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International Trade and Income Inequality at the Industry Level

M.Sc. candidate Daan Caminada
Student ID: 483432dc

Supervisor: Dr. J.M. Viaene
Co-Assessor: Dr. J. Delfgaauw

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Abstract

This research uses a fixed effects (group and time) model to estimate the effects and channels of international trade on income inequality at the industry level in a sample of 12 countries, 21 industries over the 1990-2005 time period. Income inequality is measured by the Gini index, Atkinson index, Theil index and Mean Log Deviation, which are constructed based on the Luxembourg Income Study dataset by Wang et al. (2014). Furthermore, the trade variable is given by the sum of imports and exports over the gross output of the related industry. This research cannot find results when estimating the effects and channels of international trade on income inequality for all industries and all countries. However, this research finds an effect of international trade on income inequality in three industries, which are the manufacturing paper, minerals and metals industries. International trade decreases the income inequality in the manufacturing paper industry, through exports, which could be explained by the new trade models. However, international trade increases income inequality in the minerals and metals industries, through imports, as argued by Donald Trump. This research interprets these results by showing that there are different effects of international trade on income inequality per industry, in direction, magnitude and channel. Therefore, this research signifies the importance for analyzing the effect of international trade on income inequality at the industry level, to help understand the effect of international trade on income inequality in general.

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1. Introduction

International trade is an important factor in economies, as it results in higher welfare, employment and consumer good variety. Furthermore, this international trade tends to increase over the years (World Trade Organization, 2018). This combination leads to debates about the effects of international trade on a society. These debates are widespread, leading to strong statements about for example; the European Union, Brexit, Donald Trump and the role of "cheap labor" countries in the world economy. One of the interests in these debates is the effect international trade has on employment and wages in economies and industries, implying an effect on the income inequality. This effect of international trade on income inequality is broadly discussed in literature (e.g., Spilimbergo et al, 1999; Mahler, 2004; Milanovic, 2005; Gourdon et al, 2008; Celik and Basdas, 2010; Casette et al., 2012; Faustino and Vali, 2013; Thewissen et al., 2017) and is the main topic of this research.

Traditional trade models claim that international trade alter the relative demand for skilled and unskilled labor. This change adjusts the relative factor rewards (wages) for skilled and unskilled labor and thus influences the income inequality (Heckscher and Ohlin, 1933; Stolper and Samuelson, 1941; Wood, 1994; Davis, 1996; Feensta and Hanson, 1996). Then there remains the question whether this effect flows through the export or import channel of international trade. On the one hand, new trade models (Melitz, 2003; Verhoogen, 2008) discuss that exporting firms require skilled labor. The wages for skilled labor are higher than for unskilled labor, implying an increase in income inequality when export increases. On the other hand, Donald Trump states that "cheap labor" imports lead to a decrease in unskilled labor wages and an increase in their unemployment in the United States. Implying an increase in income inequality through the import channel of international trade.

Literature mainly examines the effect of international trade on income inequality at the country level. However, the difference between skilled and unskilled labor intensities (OECD, 2011; World Bank, 2016; Anderson et al, 2018), the share of exporting firms (World Trade Organization, 2000; Bernard et al, 2007; ISGEP, 2008), trade intensities and income inequality significantly differs per industry[1]. Implying that in understanding the effect of international trade on income inequality one should start at the industry level. However only two papers[2] investigate the effect at the industry level (Mahler, 2004; Thewissen et al., 2017). Implying a gap in literature in understanding the effect of international trade on income inequality at the industry level. Furthermore, Mahler (2004) and Thewissen et al. (2017) both focusses on

[1] Chapter 3.2 and Appendix II presents the trends of both trade and income inequality and show that these significantly differ per industry.
[2] To this research's' knowledge.

the Gini index as proxy for income inequality and do not specify their result per industry. Therefore, this research aims to extent their work in three aspects. First, by estimating the effect of international trade on four different measurements of income inequality, namely the Gini index, Atkinson index, Theil index and Mean Log Deviation. Second, by determining the effect of international trade on income inequality specified per industry. And third, by estimating whether the effect of international trade flows through exports (new trade models' argument) or imports (Donald Trump argument). The combination of these three aspects imply the following research question:

What are the effects and channels of international trade on income inequality between households, within and between different industries?

In the second Chapter of this research the literature is presented. Starting with a literature review, followed by the discussion of trade models, labor mobility and the Donald Trump argument. This discussion forms the three hypotheses for this research. Then, the second Chapter concludes with a brief discussion of the mechanisms, equations and (dis)advantages of the four income inequality measurements used in this research. Next, the third Chapter includes the data description and verification of the dataset used in this research. Data for the income inequality measurements stems from Wang et al. (2014), which use the Luxembourg Income Study (LIS) to construct the income inequality measurements for 12 countries, each containing 21 industries. Furthermore, Chapter 3 presents the crucial argumentation of the analysis on the industry level, rather than the country level. Next, the fourth Chapter incorporates the methodology and discusses the fixed effects model used in this research. Then, the fifth Chapter describes the results of the data analysis, where this research has not found conclusive results for the effect of international trade on income inequality at the industry level. However, when focusing on a single industry, the manufacturing paper, metals and construction industry show a significant effect of international trade on income inequality in those industries. Where the negative effect (manufacturing paper) tends to flow through exports and the positive effect (manufacturing minerals and metals) through imports. Next, the sixth Chapter covers the discussion of this research. Where limitations of this research are reviewed and further research is discussed. Lastly, the seventh and last Chapter is the conclusion and therefore summarizes this research.

2. Literature

2.1 Literature review

2.1.1 General

Spilimbergo et al. (1999) applies the Deininger and Squire (1996) database to determine the relationship between factor endowments, trade and personal income distribution, hence income inequality. Via an OLS regression, with the Gini index as dependent variable, Spilimbergo et al. (1999) conclude that trade openness has a significant, positive effect on income inequality. However, when this trade openness is interacted with the factor endowments, the effect turns negative in skill-abundant countries. Implying that the effect of trade openness on income inequality depends on factor endowments (Spilimbergo et al., 1999).

A fairly more recent research by Milanovic (2005) discusses the effect of trade openness and foreign direct investment on income inequality, which is given by the mean-normalized per capita household income deciles. Furthermore, trade openness is measured by the sum of imports and exports over GDP. Via a pooled cross-sectional OLS for each income decile, Milanovic (2005) shows that trade openness favors the rich in lower-income countries and favors the poor and middle in higher-income countries. Implying an ambiguous effect of trade on income inequality, which is driven by the income-level of a country. This same ambiguous effect, driven by income level, is brought forward by Ravallion (2001) and Barro (2000).

Next, Bertola (2008) discusses the impact of trade openness on income inequality, which is given by the Gini index of household income. Trade openness is measured as the sum of imports and exports over GDP. Via a fixed effects OLS regression Bertola (2008) indicates that trade openness is associated with higher income inequality, hence a positive effect. According to Bertola (2008) the positive effect is mainly through interactions with government expenditure, since the positive effect is less effective on income inequality when trade openness is higher.

Next, Gourdon et al. (2008) estimate the effect of trade openness on income inequality, which is presented by the Gini index. Gourdon et al. (2008) choose a different approach towards trade openness, namely the lagged ratio of tariff revenues to imports and the relative factor endowments. With a fixed effects OLS regression Gourdon et al. (2008) show that trade openness (change in tariffs) has a positive effect on income inequality. The interaction with the factor endowment variable, shows that trade openness has a positive effect in capital-abundant and high skill-abundant countries on income inequality.

In addition, Gourdon et al. (2008) argue that all research should use a fixed effects model when discussing income inequality.

Next, Çelik and Basdas (2010) discuss the effect of globalization on income inequality, by using FDI inflows, outflows and trade openness as indicators for globalization. Furthermore, the Gini index is used as measurement for income inequality. Via an OLS regression Çelik and Basdas (2010) indicate that trade openness has a positive effect on income inequality in both developed and developing countries. Furthermore, they add another type of country called miracle countries. These countries have large populations and low wage labor (e.g. China). For these miracle countries, trade openness has a negative effect on income inequality.

Next, Cassette et al. (2012) investigate the effect of trade openness in goods and services on income inequality, differentiating between the short and long run. The interdecile ratios of individual earnings (D9/D1, D9/D5 and D5/D1) are used as measurement of income inequality. In both the short- and long-run, trade in goods and services has a positive effect on income inequality. However, the effect of the trade in services on income inequality disappears in the short run.

Last, Faustino and Vali (2013) analyze the correlation between income inequality and economic globalization, given by trade openness and foreign direct investment. Income inequality is presented as the Gini index and trade openness as the sum of imports and exports over GDP. In their research they use both an OLS fixed effects regression and generalized methods of moments estimator (GMM). Both the OLS and GMM shows that trade openness has a negative effect on income inequality, hence reduces income inequality for the 24 used OECD countries.

2.1.2 Industry

The first part of the literature review shows that research is mainly focused on the effect of trade on income inequality at the country level. However, there is some research that focusses on the effects on income inequality at the industry level.

First, Mahler (2004) analyses the effect of international trade and several domestic factors on income inequality and the willingness to redistribute income at the industry level. More specific, the effect of trade, investments, financial flows, politics and labor market institutions on income inequality at the industry level. Data for income inequality is generated from the LIS dataset. Implying that Mahler (2004) transformed information of households and individuals income to information about income inequality. Mahler (2004) uses the Gini index as dependent variable and applies a cross sectional time series analysis to determine the effect of international trade and several domestic factors on income inequality. Mahler

(2004) cannot find a significant relationship between international trade and income inequality at the industry level. Nevertheless, Mahler (2004) finds support for the relationship between financial openness and income inequality at the industry level.

Second, Thewissen et al. (2017) examines contributions to income inequality at the industry level. More specific, the effect of increasing international trade, skill-biased technological change and weaker labor market institutions on income inequality at the industry level. Once again, data is constructed from the Luxembourg Income Study. For this analysis Thewissen et al. (2017) applied a pooled time series cross-section regression analysis, hence a fixed effects regression with panel data. Once again, Thewissen et al. (2017) cannot conclude the effect of international trade on income inequality at the industry level. However, a positive effect for trade with less developed countries is found. Implying that international trade with less developed countries increases income inequality at the industry level.

Table 2.1 Overview of the Literature Review

Positive	Negative	Ambiguous
Spilimbergo et al. (1999)	Faustino and Vali (2013)	Milanovic (2005)
Bertola (2008)		Mahler (2004)
Gourdon et al. (2008)		Thewissen et al. (2017)
Çelik and Basdas (2010)		
Casette et al. (2012)		

Source: Own construction, based on the literature review.
Notes: (i) This Table shows an overview of the effect international trade has on income inequality, found in previous research; (ii) A positive (negative) effect implies that an increase in international trade leads to an increase (decrease) in income inequality (iii) An ambiguous effect shows that the effect cannot be conclusively determined.

2.2 Theoretical Framework

2.2.1 Traditional Trade Models – Trade Channel

Following traditional trade models, theories and deviations (e.g. Heckscher and Ohlin, 1933; Stolper and Samuelson, 1941; Woods, 1994; Davis, 1996; Feensta and Hanson, 1996) international trade increases the relative wages of skilled labor in skilled labor abundant economies and thus increases the gap between wages, which leads to an increase in income inequality[3]. On the other hand, international trade for unskilled labor abundant economies, increases the relative wages of unskilled labor, which narrows the gap between wages and thus lower income inequality. This effect is described by the Heckscher-Ohlin-Samuelson model and starts with difference in production factor endowments between economies. This difference creates a comparative advantage for the economies, leading to an incentive for trade. In these

[3] Assuming that the wage for high skilled labor is higher than for unskilled labor.

models, the relative price of the skilled intensive goods is relatively low in the skilled abundant economy and relatively high in the unskilled labor abundant economy. This implies that the price of the unskilled labor intensive good is relatively high in the skilled abundant economy and relatively low in the unskilled abundant economy. Showing that both economies can benefit from trade. Because of the difference in relative prices of the goods between the economies, an economy will export the goods that intensively uses their abundant factor of production and import the goods that are produced with their scarce factor. Implying that skilled labor abundant economies export skilled labor-intensive goods and import the unskilled labor-intensive goods. The export of the skilled labor-intensive good increases the demand for skilled labor in the skilled labor abundant country and therefore increases the factor reward, hence skilled labor wage, in the skilled labor abundant economy. Implying an increase in the gap between the wages of skilled and unskilled workers, and thus an increase in the income inequality. In the unskilled labor abundant country, the relative demand for unskilled labor increases, which increases the relative factor reward for unskilled labor, hence unskilled labor wage. Implying that the gap between skilled and unskilled labor wages decreases and thus a decrease in income inequality.

There is broad discussion (e.g. Markusen and Svensson, 1983; Wong, 1986; Collins et al., 1997) whether international trade and the flow of production factors are substitutes or complements. If international trade and the flow of production factors are substitutes, trade barriers are expected to increase the flow of production factors and restrictions of factor movements are expected to increase international trade (Mundell, 1957). On the other hand, when international trade and the flow of production factors are complements, an increase in international trade induces an increase in factor movement and vice versa (Markusen, 1983). Following the work of Markusen (1983), Wong (1986) and Collins et al. (1997) this research assumes the complementarity between international trade and the flow of production factors. Implying that the effect of international trade on income inequality is partially because of trade in factors of production, hence labor in this research. Indicating that change in wages and thus income inequality can partially be explained by the movement of labor between economies and industries. The movement of labor between economies and industries is given by the mobility of labor. This is determined by the labor mobility costs for switching between economies and industries. These mobility costs can be as high as 75 percent of average annual earnings (Lee and Wolpin, 2006) and are associated with aspects as; the search costs for a new job, geographical mobility, fear of unemployment and education. The latter seems critical when determining labor mobility costs. It appears that with an increase in education, labor mobility costs decline. Implying that skilled labor is expected to be more mobile than unskilled labor and therefore moves easier across economies and industries. Moreover, the skill intensity seems to differ between economies and industries OECD, 2011; World Bank, 2016; Anderson et al., 2018) indicating that industries face different labor mobility costs and thus differ in labor mobility. Furthermore, different economies and industries face diverse labor markets, institutions and government intervention. Combining all these differences between economies and industries concludes that the effect of international trade on income inequality, through the labor mobility, strongly differs per economy and industry. And should therefore be mentioned when explaining the effect of international trade on difference in wages within and between industries and thus the income inequality.

The focus of this research is on the industry level; therefore, the Heckscher-Ohlin-Samuelson model is applied on the industry level as shown in Table 2.2. For this analysis the following is assumed; 1) industry A is skilled labor intensive 2) industry B is unskilled labor intensive 3) economy X is relative skilled labor abundant 4) economy Y is relative unskilled labor abundant and 5) wages for skilled labor are always higher than for unskilled labor. These assumptions indicate that in the autarky situation, there are differences in relative factor rewards (wages) between the economies, between industries and between the same industries in different economies. There is a difference in relative factor reward (wage) in industry A for economy X and Y, due to the difference in relative supply of skilled labor in the countries. Following this logic, there is also a difference in relative factor reward (wage) for industry B in economy X and Y. Furthermore, in both economies X and Y there is a difference in relative factor reward (wage) between industry A and B. These differences can be presented as industry_economy and are as follow: A_X > A_Y > B_X > B_Y[4]. Following the HOS model, international trade induces economy X to export products from industry A and economy Y from industry B. Therefore, increasing the relative demand for skilled labor in economy X and unskilled labor in economy Y. This increase in relative demand increases the relative wages for skilled labor in economy X and for unskilled labor in economy Y. Implying that the wage differential between skilled and unskilled labor increases in economy X and thus an increase in income inequality between industries due to international trade. However, in economy Y the wage differential between skilled and unskilled labor decreases due to international trade and thus a decline in income inequality between industries. Furthermore, the wage differential in industry A (and B) increases between economies X and Y, implying higher income inequality for the identical industries between economies. In addition, labor mobility is also expected to play a role in this scenario. Due to the change in relative factor rewards and the mobility of skilled labor, skilled labor is expected to move to the economies and industries with the higher factor rewards. Implying that skilled labor is expected to move to industry

[4] Since skilled labor wages are always higher than unskilled labor wages. And, the supply of unskilled labor is higher in country Y, implying a lower wage than in country X.

A in economy X, which leads to an even greater difference in income between industry A and B in economy X. Furthermore, a bigger diverge in income for industry A between country X and Y. However, income converges between industry A and B in economy Y. This analysis concludes that the Heckscher-Ohlin-Samuelson model in combination with labor mobility, predict that international trade; 1) affects the difference in income level between industries in an economy and 2) affects the difference in income level for the same industries between different countries. This effect depends on the relative endowment of skilled and unskilled labor in an economy. Hence, according to the traditional trade models, one would expect that international trade decreases income inequality in industries which produces with unskilled labor, in a relatively well unskilled labor endowed economy. And increase income inequality in industries which produce with skilled labor, in a relatively well skilled labor endowed economy.

