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Environmental Policy Stringency and Economic Output

An econometric analysis with panel data

by

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Abstract

This analysis examines the correlation between the stringency of environmental policies and the economic output in terms of real GDP. The data is covering real GDP, the stringency of market based as well as non-market based environmental policies, interest rates, total factor productivity and human capital. 33 countries, among the OECD and the BRICS, are being analyzed in the regression model during a time period from 1990 to 2015. The analysis is also examining the potential delaying effects of environmental regulation on real GDP, with lag times of 0 years, 10 years and 20 years, as well as potential differences between countries. The results show that no significant correlation exists for neither of the three models. Nor are any significant differences in outcome, between the OECD and the BRICS countries, observed. This indicates that the relationship between environmental regulation and economic output is not as profound as previously assumed, for example by the Environmental Kuznets Curve. Hence, the results suggest that environmental reforms can be implemented without adversely effecting economic output, as emphasized by the Porter Hypothesis. Previous research on the subject have reported similar results which further supports this conclusion. The robustness of the results could be discussed with regard to country specific and time specific effects, an unbalanced data panel or an insufficient number of control variables. Also, the relevance of the real GDP measure could come into question in this type of study, where other potential effects from environmental regulation might be more relevant to examine. Future research, with different type of measures and control variables, is therefore required in order to fully understand the complex relationship between environment and economics.

Keywords: environmental regulation, policy stringency, economic output

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Introduction

Since the early 1970s, the environmental concerns has grown in our society and taken a larger portion of the public debate and the political agenda. The environmental problems, mainly caused by human activities such as burning of fossil fuels, agriculture and an excessive use of natural resources, has reached a critical point and is today risking our whole civilization as we know it (IPCC 2018). Fortunately, actions toward a more sustainable future are today more prevalent in the private sector as well as in the public divisions. These actions are partially expressed as an increase in institutional environmental regulations which should, according to the Porter Hypotheses (Xepapadeasa, de Zeeuwb 1999) be able to improve both the environment and the economy, if carefully executed (Porter, van der Linde 1995). However, this potential outcome is encountered by skepticism. It can, from an economical stand point, be debated whether it is possible or not to implement environmental regulations without negatively affecting the economic output. This paper aims to further explore this relationship, and the possibility of retaining economic growth, while implementing more profound and stringent environmental policies. The study analyzes, through a panel data regression, data covering 28 of the 36 OECD economies (*Organization of Economic Co-operation and Developments*), the BRICS countries (*Brazil, Russia, India, China, South Africa*) and Indonesia. In total 33 countries in various stages of economic development and transition states from manufacturing- to service economies. The paper examines the correlation between the stringency of environmental policies, market- as well as non-market based, and the real gross domestic product (GDP) in these countries. Differences between countries and externalities during the measured time period, have been accounted for through the treatment of individual specific effects and time specific effects. This by the introduction of control variables such as; total factor productivity, human capital and long term interest rate levels, in conjunction with the use of dummy variables. With this background, the problem in question is stated as such:
How does the stringency of environmental policies affect the economic output?

The obtained results indicate that the stringency of environmental polices does not significantly affect the economic output. Nor were any differences in the results observed between developed countries and developing countries. Further, the results suggest that in comparison, total factor productivity and human capital have a more significant effect on the economic output, especially for the developing countries or the BRICS economies. Long term interest rates levels did not show any significant outcome. In conclusion does the results support the Porter Hypothesis and correspond with previous studies on the subject. This can in turn potentially provide more insight in how environmental policy making and implementation, are affecting the economic growth and output. Which in turn might lead to more efficient and relevant policy making processes in the future. However, due to significant levels, the robustness of the determined correlation can be questioned. Hence, further research is required with regard to relevant control variables and adjustments to individual specific effects as well as time specific effects.

In the second section, previous research studies are discussed with some theories on the subject. In the third section, the method is presented. The fourth section is explaining the different data variables, as well as treating the origin of the data. The results, the analysis and a consecutive discussion is conferred in the fifth section. The paper is then concluded and summarized in section six, with references in the end.

