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The difference between trade and foreign direct investment concerning their impact on host-country income inequality

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Abstract

With multiple countries facing the increase in income inequality, the importance of (reducing) income inequality becomes more important. Literature has identified multiple factors that cause income inequality – between high-skilled and low-skilled workers – to rise, including trade and foreign direct investment. The aim of this research is to determine the impact of trade and foreign direct investment concerning their impact on host-country income inequality. By differentiating between inter- and intra-industry trade and horizontal- and vertical foreign direct investment, this research investigates this hypothesized relationship in 17 OECD countries for the 2013-2019 period. Literature suggests that inter-industry and vertical foreign direct investment negatively impact host-country income inequality. However, the results suggest that there is no significant relationship between income inequality, trade and foreign direct investment. A robustness check using GINI-index as dependent variable suggests that vertical FDI is significantly related to income inequality when controlling for the effect of so-called 'vertical' trade. These robustness checks strengthen the need for future research, since these relationships may not remain unexplored because the robustness check suggests that vertical FDI seem to play a role in explaining income inequality.

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1 Introduction

A central issue in economics concerns how income is distributed across economic agents (Owyang & Shell, 2016). In the United States, the income of American households overall has trended up since 1970, but there seem to be inequalities in the distribution of income. The Congressional Budget Office finds that the GINI coefficient – a measure of income inequality – in the U.S. in 2016 was 0.481. Income inequality in the U.S. is found to have increased by about 20% from 1980 to 2016. This rise in American income inequality is caused by multiple factors, including technological change, globalization, the decline of unions, and the eroding value of the minimum wage (Horowitz et al., 2020). Horowitz et al. (2020) claim that income inequality has caused social concerns among members of the public, researchers, policymakers, and politicians because of the diminished economic opportunity and mobility in the lower rungs of the economic ladder. Not only developed countries have faced rising income inequality, but also developing countries saw their income inequality increasing (Ravallion, 2014). For example, in 1988 the share of Chinese households in the highest ten percent was 7.3 times the share of the income of households in the lowest 10 percent, which rose to 19 times in 2002 (Zhou & Song, 2016). On top of that, the report published by the United Nation Development Programme (2013) suggests that income inequality increased by an average of 11% between 1990 and 2010 in developing countries, which emphasizes the fact that income inequality is not solely an issue in the United States.

Income inequality matters if people care about their relative income status, but what is more interesting are the consequences that income inequality has. The fact that developed as well as developing countries – for example, the United States and China – have faced rising income inequality suggests that income inequality is a global phenomenon. The consequences of income inequality could be analyzed using two different perspectives: a country- and a firm perspective. Concerning the country perspective on (the consequences of) income inequality, income inequality could harm society. Inequality can inhibit growth, it can slow poverty reduction, and might trigger bad economic policies with negative effects on growth, human development, and poverty reduction (Birdsall, 2001). According to Kondo et al. (2009), people that are living in regions with relatively higher income inequality have a higher risk for premature mortality

independent of their socioeconomic status, age, and sex. With regard to the firm perspective, Bapuji & Neville (2015) suggest that firms' characteristics and practices are embedded in the determination of income inequality within societies. The paper of Bapuji (2015) adds that addressing income inequality is in the interest of the firm because income inequality leads to poor physical and mental health, increased crime, and lower educational skills that affect organizational performance. Poor physical- and mental health affects firm performance through increased absenteeism, a lack of psychological well-being, and a decreased ability to perform their activities within the firm. Lower educational skills – such as problem-solving skills and discipline – decrease employees' ability to perform their job correctly, which affects firm performance. Lastly, it would be important to consider the effect of dealing with income inequality on goodwill towards the firm. Theory on corporate social responsibility claims that firms should add the environmental and societal dimensions to their daily business activities aimed at creating profits (Żak, 2015).

Literature has acknowledged seven main causes of income inequality: technological change, trade globalization, financial globalization, financial deepening, changes in labor market institutions, redistributive policies, and education (Dabla-Norris et al., 2015). Trade and financial globalization are broadly recognized as drivers of income inequality (Bergh & Nilsson, 2010; Heshmati, 2005). Asteriou et al. (2014) elaborate on two channels through which trade and financial globalization affect income inequality. Trade has been the engine of growth by promoting competitiveness and enhancing efficiency but has mixed effects on the wages of unskilled labor in advanced economies. On the one hand, trade openness can raise the skill premium, but – on the other hand – it could also increase real wages by lowering (import) prices. Speaking of financial globalization, Asteriou et al. (2014) claim that foreign direct investment (FDI) plays a major role. FDI has shown to increase income inequality in both advanced and emerging market economies, which could be caused by the concentration of foreign assets in relatively higher skill- and technology-intensive sectors and as a consequence of skill-specific technological change (Dabla-Norris et al., 2015).

Literature acknowledges separate effects of FDI and trade on income inequality, but there is a lack of literature on the comparison between these two modes of internationalization. This research aims at explaining the difference concerning the impact of trade and FDI on income inequality in host countries. In the context of trade, host countries are defined as those countries that import goods from the home country that produces and exports the goods, while with regard to FDI, host countries are those countries that receive FDI. It is interesting to make a comparison between the effects of trade and FDI on income inequality because both modes of entry can have different implications for income inequality in the host country. Exporting (trade) and local production (FDI) are seen as alternative ways to serve the foreign market, which suggests a substitutability relationship between FDI and trade (Majeed & Ahmad, 2007).

Therefore, this paper is concerned with the following research question:

What is the difference between trade and foreign direct investment concerning their impact on income inequality in host countries?

To investigate this, a dataset was used comprising 17 OECD countries during the period 2013-2019. This database consists of variables concerning trade, foreign direct investment, income inequality and GDP per capita and the GINI index as control variables. Trade was measured by using import data in combination with a Grubel-Lloyd index variable to differentiate between inter- and intra-industry trade. FDI was measured using data on FDI inflows for preselected sectors that are assigned to being horizontal or vertical type of FDI, while income inequality was based on the ratio between the total high-skilled and total low-skilled wages based on multiple occupations. Due to a mismatch between the occupations and the sectors covered by the trade and foreign direct investment variables, it is solely possible to determine the effect of these independent variables on a country-level. Which sectors are used for the analysis is determined by the FDI variable, since FDI data is limited available.

Previewing the results, the findings of this paper do not find evidence for trade or foreign direct investment to be significantly related to wage inequality. However, when analyzing the model that compares the effect of vertical foreign direct investment and the effect of 'vertical'-defined trade, a robustness check – using the GINI-index as dependent variable – shows that vertical FDI has significant impact on the GINI-index of a particular country, whereas 'vertical'-defined trade has no significant relationship with the GINI-index. This robustness check emphasizes the importance of addressing these hypothesized relationships, since vertical FDI seems to play a role in explaining income inequality – when measured using a GINI-index.

The remainder of this research is as follows. Chapter 1 will present an overview of relevant literature in combination with a theoretical framework, which is evaluated to develop the central research question and the hypotheses. In Chapter 2, the methodology approach is discussed that will be used for the analysis in this paper. Chapter 3 encompasses the results. The paper will end with a discussion and a conclusion based on everything that has been written in the previous chapters.

2 Trade, FDI, and Income Inequality

This chapter provides an overview of the relevant literature on trade, FDI, and income inequality and to get a deeper understanding of all the theoretical mechanisms underlying these theories. The theoretical mechanisms underlying theoretical models provide a basis on which the hypotheses will be based to test the difference in the impact of trade and FDI on host-country income inequality.

2.1 Income Inequality

As aforementioned, income inequality has been a central issue in economics, which is concerned with how income is distributed across economic agents (Owyang & Shell, 2016). Keeley (2015) claims that many developed and developing countries have faced increased income inequality. The author claims that in the 1980s the average disposable income of the richest 10% in OECD countries was about seven times higher than that of the poorest 10%, which has increased to 9½ times higher today. Income inequality refers to the extent to which income is distributed unequally among a country's population. The Lorenz curve is often used in the literature to graphically illustrate the distribution of income among a country's population. This convex curve plots the percentages of total income earned by a specific percentage of the population (Gastwirth, 1971). The line with a slope of 45 degrees illustrates the situation in which there is perfect equality of income, which is illustrated in the figure that is included in Appendix A.1. The bigger the distance between the actual income distribution line and the perfect equality line, the higher the degree of income inequality is represented. Related to the Lorenz curve is the GINI coefficient, which is a measure of relative income inequality. It represents the area between the actual income distribution line and the 45 degrees line that illustrates the situation in which there is perfect equality of income, expressed as a proportion of the area under the perfect income equality line (Dorfman, 1979).

According to Park & Kim (2021), perfect equality of income does not equal the optimal income distribution. The authors wrote a paper on the feasible income equality which is based on the

Boltzmann distribution. The authors claim that the income distribution must be unbiased, which can be achieved using the Boltzmann distribution. In the physical sciences, the Boltzmann distribution yields the equilibrium probability distribution of a physical system in its energy substates (Park & Kim, pp. 6, 2021). The Boltzmann distribution – applied to income inequality – gives the probability that a unit income is distributed to an individual which depends on the income distribution factor of that individual.

The Boltzmann distribution is graphically illustrated in the figure that is included in Appendix A.2. This figure shows that maximum social welfare is achieved when β equals β^* (the optimal value for β). If β is equal to zero, all individuals receive an equal amount of income. If β becomes higher, the higher the probability that a unit income is distributed to an individual *i* that have the highest income distribution factors. The income distribution factor measures the economic contribution that could be made depending on intelligence, personality, and physical and social skills.

This distribution provides the most probable allocation among multiple actors, which is seen as 'fair' - and in this case thus optimal - in social sciences. Individuals with higher values for $\tilde{E}_i$ contribute more to the economy and, therefore, deserve to earn more money. Thus, the theory of the Boltzmann distribution not only suggests that income should be distributed in proportion to the relative ranking of individuals based on their economic contribution which is based on intelligence, personality, and physical- and social skills, but also that social welfare is higher when income is more equally distributed.

That income inequality harms the economy is broadly recognized within the literature. As aforementioned, income inequality matters on the country- as well as at the firm level. According to Persson & Tabellini (1994) income inequality is harmful to economic growth because income inequality leads to policies that do not protect property rights and do not allow for full private appropriation of returns from investment. Neckerman et al. (2007) add that income inequality harms the economy because it raises the inequality of opportunity. Inequality at one point in time affects inequality in the next generation. This reproduction of (income) inequality goes through

multiple channels. The poor health of low-income children means that they get less education which decreases their income potential. The fact that high-income children get relatively more education – which thus increases their income potential in the future – might increase income inequality in the future. On top of that, Neckerman et al. (2007) claim that inequality is bad for health because it undermines social capital. Education and health are seen as important drivers of the economy. The combination of these consequences of income inequality for the economy as a whole emphasizes the fact that it is important to address income inequality.

2.2 Trade

Nations are more closely linked than ever before through trade in goods and services, flows of money, and investments. Trade plays a major role in the process of globalization and economic integration. Despite the impact of the Covid-19 crisis, the World Trade Organization (2021) reports that global trade has increased significantly over the last few years. The world has become more connected by deep trade links, which has made the world more vulnerable to shocks but also more resilient. Trade has diversified access to global goods and services, which allows for faster diffusion of knowledge, can contribute to speeding up economic recovery from the crisis, and increased the gains of variety (World Trade Organization, 2021; Broda & Weinstein, 2006). However, the authors (World Trade Organization, 2021) also mention that trade-driven interdependence has a downside. Trade-driven interdependence could be problematic in the case of relatively small shocks to one link in the value chain, trade comes with negative externalities such as the impact on the environment, but the authors also emphasize that this process of (trade) globalization has led to differences between developed and developing countries. Developed countries have more access to (financial) resources and are better able to handle shocks, while these resources are simply not available for developing countries. The availability of access to these resources seems to be important in determining the economic growth of that specific country.

The relationship between trade and economic growth is a matter of controversy in the literature. Trade is expected to promote efficient allocation of resources, foster technological progress,

encourage competition and promote the diffusion of knowledge (Busse & Königer, 2012). However, the causal link between trade and growth is ambiguous. Some argue that there is a positive link between trade and growth (Keho, 2017; Das & Paul, 2011; Freund & Bolaky, 2008; Frankel & Romer, 1999), while others claim that the benefits of trade are highly dependent on specific circumstances (Kim, 2011; Kavoussi, 1985). According to Keho (2017), trade openness can enhance economic growth by providing access to diverse goods and services, improving total factor productivity and knowledge dissemination. Freund & Bolaky (2008) argue that these benefits of trade are determined by domestic policies that restrict factor mobility since the gains from trade are expected to come from a reorientation of resources between and within industries. In addition, the paper of Frankel & Romer (1999) suggests that specifically within-country trade raises income. Their results show that countries that are larger have higher incomes because they have more opportunities to trade within their borders. These findings come with the question of how these increases in income are distributed among the population. Kim (2011) finds that greater international trade may foster uneven development and that this development is dependent on the level of financial development, inflation and trade openness.

Literature suggests that there is a difference in the distribution of the gains of trade between intra- and inter-industry trade, which is supported by the paper of Freund & Bolaky (2008) and Frankel & Romer (1999). Intra-industry trade is the exchange of goods between countries that takes place within industries, while inter-industry trade is concerned with those goods that are exchanged between different industries. According to Aquino (1978), the difference is important because – first – the pattern and intensity of intra-industry trade are more difficult to predict and more strongly influenced by random factors. Second, the price elasticities of imports and exports are likely to be much greater for intra-industry than for inter-industry trade. Third, the welfare gains of trade are likely to be much greater for inter-industry than for intra-industry trade, which is contrary to the findings of Frankel & Romer (1999).