Table 2.2 Effects of International Trade in Goods and Labor at the Industry Level

		Relative Wages		Change in Skilled Labor	Income Inequality
Country X	**Skilled labor abundant**				+
Industry A	Skilled Labor Intensive	+	→	+	+
Industry B	Unskilled Labor Intensive	-	→	-	+
Country Y	**Unskilled labor abundant**				-
Industry A	Skilled Labor Intensive	-	→	-	-
Industry B	Unskilled Labor Intensive	+	→	-	-

Source: Own construction

Notes: (i) This Table shows the effect international trade in goods and labor has on the relative wages and therefore income inequality at the industry level; (ii) the relative wages are presented as skilled/unskilled in skilled labor intensive industries and as unskilled/skilled in unskilled labor industries; (iii) A plus sign indicates an increase where a minus sign implies a decrease; (iv) The presented effects are based on the assumption that (un)skilled labor is (im)mobile and complement to international trade.

Over the years, economists began to modify the 2x2x2 structure of the HOS trade model, in order to predict the observed trends in trade and income inequality. This research presents three of those modifications, which are 1) three factors, 2) three goods and 3) outsourcing. The first modification is presented by Wood (1994), by relaxing the two-factor assumption, through introducing a three-factor assumption with; skilled, semi-skilled and unskilled labor. Implying three types of production, namely skill-intensive manufacturing, semi-skilled intensive manufacturing and agriculture. This creates three possible scenarios; 1) skilled labor abundant, 2) semi-skilled labor abundant and 3) unskilled labor abundant. The first and third scenario present the same outcomes as the HOS trade model. An increase in income inequality between industries for skilled labor abundant economies and a decrease in income inequality for the unskilled labor abundant economies. Furthermore, similar disparities between identical industries between different countries show. However, the second scenario predicts different results. When the international trade of this economy increases, the wage of the semi-skilled labor relative to the wage of the skilled and unskilled labor increases. Implying that the effect of international trade on income inequality can go both directions and thus depends on the type of labor endowment per industry.

The second modification to the traditional 2x2x2 trade models is proposed by Davis (1996). This model diversifies from the two goods, by introducing three goods. These three goods vary in their capital intensity. However, this could also be applied as if these three goods differ in their skill intensity, to be relevant for this research. In addition, this model introduces market imperfections, implying restrictions on factor price equalization and forces production diversification. The three goods model creates three possible scenarios; 1) skilled labor abundant, 2) semi-skilled labor abundant 3) unskilled labor abundant. In the first scenario, the economy exports the skilled labor intensive good and import the other goods. Implying that as a consequence of international trade, the relative demand for skilled labor increases, which increases the income inequality in industries and between industries. In the second scenario, the economy exports the semi-skilled intensive good and import the skilled intensive good. Implying that the demand for semi-skilled (skilled) labor increases (decreases), which decreases the income inequality in the whole economy. Showing that international trade decreases the income inequality within and between industries for this scenario. In the third scenario, the economy exports the unskilled labor intensive good and imports the semi-skilled intensive good. Implying that because of international trade, the relative demand for unskilled (semi-skilled) labor increases (decreases), which decreases (increases) income inequality. Showing that international trade decreases the income inequality between the industries in this scenario. These three different scenarios show that the effect of international trade on income inequality (at the industry level) depends on the endowments of skilled, semi-skilled and unskilled in an economy and industry.

The third modification, presented by Feenstra and Hanson (1996), shows a different effect of international trade on income inequality, by relating the change in income inequality to outsourcing. Furthermore, this proposed framework is supported by data for Mexico for 1975-1988. Their model consists of two industries which have different endowments of skilled and unskilled labor. They assume that the final product is produced, by using intermediate inputs. These intermediate inputs are produced using different intensities of skilled and unskilled labor. Industry A, with a skilled labor abundance produces the products that are more skilled labor intensive. If the trade cost fall, industry A moves the production of the least skilled labor-intensive products to industry B, which is unskilled labor intensive. Industry B acts the exact opposite, by moving the skilled labor-intensive production to industry A. This mechanism increases the skill intensity in both industries, hence specialization. This implies that the income inequality between skilled and unskilled labor in both industries increases. Thus, according to the model by Feenstra and Hanson (1996), international trade increases income inequality in and between all industries.

One may argue that the predictions of these models are confirmed by the increase in international trade and decrease in income inequality at the same period, in East Asia (relatively unskilled labor abundant) in the 1960s and 1970s and by the increase in international trade and increase in income inequality at the same period, in the United States (relatively skilled labor abundant) from 1990s onward (Atkinson and Bourguignon, 2015, p. 1854). However, in East Asia, from 1980s there are patterns of increase in trade and increase in income inequality (Kanbur and Zhuang, 2012). This same increase in both trade and income inequality is present for Latin America up to the 2000s (Goldberg and Pavcnik, 2007). These patterns interfere with the predictions of traditional trade models. In addition, all industries apt to become more skilled (labor) intensive in their production (Krugman et al., 1995), for which the traditional trade models do not adapt. Furthermore, the observed increase in intra-industry trade cannot be explained by the traditional trade models. These shortcomings of the traditional trade models led to the new trade models. These new trade models argue that trade occurs between firms rather than countries. Consequently, the focus in the new trade models is on firms and the observed patterns of international trade are explained through heterogeneity of firms, workers and production.

2.2.2 New Trade Models – Export Channel

The framework proposed by Paul Krugman (1980) forms the foundation of the new trade theories and is built on five crucial assumptions. First, there are two identical countries (except for size). Second, there are iceberg trade costs, implying that a portion of the transported costs 'melts' away. (Bosker and Buringh, 2018). Third, there are increasing returns to scale, indicating that when the output increases, the average cost declines. Fourth, this model assumes product differentiation, signifying that firms produce different products and consumers prefer one product over the other. And fifth, the model assumes imperfect competition, implying that the firms price setters. However, this research focusses on the Melitz (2003) model, since it is an extension on Krugman (1980) and a fairly popular model used in international trade research (e.g. Verhoogen, 2008; Helpman et al., 2010; Akerman et al., 2013).

Melitz (2003) proposes two crucial extension on the Krugman (1980) trade model. First, Melitz (2003) incorporates firm heterogeneity, through giving each firm different marginal cost. Second, by introducing fixed costs for exporting. Implying that that not all firms are able to export, hence only the most productive firms can overcome these fixed costs and start exporting. The critical idea is that to become productive enough for exporting, skilled labor is the key. And the use of this skilled labor requires higher wages with respect to unskilled labor. The effect of export on income inequality at the industry level is displayed in Table 2.3. In autarky the fixed costs are that high, no firm is able to export. When these fixed costs fall (e.g. trade agreement), the most productive firms will become able to start exporting. In order for these firms to become that productive, they hire skilled labor and thus pay higher wages. These higher wages diverge the wages paid between firms, which increases the income inequality between firms. Indicating that if industry A in country X has a higher share of exporting firms than industry B in country X, the wages paid in industry A are higher than in industry B, hence income inequality. Furthermore, if the share of exporting firms increases in industry A in country X, the income inequality within industry A and between industry A and B increases. On the other hand, if the share of exporting firms in industry B increases in country X, income inequality between industry A and B falls, but income inequality within industry B increases. Furthermore, the effects of exports on income inequality in an unskilled labor abundant economy could differ and depends on what type of labor a firm requires to grow in productivity. It is possible that a firm requires more unskilled labor in order to become productive enough for exporting. Implying that exports increase the relative demand for unskilled labor and therefore increase the unskilled labor wages, implying a decrease in income inequality. However, Table 2.3 shows the effect when skilled labor is required for exporting, implying that in country Y, income inequality in industry B (A) increases (decreases)[5] and overall income inequality increases. Moreover, all these effects are endorsed by the mobility of labor. Skilled labor is expected to be more mobile than unskilled labor, and thus skilled labor moves to the industries with more exporting firms, since the wages are higher that industry. This induces an even greater difference in income between the industries. The reasoning described above, signifies that international trade induces higher income inequality through the export channel of trade. Furthermore, it explains why income inequality could differ per and between industries, since the share and size of exporting firms relative to non-exporting firms determines the income inequality.

[5] A decrease in industry A is expected, because the skilled labor is likely to move to industry B for the higher wages. Implying that the wage gap between unskilled and skilled labor in industry A declines, hence a decrease in income inequality.

Table 2.3 Effects of Export at the Industry Level

		Change in Exporting Firms		Relative Demand for Skilled Labor		Relative Wages		Change in Skilled Labor	Income Inequality
Country X	**Skilled labor abundant**								+
Industry A	Skilled Labor Intensive	+	→	+	→	+	→	+	+
Industry B	Unskilled Labor Intensive	x	→	X	→	x	→	-	-
Country Y	**Unskilled labor abundant**								+
Industry A	Skilled Labor Intensive	x	→	X	→	x	→	-	-
Industry B	Unskilled Labor Intensive	+	→	+	→	-	→	+	+

Source: Own construction
Notes: (i) This Table shows the effects export has on the relative demand, relative wages, labor movement and income inequality at the industry level; (ii) the relative demand and wage are presented as skilled/unskilled in skilled labor intensive industries and as unskilled/skilled in unskilled labor industries; (iii) A plus sign indicates an increase, a minus sign a decrease and an x implies no effect of exports to the other country in that industry; (iv) The presented effects are based on the assumption that (un)skilled labor is (im)mobile.

Verhoogen (2008) introduces a modification on Melitz (2003), which predicts the relationship between international trade and income inequality, through a mechanism called 'the quality upgrading'. Furthermore, the framework proposed by Verhoogen (2008) is supported by data for Mexican manufacturing plants. The idea is very similar to Melitz (2003), but the mechanism now runs through the quality aspect. Verhoogen (2008) argues that the more productive firms produce the higher quality goods and to maintain these higher quality goods, they pay higher wages. Following Melitz (2003), only the most productive firm will start exporting. And thus, only the high-quality producers will export. Once again, implying that international trade induces higher income inequality in industries with more exporters and higher income inequality between industries, through the export channel of trade.

2.2.3 Trump's argument – Import Channel

President of the United States, Donald Trump, argues that the United States economy is seriously damaged by cheap imports from other countries. In a speech about his jobs plan he said:

> *"We allowed foreign countries to subsidize their goods, devalue their currencies, violate their agreements and cheat in every way imaginable, and our politicians did nothing about it. Trillions of our dollars and millions of our jobs flowed overseas as a result. I have visited cities and towns across this country where one-third or even half of manufacturing jobs have been wiped out in the last 20 years. Today, we import nearly $800 billion more in goods than we export. We can't continue to do that."*

(Politico, 2016)

This statement by Donald Trump can be analyzed by emphasizing the effect on the relative factor rewards in the United States due to imports, which is shown in Table 2.4. Traditional trade models predict that economies export their relative abundant factor and import their relative scarce factor. For the United States, this implies import of unskilled labor goods from countries such as China, India and Mexico and export of skilled labor goods to these countries. Indicating that the relative demand for unskilled labor in the United States falls due to international trade, through the import channel. This fall in relative demand of unskilled labor, causes the relative factor reward to decline as well, hence a decrease in the relative wages of unskilled labor. Furthermore, Trump argues that due to this fall in relative demand the unemployment of unskilled workers increases. And since unskilled labor is expected to be rather immobile with respect to the skilled labor force, the unskilled labor force cannot switch between industries to counter this effect. The combination of the fall in wages and increase in unemployment implies an increase in income inequality within industries in the United States. Furthermore, this increase is expected to be most notable in unskilled intensive industries, and therefore increases the income inequality between industries as well, through imports.

Table 2.4 Effect of Imports at the Industry Level

		Relative Demand		Relative Wages/ Unemployment		Income Inequality
United States	**Skilled labor abundant**					+
Industry A	Skilled Labor intensive	x	→	x	→	x
Industry B	Unskilled Labor intensive	-	→	-/+	→	+
China	**Unskilled labor abundant**					-
Industry A	Skilled Labor intensive	-	→	-/+	→	-
Industry B	Unskilled Labor intensive	x	→	x	→	x

Source: Own construction
Notes: (i) This Table shows the effect of import on relative demand, relative wages, unemployment and income inequality at the industry level; (ii) the relative demand and wage are presented as skilled/unskilled in skilled labor intensive industries and as unskilled/skilled in unskilled labor industries; (iii) A plus sign indicates an increase, a minus sign a decrease and an x implies no effect of imports from the other country in that industry; (iv) The presented effects are based on the assumption that (un)skilled labor is (im)mobile; (v) This Table solely focusses on the effects of imports, implying that there is no effect on industry A (B) in the United States (China) by imports from China (United States).

2.3 Hypotheses

Table 2.5 presents an overview of the constructed theoretical framework above. The positive effect of international trade on income inequality is explained through the difference in factor endowments and the complementarity between international trade and factor movement. International trade is expected to favor skilled labor and thus skilled intensive industries, through the increase (decrease) in relative demand for (un)skilled labor. Implying the wages (factor rewards) for skilled labor relatively to unskilled labor increases and thus an increase in income inequality. Furthermore, skilled labor is expected to be rather mobile, implying they can switch between economies and industries for the highest wage. Contrary, unskilled labor is expected to be immobile, implying they cannot counter the negative effects international trade has on their income.

Then there remains the question whether the effects of international trade on income inequality flow through exports or imports. First, new trade models predict that international trade increases income inequality through exports. For a firm to become productive enough for exporting, a firm should hire more skilled labor which require higher wages. Implying that income inequality within industries increases between workers at the exporting firms (higher wages) in comparison to workers at the non-exporters (lower wages). Furthermore, this explains income inequality between industries, through the share of exporters an industry has. Second, Donald Trump argues that income inequality is expected to increase through imports. The relative cheap factor rewards in countries such as China, India and Mexico decrease the relative demand for unskilled labor in the United States. This leads to an increase in unskilled labor unemployment and a decrease in relative factor rewards (wages) for unskilled labor in the United States.

The combination of the discussed theories and a dataset with relatively skilled labor abundant countries, implies the following three hypotheses for this research[6]:

H1: International trade increases income inequality at the industry level.
H2: Export increases income inequality at the industry level
H3: Import increases income inequality at the industry level

Table 2.5 Overview of the Theoretical Framework

Positive effect	Unambiguous
Heckscher and Ohlin (1933)	Wood (1994)
Stolper and Samuelson (1941)	Davis (1996)
Feenstra and Hanson (1996)	
Melitz (2003)	
Verhoogen (2008)	
Trump	
Labor mobility	

Source: Own construction, based on the theoretical framework of this research.
Notes: (i) This Table presents an overview of the theoretical framework proposed by this research, where the proposed effect per paper is presented; (ii) A positive effect indicates that an increase in international trade induces an increase in income inequality as well; (ii) An unambiguous effect implies that the effect of international trade can be either positive or negative.

[6] These hypotheses are rewritten in mathematical form in the third Chapter.

2.4 Income inequality measurements

The next section of the literature consists of a brief description of the different income inequality measurements used in this research. The scope of this research is not on the differences between the income inequality measurements. Therefore, the mechanisms, equation and (dis)advantages of each measurement are concisely described.

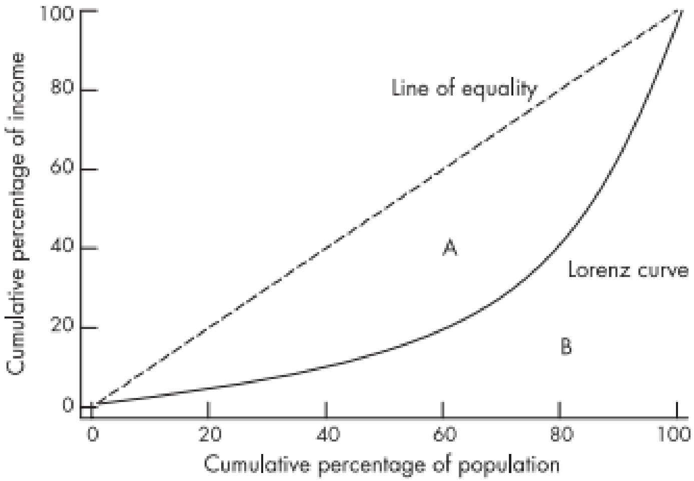
Five desirable features of income inequality measurements are highlighted by Cowell (1995); the Pigou-Dalton Transfer Principle, the Scale Independence Principle, the Principle of Population, Symmetry and the Principle of Decomposability. First, the Pigou-Dalton Transfer Principle implies that when income is redistributed from a rich to a poor individual, income inequality declines. Second, the Scale Independence Principle indicates that when all incomes are multiplied by a constant, the outcome of the income inequality measurement remains the same. Third, the Principle of Population signifies that the outcome of the income inequality measurement does not change when the individuals at each income level are multiplied by a constant. Fourth, Symmetry imposes that when two individuals swap incomes, the outcome of the income inequality measurement, does not change. Fifth and last, the Principle of Decomposability states that the income inequality measurement are decomposable in different groups. Implying that the income inequality can be presented as within group inequality and between group inequality, indicating that one can compare different groups within the same income distribution with one another and can compare different income distribution with each other (Sala-i-Martin, 2002); (World Bank Group, 2005).

