The relationship between natural resource rents and diversification in developed and developing countries: 1995 – 2015

Bachelor Thesis 2021

Author: Mathijs Lenderink
Supervisor: dr. Burak Uras
Second reader: Ayse Hazal Sezer
Date: 22-6-2021
ANR: 337898
SNR: 2021146
Program: BSc Thesis for Economics
Words: 7764

Abstract

This paper studies the relationship between the amount of natural resource rents and the level of diversification of a country's economy. Using a fixed effects model taking time and country fixed effects into account I create a model with the Herfindahl-Hirschman index as diversification index, GDP as a measurement of size of an economy and GDP per capita as a measurement of economic development. With two datasets, the first consisting of 135 developing countries and the second consisting of 36 developed countries, both with data from the years 1995 till 2015, I conclude that there is a statistically significant negative relationship between natural resource rents and the level of diversification in both developing and developed countries. Furthermore, I also conclude that a higher GDP also has a statistically significant negative relationship with the level of diversification in developing countries.

Contents

1. Introduction

Developing countries with large natural resource reserves often heavily depend on these resources as a source of income. A large share of their gross domestic product consists of exports of these natural resources. It is expected that these large reserves have a positive effect on economic growth in a country. However, this is often not the case. Large natural resource reserves often inhibit countries from long-run economic growth.

One of the main reasons for this is the Dutch disease, which explains how an economic increase in one sector can crowd out other sectors. The Dutch disease is the effect of unstable exchange rates due to natural resource exports on the economy of a country (Gylfason, 2006). This effect is called the Dutch disease due to the decline in manufacturing in the Netherlands after the discovery of large natural gas reserves in 1959. The Dutch disease partly explains how the export of natural resources can result in instability also for other economic sectors within a country. The Dutch disease can be prevented by increasing the economic diversification of a country, thus increasing the number of active sectors in the economy of a country. For example, for export diversification, an increase in the number of sectors exporting products will result in a lower dependency on one specific good or resource as the main income for a country.

Economic diversification is important for a country for multiple reasons. For example, export diversification, which is a large part of economic diversification, is associated with higher long-run economic growth. Also, diversification provides more information about foreign markets. Finally, diversification reduces a countries dependency on natural resources through which countries are affected less by highly volatile natural resource prices (Ploeg & Venables, 2011). Export diversification accomplishes this by increasing the amount of export sectors of the country. This is called horizontal export diversification, which results in countries being less dependent on a small number of commodities (Herzer & Nowak-Lehnmann, 2006). This lower dependency creates more security for investors, which in result would attract risk-averse investors who would previously not have invested in a country. Which in turn is beneficial for long-term growth and development (Dawe, 1996). Vertical export diversification is the shift from exporting primary commodities to exporting manufactured goods. Vertical diversification is associated with economic growth but does not decrease the dependency on natural resources as much as horizontal diversification. Since the manufactured goods still rely on the natural resources of a country, the economy would still be heavily affected by for example volatile natural resource prices.

Al-Marhubi (2000) concluded that export diversification is associated with faster growth and later Herzer (2006) concluded that export diversification is important for long-run economic growth. Herzer (2006) looked specifically at Chile, which diversified its economy from the basis of natural resource exports. The conclusion from Herzer (2006) specifically about countries which are dependent on either

agricultural or natural resource exports sounds as follows: “a noteworthy conclusion of this paper is that export diversification on the basis of natural resources can play an important role in the growth process of developing countries, which are dependent on agricultural and mining exports.” (Herzer & Nowak-Lehnmann, 2006). Agosin (2007) speculates that output growth is stimulated through two channels related to diversification of export. The first channel, the portfolio effect, explains how diversification of exports result in less export volatility through horizontal diversification. This effect stimulates long-run growth because stable economies grow faster than unstable economies. The second channel explains how export diversification to export products that are associated with export profiles from high-income countries is associated with faster growth. These conclusions show that diversification is important for long-run growth in countries, but it is still unclear what determinants affect diversification in a country.

With only a few papers that have been published on the topic of determinants of diversification it is important to look more in depth into certain determinants. The effect of natural resources on diversification has till now not been one of the main determinants other papers researched. It is important for developing countries to know the effect of natural resources on economic diversification, because many developing countries have the natural resource sector as one of their main export sectors. When the effect of natural resources on diversification becomes known, developing countries can change policy to dampen the negative effects that accompany a low level of diversification or developing countries can start earlier with policy to increase diversification.

There have been studies that research the determinants of diversification and export diversification, but none of these papers have investigated the relationship between natural resource reserves and economic diversification. Papers that research different determinants of diversification are for example Parteka (2013) who research the effect of gross domestic product per capita and Agosin (2012) who research the effect of multiple different variables. There are different indices to measure diversification in a country, but the Herfindahl-Hirschman index, the Theil index and the Gini index have been shown to be highly correlated and show similar results in measuring diversification (Elhiraika & Mbate, 2014).

The paper by Parteka (2013) takes a closer look into the effect of gross domestic product per capita on export diversification. They look at 60 countries between 1985 and 2004. As a diversification index they use the Theil index. The final variables they chose as determinants of export diversification were gross domestic product per capita, gross domestic product, population, distance to a world market, freetrade index, inclusion in trade agreement. With these variables they create multiple models. Another important paper is the paper by Agosin (2012), which also looks at multiple different determinants for export diversification. They use data from 1962-2000 and look at 168 countries. As diversification index they settled on the Gini index, but only after a thorough comparison between the Theil index, the Herfindahl-Hirschman index and the Gini index. The variables they looked at were trade openness, schooling, terms of trade, financial development, exchange rate volatility and distance. Different from

these papers for the regression I will use the Herfindahl-Hirschman index as the market concentration index to measure economic diversification, in the method section I will further explain the different indices to measure diversification.

1.1 Research question

The question that this paper will try to answer is whether the export of natural resources increases or decreases the level of economic diversification in a country. The level of diversification in a country will be measured by the Herfindahl-Hirschman concentration index, which measures economic concentration in a country using the market share of goods. Diversification in this thesis is defined in the market share of all goods, so if a country produces one specific good in large quantities the diversification of this country is low, if a country produces a lot of different goods in relatively the same quantities the diversification of this country would be high. The export of natural resources will be measured in natural resource rents of a country, which is the revenue that is generated by the export of natural resources, minus the extraction cost. The natural resources included in the natural resource rents are oil, gas, coal, mineral and forest. My hypothesis for this research question is that an increase in the export of natural resources will result in a more concentrated market. I expect this because a country with a high natural resource exports has less incentive to diversify since the export of natural resources is profitable of itself.

1.2 Methodology

In order to show the relationship between natural resource export and the diversification of developing and developed countries I first look at the determinants of diversification in existing literature. Most papers include a form of gross domestic product and gross domestic product per capita in their model as the base explanatory variables. Gross domestic product because it measures market size and gross domestic product per capita because it can be a measure of development of a country. As growing gross domestic product per capita is associated with positive changes in the quality of institutions, human capital and more favorable conditions for doing business (Parteka & Tamberi, 2013). I first create a fixed effects model with natural resource rents, time dummies and country dummies. This model I will extend by adding gross domestic product to the model. Finally, the final model will consist of natural resource rents, gross domestic product, gross domestic product per capita, time dummies and country dummies. I will then use these three models first with data from developing countries and second with data from developed countries. I will compare results from the developing countries and the developed countries to see if the effect of the determinants differs between developing countries and developed countries.

