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Economic growth, energy consumption and CO2 emissions in European's manufacturing sector

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The present dissertation entitled

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Summary

Improving energy efficiency and environmental efficiency is a major concern of the European Union in reducing pollution, improving energy security and economic development, especially in the transport sector, which is one of the most energy intensive sectors. The aim of this diplomatic work is to determine the existence or not of a causal relationship between the variables of energy consumption, economic growth and emissions in the European industrial sector. To calculate this relationship between our variables, we will look at the data from 25 European countries in 9 different sectors in the 1995-2009 period using the Granger Causality method on STATA.

Keywords: Europe,Development, Growth, Energy consumption, Emissions.

Περίληψη

Η βελτίωση της ενεργειακής αλλά και της περιβαλλοντικής αποδοτικότητας αποτελεί κύριο μέλημα της Ευρωπαικής Ενωσης για της μείωση των ρύπων, την βελτίωση της ενεργειακής ασφάλειας και την οικονομική ανάπτυξη ιδιαίτερα στον τομέα των μεταφορών που αποτελεί ένα από τους πιο ενεργοβαρής τομείς. Στόχος της συγκεκριμένης διπλωματικής εργασίας είναι ο υπολογισμός της ύπαρξης ή όχι αιτιατής σχέσης ανάμεσα στις μεταβλητές της ενεργειακής κατανάλωσης, της οικονομικής ανάπτυξης και των εκπομπών ρύπων στον Ευρωπαϊκό βιομηχανικό τομέα.Για τον υπολογισμο αυτης της σχεσης μεταξυ των μεταβλητων μας θα εξετασουμε τα δεδομενα απο 25 χωρες της Ευρωπης σε 9 διαφορετικους κλαδους του βιομηχανικου τομεα την περιοδο 1995-2009, χρησιμοποιωντας τη μεθοδο του Γκρειντζερ πανω στη ΣΤΑΤΑ.

Λέξεις κλειδιά: Ευρώπη, Αναπτυξη, Μεγενθυνση, Καταναλωση Ενεργειας, Εκπομπες Ρυπων.

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Chapter 1

Introduction

The relationships between output and energy consumption, as well as output and environmental pollution, have been the subject of intense research over the past few decades. However, the empirical evidence remains controversial and ambiguous to date.

Economic development is closely related to energy consumption since higher economic development is expected when more energy is consumed. However, it is also equally likely that more efficient use of energy (which could lead to a reduction in energy consumption) requires a higher level of economic development. That is, better economic performance may be a catalyst for energy efficiency. As such, energy consumption and economic development may be jointly determined. The importance of this nexus has been well-documented in the literature. In a seminal study, Kraft and Kraft (1978) found a uni-directional Granger causality running from output to energy consumption for the United States during the period 1947–1974. The subsequent studies on this subject, which differ in terms of the time period covered, country chosen, econometric techniques employed, and the control variables used in the estimation, either confirm or contradict the results of Kraft and Kraft (1978). With the development of time series econometric techniques, more recent studies tend to focus on the cointegrating relationship between output and energy consumption.

The relationship between output and pollution has also been extensively studied in the literature. Whether continued increase in national income brings greater harm to the environment is critical for the design of development strategies for developing economies. Most empirical studies in this subject mainly focus on testing the validity of the Environmental Kuznets Curve (EKC), which postulates that the relationship between economic development and the environment resembles an inverted U-curve. The findings of Hettige, Lucas, and Wheeler (1992), Cropper and Griffiths (1994), Selden and Song (1994), Grossman and Krueger (1995), and Martinez-Zarzoso and Bengochea-Morancho (2004) are consistent with the EKC hypothesis. However, increased national income level does not necessarily warrant greater efforts to contain the emissions of pollutants. The empirical results of Shafik (1994) and Holtz-Eakin and Selden (1995) show that pollutant emissions are monotonically increasing with income levels.

An assessment of the existing literature suggests that most studies focus either on the nexus of output-energy or output-pollution where little effort has been made to test these two links under the same framework. This study is an attempt to fill the gap. Malaysia appears to be an interesting case study for this subject given that it is one of the highest growth open economies in the developing world, and it has experienced a significant rise in pollutant emissions and energy consumption in recent years. The choice of this country is also motivated by the fact that no known study has been conducted to examine the relationship between output, energy consumption and pollutant emissions in Malaysia.

We prefer a country-specific case study to a cross-sectional study since empirical analyses conducted at the aggregate level are unable to capture and account for the complexity of the economic environments and histories of each individual country. Hence, any inference drawn from these studies provides only a general understanding of how the variables are broadly related, and thus offers little guidance for policy formulation. In this spirit, a country-specific in-depth case study appears to be more promising in order to find deeper answers for the issue at hand.