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Economic Output and The Environment

There a many previous studies, with different views and theories treating the relationship between economy and environment. However, these have mainly been focusing on the environmental impacts caused by the economic growth, rather than how environmental engagement and regulation are affecting the economic output. Where the later, at the current state seem more relevant, following the increased desire for political and institutional solutions for the environmental problems. One of the most well known studies regards the Environmental Kuznets Curve. The theory suggests that the environmental damage caused by a country, at first should increase to later decrease with an expanding economic output. This is explained by the prioritization countries in early stages of development have to do (Stern 2004). Hence, the Environmental Kuznets Curve indicates that there is a trade-off relationship between environment and economy, where less developed countries have to prioritize one of these areas instead of pursuing an improvement in both. However, this conclusion is contradicted by the Porter Hypothesis, stating that it is possible to improve the environment and the economy at the same time with well executed environmental regulations. The Porter Hypothesis was first presented by Porter and van der Linde in an article from 1995, where they provided an argumentation against the previously thought, and partially suggested by the Environmental Kuznets Curve, trade-off relationship between environment and economy. This relationship, is something which Porter and van der Linde mean has been exaggerated. The reason for this, they explain, is partly due to an overestimation of compliance costs following new regulations, as well as an underestimation of the productivity gains following the incentives for technological development. Porter and van der Linde continues with explaining that well-designed environmental regulations, have a large chance of leading to more competitiveness among firms and that the technological progress that follows, tend to outweigh the negative costs associated with more stringent policies. They also discuss the possibility, that the static mindset regarding the relationship between environment and economy, in it self, has been inhibiting the full potential of the positive outcomes, that follows after the implementation of an environmental regulation. This mainly due to inefficiencies and an inhibition of actions.

Similar results, supporting the Porter Hypothesis, have been shown in an article published by the OECD, Botta and Koźluk (2016), which summarizes the interaction between environmental policies and economic performance. Based on two decades of data, covering 24 of the 36 OECD nations, the authors show that the economic productivity has not been negatively effected by the introduction of more stringent environmental policies, except from temporary adjustments at initiation. Botta and Koźluk also concludes that the most productive and technologically advanced industries and firms, tend to benefit from more stringent policies. This, as explained by the Porter Hypothesis, due to the following effective reallocation of resources as well as an increase in innovative stimulation, that results from competitiveness. Just as in the OECD study and in the article by Porter and van der Linde, does Dechezleprêtre and Sato (2014) find that the suggested trade-off relationship, is not as significant as previously assumed. Nor do they observe any significant effects on employment rates after the introduction of an environmental regulation. The writers also find, like Botta and Koźluk, evidence for short-term negative effects on productivity after the implementation of new or reinforcements of current environmental regulations. This can be assumed being a consequence of new market rules, investment requirements or a lack of the right know-how. They also see that these short-term negative effects tend to decline, or in some cases even disappear, after a few years of adjustment. In some of their studies, it is seen that a few of these initial negative effects on productivity turn into positive effects on the economic output in the long-run. Presumably due to the increase in innovation explained by the Porter Hypothesis. These conclusions are interesting since they suggest that the assumed negative effects on the economic output caused by environmental policies might be induced by a the implementation process of the regulation itself, rather than its particular focus on environmental action. The results also reinforce the Porter Hypothesis and the conclusion that environmental policies might not affect economic output as significantly as previously thought and suggested by the Environmental Kuznets Curve.

In another report, treating the *American Clean Air Act Amendment* from 1990, Muller and Jha (2017) explains that no significant correlation between environmental policy and economic output in terms of GDP has been observed. Muller summarizes: "We find evidence that environmental policy significantly reduces the per-capita pollution emissions in American cities without adversely affecting GDP per capita." The reduction of the per-capita pollution emissions, the writers discuss, results in an increase of peoples health and overall well being, or put differently, societal positive effects. These positive effects does not display themselves as economic output in terms of the conventional GDP measure, even though the general well-being most likely has been increased. The study also explains the societal capability of implementing and strengthening environmental policies, that dramatically reduces the pollution and the following consequences. This, without inhibiting innovation and economic growth, which corresponds with earlier studies on the subject.