1.3 Set-up of rest of the thesis

This paper will continue with the literature review where I will discuss the findings of previous studies on this topic. I will then introduce the method and data I will be using in this study. After the introduction

of the data and the method I will show and discuss the results, in this discussion I will also look at possible policy implications and suggestions for further research. This study concludes with a short conclusion of the results and policy implications.

2. Literature review

In this section I will start by discussing the existing literature on the determinants of export diversification. Even though there has been extensive study into the relationship between diversification and economic growth, so far only few papers have been written discussing the topic of determinants of export diversification. Especially the effect of natural resource rents has not been one of the main variables of interest. The papers that study the effect of certain determinants on diversification all vary greatly in the determinants they include in their study and the methodology they use. After summarizing the findings of the existing papers, I will discuss in more detail the variables I will be using and the use of these variables in the existing literature.

The existing studies are hard to compare. They vary in time period, country sample size and research method. There have been multiple country specific studies that study the determinants of export diversification in a specific country, but there have only been a few studies that research the determinants of export diversification with data over a longer period and a large sample of countries. Country and area specific studies often use country specific variables, which makes it hard to compare those studies with studies that research the determinants in multiple countries across the world. Examples of countries and areas that have already been studied are: Africa (Elhiraika & Mbate, 2014) (Fonchamnyo & Akame, 2017), East Asia (Ferdous, 2011), Brazil (Cireraa, Marinb, & Markwaldc, 2015) and Pakistan (Mubeen & Ahmad, 2016). I will now first summarize the important papers that study a large sample of countries, afterwards I will look more closely at specific country and region cases.

The first important paper, Agosin (2012), uses data from 1962 to 2000 from many countries. This allowed them to isolate country specific effects which can explain differences across countries. As diversification index they discuss the Gini index, Theil index and the Herfindahl-Hirschman index. They concluded that the development of all three indices was similar. In their model they then used all three as outcome variables in their estimations to compare the different estimations with different outcome variables. In their model they studied the following determinants: Trade openness, Human capital, Remoteness, terms of trade, domestic credit, exchange rate volatility and overvaluation. Their results from their combined three models mainly suggested that trade openness increases specialization, financial development does not increase diversification, higher exchange rate volatility has a negative effect on diversification, increasing human capital has a positive effect on diversification and finally that the distance to a major market reduces diversification. When testing the validity of their

determinants they found that the more they increased their set of determinants the weaker the tests became. In Agosin (2012) they state that up to their study there had been no studies that used a long panel of countries. In this study I will add to the literature by using two long panels of countries, one long panel of developing countries and one long panel of developed countries. Where Agosin (2012) explores multiple determinants, I will limit my study to natural resources, gross domestic product and gross domestic product per capita. From their conclusion that the three diversification indices were similar I chose to use the Herfindahl-Hirschman index in this study.

The second important paper, Cadot (2011), studies the development of export diversification patterns along the economic development of a country. They do this using a dissected form of the Theil index as diversification index. As variables of interest they use the number of active exportation lines, which measures the amount of countries they export to, and a measure of new export products. They find a positive significant effect of gross domestic product per capita on diversification and a negative significant effect of export of raw materials on diversification. They also find a hump-shaped relationship between export diversification and economic development. Which means that the diversification along economic development has concentration points where countries concentrate over the process of diversification and development. They hypothesize that this observed reconcentration can possibly be explained by the existence of small, rich and concentrated oil producers. They also state two reasons why countries should not diversify. First, according to the Ricardian theory of comparative advantage countries should specialize instead of diversify. The Ricardian theory of comparative advantage in short states that countries will specialize in goods where they have a comparative advantage. Second, they state that the Heckscher-Ohlin model implies that endowments heavily determine export patterns, so that factor accumulation is important instead of diversification. The Heckscher-Ohlin model in short states that countries with relatively high capital and relatively scarce labor will export capital intensive products and import labor intensive products, while for countries with relatively high labor and scarce capital will export labor intensive products and import capital intensive products. These two reasons why a country should not diversify however are in conflict with Al-Marhubi (2000), Herzer (2006) and van der Ploeg (2011) who state that diversification is good for long-run economic growth.

The third important paper, Parteka (2013), focuses on the effect of gross domestic product per capita on diversification and the role of country specific factors. In their model they use the Theil index as the diversification index. Their model consists of the following variables: gross domestic product per capita, gross domestic product, population, market distance, free trade index and the participation of a trade agreement. They create multiple different models with these variables. Their first model contains only gross domestic product and gross domestic product per capita, from the estimations they conclude from this model that both gross domestic product and gross domestic product per capita have a positive effect on diversification. From their final model they concluded that the most significant and robust

factors that affect diversification are development, country size, country location and trade conditions. Development measured by gross domestic product per capita and country size measured by gross domestic product both have a positive effect on diversification. Country location measured by the distance from the closest major market has a negative effect on diversification, such that the farther away from a major market the less diversified a country becomes. Finally, trade conditions, have a positive effect on diversification such that a higher free trade index and the participation of a trade agreement increase the diversification of a country. To take into account country specific effects they include individual dummies into the model and from a test of joint significance they conclude that the inclusion of country specific effects in the model is correct. In this study I will use the variables from their initial model, gross domestic product and gross domestic product per capita, as explanatory variables in my model and I will add natural resource rents.

Another paper that studies export diversification is Bebczuk (2006). Their sample consists of 56 countries over a time period of 1970 to 2002. The diversification index they use is the Herfindahl-Hirschman index. This paper takes into account a part of the effect of the Dutch disease, to do this they added the share of fuel, manufactures and agricultural in total exports. In their model they do account for time effects and they concluded from the Hausman test that fixed effects would be the best method. An important notion they make is that variables which normally are associated with good macroeconomic performance, such as gross domestic product, exports, infrastructure, credit and investment rate, have a positive and significant effect on the Herfindahl-Hirschman index. This means that these variables act against diversification and for more concentration, thus leading to the notion that more developed countries eventually concentrate their exports. This is in conflict with the common conception that an economy diversifies over the course of the development of said economy. The model of Bebczuk (2006) consisted of the following variables: exports to gross domestic product, manufacturers exports to total exports, fuel exports to total exports, gross domestic product per capita, gross fixed capital to gross domestic product, credit to the private sector to gross domestic product, telephone lines per 1000 people, net foreign direct investment to gross domestic product. Their results for exports to gross domestic product and per capita gross domestic product were both found to affect diversification negatively. Which means that a higher export to gross domestic product and per capita gross domestic product result in lower diversification. From their results they also concluded that the relationship between development and export diversification is U-shaped. Such that at low development levels export diversification increases, while at the high development levels countries again concentrate their exports.