To explain the difference between inter- and intra-industry trade, there is need to first determine how these different types of trade can be explained separately by using several trade models.

Countries could start trading because there is a lack of the availability of resources, but this is not the only reason for countries to start trading. According to Ricardo's theory of comparative advantage, two countries trade with each other when the ratios of comparative costs of producing goods differ. Countries will specialize in producing that specific good in which it has a comparative advantage. Trade can improve total factor productivity because countries start specializing in the production of goods that they are relatively better in. The Ricardian model assumes that international trade is solely due to international differences in the productivity of labor. Because it is unrealistic to assume that countries solely trade because of differences in labor productivity, Eli Heckscher and Bertil Ohlin developed the Heckscher-Ohlin theory.

The Heckscher-Ohlin theory is a model that assumes that trade is driven by differences in countries' resources. A country that has a relative abundance of a specific factor of production will specialize in the production of that particular good but will import the good that requires the production factor that is relatively scarce assuming that there are only two different production factors (Krugman et al., 2018). The fact that the good that requires the scarce production factor is imported has implications for the distribution of the gains of trade. Assuming two production factors (labor and capital) – having equal relative and absolute prices – wages rise (rents fall) in the labor-abundant country, and wages in the labor-scarce country fall (rents rise). Subasat (2002) claims that the prices of the production factors would gradually converge within a country until they become equalized in both countries. This suggests that international trade has the same effect on prices as the international free mobility of factors.

The Heckscher-Ohlin model illustrates how factor prices respond to inter-industry trade. By exporting those goods that require the production factor that is abundant in that country, this type of trade is associated with the good exchange between different industries. Because the Heckscher-Ohlin model is based on trade based on factor endowments of a trading country, the trade will be inter-industry because this type is based on comparative advantages. The fact that this type of trade is based on comparative advantages, means that it has income distributional consequences for the people working in both industries. Wages in industries that require the

abundant production factor could increase, while wages in the industries that require the production factor that is relatively scarce will decrease.

In contrast to inter-industry trade, intra-industry trade is the exchange of goods that takes place within industries. The Heckscher-Ohlin model emphasizes differences between countries as determinants of international trade. Intra-industry trade is more concerned with trade in goods that are relatively similar, but firms are allowed to differentiate based on product characteristics. According to Brander (1981), intra-industry models are models that stress similarity among countries and increasing returns to scale caused by trade. One model that stresses intra-industry trade is the model of Melitz (2003), which is included in Appendix B. The Melitz model is a model for intra-industry trade which assumes productivity differences between firms within a monopolistic competition framework. In the autarky situation, the cut-off point of productivity is represented by λ_A in which only those firms will have a positive profit that will have a productivity higher than λ_A. The Melitz model illustrates that when trade liberalization comes in, only the most productive firms will be able to stay in the market. The least productive firms will leave the market, which shifts λ_A to λ_O. Finally, there is a shift from $\lambda_O$to λ_E. λ_E will be the cut-off productivity level for the most productive firms that will differentiate them from domestic firms that will remain selling their products domestically. The Melitz model is concerned with intra-industry trade because firms compete on the same production factor and are only able to differentiate on productivity. This type of trade has different implications for inequality in comparison to inter-industry trade.

According to Chusseau & Hellier (2012) there is room for different income distribution patterns because firms exhibit different profit levels according to their productivity. The openness of the economy causes a diversion between domestic-oriented and exporting firms. It is expected that this diversion leads to different income distributions because more productive firms will face higher profits than firms that exit the market or remain domestically. Chusseau & Hellier (2012) claim that the divergence in productivity creates inter-group and intra-group inequality which is stimulated by fair wage-induced unemployment. In other words, concluding from the Melitz

model it is expected that intra-industry can increase income inequality between workers within that industry since more productive firms receive higher profits than firms that remain domestically given the fact that they are paid at their marginal productivity. The most productive firms are best able to encounter foreign competition and can use economies of scale to maximize their profits given the size of the market.

2.3 Foreign Direct Investment

Foreign Direct Investment (FDI) is defined as *"a category of international investment that reflects the objective of a resident in one economy (the direct investor) obtaining a lasting interest in an enterprise resident in another economy (the direct investment enterprise)"* (Patterson et al., 2004, p. 3). FDI is acquiring ownership of assets to control production and reduce distribution costs (Lokesha & Leelavathy, 2012). '*There are two general principles of the theory of FDI: firms internalize missing or imperfect external markets until the costs of further internalization outweigh the benefits and firms choose locations for their constituent activities that minimize the overall costs of their operations*' (Buckley et al., 2007, p. 500). This internalization of market activities means that firms use FDI to replace imperfect external markets, which allows firms to enter markets that have market imperfections. Dunning (1980) adds that FDI will be conducted to gain access to foreign markets and resources. He argues that FDI is part of a large internationalization theory, which tries to explain reasons for firms to start operating internationally. Exporting (trade) and licensing are seen as alternative ways in the process of internationalization. Exporting and licensing do not require such a high investment, but limit the withdrawn market knowledge and access to essential resources.

Literature has distinguished two different types of FDI: horizontal- and vertical FDI. Horizontal FDI encompasses a firm willing to locate production in the destination market to save on transportation costs, while vertical FDI is concerned with the comparative advantage across countries as a motive for the foreign location of some stages of production (Ramondo et al., 2011). Horizontal FDI is often conducted to seek new markets, while vertical FDI is more concerned with efficiency-seeking. The literature claims that vertical FDI is common in electric

machinery and textile industries, while horizontal FDI is common in the transportation equipment industry (Fukao & Chung, 1996, cited in Fukao & Wei, 2008). The paper of Fukao & Wei (2008) suggests that horizontal FDI is determined by the similarity in size and relative factor endowments between home and host country, while vertical FDI is concerned with the importance of the two countries' relative factor endowments because firms choose locations based on input costs (Yokota & Tomohara, 2009). According to Yokota & Tomohara (2009), both types of FDI behave similarly regarding FDI destinations in the food and chemical industries, but in the electric machinery industry, vertical FDI is dominant in less developed host countries. The authors suggest that this is the case due to the fact that vertical FDI seeks cost advantages in low-developed countries to produce cheap electric machinery for either the host market, the home market, or another export market.

It is interesting to make the distinction between horizontal- and vertical FDI because both types of FDI could have different implications for income inequality in the host country. Feenstra & Hanson (1995) wrote a paper in which they developed a model that shows that capital flows from North to South – or any increase in the Southern capital stock relative to that in the North – can increase the relative wage of skilled labor in both regions. This North-South flow capital model shows that Northern countries primarily use high-skilled labor, while Southern countries are more specialized in labor that is relatively low-skilled. Northern firms will be offshoring relatively low-skilled labor activities to Southern countries because Southern countries are low-skilled labor abundant. These activities – transferred from the North to the South – will be more skilled-labor intensive than those that are produced in the Southern countries, but less skilled-labor intensive than those produced in the Northern countries. Therefore, the relative demand for skilled labor in both countries increases, which results in a higher relative wage for skilled workers and might cause an increase in income inequality.

This capital flow from North to South is a vertical type of FDI because this type of investment is based on comparative advantages and aimed at efficiency-seeking. By offshoring relatively low-skilled labor activities by the North, those firms aim to reduce costs and aim to be better able to

serve the foreign market. However, the paper of Bera & Gupta (2009) shows that there is a significant difference in the type of industry the Northern and the Southern countries conduct FDI in. The authors suggest that the South-South capital flows have increased over the last few years indicating that developing countries have developed rapidly. This horizontal type of FDI represents the motive of market seeking as developing Southern countries try to enter relatively similar markets to be able to serve those markets and increase their profits. On top of that, the authors conclude that FDI is higher in countries with lower import intensity, explaining the market-seeking motive since firms will face less foreign competition in those countries. Lastly, the results of their paper suggest that Southern firms are more likely to invest in more dynamic/growing sectors in comparison to Northern countries. This explains why North-South capital flows are considered as vertical FDI, while investments in similar countries (South-South capital flows) are considered to be horizontal FDI.

Another theoretical model that tries to explain patterns of FDI is the Knowledge Capital model. According to Markusen & Maskus (2002), the Knowledge Capital model is a model that explains how investment patterns of firms are affected by the difference in skilled labor between the source and host country, as a measure of relative endowments. The Knowledge Capital model allows for two different types of firms: vertically integrated- and horizontally integrated firms. Vertically integrated firms are those firms whose multinational activity is based on comparative advantages, which are driven by differences in factor endowments, while horizontally integrated firms are those firms that will conduct FDI in countries that are relatively similar in size or relative endowments.

The paper of Markusen & Maskus (2002) encompasses three different models that are included in Appendix C. The figure included in Appendix C.1 represents the general knowledge capital model, while the other figures (included in Appendix C.2 and C.3) are there to illustrate the horizontal and vertical models. The model is based on a world with two countries, two factors – skilled and unskilled labor – and two goods. The figures illustrate the difference between the horizontal and vertical model, assuming that horizontal firms will be dominant in the source

country if countries are similar in size while vertical firms will be dominant when the source country is small, is relatively skilled labor abundant and trade costs are not extreme.

The Knowledge Capital model and the horizontal model – respectively the figures included in Appendix C.1 and C.2 – show an inverted U-shaped curve along the SW-NE diagonal, which illustrates that most of those firms conduct in countries with similar size or relative endowments. This could be explained by the fact that horizontal firms are there to seek (access) to new markets and thus aim for increasing returns to scale to reduce costs. The figure included in Appendix C.3 represents the graphical illustration of the FDI pattern for vertical firms, which shows that affiliate production will only take place when countries differ in relative endowments. The fact that the SW-NE diagonal is relatively flat, indicates that there is no or less affiliate production of vertical firms when countries are relatively similar in endowments. This is in line with the efficiency-seeking motive of vertical firms, which suggests that vertical firms conduct FDI based on their comparative advantage in a specific endowment.

Knowing that these different types of FDI have different motives and could have different consequences emphasizes the need for a separate analysis of the different impacts on income distribution. According to the North-South model of Feenstra & Hanson (1995), this type of vertical FDI leads to a bigger gap between the income of skilled- and unskilled labor because the relative demand for skilled labor increased in both countries due to the Northern country that keeps production that requires skilled labor at home and the Southern country receives those activities from the North that require their skilled labor. This will lead to less demand for unskilled labor resulting in lower wages, which increases the gap between people that are categorized as skilled- and unskilled labor. Based on the knowledge capital model, Markusen & Maskus (2002) suggest that – applied to the US – an increase in the difference between the relative skill endowment of the parent country and that of the affiliate is associated with an increase in outward affiliate production conducted by the Northern country, which is also found in Kristjánsdóttir (2010). The model of Markusen & Maskus (2002) emphasizes the differences between horizontal- and vertical FDI and the implications of income inequality will be in line with

those of the North-South model. Horizontal FDI – because of market-seeking motives – will not affect the income distribution for workers, but it will affect the profit distribution in the market because only the most productive firms will be able to participate in foreign markets (Melitz, 2003). Vertical FDI is based on comparative advantages, which leads to differences in the prices of endowments. The fact that demand increases for skilled-labor workers in both countries suggest that this negatively affects income distribution.

2.4 Hypotheses

Based on the theoretical framework, it can be concluded that trade and FDI can have a significant impact on income inequality in the host country. Literature has made the distinction between intra- and inter-industry trade, which has different implications for the income inequality in the host country, but also FDI has been separated into horizontal and vertical FDI. This paper aims to explain the difference between trade and FDI concerning their impact on income inequality in the host country, given the fact that there is a need to take these different forms of trade and FDI into account.

Because of the ambiguity of income inequality, it is important to correctly operationalize income inequality, especially because of its close links to wage inequality. Income inequality refers to the extent to which income is distributed unequally among the population of a country, which is often measured using the GINI-coefficient, the Theil-index, or - for example - the Coefficient of Variation (De Maio, 2007). Wage inequality refers to the differences in the wages workers receive for doing the same work. Although that income inequality and wage inequality are closely related, it is important to consider that trade and FDI will mainly affect wage inequality instead of income inequality. Therefore, this paper will use a constructed wage inequality variable as dependent variable instead of using the GINI-coefficient, because this coefficient solely measures the difference between the equal distribution of income and the actual distribution of income. Since trade and FDI can have an impact on wages – earned by high and low skilled workers – this variable will be the main focus of this research.

To investigate the relationship between trade, foreign direct investment and income inequality in host countries, multiple hypotheses need to be developed. Literature suggests that the link between trade and income is ambiguous. Aquino (1978) claims that the gains of trade are likely to be much greater for inter-industry than for intra-industry trade, which suggests that there could be differences in the distribution of income between those two types of trade. Based on the Heckscher-Ohlin model, inter-industry trade could lead to an increase in the income inequality, since it is expected that only people working in the sectors that require the abundant production factor will see their wages rise. Although the Melitz model might suggest that the most productive firms will face higher profits – since they act internationally – this is leads to a different income distribution within that sector and does not redistribute income between high- and low-skilled labor. Based on these theoretical frameworks, the following hypotheses are developed, where host countries are defined as the country that imports goods from the country that exports the goods:

Hypothesis 1a: Inter-industry trade is expected to increase income inequality in host countries.

Hypothesis 1b: Intra-industry trade is not related to income inequality in host countries.