The dissertation is organized as follows: Chapter 2 provides the literature review of recent surveys and particularly that which based on Granger Causality, Chapter 3 demonstrates the Granger Causality structural methodology, Chapter 4 presents the data used and the descriptive statistics of our dataset, Chapter 5 includes the empirical results of our empirical analysis and Chapter 6 Ends with findings and conclusion.

Chapter 2

Literature Review

2.1 Earlier studies on energy consumption, CO2 emission and economic growth

This section serves as a brief introduction to the complex relationship between energy consumption and economic growth and between energy consumption and greenhouse emissions. We provide a critical overview of recent literature dealing with energy, carbon emissions and economic growth. We focus mainly on econometric literature examining causal effects between energy consumption and economic growth and on literature adding carbon emissions into the investigation of this topic.

In this section, we will review the methods and main finding from different relevant literature related to the topic. The findings differed from country to country and were often contradictory as a result of diverse energy consumption and output measures, econometric methods used, the presence of omitted variable bias, model specification and the time horizons considered.

A large number of studies found the existence of a causal relationship between energy consumption, CO2 emission and economic growth such as China by Chang. Similar results were found in Turkey by Halicioglu (2009) who also found that the income had a more significant impact in explaining the CO2 emission in Turkey than the energy consumption. Pao and Tsai (2011) found similar results in Brazil. Lean and Smyth (2010) found a causal relationship running from electricity consumption and CO2 emission to economic output, and causal relationship exists between CO2 emission to energy consumption in the ASEAN countries. Ozturk and Acaravci (2010) found similar results in Turkey where a short run and long run causal relationship between energy consumption, CO2 emission and growth exists. Similar results were found in the BRIC countries by Pao and Tsai (2010) .While one directional causal relationship from GDP to energy consumption and from energy consumption to CO2 emission exists in China. Menyah and Rufael (2010) found a long run and a one directional casual relationship from energy consumption and CO2 emission to economic growth in South Africa. Pao et al.(2011) also found similar results in Russia. Menyah and Rufael (2010) suggested that nuclear energy consumption can reduce CO2 emission. Freitas and Kaneko (2011) found similar results in Brazil. However, it was also found that the increase in the consumption of clean energy reduces CO2 emission. Niu et al. (2011) found a long run relationship between energy consumption, CO2 emission and economic growth in eight Asian economies, however, despite the fact that CO2 emission per capita and energy efficiency of energy use in the developing countries is much lower than the developed countries, the CO2 emission per unit of energy use is much higher than the developed countries. Arouri et al. (2012) used the bootstrap panel unit root tests and co-integration techniques to investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) over the period 1981–2005. Their results show that in the long-run, there is a positive significant impact of energy consumption on CO 2emissions. Shahbaz et al. (2014) in-vestigated the non-linear relationship between foreign direct in-vestment and environmental degradation using panel data of 110 developed and developing economies. The results indicated that environmental Kuznets curve exists and foreign direct investment increases environmental degradation.

Nevertheless, as referred by Yang (2000), found bidirectional causality between aggregate energy consumption and GDP in Taiwan. However, the direction of the causality varied when he considered the disaggregation of energy sources (coal, oil, natural gas and electricity). He found bidirectional causality between GDP and coal, GDP and electricity consumption and GDP and total energy consumption, but unidirectional causality running from GDP to oil consumption and from natural gas to GDP.

Sari and Soytas (2004) and Xing-Ping Zhang et al(2009) used a generalized forecast error variance decomposition analysis to examine how much of the variance in national income growth could be explained by the growth of different sources of energy consumption (coal, oil, hydro power, asphaltite, lignite, waste and wood) and of employment, respectively in Turkey and China.Wolde-Rufael (2004) used the Toda-Yamamoto causality test as Payne (2009) to investigate the causal relationship between various kinds of industrial energy consumption and GDP in Shangai for the period 1952-1999. The study found unidirectional Granger causality from coal, coke, electricity and total energy consumption to real GDP, but no causality in any direction, between oil and real GDP, Payne (2009) compared the causal relationship between renewable and non-renewable energy consumption and real GDP for the USA using annual data from 1949 to 2006. The author used Toda-Yamamoto causality tests in a multivariate framework (including employment and capital formation) and found no Granger causality between renewable and nonrenewable energy consumption and real GDP.