Table 1: Summary of studies with a large sample of countries

Paper Title	Author, (Year)	Diversification index	Significant Relationships with Diversification
Determinants of export diversification around the world: 1962-2000	Manuel R. Agosin, Roberto Alvarez and Claudia Bravo-Ortega (2012)	Herfindahl-Hirschman, Theil and Gini	Trade openness – Financial development – Exchange rate volatility – Human capital + Distance to market –
Export diversification: What's behind the hump?	Olivier Cadot, Celine Carrere, and Vanessa Strauss-Kahn (2011)	Theil index	GDP per capita + Raw materials –
What determines export diversification in the development process? Empirical Assessment	Aleksandra Parteka and Massimo Tamberi (2013)	Theil index	GDP + GDP per capita + Distance to market – Free trade +
Explaining export diversification: an empirical analysis	Ricardo N. Bebczuk and N. Daniel Berrettoni (2006)	Herfindahl-Hirschman index	GDP per capita – Export to GDP – Infrastructure –

Note: The sign behind a variable in the last column, 'Significant Relationships with Diversification', is the significant relationship found on diversification in a study. So, a '-' means that a significant negative relationship with diversification was found of that variable, a '+' means that a significant positive relationship with diversification was found of that variable.

I will now continue with the papers researching export diversification estimators in specific areas or countries. Elhiraika (2014) researches the determinants of export diversification in the region of Africa. His sample of countries consist of 53 African countries with data from 1995 to 2011. Because African countries have low levels of income per capita they theorize that these countries must still be in the diversification phase on the U-shaped pattern found by other researchers regarding export diversification and development. As diversification index they use the Herfindahl-Hirschman index and as model estimators they use gross domestic product per capita, public investment, population growth, human capital, exchange rate, terms of trade and government effectiveness. They also add in a dummy variable to measure the effect of a country being oil rich. From this model they conclude that key long-run determinants of export diversification that have a positive effect are gross domestic product per capita, public investment, institutions, human capital and infrastructure.

Another study based on African countries is Fonchamnyo (2017). The sample of countries in this study consists of 32 countries in the sub-Sahara African region, a region where most countries have a high concentration of exports in a small number of products. These countries have a relatively high dependency on fuels, metals and minerals. In this study they use as diversification index also the Herfindahl-Hirschman index. Contrary to the findings of Elhiraika (2014) they found that gross domestic product per capita has a negative effect on diversification, while they concluded that trade openness, value added in agriculture, value added in manufacturing and foreign direct investment promoted diversification.

The final area specific study I will discuss is Ferdous (2011). This study focuses on east Asian economies between the year 1980 and 2008. As a measure of diversification again the Herfindahl-Hirschman index is used. Factors they consider to affect diversification are tariff rates, exchange rates, gross domestic product and trade intensity. From their model they conclude that gross domestic product has a negative effect on diversification, such that specialization increases with gross domestic product. This conclusion is again in conflict with the earlier stated common conception that diversification increases with economic growth.

In this paper I will discuss the effect on diversification of the following determinants: gross domestic product, gross domestic product per capita and natural resource rents as a percentage of gross domestic product. Through gross domestic product I measure the size of the economy of a certain country, with gross domestic product per capita I measure the development of said economy and finally natural resource rents as percentage of gross domestic product measures the effect of natural resources in a country on diversification. In the existing literature both gross domestic product and gross domestic product per capita have been used as determinants of diversification, but the effect of both differs per paper. First gross domestic product was found to have a statistically significant positive relationship with diversification by Parteka (2013), but a statistically negative relationship was found by Ferdous (2011). Second, gross domestic product per capita was found to have a statistically significant positive relationship with diversification by Parteka (2013) and Elhiraika (2014), but other papers concluded that gross domestic product per capita has a statistically significant negative relationship with diversification namely Bebczuk (2006) and Fonchamnyo (2017). This shows that there is no clear conclusion regarding the relationship of gross domestic product and gross domestic product per capita with diversification. The relationship between natural resources and diversification has not been studied extensively except by papers that have added dummy variables for oil rich countries or papers that add fuel exports in their model. In those studies the relationship of the oil-rich dummy variable and the fuel exports with diversification was estimated to be statistically significant negative (Elhiraika & Mbate, 2014) , (Bebczuk & Berrettoni, 2006) .

3. Method

There are multiple indices that calculate the level of diversification in a country. Examples are the Herfindahl-Hirschman index, the Gini index and the Theil index. All these indices are possible indices to use in this model, but since they are shown to be highly correlated and all provide similar results in level of diversification it is only necessary to use one (Elhiraika & Mbate, 2014). In this study only the Herfindahl-Hirschman index will be used as a measure of diversification. The calculation of the Herfindahl-Hirschman index is as follows:

$$HHI_{it} = \sum_{j}^{n} \left(\frac{X_{ijt}}{\sum_i X_{it}} \right)^2$$

The Herfindahl-Hirschman index of country *i* is calculated by taking the square of the share of good *j* at time *t* and then summing all the results from all *n* goods. Where here *n* is the number of goods in the market, *j* is one of these goods, *t* is the year in question and *i* is the country in question. The Herfindahl-Hirschman index is an index that ranges between 0 and 1. Where the index is one the market is fully concentrated in one good; the index will be closer to 0 the more diversified the economy is. The base model consists of the diversification index and natural resources, equation 1M.

$$DIV_{it} = \alpha + f(NRR_{it}) + \varepsilon_{it} \quad (1M)$$

As explanatory variables I add in two macroeconomic performance variables, gross domestic product and gross domestic product per capita. By adding gross domestic product as an explanatory variable the effect of the size of the economy per country is isolated (Bebczuk & Berrettoni, 2006). I add gross domestic product per capita as a measure of development of a country, which was also done by Parteka (2013). Furthermore, the United Nations (2007) states that gross domestic product per capita is a development indicator. The model would then be extended into equation 2M.

$$DIV_{it} = \alpha + f(NRR_{it}) + \sum_{l=1}^{L} \delta_l X_{l,i} + D_t + \varepsilon_{it} \quad (2M)$$

Where DIV is the diversification index, α is a constant, NRR is natural resource rents, X is a set of explanatory variables, δ is the estimate of explanatory variable *l* and D are the time dummies. Finally, *i* and *t* is per country and per year respectively.

For the full model with the Herfindahl-Hirschman index, gross domestic product, gross domestic product per capita and natural resource rents the model is extended into equation 3M.

$$HHI_{it} = \alpha + \beta 1 * \log(GDP_{it}) + \beta 2 * \log(GDPpc_{it}) + \beta 3 * NRR_{it} + D_t + D_i + \varepsilon_{it} \quad (3M)$$

The dependent variable in this model, HHI, is the Herfindahl-Hirschman index from 0 to 1 where 0 is fully diversified and 1 is fully concentrated. The first independent variable in this model is the natural logarithm of GDP, which is the gross domestic product of a country. The second independent variable is the natural logarithm of GDPpc, which is gross domestic product per capita of a country. The third independent variable is NRR, which is the natural resource rents of a country as a percentage of gross domestic product where NRR is 0 when a country has 0 natural resource rents and 1 when all gross domestic product consists of is natural resource rents. In this model Dt are the time dummies and Di are the country dummies. In this model the *i* is per country and *t* is per year. I took the natural logarithm of GDP and GDPpc to normalize the data.

