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Abstract

The share of renewables in the global energy mix needs to increase or we will never reach the environmental targets. In 2050 the world will use 80% more energy than it does today and without policy interventions, the fossil-fuel based energy in the global energy mix will remain at 85%. Under this circumstance, increasing the share of renewables in the total energy consumption is most critical to achieve the target set by the Paris Agreement to limit the long-time increase in global temperature below two degrees Celsius. So what is it that affects the use of renewables? In this thesis, I examine factors that affects the share of renewables in the global energy mix in OECD countries using the panel data for the period 1995-2014. My results reveal that carbon dioxide emission, total energy use, GDP per capita and an increasing urban population have a negative effect on the share of renewable energy in the total energy mix. On the other hand, total renewable energy supply and oil price have a significant positive effect on the share of renewable energy consumption.

Keywords: Renewable Energy, Panel Data, Fixed Effect, Hausman test.

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Abbreviations

FE – Fixed Effect
RE – Random Effect
GHG – Greenhouse gas
OECD – Organization for Economic Co-operation and Development
UN – United Nations
GW - Gigawatt

1. Introduction

As the global energy consumption increases, there is a growing concern about the environmental impact. The impact will exacerbate in the future given the growing global energy consumption for instance, in 2050 the world will use 80% more energy than it does today (OECD, 2012). The same study by the Organization for Economic Co-operation and Development indicates that without policy interventions the share of fossil-fuel based energy in the global energy mix will remain at about 85%. This has a serious implication for the global warming.

Energy sector is the key contributor to the greenhouse gas (GHG) emissions and especially carbon dioxide emission. The CO_2 from the combustion of fossil fuels and biomass for energy use is the main contributor to the enhanced greenhouse effect (OECD, 2015). Carbon dioxide emissions from energy use are increasing all over the world, mainly due to the increasing energy demand. With current policies, these greenhouse gas (GHG) emissions will exceed 20 billion tons in 2050. This is about three times more than the amount that would be required to avoid the long-time increase in global temperature to two degrees Celsius. Studies done by the OECD shows that since 1990, the CO_2 emissions from energy use have grown more slowly in the member countries of the OECD as a group then they have worldwide (OECD, 2015). In 2015, the members of the OECD have emitted less than 40% of global carbon dioxide emissions from energy use. This can be compared to the more than 50% in 1990. This trend could be explained by the rapid growth of emissions in emerging economies.

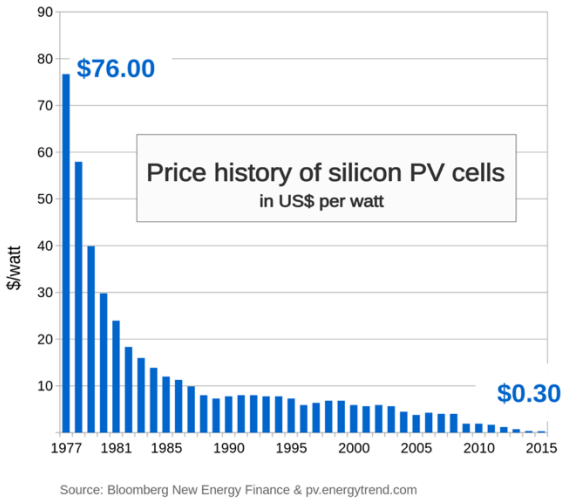
The consumption of energy is also expected to increase due to an increasing population in the world. For example, by the year 2050 it is expected to be 9 billion people in the world compared to the 7 billion that was in 2012. As the population of the earth increases, this will result in a growing demand for energy but also expanding cities. Hence, there is a need to increase the share of renewables (or clean energy) in the total energy-mix to mitigate climate change. This is because, as indicated by Dincer (2000), renewable energy is one of the

most important solutions to current environmental problems, and the exploitation of renewable energy is a key part of sustainable development. In view of this, the European Union are embracing the clean energy transition. An effective way of doing so is through the development of advanced and competitive green technology. To work towards the goal of the European Union they have also set up short and mid-term targets. The short target of a 20 percent share of renewable energy in 2020 and a 27 percent share by 2030 (ECa, 2018). Sweden aims at a target of 49% of final energy consumption from renewable sources (ECb, 2008).

There are different approaches to reach these targets. It could be on a global level like the UN where they agree on targets like the Kyoto protocol in 1997 where they together decided to reduce the greenhouse emission. But it could also be in a single country perspective like in Sweden for example, in Sweden there is a governmental funding where they help to pay 20% of the investment cost if a private person decides to invest in solar power (Energimyndigheten, 2019). Solar power is one of the fastest growing sources for producing renewable energy and is together with hydropower and wind power the main sources of renewable energy production. In 2017, solar power only stood for 2% of the total energy that was produced globally that year (IEA, 2018). Hydropower had a capacity to produce over 1200 GW and Wind power 515 GW worldwide. Their share in the global energy mix is 16% for hydropower respectively almost 4% for wind power. This means that on a global level the share of renewables was somewhere around 22% in 2017. Why the share of wind and solar power is so low could be explained by how expensive and ineffective the renewables have been earlier compared to the non-renewables. See appendix II for more information about the different sources of renewable energy.