Besides trade theories, the previous chapters have looked into the relationship between (horizontal and vertical) FDI and income inequality. The Feenstra and Hanson model (1995) has shown that capital flows from North to South, or any increase in the Southern capital stock relative to that in the North, can increase the relative wage of skilled labor in both regions. Northern firms will offshore multiple activities to the South, which will be more skilled-labor intensive than those formerly produced in the South. The relative demand for skilled labor increases, which results in a higher relative wage for skilled workers. The Knowledge-Capital model of Markusen & Maskus (2002) adds that there could be different implications when making a distinction between horizontal and vertical types of FDI. Vertical firms geographically fragment their production into stages – typically on the basis of factor intensities – locating skilled-labor

intensive activities in skilled-labor-abundant countries, while horizontal firms are those firms that replicate similar activities in many locations. Firms are likely to invest in markets that are relatively similar to their markets, and therefore it is expected that there is a difference in the impact on income inequality between horizontal- and vertical FDI. Based on these theories, the following hypotheses are developed – where the host country is defined as the country that receives the FDI from a foreign country:

Hypothesis 2a: Horizontal foreign direct investment is expected to have no effect on income inequality in host countries.

Hypothesis 2b: Vertical foreign direct investment is expected to increase income inequality in host countries.

This research aims at explaining the difference between the impact of trade and FDI on income inequality in the host country. It is in the interest of this research to determine which type of internationalization has relatively more or less impact on income inequality in the host country. As described in the previous chapter, vertical foreign direct investment and inter-industry trade are both expected to increase income inequality in home countries. Vertical foreign direct investment concerns the comparative advantage across countries as a motive for the foreign location of some stages of production, whereas inter-industry trade concerns the trade that is also based on comparative advantages. Because vertical foreign direct investment uses foreign located production stages, it is expected that this leads to more impact on host-country income inequality.

Hypothesis 3: Vertical foreign direct investment is expected to affect income inequality in the host country more than inter-industry trade.

3 Methodology

This chapter provides an overview and operationalization of the variables used for the analysis. All the variables will be operationalized to make sure the correct definition is used when interpreting the results. In addition to this, the empirical strategy will be substantiated and potential econometric issues will be discussed before estimating the relationship between trade, FDI, and income inequality.

3.1 Data and variables

This paper examines the difference in the impact of trade and FDI on income inequality in the host country. To recall, host country is defined as the country that imports / receives goods from the country that exports the goods, and – in the context of FDI – the host country receives the FDI from a foreign country. To analyze the impact of trade and FDI on income inequality in host countries, the OECD countries will be used for analysis. The OECD has 38 member countries listed in the table that is included in Appendix D. The research will focus on a selection of the OECD countries, because of data availability. In addition, Alderson & Nielsen (2002) did research on the relationship between the GINI-coefficient and real GDP per capita for 16 OECD countries. Their paper suggests that the increase in inequality in the OECD countries is caused by 'lost jobs' as a consequence of growing capital flows, trade and migration. The authors claim that this has affected the distribution of income between skilled and unskilled workers, which suggest an increase in income inequality. The fact that these – selected – OECD countries have faced rising income inequality, makes it interesting to use these countries for the analysis in this research. The methodological part on income inequality and FDI limits the country sample to 17 countries instead of 38 countries, because of data availability. The list of countries that are excluded is extensively discussed when the methodology of measuring income inequality and FDI is substantiated.

Wage inequality

Before analyzing income/wage inequality, it is important to emphasize that there is a difference between income and wage. Wage is the money that is paid over a specific period of time, while income is the total amount of money that includes wages, dividends, gifts, and interest. Wage is often used as a proxy for income, as mentioned in Sbardella et al. (2017). They claim that wages reflect the skill levels of workers, which is in line with the aim of this research. This research aims to measure the wage inequality based on differences between high- and low-skilled workers, therefore wage inequality will be used as a measure of income inequality. This way of measuring wage inequality is preferred over using the GINI-coefficient, since the GINI-coefficient does not allow to differentiate between high and low-skilled labor.

Data on wage inequality is derived from a database provided by the International Labour Organization (2022). Their database provides annual data on the average monthly earnings of employees by sex and occupation for 149 countries available for a time period of 2010 to 2021. Their database allows for differentiation of different types of occupations, which need to be classified as to whether they belong to high-skilled or low-skilled labor. The occupations used in the database are classified based on the International Standard Classification of Occupations (ISCO) (International Labour Office, 2013). This classification of occupations is used for structuring and organizing information on the labor market, which is also known as ISCO-08. This classification consists of the following groups:

1. Managers (ISCO-08)
2. Professionals (ISCO-08)
3. Technicians and associate professionals (ISCO-08)
4. Clerical support (ISCO-08)
5. Services and sales (ISCO-08)
6. Skilled agricultural, forestry and fishery workers (ISCO-08)
7. Craft and related trades workers (ISCO-08)
8. Plant and machine operators, and assemblers (ISCO-08)
9. Elementary occupations (ISCO-08)

To investigate whether the wage inequality between high- and low-skilled labor has changed, those groups need to be classified as to whether they belong to high- or low-skilled labor. In 2013 the International Labour Office published a book that presents the structure and definitions of all groups in the International Standard Classification of Occupations 2008 (ISCO-08) including assigning the groups of different skill levels, which could be used to determine whether a group belongs to high- or low skilled labor.

According to the International Labour Office (2013), there are four different skill levels:

1. *Skill level 1*

Occupations at Skill Level 1 typically involve the performance of simple and routine physical or manual tasks. For these occupations, basic skills in literacy and numeracy are required but are not the major part of the work. Completion of primary education allows for proper performance in these occupations.

2. *Skill level 2*

Occupations at Skill Level 2 typically involve the performance of tasks such as operating machinery, driving vehicles and ordering, and storage of information. Workers need to be able to read information such as safety instructions, so they might need a certain level of literacy and numeracy skills and good interpersonal communication skills to do the work properly. To do these tasks properly, the knowledge and skills are generally obtained through the completion of the first stage of secondary education.

3. *Skill level 3*

Occupations at Skill Level 3 typically involve the performance of relatively complex technical and practical tasks that require an extensive body of specialized knowledge. This type of occupations requires high levels of literacy and numeracy and well-developed interpersonal communication skills. This knowledge could be obtained by studying at a higher educational institution.

4. *Skill level 4*

Occupations at Skill Level 4 typically involve the performance of tasks that require complex problem-solving, decision-making combined with a large body of knowledge in a specialized field. Very high levels of interpersonal communication skills are required in combination with extended

levels of literacy and numeracy. Knowledge and skills that are required for this skill level could be obtained by studying at a higher educational institution for a period of 3-6 years.

Table 1 shows the mapping of ISCO-08 major groups to skill levels. From this table, it can be concluded that (1) managers, (2) professionals and (3) technicians and associate professionals are assigned to high-skilled labor, while (4) clerical support workers, (5) services and sales workers, (6) skilled agricultural, forestry and fishery workers, (7) craft and related trade workers, (8) plant and machine operators and assemblers & (9) elementary occupations are assigned to low-skilled labor. This division allows to separate high- and low-skilled work when investigating the effects of wage inequality, and thus the difference in wages between high-skilled and low-skilled workers.

ISCO-08 major groups	Skill level
1. Managers	3 + 4
2. Professionals	4
3. Technicians and Associate Professionals	3
4. Clerical Support Workers	2
5. Services and Sales Workers	2
6. Skilled Agricultural, Forestry and Fishery Workers	2
7. Craft and Related Trade Workers	2
8. Plant and Machine Operators, and Assemblers	1
9. Elementary Occupations	1

TABLE 1: MAPPING OF ISCO-08 MAJOR GROUPS TO SKILL LEVEL
(SOURCE: INTERNATIONAL LABOUR OFFICE, 2013)

To measure the wage inequality, a ratio of the average weighted high-skilled wage and the average weighted low-skilled wages will be calculated. This is preferred over subtracting the average weighted low-skilled wage from the average weighted high-skilled wage because it is of interest to observe relative changes. Absolute changes will be a higher percentage of the low-skilled wage compared to the high-skilled wages.

Data on wage inequality is provided for multiple years for a country for each occupation group transformed from the local currency to US dollars using the 2017 purchasing power parity for private consumption expenditures. This allows for a comparison between different countries since the data is corrected for differences in relative prices between different countries. To prevent over- or under-representation of certain occupation groups, the wage data will be calculated using a weighted average.

Using the weighted average wage allows analyzing the impact of trade and FDI on a higher aggregate level since each high-skilled occupation contributes to the over-time difference based on their contribution to the total wages earned in occupations that are classified as high-skilled. This higher aggregate level is used because there is a mismatch between the occupations covered by this dataset and the sectors used to measure trade and FDI as discussed later. However, to see whether wage inequality has changed, this weighted average monthly wage will be used. When determining wage inequality – differentiating between high-skilled and low-skilled labor – per country a sum function will be used to see the aggregate effect, shown in equation (1) and (2):

(1) $Average\ monthly\ wage_{HS,t} = \sum_{i=3}(wage_{HS,i,t} * \frac{wage_{HS,i,t}}{\sum_{i=3} wage_{HS,i,t}})$

(2) $Average\ monthly\ wage_{LS,t} = \sum_{i=6}(wage_{LS,i,t} * \frac{wage_{LS,i,t}}{\sum_{i=6} wage_{LS,i,t}})$

Where *HS* and *LS* denote whether the sector is defined as high- or low-skilled, *i* denotes the ISCO-08 group and *t* denotes year. This weighted average – in the low/high-skilled sector of a country – is calculated by taking the sum of the average monthly wage for low/high-skilled ISCO-group *i* in time period *t* for a country multiplied by the average monthly wage for low/high-skilled ISCO-group *i* in time period *t* in that country divided by the total wage earned in that time-period *t* for all low/high-skilled classified occupations in that country as shown in equation (1) and (2). Equation 1 is used to calculate the average monthly wage for high-skilled labor per country per year, which allows to do an analysis over multiple moments in time and thus whether wage inequality change over time in a specific country caused by trade or FDI, when separating high-skilled and low-skilled labor. Equation 2 shows the equation for the average monthly wage for

low-skilled labor per country per year. So, wage inequality is determined by dividing equation (1) by equation (2), which provides the ability to see whether the ratio between both types of wage has changed and thus whether the wage inequality had changed over time.

Foreign Direct Investment

One of the main independent variables of interest concerns the investment in which the investor establishes an interest in and influence over an enterprise resident in a foreign country, which is called Foreign Direct Investment (FDI). As aforementioned, '*FDI has two main motives: firms internalize missing or imperfect external markets until the costs of further internalization outweigh the benefits and firms choose locations for their constituent activities that minimize the overall costs of their operations* (Buckley et al., 2007, p. 500). Based on the literature discussed in chapter 2, there are two different types of FDI: horizontal- and vertical FDI. Horizontal FDI encompasses a firm willing to locate production in the destination market to save on transportation costs, while vertical FDI is concerned with the comparative advantage across countries as a motive for the foreign location of some stages of production (Ramondo et al., 2011). It is important to make this distinction because both types of FDI are expected to have a different effect on host country income inequality.

FDI-related data are derived from The Investment Map provided by the International Trade Centre (2022). This database consists of FDI statistics for about 200 countries and detailed FDI sectoral and/or country breakdown for about 115 countries. The data is available for FDI stocks and FDI flows, but – in the context of this research – FDI flows will be used since it is of interest to investigate how newly conducted FDI relates to host country income inequality. This data is available for the time span running from 2013 to 2020. It is important to mention that the data is only available – at the desired disaggregated level – when considering 'World' as partner country, the database does not allow for analyzing bilateral FDI since this data is solely available for a limited number of countries. On top of that, to analyze the relationship between FDI and host country income inequality, it is not necessary to know from which country the FDI comes from since only the domestic effects on income inequality are of interest. Thereby, when differentiating

between horizontal- and vertical FDI, this could be done by analyzing in which sectors that specific country receives relatively high values of FDI in comparison to other sectors.

To be able to differentiate between horizontal- and vertical FDI, it is important to determine what sectors belong to a particular type of FDI. The literature discussed in chapter 2 suggests that horizontal FDI is determined by the similarity in size and relative factor endowment between home and host country, while vertical FDI is concerned with the importance of the two countries' relative factor endowments since firms choose locations based on input costs (Fukao & Wei, 2008). Due to limited data availability, there is need to limit the number of sectors used for the analysis. Based on the database provided by the International Trade Centre (2022), the sectors that are used for the analysis are listed in table 2 that is shown below. (H) represents a sector that is classified as being horizontal, while (V) represents a sector that is classified as being vertical. This classification will be discussed later.

Primary Sector	**Secondary Sector**	**Tertiary Sector**
Mining and quarrying (H)	Manufacture of textiles (V)	Transport and Storage (H)
Agriculture, forestry and fishing (V)	Manufacture of Chemicals and Chemical products (H)	Electricity, gas, steam and air conditioning supply (V)

TABLE 2: SECTORS USED TO ANALYZE THE IMPACT OF FDI ON HOST-COUNTRY INCOME INEQUALITY.

Due to the limited availability of data concerning FDI, the analysis of FDI will be limited to these six sectors. Initially this research focused on the analysis of OECD countries and their relationship between trade, FDI and income inequality. However, the following countries have to be removed from the analysis: United States & New Zealand (data only available as the total amount of FDI), Japan & Turkey (data only available for 1 year), Portugal, Canada, Belgium, Israel, Switzerland, Denmark, Finland, Norway, Ireland, Latvia & Luxembourg (too much missing data) and Iceland (too few years of data available to do a proper analysis). These countries could not be included in the analysis for multiple reasons. If the missing data were solved by using the imputation of the mean FDI value for that specific sector, then the data would be too biased because this mean is calculated based on too few observations. On top of that, countries that solely have data on the highest aggregate level are removed from the analysis, because it is not able to differentiate

different sectors. This all leads to a country-sample of 17 different countries, which is shown in table 4.