The Environmental Kuznets Curve and the Porter Hypothesis are in some sense contradicting each other, as well as concluding different views on the relationship between economy and environment. However are the results obtained in the previous research consistent and seem to fall in favor for the Porter Hypothesis. This could be explained by different factors, for example that there might be a certain level of development that is required in order to implement strong environmental regulations. In turn, this means that economic output has to increase in order for a country to be able to introduce strong regulations. Which is basically what the Environmental Kuznets Curve is suggesting. Since most of these studies are focused on more developed countries e.g. the OECD, it can be argued that both theories are relevant with regards to the results. In summary, the previously assumed trade-off relationship, seen in the Environmental Kuznets Curve, between environment and economy seems to be over estimated. This in turn suggests that eventual effects on economic output caused by environmental polices are rather low. With these studies in mind, it can be assumed that a similar result should be obtained in this paper as well. Presumably, that no significant effects on economic output follows increased stringency in environmental policies.

3

Method

In order to answer the problem statement: **"How does the stringency of environmental policies affect the economic output?"**, a regression model has been used. This has been done with an econometric analysis through panel data regression. The analysis includes the 33 countries during the time span from 1990 to 2015, as well as the control variables; total factor productivity, human capital and interest rates. The analysis is performed with three regression models, each with a different time lag. In general, strengthening of existing policies as well as the introduction of new ones are assumed to require some time before implementation and full potential effect on the economy, society or environment. Hence, three different models have been compiled. Each covering a certain lag time; 0 years, 10 years and 20 years. This is relevant in order to evaluate eventual short-term respective long-term effects, as well as increase the significance of the obtained results. Further, three constellations of different countries are being examined. All 33 countries referred to as "all countries", the OECD economies and the BRICS nations (including Indonesia). This is done in order to determine potential variations between developing countries and developed countries.

3.1 Panel data regression

The econometric analysis in this paper is executed through a regression of panel data. Panel data consists of data which is both time sectional and cross sectional, which means that time dimensional and observation dimensional properties can be measured at the same time. In short, an analysis is made by performing repeated cross sectional observations of the same subject under a certain time frame. One advantage with the panel data regression, in comparison to other types of regression models, is the revealing of dynamics within cross-sectional data. Also, due to the fact that the number of observations is very large in a panel data regression, because of the multiple dimensions, the data tends to be rich in content. This in turn will provide a more robust data basis for the analysis (Dougherty 2011, s. 514-518). In this paper, the panel data regression model consists of several variables being described in section three. All variables are logarithmic, with the reason to obtain the annual variation changes in percentage during the time period. This in order to restrict the parameters to the same relative level. The model has one dependent variable which is the annual change in real GDP and two explanatory variables which are the annual changes in market based environmental policy stringency (Market

EPS) and non-market based environmental policy stringency (Non-Market EPS). Also, data from the control variables are included. These are the annual changes in; human capital, total factor productivity and interest rates. Furthermore, dummy variables has been generated in order to deal with the time specific effects.

The panel data regression model is linear and follows:

$$Y_{i,t} = \beta_0 + \beta_1(EPS)_{1i,t-z} + \beta_2(EPS)_{2i,t-z} + I_i + T_{t-z} + E_{i,t-z} \tag{3.1}$$

Where $Y_{i,t}$ is the dependent variable represented by the annual change in economic output (real GDP) in country i at time t. $EPS_{1i,t-z}$ and $EPS_{2i,t-z}$ are the explanatory variables, the annual changes of Market EPS and Non-Market EPS in country i at time $t-z$, where z describes the time lag and inherent the values of 0, 10 and 20 depending on the model. I_i and T_{t-z} are the individual specific effects for each country i, respective the time specific effects for each year $t-z$ in the observation. These are in the model schematic representations of the effect obtained by the control variables and the dummy variables. β_0 is the intercept while β_1 and β_2 are the marginal effects or the correlation factors for $EPS_{1i,t-z}$ respective $EPS_{2i,t-z}$. $E_{i,t-z}$ is the error term (McManus 2011, s. 8-15).

The aim with the regression analysis is to acquire consistent, effective and significant estimates of the marginal effects, the correlation factors β_1 and β_2. Put differently, environmental regulation described by Market EPS and Non-Market EPS induce an effect on the economic output if β_1 and/or β_2 are positive or negative as well as significantly large enough for the explanatory variables to affect the dependent variable (Dougherty 2011; Wooldridge 2016). However, the way these coefficients can be interpreted changes whether the model is a fixed effects model or a random effects model. The major difference between these models is that the random effects model accounts for both variations in time and in subjects or individuals, while the fixed effects model only accounts for variations in time. Yet, since this study is dealing with countries, the observations can not be described as being a random sample taken from a given population. Which in turn means that the variation between countries, in this case, is irrelevant. This amplifies even more by the fact that the countries, in this study, are not randomly selected (Dougherty 2011, s. 518-527). The largest portions of the countries are a part of either the OECD or the BRICS, both organizations which gathers certain types of countries with similar interests and economy. Hence, a fixed effects model has been used.