The graph below shows how the price per watt has changed between the years 1977 to 2015. There has been a huge price drop from 76$ in 1977 to 0.3$ in 2017. Even though the price drop, only 2% of the global power output comes from solar power (IEA, 2018).

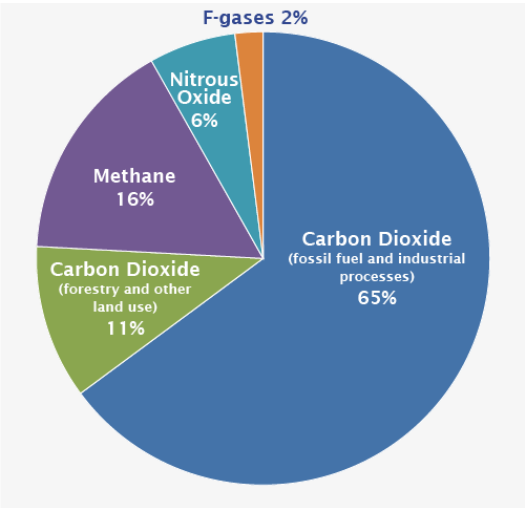
Graph 1: Price history of silicon PV cells



Source: Wikipedia

The human impact on the planet is seen all over the world. Carbon Dioxide is the most discussed source of all the greenhouses gases but there are also Methane, Nitrous Oxide and F-gases effecting the environment negatively. The graph below shows how big each share of the global greenhouse gas emission is by type of gas.

Graph 2: Global Greenhouse Gas Emission by Gas



Source: OECD 2014

The fossil-fuel and industrial sector represents 65% of the total global Carbon dioxide emissions (EPA, 2014). The CO_2 emissions worldwide is rapidly increasing due to the high pressure to ensure energy supply. Carbon dioxide

emission is a major contributor to the climate change. To reach environmental targets set by the Paris Agreement and avoid the global temperature reaching two degree Celcius the GHG emissions needs to decrease.

Therefore, it is important to increase the share of renewables in the total energy consumption. In this regard, it is worth investigating the following key research questions: What factors affect the share of renewable energy consumption in the global energy-mix? Can these create an understanding what has to be done to reduce Greenhouse gas (GHG) emissions and reach environmental targets for example?

To reach the environmental targets it is important to get an understanding what it is that affects the use of renewables. In this study, I aim to find what factors that determinates the percentage use of renewable energy in OECD countries. I seek to determine what socioeconomic and demographic factors that affect the share of renewables in the global energy-mix. By combining earlier studies within the area of renewable energy determinants and using a more up to date time series data, I create a broader analysis where I also include all the member countries of the Organization for Economic Co-operation and Development. Most of the OECD countries are high income countries. This is a good reason why the countries in this data set have a competitive advantage compared to many other countries around the world. But this is not only an economic question but also the location of a country plays a big role in whether it is easy to get access to renewable energy sources like solar power and hydropower.

This paper consists of six different chapters. The first chapter is the introduction. It gives an idea on what is the purpose and background of this thesis. Chapter two describes earlier work done within the area of determinant of renewable energy and chapter three describes the methodology used in this thesis. In the fourth chapter, I present the results of empirical analysis, which is followed by the discussion where I discuss my results related to earlier work used to conduct this thesis. The last chapter is the conclusion where I conclude the whole thesis and give some example on what could be done in the future.

2. Table of Content Literature review and Theoretical framework

In this section, I briefly review relevant earlier work done within the area of renewable energy determinants. Particularly, I present how their approach to find what determinants affect the renewable energy consumption is described in their studies and also how I will use this information to contribute with more information to fill the existing research gaps.

The study by Aguirre and Ibukunle (2014) investigated the determinants of the growth of renewable energy consumption. Similarly, Marques et al (2010) examined factors affecting renewable energy consumption. However, previous studies did not consider factors related to policy and the renewable energy potential of countries. Those factors will not be considered in this study either. In the study Marques et al (2010) they decided to divide the different determinants into three categories: Political, Socioeconomic and country-specific factors. This was later adapted by Aguirre and Ibukunle. This study focuses only on the socioeconomic category which consists of carbon dioxide emissions, welfare (GDP per capita), energy needs (Population growth and energy use) and energy prices (Oil, gas and coal). The results from their study indicates that CO_2 emission have a significant effect on the renewable energy growth. Their result suggested that the reason for this was that environmental concerns were relevant in the countries they studied. The energy use variable on other hand have a significant negative effect on the participation of renewable energy. This implies that under high pressure to ensure energy supply, the countries included in their study tends to employ less renewables. The study by Marques et al (2010) was in the opinion of Aguirre and Ibukunle (2014) a limited study. A short time-series with data only ranging from 1990-2006 and a small sample of only 24 countries were included because of the gap in data. In the study by Aguirre and Ibukunle (2014) they wanted to expend their study with a longer time-series. They also wanted to include more countries. This resulted in a sample of data with a total of 38 countries from all over the world and a time-series ranging from 1990-2010. Instead of focusing on a specific area or members of an organization like the OECD they wanted to include as

many countries as possible where data where available. Searching the determinants of renewable energy consumption is already here considered to be a challenge since there are huge gaps in data. This is also explained to be easier in the future where more data will be available.