In order to show the relationship between natural resource rents and diversification I start by first using the simple model, model 1R, with only natural resource rents, country dummies and time dummies.

$$HHI_{it} = \alpha + \beta 1 * NRR_{it} + D_t + D_i + \varepsilon_{it} \quad (1R)$$

In model 2R I add the explanatory variable of gross domestic product, GDP, per country.

$$HHI_{it} = \alpha + \beta 1 * NRR_{it} + \beta 2 * \log(GDP_{it}) + D_t + D_i + \varepsilon_{it} \quad (2R)$$

The final model, model 3R, consists of natural resource rents, gross domestic product and gross domestic product per capita.

$$HHI_{it} = \alpha + \beta 1 * NRR_{it} + \beta 2 * \log(GDP_{it}) + \beta 3 * \log(GDPpc_{it}) + D_t + D_i + \varepsilon_{it} \quad (3R)$$

In the rest of this thesis I will continue with these three models to find the relationship between these determinants and diversification in developing and developed countries. After that I will compare the results from data of developing countries with data from the developed countries.

From the outcome of the Hausman test I conclude that a fixed effects model should be used. So, a model that takes into account panel effects, thus country dummies need to be included in the model. The regression estimation method that I will use is fixed effects. Fixed effects is better in this case because fixed effects models limit the sources of bias to variables to vary over time that correlate with the outcome over time, which in the case of panel data is important (Collischon & Eberl, 2020). A fixed effect model is able to do this because it measures changes within groups across time.

3.1 Hypothesis

The key variable of interest in this model is the variable natural resource rents. My hypothesis of the relationship between natural resource rents and diversification is the following. A higher natural resource rents as percentage of gross domestic product will result in a more concentrated market. When a large share of a country's gross domestic product is natural resource rents the country has no real incentive to diversify since the export of natural resources is profitable. Also, the higher the percentage of natural resource rents the larger the market that is centered around a specific good or resource as most countries export the raw resource. For example, oil is often exported in the raw form of oil and not in the form of a broad spectrum of already processed goods.

4. Data description and Descriptive analysis

To study the relationship between natural resources and diversification I first look at data from countries that are labelled as developing countries by the United Nations in the World economic situation and

prospects report from the United Nations in 2020 (United Nations, 2020). A list of the countries used in the first dataset of the 135 countries that are labelled as developing countries can be found in the appendix (table A1). The dataset consisting of developing countries will be referred to as dataset 1. From the original full list of developing countries, I dropped the following countries due to missing data: Anguilla, Cape Verde, Cook Islands, Djibouti, Guadeloupe, Martinique, Mayotte, Montserrat and the Netherlands Antilles.

Table 2: Summary statistics of the set of developing countries, dataset 1.

Variable	Observations	Mean	Std. Dev.	Min	Max
Herfindahl-Hirschman index	2298	0.169	0.147	0.033	0.992
GDP in Billion USD	2809	131	484	0.0234	8910
GDP per capita in USD	2809	5280	6554	216	64865
Natural resource rents % of GDP	2799	8.00	11.54	0.000	86.25
Log(GDP)	2809	23.53	2.13	16.97	29.82
Log(GDP per capita)	2809	7.97	1.15	5.37	11.08
Normalized natural resource rents	2835	0.079	0.115	0.000	0.863

Note: Observations is the number of observations the variable has. Mean is the average of that variable. Std. Dev. is the standard deviation of that variable. Min and Max are the minimum and maximum values of that variable. USD stands for constant 2010 United States Dollars.

As comparison and further study, I will compare the results from the developing countries to developed countries. The list of the 36 developed countries in the dataset of developed countries can be found in the appendix (table A2). The dataset consisting of developed countries will be referred to as dataset 2.

Table 3: Summary statistics of developed countries, dataset 2.

Variable	Observations	Mean	Std. Dev.	Min	Max
Herfindahl-Hirschman index	705	0.094	0.091	0.037	0.676
GDP in Billion USD	714	1130	2510	5.54	16727
GDP per capita in USD	714	35664	21458	3784	111968
Natural resource rents	714	1.02	1.84	0.000	12.19
Log(GDP)	714	26.25	1.85	22.44	30.45
Log(GDP per capita)	714	10.26	0.73	8.24	11.63
Normalized natural resource rents	714	0.010	0.018	0.000	0.122

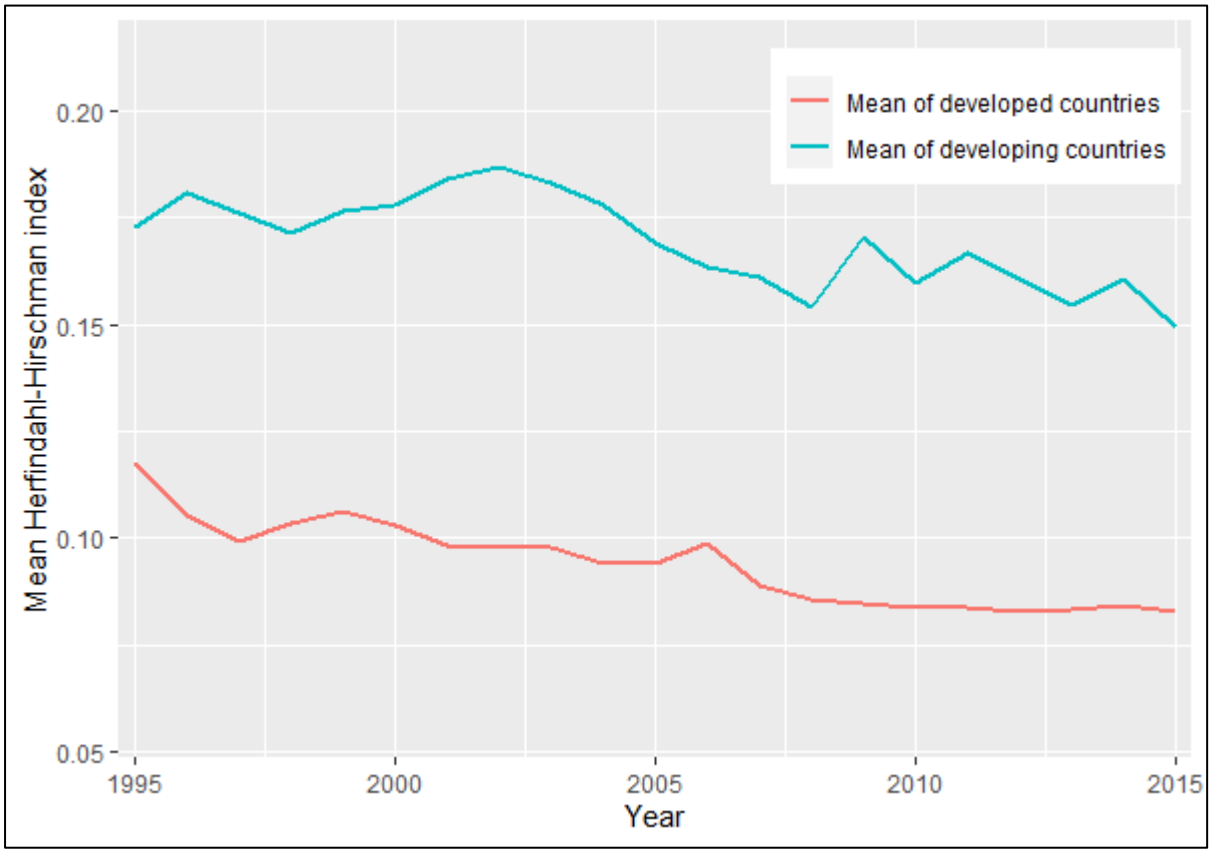
Note: Observations is the number of observations the variable has. Mean is the average of that variable. Std. Dev. is the standard deviation of that variable. Min and Max are the minimum and maximum values of that variable. USD stands for constant 2010 United States Dollars.