The panel data being used in this study misses some data points, which means that the panel is unbalanced. This is problematic since it reduces the amount of cross sectional observations, which in turn results in a less significant outcome. The missing observations due to an unbalanced panel may also be endogenous to the model. Hence, the problem of endoginity has to be fixed. This could be dealt with by using the initial values of the explanatory variables or lag all explanatory variables with at least one period (Dougherty 2011, s. 331-335). Since lagging of the explanatory variables already has been done, in order to examine the long-term and short-term effects, this will most likely not be a problem.

3.2 Individual and time specific effects

Since the data include both developed and developing countries e.g. Denmark and India as well as big and small economies, e.g. China and Sweden. Large variances exist between the countries economic situations and prerequisites. These include different levels of infrastructure, education, organization, financial market and available capital. Which are all factors that will have an affect on the economic output, differing between the countries. In order to deal with these variances or so called individual specific effects, control variables such as human capital, total factor productivity and interest rate levels has been included. These control variables does not exclude all of the countries differences, but they will ultimately contribute to a more relevant set of data and in the end, a more significant result. Time specific effects is a similar concept that has to be treated. Except for some time periods, overall economic output has consistently been growing. However, during these certain time periods, years of economical recession, financial crises or certain political events have resulted in a declined in most countries economic output, even though underlying factors have remained relatively constant. This problem is dealt with by the introduction of dummy variables. These variables will distinguish certain years of exceptional overall economic growth or decline, and make it possible to overlook these variations during the analysis. This in turn will contribute to determine a more realistic outcome (Dougherty 2011; Wooldridge 2016).

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Data

The data concerning real GDP, Market EPS, Non-Market EPS and interest rate levels used in this analysis is based and retrieved from the OECD database (OECD 2019). Data covering human capital as well as total factor productivity are taken from Penn World Tables, provided by the University of Groningen (Feenstra, Robert C., Inklaar and P. Timmer, 2015). In total, the data is covering 33 countries from the year 1990 to 2015. The choice of these 33 nations as well as the time period is based on the data provided on the Market EPS and the Non-market EPS, which is limited in both time and nation coverage, and therefore determining. Due to the in total relative large coverage of countries and time, some data points are missing which potentially cause a decline in statistical significance. However, since it is desirable with a data coverage as large as possible, unbalanced panels have been used instead of balanced panels with less data.

Real GDP is a common and popular way of measuring economic output. It is an accessible and comparable way of measuring and therefore used in this study as well. Market EPS and Non-Market EPS are based on the OECD Environmental Policy Stringency Index for market and non-market based policies. Which is a country-specific and internationally-comparable measure of the stringency of environmental policy. Stringency is defined as the degree to which environmental policies put an explicit or implicit price on polluting or environmentally harmful behaviour. These particular indicators have been used since they are relatively representative measures of the environmental actions taken by a nation. As mentioned in section three, control variables has been included in order to account for individual specific effects. The three variables; total factor productivity, human capital and interest rates are all important factors for a nations productivity and in the extent economic output. Total factor productivity and human capital represent the country specific properties such as differences in education levels, infrastructure, institutional and corporate structures as well as resource access. Long-term interest rates are one of the determinants of business investment. Business investment is, in turn, a major source of economic growth. More elaborated descriptions are presented in *Table 4.1.*

Table 4.1: Variable descriptions

Variable	**Description**
Real GDP	A nations total economic output adjusted for inflation with 2010 years prices. Purchasing power parity adjusted to US dollars.
Market EPS	A bound value between 0 (not stringent to 6 (highest degree of stringency). The value is based on for four market based environmental policy instruments. These include taxes on; CO_2, diesel, NO_X and SO_X
Non-Market EPS	A bound value between 0 (not stringent to 6 (highest degree of stringency). The value is based on for five non-market based environmental policy instruments. These include emission limit values on NO_X, SO_X, PM, a sulphur content limit to diesel and the level of the renewable energy RDD (*Research, Development and Demonstration*) public budget.
Total Factor Productivity	The portion of productivity not explained by capital or labour inputs. Level at current PPP with USA=1 in the comparative index. In Cobb-Douglas form, the total productivity output is calculated from A (total factor productivity), K (capital) and L (labour) with α and β representing the capital's and labour's share of output, commonly 0.3 and 0.7 respectively: $Y = A * K^{\alpha} * L^{\beta}$ (4.1)
Human Capital	A value based on the populations average years of schooling, enrolling rate and an assumed rate of output to education. In other words, a comparable measure on how competent the population is in terms of educational based knowledge.
Interest Rates	Refers to the government issued bonds maturing in ten years (long-term interest rates), traded on financial markets.