Since I want to investigate the members of the OECD I have also included a study by Shi from 2014. In this study they investigate 26 members of the OECD in a panel data set over the period 1990-2010 to find out what factors that influence the share of renewable energy in total energy supply. Since I believe that it is important to look at it in not only a consumer-perspective I wanted to see the results from a supply-perspective as well. Here the author finds a positive effect of Research and Development (R&D) on the share of renewable energy supplied in the market. This is being explained in a way that because of an increase in R&D activities countries spends more time on making the technology more efficient and reduces the costs in producing renewable energy. Just as in the study by Aguirre and Ibukunle it is proven that a large energy consumption growth decreases the share of renewable energy in total energy supply witch is also the same in the share of renewable energy consumption.
In a study by Salim and Shafiei (2014) they wanted to investigate how urbanization affects the renewable and non-renewable energy consumption. Their aim with the study was to figure out what demographic factors that affects the renewable and non-renewable energy consumption in OECD countries. Significant factors that was proven to effect the non-renewable energy consumption was urbanization, population and population density. Also shown in the study was that population density has a negative effect on the renewable energy consumption. This means that as more people live in a limited area they tend to use less renewable energy.

To be able to conduct all tests in Stata I have been using literature by Colin Cameron and Trivedi (2009). This literature contains information about how to conduct Fixed effect model, Random effect model and Pooled OLS model. It also contains information about the Hausman-test that has been used in this thesis.

By combining the studies made by Marques et al (2010), Shi (2014) and Aguirre and Ibukunle (2014) I have taken the socioeconomic factors and combined them with the demographic factors from the study by Salim (2014). These factors will be used to create the theoretical framework for this thesis and create a broader analysis with more recent data. Compared to earlier work this study will also include all the member countries of the OECD.

3. Data and Empirical approach

3.1 Data and description of the variables

This analysis is based on panel data of the 36 members of the OECD (Information about the OECD can be find in APPENDIX I). Data is obtained from the World Development Indicators (WDI), the OECD database and BP statistical of the world with data is ranging from 1995-2014 (A total of 720 observations). Data for the independent variables CO_2 emission, Population growth, GDP per capita, Urban population, Total renewable energy supply, Oil price, Gas price and coal price are collected to find the determinants on the dependent variable renewable energy consumption in percentage of total energy consumption. To conduct this panel data analysis, the statistical software Stata is used.

Table 2: Description of study variables

Variable	Description
RENEW	Renewable energy consumption (% of total energy consumption)
CO_2	Carbon dioxide emission (Metric tons per capita)
POP	Population growth (Annual %)
GDP	GDP per capita (Current US$)
URB	Urban population (Sum)
ENE	Total energy use (kg of oil equivalent per capita)
RENEWS	Total renewable energy supply (ktoe)
OILPRICE	The price of crude oil (US dollars per barrel
GASPRICE	The price of gas (US dollars per million Btu
COALPRICE	The price of coal (US dollars per tonne)

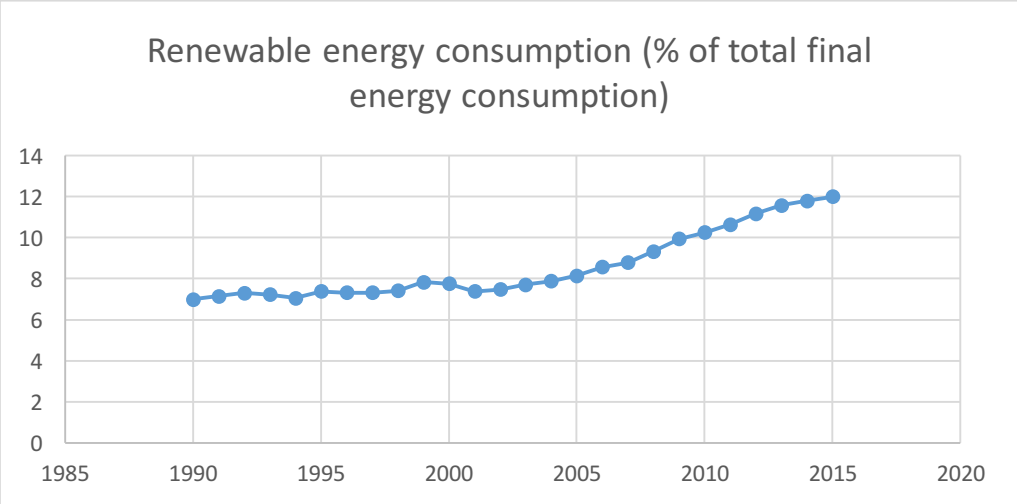
Source: Own design

3.2 Dependent variable

Renewable energy consumption

The data for renewable energy consumption is measured in Renewable energy consumption in percentage of total energy consumption. Data was collected from the world development indicators. In the graph below you can see how the renewable energy consumption in percentage of total energy consumption has increased from 7 percent in 1990 to around 12 percent in 2015.