2.4.1 Lorenz Curve

In 1905 Max Otto Lorenz presented the Lorenz-curve, with the purpose to display the income distribution by presenting the relationship between the cumulative percentage of the population and the cumulative percentage of the incomes. The Lorenz curve is best explained by using a graphical representation of the curve itself, which is shown in Figure 2.1 below.

The Lorenz curve indicates where the wealth in a society is clustered. The x-axis presents the cumulative percentage of the population, where the y-axis does this for the cumulative percentage of income. The diagonal line represents a perfectly equal distribution of incomes in a society. The further the curve departs from the diagonal line, the more unequal the income distribution becomes.

Figure 2.1 Lorenz Curve



Source: De Maio (2007)
Note: The x-axis shows the cumulative percentage of the population, where the y-axis presents the cumulative percentage of income.

2.4.2 Gini Index

In 1912 Corrado Gini wrote a paper in which he presented the Gini index, with the purpose to measure income inequality. The Gini Index is a popular income inequality proxy used in research, since there is widespread data available for this measurement (Mahler, 2004; Bertola, 2008; Celik and Basdas, 2010; Faustino and Vali, 2013; Thewissen et al., 2017). The Gini index is based on the Lorenz curve, where it is equivalent to the area between the 45 degrees line and the Lorenz curve divided by the total area under the 45 degrees line (Figure 2.1; A/A+B). The Gini index is presented as a number between 0 and 100, where an index of 0 represents perfect equality and a value of 100 perfect inequality (where all is earned by one). Implying that if the value of the Gini index increases, income inequality increases. The general equation[7] of the Gini index is given the following expression (World Bank Group, 2005):

$$Gini = 1 - \frac{1}{N}\sum_{i=1}^{N}(y_i + y_{i-1}) \tag{2.1}$$

The Gini index satisfies four of the five desirable features; The Pigou-Dalton Transfer Principle, the Income Scale Independence Principle, the Principle of Population and Symmetry. However, the Gini index is not decomposable, implying that the Gini of the whole income distribution is not equal to the sum of the Gini indices for subgroups of the whole income distribution. A second disadvantage of the Gini index is that it

[7] Where y_i is the income of individual i, and y_{i-1} the income of individual i-1

does not deviate between different kinds of income inequality. Lorenz curves can intersect, indicating different income inequality for economies. However, the Gini index generates the same value for both economies, indicating that they have similar income inequality. Implying that comparison between Gini indices may be complicated and can show wrong results. A third disadvantage of the Gini index, is that it is most sensitive in the middle part of the income range. Implying that the Gini index is not neutral nor value free (De Maio, 2007). Suggesting that when a research focusses on the top or bottom part of the income distribution, one should be careful with using and interpreting the Gini index. A fourth disadvantage of the Gini index is that its construction is solely based on household surveys. Implying that countries or years for where there is no household survey, the Gini index is lacking (Conceição and Galbraith, 2000).

2.4.3 Atkinson Index

Because of the shortcomings and critics on the Gini index, Anthony Barnes Atkinson proposed the Atkinson index in 1970. The Atkinson index indicates the level of social utility that is gained from complete redistribution (Atkinson, 1975). A crucial feature of the Atkinson index, is the inclusion of sensitivity to inequalities in different parts of the income distribution (Atkinson and Micklewright, 1992). Atkinson argues that the Gini index is not purely statistical and includes social judgements about the weight embodied in different parts of the income distribution (Atkinson, 1975). To overcome this, Atkinson proposed to include Rawl’s conception of social injustice when measuring income inequality. Atkinson practices this by including a sensitivity parameter (ε), which is also called the inequality aversion parameter, with a range from 0 to infinity[8]. Where a sensitivity parameter of 0 indicates that the researcher is indifferent about the nature of the income distribution. On the other hand, a sensitivity parameter towards infinity signifies that the researcher is only interested in incomes at the lower end of the income distribution. Implying that if the sensitivity parameter increases, the more sensitive the index becomes towards inequalities at the bottom of the income distribution.

The outcome of the Atkinson index varies between 0 and 100. Where an Atkinson index of 0 reflects that there is no social utility achieved from complete redistribution. On the other hand, an Atkinson index of 1 reflects that social utility is achieved from complete redistribution. Implying that when the Atkinson index increases, the social utility that can be achieved from complete redistribution increases

[8] In practice, the sensitivity parameter incorporates values of 0.5, 1, 1.5 or 2.

as well, which indicates higher income inequality. The equation for the Atkinson index[9] is as follows (Salverda et al., 2009):

$$Atkinson\ (\varepsilon) = 1 - \left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)^{1-\varepsilon} - 1\right]^{\frac{1}{1-\varepsilon}} \quad (2.2)$$

The Atkinson index includes four out of five desirable features for an income inequality measurement; The Pigou-Dalton Transfer Principle, the Income Scale Independence Principle, the Principle of Population and Symmetry. However, just as the Gini index, the Atkinson index is not decomposable. Another important advantage of the Atkinson index, is the possibility to account for social judgement, through the sensitivity parameter. This allows a researcher to for a deeper analyze of income inequality, through using different values of social judgement.

2.4.4 Generalized Entropy index

The general formula[10] for the generalized entropy (GE) index is as follows (World Bank Group, 2005):

$$GE(a) = \frac{1}{\alpha(\alpha-1)}\left[\frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)^{\alpha} - 1\right] \quad (2.3)$$

The outcome of a GE index varies between 0 and ∞. Where a GE index of 0 reflects perfect equality and as the index approaches ∞, inequality increases. The GE index includes, just as the Atkinson index, a sensitive parameter (α). The sensitive parameter reflects the weight which is given to distances between incomes at different parts of the income distribution (World Bank Group, 2015). In contrast to the Atkinson index, a lower value of α reflects that the GE index is more sensitive towards the changes in the lower end of the income distribution. Implying that as α increases, the GE index becomes more sensitive towards the higher end of the income distribution[11].

Theil Index

The Theil index stems from the generalized entropy index family and is proposed by Henri Theil (1967). The idea was to incorporate the information theory of Claude Shannon (1948) within an income inequality measurement, with the intention to create a general portioning theory (Conceição and Galbraith, 2000). The Theil index has a lower bound of 0 and an upper bound of log *n.* [12] Furthermore, the Theil index

[9] Where y_i is the income of individual i, and $\bar{y}$ the mean income
[10] Where y_i is the income of individual i, and $\bar{y}$ the mean income
[11] In practice, the sensitivity parameter incorporates values of 0, 1 and 2.
[12] Where n represents total population.

incorporates a sensitivity parameter of 1 and thus implies the following expression (Conceição and Galbraith, 2000):

$$Theil\ (1) = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{y_i}{\bar{y}}\right)\log\left(\frac{y_i}{\bar{y}}\right) \tag{2.4}$$

The Theil index incorporates all five desirable features for an income inequality measurement; The Pigou-Dalton Transfer Principle, the Income Scale Independence Principle, the Principle of Population, Symmetry and is decomposable. The latter is a very important feature of the Theil index, implying that it is additive decomposable to within and between group components. Indicating that the Theil index allows to divide the population into subgroups and comparison between these subgroups (Conceição and Galbraith, 2000).

Mean Log Deviation

The mean log deviation, just as the Theil index, stems from the Generalized Entropy index. The Mean Log Deviation incorporates a sensitivity parameter of 0, implying that this measurement is very sensitive towards changes in the lower end of the income distribution. The next relationship gives the Mean Log Deviation:

$$Mean\ Log\ Deviation\ (0) = -\frac{1}{N}\sum_{i=1}^{N}\log\left(\frac{y_i}{\bar{y}}\right) \tag{2.5}$$

The Mean Log Deviation has the same advantages as the Theil index, since they both stem from the same general equation (Generalized Entropy). The Mean Log Deviation satisfies; The Pigou-Dalton Transfer Principle, the Income Scale Independence Principle, the Principle of Population, Symmetry and the Principle of Decomposability.

3. Data Description

3.1 Data Overview

This research combines two datasets (version 1.0 and 1.1) constructed by Wang et al. (2014) to estimate the effect of international trade on income inequality at the industry level. The dataset contains information about four different measurement of income inequality at the industry level, namely the Gini index, Atkinson index, Theil index and the Mean Log Deviation. Wang et al. (2014) constructed this dataset on basis of the Luxembourg Income Studies (LIS) micro data. Data for the Theil-index and Atkinson index is only reported at the household level. Therefore, this research focusses on the data at the household level, rather than the individual level. Furthermore, the sample of individuals in the households is restricted to the age between 25 and 54, since this group is most dependent on earnings as a source of income (Thewissen et al., 2017). The dataset, and thus this research, focusses on 12 OECD countries. Furthermore, data for these income inequality measurements is reported for 1986-2005, but due to the availability of international trade data, this research is limited to a time period of 1990-2005. However, data is reported for different years, implying a nonconsecutive time coverage. To overcome this problem, data is divided in four periods, each containing four years. The combination of the 12 OECD countries and time period is represented in Table 3.1 below.

Table 3.1 Period Overview

	Period 1				Period 2				Period 3				Period 4			
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Czech Republic							X								X	
Denmark			X			X					X				X	
Finland		X				X					X				X	
Germany					X						X				X	
Ireland					X	X	X				X				X	
Sweden			X								X					X
United Kingdom										X					X	
United States		X			X			X			X				X	
Austria															X	
Belgium						X					X					
Poland						X				X					X	
Spain						X					X					

Source: Own construction based on Wang et al. (2014)
Notes: (i) Table 3.1 displays the years for which the income inequality measurements are reported in Wang et al. (2014); (ii) The construction of the periods is based on data coverage and is as follows; period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (iii) For Ireland 1994-1996 and United States 1994 and 1997 the average is computed, to qualify as one period.

In addition, the data for these 12 countries is reported for 21 industries[13]. Industries are based on ISIC 3.0 classification, implying the following industries: AtB. Agriculture, C. Mining, D. Manufacturing, 15t16. Manufacturing food, 17t19. Manufacturing textile, 20. Manufacturing wood, 21t22. Manufacturing paper, 23t25 Manufacturing chemicals, 26. Manufacturing minerals, 27t28. Manufacturing metals, 29t33. Manufacturing machinery, 34t25. Manufacturing transport, 36t37. Other manufacturing and F. Construction, E. Utilities, GtH. Wholesale, I. Transport and Communications, 60t63. Transport and storage, 64. Post and telecommunications, JtK. Finance and LtQ. Community.

[13] Data for all four income measurements is not reported for Denmark and Sweden in 1992 for the transport equipment and manufacturing n.e.c. recycling industries.

The combination of four periods, 12 countries and 21 industries create a panel dataset, with a possible 693 unique observations for the base model and 33 for the regressions per industry[14]. However, different combinations of missings lead to a dataset with 619 unique observations for the base model and 30 observations for the regressions per industry. This dataset is unbalanced, since data over time is not reported for the same individuals. To estimate the effect of international trade on income inequality at the industry level, this research uses four independent variables, namely the Gini index, Atkinson index, Theil index and the Mean Log Deviation. The most important and explanatory variable is "Trade", where the other variables are added as control variables in the regression. Table 3.2 displays the different variables used in the regression, their description, formula and source. In addition, a summary of the dataset can be found in Appendix I, where this summary shows that there are no alarming missings nor outliers.

The four control variables of this research are as follows; Industry Growth (industry level), Technology (industry level), Government (country level) and Unemployment (country level). Since these are control variables, a brief explanation of their expected effect is presented. First, Industry Growth is expected to have an effect on income inequality. Kuznets (1955) argues that an inverted U shape curve is observed for the relationship between income inequality and economic growth. Implying that income inequality increases at the beginning stage of development, but will fall when the development continues. Second, Technology is expected have an effect on income inequality, through innovation. Innovation can create jobs (Van Reenen, 1997; Smolny, 1998; Greenan and Gullec, 2000) or destroy jobs (Leontief et al., 1986; Kalmbach and Kurz, 1990) and thus affect the income inequality. Furthermore, technology can change the demand for skilled and unskilled labor (Caroli and Van Reenen, 2001; Acemoglu, 2002; Greenan, 2003) and thus affect income inequality. Third, the composition of the government is expected to affect income inequality. A more left-wing oriented government is likely to focus more on income redistribution, minimal wage and employment protection and is therefore expected to decrease income inequality (Solt, 2008; Mohl and Pamp, 2008). Fourth, Unemployment is expected to have a positive effect on income inequality. When unemployment increases, the share of people with a low/zero income increases and thus the gap between poor and rich diverges. Implying that income inequality tends to increase when unemployment rises[15] (Atkinson and Bourguignon, 2015, p. 1625).

[14] Table 3.1 shows 33 unique period-country combinations, with the average over Ireland 1994-1996 and United States 1994 and 1997. Implying 33*21 industries = 693 possible observations.

[15] This effect could be disturbed by factors such as; union density and (un)employment protection/benefits. These are not controlled for in the regression analysis, since it is not the focus of the research.

Another possible control variable could be education/human capital, since it is expected to affect income inequality (e.g. Gregorio and Lee, 2002; Sylwester, 2002; Erosa, et al., 2010). However, data for education is not available at the industry level. Furthermore, the main argument for including education/human capital in the regression analysis is to control for differences in skill levels between industries. Nevertheless, this difference is already captured by the Technology variable in this research. However, this research acknowledges that if education/human capital data would be available at the industry level, it should be included in the regression analysis.

Table 3.2 Data Description

Variable Name	Description	Formula and notes	Sources
Gini	The Gini index of income, with a value between 0 and 100. Where 0 indicates perfect equality of income and 100 perfect inequality of income.		Wang et al. (2014)
Atkinson	The Atkinson index of income, with a value between 0 and 100. Where a higher value indicates that society has to give up a higher share of income to reach perfect equality. Sensitivity parameter ε is set to 0.5.		Wang et al. (2014)
Theil	Theil index of income, with a value between 0 and ∞. Where 0 indicates perfect equality of income and the approach towards ∞, perfect inequality of income. Sensitivity parameter α=1.		Wang et al. (2014)
Mean Log Deviation or MLD	Mean Log Deviation of income. Value between 0 and ∞. Where 0 indicates perfect equality of income and the approach towards ∞, perfect inequality of income. Sensitivity parameter α=0.		Wang et al. (2014)

Continued on the next page

Table 3.2 Continued

Variable Name	Description	Formula and Notes	Sources
Trade	Proxy for international trade.	(Import+Export)/Gross Output. All values are reported at the industry level, where import and export are corrected for exchange rates at 8/25/2018.	OECD (2012)[16] for manufacturing based industries. EBOPS (2002) for service based industries
Import	Proxy for international trade through the import channel.	Import/Gross Output. All values are reported at the industry level, where import is correct for exchange rates at 8/25/2018.	OECD (2012) for manufacturing based industries. EBOPS (2002) for service based industries
Export	Proxy for international trade through the export channel.	Export/Gross Output. All values are reported at the industry level where import is correct for exchange rates at 8/25/2018.	OECD (2012) for manufacturing based industries. EBOPS (2002) for service based industries
Trade2	Proxy for international trade, used for the robustness check.	(Import+Export)/Value Added. All values are reported at the industry level, where import and export are corrected for exchange rates at 8/25/2018.	OECD (2012) for manufacturing based industries. EBOPS (2002) for service based industries
Import2	Proxy for international trade through the import channel, used for the robustness check.	Import/Value Added. All values are reported at the industry level, where import is correct for exchange rates at 8/25/2018.	OECD (2012) for manufacturing based industries. EBOPS (2002) for service based industries

Continued on the next page

[16] Where OECD (2012) covers; AtB. Agriculture, C. Mining, D. Manufacturing, 15t16. Manufacturing food, 17t19. Manufacturing textile, 20. Manufacturing wood, 21t22. Manufacturing paper, 23t25 Manufacturing chemicals, 26. Manufacturing minerals, 27t28. Manufacturing metals, 29t33. Manufacturing machinery, 34t25. Manufacturing transport, 36t37. Other manufacturing and F. Construction. And EBOPS (2002) covers; E. Utilities, GtH. Wholesale, I. Transport and Communications, 60t63. Transport and storage, 64. Post and telecommunications, JtK. Finance and LtQ. Community.

Table 3.2 Continued

Variable Name	Description	Formula and Notes	Sources
Export2	Proxy for international trade through the export channel, used for the robustness check.	Export/Value Added. All values are reported at the industry level, where import is correct for exchange rates at 8/25/2018.	OECD (2012) for manufacturing based industries. EBOPS (2002) for service based industries
Industry Growth	Growth rate of value added volume (percentage per year).	$VA_Q = \Delta ln\, V_{jt}$ [17]	EU-KLEMS (2011)
Technology	ICT capital compensation as share of the total capital compensation.		EU-KLEMS (2011)
Government	Cabinet posts hold by left wing parties in the government as share of total cabinet posts.		Armingeon et al. (2012)
Unemployment	Unemployment as percentage of total labor force.		International Labour Oranization (2017)

Source: Own Construction
Note: This Table presents the description, calculation and source of all the variables used in this research

3.2 Why focusing on the industry level?

A crucial decision for this research is to estimate the effect of international trade on income inequality at the industry level, rather than the country level. Therefore, this section provides three arguments based on; 1) The difference in endowments and skill intensities between industries; 2) The difference in share of exporting firms between industries; 3) The difference in trade intensity and income inequality between industries.