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Analysis

5.1 Results

The final results from the three models with; 0 year lag time, 10 year lag time and 20 year lag time, are presented in *Table 5:1*, *Table 5:2* and *Table 5:3*. In this section, the different lag time models are referred to as *Model 1*, *Model 2* and *Model 3* respectively. The regression model has been executed for all 33 countries, as well as for the OECD and the BRICS (including Indonesia) nations in separate. *Table 5:1*, *Table 5:2* and *Table 5:3* are presenting the results from the different lag times and the different country constellations. Including the observed marginal effects of Market EPS, Non-Market EPS and the other control variables on the economic output. As well as the intercept or the constant term, the number of observations, the coefficient of determination and the Breusch-Pagan and Breusch-Godfrey tests for heteroskedasticity and autocorrelation.

The marginal effects on real GDP, concerning all 33 countries, generated by Market EPS and Non-Market EPS from *Table 5:1*, *Table 5:2* and *Table 5:3* have been inserted into Equation 3:1. Derived from these coefficients, the following expressions for economic output is presented for *Model 1*, *Model 2* and *Model 3*:

$$Y_{i,t} = 0.0095 + 0.00013(EPS)_{1i,t-z} + 0.0023(EPS)_{2i,t-z} + I_i + T_{t-z} + E_{i,t-z} \quad (5.1)$$

$$Y_{i,t} = 0.0992 + 0.0002(EPS)_{1i,t-z} + 0.0087(EPS)_{2i,t-z} + I_i + T_{t-z} + E_{i,t-z} \quad (5.2)$$

$$Y_{i,t} = 0.0129 - 0.0019(EPS)_{1i,t-z} + 0.0082(EPS)_{2i,t-z} + I_i + T_{t-z} + E_{i,t-z} \quad (5.3)$$

Table 5.1: Model 1 Regression Results.

	Marginal Effect On Real GDP		
	All Countries	OECD	BRICS
Market (EPS)	0.0013 (0.0031)	0.0019 (0.0026)	0.0043 (0.0091)
Non-Market (EPS)	0.0023 (0.0055)	0.0072 (0.0054)	0.0015 (0.0269)
Total Factor Productivity	0.0248* (0.0155)	0.0415** (0.198)	−0.1004 (0.0720)
Human Capital	0.0167 (0.0960)	−0.2023*** (0.0631)	−0.3706 (0.3853)
Interest Rates	−0.0059* (0.0032)	−0.0074** (0.0028)	−0.0321* (0.0119)
Constant Term	0.0095* (0.0468)	0.1142*** (0.0316)	0.1328 (0.1001)
Observations	616	545	71
R^2	0.0834	0.0826	0.5087
Breusch-Pagan test	X^2=40.23 P=0.0000	X^2=5.3 P=0.0000	X^2=1.1 P=0.0000
Breusch-Godfrey test	X^2=140.7 P=0.000	X^2=25.25 P=0.000	X^2=4.4 P=0.000

*Standard errors for each parameter are presented within parenthesis. ***/**/* are representing the different levels of significance with 1/5/10%.*

Table 5.2: Model 2 Regression Results.