Graph 3: Trend line on the share of renewables



Renewable energy consumption (% of total final energy consumption) in OECD countries between 1990-2015. Source: WDI (2019)

3.3 Independent variables

The independent variables used in this regression are all chosen from earlier studies where they have been searching for the determinants of renewable energy consumption or supply. These variables are mainly divided into two different categorize, Socioeconomic and demographic factors. Data has been collected from the World development indicators, the OECD database and BP Statistical review of the world.

Demographic Factors:

URB - Urban Population

The data for Urban Population is measured in the amount of people living in an urban area. Bigger cities demand more energy. I expect that an increase in the amount of people living in bigger cities will not increase the amount of renewable energy. I believe that it will rather have a negative effect on the consumption of renewable energy because of the increasing energy demand and limited space to deploy renewables.

POP - Population Growth

The data for Population Growth is measured in percentage change from previous year. The effect of this variable is uncertain since it is hard to know since an increace in population could be supplied by either renewable energy or non renewable resourses. As the population is increasing more energy will be needed. I believe that the oucome depends on how fast the population is growing but also if there is easy to employ renewables in those places.

Socioeconomic Factor:

CO_2 - Carbon dioxide Emission

The data for carbon dioxide emission is measured in metric tons per capita. I expect that an increase in carbon dioxide emission will have a negative effect on the percentage use of renewable energy consumption. When more renewable energy is used we will emit less CO_2. I believe that an increase in carbon dioxide emission with its consequences will create a bigger concern of environmental damages and a willingness to increase the renewable investments.

GDP - GDP per capita

The data for GDP per capita is measured in US dollars. I expect that higher income counties are more likely to invest in renewable energy, since it is easier for them to afford research on development of such technologies. The data used from sample of countries in this analysis will be important since we could expect huge gaps between high and low income counties.

ENE - Energy Use

The data for Energy Use is measured in kg of oil equivalent. Just as in population growth the effect of this variable is uncertain since large energy use could be supplied by either renewables or non-renewables.

RENEWS - Total primary renewable energy supply

The data for Total Primary Energy Supply is measured in ktoe (Tonne of Oil equivalent). This variable I expect to have a positive effect in the renewable energy consumption in percentage of total energy consumption since the supply of renewables will also explain the consumption.

OILPRICE GASPRICE COALPRICE – Prices of oil, gas and coal are collected from the BP statistical review of the world. The data is measured in US dollars per barrel. Since there are huge gaps trying to find prices on renewable resources I have decided to use the non-renewable supplement instead. These non-renewable resources are most likely to have a positive effect on the consumption of renewable energy. This because of increasing prices of non-renewables will create a lower demand and will result in a growing demand for renewables if those prices will be lower.

3.4 Descriptive statistics

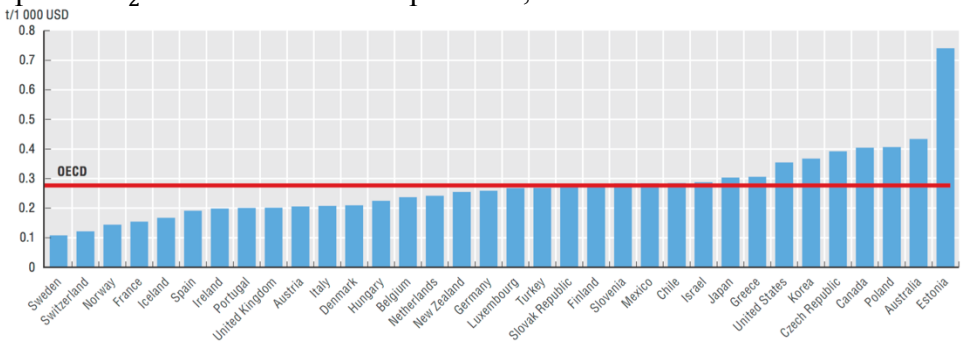
Table 1 Summary statistics of pooled data

Variable	Obs	Mean	Std.Dev.	Min	Max
RENEW	720	16.689	15.35	.444	77.345
CO2	720	8.855	4.169	2.683	24.825
POP	720	.537	.772	-2.258	2.891
GDP	720	29290.6	20393.3	2168.796	119000
URB	720	2.57e+07	4.33e+07	245000	2.59e+08
ENE	720	4188.314	2344.52	1052.7	18178.14
RENEWS	720	10698.65	20655.46	37.38	157000
OILPRICE	720	54.676	35.088	12.716	111.67
GASPRICE	720	4.443	2.039	1.687	8.849
COALPRICE	720	53.907	22.844	27.006	117.418

Source: Own calculations based on data from WDI, the OECD database and BP statistical of the world.