2.2 Researches based on Granger Causality Method

Coondoo and Dinda (2002) and Dinda and Coondoo (2006) question the Granger causality between income and carbon dioxide emissions in groups of countries using panel data and maintain that the direction of causality is unclear. For instance, if there is unidirectional causality running from emissions to GDP then the relationship may be such that emissions occur during production and, as a result, income rises. On the other hand, if there is unidirectional causality running from income to emissions, then the relationship may be referred to as an Engel curve for an economic bad (see Coondoo and Dinda (2002) for a formal model and detailed explanations for causality relations). Upon existence of bidirectional causation, then the variables are directly affecting each other and there is a feedback effect.

Some authors have studied the relationship between total energy (electricity) consumption and economic growth using the VAR methodology. For instance, Lee and Chang (2007) used a panel bi-variated VAR of 22 developed and 18 developing countries to study that relationship taking into account structural breaks in the time series. They found bidirectional causality between energy consumption and real GDP in developed countries but unidirectional causality, running from GDP to energy consumption in developing countries. Soytas and Sari (2009) studied the relationship between income, energy consumption and carbon emissions controlling for gross fixed capital formation and labor for Turkey using a VAR model. They found Granger causality running from carbon emissions to energy consumption and not the reverse. Furthermore, their study showed a lack of long run causality between income and emissions.

The next table presenting earlier surveys on energy consumption, CO2 emission and total Growth and their results.

Summary of results arrived at by related earlier studies on energy consumption, CO_2 emission and growth.

Authors	Country	Period	Variables	Methodology	Conclusion
Chang	China	1982–2004	GDP, energy consumption, CO_2 emission	Multivariate cointegration, vector error correction model	GDP ↔ CO_2 EC ↔ GDP EC → CO_2
Halicioglu	Turkey	1960–2005	CO_2 emission, energy consumption, per capita income, foreign trade	Granger causality ARDL cointegration	CO_2 ↔ GDP EC ≠ GDP FT ≠ CO_2
Lean & Smyth	ASEAN	1980–2006	CO_2 emission, electricity consumption, GDP per capita	Johansen Fisher panel cointegration, Panel VEC Granger causality	ELC lnp CO_2 ELC → GDP CO_2 → ELC
Ozturk & Acaravci	Turkey	1968–2005	GDP, CO_2 emission, energy consumption, employment	Granger causality ARDL cointegration	EC ≠ GDP CO_2 ≠ GDP EM → GDP
Pao & Tsai	BRIC	1971–2005	GDP, CO_2 emission, energy consumption	Panel Pedroni cointegration, Panel VEC Granger causality	EC lnp CO_2 EC ↔ CO_2 EC ↔ GDP CO_2 → GDP
Zhang & Cheng	China	1960–2007	GDP, gross fixed capital formation, energy consumption, CO_2 emission, urban population	Granger causality; VEC; generalized impulse response, VAR	GDP → EC EC → CO_2 EC no→ GDP CO_2 no→ GDP
Menyah & Rufael	South Africa	1965–2006	GDP, CO_2 emission, energy consumption, gross fixed capital formation, employment	Granger causality ARDL cointegration	CO_2 lnp GDP CO_2 → GDP EC → GDP EC → CO_2
Pao & Tsai	Brazil	1980–2007	CO_2 emission, energy consumption, GDP	Cointegration Grey, Granger causality, prediction model (GM)	GDP lnp CO_2 EC lnp CO_2 GDP ↔ CO_2 GDP↔ EC EC ↔ CO_2
Pao et al.	Russia	1990–2007	GDP, energy consumption, CO_2 emission	Granger causality VEC, JJ cointegration	GDP ↔ CO_2 GDP ↔ EC EC ↔ CO_2
Menyah & Rufael	USA	1960–2007	CO_2 emission, renewable energy consumption, nuclear energy consumption, GDP	Modified Granger causality VEC	EC → CO_2 REC ≠ CO_2 NEC → CO_2
Lise	Turkey	1980–2003	GNP, CO_2 emissions	OLS	CO_2 have positive effect on GDP
Freitas & Kaneko	Brazil	1970–2009	CO_2 emission, GDP, population	Decomposition approach and model formulation	GDP and POP have positive effect CO_2
Niu et al.	APC	1971–2005	GDP, energy consumption, CO_2 emission	Panel Pedroni cointegration, Panel VEC Granger causality	EC ↔ GDP EC → CO_2

Note: ↔, →, ≠, no→, lnp is the bi-directional causal relationship, one directional causal relationship, no causal relationship, no unidirectional causal relationship, and long run positive relationship. VAR is vector autoregressive model, VEC is the vector error correction model, JJ is the Johansen–Juselius, TY is Toda–Yamamoto, ARDL is autoregressive distributed lag, EC is energy consumption, CO_2 is carbon dioxide emission, FT is foreign trade, EM is the employment ratio, ECL is the electricity consumption, BEC is the biomass consumption, REC is the renewable energy consumption, NEC is the nuclear energy consumption, OCN is the oil consumption, APC is the Asian pacific countries.