First, traditional trade models explain the effect of international trade on income inequality through the difference in intensities and endowments of skilled and unskilled labor. Data shows that skilled and unskilled labor intensity greatly differs per industry, per country (e.g. OECD, 2011; World Bank, 2016; Anderson et al., 2018). With differences in skill intensity as big as 8.3 in manufacturing chemicals and 0.8 in manufacturing textiles (OECD, 2011)[18]. This big differences in skilled and unskilled labor per

[17] Where V_{jt} is is the value added of gross output, averaged over two years
[18] Measured as the R&D divided by value added in 1999.

industry, per country, presents the first argument for an analysis at the industry level to understand the effect of international trade on income inequality in general.

The second argument is based on the new trade models, which explain the effect of international trade on income inequality through exports. Data (World Trade Organization, 2000; Bernard et al., 2007; ISGEP, 2008) shows that the share of exporting firms is increasing. Where Bernard et al. (2008) show that the difference of the share of exporting firms, between industries, is as big as 36% in manufacturing chemicals and 12% in manufacturing[19]. This big difference in the share of exporting firms per industry, per country, signifies the second argument for an analysis at the industry level to understand the effect of international trade on income inequality in general.

The third argument for an analysis at the industry level, is based on the trend of trade and income inequality at the industry level. Table 3.3 and Figure 3.1 display the mean Gini index per industry over time, where is clearly shown that the Gini index significantly differs per industry. A fine example is the difference between the agriculture and construction industry, where the mean over all periods show a Gini index of 37.18 and 24.21 for the agriculture and construction industry respectively. This indicates a difference greater than 10% per period and over all periods. Moreover, this same difference between industries appears for the Atkinson index, Theil index and Mean Log Deviation (Appendix II). Implying that there is significant variation in the level of income inequality between the industries. This variation of income inequality between industries is just as big (or even bigger) as the variation of income inequality between countries (OECD, 2018).

A second conclusion can be drawn from Table 3.3 and Figure 3.1; the Gini index is increasing between industries. In all industries[20], the Gini index is increasing over the years with an average of 3.04 points. This same result holds for the Atkinson index, Theil index and Mean Log Deviation[21]. This increase of the income inequality between industries is similar to trend of increasing income inequality within and between economies (World Income Database, 2018). This, once again, stresses the importance of income inequality at the industry level for understanding the effect of international trade on income inequality in general.

[19] For the United States in 2002
[20] except for the paper manufacturing industry, where the change of the Gini index over the periods is -2.02
[21] The Mean Log Deviation in the food manufacturing industry declines with -0.76

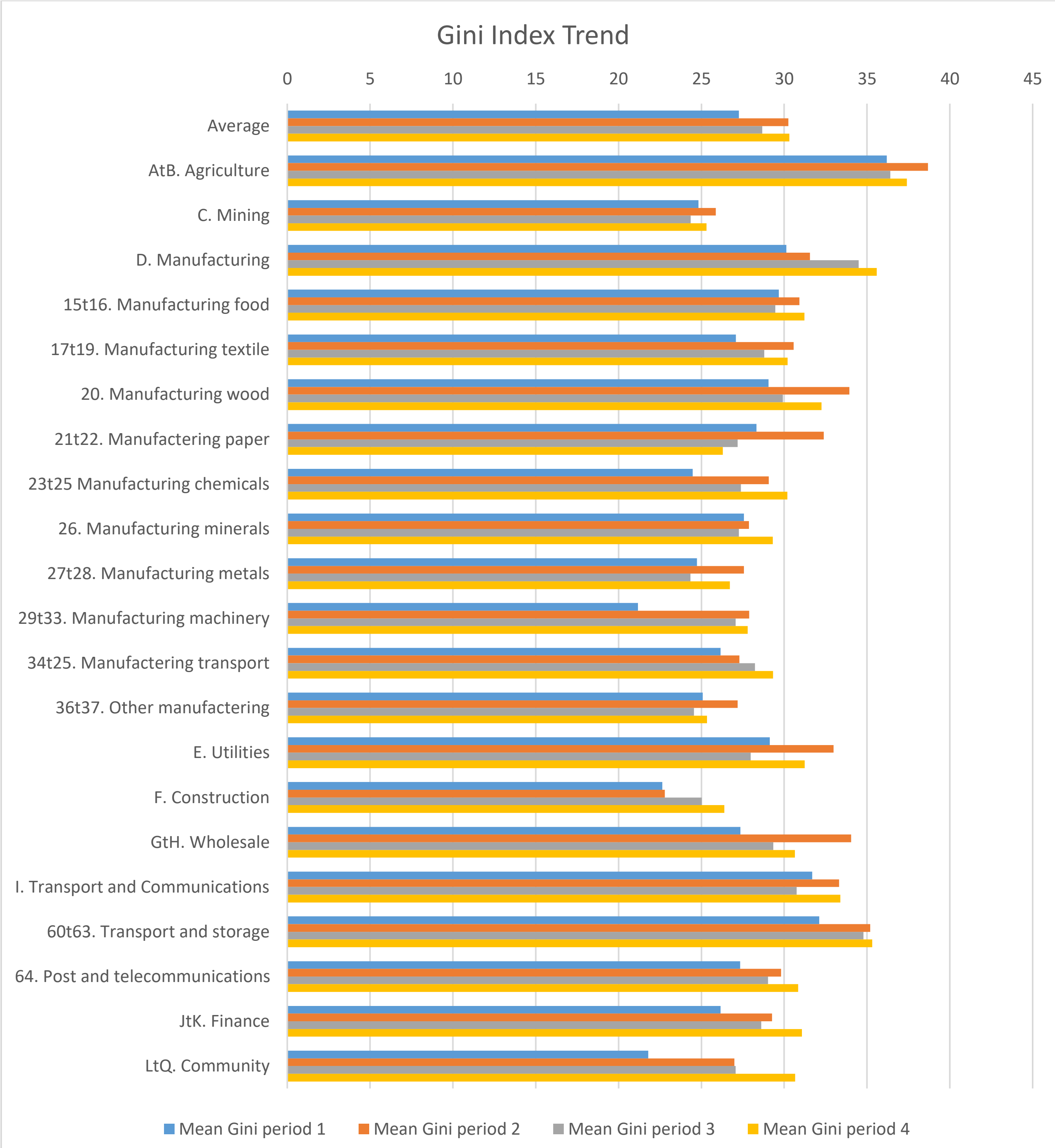
Table 3.3 Gini Index over Time and across Industries for all Countries

Industry	Period 1	Period 2	Period 3	Period 4	Δ Gini	Average Periods
AtB. Agriculture	36.20	38.69	36.41	37.41	1.21	37.18
C. Mining	24.82	25.87	24.35	25.31	0.49	25.09
D. Manufacturing	30.13	31.56	34.50	35.58	5.46	32.94
15t16. Manufacturing food	29.68	30.92	29.46	31.22	1.54	30.32
17t19. Manufacturing textile	27.09	30.56	28.80	30.20	3.11	29.16
20. Manufacturing wood	29.06	33.93	29.92	32.26	3.20	31.29
21t22. Manufacturing paper	28.32	32.39	27.19	26.30	-2.02	28.55
23t25 Manufacturing chemicals	24.47	29.07	27.38	30.19	5.72	27.78
26. Manufacturing minerals	27.56	27.87	27.27	29.31	1.75	28.00
27t28. Manufacturing metals	24.74	27.57	24.34	26.72	1.98	25.84
29t33. Manufacturing machinery	21.17	27.89	27.06	27.80	6.63	25.98
34t25. Manufacturing transport	26.16	27.30	28.23	29.33	3.17	27.76
36t37. Other manufacturing	25.09	27.19	24.56	25.34	0.26	25.54
E. Utilities	29.12	32.99	27.98	31.24	2.12	30.33
F. Construction	22.65	22.79	25.03	26.38	3.74	24.21
GtH. Wholesale	27.35	34.04	29.34	30.64	3.29	30.34
I. Transport and Communications	31.69	33.31	30.76	33.39	1.70	32.29
60t63. Transport and storage	32.11	35.19	34.79	35.32	3.21	34.35
64. Post and telecommunications	27.35	29.81	29.02	30.84	3.49	29.25
JtK. Finance	26.15	29.27	28.61	31.06	4.91	28.77
LtQ. Community	21.79	26.99	27.07	30.66	8.87	26.62
Average Industries	27.27	30.25	28.67	30.31	3.04	29.12

Source Based on own calculations from Wang et al. (2014)

Notes (i) This Table displays the trends in the Gini index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Gini is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v) Visual presentation of this trend can be found in Figure 3.1.

Figure 3.1 Gini Index over Time and across Industries for all Countries



Source Based on own calculations from Wang et al. (2014)
Notes (i) This Figure displays the trends in the Gini index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table 3.3.

These two conclusions, from income inequality trends, are strengthened when focusing on a single country. Table 3.4 and Figure 3.2 show the trend of the Gini index for the United States, implying that when focusing on this single country, the same results show. Hence, a significant difference in income inequality between different industries and an increase over time. These two arguments, once more, justify the importance of an analysis at the industry level.

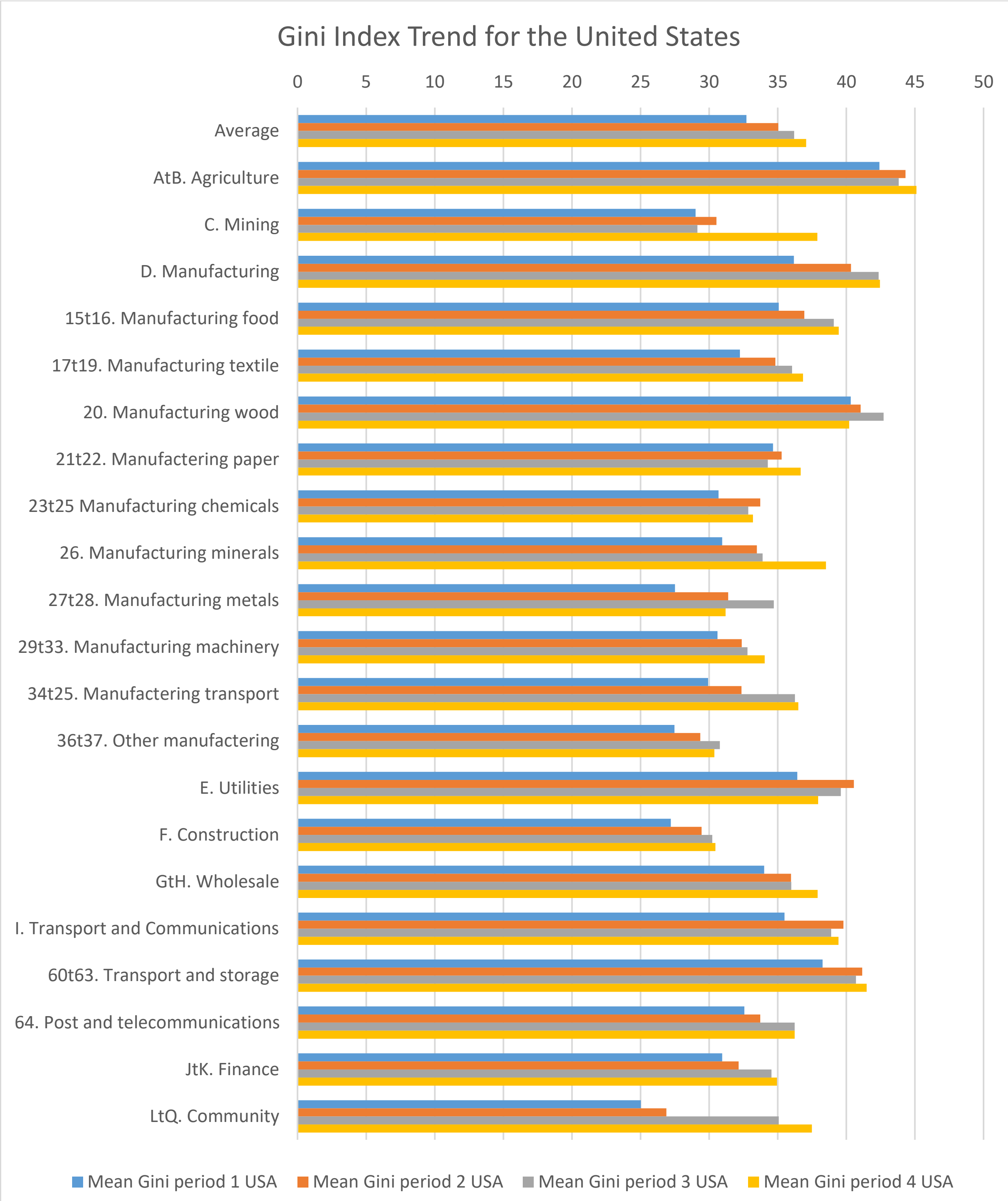
Table 3.4 Gini Index over Time and across Industries for the United States

Industry	Period 1	Period 2	Period 3	Period 4	Δ Gini	Average Periods
AtB. Agriculture	42.42	44.31	43.81	45.11	2.69	43.91
C. Mining	29.02	30.54	29.15	37.88	8.86	31.65
D. Manufacturing	36.18	40.34	42.35	42.45	6.27	40.33
15t16. Manufacturing food	35.07	36.93	39.09	39.44	4.37	37.64
17t19. Manufacturing textile	32.24	34.83	36.04	36.83	4.60	34.99
20. Manufacturing wood	40.33	41.04	42.71	40.20	-0.13	41.07
21t22. Manufacturing paper	34.65	35.29	34.27	36.68	2.03	35.22
23t25 Manufacturing chemicals	30.68	33.72	32.84	33.20	2.52	32.61
26. Manufacturing minerals	30.94	33.48	33.90	38.51	7.56	34.21
27t28. Manufacturing metals	27.50	31.39	34.71	31.19	3.69	31.20
29t33. Manufacturing machinery	30.61	32.37	32.79	34.05	3.45	32.46
34t25. Manufacturing transport	29.93	32.37	36.26	36.49	6.56	33.76
36t37. Other manufacturing	27.48	29.35	30.78	30.39	2.91	29.50
E. Utilities	36.42	40.54	39.60	37.95	1.54	38.63
F. Construction	27.21	29.45	30.23	30.45	3.24	29.34
GtH. Wholesale	34.02	35.97	35.99	37.91	3.90	35.97
I. Transport and Communications	35.50	39.78	38.89	39.42	3.92	38.40
60t63. Transport and storage	38.28	41.16	40.69	41.48	3.20	40.40
64. Post and telecommunications	32.57	33.72	36.24	36.23	3.66	34.69
JtK. Finance	30.95	32.15	34.54	34.93	3.98	33.14
LtQ. Community	25.03	26.88	35.07	37.49	12.46	31.12
Average Industries	32.72	35.03	36.19	37.06	4.35	35.25

Source Based on own calculations from Wang et al. (2014)

Notes (i) This Table displays the trends in the Gini index over time for each industry in the United States, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Gini is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v) Visual presentation of this trend can be found in Figure 3.2.

Figure 3.2 Gini Index over Time and across Industries for the United States



Source Based on own calculations from Wang et al. (2014)

Notes (i) This Figure displays the trends in the Gini index over time for each industry in the United States, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table 3.4.

The third argument about trends, is based on the trend of international trade. Table 3.5 and Figure 3.3 show that there is a huge difference in trade between industries. A fine example is the difference between the mining and community industry[22]. These huge differences in trade intensities indicate that all industries face different impacts of international trade. Implying that the effect of international trade on income inequality significantly differs per industry. And thus, once more stresses the importance of the analysis at the industry level.