By looking at the descriptive statistics we can get an understanding that there are huge differences between the different countries in this study. The variable RENEW have a mean value of 16.689. This tells us that during the period 1995-2014 in the selected countries there is a mean value of 16,689%. The minimum value represents Korea in 1995 and the maximum value represents Iceland in 2014. There are also big differences examining the carbon dioxide emission that is measured in Metric tons per capita. The indicates that in the year 2000, Latvia emitted 2.683 metric tons of carbon dioxide per capita as their share of renewables is 35.82 % in the same period. The country that instead emits the most CO2 in this time period was Luxembourg in 2005. They emitted a total of 24.825 metric tons per capita. In this period their share of renewables in the total energy-mix was at a shocking low 1.89%. The GDP per capita for those counties in the same periods shows 3352.73 in Latvia and 80289,69 in Luxembourg. This could indicate that GDP per capita do not affect the percentage share of renewable energy in the total energy consumption.

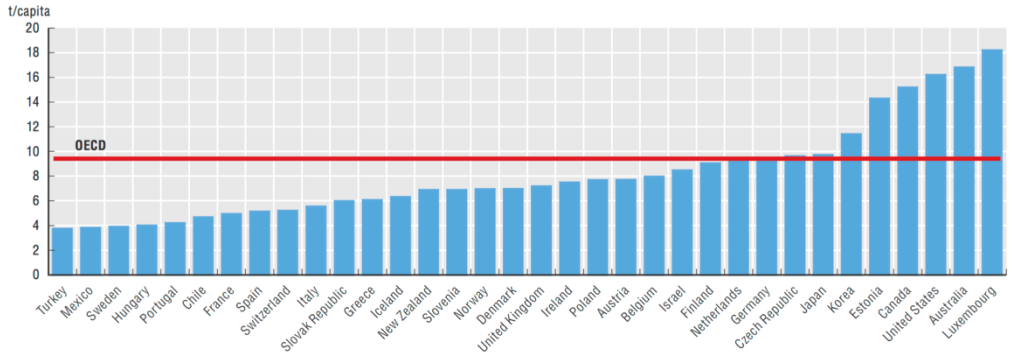
Graph 4: CO_2 emission intensities per GDP, 2013



Source: Collected from OECD (2015)

Graph 4 describes how the CO_2 emission intensity per GDP were in OECD countries in 2013 and graph 5 the CO_2 emission intensities per capita in the same year. By just looking at the graphs it is hard to see if there is a relationship between the variables.

Graph 5: CO_2 emission intensities per capita, 2013



Source: Collected from OECD (2015)

3.5. Empirical Approach

3.5.1 Hausman-test

To determine whether to use either Fixed Effects or Random Effects I conduct A Hausman-test. The Hausman-test is also known as the Hausman specification test. The test detects endogenous regressors in a regression model.
This testing is conducted with the hypotheses as follows:

H_0: P-value > 0.05, there is no correlation between unobserved characteristics and explanatory variables, then the Random Effect (RE) model is valid to use.
H_1: P-value < 0.05, there is correlation between unobserved characteristics and explanatory variables, then the Fixed Effect (FE) model is valid to use.

3.5.2 Lagged values

To test if any values from previous periods has an effect on the upcoming ones I have decided to lag the variables GDP per capita and Population growth with one period. It could be interesting to see if the population growth and GDP per capita from the previous period will have an effect on the model.

3.5.3 Logarithmic data

To make the results easier to interpreted I used a Log-Log model. This makes it possible to measure the coefficient results as elasticities. This equation looks like:

$$LogY = B_0 + B_1 LogX_1 + B_2 Log + \varepsilon$$

4. Results

4.1 Statistical Tests

The selection of Panel data regression model:

Hausman-test

To determine which model to use I conduct a Hausman-test on a 5% significant level. The hypotheses are as follows:

The null hypothesis is H_0: An unobserved characteristic is uncorrelated with the error term.

The alternative hypothesis is H_1: An unobserved characteristic is correlated with the error term.

H_0: P-value > 0.05, then the Random Effect (RE) model is valid to use.

H_1: P-value < 0.05, then the Fixed Effect (FE) model is valid to use.

Table 2: Results from Hausman-test

Chi2=24.01
Probability>Chi2=0.0043
0.0043<0.05

Source: Own calculations from STATA (2019)

From the table above, it shows that probability=0.0043 which is smaller than a=0.05. I therefor reject the null-hypothesis. Based on the Hausman-test to select model, it can be concluded that the model used in this study is more appropriate to follow the Fixed Effect (FE) Model than the Random Effect (RE) Model.

4.2 Regression results

The table below shows results from my regression analysis. It is the same regression as in column 1 in table 2 but in this regression model I decided to lag all values but Population growth because the population growth was negative for some years. The significant variables presented in the table are Carbon

dioxide emission, GDP per capita, Urban Population, Total Energy Use, Renewable Energy Supply and Oil-price. The non-significant ones are Gas-price, Coal-price and Population Growth. There are a total 720 observations and the R^2 value is 0.837. The F-test for overall significance shows that the overall model is significant.