As aforementioned, it is of interest to make the distinction between horizontal- and vertical FDI in their relationship to host country income inequality. To be able to apply the distinction between horizontal- and vertical FDI to the chosen sectors shown in Table 2, a literature-based substantiation is needed. Starting with the mining and quarrying sector, according to Petrova et al. (2018) this sector plays an important role within the EU, especially in those countries that are specialized in the extraction of fossil fuels. The authors claim that the mining and quarrying sector is oriented toward specialization, high qualifications and development of skills and competences to ensure a strong competitive position in the market. According to Calzada Olvera (2021), the global mining productivity has declined with 3.5% per year. In this particular sector, there is less room for product differentiation, firms compete on prices. As suggested by the Knowledge-Capital model, horizontal firms are there to seek (access) to new (relatively similar) markets and thus aim for increasing returns to scale to reduce costs. Based on these arguments – and in line with the two different motives FDI – this sector is expected to be horizontal FDI, since market seeking will be the driving motive instead of conducting FDI based on comparative advantages which characterizes vertical FDI.

Concerning the manufacturing of textile and transport and storage, literature has examined the determinants of location choice of Japanese MNEs in textile, different types of machinery, and transportation equipment industries. They claim that vertical FDI is common in electric machinery and textile industries, while horizontal FDI is common in the transportation (equipment) industry (Fukao & Chung, 1996, cited in Fukao & Wei, 2008). In textile industries, FDI is commonly conducted because of the fact that one actor has a comparative advantage in producing a specific product, which confirms that this type of FDI is vertical. With regard to the transportation industry, Gordon (1992) reports that they have found a productivity growth slowdown the last 50 years. The fact that productivity growth stagnates, might indicate that it is difficult to gain a comparative advantage since the relative difference in the level of productivity is limited by

minimal productivity growth. This finding supports the argument of Fukao & Chung (1996, cited in Fukao & Wei, 2008) that the transportation (equipment) industry is a horizontal type of FDI.

Regarding the agriculture, forestry and fishing sector, Saing et al. (2012) claim that a major reason for (the rise in) foreign direct investment is the attempt by food- and energy-importing countries to tackle their domestic food and energy crisis. Foreign investors are trying to get access to (for them new) resources that they could get when conducting FDI in a particular country. FDI in the agriculture, forestry and fishing sector is classified as being vertical FDI, since foreign investors seek efficiency and try to get access to new resources by conducting FDI in those countries. Concerning the manufacturing of chemicals and chemical products, Robinson et al. (2002) claim that the chemical sector is characterised by high volume products that are undifferentiable by product characteristics that is produced by a technology that is not different from competitors. They claim that firms can get a competitive advantage by focussing on service and relationship management rather than being focused on differentiating products or using different technologies. The fact that Robinson et al. (2002) claim that in the chemical industry that is less room for differentiation suggests that those different firms (/markets) are relatively similar, indicating that FDI in this sector could be classified as being horizontal. Lastly, FDI in the electricity, gas, steam and air conditioning supply sector is seen a vertical investment, since in this sector the electricity supply is often vertically integrated because of the level of specificity of assets given use or location and based on the fact that these activities must be coordinated. Firms are seeking for efficiencies and – in the case of vertical integration in the electricity supply sector – acquire an operation that is usually done by other actors in the value chain. This vertical FDI gives firms the ability to eliminate market distortions, better coordinate investments and reduce risks. So, FDI in the electricity, gas, steam and air conditioning supply sector is of vertical type, since firms seek efficiency and try to use foreign resources via vertical integration given the high level of specificity of assets that is required to operate in this market.

To recap, literature on FDI has identified two different types of FDI: horizontal- and vertical. Because vertical FDI is expected to have an effect on host-country income inequality, it is important to make the distinction in the analysis. Based on the literature discussed above, the six chosen sectors are equally balanced in the division horizontal vs. vertical FDI. While the agriculture, forestry and fishing sector, manufacture of textiles sector and the electricity, gas, steam and air conditioning supply sector are classified as being vertical FDI, the mining and quarrying sector, the manufacture of chemicals and chemical products and the transport and storage sector recognized as being horizontal. In each type of sector – respectively the primary, secondary or tertiary – there is one sector concerning vertical FDI and one sector horizontal FDI, which decreases the likelihood that the results are biased because all of vertical FDI classified sectors come from e.g., the primary sector.

Trade

The trade-related data are derived from the 'Atlas of Economic Complexity' database provided by the Growth lab at Harvard University (2019). This database contains trade data for 250 different countries, classified into 20 categories of goods and 5 categories of services. This data is derived from countries' reporting to the United Nations Statistical Division (COMTRADE). The data contains trade flows data classified using the Standard International Trade Classification (SITC) Revision 2. The database covers data from 1962 to 2019 and allows for an analysis on multiple digit-detail levels, which allows for a deeper analysis of trade data. The data provides information on the values for export and import for a good and services in a specific country for a specific year. Because the data at a 4-digit level is limited available, this research will use trade data at a 2-digit level. Analyzing at a 2-digit level implies that the analysis is less specific, since the 4-digit level of SITC is more specified towards a specific good the so-called 'subgroup' (e.g., sneakers or wine) while the 2-digit level of SITC concerns the so-called 'division' (e.g., footwear or beverages).

The effect of trade on income inequality – regardless of the distinction between intra- and inter-industry trade – will be measured using the import of a product division (according to the 2-digit level of SITC) for a specific country in a specific time period. The import of a product division will be used for the analysis, since the database does not provide the possibility to analyze bilateral

trade and because this research aims to explain host country income inequality affected by incoming trade flows. As aforementioned in the theoretical framework, it is important to make the distinction between inter- and intra-industry trade when analyzing its impact on host-country income inequality. Intra-industry trade refers to the exchange of similar products belonging to the same industry. A measure of intra-industry trade that takes place between countries is the Grubel-Lloyd (GL) index (Grubel & Lloyd, 1971). The Grubel-Lloyd index measures intra-industry trade of a particular product/division, which was introduced by Herb Grubel and Peter Lloyd in 1971. The Grubel-Lloyd will be used as a proxy to measure whether a product division belongs to intra- or inter-industry trade, which allows to see whether the effect of trade is higher for product divisions that are more intra- or inter-industry trade according to this index. During the analysis, an interaction term between the Grubel-Lloyd index and trade will be used in order to be able to investigate whether the effect of trade is higher for product divisions that are more intra- or inter-industry trade.

Concerning hypothesis 1a and 1b, a model is created that tests the relationship between trade and wage inequality. Since the variable wage inequality is measured at the country-level, this implies that the data on trade also needs to be at the same level of measurement. To determine the total amount of trade and whether this belong to inter- or intra-industry trade, a weighted average of the Grubel-Lloyd index was calculated based on the total of all product division Grubel-Lloyd indexes and the contribution to the total amount of trade, which is shown in equation (3). On top of that, hypothesis 3 concerns the comparison between vertical foreign direct investment and inter-industry trade. Because of the fact that data on FDI is very limited, this has the consequence that only a limited number of sectors could be used in model 3 for the analysis of the comparison between vertical FDI and inter-industry trade. Those ‘vertical sectors’ are shown later in table 3.

The weighted GL-index per country is calculated as shown in the following equation (3):

(3) $$GL_i = \frac{M_{d,i}}{\sum_i^d [M_{d,i}]} * \frac{\sum_i^d [(X_{d,i}+M_{d,i}) - |X_{d,i}-M_{d,i}|]}{\sum_i^d [X_{d,i}+M_{d,i}]}; 0 \leq GL_i \leq 1$$

where $X_{d,i}$ is the export of product division *d* by country *i*, $M_{d,i}$ is the import of product division *d* by country *i*, *i* represent the country, *d* represents the product division as defined by the SITC. If GL_i = 1, then there is a high level of intra-industry trade. This means that the country exports the same quantity of good *i* as much as it imports (Grubel & Lloyd, 1971). For hypotheses 1a and 1b, N will be covering 87 different divisions as defined by the SITC. With regard to hypothesis 3, N will cover 18 different divisions.

Appendix E shows an overview of the type of product divisions that are dealt with within this database. Based on the export and import value of those product divisions, the Grubel-Lloyd index is calculated. This index will be used to determine whether that sector belongs to inter- or intra-industry trade. As aforementioned, intra-industry is the exchange of goods that takes place within industries, while inter-industry is concerned with those goods that are exchanged between different industries. Trade between different industries – inter-industry trade – is based on comparative advantages, because one of the two involved parties is relative better or more specialized in the production of that particular good. Lundberg (1992) claims that the more endowments of production factors differ, the larger the amount of inter-industry trade. Concerning intra-industry trade, this trade concerns trade within industries, which is related to differences in economies of scale since there is no comparative advantage because the same production factors are used.

Because the data of FDI is the limiting factor, those six sectors will be used when comparing the effect of vertical FDI and inter-industry trade concerning hypothesis 3. Those six sectors – mining and quarrying; agriculture, forestry and fishing; manufacture of textiles; manufacture of chemicals and chemical products; transport and storage; and electricity, gas, steam and air conditioning supply – need to match with the right SITC product code. The SITC product codes

that are linked to a specific FDI sector are addressed based on whether this product group plays a primary role in this FDI sector. In other words, - based on the FDI sector – a SITC product code is assigned to that specific sector, because this belongs to the 'trade' in that sector. The total amount of trade within that sector is calculated by summing up the import value of all the relevant SITC product codes for that relevant year. Table 3 shows which SITC product codes are used to measure trade in that specific FDI sector. This assignment of SITC product codes to the FDI sectors is based on the EU-classification of Economic Activities provided by the European Commission. This classification provides a definition of each sector, which is used to determine which SITC product codes belong to which FDI sector (European Commission, 2022).

When addressing the relevant SITC products codes to the correct FDI sector – for the Mining and Quarrying sector – SITC product codes concerning manufacturing of metal/coal/etc. are not included since the EU-classification solely focus on the extraction of minerals and supplementary activities aimed at preparing crude materials for marketing – e.g., crushing, cleaning, drying or sorting.

FDI Sector	**Relevant SITC product codes**
Mining and quarrying (H)	28, 32, 33, 34, 67, 68
Agriculture, forestry and fishing (V)	0, 1, 2, 3, 4, 5, 6, 7, 8, 24, 29
Manufacture of textiles (V)	26, 65, 84
Manufacture of chemicals and chemical products (H)	51, 52, 56, 57, 59, 62, 87
Transport and storage (H)	78, 79
Electricity, gas, steam and air conditioning supply (V)	34, 35, 71, 77

TABLE 3: OVERVIEW OF RELEVANT SITC PRODUCT CODES PER FDI SECTOR

Control variables

For the statistical analysis of these hypothesized relationships, control variables will be included. These control variables control the effect of exogenous variables that could affect the dependent variable or the relationship between the dependent variables and the independent variables. One of the control variables will be the GDP per capita of a country coming from the database of the World Bank (2022), to make sure that the analysis is not affected by the fact that one country has

more GDP per capita – which indicates that this country is relatively wealthier – than other countries in the analysis. Luan & Zhou (2017) claim that the more developed a country is – and thus the higher de GDP per capita – the less income inequality is expected. In line with this finding, – based on Kuznets theory – Baymul & Sen (2020) claim that income inequality may increase at relatively lower levels of GDP per capita – economic development – but at some level of structural transformation (workers move from low productivity firms to the high productivity sectors), income inequality starts to decrease.

Another exogenous factor that needs to be taken into account is the GINI-coefficient. The GINI-coefficient will be added as a control variable to control for the existing income inequality in a particular country. This research is interested in the change in income inequality as a consequence of the impact of trade and FDI. To make sure that the change is measured, it needs to be taken into account that some countries already have more income inequality than other countries. Because countries that relatively low levels of the GINI-coefficient, face higher percentual increases in their GINI-coefficient if it increases with the same absolute number in comparison to countries with a relatively high GINI-coefficient. Data on the GINI-coefficient is provided by the World Bank (2021) for a time-period of 2013-2019 for all countries that are used for the analysis.

3.2 Empirical strategy

To examine the relationship between trade, FDI and host country income inequality, three following empirical models will be used:

Model 1:

$$Wage\ inequality_{it} = \beta_0 + \beta_1 lnTrade_{it} + \beta_2 GL\_index_{it} + \beta_3 GL\_index_{it} * lnTrade_{it} + \beta_4 X_{it} + \alpha_i + \in_{it}$$

Where *i* denote country and *t* denote the year. The dependent variable wage inequality is represented as defined by diving equation (1) and (2), as $Wage\ inequality_{it}$. The independent variable trade $lnTrade_{it}$ is the natural logarithm of the total import of country *i* in period *t*,

GL_index_{it} represents the Grubel-Lloyd index of country *i* in period *t* as defined in equation (3), X_{it} captures the effect of control variables – GDP per capita and the GINI index. The error term $\in_{it}$ is a composition of unobserved country and time specific heterogeneity. α_i captures the random effect variance. Based on chapter 2, it is expected that $\beta_1 > 0$, because trade is expected to increase wage inequality. Considering the interaction term between the GL-index and the trade of a country, it is expected that $\beta_3 < 0$, because it is expected that – given that trade positively relates to wage inequality – if the GL-index is relatively low (which indicates inter-industry trade) the wage inequality increases. A significant negative β_3 coefficient indicates that the increase of wage inequality due to trade will be bigger for inter-industry trade than for intra-industry trade.