Table 2 and 3 consist of seven variables of which one is the Herfindahl-Hirschman index (hhindex), a measure of diversification between 0 and 1 where 1 is fully concentrated and closer to 0 is more diversified. Three of the variables are the original values of the variables used in the model, gross domestic product, gross domestic product per capita and natural resource rents (gdp, gdppc, naturalres). Gross domestic product is measured in constant 2010 United States Dollars. Gross domestic product per capita is also measured in constant 2010 United States Dollars. Natural resource rents as a percentage of gross domestic product are calculated by taking the difference between the estimated

world price of a commodity and the average cost of extraction of said commodity, then multiplying this difference per commodity with the physical quantities of all commodities exported by said country and finally dividing that by the gross domestic product of said country. The last three variables are the normalized values of the variables in the model, log of gross domestic product, log of gross domestic product per capita and natural resource rents as percentage of gross domestic product divided by 100 to normalize it to values between 0 and 1. The data of the variables are collected from The World Bank and the World Integrated Trade Solution database.

For a country to be considered a developing country it must have little industrial and economic activity and the gross domestic product per capita of the country has to be relatively low. There are no precise definitions of developing and developed countries, a country can announce for themselves in which category they fall, developing or developed. To keep this system in check, other countries can challenge that status and thus limit other countries from using resources that are only meant for a specific group of countries.

Figure 1: Development of the Herfindahl-Hirschman index

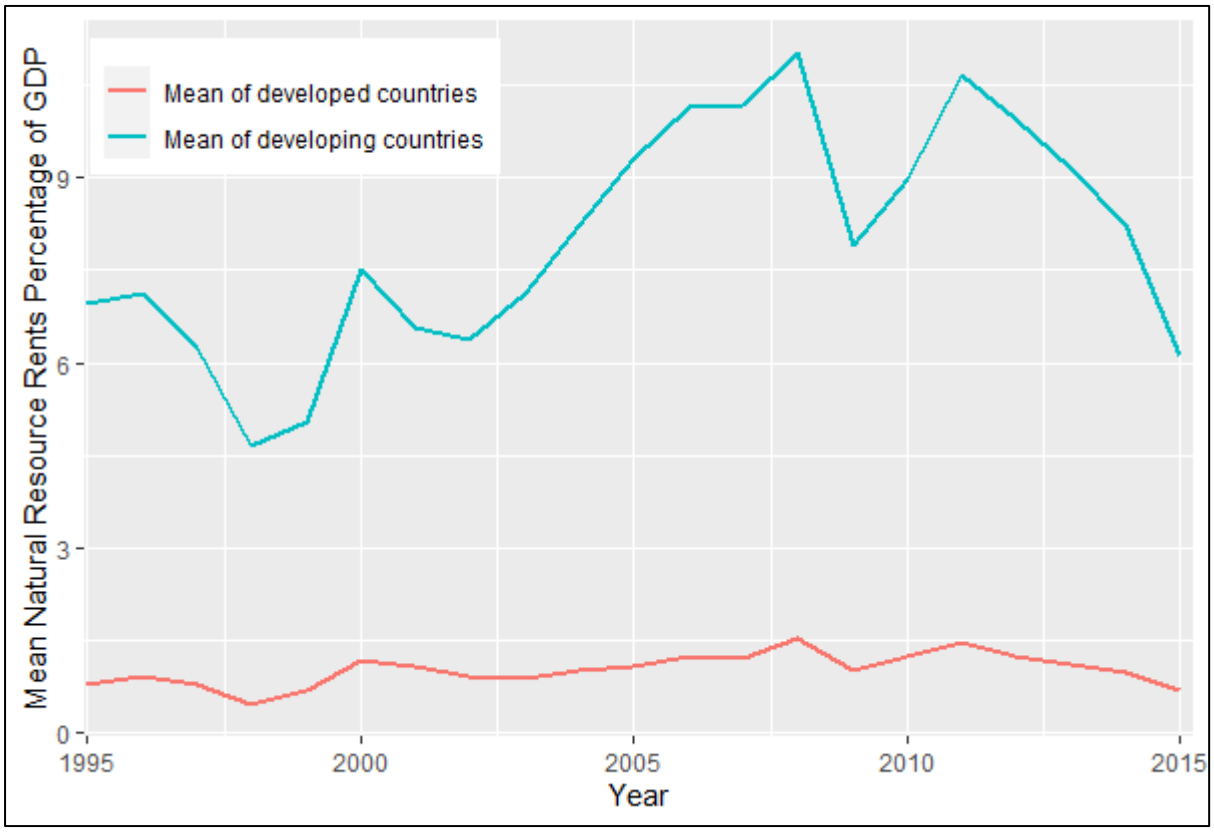


Note: The light blue line shows the development of the mean Herfindahl-Hirschman index of dataset 1, the developing countries. The orange line shows the development of the mean Herfindahl-Hirschman index of dataset 2, the developed countries. Data source: World Integrated Trade Solution.

Figure 1 shows the mean Herfindahl-Hirschman index for both dataset 1 and dataset 2. In the figure you can see the development of the Herfindahl-Hirschman index over the course of the years between 1995 and 2015. The light blue line is the mean of the Herfindahl-Hirschman index of the developing

countries. The orange line is the mean of the Herfindahl-Hirschman index of the developed countries. From the difference in the two lines you can see that the average Herfindahl-Hirschman index is lower in the developed countries than in the set of development countries. This thus means that the developed countries are more diversified than developing countries. The figure also shows the declining trend for both country sets. This declining trend means that the average Herfindahl-Hirschman index is decreasing and thus the average level of diversification is increasing.

