employment of circa 40 000. The positive effect is somewhat surprising but nonetheless interesting as this suggests that a rise in manufacturing-oriented trade with China generally has created more employment within the affected sector. It evidently supports the theories and research claiming that trade and competition has a

positive effect on the economy and in this case even employment in the exposed manufacturing industry.

The share of high-technology manufacturing in the economy shows to have a highly significant positive effect. This might suggest that the production of more advanced products such as computers, aircraft and mobile phones are relatively more positively affected by the rise of Chinese imports than more traditional goods production. This, in turn, can be explained by the benefits from trade such as access to cheaper intermediate goods for high tech production, and so boosting countries high tech manufacturing industry. This interpretation is also applicable, as well as, supported by the results from model 1 where the variable is also significantly positive.

The level of means put towards research and development appears to have no significant effect on manufacturing employment level. This suggests that whether or not the new technology leading to higher productivity is developed domestically or abroad does not matter. Although one might think that adaptation of technology developed domestically would be quicker and more effective this seems not to be the case. The key to the rise in productivity might lie in the use of new production technology, and not the development of it. The variable measuring the effect of Human capital also has a non-significant effect on employment when controlling for other country-specific factors.

8. Discussion and concluding remarks

The debate about China's potentially harmful manufacturing exports to the OECD countries has in recent time intensified. For instance, researchers like Autor et al. argue that increasing import penetration from China is causing a fall in the employment of manufacturing workers in the developed nations. In this paper, we have examined if import penetration has affected the employment of manufacturing workers in an aggregate of the OECD countries in the short term. This is analyzed by using panel data for 26 OECD countries in the period of 1997-2011. The results from the regression show dissimilar effects of import penetration as model 1 shows import penetration to be negatively correlated with the employment of manufacturing workers, while model 2 shows the reverse. Hence the discussion will be

divided into three parts, one for each model and one where both results are analyzed in unison.

8.1 Model 1

The results from model 1 show clearly that import penetration from China has had a negative effect on the employment of manufacturing workers. It seems that when China's import penetration increases, firms cave to the pressure of the new competition which offsets losses in employment. This result is not surprising as the majority of studies stated in this paper have arrived at the same conclusion. Even though researches like Krugman (1980) suggests that trade is not the major cause for the reduction of manufacturing workers, the results from this paper show that is does, however, have a negative effect. Furthermore, the results are also in line with the model of Heckscher- Ohlin who argues that because of low skilled manufacturing workers being relatively scarce in the OECD countries, they will lose due to increased international trade with low-skill abundant countries like China. With regards to the direct effect of import penetration, it is thought to indicate that a domestic market would be satisfied to a greater extent of cheaper foreign goods. This would then lead to a reduction of domestic output, followed by a decline of manufacturing workers as these industries would either cut down on staff, exit the market or relocate to new sectors outside the manufacturing industry.

The variable controlling for human capital demonstrates a positive effect for manufacturing employment. These results are not surprising either since earlier research show that manufacturing firms are shifting their employment towards workers with a higher skill set. Hence, it is expected that a higher level of human capital has a positive effect on manufacturing employment. The same holds true for high-technological exports. As products from China gain more ground in the domestic manufacturing industry due to their comparative advantage, many firms will relocate to new sub-sectors within the manufacturing industry and produce other goods where they themselves have a stronger comparative advantage. For the OECD, these types of goods are for example considered to be computers and jet engines. Hence, the more firms relocate to manufacturing sub-sectors and produce

high technological goods, the more people will be employed. Lastly, the effects of RnD also has a positive effect on manufacturing employment. This is somewhat more surprising as previous studies have stated that the development of new production technologies are what is considered the main cause for employment to fall within the manufacturing industry. However, researchers have also shown that the development of new production technology is beneficial for manufacturing workers with a higher skill set. Hence, one can assume that the development of new technology could benefit the workers with higher human capital, that are being employed by firms who have relocated to new sub-sectors within the manufacturing industry. In conclusion, the results from model 1 can be interpreted as import penetration has had negative effects on the employment of manufacturing workers as China outbids domestic producers in the domestic market, and whatever gains in employment that has been caused by the increase in trade does not outweigh these job-losses. Presumably, the increase in competition has forced manufacturing firms to relocate to new sectors, adopting new technology in their production and instead hire manufacturing workers with a higher skill set.

8.2 Model 2

Model 2 shows that when we do take country-specific effect into account, increased import penetration from China has had a positive and significant effect on the manufacturing employment within the OECD countries. These findings are interesting since it seems to contradict the outcomes of import penetration predicted by theories of Heckscher-Ohlin, Samuelson as well as a majority of the previous research. According to both the theories and research highlighted in the previous chapter, one would expect the increased import penetration from China to lower the employment of manufacturing workers in the OECD countries, as the results from model 1 demonstrated. Instead, the results show that increasing import penetration actually increases employment of manufacturing workers in the domestic markets. The results suggest that the more goods imported from China, the more labour is being employed within the domestic manufacturing sector. Consequently, this indicates that Chinese exports have contributed to an increase in employment of manufacturing workers throughout the OECD countries.