Model 2:

$$Wage\ inequality_{it} = \beta_0 + \beta_1 FDI\_H_{it} + \beta_2 FDI\_V_{it} + \beta_3 X_{it} + \alpha_i + \in_{it}$$

Where *i* denote country and *t* denote the year. The dependent variable wage inequality is represented as defined by diving equation (1) and (2), as $Wage\ inequality_{it}$. The main independent variables FDI_H_{it} and FDI_V_{it} denote the inflow of horizontal and vertical foreign direct investment in country *i* in period *t*. X_{it} captures the effect of control variables – GDP per capita and the GINI index. The error term $\in_{it}$ is a composition of unobserved country and time specific heterogeneity. α_i captures the random effect variance. Based on hypothesis 2a, it is expected that β_1 is not significantly different from zero, since it is expected that horizontal FDI does not affect income inequality. Based on chapter 2 – concerning hypothesis 2b – it is expected that β_2 (total FDI sectors representing vertical FDI) shows a positive significant coefficient, because it is theoretically expected that vertical FDI is positive related to host country income inequality.

Model 3:

$$Wage\ inequality_{it} = \beta_0 + \beta_1 FDI\_V_{it} + \beta_2 lnTrade\_V_{it} + \beta_3 GLindex\_V_{it} + \beta_4 lnTrade\_V_{it} * GLindex\_V_{it} + \beta_5 X_{it} + \alpha_i + \in_{it}$$

Where *i* denote country and *t* denote the year. The dependent variable wage inequality is represented as defined by diving equation (1) and (2), as $Wage\ inequality_{it}$. The independent variable FDI_V_{it} denotes the inflow of vertical foreign direct investment in country *i* in period *t*. $lnTrade\_V_{it}$ represents the natural logarithm of the total amount of trade in country *i* in period *t* concerning product divisions that are assigned to the vertical sector as done in table 3. The error term $\in_{it}$ is a composition of unobserved country and time specific heterogeneity. α_i captures the random effect variance. Hypothesis 3 claims that vertical FDI has more effect on host country income inequality than inter-industry trade, therefore it is expected that the effect of β_1 is bigger than the effect of vertical trade (β_2) and the effect of vertical trade when including the effect of the Grubel-Lloyd index of these particular product divisions (β_4). It is expected that vertical FDI is positively related to wage inequality and that the negative effect of vertical FDI – β_1 – on wage inequality is bigger than the effect of vertical trade – β_2 – negative effect of inter-industry type of trade – β_4 – indicating that vertical FDI has the biggest impact on host-country income inequality when controlling for multiple control variables.

Statistical analysis

The quantitative analysis will be done using a panel data analysis to investigate the relationship between the aforementioned variables. Panel data typically refers to data containing time-series observations of a number of individuals and allows for an analysis of multiple moments in time. In the context of this research, the relationship between income inequality, trade and foreign direct investment needs to be examined. The dataset used for this investigation provides data for multiple countries (economic entities) at multiple moments in time and the analysis is of the same economic entity through time. This analysis over multiple moments in time allow for deeper understanding, because it is possible to observe the effect developing through time and indicates how large the effect is. A cross-section analysis is not eligible for this analysis, since this does not

allow for measurement of multiple moments in time and how the effects of variables develop through time, whereas a time-series analysis only allows for the analysis of a single or a few economic entities.

Panel data has two different forms: fixed-effects or random-effects panel data. Before doing the panel data analysis, the Hausman test will be done to see whether the fixed-effects or random-effects specification will be the best type of analysis for the data to make sure that the statistical analysis fits the model. On top of that, the statistical analysis will also include a robustness check to test the strength of the statistical model. To check for multicollinearity, the correlation matrix will be analyzed. To prevent heterogeneity and autocorrelation to become problematic, all the regression analysis will be run using robust standard errors. To check whether the results are robust, three different robustness checks will be done. First, it will be checked whether the results differ if the GINI-index is used as a proxy for wage inequality. Second, model 1 will re-analysed using a trade variable including 35 OECD countries instead of the 17 selected countries due to limited data availability. Third – based on the theoretical framework –, sectors were assigned to being 'vertical' or 'horizontal' FDI. The relationship between wage inequality and vertical FDI will be re-analysed when assuming that the 'mining and quarrying' sector belongs to vertical FDI instead of being horizontal as suggested by Wang et al. (2012).

4 Results

This chapter presents the empirical verification of the hypotheses that followed from the theoretical framework presented in chapter 2. Based on the methodology – as described in chapter 3 – the different datasets were merged into one dataset to estimate the relationship between the dependent variable – wage inequality – and the main independent variables – trade and foreign direct investment.

4.1 Estimation results

Before estimating the relationship between trade, FDI and host-country income inequality, the descriptive statistics are illustrated to provide an overview of the countries included in the analysis and the description of the variables illustrates the content of the dataset. Table 4 shows the countries that are included in the analysis, which is different from the list of OECD countries – included in Appendix D – but some countries are excluded because of data availability as described in the previous chapter on the methodology.

#	Country	ID
1	Australia	AUS
2	Austria	AUT
3	Costa Rica	CRI
4	Czech Republic	CZE
5	Estonia	EST
6	Germany	DEU
7	Greece	GRC
8	Hungary	HUN
9	Korea, Republic of	KOR

#	Country	ID
10	Mexico	MEX
11	Netherlands	NLD
12	Poland	POL
13	Slovakia	SVK
14	Slovenia	SVN
15	Spain	ESP
16	Sweden	SWE
17	United Kingdom	GBR

TABLE 4: LIST OF INCLUDED COUNTRIES IN THE ANALYSIS.

Variable	Obs	Mean	Std. Dev.	Min	Max
Wage inequality	119	2.125	.486	1.567	4.171
FDI Horizontal (million US$)	119	1828.513	9209.756	-50102.86	50167.89
FDI Vertical (million US$)	119	-137.911	2651.872	-15516.57	11829.91
Total Trade (in US $)	119	2.731e+11	2.789e+11	1.376e+10	1.215e+12
GL-index total Trade	119	0.3531577	0.0771696	0.1166665	0.4451037
Trade H. (in US $)	119	1.003e+11	1.061e+11	4.550e+09	4.603e+11
GL-index H.	119	.66	.167	.203	.884
Trade V. (in US $)	119	6.546e+10	7.056e+10	2.799e+09	3.099e+11
GL-index V.	119	.677	.159	.285	.868
GDP per capita (in US $)	119	30077.072	16107.153	8744.516	68156.628
GINI index	119	32.668	6.5	23.2	49.2

TABLE 5: DESCRIPTIVE STATISTICS

Table 5 provides the descriptive statistics based on the database that is used for the analysis in this research. The database has 119 observations on each variable for 17 different countries running from 2013 to 2019. As described in the previous chapter on methodology, wage inequality per country is measured by dividing the weighted average income of high-skilled workers in year *t* in that country by the weighted average income of low-skilled workers in year *t* in that country. A mean of 2.125 of this variable suggests that high-skilled workers earn 2.125 times more than low-skilled workers. The minimal value of 1.567 indicates that for every country in all time periods, high-skilled workers receive higher wages than low-skilled wages.

FDI horizontal – consisting of mining and quarrying; manufacturing of chemicals and chemical products; and transport and storage – has a mean value of 1828.513, and FDI vertical has a negative mean of -137.911. This negative mean of FDI vertical indicates that the value of disinvestment by foreign investors is greater than the value of capital newly invested in that particular country, which should be taken into account when analysing the results. Both FDI variables have a relatively high standard deviation, which indicates that the observed datapoints deviate relatively a lot from the mean.

Furthermore, the descriptive statistics on the trade variables show huge differences in magnitude. Before analyzing, a histogram was made to see whether the variable is normally distributed or not. It turned out that the variable for total trade, horizontal trade and vertical trade were not normally distributed. To overcome this problem, the natural logarithm was taken.

Because of data availability, missing data was replaced by calculating the mean value based on the other observations for the variables income inequality and the GINI-index. For data on FDI, '0' values were not replaced because this value could represent the situation in which there was no FDI inflow for that particular sector in that specific year. Concerning the GINI-index, for Germany the GINI-index for 2019 is the mean GINI-index of the period 2013 till 2018. For Poland, the GINI-index for 2019 was missing, which is replaced by computing the extrapolated GINI-index by multiplying the GINI-index of 2018 by the average change of the GINI-index over the period 2013-2018. There is a trend visible concerning the GINI-index for Poland, so imputing the average GINI-index will affect the results significantly. For Australia, the mean GINI index – based on observations for 2014, 2016 and 2018 – replaces the missing value for 2013, 2015, 2017 and 2019, since there was no clear trend visible. With regard to wage inequality, for Poland, the Netherlands, Australia, Germany and Estonia missing values were replaced by the average wage of that sector across the time-period 2013-2019. All the other data is calculated as described earlier in the chapter on methodology.

Before using regression analyses, it is helpful to consider the correlation matrix included in Appendix F. The correlation matrix shows to what degree the variables are correlated with each other. High levels of correlation indicate that variables move together, which has statistical implications for the analysis. As the correlation matrix suggests, there is an extremely high correlation between the trade variables. Trade concerning the predefined vertical sectors, trade concerning the predefined horizontal sectors and total trade are highly correlated. The total trade is based on trade in all sectors, which explains this high correlation. The robust standard error accounts for heteroskedasticity and/or autocorrelation. Given the fact that these variables are not in the same model, there is no potential danger of multicollinearity.

Before estimating the hypothesized relationships – between wage inequality, trade and foreign direct investment –, for each model a Hausman test is done to check a fixed-effects or a random-effects model is preferred. The findings of the Hausman test are included in Appendix G.1, G.2 and G.3.

The results of the Hausman test are for each model separately shown in Appendix G.1, G.2 and G.3. A Hausman test looks to see if there is a correlation between the error term and the regressors in the model. This test determines whether the fixed-effects or the random-effects model should be used. If the p-value is smaller than 0.05, the null hypothesis – random effects model is preferred – can be rejected, which means that the fixed-effects model is preferred. Table 1 – included in Appendix G.1 – shows a significant Hausman test (p-value < 0.05), which means that for model 1 the fixed-effects model is preferred. Table 2 and table 3 – included in Appendix G.2 and G.3 – show that the p-value is bigger than 0.05 (respectively 0.931 and 0.930), which indicates that the random effects model is preferred for these models.

Table 6, 7 and 8 present the outcomes of the analysis of each of the three models separately. To prevent heterogeneity and autocorrelation to become problematic, all the regression analysis will be run using robust standard errors.

	(1) Wage inequality	(2) Wage inequality	(3) Wage inequality
Ln Total trade	-0.292	-0.326	-0.292
	(0.221)	(0.306)	(0.351)
Grubel-Lloyd index	-3.925	-4.562	-5.344
total trade	(0.727)	(0.716)	(0.678)
Interaction term	0.160	0.186	0.229
total trade	(0.727)	(0.717)	(0.666)
GDP per capita		0.00000143	0.00000134
		(0.740)	(0.764)
GINI index			0.0237*
			(0.033)
Constant	9.562	10.40	8.642
	(0.115)	(0.194)	(0.256)
Observations	119	119	119
p-values in parentheses			
* p<0.05, ** p<0.01, *** p<0.001			

TABLE 6: OUTCOMES FIXED EFFECTS ANALYSIS MODEL 1 USING ROBUST STANDARD ERRORS

Starting with model 1 – which is illustrated in table 6 –, this model represents the hypothesized relationship between trade on the country level composed as the total of all sectors with wage inequality measured per country per year divided into high- and low skilled labor. Table 6 presents the outcomes of the fixed effects regression analysis concerning model 1 using robust standard errors. The first column represents the model without any control variable, the second column includes GDP per capita as control variable and the third column includes both control variables. The interaction term is included in all the regressions to see whether it matters what type of trade – inter or intra-industry – is included. In all three regression analysis, the interaction term is not significantly (p-value > 0.05) different from zero (respectively 0.727, 0.717 and 0.666), even when controlling for GDP per capita and the GINI index. With regard to the control variables, only the GINI index reports a significant relationship (p-value < 0.033) with wage inequality concerning the third regression analysis which includes both control variables – GDP per capita and the GINI index.

	(1) Wage inequality	(2) Wage inequality	(3) Wage inequality
Horizontal FDI	-0.000000503	0.000000534	0.000000361
	(0.293)	(0.341)	(0.499)
Vertical FDI	0.000000252	-0.0000000658	-0.00000131
	(0.839)	(0.679)	(0.380)
GDP per capita		-0.00000702**	-0.00000501*
		(0.009)	(0.019)
GINI index			0.0285**
			(0.001)
Constant	2.126***	2.335***	1.345***
	(0.000)	(0.000)	(0.000)
Observations	119	119	119

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 7: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 2 USING ROBUST STANDARD ERRORS

Table 7 represents the outcomes of the regression analyses concerning model 2 using robust standard errors. This model represents the relationship between different types of FDI concerning their impact on wage inequality. In line with model 1, the results of model 2 show no significant relationship between wage inequality and one of the independent variables – horizontal and vertical FDI – for all three random effects regression analyses. Both of the FDI variables are not

significantly different from zero (p-value > 0.05). However, both control variables – GDP per capita and the GINI-index – are significant (p-value < 0.05) when included in the analysis.