Table 1: Fixed effect Log-Log model.

	(1) logRENEW
logCO2	-0.340***
	(-4.33)
logGDP	-0.0743*
	(-2.37)
logURB	-0.899***
	(-8.32)
logENE	-0.890***
	(-10.78)
logRENEWS	0.860***
	(34.09)
logOILPRICE	0.0578*
	(2.37)
logGASPRICE	-0.0254
	(-1.62)
logCOALPRICE	0.000430
	(1.00)
POP	0.00727
	(0.47)
_cons	18.18***
	(9.88)
N	720
R^2	0.837

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fixed Effect (FE) Model generates the following equation:

$$LogRENEW = LogCO_2 * -0.340 + LogGDP * -0.0743 + LogURB * -0.899 + LogENE * -0.890 + LogRENEWS * 0.860 + LogOILPRICE * 0.0578$$

Interpreting the results (only variables that are statistically significant):
If the $\boldsymbol{CO_2}$ ***emission*** increase by one percentage, the share of renewable energy consumption in the total energy-mix decrease by 0.34 percentage.
If the ***GDP per capita*** increases by one percentage, the share of renewable energy consumption in the total energy-mix decrease by 0.0743 percentage.
If the ***Urban population*** increase by one percentage, the share of renewable energy consumption in the total energy-mix decrease by 0.899 percentage.
If the ***Total energy use*** increases by one percentage, the share of renewable energy consumption in the total energy-mix decrease by 0.89 percentage.
If the ***Renewable energy supply*** increases by one percentage, the share of renewable energy consumption in the total energy-mix increases by 0.86 percentage.
If the ***Oil-price*** increases by one percentage, the share of renewable energy consumption in the total energy-mix increases by 0.0578 percentage.

To find my final regression model I tried a few different approaches. In the table below columns 1 and 3 are fixed effect models. The difference between them is that in model 3 I have used lagged values for GDP per capita and Population Growth. In columns 2 and 4 I used the same variables as in model 1 and 3 but they are instead random effect models. Column 5 is a Pooled OLS-model.

Table 2: FE model, PE model and Pooled OLS model results.

	(1) RENEW	(2) RENEW	(3) RENEW	(4) RENEW	(5) RENEW
POP	0.363	0.374			0.371
	(1.55)	(1.57)			(1.59)
GDP	-0.0000199	-0.0000144			-0.0000165
	(-1.65)	(-1.17)			(-1.38)
CO2	-1.754***	-1.726***	-1.728***	-1.696***	-1.736***
	(-18.99)	(-18.76)	(-18.82)	(-18.51)	(-19.16)
URB	-0.000000274***	-0.000000240***	-0.000000292***	-0.000000249***	-0.000000252***
	(-11.13)	(-10.86)	(-11.15)	(-10.75)	(-11.12)
ENE	0.00145***	0.00154***	0.00141***	0.00151***	0.00150***
	(12.78)	(13.46)	(12.22)	(12.92)	(13.41)
RENEWS	0.000158***	0.000171***	0.000159***	0.000171***	0.000166***
	(6.52)	(7.03)	(6.54)	(6.95)	(6.93)
OILPRICE	0.0497***	0.0462***	0.0475***	0.0439***	0.0475***
	(9.84)	(9.07)	(9.70)	(8.88)	(9.53)
GASPRICE	-0.0871	-0.0992	-0.122*	-0.130*	-0.0947
	(-1.74)	(-1.95)	(-2.45)	(-2.55)	(-1.91)
COALPRICE	-0.00365	-0.00323	-0.00289	-0.00268	-0.00339
	(-0.52)	(-0.45)	(-0.42)	(-0.38)	(-0.49)
GDPlag			-0.0000113	-0.00000580	
			(-0.96)	(-0.48)	
POPlag			0.207	0.214	
			(0.87)	(0.88)	
_cons	29.77***	28.18***	30.26***	28.40***	28.77***
	(28.88)	(14.97)	(28.23)	(14.89)	(12.44)
N	720	720	684	684	720

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The statistically significant variables in all five models are carbon dioxide emission, Urban population, Total energy consumption, Renewable energy supply and Oil-price. The variables carbon dioxide emission and Urban population have a significant negative effect on the consumption of renewable energy. The variables Total energy consumption, Renewable energy supply and Oil-price have a significant positive effect on the renewable energy consumption. In table 3 and 4 where I used lagged values for GDP per capita and Population growth also the variable Gas-price had a significant negative effect.

The significant variables in all regressions I have conducted indicates that it is a robust test where the same determinants consist with the Fixed Effect (FE) Model.