Table 3.5 International Trade over Time and across Industries for all Countries

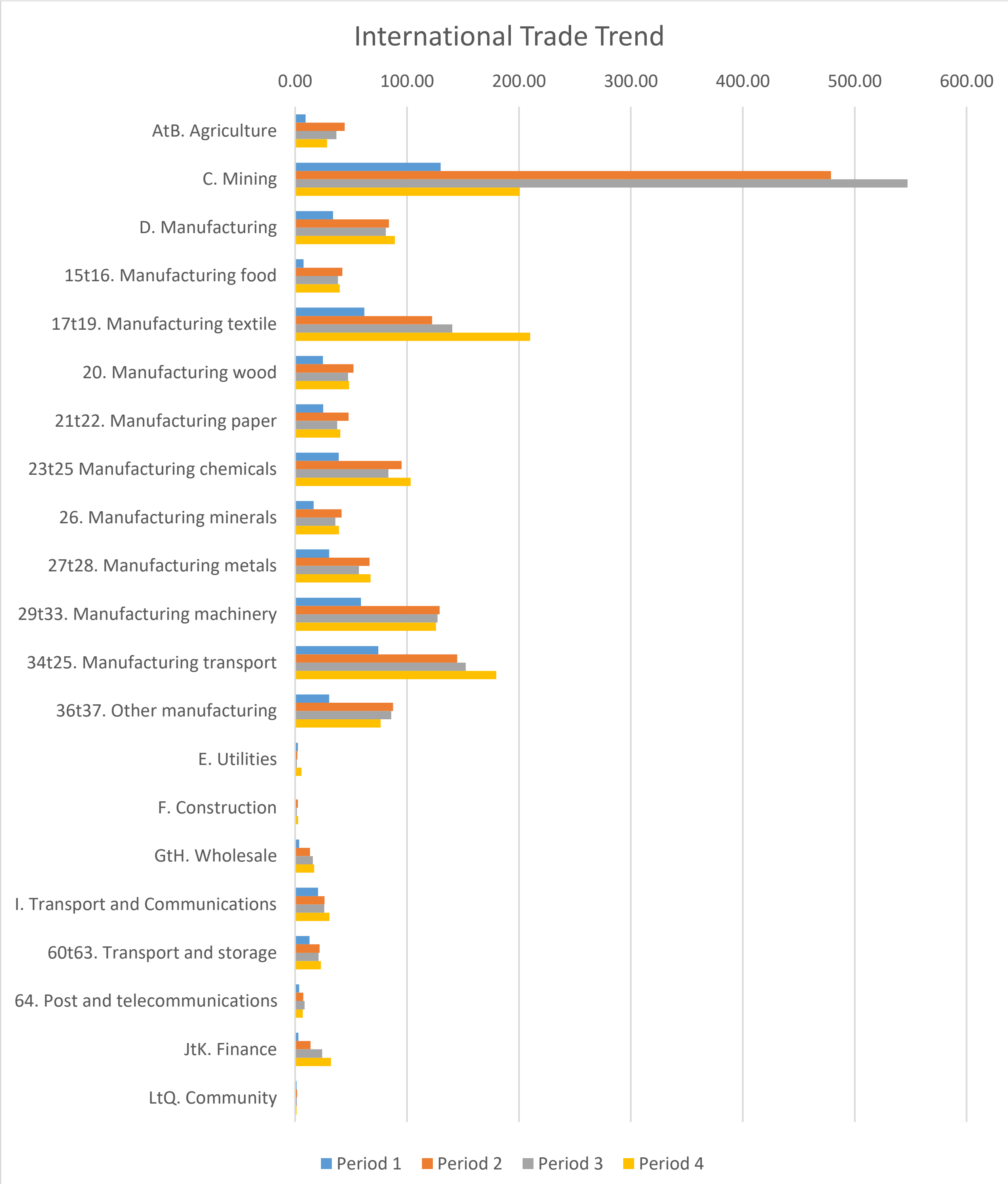
Industry	Period 1	Period 2	Period 3	Period 4	Δ Trade	Average Periods
AtB. Agriculture	9.28	44.28	36.96	28.59	19.31	29.77
C. Mining	129.95	478.75	547.35	200.71	70.76	339.19
D. Manufacturing	33.89	83.88	81.08	89.17	55.28	72.00
15t16. Manufacturing food	7.60	42.19	38.25	39.79	32.19	31.95
17t19. Manufacturing textile	61.76	122.52	140.47	210.07	148.31	133.70
20. Manufacturing wood	24.79	52.08	47.33	48.23	23.44	43.10
21t22. Manufacturing paper	25.18	47.79	37.63	40.37	15.19	37.74
23t25 Manufacturing chemicals	38.90	95.03	83.26	103.27	64.37	80.11
26. Manufacturing minerals	16.47	41.43	35.95	39.27	22.80	33.28
27t28. Manufacturing metals	30.52	66.55	56.94	67.44	36.92	55.36
29t33. Manufacturing machinery	58.83	129.02	127.16	125.97	67.14	110.24
34t25. Manufacturing transport	74.35	144.85	152.50	179.77	105.42	137.86
36t37. Other manufacturing	30.40	87.55	85.83	76.46	46.06	70.06
E. Utilities	2.39	1.95	1.52	5.68	3.29	2.88
F. Construction	0.37	2.34	1.61	2.70	2.34	1.75
GtH. Wholesale	3.59	13.23	15.81	16.97	13.38	12.40
I. Transport and Communications	20.46	26.36	25.99	30.71	10.25	25.88
60t63. Transport and storage	12.88	21.89	20.93	22.96	10.08	19.66
64. Post and telecommunications	3.59	7.38	8.48	6.93	3.34	6.59
JtK. Finance	3.00	13.84	24.09	32.09	29.09	18.25
LtQ. Community	1.40	1.71	1.50	1.36	-0.04	1.49
Average Industries	28.08	72.60	74.79	65.17	37.09	60.16

Source Based on own calculations from Wang et al. (2014)

Notes (i) This Table displays the trends in international trade over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Trade is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v) Visual presentation of this trend can be found in Figure 3.3.

[22] The huge spike in mining is found in several countries as; Belgium (1995, 2000), Finland (1991, 1995, 2000, 2004) and Germany (2004) and Spain (2000). Where Belgium 1995 and 2000 show enormous (growth in) values of output and export for the mining industry, which can explain the spike in the presented trade data.

Figure 3.3 International Trade over Time and across Industries for all Countries



Source: Based on own calculations from Wang et al. (2014)
Notes: (i) This Figure displays the trends in international trade over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table 3.5.

3.3 Testing the Data

The data used in this research is tested for correlation, multicollinearity, heteroskedasticity and autocorrelation. In addition, a Hausman test is performed to confirm a fixed effects model is most suitable for this dataset. The dataset shows that there is no alarm for correlation, with all values below 0.3. Furthermore, all the vif-test show a value of 1.05, implying that it can be assumed that there is no multicollinearity in this dataset. Next, the Breusch-Pagan test shows that there is no heteroskedasticity present in this dataset. Then, the Prais-Winsten estimations show values between 1.76-1.82. With 5 independent variables and more than 600 observations, it is safe to assume that the regressions are not influenced by autocorrelation in the dataset. Last, all the Hausman tests show (Prob Chi <0.05) that a fixed model in most suitable for all four measurements of income inequality in all regressions.

An important issue in this dataset is whether the different measurements of income inequality indicate the same level of income inequality. To show that this is true, a correlation between the different measurements of income inequality is presented in Table 3.6 below. This correlation table shows that correlation between the measurements is very close to 1 and significant at the 0.01 level. Implying that all four measurements have a very strong, positive linear relationship. And thus, it can be assumed that the effect of the independent variables is nearly the same for each measurement of income inequality.

Table 3.6 Correlation Matrix for the Income Inequality Measurements

Matrix of correlations				
	Gini	Atkinson	Theil	Mean Log Deviation
Gini	1.000			
Atkinson	0.946***	1.000		
Theil	0.956***	0.981***	1.000	
Mean Log Deviation	0.876***	0.963***	0.933***	1.000

*** p<0.01, ** p<0.05, * p<0.1

Source: Own calculations from Wang et al. (2014)

Note: The correlation matrix shows that the correlation between the different measurements of income inequality is close to 1, and significant at the 0.01 level.

4. Methodology

To estimate the effect of international trade on income inequality at the industry level, this research relies on a pooled time series cross-section regression analysis. Since the dataset is unbalanced, and the dependent variable is reported over different countries and industries a cross-section pooled regression seems most suitable. Furthermore, the different periods of time create a time-series. And thus, a pooled time series cross-section regression analysis. The panel data is constructed as industry-by-country over the time period. Considering many different indicators explaining income inequality, which cannot all be concluded in the model, unit fixed effects are added to the model. The data is reported over time, for 21 different industries in 12 different countries. Therefore, the regression includes industry-by-country and period fixed effects, to account for possible time and specific industry by country shocks. Implying that when there is a certain shock in the Spanish construction industry, the industry-by-country fixed effects controls for this.

4.1 The Model

The combination of the variables presented in Table 3.2 and the choice for a fixed model, lead to the following regression specification:

$$II_{ijt} = \alpha + \beta_1 X_{ijt} + \beta_2 Z_{jt} + \mu_{ij} + \theta_t + \varepsilon_{ijt} \quad (4.1)$$

The subscripts i, j and t respectively represent industry, country and period (time). Where II_{ijt} denotes income inequality, hence the Gini index, Atkinson index, Theil index and Mean Log Deviation. Next, α indicates the intercept. Then X_{ijt} symbolizes the vector of variables reported at the industry level, including Trade, Import and Export. Furthermore, X_{ijt} includes the Industry Growth and Technology variables for the industry level as well. Next, Z_{jt} is the vector of the other independent variables, which are reported at the country level; Government and Unemployment. Then, μ signifies the industry-by-country fixed effects and θ the period (time) fixed effects. Last, ε represents the error term.

The hypotheses based on the regression specification and theoretical framework are summarized in Table 4.1, where hypotheses 1, 2 and 3 hold for all four measurements of income inequality.

Table 4.1 Hypotheses

Hypothesis 1: International Trade
H0: $\beta_1 = 0$
H1: $\beta_1 > 0$
Hypothesis 2: Export Channel
H0: $\beta_1 = 0$
H1: $\beta_1 > 0$
Hypothesis 3: Import Channel
H0: $\beta_1 = 0$
H1: $\beta_1 > 0$

Source: Constructed from general hypothesis and specification 4.1, which is based on the literature review and theoretical framework.
Notes: (i) Hypotheses 1, 2 and 3 hold for all four measurements of income inequality, since the correlation matrix showed that the effect of the independent variables is expected to be the same on all four measurements of income inequality; (ii) The null hypothesis states that there is no effect on income inequality, where the alternative hypothesis includes that there is a positive effect on income inequality.

5. Results

Chapter 5 presents the results of the regression analyses in this research. First, the values of the Bayesian Information Criterion (BIC) show the lowest value for all the regressions with the Atkinson index as dependent variable. Implying that in all regressions the models where the Atkinson index is used are preferred over the other models. Second, the relatively small sample size (N=30) used for the regression analysis per industry, can be an indicator for the high values of explanatory power. Furthermore, this small sample size could undermine the internal and external validity of these regressions. Therefore, the conclusions drawn from regression analyses per industry should be treated carefully.

5.1 Regression Results for all Industries

Table 5.1 below presents the results for the panel data regressions for all countries, all industries. Furthermore, this Table includes the regression for all dependent variables, hence the four income inequality measurements. These regression models contain industry-by-country (group) and period (time) fixed effects. The first thing that is plainly depicted is the explanatory power of the models. The first model (Gini) has an explanatory power of 13.2 percent. This shows that the variables presented in this model, can explain 13.2 percent of the variance in the Gini index. The explanatory power for the other models, varies between 12.1 and 14.1 percent. Showing that the variables in these models can explain between 12.1 and 14.1 percent of the variance in income inequality in the respective model.

Regarding the main explanatory variable, the following can be stated; All four models show that there is no significant effect of international trade on income inequality at the industry level. Implying that the null hypothesis of hypothesis 1 cannot be rejected for any of the income inequality measurements in these models. Indicating that this research cannot find conclusive evidence for the expected positive effect of international trade on income inequality at the industry level. In addition, the regression analyses show that there is no significant effect of economic growth within an industry on income inequality at the industry level.

However, the models present some significant results, which are worth discussing. First, there is a positive effect of technology on income inequality, significant for all four measurements of income inequality. Showing that a ten percent increase of Technology induces an increase in the Gini index, Atkinson index, Theil index and Mean Log Deviation of 0.12, 0.08, 0.20 and 0.18 points respectively[23]. Furthermore, the presented effect coheres with the expectation that technology replaces unskilled labor

[23] Marginal effects calculated as; Mean Technology * (0.1) * coefficient

and therefore decreases the relative demand for unskilled labor (Caroli and Van Reenen, 2001). This decrease in relative demand for unskilled labor induces lower relative factor rewards for unskilled labor and encourage unemployment. The combination of lower wages and unemployment for unskilled labor, implies an increase in wage differential between skilled and unskilled labor and thus an increase in income inequality. Furthermore, unskilled labor is expected to be immobile, implying that they cannot counter these effects by switching economies or industries. For the Atkinson index, the positive effect implies that when technology increases, society has to give up a higher share of their income to reach full income equality.

Next, Table 5.1 indicates a positive effect of the color of the government on income inequality in models 2 and 4. Showing that the color of the government has a positive effect on the Atkinson index and the Mean Log Deviation, of 0.008 and 0.025 respectively. This effect indicates that when Government increases with ten percent, the Atkinson index increases with 0.03 and the Mean Log Deviation with 0.10 points[24]. For the Atkinson index this indicates that if the government becomes more left winged, society has to give up a higher share of income to reach income equality. For the Mean Log Deviation this effect shows that when the government becomes more left winged, income inequality increases. The Atkinson index and Mean Log Deviation tend to be more sensitive to changes in the lower end of the income distribution[25], implying that the color of the government is expected to have the biggest impact at the lower end of the income distribution, since the effect is not significant on the Gini and Theil index. However, a more left-wing oriented government is expected to decrease the income inequality (Solt, 2008; Mohl and Pamp, 2008). This research explains the founded negative effect due to the delay government plans have on a society. It takes a government time to adapt new policies and thus have influence on the income redistribution of a country. However, lagging the Government variable in the analysis implies a lag of four years and a loss of data for 1 period. Indicating a data coverage loss of 25% which led to the decision to not include a lagged variable of Government.

Lastly, Table 5.1 shows a significant positive effect of unemployment on income inequality, with a magnitude of 0.223, 0.172, 0.327 and 0.545 respectively for models 1-4. Implying that a ten percent increase in Unemployment induces an increase in the Gini index, Atkinson index, Theil index and Mean Log Deviation of 0.19, 0.15, 0.28 and 0.47 points respectively[26]. This coheres with logic, since more people face a low/zero income with an increase in unemployment. This diverges the wage difference between

[24] Marginal effects calculated as; Mean Government * (0.1) * coefficient
[25] Since they incorporate a sensitivity parameter of 0.
[26] Marginal effects calculated as; Mean Unemployment * (0.1) * coefficient

incomes and thus increase income inequality. Furthermore, unskilled labor is expected to be immobile and can therefore not counter unemployment by switching economies and industries. Implying a bigger impact of unemployment on the unskilled labor force, which indicates an even higher level of income inequality.

Table 5.1 Panel Data Regression with Trade on Income Inequality for all Industries

	Trade Analysis			
	(1)	(2)	(3)	(4)
	Gini	Atkinson	Theil	MLD
Trade	-0.002	-0.004	-0.009	-0.010
	(0.006)	(0.004)	(0.008)	(0.011)
Technology	0.090**	0.058**	0.142***	0.132*
	(3.595)	(2.392)	(5.147)	(6.780)
Industry Growth	0.028	0.006	0.019	0.014
	(0.029)	(0.019)	(0.041)	(0.054)
Government	0.009	0.008**	0.013	0.025**
	(0.006)	(0.004)	(0.009)	(0.012)
Unemployment	0.223**	0.172***	0.327**	0.545***
	(0.092)	(0.061)	(0.132)	(0.174)
Constant	24.832***	5.173***	9.850***	11.185***
	(1.015)	(0.675)	(1.453)	(1.915)
Observations	619	619	619	619
Adjusted R^2	0.132	0.138	0.121	0.141
BIC	3094.77	2595.131	3534.704	3872.547
Number of Groups	231	231	231	231
Industry-by-Country FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES

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

Next, Table 5.2 indicates whether the effect of trade on income inequality flows through imports (Trump) or exports (new trade models). First, the explanatory power of the models varies between 10.7 and 12.6 percent, implying that the variables used in these models can explain between 10.7 and 12.6 percent of the variance in the respective income inequality measurement.

Both Import and Export show no significant result on any of the four measurements of income inequality. Implying that the null hypothesis for hypotheses 2 and 3 cannot be rejected for any of the income inequality measurements. Indicating that this research cannot determine the effect imports and/or exports have on income inequality at the industry level. In addition, all models show that there is no significant effect of industry growth on any of the income inequality measurements, for both the import and export analysis.

The significant effects in these models are very similar to the trade analysis in Table 5.1, in both magnitude and direction. Therefore, the presented effects are briefly described. First, there is a positive effect of Technology on income inequality. Implying that with an increase in Technology, income inequality increases. Second, Government show a significant, positive effect on the Atkinson index and Mean Log Deviation, in both the import and export analysis. Indicating that the color of the government has a bigger impact on the lower end of the income distribution, since the Gini and Theil index are not significant. The positive effect shows that an increase of left-wing parties in the government, increases income inequality. Third, Unemployment displays a positive effect on income inequality for all income inequality measurements in both the import and export analysis. Implying that with an increase in Unemployment, income inequality increases as well.