	Marginal Effect On Real GDP		
	All Countries	OECD	BRICS
Market (EPS)	0.0002 (0.0032)	0.0020 (0.0033)	0.0050 (0.0264)
Non-Market (EPS)	0.0087** (0.0040)	0.0077** (0.0039)	0.0552* (0.0193)
Total Factor Productivity	0.0248* (0.0149)	0.0297** (0.0143)	0.7315* (0.3434)
Human Capital	−0.1704** (0.0688)	−0.1641** (0.0711)	1.4731* 1.0120
Interest Rates	0.0006 (0.0044)	−0.0006 (0.0052)	0.0299* (0.0354)
Constant Term	0.0992** (0.0325)	0.0996** (0.0341)	−0.2841* (0.2612)
Observations	397	364	33
R^2	0.1168	0.0985	0.3341
Breusch-Pagan test	X^2=20.27 P=0.0000	X^2=20.24 P=0.0000	X^2=1.0 P=0.0000
Breusch-Godfrey test	X^2=83.75 P=0.000	X^2=70.45 P=0.000	X^2=2.2 P=0.000

*Standard errors for each parameter are presented within parenthesis. ***/**/* are representing the different levels of significance with 1/5/10%.*

Table 5.3: Model 3 Regression Results.

	Marginal Effect On Real GDP		
	All Countries	OECD	BRICS
Market (EPS)	−0.0019 (0.0065)	−0.0023 (0.0065)	−1.6491*** (0.0781)
Non-Market (EPS)	0.0082 (0.0097)	0.0089 (0.0100)	0 (omitted)
Total Factor Productivity	0.2704* (0.1592)	0.2732* (0.1621)	−5.5582*** (0.2268)
Human Capital	0.0717 (0.4000)	0.0922 (0.4199)	−14.1562*** (0.4583)
Interest Rates	−.0.145 (0.0095)	−0.0128 (0.0093)	−2.5078*** (0.1085)
Constant Term	0.0129 (0.1920)	−0001 (0.2047)	5.2510*** (0.1738)
Observations	397	125	18
R^2	0.0086	0.0058	0.5029
Breusch-Pagan test	X^2=7.42 P=0.0000	X^2=8.52 P=0.0000	X^2= P=
Breusch-Godfrey test	X^2=10.23 P=0.000	X^2=10.22 P=0.000	X^2=2.2 P=0.000

*Standard errors for each parameter are presented within parenthesis. ***/**/* are representing the different levels of significance with 1/5/10%.*

5.2 Result analysis

From the results it can be determined that neither of the marginal effects presented in *Equation 5.1*, *Equation 5.2* and *Equation 5.3*, are large enough to indicate that the explanatory variables $(EPS)_{1i,t-z}$ and $(EPS)_{2i,t-z}$ have any significant effect on the dependent variable $Y_{i,t}$. Put differently, the Market EPS and the Non-Market EPS does not show to induce any significant effect on the economic output presented as the real GDP. One way of interpretation, when for example looking at *Model 2* (*Equation 5.2*), is that each unit of increase in Market EPS, results in an increase of 0.0002 units of real GDP. This effect is relatively small, and increasingly so with regards to the annual variations in percent which is in fact what is being measured in the model.

In all models, it seems like Non-Market EPS tend to effect economic output more than Market EPS in terms of larger marginal effects, with an increasing effect over time. Even though the marginal effects are small, both Market EPS and Non-Market EPS show positive effects on the real GDP in all of the models, except for one of the Market EPS measures which show negative effects in *Model 3*. No particular differences in the effects of Market EPS and Non-Market EPS are observed between the OECD and "all countries". In the BRICS, Market EPS shows a stronger effect on real GDP while Non-Market EPS shows a smaller effect on real GDP, this in comparison with the OECD countries and "all countries". Among the control variables, total factor productivity and human capital show a rather significant effect on the economic output. Total factor productivity induce a positive effect on economic output for "all countries" and the OECD, while varying within the BRICS in the three models. Especially for the BRICS does human capital have a significant effect on real GDP, with a large positive effect in *Model 2*. Total factor productivity is of larger significance among the OECD. Furthermore, interest rates does not show any significant effect on the economic output for any of the groups in the three models. In *Model 3*, the BRICS nations, show remarkably high marginal effects, which can be assumed being caused by the insufficient number of observations, due to the properties in the lagging of time. An increase of lag time results in a lower number of observations. In conclusion, these results suggest that total factor productivity and human capital, other external factors, as well as individual specific effects and time specific effects, have a larger impact on the economic output of a country, than Market EPS and Non-Market EPS. The obtained results are also corresponding with earlier studies on the subject, which have reported similar observations.