5. Discussion

5.1 Result discussion

In table 2, the results indicated that the same variables had statistically significant effect in all five models. This indicates that the results are robust. The only difference between them where the variable Gas-price that had a negative effect on the consumption of renewable energy in the regression models where I used lagged values. By using lagged values for the variables population growth and GDP per capita I wanted to see if the data from previous period would have an effect on the upcoming one. This resulted in an unexpected result where the price of gas had a significant negative effect on the share of renewable energy consumption. Since gas is a non-renewable energy resource an increase in price would lead to a decrease in demand. If renewable energy is seen as a substitute to gas, then renewable energy would get a higher demand on the market. The problem in this model could be that gas-price either correlates with the price of crude oil or that gas is not seen as a substitute to renewable energy in the same way as crude oil. An explanation for this is yet hard to estimate. This resulted in leaving out the lagged variables and instead use population growth and GDP per capita just as they are. Since the results in table 2 are hard to interpreted I decided to use a Log-Log model which is shown in Table 1. The R^2 in the Log-Log model is 0.837 which also is an improvement compared to the R^2 0.6819 in the first fixed effect model where I did not use logarithmic values. The Hausman-test conducted in this thesis indicated that I should drop the null hypothesis since the P-value = 0.0043<0.05. The fixed effects model is best fitted to data used in this study since there are characteristics in the error term that correlates with the variable used in this thesis. To examine which those variables are is beyond the scope of this paper.

Going back to the study by Aguirre and Ibikunle, the variable Total energy use negatively affects the consumption of renewable energy. This study that I have conducted indicates the same result where an increase in Total energy use by 1% leads to a decrease in the share of renewable energy consumption by 0.89%.

The conclusion made by Aguirre and Ibikunle was that this implies that under high pressure to ensure energy supply, countries tends to employ less renewables in the total energy-mix. This could be the case or was it just because that they did not have the incitement to use renewables or that the renewable energy sources where ineffective and expensive.
As in previous studies the variable carbon dioxide emission also had a negatively significant effect on the share of renewable energy consumption, telling us that as carbon dioxide emission decreases by 1% the share of renewable energy consumption in the total energy mix will increase by 0.34%. Earlier studies have shown that increasing levels of carbon dioxide emissions will create a bigger concern of environmental damages and an incitement to increase the renewable investments. This because of that renewable energy is one of the most important solutions to current environmental problems, and the exploitation of renewable energy is a key part of sustainable development. This is also very well explained in literature (see for example Sadorsky, 2009).
The variable Urban population did have a negative effect just as expected. Bigger cities will create a bigger demand for energy to supply not only the people living there but also big city industries. Just as the results from the study made by Salim and Shafiei (2014) also indicated, population density tends to have a negative effect on the consumption of renewable energy consumption.

The results also indicate that as the price of crude oil increases we tend to use a bigger share of renewable energy in the total energy-mix. In the same time, we can see from the graph describing how the price history of silicon PV cells in US$ per watt has decreased from 76US$ in 1977 to 0.33US$ in 2015. In an economic perspective this makes the solar energy technique more attractive to a bigger crowd. Even though most of the OECD countries are high income countries there are still differences between the GDP per capita. In the model we can see that GDP per capita has a small negative effect on the share of renewable energy in the total energy-mix. This could be explained by how countries investing in renewables as they are still expensive could suffer from a decrease in GDP per capita for that country in that time period. Since there are huge differences in all countries considering the environmental targets GDP per

capita could easily change between having a non, negative or positive effect on the consumption of renewables depending on what countries you are studying. I also mentioned this when I compared the descriptive statistics where the GDP per capita was not higher in countries where the share of renewables was larger. Hence, cheaper technologies make it easier for all countries to adjust toward ¨green¨ technology which do not have the same negative effect on the environment.

There are also downsides with the sources of renewable energy. More about these can be found in Appendix III. The conclusion is though that they are a far better alternative than the non-renewables when it comes to mitigate climate change.

6. Conclusion

The purpose of this study was to examine what determinants that have an effect on the consumption of renewable energy in percentages of total energy consumption in OECD countries. To conduct this analysis, I used an econometric approach looking at it in a panel-data set. All members of the OECD were included resulting in data collected from a total of 36 countries. By conducting a Hausman-test I could see that a Fixed effect model was preferred in this study. To make the results easier to interpreted I transformed my model into a Log-Log model.

Results of the study indicate that renewable energy supply and oil-price have a positive effect on the proportion of renewable energy consumption. This result is statistically significant. However, other variables included in the regression analysis namely carbon dioxide emission, GDP per capita, total energy use and urban population found to have a negative impact on the consumption of renewable energy. For further work within the area of renewable energy more determinants might be investigated. There where gaps in data when I tried to look for energy potential, higher education level in the population and prices on renewable energy like solar, hydro and wind power.

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Appendix I

OECD

The Organization for Economic Co-operation and Development also known as the OECD is an organization founded back in 1961 to stimulate world trade and economic progress (OECD, 2019). With a total of 36 countries they work together providing a platform to compare policy experiences, seek answers to common problems, identify good practices and coordinate domestic and international policies of its members.