	(1) Wage inequality	(2) Wage inequality	(3) Wage inequality
Vertical FDI	0.000000550	0.000000467	-0.000000337
	(0.628)	(0.700)	(0.770)
Ln Trade in vertical sectors	-0.157	-0.114	-0.0990
	(0.077)	(0.292)	(0.283)
GL-index vertical sectors	1.532	2.016	1.598
	(0.581)	(0.508)	(0.559)
Interaction term vertical sectors	-0.0590	-0.0796	-0.0542
	(0.638)	(0.561)	(0.660)
GDP per capita		-0.00000287	-0.00000154
		(0.160)	(0.518)
GINI index			0.0288***
			(0.000)
Constant	5.883**	4.927	3.451
	(0.007)	(0.058)	(0.098)
Observations	119	119	119

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 8: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 3 USING ROBUST STANDARD ERRORS

Finally, table 8 represents the findings on the random effects regression analysis concerning model 3 on the comparison between vertical FDI and inter-industry trade. Vertical FDI has a p-value of 0.628, 0.700 and 0.770 and the interaction term has a p-value of 0.638, 0.561 and 0.660. All independent variables – regardless of the control variables – are thus not significantly different from zero (p-value > 0.05). The GINI-index is only significant in the third regression analysis including all variables (p-value < 0.05).

4.2 Robustness checks

This section provides a robustness check to check whether the assumptions are met and to detect potential problems. The Hausman test was already used to determine what type of panel data analysis should be used given this data. To see whether the results provided by the previous section are robust, several methodological changes will be made to see whether the methodological choices determined the outcomes of this research. First, it will be checked whether the results differ if the GINI-index is used as a proxy for wage inequality. Second – given the fact that the data availability of FDI limited the sample of countries included in the analysis – model 1 will re-analysed using a trade variable including 35 OECD countries instead of the 17 selected countries due to limited data availability. Third – based on the theoretical framework – sectors were assigned to being 'vertical' or 'horizontal' FDI. The relationship between wage inequality and vertical FDI will be re-analysed when assuming that the 'mining and quarrying' sector belongs to vertical FDI instead of being horizontal as suggested by Wang et al. (2012).

GINI-index as a proxy for wage inequality

Since the GINI-index is seen as a proper proxy for wage inequality, it makes sense to test whether what the results would have been if GINI-index would be the dependent variable (De Maio, 2007). Before analysing the relationship between the GINI-index – as a proxy for wage inequality, the Hausman test is performed to determine whether a fixed effects or a random effects model is preferred. The results of the Hausman tests – for each model – are included in Appendix H.1, H.2 and H.3. All the Hausman test report an insignificant p-value (>0.05), which means that the random-effects model is preferred. The outcomes of these random-effects models are shown in table 9, 10 and 11.

Table 9 shows the outcomes of two different random-effect regression analyses concerning model 1. In table 6 three different regression analyses were shown, but since the third regression analysis included GINI-index as a control variable, this analysis is dropped. Using GINI-index as a proxy for wage inequality, none of the independent variables is significant even the control variable – GDP per capita – is not significantly different from zero (p-value > 0.05).

	(1) GINI-index	(2) GINI-index
Ln Total trade	-1.052	-0.493
	(0.505)	(0.798)
Grubel-Lloyd index	6.101	11.65
total trade	(0.955)	(0.912)
Interaction term	-0.852	-1.081
total trade	(0.852)	(0.806)
GDP per capita		-0.0000332
		(0.548)
Constant	65.36	52.09
	(0.082)	(0.256)
Observations	119	119

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 9: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 1 USING ROBUST STANDARD ERRORS AND THE GINI-INDEX AS DEPENDENT VARIABLE

Concerning model 2, table 10 represents the outcomes of the random effects regression analyses using GINI-index as dependent variable. To recall, this model represents the relationship between different types of FDI concerning their impact on wage inequality – which is now measured using the GINI-index. Table 10 shows no significant relationships (p-value > 0.05) between the GINI-index and the independent and control variables.

	(1) GINI-index	(2) GINI-index
Horizontal FDI	-0.00000584	0.00000389
	(0.300)	(0.601)
Vertical FDI	0.0000304	-0.0000221
	(0.078)	(0.183)
GDP per capita		-0.0000669
		(0.055)
Constant	32.67***	34.66***
	(0.000)	(0.000)
Observations	119	119

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 10: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 2 USING ROBUST STANDARD ERRORS AND THE GINI-INDEX AS DEPENDENT VARIABLE

Table 11 concerns model 3 that encompasses the random effects regression analysis concerning model 3 on the comparison between vertical FDI and inter-industry trade. When using GINI-index as a proxy for wage inequality, this model shows that vertical FDI is significantly related (p-value < 0.05) to the GINI-index. In both regression analyses, vertical FDI significantly differs from zero. Trade-related variables – such as the Grubel-Lloyd index, Trade and the interaction term – remain not significantly different from zero (p-value > 0.05).

	(1) GINI-index	(2) GINI-index
Vertical FDI	0.0000290*	0.0000280*
	(0.024)	(0.017)
Ln Trade in vertical sectors	-1.344	-0.780
	(0.285)	(0.665)
GL-index vertical sectors	14.67	18.45
	(0.691)	(0.63)
Interaction term vertical sectors	-0.900	-1.054
	(0.588)	(0.549)
GDP per capita		-0.0000325
		(0.505)
Constant	70.26*	57.52
	(0.016)	(0.164)
Observations	119	119

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 11: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 3 USING ROBUST STANDARD ERRORS AND THE GINI-INDEX AS DEPENDENT VARIABLE

Model 1 with all OECD countries

Since the data on FDI is limited available, this has the consequence that some OECD countries had to be dropped from the analysis since there was no or not enough data available on FDI. However, because the trade data is available for these countries, it is possible to increase the sample of countries for model 1 to test whether trade and wage inequality are related or not. Since the previous robustness check indicates that changing the dependent variable – using GINI-index in this case – could lead to different outcomes, model 1 with the extended sample of countries is analysed using the GINI-index as dependent variable as well as the initial variable Wage inequality.

Before analysing this relationship, a Hausman test is done to determine which model is used. The outcomes of the Hausman test are included in Appendix I.1 and I.2. Since the Hausman test of the model using wage inequality (included in Appendix I.1) reports a p-value that is bigger than 0.05, the random effects model is preferred. However – when using GINI-index as dependent variable – the Hausman test (included in Appendix I.2) reports a p-value that is smaller than 0.05, the fixed effects model is preferred.

Table 12 shows the outcomes of the random effects model concerning model 1 with 27 different countries included. This differs from the number of countries included in the analysis with GINI-index as shown in table 13 because data on wage inequality was not (enough)available for Colombia, Chile, Canada, Denmark, France, Italy and Lithuania. As shown in table 12, all independent variables are not significantly different from zero.

	(1) Wage inequality	(2) Wage inequality
Ln Total trade	0.102	-0.00645
	(0.635)	(0.82)
Grubel-Lloyd index	3.069	1.172
total trade	(0.567)	(0.849)
Interaction term	-0.189	-0.0964
total trade	(0.476)	(0.748)
GDP per capita		-0.00000188
		(0.509)
Constant	0.466	2.651
	(0.915)	(0.645)
Observations	189	189

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 12: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 1 USING ROBUST STANDARD ERRORS FOR 27 COUNTRIES

Table 13 shows the outcomes of the fixed-effects model including 34 OECD countries – observations of Japan, Switzerland, New Zealand and Korea were dropped because GINI-index data was not available. Missing data is replaced by the mean GINI index for that country, despite a trend was observed – in that case the missing values were replaced by the GINI-index of the previous year multiplied by the average trend. The trade variable is calculated by the sum of all imports for all sectors and the Grubel-Lloyd index represents the average Grubel-Lloyd index of

that country. Table 13 shows that all independent variables – including GDP per capita – are not significantly different from zero.

	(1) GINI index	(2) GINI index
Ln Total trade	0.543	2.354
	(0.812)	(0.389)
Grubel-Lloyd index	65.74	94.95
total trade	(0.372)	(0.218)
Interaction term	-3.288	-4.693
total trade	(0.352)	(0.205)
GDP per capita		-0.0000368
		(0.070)
Constant	25.24	-11.40
	(0.597)	(0.840)
Observations	238	238

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

TABLE 13: OUTCOMES FIXED EFFECTS ANALYSIS MODEL 1 USING ROBUST STANDARD ERRORS FOR 34 COUNTRIES

Model 2 and 3 with 'Mining and Quarrying' as vertical sector

To recall, mining and quarrying was defined as being 'horizontal' FDI, because of the fact – based on the Knowledge-Capital model – horizontal firms are there to seek (access) to new (relatively similar markets and thus aim for increasing returns to scale to reduce costs. Based on these arguments, it was expected that mining and quarrying to be horizontal FDI, since market seeking will be the driving motive instead of conducting FDI based on comparative advantages which characterizes vertical FDI. However, Wang et al. (2012) claims that the major target of foreign direct investment is getting control over the mineral resources, which suggests that this sector belongs to vertical FDI. To make sure that the results are not affected by the fact that the mining and quarrying sector could be horizontal or vertical, the analysis is re-run including mining and quarrying in the vertical sector.

Before estimating these relationships, it is necessary to do a Hausman test again to determine which model should be used. The results of the Hausman test are shown in Appendix J.1 and J.2. Since both p-value are bigger than 0.05, this indicates that the random-effects model should be used. Table 14 concerns model 2 that illustrates the relationship between wage inequality and

horizontal and vertical FDI. As shown in table 14, horizontal and vertical FDI are not significantly different from zero (p-value > 0.05). Solely the control variables are significant in those regression analysis in which these were included.

	(1) Wage inequality	(2) Wage inequality	(3) Wage inequality
Horizontal FDI	9.36e-08	0.000000540	0.000000612
	(0.846)	(0.310)	(0.178)
Vertical FDI incl. M&Q	-0.00000113	-0.000000170	-0.000000853
	(0.178)	(0.842)	(0.248)
GDP per capita		-0.00000694*	-0.00000470*
		(0.010)	(0.028)
GINI index			0.0286**
			(0.001)
Constant	2.126***	2.333***	1.332***
	(0.000)	(0.000)	(0.000)
Observations	119	119	119

p-values in parentheses: * p<0.05, ** p<0.01, *** p<0.001

TABLE 14: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 2 USING ROBUST STANDARD ERRORS INCLUDING MINING AND QUARRYING AS VERTICAL FDI

Table 15 concerns the comparison between vertical FDI and inter-industry trade analyzed in model 3. Again, all independent variables – regardless of GINI-index as a control variable – are not significantly different from zero (p-value > 0.05) for each regression analysis separately.

	(1) Wage inequality	(2) Wage inequality	(3) Wage inequality
Vertical FDI incl. M&Q	-0.000000776	-0.000000259	-0.000000700
	(0.181)	(0.708)	(0.306)
Ln Trade in vertical sectors	-0.149	-0.112	-0.101
	(0.100)	(0.297)	(0.269)
GL-index vertical sectors	1.661	2.032	1.611
	(0.543)	(0.493)	(0.545)
Interaction term vertical sectors	-0.0648	-0.0804	-0.0549
	(0.598)	(0.546)	(0.647)
GDP per capita		-0.00000276	-0.00000104
		(0.229)	(0.682)
GINI index			0.0291***
			(0.000)
Constant	5.693*	4.884	3.474
	(0.011)	(0.060)	(0.093)
Observations	119	119	119

p-values in parentheses: * p<0.05, ** p<0.01, *** p<0.001

TABLE 15: OUTCOMES RANDOM EFFECTS ANALYSIS MODEL 3 USING ROBUST STANDARD ERRORS INCLUDING MINING AND QUARRYING AS VERTICAL FDI

5 Discussion

This chapter relates the results to the theory discussed in chapter 2 – given the limitations of this research. In the end, some future recommendations will be done based on this research, because there are a lot of opportunities to continue researching this specific topic.

5.1 Results

In the previous chapter, three different models were used to do a statistical analysis concerning the hypothesis that were derived from the theory in chapter 2. Model 1 concerns hypothesis 1a and 1b. Hypothesis 1a stated that inter-industry is expected to increase income inequality in host countries. Table 6 shows the outcomes of three different random effects regression analysis concerning model 1. Only the control variable GINI-index is significantly different from zero. All other the independent variables – especially the interaction term between the Grubel-Lloyd index and the total trade – are not significantly different from zero, this means that there is no significant support for hypothesis 1a. Based on this random effect model, it cannot be concluded that inter-industry is expected to increase income inequality. Even when using a bigger sample of countries – shown as robustness check in table 12 and 13 – all independent variables that are trade-related are not significantly different from zero. When the relationship between intra- and inter-industry trade and the GINI-index was tested, it turned out that the effects of trade remain insignificant as shown in table 9. Concerning hypothesis 1b – which claims that intra-industry trade is not related to income inequality in host countries –, the results and the outcomes of the robustness check show an insignificant relationship, which means that this supports hypothesis 1b that there is no significant effect of intra-industry trade based on this sample.

Hypothesis 2a claims that horizontal foreign direct investment is not expected to have an effect on income inequality in host countries and hypothesis 2b suggests that vertical foreign direct investment is expected to increase income inequality in host countries. Looking at the outcomes of the random effects model in table 7, all three regression analyses do not report a significant relationship between (the different) types of FDI and income inequality. Concerning hypothesis

2a, it can be concluded that there is no significant effect of horizontal foreign direct investment. Thereby – based on the operationalization of wage inequality in the context of this research – there is no support for hypothesis 2b claiming that vertical foreign direct investment is expected to increase income inequality in host countries.