However, the results presented does not stand without credibility since other theories such as the theory of heterogeneous firms, Intra industry trade and other research paints a different picture. In contrast to the models of Heckscher-Ohlin and Samuelson who argues that winners and losers from trade will be found in different industries, the theory of heterogeneous firms and intra industry trade argues that winners and loser can be found within the same narrowly defined industry (Marrewijk, 2017, Melitz, 2003). This is because the theories disregard the assumption of perfect competition and access to identical technology present within the Neoclassical trade theories. Instead, the theories allows for firms to be heterogeneous with large productivity differences while co-existíng together. Hence, instead of a reduction in employment of manufacturing workers, import penetration could also just as well shift the employments of manufacturing workers to more efficient firms. This is because the less efficient firms exit the markets while other more efficient firms expand and hire more workers in light of increased access to Chinese intermediate goods, which would then lead to higher output and lower marginal costs. This suggests that production of more advanced products such as computers, aircrafts and mobile phones are relatively more positively affected by the rise of Chinese imports than more traditional goods production, as these types of products rely heavily on access to intermediate goods. As Either (1982) pointed out, the largest and fastest growing type of intra industry trade since WW2, is the exchange of intermediate manufacturing goods. By allowing for an increase in intermediate goods to final goods producers, their output can increase further along with their market power.

This is further supported by Bernard et al (2006) whose empirical research of the US manufacturing industry showed that the most efficient industries that experienced relatively large declines in trade costs (due to tariffs and other trade barriers being removed) demonstrated relatively strong productivity growth. They also found that firms with low productivity within the same industry are more likely to exit the market when trade costs are being reduced. Hence, the results does not leave out the possibility that sub-sectors may have been affected differently. Trade-exposed sub-sectors might have experience a decline in employment while increases in employment made by other sub-sectors have dominated these possible negative effects. In conclusion, these findings go against the thought that the effects

of Chinese import penetration on the OECD countries would be harmful for the employment of manufacturing workers.

8.3 Concluding remarks

While the model that includes only time dummies show that Chinese import penetration on the manufacturing market is negatively connected to the sectors employment levels, the model that also includes dummies for each country shows the opposite results. This result reveals that there is something in these country specific effects that is crucial in deciding what effect of import penetration from China will have on the domestic manufacturing employment level. These unobserved variables (that are found in the error term of model 1 and are scooped up by the cross-sectional dummies in model 2) are therefore an important subject for research to come. It is unfortunate that this study did not locate these omitted variables in the research. The paper does, however, still provide an interesting result that does give some clarity to the issue.

On an aggregate level, there is no evidence that increased imports of manufactured goods from China could be harmful to the domestic manufacturing industry. If negative effects of import penetration are observed, it would probably be the result of one of two things. Either it is a result of domestic conditions, such as rules and regulations for firms and trade policy, or it is only observed in sub-sectors of the manufacturing industry with a specific type of production, most likely some type of traditional production rather than high-technology production. Either way, the employment losses that do stem from Chinese import penetration appear not to outweigh the increase in job opportunities that the import penetration causes in other parts of the sector. The OECD manufacturing industry does indeed seem to be able to thrive from China's sudden boom on the international market. As long as conditions are good in the countries and one can bare to sacrifice of some less fortunate sub-sectors. What conditions that are needed for each country we leave to further research.

Although studies differ in results of how much import penetration from China lowers employment levels it is very rare to find one that finds that the relationship is actually positive on industry level. Many studies show that the economy as a whole has large gains to

make by increasing international trade, even though other research points out the potential employment losses that free trade can cause on a smaller sectors within the manufacturing sector. From this study we can conclude that even if we look at manufacturing as a specific sector in the OECD economies, we still experience the general gains of trade. These results does indeed contradict the popular belief that China's import penetration on the OECD countries is generally damaging in terms of employment of manufacturing workers.

Lastly one must note that since this study uses a limited sample of OECD countries, the conclusions drawn from this study have limitations and results must be interpreted carefully. This is especially true due to some limitations in the collected data and problem with omitted variables. It is, however, unlikely that elimination of all the weaknesses of this study would drastically change its outcome but one cannot exclude the possibility that results could indeed differ. Further research is required in order to conclude whether increased IP has the same effect in other regions and countries, since the vast differences between the OECD countries could cause the effect of Chinese import penetration to vary to a large extent. It would also be of great value to look at how sub-industries in the aggregate of these countries are affected and if they are affected differently under different circumstances. The understanding of the effects of China's import penetration will also greatly improve with time as data becomes available to conduct research on the long-term effects.

9. References

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Appendix

OECD countries included in panel data: Australia, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, United States.

OECD countries not included in panel data: Canada, Chile, Iceland, Latvia, Lithuania, Luxembourg, Switzerland, New Zealand, Mexico, Turkey.