From the tables, it is determined that *Model 2* has the highest overall coefficients of determination (R^2) at approximately 12, 10 and 33 percent for the three groups; "all countries", OECD and BRICS. The BRICS group shows considerably larger R^2 values in all models, which could be a consequence of the reduced number of individuals compared with the other groups. The coefficient of determination represents the fraction of the variance in the dependent variable, that is predictable from the explanatory variables. It can be interpreted as the extent to which the dependent variable is predictable. The R^2 value ranges from 0 to 1 and provides a percentage prediction rate. This interpretation suggests that *Model 2* is the model with the highest level of significance, possibly explained by the fact that an increase in

certain variables require some time before the full implementation are showing any effects on the economic output. Even though non of these R^2 values are particularly high, this is a panel data regression which means that the number of observations is large due to the multiple dimensions. This makes the regression model more significant than the coefficient of determination suggests (Dougherty 2011, s. 104-108).

The Breusch-Pagan and the Breusch-Godfrey tests are indicating a low risk for heteroskedasticity and autocorrelation. This makes sense, since robust standard errors have been used in the fixed effects model. Robust standard errors help to obtain unbiased standard error and in turn remove heteroscedasticity and autocorrelation (Djurfeld - Larsson - Stjärnhagen 2010, s. 367).

5.3 Discussion

The results are not as unexpected as first may seem. Similar results has already been shown in most of the previous research. For example did Muller and Jha (2017) not see any significant correlation between environmental policy and economic output in terms of real GDP. Neither did Dechezleprêtre and Sato (2014) see any correlation between environmental regulations and economic productivity, except for an initial negative effect short after the implementation of the regulation. This short-term negative effect was also seen by Botta and Koźluk (2016), but not observed in this study. Further, the obtained results corresponds very well with the OECD article written by Botta and Koźluk, which studied 24 OECD countries during a similar time period as this study.

In the results it was seen that Non-Market EPS tend to effect economic output more than Market EPS, in terms of larger marginal effects. The effect induced by the Non-Market EPS was also seen to increase over time. One reason for Non-Market EPS to play a larger roll than Market EPS, might be due to market related properties of the policies. For example, when an increase in the price of a certain input good occurs, with the use of taxes, it can be assumed that higher costs are following for firms using the particular good. This might result in a short-term decision, leading the firms to pay these higher prices instead of investing in more efficient technology. This will in turn leave the firms with higher costs. In comparison, when a firm is facing an emission limit, it is forced to develop and innovate new technologies in order to continue with the production under these new circumstances. This will inevitable leave the firm with more costs, but will also spur innovation which in the long run can be assumed to increase efficiency and in turn, productivity. This is a conclusion that corresponds with the Porter Hypothesis, and could be an explanation for the increased positive effect with time that Non-Market EPS induces on the real GDP. In the group with the BRICS economies, Market EPS was shown having a larger effect than Non-Market EPS. This outcome makes sense, since developing countries in general inhabit less institutional power in comparison with developed countries, which might lead to that strong and efficient non-market based policies are hard to implement and follow up in these countries.

Total factor productivity and human capital showed a more significant effect on economic output than the Market EPS and Non-Market EPS. This seems reasonable, since the total factor productivity is a representation of different nations attributes beyond labour and capital inputs. For the BRICS does human capital have a significant effect on real GDP, with a large positive effect in *Model 2*. Since, developing countries inhabit a lower degree of infrastructure, organizational structures and general corporate environment, educated people tend to play a more important roll. Also, most developing countries can be assumed to have a rather low educational level, which in turn means that small educational improvements should result in a larger outcome in comparison with developed countries, where a high level of education is the standard. Interest rates does not show any significant effect on economic output for neither of the groups. This might be explained by that most economies are more dependent on the relative level of the interest rates, and not their annual changes. It can be assumed that an interest level difference between

5% and 10% plays a larger roll than whether these interest rates increase or decrease with a few percents each year (observe not percentage points). Hence, further studies with the actual long-term interest rate levels instead of their annual changes, would be of interest.