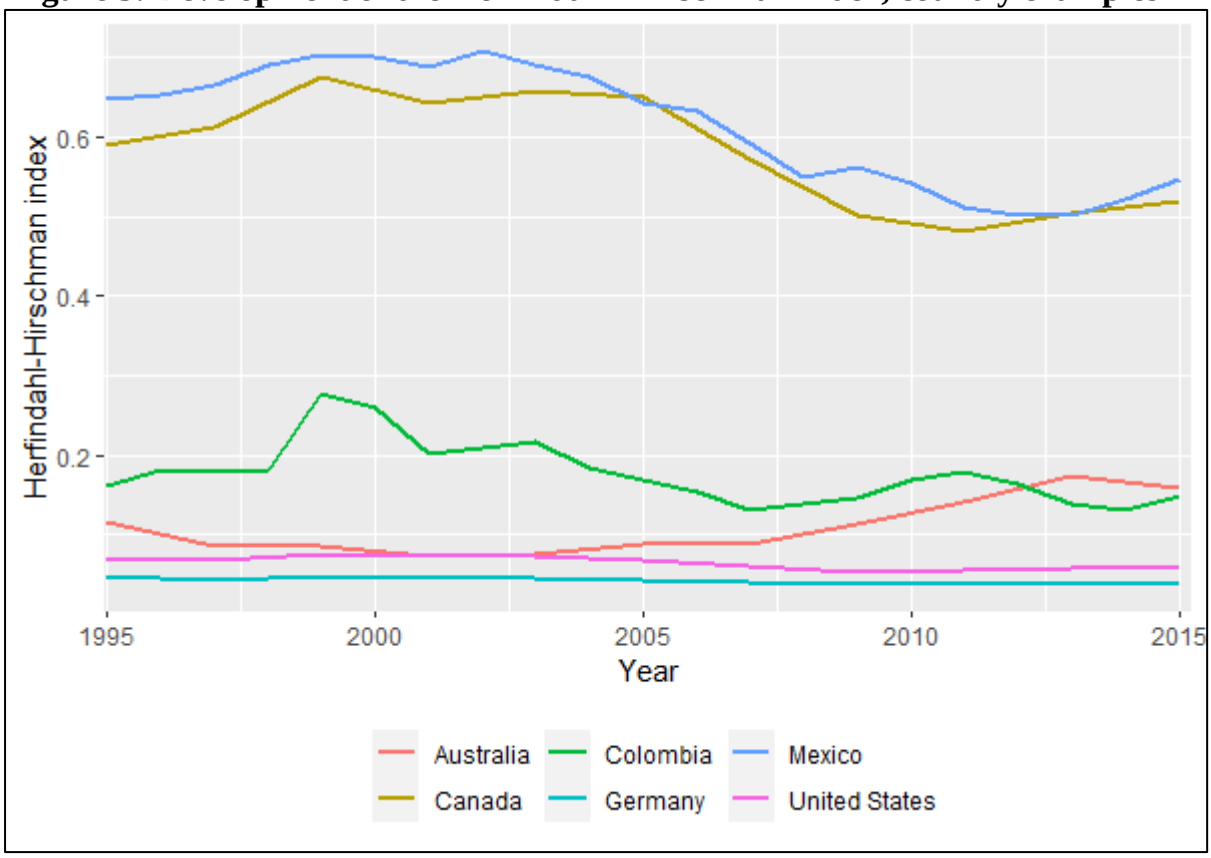
Figure 2: Development of natural resource rents



Note: The light blue line shows the development of natural resource rents as a percentage of gross domestic product of dataset 1, the developing countries. The orange line shows the development of natural resource rents as a percentage of gross domestic product of dataset 2, the developed countries. Data source: World Bank

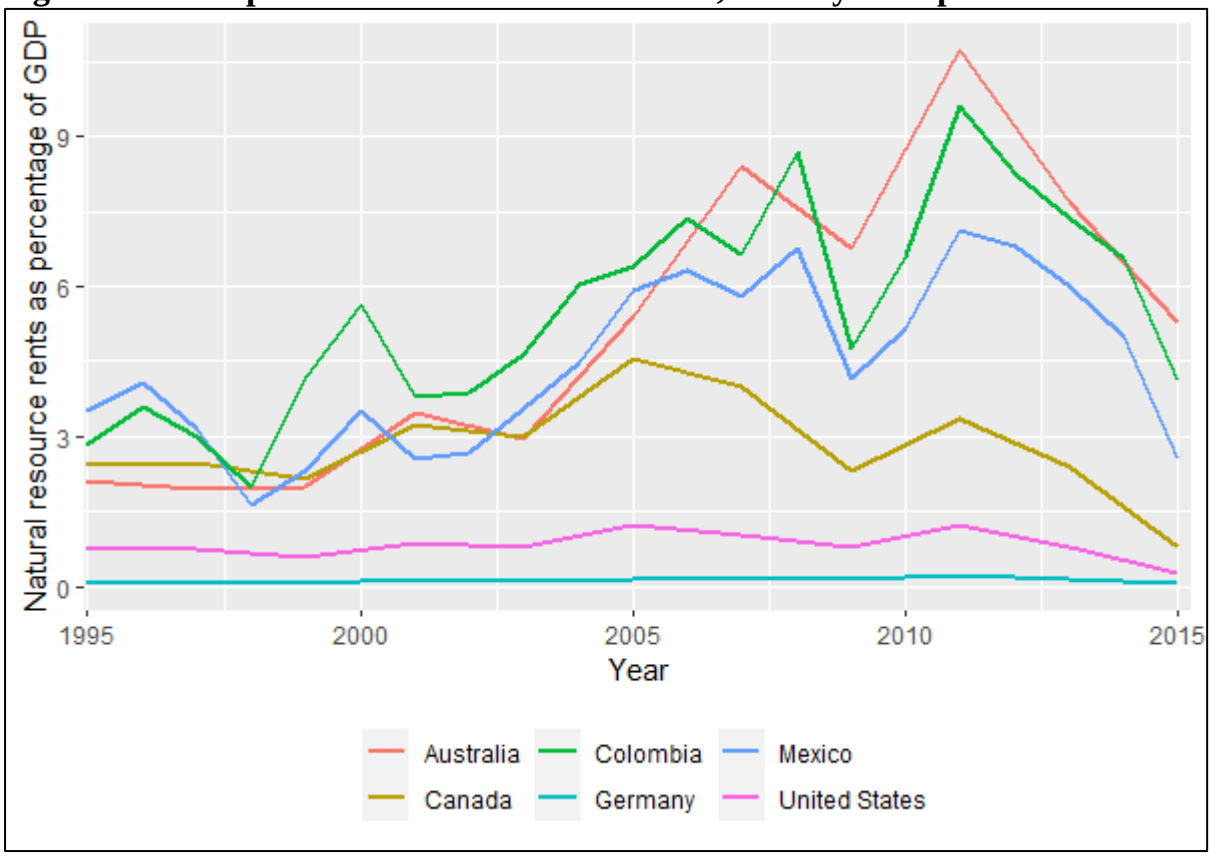
Figure 2 shows the development of the mean of natural resource rents as a percentage of gross domestic product over the years 1995 till 2015. The light blue line shows the mean of natural resource rents as a percentage of gross domestic product for the developing countries, the orange line shows the mean of natural resource rents as a percentage of gross domestic product for the developed countries. The large gap between these lines shows that developing countries are more dependent on the export of natural resources, because a larger part of their gross domestic product is natural resource rents compared to developed countries.