Table 5.2 Panel Data Regression with Import and Export on Income Inequality for all Industries

	Import Analysis				Export Analysis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gini	Atkinson	Theil	MLD	Gini	Atkinson	Theil	MLD
Import	-0.001	-0.002	-0.005	-0.003				
	(0.006)	(0.004)	(0.009)	(0.012)				
Export					0.034	0.013	0.022	0.021
					(0.019)	(0.013)	(0.028)	(0.036)
Technology	0.085**	0.054**	0.133**	0.118*	0.087**	0.053**	0.129**	0.117*
	(3.630)	(2.417)	(5.193)	(6.849)	(3.545)	(2.367)	(5.088)	(6.711)
Industry Growth	0.029	0.008	0.022	0.020	0.029	0.008	0.021	0.019
	(0.028)	(0.019)	(0.040)	(0.052)	(0.028)	(0.019)	(0.040)	(0.052)
Government	0.008	0.008*	0.012	0.023*	0.008	0.008*	0.012	0.023*
	(0.006)	(0.004)	(0.009)	(0.012)	(0.006)	(0.004)	(0.009)	(0.012)
Unemployment	0.193**	0.151**	0.285**	0.488***	0.186**	0.150**	0.285**	0.486***
	(0.092)	(0.061)	(0.132)	(0.174)	(0.092)	(0.061)	(0.132)	(0.174)
Constant	25.010***	5.186***	9.882***	11.244***	24.036***	4.745***	9.082***	10.570***
	(0.985)	(0.656)	(1.409)	(1.858)	(1.099)	(0.734)	(1.577)	(2.080)
Observations	619	619	619	619	619	619	619	619
Adjusted R^2	0.119	0.121	0.107	0.124	0.126	0.123	0.108	0.125
BIC	3134.543	2631.036	3577.773	3920.313	3129.533	2629.647	3577.159	3919.869
Number of Groups	231	231	231	231	231	231	231	231
Industry-by-Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES

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

Appendix III includes the robustness analysis for the regression model with all industries. In Table III.1, the main dependent variable (Trade) is replaced by a different proxy for international trade, calculated as the sum of imports and exports over the value added, rather than over the gross output for the respective industry. Furthermore, Import and Export are replaced by Import2 and Export2 in Table III.2. Once again, calculated over the value added, rather than the gross output. The robustness analysis with Trade2, Import2 and Export2 show that there is no significant effect on any of the measurements of income inequality. Implying that the construction of the Trade, Import and Export variables is not the reason for insignificance of the main explanatory variable. In addition, the results of the robustness analysis are fairly identical to the outcomes presented in Tables 5.1 and 5.2. Implying that the model used in this research is adequately robust.

5.2 Regression Results per Industry

Table 5.1 showed that there was no significant effect of international trade on any of the income inequality measurements, for all industries all countries. Then, Table 5.2 showed that this effect remains insignificant when focusing on either the import or export channel of trade. However, when shifting the focus to one industry, rather than all industries, some significant results appear. These results appear in the following (manufacturing) industries; 21t.22 Manufacturing paper, 26. Manufacturing minerals, 27t28. Manufacturing metals[27].

Table 5.3 presents the effect of international trade on income inequality for the manufacturing paper industry. Models 1-4 indicate that income inequality decreases due to an increase in international trade. Indicating that a ten percent increase of Trade, induces the Gini index, Atkinson index, Theil index and Mean Log Deviation to decrease with 0.83, 0.42, 0.87 and 1.00 points respectively[28]. This effect implies that the null hypothesis of hypothesis 1 can be rejected, for all four income inequality measurements. However, the alternative hypothesis of hypothesis should also be rejected, since the presented effect is negative. The negative effect of international trade on income inequality is expected in unskilled intensive industry in an unskilled labor abundant economy. Implying that the manufacturing paper industry might be relatively unskilled labor intensive. Then, international trade increases the relative factor rewards for unskilled labor in unskilled labor abundant economies, which decreases the income inequality within and between industries. Furthermore, it is possible that labor is more mobile for

[27] However, Table 3.5 and Figure 3.3 show that trade in these industries changed less than the average change over all industries.
[28] Marginal effects calculated as; Mean Trade * (0.1) * coefficient

unskilled labor in the manufacturing paper industry. Implying that unskilled labor can easier move to or from the paper industry to counter the possible negative effects of international trade on their income.

Table 5.3 Panel Data Regression with Trade on Income Inequality for the Manufacturing Paper Industry

	Trade Analysis			
	(1) Gini	(2) Atkinson	(3) Theil	(4) MLD
Trade	-0.120*	-0.061**	-0.125*	-0.145**
	(0.060)	(0.028)	(0.064)	(0.060)
Technology	2.062	4.779	18.463	4.433
	(32.097)	(14.839)	(34.701)	(32.134)
Industry Growth	-0.017	0.009	-0.033	0.113
	(0.151)	(0.070)	(0.163)	(0.151)
Government	0.030	0.016	0.031	0.041
	(0.025)	(0.011)	(0.027)	(0.025)
Unemployment	0.092	0.022	0.125	-0.097
	(0.298)	(0.138)	(0.323)	(0.299)
Constant	30.147***	7.634**	12.898	19.488**
	(7.380)	(3.412)	(7.979)	(7.388)
Observations	30	30	30	30
Adjusted R^2	0.555	0.605	0.572	0.649
BIC	142.570	96.280	147.251	142.640
Number of Groups	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES

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

Next, when focusing on the import and export channel of trade, significant results for the Atkinson index and Mean Log Deviation appear in the export analysis. Indicating that the effect of international trade on income inequality flows through the export channel. This effect shows that when Export increases with ten percent, the Atkinson index declines with 0.05 points and the Mean Log Deviation with 0.12 points[29]. Implying that null hypothesis of hypothesis 2 cannot be rejected for any of the income inequality measurements. Moreover, the null hypothesis for hypothesis 3 cannot be rejected for the Gini and Theil index. However, the null hypothesis for hypothesis 3 can be rejected for the Atkinson index and Mean Log Deviation, but the alternative hypothesis should also be rejected, since the presented effect is negative. In addition, since the effect is only significant for the Atkinson index and Mean Log Deviation, the impact seems biggest at lower end of the income distribution. New trade models predict that income inequality

[29] Marginal effects calculated as; Mean Export * (0.1) * coefficient

increases through the export channel, because exporting firms need skilled workers, to become productive enough for exporting. These skilled workers get paid higher wages, which increases the income inequality within and between industries exports. However, the effect presented in Table 5.4 is negative. A possible explanation for this negative effect is that the manufacturing paper industry relies on unskilled labor, and thus implying that for firms to become productive enough to export paper products they should hire more unskilled workers. Indicating that the wage for unskilled workers increases in the manufacturing paper industry due to an increase in relative demand for unskilled labor. And thus, indicating a decrease in income inequality in this industry through the export channel. However, this effect leads to higher income inequality between the manufacturing paper industry and other industries, since the wages for unskilled labor is higher in the paper industry, but the unskilled labor force is immobile to move to this industry for the higher factor rewards. Hence an increase in the wage differential of unskilled workers between industries and thus higher income inequality between industries.

Table 5.4 Panel Data Regression with Import on Income Inequality for the Manufacturing Paper Industry

	Import Analysis				Export Analysis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gini	Atkinson	Theil	MLD	Gini	Atkinson	Theil	MLD
Import	-0.095	-0.045	-0.101	-0.101				
	(0.060)	(0.028)	(0.064)	(0.063)				
Export					-0.032	-0.017*	-0.033	-0.045**
					(0.021)	(0.009)	(0.022)	(0.020)
Technology	6.776	6.728	23.580	7.989	-1.270	3.325	14.940	1.750
	(34.700)	(16.500)	(37.280)	(36.870)	(34.050)	(15.620)	(36.720)	(32.980)
Industry Growth	-0.012	0.009	-0.026	0.106	-0.045	-0.003	-0.063	0.089
	(0.163)	(0.077)	(0.175)	(0.173)	(0.159)	(0.072)	(0.171)	(0.154)
Government	0.031	0.016	0.032	0.038	0.024	0.013	0.024	0.036
	(0.027)	(0.013)	(0.029)	(0.029)	(0.025)	(0.011)	(0.028)	(0.025)
Unemployment	0.101	0.026	0.135	-0.089	0.061	0.006	0.093	-0.137
	(0.315)	(0.150)	(0.339)	(0.335)	(0.318)	(0.146)	(0.343)	(0.308)
Constant	27.900***	6.448	10.560	16.60*	28.570***	6.901*	11.240	17.960**
	(7.623)	(3.624)	(8.189)	(8.099)	(7.746)	(3.554)	(8.353)	(7.504)
Observations	30	30	30	30	30	30	30	30
Adjusted R^2	0.535	0.546	0.559	0.544	0.525	0.588	0.542	0.654
BIC	143.940	100.503	148.122	150.509	144.538	97.533	149.243	142.251
Number of Groups	11	11	11	11	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES

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

The results for the manufacturing minerals and manufacturing metals industries regressions indicate different results, which are presented in Table 5.5-5.8. First, Table 5.5 shows that there is a positive effect of international trade on income inequality for the Atkinson index and Mean Log Deviation in the manufacturing minerals industry. Implying that the effect has the biggest impact on the lower end of the income distribution. Models 2 and 4 show that a ten percent increase in Trade induces, the Atkinson index to increase with 0.69 points and the Mean Log Deviation with 2.13 points[30]. Implying that the null hypothesis for hypothesis 1 can be rejected for the Atkinson index and Mean Log Deviation. However, the null hypothesis for hypothesis 1 cannot be rejected for the Gini and Theil index.

The positive effect of international trade on income inequality is expected, since the countries used in this research are assumed to be relatively skilled labor abundant. With this assumption, international trade increases the relative demand for skilled labor and thus its factor rewards, hence higher wages for the skilled labor force. This leads to an increase in income inequality within industries. Furthermore, this effect increases the wages in skilled intensive industries and thus leads to higher income inequality between industries, which relies on their skill intensity. Secondly, skilled labor is expected to be more mobile. Implying that they can switch to the minerals industry for the relative higher wages. Indicating that income inequality within the minerals industry increases even more. Furthermore, this also implies that income inequality between the minerals industry and industries increases.

[30] Marginal effects calculated as; Mean Trade * (0.1) * coefficient

Table 5.5 Panel Data Regression with Trade on Income Inequality for the Manufacturing Minerals Industry

	Trade Analysis			
	(1)	(2)	(3)	(4)
	Gini	Atkinson	Theil	MLD
Trade	0.169	0.100*	0.170	0.307**
	(0.115)	(0.050)	(0.115)	(0.106)
Technology	78.395	26.560	63.163	41.398
	(57.476)	(25.101)	(57.582)	(52.821)
Industry Growth	0.034	-0.020	-0.056	-0.041
	(0.209)	(0.091)	(0.210)	(0.193)
Government	-0.011	-0.007	-0.015	-0.014
	(0.027)	(0.012)	(0.027)	(0.025)
Unemployment	-0.100	-0.066	-0.082	-0.241
	(0.355)	(0.155)	(0.356)	(0.326)
Constant	12.951*	-0.212	-1.029	-1.201
	(6.354)	(2.775)	(6.365)	(5.839)
Observations	30	30	30	30
Adjusted R^2	0.463	0.487	0.422	0.575
BIC	153.679	103.972	153.790	148.611
Number of Groups	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES

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

Next, Table 5.6 indicates that the effect of international trade on income inequality for the manufacturing minerals industry flows through the import channel, since the effects are significant for import analysis. Models 1-4 indicates that a ten percent increase in Import induces the Gini index, Atkinson index, Theil index and Mean Log Deviation to increase with 0.68, 0.34, 0.64 and 0.88 points respectively[31]. Implying that the null hypothesis of hypothesis 2 can be rejected for all four measurements of income inequality. However, the null hypothesis of hypothesis 3 cannot be rejected for any of the income inequality measurements. The presented positive effect of import on income inequality coheres with Trumps argument. Due to international trade, the relative demand for unskilled labor in the manufacturing minerals industry declines. This leads to lower wages and unemployment for the unskilled labor force in the manufacturing minerals industry. And since the unskilled labor force is immobile, they cannot counter these effects by moving to a different industry or economy. This combination increases the income inequality within the minerals industry through imports, as argued by Donald Trump.

[31] Marginal effects calculated as; Mean Import * (0.1) * coefficient

Table 5.6 Panel Data Regression with Import on Income Inequality for the Manufacturing Minerals Industry

	Import Analysis				Export Analysis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gini	Atkinson	Theil	MLD	Gini	Atkinson	Theil	MLD
Import	0.164*	0.083**	0.154*	0.213**				
	(0.0780)	(0.0350)	(0.0800)	(0.0805)				
Export					0.013	0.029	0.029	0.129
					(0.077)	(0.034)	(0.076)	(0.077)
Technology	62.310	18.550	48.150	21.320	79.920	27.260	64.540	43.120
	(53.780)	(24.130)	(55.200)	(55.550)	(62.780)	(28.420)	(62.600)	(62.640)
Industry Growth	0.077	0.001	-0.015	0.009	0.025	-0.022	-0.062	-0.042
	(0.195)	(0.087)	(0.200)	(0.202)	(0.229)	(0.104)	(0.228)	(0.228)
Government	-0.007	-0.005	-0.011	-0.007	-0.008	-0.005	-0.012	-0.009
	(0.024)	(0.011)	(0.025)	(0.025)	(0.029)	(0.013)	(0.029)	(0.029)
Unemployment	0.132	0.061	0.143	0.117	-0.018	-0.062	-0.033	-0.310
	(0.326)	(0.146)	(0.334)	(0.336)	(0.412)	(0.186)	(0.411)	(0.411)
Constant	11.510*	-0.526	-2.071	-0.606	17.450**	1.946	3.106	4.415
	(5.847)	(2.624)	(6.002)	(6.040)	(6.232)	(2.821)	(6.214)	(6.218)
Observations	30	30	30	30	30	30	30	30
Adjusted R^2	0.629	0.602	0.553	0.597	0.369	0.363	0.329	0.436
BIC	142.583	96.352	146.057	147.056	158.513	110.466	158.258	157.099
Number of Groups	11	11	11	11	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	NO	NO	NO	NO	NO	NO	NO
Sector FE	NO	NO	NO	NO	NO	NO	NO	NO

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

Next, Table 5.7 presents that there is a positive effect of international trade on income inequality for the Gini, Atkinson and Theil index in the manufacturing metals industry[32]. Models 1-3 show that a ten percent increase in Trade causes the Gini, Atkinson and Theil index to increases with 0.85, 0.46, 1.07 points respectively in the manufacturing metals industry[33]. Implying that the null hypothesis for hypothesis 1 can be rejected for these three income inequality measurements. However, the null hypothesis of hypothesis 1 cannot be rejected for the Mean Log Deviation. The presented positive effect of international trade on income inequality is expected and similar to the manufacturing minerals industry, implying that the same argumentation for this effect holds and is therefore not described here. Furthermore, Table 5.7 shows

[32] This research cannot explain why there is no significant effect on the Mean Log Deviation. This effect remains insignificant when removing possible outliers.
[33] Marginal effects calculated as; Mean Trade * (0.1) * coefficient

that there is a negative effect of industry growth on the Gini and Theil index, with a magnitude of .234 and .199 respectively. Implying that when the manufacturing metals industry grows, income inequality declines, which coheres with the predictions of Kuznets (1955).

Table 5.7 Panel Data Regression with Trade on Income Inequality for the Manufacturing Metals Industry

	Trade Analysis			
	(1)	(2)	(3)	(4)
	Gini	Atkinson	Theil	MLD
Trade	0.123*	0.066*	0.155**	0.134
	(0.061)	(0.032)	(0.066)	(0.087)
Technology	-18.814	-8.610	-18.793	-17.271
	(15.307)	(7.925)	(16.383)	(21.681)
Industry Growth	-0.243**	-0.089	-0.199*	-0.151
	(0.100)	(0.052)	(0.107)	(0.141)
Government	0.000	-0.001	-0.014	0.014
	(0.022)	(0.011)	(0.024)	(0.031)
Unemployment	0.175	0.163	0.405	0.340
	(0.283)	(0.147)	(0.303)	(0.401)
Constant	14.696***	-0.162	-2.388	0.330
	(4.624)	(2.394)	(4.950)	(6.550)
Observations	30	30	30	30
Adjusted R^2	0.727	0.676	0.676	0.632
BIC	136.789	97.292	140.865	157.677
Number of Groups	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES

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

Table 5.8 presents that the effect of international trade on income inequality flows through the import channel. Showing that a ten percent increase in Import leads to an increase in the Gini index, Atkinson index, Theil index and Mean Log Deviation of 0.34, 0.19, 0.42 and 0.44 points respectively[34]. Implying that the null hypothesis for hypothesis 2 can be rejected for all four income inequality measurements. And the null hypothesis for hypothesis 3 cannot be rejected for any of the income inequality measurements. The presented positive effect of import on income inequality for the manufacturing metals industry is similar to the effects in the manufacturing minerals industry and are therefore not described here.