As a robustness check, the relationship of vertical and horizontal FDI and the GINI index – as a measure of income inequality – was tested. Table 10 shows the results and suggests that even using the GINI index as a measure of income inequality does not lead to a significant relationship between horizontal and vertical FDI and income inequality. On top of that, table 14 shows the robustness check when 'mining and quarrying' was assumed to be vertical FDI. However, it turned out that this does not affect the outcomes and that the effect of horizontal and vertical FDI remains insignificant concerning model 2 and hypothesis 2a and 2b.

Lastly, hypothesis 3 suggests that vertical foreign direct investment is expected to affect income inequality in the host country more than inter-industry trade. Table 8 shows that all independent variables are not significantly related to wage inequality. However, the outcomes of the robustness check concerning model 3 that uses GINI-index as a proxy of income inequality – shown in table 11 – suggest that vertical FDI is significant related to the GINI-index when controlling for the effect of 'vertical' trade and GDP per capita. Both regression analysis report a positive significant relationship, which suggests that an increase in vertical FDI increases the GINI-index of that particular country. Table 11 suggests that trade does not significantly affect wage inequality, which suggests that the effect is zero.

Based on table 8, it cannot be concluded that vertical FDI has a bigger significant impact on host-country income inequality compared to 'vertical' trade. Table 11 shows that the outcomes of the robustness check suggest that there is a significant relationship between vertical FDI and the GINI-index. Based on this research, it cannot be claimed that vertical FDI has a bigger significant impact on host-country income inequality compared to 'vertical' trade, but the robustness check – table 11 – strengthens the need for future research further investigating this relationship.

5.2 Limitations and future research

One of the main limitations of this research is the limited availability of data. Especially for the FDI variable is it hard to gather data. A consequence of (a lot of) missing data on this FDI variable was that several countries had to be removed from the analysis, because there was too much data missing to use the average based on the available data or the data was not even there. A lot of valuable information was lost due to this lack of availability of data. In addition to this, the variable capturing income inequality has some limitations. For 3 out of 17 countries, there was only data available for 2014 and 2018, which means that this data needed to be extrapolated in order to include these countries into the analysis. On top of that, the data on income inequality from this database was based on multiple other resources. It is not possible to eliminate the problem of ambiguous operationalization, since this data was based on multiple sources. On top of that, a sample of 17 countries is relatively small. A small database often implies less external validity.

One of the aims of this research was to investigate whether there is a relationship between trade and FDI and host-country income inequality. This research was limited by the fact that it was not possible to get data on country level, since this was not available. The database did not allow to see the FDI from country X into country Y, and even if it was available, it was not available for the correct sectors used in this analysis.

Furthermore, since the income inequality variable was not available per sector (as defined by FDI and trade), the analysis was done on the country level taking out valuable variation information provided by different sectors separated under trade data.

The operationalization of horizontal- and vertical FDI could be a limitation, although it turned out that defining ‘mining and quarrying’ as ‘vertical’ did not affect the results. Since this research uses a certain definition of horizontal- and vertical FDI – and their corresponding sectors based on literature – this has resulted in these outcomes. There is no hard evidence for some sectors being horizontal or vertical, which makes it tricky to estimate the relationship of horizontal- and vertical

FDI with income inequality. Although this distinction was based on the literature, it is hard to define some criteria to assign a sector to being 'horizontal' or 'vertical'.

Overall, the findings of this paper provide multiple aspects for future research. There are still many unanswered questions about the relationship between income inequality, trade and foreign direct investment. In future investigations, it might be possible to use a different measure for income inequality, trade or foreign investment. The way of measuring these variables could be done differently, because the measurement in the context of this research was done based on a definition of these concept substantiated by the literature. The outcomes of the robustness check strengthen these recommendations, since it seems that vertical FDI has a significant relationship with the GINI-index. This research is not able to claim that there is a significant relationship, but provides multiple aspects for future research since the robustness check suggests that there might be a significant relationship between vertical FDI and GINI-index in a model where 'vertical' trade is not significantly related to the GINI-index. Thereby, given the limited sample of this research, future research should use a bigger sample, which allows for a better analysis of the relationships. Although there is limited data available on foreign direct investment, future research should continue on this topic because of its relevance and the fact that the effect of trade and foreign direct investment is recognized within the literature.

6 Conclusion

Income inequality has been a central issue within economics. Many countries have faced negative consequences of the rising income inequality in their country. This paper is aimed at gathering a deeper understanding of the relationship between income inequality, trade and foreign direct investment in a sample of selected OECD countries.

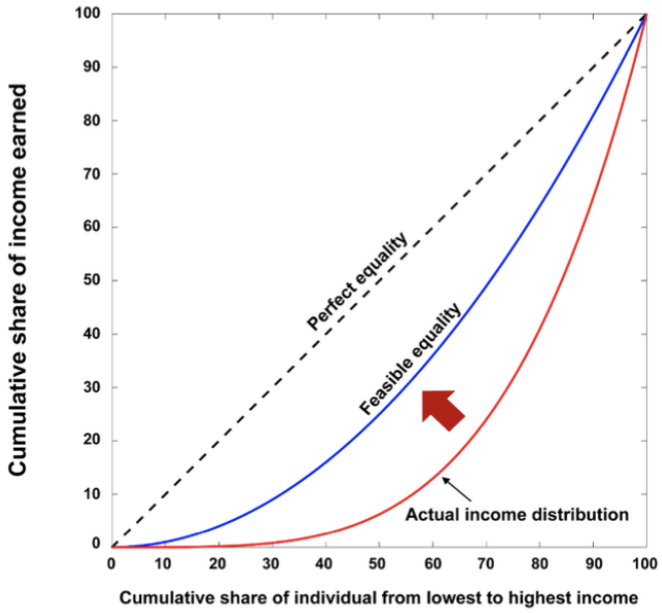
The income inequality of a country is determined by multiple factors including trade and foreign direct investment. Literature has acknowledged two different types of trade – inter-industry and intra-industry trade –, and two types of foreign direct investment – horizontal and vertical – which both have other implications for host-country income inequality. Income inequality is measured by dividing the weighted average monthly wage of high-skilled workers by the weighted average monthly wage of low-skilled workers, trade as the value of imports for that particular sector – defined by the SITC – and foreign direct investment as the FDI flow in a specific sector for that year. To investigate these hypothesized relationships, fixed and random effects models are used. Looking closely to the interpretation of the estimations, the results present that trade as well as foreign direct investment are not statistical significantly different from zero. So, there was no statistically significant relationship found between income inequality, trade and foreign direct investment based on the database and operationalizations of the variables used. This means that this paper is not able to give a proper statistically substantiated answer to the central question of this research. A robustness check using GINI-index as dependent variable suggests that vertical FDI related, but – based on the operationalization of wage inequality – it is not possible to claim that this research finds a significant relationship.

There could be several explanations for these results. This paper uses a relatively small panel sample, because of the limited availability of data of the independent variables. Furthermore, the analysis of the effect on wage inequality must be done on the country-level, since the wage inequality data was not eligible to differentiate to the same sectors as trade was able to. Finally, the results could be insignificant because of incorrect operationalization of the used variables and their or – such as horizontal and vertical FDI –.

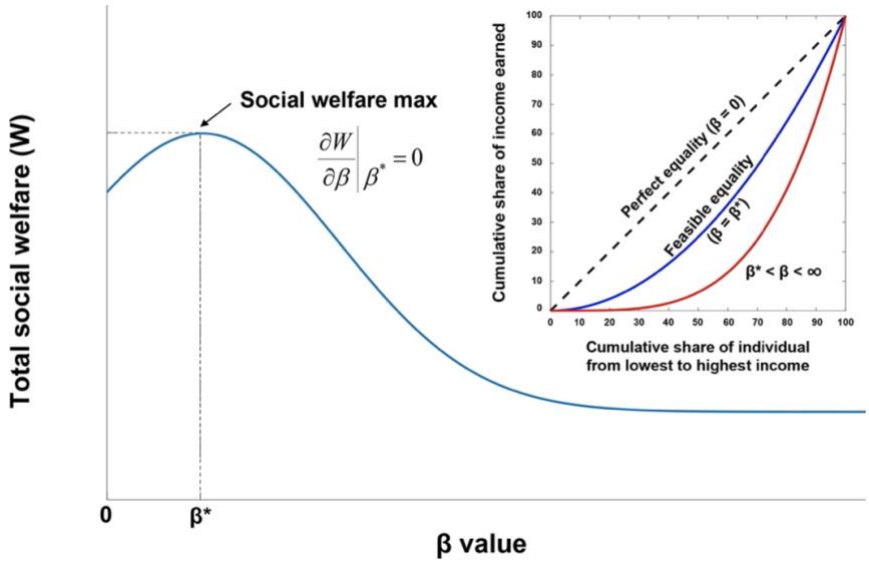
These limitations provide opportunities for future research. Future research should focus on using a bigger sample to investigate this relationship and could use other proxies for the main independent variable since the operationalization of the variables seem to play an important role in determining the outcomes of such research. The fact that the robustness check suggests that there is a significant relationship between the GINI-index and vertical FDI – when controlling for the effect of 'vertical' trade – strengthens the need for future research since these relationships could not remain unexplored.

7 Appendix

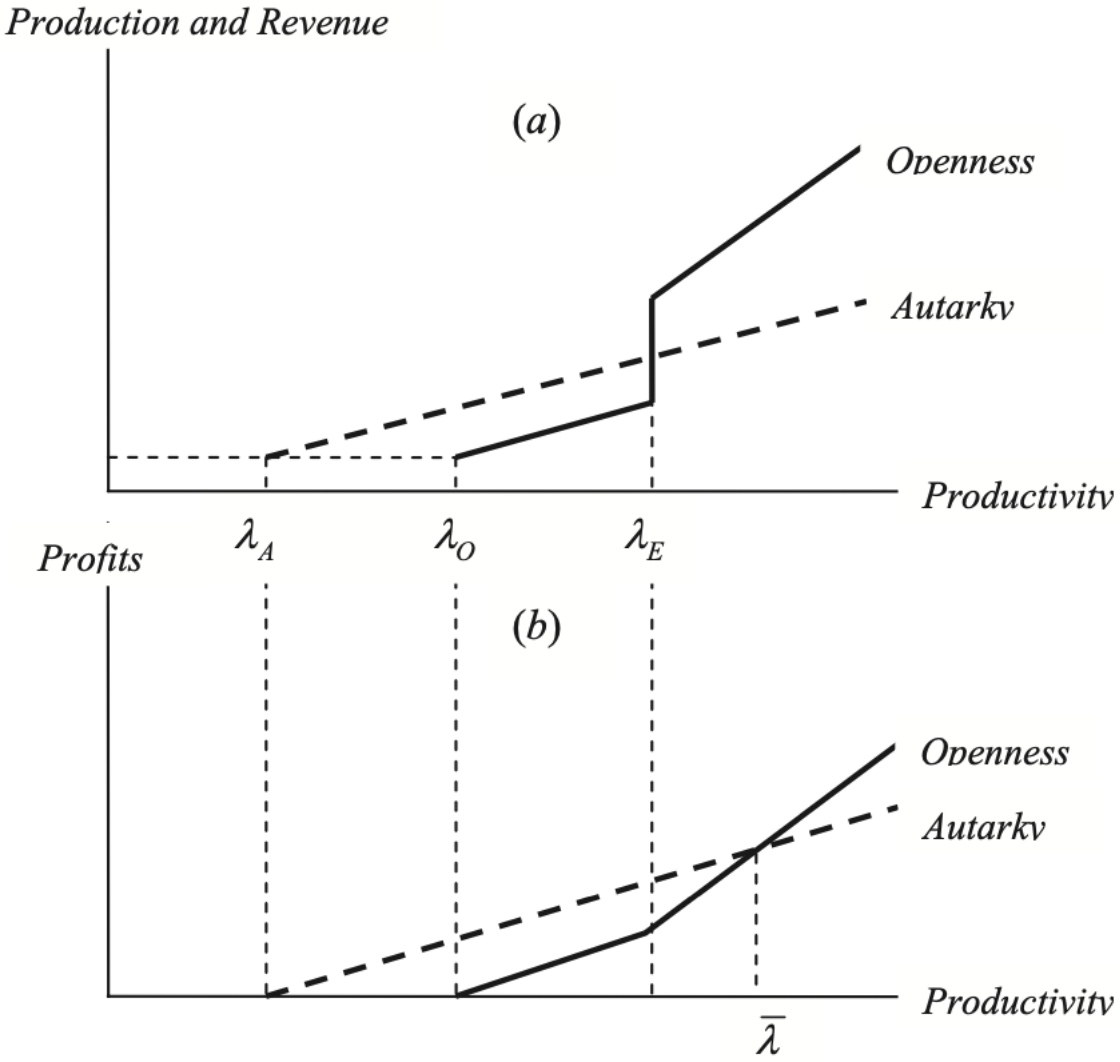
Appendix A.1 The Lorenz curve (Source: Park & Kim, 2021)