Figure 3: Development of the Herfindahl-Hirschman index, country examples



Data Source: World Integrated Trade Solutions

Figure 4: Development of natural resource rents, country examples



Data Source: World Bank

Figure 3 and 4 show the development of the Herfindahl-Hirschman index and natural resource rents for 2 developing countries and 4 developed countries. Australia is a developed country with, for a developed country, relatively high natural resource rents as a percentage of gross domestic product. In the case of Australia figure 3 and 4 also show that with an increase in natural resource rents as a percentage of gross domestic product the Herfindahl-Hirschman index also increases. This trend seen in the case of Australia does not appear to return in the remaining five countries. Either the development of both the Herfindahl-Hirschman index and natural resource rents as a percentage of gross domestic product are steady, which is the case for Germany and the United States, or the development is volatile and has no clear trend, which is the case for Colombia, Mexico and Canada.

5. Results

Table 4: Estimation results from set of developing countries

Model:	(1R)	(2R)	(3R)
Dataset:	Developing	Developing	Developing
Natural Resources	0.318***	0.309***	0.298***
	(0.11)	(0.11)	(0.11)
log(GDP)		0.071**	0.146***
		(0.04)	(0.05)
log(GDPpc)			-0.084*
			(0.05)
constant	0.295***	-1.318	-2.559**
	(0.01)	(0.81)	(1.00)
time-dummies:	Yes	Yes	Yes
country-dummies:	Yes	Yes	Yes
Number of observations:	2298	2298	2298
R^2:	0.734	0.737	0.739

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. The dependent variable is the Herfindahl-Hirschman index. The Standard errors are below the estimates between parentheses.

The results from the estimations with the developing country data from the first model, model 1R, shows that the coefficient associated with natural resources is statistically significant. The estimation is positive, meaning that natural resource rents are positively correlated with the Herfindahl-Hirschman index and thus have a negative relationship with diversification, because a higher value of the Herfindahl-Hirschman index means a more concentrated market and thus less diversification.

The results from the second model, model 2R, with developing country data shows that both natural resource rents and gross domestic product have a statistically significant positive relationship with the Herfindahl-Hirschman index. This positive relationship with the Herfindahl-Hirschman index means that both variables have a statistically significant negative relationship with diversification in a country.

The final model, model 3R, with developing country data extends model 2R by adding the variable of gross domestic product per capita. The estimation results for both gross domestic product and natural resource rents are both still significant and both still show a positive relationship with the Herfindahl-Hirschman index. The added variable of gross domestic product per capita shows a negative relationship, but the relationship is not statistically significant.

The estimates of the time dummies in all models with developing country data show an overall negative relationship with the Herfindahl-Hirschman index. This shows that the overall trend of the Herfindahl-Hirschman index is negative, thus the average country in the developing country dataset is becoming more diversified. This trend can also be seen in graph 1.

Table 5: Estimation results from developed countries

Model:	(1R)	(2R)	(3R)
Dataset:	Developed	Developed	Developed
Natural Resources	0.700***	0.701***	0.653***
	(0.20)	(0.20)	(0.21)
log(GDP)		0.001	0.04
		(0.02)	(0.06)
log(GDPpc)			-0.037
			(0.05)
constant	0.092***	0.073	-0.608
	(0.01)	(0.57)	(1.17)
time-dummies:	Yes	Yes	Yes
country-dummies:	Yes	Yes	Yes
Number of observations:	705	705	705
R^2:	0.966	0.966	0.966

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively. The dependent variable is the Herfindahl-Hirschman index. The Standard errors are below the estimates between parentheses.

The results of the estimations with data from the developed countries show in model 1R that the variable natural resource rents has a positive significant relationship on the Herfindahl-Hirschman index. The positive relationship means that an increase in natural resource rents is negatively correlated with diversification in a country.

In model 2R the variable gross domestic product is added. The estimations from model 2R show a positive significant relationship between natural resource rents and the Herfindahl-Hirschman index and a positive, but not significant, relationship between gross domestic product and the Herfindahl-Hirschman index.

In model 3R the model is extended to the full model consisting of natural resource rents, gross domestic product and gross domestic product per capita. The estimates show that the variable natural resource

rents has a significant positive relationship with the Herfindahl-Hirschman index and gross domestic product a not significant and negative relationship with diversification. Finally, the relationship of gross domestic product per capita with diversification is not significant and negative.

The estimates from the time dummies in all models with developed country data also show, just as the estimates from the developing country data, a negative correlation with the Herfindahl-Hirschman index. This shows that there is also an overall negative trend of the Herfindahl-Hirschman index for developed countries. This negative trend means that the average developed country is becoming more diversified over time. This trend can also be seen in graph 1.

5.1 Robustness

First to check robustness we incorporated the three models to see whether the same relationship applies when adding explanatory variables. For both the developing countries and the developed countries we found that natural resources have a significant negative relationship with diversification in model 1R. In model 2R I add gross domestic product as an explanatory variable, the relationship of natural resources does not change and is still significant for both developing and developed countries. Finally, in model 3R I add gross domestic product per capita as an explanatory variable. The estimate of natural resources still concludes a negative significant correlation with diversification for both developed and developing countries.

The unchanging estimates of natural resource rents in all three models shows that the estimates are robust. The comparison of results between developing and developed countries also shows that the evidence of a statistically significant negative relationship of natural resources with diversification is not isolated to developing countries only, but also holds for developed countries.

6. Discussion

My hypothesis in short was that an increase in natural resource rents as a percentage of gross domestic product would lead to a more concentrated market. From the results I found evidence that the relationship between natural resource rents as percentage of gross domestic product and diversification indeed is negative. The positive relationship of natural resource rents and market concentration is significant for both developing countries and developed countries.

The relationships for which I found statistically significant evidence from developing countries are the negative relationship between natural resource rents and diversification, and the negative relationship between gross domestic product and diversification. Elhiraika (2014) included a dummy variable that represented oil-rich countries. The relationship of this variable with diversification was negative. As oil is one part of natural resources, they found the same relationship of oil rich countries with diversification as I found of natural resources on diversification. Bebczuk (2006) partly included the effect of natural

resources by including the variable fuel exports to total exports in their model. This variable was measured as the percentage of fuel exports from total exports. The relationship they found from their estimations was a negative relationship between the fuel exports variable and diversification. Both studies are in line with my results. The result from the estimation of the relationship between natural resources and diversification from the developed countries was also negative and statistically significant. The relationship between gross domestic product and diversification from the developed countries is also negative, but not statistically significant. In addition to the evidence for the statistically significant negative effect of natural resources on diversification in developing countries I also find evidence that this negative relationship holds for developed countries.

The effect of gross domestic product on diversification has been researched more extensively. Ferdous (2011) found a negative relationship between gross domestic product and diversification. In contrast Parteka (2013) found a positive relationship between gross domestic product and diversification. Ferdous (2011) also used a fixed effects model, but their data consisted only of East-Asian countries. Parteka (2013) used instrumental variable fixed effects model with dataset consisting of 60 countries. The result from estimations from the developing country dataset is a negative relationship between gross domestic product and diversification. This result is line with Ferdous (2011), but not in line with Parteka (2013). The results from my estimations of gross domestic product from the developed countries are not statistically significant, therefore no conclusions can be drawn from these results.