A desirable result, in terms of an argument in favor for more stringent environmental policies, would have been a positive correlation between the dependent variable and the explanatory variables. In other words, that more economic output would have been generated by more stringent environmental policies. The outcome of this, might have been that political actions against environmental problems not only would be supported by the climate change argument itself, but also with backing from an economical stand point, derived from the sequent increase in economic output and well being. Even though no positive correlation was seen, positive conclusions, from this view point, can be drawn from the study. One is that more stringent environmental policies does not show a significant decrease or negative effect on economic output, which in itself is a positive result. The previously thought trade-off relationship between environment and economy, shown in the Environmental Kuznets Curve, can therefore assumed being false, when considering the results obtained here. This is, again, the same conclusion made by most of the previous studies. Following the thoughts of Porter and van der Linde (1995) and the Porter Hypothesis, the reason for this could be due to an overestimation of the compliance costs following the policy, as well as an underestimation of the productivity gains caused by the increased competitiveness as a consequence of innovative stimulation. In summary, this conclusion implies that arguments against thougher polices on the environmental problems, no longer can be motivated with a potential loss of economic output and lower economic growth. This might in turn encourage politicians and governments around the world to strengthen existing environmental policies, or implementing new thougher ones. On the other hand can the opposite argument, that environmental regulations stimulate economic output, neither be stated. For the same reason as from the opposite viewpoint, even though many climate change acknowledgers certainly would like to use it despite its falsity.

Returning to the research performed by Muller and Jha, where positive effects on society could be determined, even though not represented as an increase in economic output, but in the well being of people. The relevance of the real GDP measure could be discussed. Real GDP might be, in this type of study, an irrelevant measure to check for, since positive effects caused by stronger environmental policies such as an increase in public health might not be representative in the real GDP value. Nor are other positive effects such as happiness, overall satisfaction and well being included in the real GDP measure. On the other hand could it be discussed, that an overall increase in well being should result in a higher productivity within the labour force, which should be reveled in the economic output. Real GDP does however, measure a dollar spent on psychiatric care the same way as a dollar spent on cancer research. Which in turn makes these conclusions highly questionable. In future research, it would therefore be interesting and relevant to examine the correlation between environmental policies and regulations to another type of measure, in order to provide a broader picture of the relationship and highlight other, maybe yet unknown societal effects, following more stringent environmental policies. A popular

measure, competing with real GDP and potentially more relevant in this type of study is the human development index (HDI). Which, except for economic output, measures other factors of well being such as lifespan, literacy, education and the standard of living.

Another topic of discussion is the question regrading the opposite relationship, whether economic growth and output derive more stringent environmental policies. Even though no significant correlation was observed in this study, this is an interesting view point. In this study, focus has been put on the potential effects on economic output induced by environmental regulation. However, the opposite relationship might be possible. During certain years or time periods of economic growth, a larger fraction of resources could potentially be directed towards environmental policies and regulation. A study like this could be executed by switching the dependent and the explanatory variables. Putting Market EPS or Non-Market EPS as the dependent variable and real GDP as well as other measures of economic output as the explanatory variables. An additional aspect of interest, to consider in future studies, would be the potential correlation of real GDP levels and stringency levels. This examination could show potentail correlation between a nations over all well being and EPS. A large portion of the developing countries are arguing that, in order to take action against climate change, a certain level of well being has to be reached primarily. This argumentation inhibit sustainable development and cause friction between developing countries and developed countries. At the same time as developed nations are blaming developing economies for not taking enough responsibility. A study like this, could therefore potentially put pressure on large and more developed economies, as well as developing countries, to act and implement tougher environmental regulations. However, returning to the obtained results, it is shown in this study, backed by the Porter Hypothesis and previous research, that an improvement in economic output and environmental regulations is possible to pursue at the same time. Improving environment without adversely affecting the economic output.

6

Conclusion

In this study, has the potential effect on economic output as real GDP, induced by the stringency of environmental policies, market based as well as non-market based, been analyzed. The analysis, executed through a study with panel data regression, included three control variables for each of the 33 countries between the years of 1990 and 2015. Like the previous studies, examining the potential relationship between the economy and the environment, no significant correlation has been determined. This indicates that there is a lack of economic based logic for opposing more stringent policies on the environment, with argumentation of a decrease in economic output. On the opposite, more stringent environmental policies can not be argued for with an increase in economic output, as a sequent from environmental regulations, which the Porter Hypotheses emphasizes. Hence, potential negative and positive effects on the economic output could be highly questionable. In turn, this study also suggests that other underlying factors are more considerable when examining economic output. Although previous research indicate more or less similar outcomes, the significance of the results could be discuss with regard to significance levels as well as to data coverage. Also, the relevance of real GDP as a measure of well being in terms of economic output could be debated. Especially in this case, where other societal benefits might be more relevant to measure. Hence, it is concluded that more research is required in order fully understand and explore this complex and sometimes contradicting relationship.

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