[34] Marginal effects calculated as; Mean Import * (0.1) * coefficient

Furthermore, Table 5.8 show to other significant effects worth discussing. First, a negative effect of Technology on the Gini, Atkinson and Theil index in the import analysis. Implying that a ten percent increase in Technology induces the Gini, Atkinson and Theil index to decrease by 0.36, 0.18 and 0.37 points respectively[35]. Technology can create jobs (Van Reenen, 1997; Smolny, 1998; Greenan and Gullec, 2000), which induces a decline in unemployment. This leads to a decrease of people with a low/zero income and thus a fall in income inequality. Second, Table 5.8 shows a negative effect of Industry Growth on income inequality for the Gini, Atkinson and Theil index in the import analysis and for the Gini and Theil index in the export analysis. This effect coheres with the predictions of Kuznets (1955).

Table 5.8 Panel Data Regression with Import on Income Inequality for the Manufacturing Metals Industry

	Import Analysis				Export Analysis			
	(1) Gini	(2) Atkinson	(3) Theil	(4) MLD	(5) Gini	(6) Atkinson	(7) Theil	(8) MLD
Import	0.084***	0.046***	0.102***	0.106**				
	(0.024)	(0.012)	(0.025)	(0.034)				
Export					0.039	0.021	0.054	0.036
					(0.024)	(0.012)	(0.025)	(0.034)
Technology	-0.259*	-0.127*	-0.265*	-28.530	-13.310	-5.659	-13.170	-10.100
	(12.690)	(6.249)	(13.080)	(17.930)	(15.320)	(7.956)	(16.010)	(21.610)
Industry Growth	-0.217**	-0.0744*	-0.166*	-0.120	-0.257**	-0.0965	-0.221*	-0.163
	(0.081)	(0.039)	(0.084)	(0.115)	(0.106)	(0.055)	(0.111)	(0.150)
Government	0.007	0.003	-0.005	0.021	0.005	0.002	-0.010	0.021
	(0.017)	(0.008)	(0.017)	(0.024)	(0.023)	(0.011)	(0.024)	(0.032)
Unemployment	0.005	0.070	0.199	0.132	0.095	0.120	0.298	0.259
	(0.233)	(0.115)	(0.240)	(0.330)	(0.299)	(0.155)	(0.313)	(0.422)
Constant	16.640***	0.822	0.326	1.627	18.970***	2.135	2.605	5.350
	(2.927)	(1.441)	(3.015)	(4.133)	(3.671)	(1.907)	(3.838)	(5.179)
Observations	30	30	30	30	30	30	30	30
Adjusted R^2	0.703	0.646	0.601	0.639	0.683	0.618	0.631	0.580
BIC	139.334	99.984	147.086	157.093	141.321	102.265	144.764	161.677
Number of Groups	11	11	11	11	11	11	11	11
Industry-by-Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES

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

[35] Marginal effects calculated as; Mean Technology * (0.1) * coefficient

6. Discussion

Tables 5.1 and 5.2 show that the null hypothesis for hypotheses 1, 2 and 3 cannot be rejected in the base model with all countries and all industries. Implying that this research cannot conclude the effect of international trade, imports or exports on income inequality at the industry level. Nevertheless, the opposite, a negative significant effect has also not been indicated in any of the models for all countries, all industries. However, when focusing on specific industries, some significant results appear. These results should be treated very carefully, since the sample size is very small (N=30). The null hypothesis for hypotheses 1, 2 and 3 cannot be rejected for the regression for the manufacturing paper industry. Since the regression shows a negative effect of international trade and export on income inequality. Implying that in the manufacturing paper industry, international trade increases income inequality through exports. This effect interferes with the predictions and is expected in an unskilled labor-intensive industry in an unskilled labor economy. In such a setting, international trade increases the relative factor rewards, hence wages, for the unskilled labor force due an increase in their relative demand and thus a decrease in income inequality. A second explanation could be that unskilled labor in the manufacturing paper industry is more mobile. Implying that the unskilled labor force can counter the negative effects of international trade on their income by switching industries or economies.

Next, the null hypothesis for hypotheses 1 and 2 can be rejected for the regression for the manufacturing minerals and metals industry. Implying that in the manufacturing minerals and metals industry, international trade increases income inequality through imports. This finding supports the argument of Donald Trump, who states that imports from cheap labor economies decreases the relative demand for unskilled labor in the United States. This leads to a decrease in the wages for unskilled labor and higher unemployment in the United States. Since unskilled labor is expected to be rather immobile, they cannot counter the negative effects of international trade on their income by switching economies or industries, which implies the effect of international trade on income inequality is strengthened by labor mobility.

The results per industry should be treated carefully, due to a small sample size. However, a critical conclusion can be drawn from the regressions per specific industry. The effect of international trade on income inequality differs per industry, in direction and magnitude. Furthermore, the increase in income inequality seems to flow through exports, while a decrease flows through imports. Implying that international trade has different effects on the incomes within and between industries, which shows that analysis at the industry level is crucial for understanding the relationship between international trade and income inequality in general.

Regarding to the inconclusive results, a few these inconsistencies with respect to the theory could be explained by having a closer look at the dataset used for this research. For the explanatory variable of this research, international trade, not many regards can be made. International trade is proxied by the sum of imports and exports divided by the gross output at the specific industry in the respective country. Furthermore, the robustness analysis showed the same results, where international trade is proxied by the sum of imports and exports divided by the value added of the specific industry in the respective country. Another proxy for international trade could be the sum of imports and exports divided by the GDP in that specific industry in the respective country. This might generate some results, since this proxy showed results in other research (Milanovic, 2005; Bertola, 2008; Faustino and Vali, 2013) However, GDP data is not available at the industry level and is therefore not an option for this research.

Regarding the independent variable in this research, income inequality, three implications should be mentioned. First, the income inequality measurements are generated by the individual level data of the Luxembourg Income Studies. This database in unbalanced, implying that the data of the individuals is not from the same individual at each time period. This could create disturbances in the dataset, and therefore present these insignificant results. Indicating that when the dataset is balanced, rather than unbalanced, results may differ. Second, the Luxembourg Income Study reports data in waves. Implying that data is not reported for each year, but for every few years. This creates gaps in the time series, which this research countered by clustering years in four different periods. However, this led to a time period, where not every country was covered in each period. Shorter time periods, where every country is represented at each period, is not possible because it creates autocorrelation in the dataset. Therefore, this research is restricted to four periods, each containing four years, but not data for every country. This could be a serious harm for the outcome of the regression and thus explain the insignificant results. Furthermore, this short time period deducts this research from including lagged variables, because that would sacrifice 25% of the data coverage. Third, this research is restricted to certain control variables, due the lack of data reported at the industry level. For example, a variable indicating the difference in education or human capital is preferred in the analysis. However, there is no data available for education or human capital at the industry level, which forced this research to use Technology as a proxy for skill difference between industries. Implying that when more industry level data is available, a more complete model could be constructed. This more comprehensive model could be a start in explaining the income inequality at the industry level and thus helps to understand the effect of international trade on income inequality in general.

Another important point are the possible endogeneity and reverse causality following from it, in this dataset. However, when regressing the residuals of the income inequality measurements on international trade (Davidson and MacKinnon, 1993), there is no sign of possible endogeneity in the dataset. Nevertheless, the results of the regressions should still be treated carefully. There is a possible effect of income inequality on international trade, which indicates that there could be reversed causality in the dataset.

7. Conclusion

This research discusses the effect of international trade on income inequality at the industry level. Traditional trade models describe that international trade changes the factor rewards for skilled and unskilled labor within and between industries, which leads to changes in income inequality (Heckscher and Ohlin, 1933; Stolper and Samuelson, 1941; Wood, 1994; Davis, 1996; Feenstra and Hanson, 1996). New trade models argue that this effect flows through the export channel of international trade. They explain that exporting firms require more skilled labor and therefore pay higher wages. Implying that these firms contribute to income inequality within and between industries through the export channel of international trade (Melitz, 2003; Verhoogen, 2008). On the other hand, United States president Donald Trump argues that the effect of international trade on income inequality flows through the import channel. He argues that imports from cheap labor countries reduces the relative demand for unskilled labor in the United States. Implying relative lower wages and higher unemployment for the unskilled labor force, hence an increase in income inequality. Furthermore, since international trade and factor mobility are assumed to be complements, the effects of international trade, import and export are enhanced by the (im)mobility of (un)skilled workers.

The difference between skilled and unskilled labor intensities (OECD, 2011; World Bank, 2016; Anderson et al, 2018), the share of exporting firms (World Trade Organization, 2000; Bernard et al, 2007; ISGEP, 2008), trade intensities and income inequality significantly differ per industry. The differences in these four aspects imply that analysis at the industry level is crucial for understanding the effect of international trade on income inequality in general.

The literature review and theoretical framework present a positive effect of international trade on income inequality, when assuming that the countries used in this research are relatively skilled labor abundant. This leads to the hypotheses that there are positive effects of international trade, import and export on income inequality at the industry level.

The dataset used in this research stems from Wang et al. (2014) which presents the income inequality measurements for the time-period 1986-2005, for 12 countries, covering 21 industries. International trade data is collected from OECD (2012) and EBOPS (2002). Furthermore, the control variables added in the regression are: Industry Growth (EU-KLEMS, 2011), Technology (EU-KLEMS, 2011), Government (Armingeon et al., 2012) and Unemployment (ILO, 2017). The availability of international trade data at the industry level, leads to a time period of 1990-2005, divided in four periods.

A panel data regression could not conclude the effect of international trade on income inequality. However, when specified per industry, there appears a negative effect in the manufacturing paper industry of international trade on income inequality, which flows through the export channel. Furthermore, for the manufacturing minerals and metals industry international trade has a positive effect on income inequality through the import channel. Implying that there is an effect of international trade on income inequality at the industry level, and this effect differs per industry in direction, magnitude and channel. However, these results should be treated carefully, due to the small sample size (N=30) used for the per industry regression analyses.

This research acknowledges its limitations, which are mainly due to data shortage. The time period is inconsistent and the panel data unbalanced. Furthermore, there is limited data available at the industry level for extensive research. Therefore, this research argues further research to focus three aspects, which are; 1) Different proxies for international trade; 2) Balanced data for income inequality measurements, covering whole time periods for the same industries, and; 3) More data at the industry level, for a more complete model.

Lastly, the model used in this research can be extended and modified for other interesting aspects in future research. For example, the effect of certain trade agreements (e.g. TTIP), the entrance of countries in the World Trade Organization (e.g. China), change in trade barriers and costs, change of radical political views in countries (e.g. Turkey, Brexit), shocks in certain industries (e.g. bad harvest) and innovations in particular industries (e.g. electric cars).

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Appendix I: Data Summary

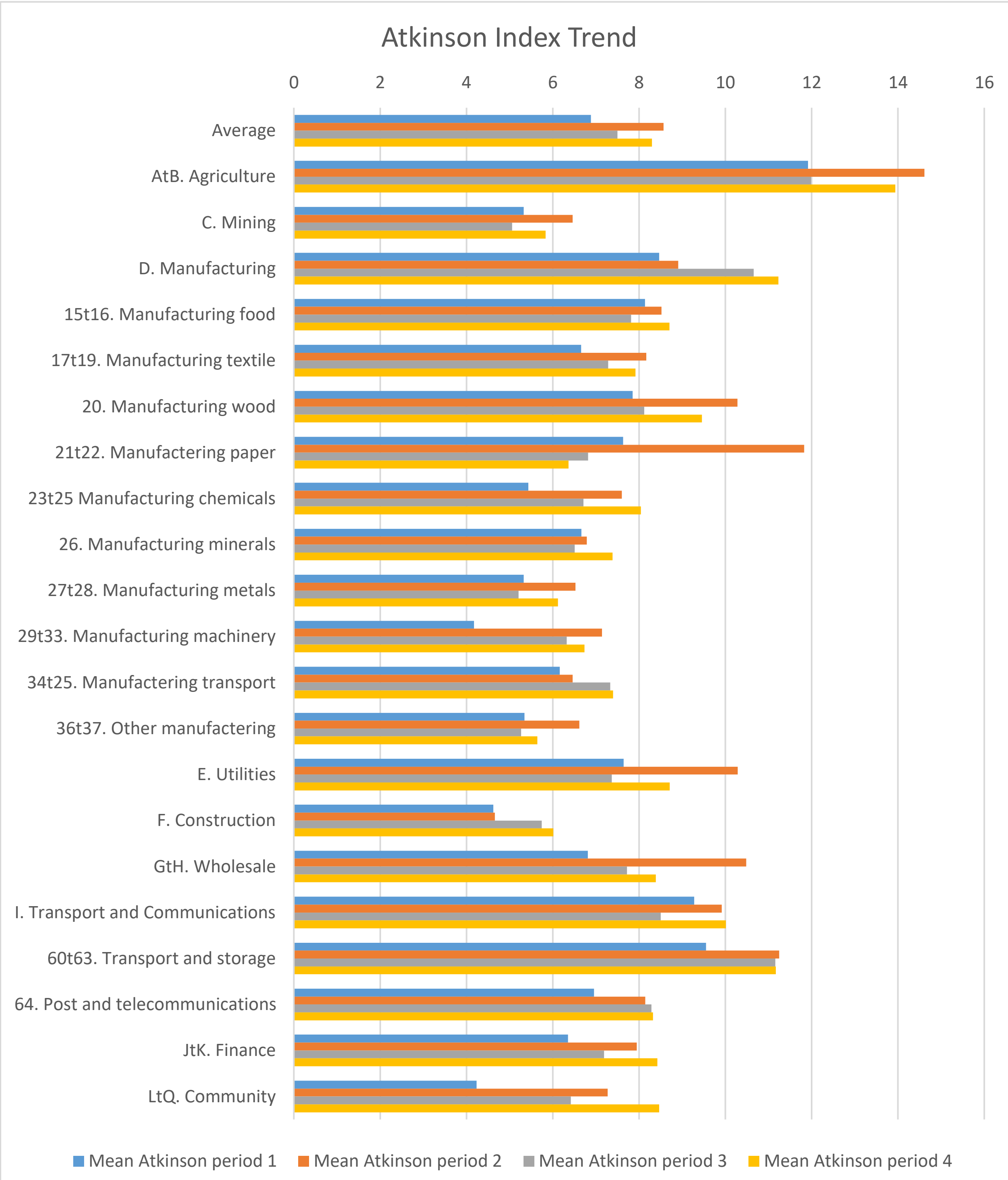
Table I.1 Data Summary

	Observations	Mean	SD	Minimum value	Maximum value
Gini	689	29.44	6.42	9.54	60.82
Atkinson	689	7.96	3.85	1.32	45.66
Theil	689	16.02	8.10	2.52	85.78
Mean_Log_Deviation	689	18.25	10.62	2.69	151.40
Trade	654	69.30	216.50	0	3,803
Import	654	41.45	146.90	0	2,650
Export	654	27.75	71.27	0	1,170
Trade2	654	193.90	520.30	0	8,667
Import2	654	108.00	348.00	0	6,040
Export2	654	75.83	183.70	0	2,670
Industry Growth	630	3.05	7.55	-35.75	50.69
Technology	630	13.80	12.70	0	100
Government	693	40.98	40.44	0	100
Unemployment	693	8.67	4.44	3.99	22.67
Number of groups	231	231	231	231	231

Source: Own calculations based on Wang et al. (2014), OECD (2012), EBOPS (2012), EU-KLEMS (2011), Armingeon et al. (2012) and ILO (2017)
Notes: (i) The data summary shows that there are no alarming missings nor outliers in this dataset; (ii) The (low) minimum value of Gini of 9.54 is found in the mining industry in Belgium, 1995 and could be linked to the spike in trade for that same industry, country, period combination (see Table 3.5). However, removing these 'outliers' do not significantly alter the results of the regressions.

Appendix II: Income Inequality Trends

Figure II.1 Atkinson Index over Time and across Sectors for all Countries



Source: Based on own calculations from Wang et al. (2014)

Notes: (i) This Figure displays the trends in the Atkinson index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table II.1.