The statistically significant results from the estimations from the model with developing country data shows that natural resources rents as a percentage of gross domestic product is positively correlated with concentration of the economy of a developing country. When considering the evidence from this study showing the negative relationship between natural resource rents and diversification, policy makers can take action against the negative consequences of a concentrated market. With this knowledge policy makers can start earlier or increase the intensity of policies stimulating diversification of sectors within a country. The most important reason to stimulate diversification is because diversification is associated with an increased long-run economic growth and reduces the dependency of a country on specific exports (Ploeg & Venables, 2011). Due to the rise of green energy alternatives and overall pollution reduction are countries that have high fossil fuel exports at risk of losing a large part of their gross domestic product due to reducing demand. These countries would benefit of investing their current savings from the export of natural resources into long term economic growth projects.

This study shows that natural resources rents are negatively correlated with the level of diversification in both developing and developed countries. Further research can study whether this correlation also implies causation. So, whether high natural resource exports cause a lower level of diversification. Since correlation does not imply causation it cannot be concluded that an increase in natural resource exports causes a lower level of diversification.

7. Conclusion

In this study I examine the relationship between diversification and three variables, namely: natural resource rents, gross domestic product and gross domestic product per capita. I study this relationship using data from two different sets of countries over the years 1995 to 2015. The first dataset consists of countries that are labelled as developing countries by the United Nations in 2020. The second dataset consists of countries labeled as developed countries by the United Nations in 2020. The model used in this study is a fixed effects model taking into account both time and country effects.

From the results of this study I conclude that in regard of developing countries a higher level of natural resource rents as a percentage of gross domestic product has a statistically significant negative relationship with the level of diversification. For developing countries, I also conclude that a higher gross domestic product has a statistically significant negative relationship with the level of diversification in a country. For developed countries I conclude that an increased level of natural resource rents as a percentage of gross domestic product has a statistically significant negative relationship with the level of diversification in a country. Furthermore, I conclude that the average level of diversification has increased for both developing countries and developed countries over the years 1995 to 2015.

Bibliography

Agosin, M. R., Alvarez, R., & Bravo-Ortega, C. (2012). Determinants of export diversification around the world: 1962-2000. *The world economy*, 295-314.

Al-Marhubi, F. (2000). Export diversification and growth: an empirical investigation. *Applied Economics Letters*, 7, 559-562.

Bebczuk, R. N., & Berrettoni, N. D. (2006). Explaining Export Diversification: an empirical analysis. *Department of Economics, Universidad Nacional de La Plata, Argentina*, 1-25.

Cadot, O., Carrere, C., & Strauss-Kahn, V. (2011). Export diversification: what's behind the hump? *The Review of Economics and Statistics*, 590–605.

Cireraa, X., Marinb, A., & Markwaldc, R. (2015). Explaining export diversification through firm innovation decisions: The case of Brazil. *Elsevier Research Policy*, 1962-1973.

Collischon, M., & Eberl, A. (2020). Let's Talk About Fixed Effects: Let's Talk About All the Good Things and the Bad Things. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, 72, 289-299.

Dawe, D. (1996). A new look at the effects of export instability on investment and growth. *World Development*, Vol. 12 pp 1905-1914.

Elhiraika, A., & Mbate, M. (2014). Assessing the determinants of export diversification in Africa. *Applied econometrics and international development*, 147-162.

Ferdous, B. (2011). Pattern and Determinants of Export Diversification in East Asian Economies. *IPEDR*, 156-160.

Fonchamnyo, D. C., & Akame, A. R. (2017). Determinants of export diversification in Sub-Sahara African region: a fractionalized logit estimation model. *Journal of Economics and Finanance*, 330-342.

Gylfason, T. (2006). Natural resources and economic growth: From dependence to diversification. *Economics liberalization and inegration policy*, 201-231.

Herzer, D., & Nowak-Lehnmann, F. D. (2006). What does export diversification do for growth? An econometric analysis. *Applied Economics*, 38:15 1825-1838.

Mania, E., & Rieber, A. (2019). Product export diversification and sustainable economic growth in developing countries. *Structural Change and Economic Dynamics*, 51, 138-151.

Mubeen, N., & Ahmad, N. (2016). Towards measurement and determinants of export diversification: An empirical analysis of Pakistan. *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, Vol. 10, Iss. 3, pp. 588-605.

Parteka, A., & Tamberi, M. (2013). What Determines Export Diversification in the Development process? Empirical assesment. *The World Economy*, 36, 807-824.

Ploeg, F. v., & Venables, A. J. (2011). Natural resource wealth: the challenge of managing a windfall. *University of Oxford*.

UN. (2007, June 15). *Development indicators.* From un.org: https://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/econ_development/gdp_percapita.pdf

United Nations. (2020). World economic situation and prospects. *United Nations*, 164-200.

Appendix

Table A1: developing countries

Afghanistan	Cuba	Libya	Samoa
Albania	Czech Republic	Lithuania	Sao Tome and Principe
Algeria	Dominica	Madagascar	Saudi Arabia
Angola	Dominican Republic	Malawi	Senegal
Antigua and Barbuda	Ecuador	Malaysia	Seychelles
Argentina	Egypt, Arab Rep.	Maldives	Sierra Leone
Armenia	El Salvad	Mali	Slovenia
Azerbaijan	Eritrea	Malt	Solomon Islands
Bahrain	Estonia	Mauritania	South Africa
Bangladesh	Fiji	Mauritius	Sri Lanka
Barbados	Gabon	Mexico	St. Kitts and Nevis
Belarus	Gambia, The	Micronesia, Fed. Sts.	St. Lucia
Belize	Georgia	Moldova	Sudan
Benin	Ghana	Mongolia	Suriname
Bhutan	Grenada	Morocco	Tajikistan
Bolivia	Guatemala	Mozambique	Tanzania
Bosnia and Herzegovina	Guinea	Myanmar	Thailand
Botswana	Guyana	Namibia	Togo
Brazil	Honduras	Nepal	Tonga
Bulgaria	Hungary	Nicaragua	Trinidad and Tobago
Burkina Faso	India	Niger	Tunisia
Burundi	Indonesia	Nigeria	Turkey
Cambodia	Iran, Islamic Rep.	North Macedonia	Turkmenistan
Cameroon	Iraq	Oman	Tuvalu
Central African Republic	Jamaica	Pakistan	Uganda
Chad	Jordan	Palau	Ukraine
Chile	Kazakhstan	Panama	United Arab Emirates
China	Kenya	Papua New Guinea	Uruguay
Colombia	Kiribati	Paraguay	Uzbekistan
Comoros	Korea, Rep.	Peru	Vanuatu
Congo, Rep.	Kyrgyz Republic	Philippines	Vietnam
Costa Rica	Latvia	Poland	Zambia
Cote d'Ivoire	Lebanon	Romania	Zimbabwe
Croatia	Lesotho	Rwanda	

Table A2: developed countries

Australia	Estonia	Japan	Portugal
Austria	Finland	Latvia	Romania
Belgium	France	Lithuania	Slovakia
Bulgaria	Germany	Luxembourg	Slovenia
Canada	Greece	Malta	Spain
Croatia	Hungary	Netherlands	Sweden
Cyprus	Iceland	New Zealand	Switzerland
Czechia	Ireland	Norway	United Kingdom
Denmark	Italy	Poland	United States