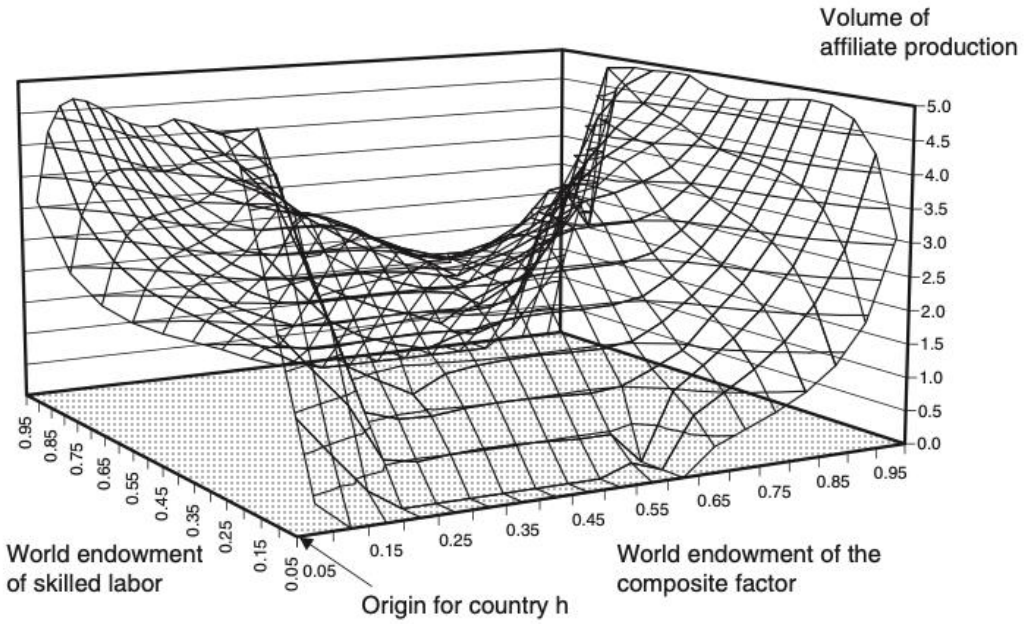
Appendix A.2 Total social welfare as a function of β value (Source: Park & Kim, 2021)



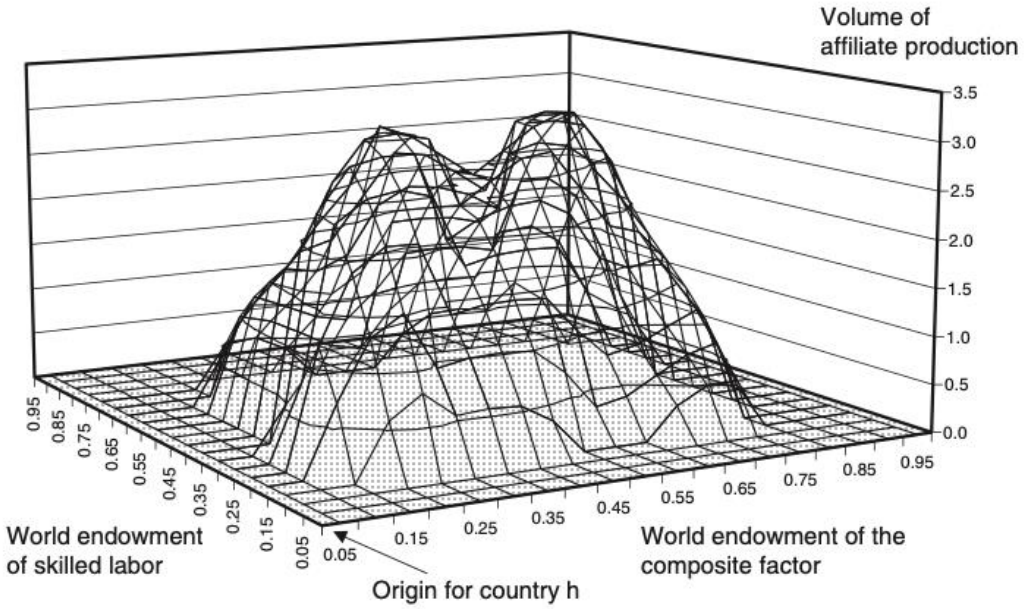
Appendix B The Melitz model (Source: Chusseau & Heller, 2012)



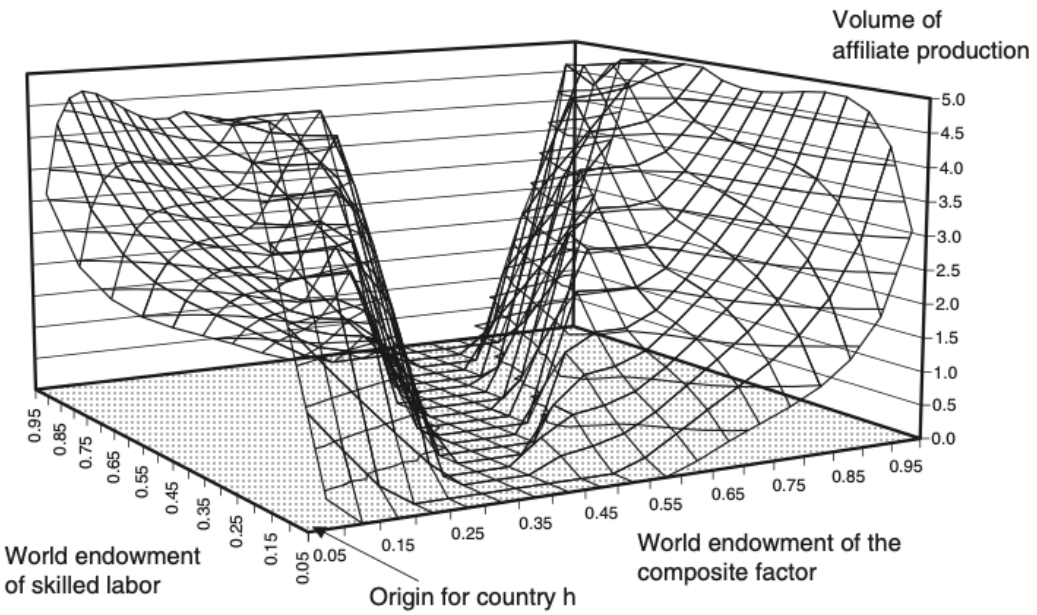
Appendix C.1 The Knowledge-Capital model: KK Model (Source: Markusen & Maskus, 2002)



Appendix C.2 The Knowledge-Capital model: HOR Model (Source: Markusen & Maskus, 2002)



Appendix C.3 The Knowledge-Capital model: VER Model (Source: Markusen & Maskus, 2002)



Appendix D List of OECD countries

#	Country	ID
1	Austria	AUT
2	Australia	AUS
3	Belgium	BEL
4	Canada	CAN
5	Chile	CHL
6	Colombia	COL
7	Costa Rica	CRI
8	Czech Republic	CZE
9	Denmark	DNK
10	Estonia	EST
11	Finland	FIN
12	France	FRA
13	Germany	DEU
14	Greece	GRC
15	Hungary	HUN
16	Iceland	ISL
17	Ireland	IRL
18	Israel	ISR
19	Italy	ITA

#	Country	ID
20	Japan	JPN
21	Korea	KOR
22	Latvia	LVA
23	Lithuania	LTU
24	Luxembourg	LUX
25	Mexico	MEX
26	the Netherlands	NLD
27	New Zealand	NZL
28	Norway	NOR
29	Poland	POL
30	Portugal	PRT
31	Slovak Republic	SVK
32	Slovenia	SVN
33	Spain	ESP
34	Sweden	SWE
35	Switzerland	CHE
36	Turkey	TUR
37	United Kingdom	GBR
38	United States	USA

Appendix E Standard International Trade Classification (SITC)

(Source: SCB Statistics Sweden,n.d.)

SITC Product Code	Description
0	Food and Live Animals
1	Meat and Meat Preparations
2	Dairy Products and Birds' Eggs
3	Fish Crustaceans, Molluscs; Prep. Thereof
4	Cereals and Cereal Preparations
5	Vegetables and Fruit
6	Sugars, Sugar Preparations and Honey
7	Coffee, Tea, Cocoa, Spices; Manuf. Thereof
8	Feeding Stuff for Animals
9	Miscellaneous Edible Products and Prep.
11	Beverages
12	Tobacco and Tobacco Manufactures
21	Hides, Skins and Furskins, Raw
22	Oil Seeds and Oleaginous Fruit
23	Crude Rubber
24	Cork and Wood
25	Pulp and Waste Paper
26	Textile Fibres and Their Wastes
27	Crude Fertilizers and Crude Minerals
28	Metalliferous Ores and Metal Scrap
29	Crude Animal and Vegetable Materials, N.E.S.
32	Coal, Coke and Briquettes
33	Petroleum, Petrol Production and Related Materials
34	Gas, Natural and Manufactured
35	Electric Current

41	Animal Oils and Fats
42	Fixed Vegetable Fats and Oils
43	Process. Animal and Vegetable Fats and Oils; Waxes
51	Organic Chemicals
52	Inorganic Chemicals
53	Dyeing and Tanning Extra;Synth. Tann. Mrtls
54	Medicinal and Pharmaceutical Products
55	Essential Oils, Perfume; Clean Preparat.
56	Fertilizers
57	Plastics in Primary Forms
58	Plastics in Non-Primary Forms
59	Chemical Materials and Products
61	Leather, Leather Manuf; Dressed Furskins
62	Rubber Manufactures, N.E.S.
63	Cork and Wood Manufacture; Excl. Furniture
64	Paper and Paperboard; Articles Thereof
65	Textile Yarn, Fabrics; Made-Up Articles
66	Non-Metallic Mineral Manufactures, Nes
67	Iron and Steel
68	Non-Ferrous Metals
69	Manufactures of Metal, N.E.S.
71	Power Generating Machinery and Equipment
72	Machinery for Particular Industries
73	Metalworking Machinery
74	General Industrial Machinery and Equipment, N.E.S.
75	Office Machinery, Automatic Data-Processing Equipment
76	Telecom; Sound Recording and Reprod. App.
77	Electric Machines, Apparatus and Appliances

78	Road Vehicles
79	Other Transport Equipment
81	Prefabricated Build; Sanitary, Heating and Lighting fixtures
82	Furniture and Parts Thereof
83	Travel Goods, Handbags and Sim. Containers
84	Articles of Apparel; Clothing Accessories
85	Footwear
87	Professional, Scientific, Control. Instrum.
88	Photographic Apparatus; Optical Goods; Watches
89	Miscellaneous Manufactured Articles, N.E.S.
91	Postal Packages Not Class. Accord. To Kind
93	Commodities Not Class. Accord. To Kind
96	Coin (Excl. Gold Coin) Not Legal Tender
97	Gold, Non-Monetary

Appendix F Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Wage inequality	1.000										
(2) FDI H	-0.115	1.000									
(3) FDI V	0.036	0.342	1.000								
(4) Trade	-0.121	-0.023	0.041	1.000							
(5) GL-index Trade	-0.485	-0.379	-0.129	0.037	1.000						
(6) Trade H	-0.108	-0.005	0.035	**0.987**	-0.017	1.000					
(7) GL-index H	-0.589	-0.299	-0.144	0.262	0.913	0.213	1.000				
(8) Trade V	-0.087	-0.055	0.043	**0.992**	0.024	**0.984**	0.240	1.000			
(9) GL-index V	-0.063	-0.411	-0.144	0.121	0.704	0.061	0.625	0.133	1.000		
(10) GDP per capita	-0.395	0.237	-0.085	0.421	-0.033	0.423	0.251	0.359	-0.195	1.000	
(11) GINI index	0.512	0.141	0.168	0.019	-0.454	0.003	-0.566	0.029	-0.288	-0.303	1.000

Appendix G Hausman test of the main analysis

Hausman (1978) specification test

	Coef.
Chi-square test value	81.12
P-value	.000

TABLE 1: HAUSMAN TEST FOR MODEL 1

Hausman (1978) specification test

	Coef.
Chi-square test value	.440
P-value	.931

TABLE 2: HAUSMAN TEST FOR MODEL 2

Hausman (1978) specification test

	Coef.
Chi-square test value	.860
P-value	.930

TABLE 3: HAUSMAN TEST FOR MODEL 3

Appendix H Hausman test concerning the Robustness check using GINI as dependent variable

Hausman (1978) specification test

	Coef.
Chi-square test value	-44.801
P-value	1

TABLE 1: HAUSMAN TEST FOR MODEL 1 CONCERNING THE ROBUSTNESS CHECK

Hausman (1978) specification test

	Coef.
Chi-square test value	.985
P-value	.805

TABLE 2: HAUSMAN TEST FOR MODEL 2 CONCERNING THE ROBUSTNESS CHECK

Hausman (1978) specification test

	Coef.
Chi-square test value	5.153
P-value	.162

TABLE 3: HAUSMAN TEST FOR MODEL 3 CONCERNING THE ROBUSTNESS CHECK

Appendix I Hausman test concerning the Robustness check on model 1 concerning trade

Hausman (1978) specification test

	Coef.
Chi-square test value	1.10
P-value	0.776

TABLE 1: HAUSMAN TEST FOR MODEL 1 CONCERNING THE ROBUSTNESS CHECK CONCERNING WAGE INEQUALITY AND 27 COUNTRIES

Hausman (1978) specification test

	Coef.
Chi-square test value	30.32
P-value	0.000

TABLE 1: HAUSMAN TEST FOR MODEL 1 CONCERNING THE ROBUSTNESS CHECK CONCERNING GINI-INDEX AND 34 COUNTRIES

Appendix J Hausman-test concerning the Robustness check of model 2 and 3 on FDI

Hausman (1978) specification test

	Coef.
Chi-square test value	0.52
P-value	0.9152

TABLE 1: HAUSMAN TEST FOR MODEL 1 CONCERNING THE ROBUSTNESS CHECK ON FDI

Hausman (1978) specification test

	Coef.
Chi-square test value	.97
P-value	.914

TABLE 2: HAUSMAN TEST FOR MODEL 2 CONCERNING THE ROBUSTNESS CHECK ON FDI

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