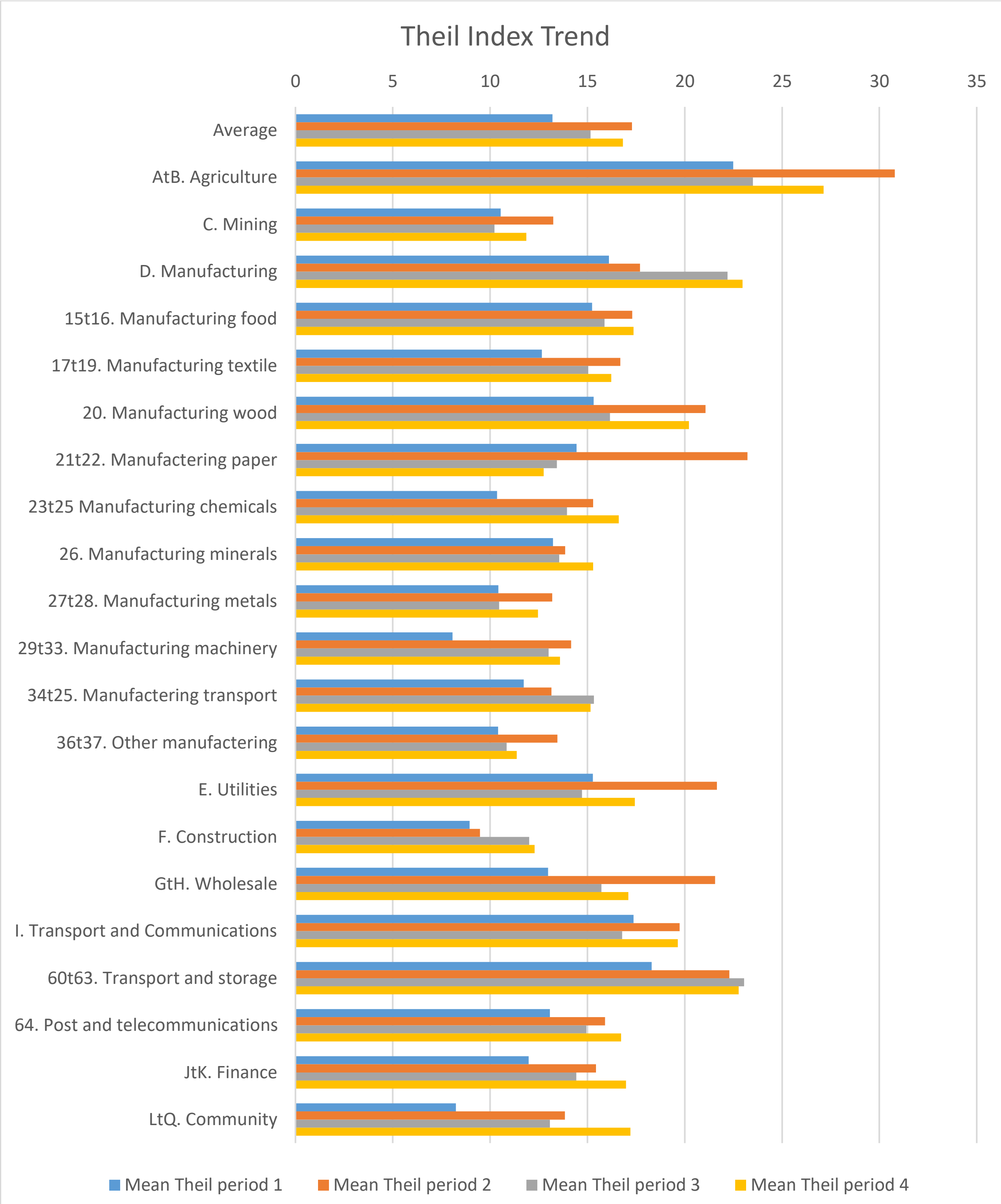
Table II.1 Atkinson Index over Time and across Sectors for all Countries

Industry	Period 1	Period 2	Period 3	Period 4	Δ Atkinson	Average Periods
AtB. Agriculture	11.92	14.61	11.99	13.94	2.02	13.11
C. Mining	5.33	6.46	5.06	5.83	0.50	5.67
D. Manufacturing	8.47	8.91	10.66	11.23	2.77	9.82
15t16. Manufacturing food	8.14	8.52	7.81	8.71	0.57	8.29
17t19. Manufacturing textile	6.66	8.17	7.29	7.91	1.26	7.51
20. Manufacturing wood	7.85	10.28	8.12	9.46	1.61	8.93
21t22. Manufacturing paper	7.63	11.83	6.82	6.36	-1.26	8.16
23t25 Manufacturing chemicals	5.44	7.60	6.71	8.04	2.60	6.95
26. Manufacturing minerals	6.66	6.79	6.51	7.39	0.73	6.84
27t28. Manufacturing metals	5.33	6.53	5.21	6.12	0.79	5.80
29t33. Manufacturing machinery	4.17	7.14	6.32	6.74	2.56	6.09
34t25. Manufacturing transport	6.16	6.46	7.33	7.40	1.24	6.84
36t37. Other manufacturing	5.34	6.62	5.27	5.64	0.30	5.72
E. Utilities	7.64	10.29	7.37	8.71	1.07	8.50
F. Construction	4.62	4.66	5.75	6.02	1.40	5.26
GtH. Wholesale	6.82	10.48	7.72	8.39	1.57	8.35
I. Transport and Communications	9.28	9.92	8.50	10.01	0.73	9.43
60t63. Transport and storage	9.55	11.25	11.16	11.17	1.62	10.78
64. Post and telecommunications	6.96	8.15	8.28	8.32	1.36	7.93
JtK. Finance	6.35	7.95	7.19	8.42	2.07	7.48
LtQ. Community	4.23	7.27	6.42	8.46	4.23	6.60
Average Industries	6.88	8.57	7.50	8.30	1.42	7.81

Source: Based on own calculations from Wang et al. (2014)

Notes: (i) This Table displays the trends in the Atkinson index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Atkinson is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v) Visual presentation of this trend can be found in Figure II.1.

Figure II.2 Theil Index over Time and across Sectors for all Countries



Source: Based on own calculations from Wang et al. (2014)
Notes: (i) This Figure displays the trends in the Theil index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table II.2.

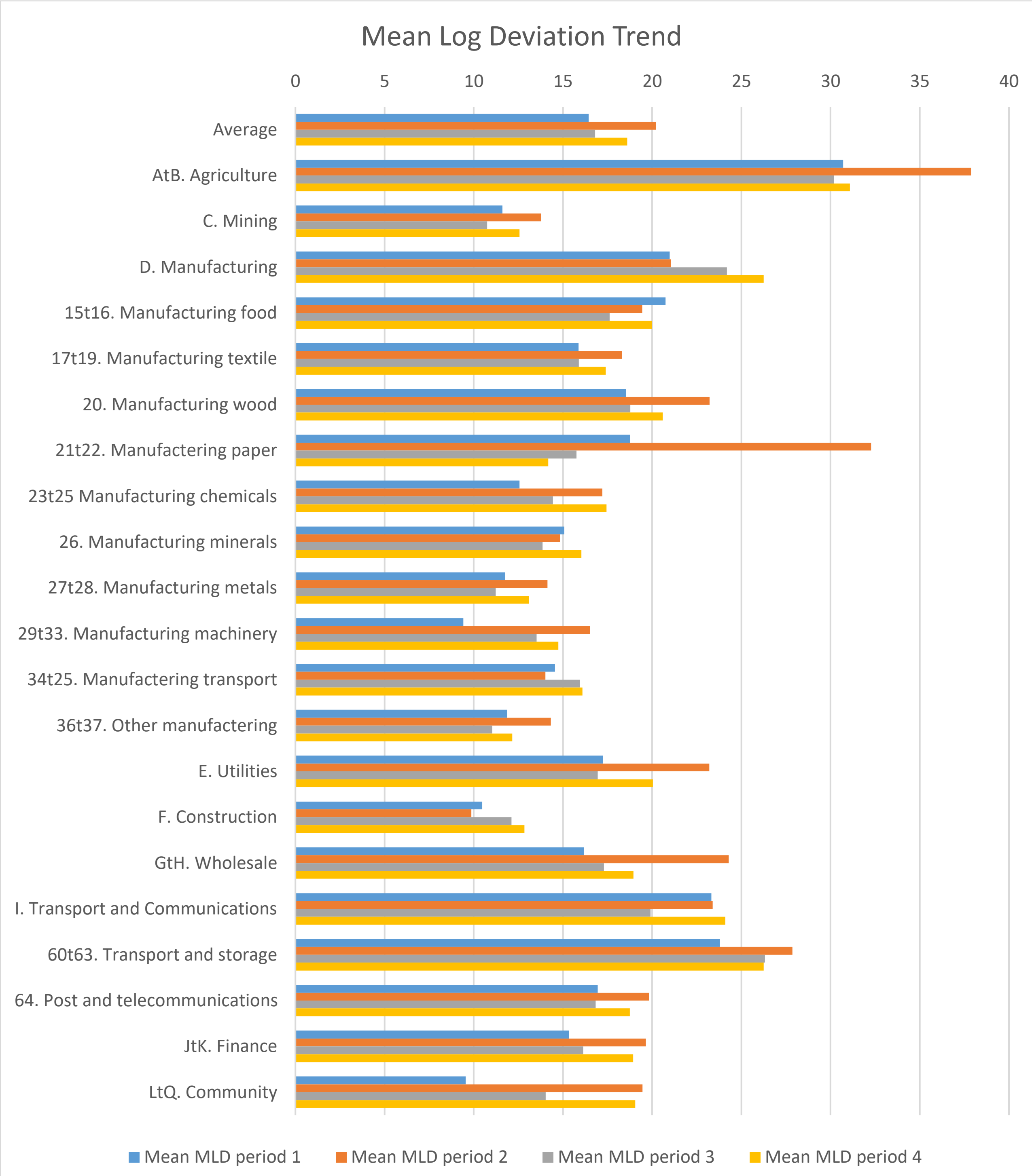
Table II.2 Theil Index over Time and across Sectors for all Countries

Industry	Period 1	Period 2	Period 3	Period 4	Δ Theil	Average Periods
AtB. Agriculture	22.49	30.79	23.50	27.14	4.64	27.14
C. Mining	10.54	13.25	10.23	11.86	1.32	11.80
D. Manufacturing	16.10	17.71	22.20	22.97	6.87	21.46
15t16. Manufacturing food	15.23	17.30	15.88	17.37	2.13	16.98
17t19. Manufacturing textile	12.66	16.69	15.04	16.22	3.56	16.04
20. Manufacturing wood	15.32	21.07	16.16	20.21	4.89	19.41
21t22. Manufacturing paper	14.44	23.22	13.44	12.75	-1.69	15.54
23t25 Manufacturing chemicals	10.36	15.30	13.95	16.61	6.25	15.62
26. Manufacturing minerals	13.23	13.86	13.55	15.29	2.06	14.50
27t28. Manufacturing metals	10.43	13.20	10.46	12.47	2.04	12.15
29t33. Manufacturing machinery	8.07	14.16	13.01	13.60	5.53	13.59
34t25. Manufacturing transport	11.72	13.15	15.34	15.16	3.43	14.70
36t37. Other manufacturing	10.42	13.46	10.86	11.37	0.96	11.76
E. Utilities	15.28	21.65	14.73	17.44	2.16	17.82
F. Construction	8.95	9.48	12.01	12.29	3.34	11.52
GtH. Wholesale	12.98	21.55	15.72	17.10	4.12	17.87
I. Transport and Communications	17.36	19.73	16.78	19.65	2.29	18.95
60t63. Transport and storage	18.30	22.30	23.05	22.77	4.48	22.72
64. Post and telecommunications	13.08	15.91	14.94	16.73	3.65	16.08
JtK. Finance	11.98	15.44	14.42	16.99	5.01	15.96
LtQ. Community	8.25	13.84	13.07	17.21	8.96	15.33
Average Industries	13.20	17.29	15.16	16.82	3.62	16.52

Source: Based on own calculations from Wang et al. (2014)

Notes: (i) This Table displays the trends in the Theil index over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Theil is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v Visual presentation of this trend can be found in Figure II.2.

Figure II.3 Mean Log Deviation over Time and across Sectors for all Countries



Source: Based on own calculations from Wang et al. (2014)

Notes: (i) This Figure displays the trends in the Mean Log Deviation over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Numerical presentation of this trend can be found in Table II.3.

Table II.3 Mean Log Deviation over Time and across Sectors for all Countries

Industry	Period 1	Period 2	Period 3	Period 4	Δ MLD	Average Periods
AtB. Agriculture	30.71	37.87	30.20	31.09	0.38	32.47
C. Mining	11.61	13.79	10.75	12.56	0.95	12.18
D. Manufacturing	20.98	21.05	24.19	26.25	5.27	23.12
15t16. Manufacturing food	20.75	19.45	17.62	19.99	-0.76	19.45
17t19. Manufacturing textile	15.88	18.32	15.89	17.40	1.52	16.87
20. Manufacturing wood	18.54	23.21	18.77	20.60	2.06	20.28
21t22. Manufacturing paper	18.76	32.28	15.75	14.17	-4.59	20.24
23t25 Manufacturing chemicals	12.57	17.20	14.44	17.45	4.88	15.41
26. Manufacturing minerals	15.07	14.85	13.86	16.04	0.96	14.95
27t28. Manufacturing metals	11.76	14.14	11.22	13.10	1.34	12.55
29t33. Manufacturing machinery	9.42	16.52	13.52	14.74	5.33	13.55
34t25. Manufacturing transport	14.55	14.02	15.96	16.09	1.54	15.15
36t37. Other manufacturing	11.86	14.33	11.04	12.16	0.30	12.35
E. Utilities	17.25	23.20	16.94	20.03	2.79	19.36
F. Construction	10.47	9.86	12.12	12.84	2.37	11.32
GtH. Wholesale	16.18	24.30	17.30	18.95	2.77	19.18
I. Transport and Communications	23.32	23.39	19.91	24.10	0.78	22.68
60t63. Transport and storage	23.80	27.87	26.32	26.25	2.45	26.06
64. Post and telecommunications	16.95	19.83	16.83	18.74	1.80	18.09
JtK. Finance	15.33	19.64	16.13	18.93	3.60	17.51
LtQ. Community	9.54	19.46	14.04	19.06	9.52	15.52
Average Industries	16.44	20.22	16.80	18.60	2.15	18.01

Source: Based on own calculations from Wang et al. (2014)

Notes: (i) This Table displays the trends in the Mean Log Deviation over time for all countries, all industries, where period 1 = 1990-1993, period 2 = 1994-1997, period 3 = 1998-2001, period 4 = 2002-2005; (ii) Change in Mean Log Deviation is calculated as period 4 minus period 1; (iii) Average over periods is calculated as the sum of all periods divided by 4 and is therefore unweighted; (iv) Average over industries is calculated as the sum of all industries divided by 21 and is therefore unweighted; (v Visual presentation of this trend can be found in Figure II.3.

Appendix III Robustness

Table III.1 Panel Data Regression with Trade2 on Income Inequality for all Industries

	Trade Analysis			
	(1)	(2)	(3)	(4)
	Gini	Atkinson	Theil	MLD
Trade2	-0.001	-0.001	-0.003	-0.003
	(0.002)	(0.001)	(0.003)	(0.004)
Technology	9.281**	6.127**	15.006***	13.543*
	(3.819)	(2.536)	(5.456)	(7.185)
Industry Growth	0.026	0.005	0.017	0.011
	(0.029)	(0.019)	(0.041)	(0.054)
Government	0.011	0.010**	0.014	0.029**
	(0.007)	(0.005)	(0.010)	(0.013)
Unemployment	0.185*	0.152**	0.309**	0.469**
	(0.102)	(0.068)	(0.145)	(0.191)
Constant	25.019***	5.168***	9.601***	11.431***
	(1.113)	(0.739)	(1.591)	(2.095)
Observations	619	619	619	619
Adjusted R^2	0.122	0.131	0.117	0.134
BIC	3036.298	2546.428	3462.850	3792.177
Number of Groups	231	231	231	231
Industry-by-Country FE	YES	YES	YES	YES
Period FE	YES	YES	YES	YES

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

Table III.2 Panel Data Regression with Import2 and Export2 on Income Inequality for all Industries

	Import Analysis				Export Analysis			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gini	Atkinson	Theil	MLD	Gini	Atkinson	Theil	MLD
Import2	-0.002	-0.002	-0.003	-0.003				
	(0.002)	(0.001)	(0.003)	(0.004)				
Export2					0.011	0.000	0.002	-0.003
					(0.008)	(0.005)	(0.011)	(0.014)
Technology	10.158***	6.420***	15.801***	13.887**	9.594***	5.880**	14.613***	12.870**
	(3.489)	(2.321)	(4.985)	(6.577)	(3.405)	(2.273)	(4.883)	(6.436)
Industry Growth	0.033	0.010	0.027	0.025	0.031	0.010	0.027	0.026
	(0.028)	(0.018)	(0.040)	(0.052)	(0.028)	(0.019)	(0.040)	(0.053)
Government	0.008	0.008*	0.012	0.023*	0.007	0.008*	0.012	0.023*
	(0.006)	(0.004)	(0.009)	(0.012)	(0.006)	(0.004)	(0.009)	(0.012)
Unemployment	0.179*	0.143**	0.274**	0.457***	0.174*	0.144**	0.276**	0.462***
	(0.092)	(0.061)	(0.131)	(0.173)	(0.092)	(0.061)	(0.131)	(0.173)
Constant	25.060***	5.208***	9.823***	11.435***	24.148***	5.071***	9.429***	11.474***
	(0.953)	(0.634)	(1.361)	(1.796)	(1.090)	(0.728)	(1.563)	(2.060)
Observations	619	619	619	619	619	619	619	619
Adjusted R^2	0.122	0.125	0.114	0.123	0.126	0.122	0.111	0.122
BIC	3159.603	2651.614	3604.044	3949.530	3157.167	2653.614	3606.086	3950.333
Number of Groups	231	231	231	231	231	231	231	231
Industry-by-Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Period FE	YES	YES	YES	YES	YES	YES	YES	YES

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