The Organization for Economic Co-operation focuses on helping the governments around the world with restoring confidence in markets and the institutions that make them function (OECD, 2019). They want to re-establish healthy public finances as a basis for future sustainable economic growth. To Foster and support new sources of growth though environmental friendly 'green growth' strategies, innovation and emerging economies. The OECD also wants to ensure that people of all ages can develop the skills to work satisfyingly and productively in the jobs of tomorrow. In the beginning in 1961 there were only 20 member countries compared to the 36 today. Latest to join were Lithuania in July 2018 and in May 2019 Colombia will also be a part for the OECD and become the 37th country to join. Most members of the OECD are considered to be high income countries. The ones who are not are Poland, Mexico and Turkey. They are considered to be middle income countries.

The members of the OECD in 2019:
Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

Appendix II

Renewable energy

Renewable energy is energy collected from renewable resources (Jordbruksverket, 2018). These are naturally replenished on a human timescale. Example of renewable resources is solar energy, hydropower and wind power. There is also share opinions on people arguing that nuclear power is a part of the renewable resources. This since there is almost no carbon dioxide emitted during the process of producing energy in a nuclear power plant. But since there is chemical waste, nuclear power has been excluded from being a renewable resource. Here are some short facts about the solar, hydro and wind power.

Solar energy

Solar Energy is energy that can be harnessed directly from the sun, even in a cloudy weather (IRENA, 2019). It can be used in two ways, generating electricity with a photovoltaics (PV) system or by heating and desalinating water with a concentrating solar power (CSP) device. Even though the sun is a great energy source the technology to take that energy and convert it to electricity have earlier been ineffective and expensive. The graph below shows how the price per watt has changed between the years 1977 to 2015. The high price and earlier ineffectiveness has led to that in 2017 only 2% of the global power output (IEA, 2018).

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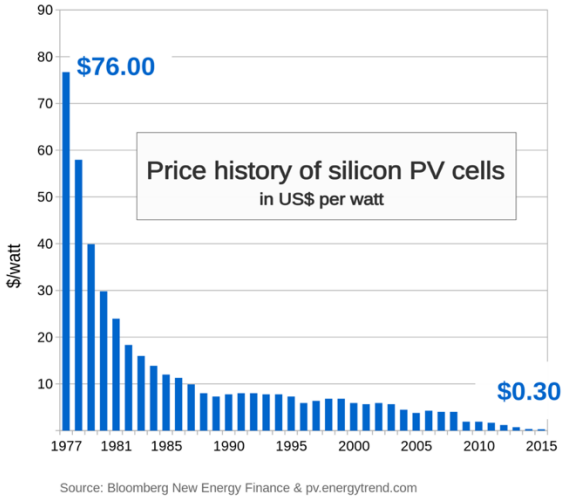

Hydro Power

Hydropower is energy derived directly from flowing water. The basic principle of hydropower is using water drive turbines. Already introduced more than 2000 year ago in ancient Greece to help running wheels used for grinding grains, hydropower is today one of the most cost-effective methods generating electricity. It is also the largest source of producing renewable electricity in the world producing around 16% of the worlds energy (IEA, 2018). Here is a typical example looking at the competitive advantages. In Norway, for example they are able to produce 99% of their electricity from hydropower (IRENA, 2018).

Wind power

Wind power is energy derived from air in motion (IRENA, 2018). It is used in the mayor part of the world to produce ¨green¨ electricity. The blades connected to the turbine is set in motion by the wind. As the blades starts to rotate they also turn the turbine connected to them. The turbine in its turn is connected to a generator. The generator is producing electrical energy through electromagnetism. Globally, wind power accounts for around 4% of the electricity generated (IEA, 2018).

Appendix III

Downside of renewable resources

It is not very common to hear people talk about renewable energy resources in a negative way. The renewable energy sources do also have downsides. The wind turbines for example occupies a lot of land space. People mostly doesn't want to live up close to the turbines because of the sound created as the blade rotates. It is also considered to destroy the esthetic of landscapes since they are considered to not be a part of the ¨natural¨ landscapes. They are also a danger to birds. The birds flying by could end up in the rotor blade ending their life. Since some bird are endangered species it is important to place these wind turbines in places where you hurt birds as little as possible. It is also sufficient that wind turbines need wind to turn the blades. Solar power also needs the sun to shine to generate electricity. Water Power do also have downsides. For example, it can bring damages to the aquatic ecosystem where fishes may take damage when passing by the hydroelectric power-plant. To avoid this, they have introduced a variety of methods including fish ladders and in-take screens to avoid these damages.

One of the biggest disadvantages of renewable energy resources is that it is difficult to generate the same amount of electricity that the traditional fossil-fuels ones generates. In a decarbonizing perspective maybe also the nuclear power should be included in the renewable energy categories. Since population are getting bigger and the share of people living in urban areas is increasing maybe the only way of reaching environmental targets and also supplying the amount of energy that is demanded, nuclear power might be the way to go. In a society where we are trying to reduce the amount of fossil-fuel we are using and instead going I a direction where electric driven cars it is also very important that the electricity that is being used comes from resources that do not causes damages to the environment. Right now there isn't really an energy source that is a 100% perfect that doesn't have a negative downside. It is more important to look at what you want focus on preventing.