Chapter 3

Methodology

3.1 Granger Causality

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another, first proposed in 1969. Ordinarily, regressions reflect "mere" correlations, but Clive Granger argued that causality in economics could be tested for by measuring the ability to predict the future values of a time series using prior values of another time series. Since the question of "true causality" is deeply philosophical, and because of the post hoc ergo propter hoc fallacy of assuming that one thing preceding another can be used as a proof of causation, econometricians assert that the Granger test finds only "predictive causality".

A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y.

Granger also stressed that some studies using "Granger causality" testing in areas outside economics reached "ridiculous" conclusions. "Of course, many ridiculous papers appeared", he said in his Nobel lecture. However, it remains a popular method for causality analysis in time series due to its computational simplicity. The original definition of Granger causality does not account for latent confounding effects and does not capture instantaneous and non-linear causal relationships, though several extensions have been proposed to address these issues

3.1.1 Building the VAR Model

The general structure of the VAR model used in multivariate time series is that each variable, at a point in time, is a linear function of the most recent lag of both itself and the other variables. To illustrate, a trivariate VAR(1) model for GVA, EC and CO2 for one case has the usual matrix form for a regression equation with multivariate outcomes, such that:

$$\begin{bmatrix} Y_{GVA,t} \\ Y_{EC,t} \\ Y_{CO2,t} \end{bmatrix} = \begin{bmatrix} c_{GVA} \\ c_{EC} \\ c_{CO2} \end{bmatrix} + \begin{bmatrix} A_{1,1} & A_{1,2} & A_{1,3} \\ A_{2,1} & A_{2,2} & A_{2,3} \\ A_{3,1} & A_{3,2} & A_{3,3} \end{bmatrix} \begin{bmatrix} Y_{GVA,t-1} \\ Y_{EC,t-1} \\ Y_{CO2,t-1} \end{bmatrix} + \begin{bmatrix} e_{GVA,t} \\ e_{EC,t} \\ e_{CO2,t} \end{bmatrix} \tag{1}$$

or, in scalar notation,

$$Y_{GVA,t} = c_{GVA} + A_{1,1}Y_{GVA,t-1} + A_{1,2}Y_{EC,t-1} + A_{1,3}Y_{CO2,t-1} + e_{GVA,t} \tag{2}$$

$$Y_{EC,t} = c_{EC} + A_{2,1}Y_{GVA,t-1} + A_{2,2}Y_{EC,t-1} + A_{2,3}Y_{CO2,t-1} + e_{EC,t} \tag{3}$$

$$Y_{CO2,t} = c_{CO2} + A_{3,1}Y_{GVA,t-1} + A_{3,2}Y_{EC,t-1} + A_{3,3}Y_{CO2,t-1} + e_{CO2,t} \tag{4}$$

As shown in **Equations 1–4**, the regressors (predictors) of each outcome are the same, which are the lagged values of GVA, EC and CO2 . Intercept terms are indicated by the **c terms**, regression coefficients are indicated by the subscripted **A values**, and error in prediction of each outcome at **time t** is indicated by the **e terms**. The equations can be solved using ordinary least squares (OLS) estimation. Since within the VAR (p), each equation has the same explanatory variables, each equation may be estimated separately. Recommended sources for information about estimation in VAR modeling are Lütkepohl (2005) and Hamilton (1994).

3.1.2 Stationarity test ADF

The augmented Dickey-Fuller test (ADF) is the most widespread test in the economic to control the zero hypothesis that the time series which is tested has a unitary root (or is I(1) non-stagnant). The augmented title demonstrates the insertion until p lags in the original control model to parametrically correct the existence of autocorrelation in the time series which is controlled. The zero hupothesis versus the alternative hypothesis is:

$H_0 : a = 0$

$H_1 : a \prec 0$

In the model:

$\Delta_{Y_t} = ay_{t-1} + b_1\Delta_{Y_{t-1}} + \ldots + b_p\Delta_{Y_{t-p}} + u_t$

Where ut is a regression error , white noise type , and is evaluated using conventional t-student statistic for the its estimated coefficient, but non-conventional critical values are adopted (due to non-stagnation, under the null hypothesis, the statistic converges asymptotically into a function Brown but not to the known t-student distribution).

3.1.3 Selecting Lag Length

Lag length selection refers to the number of previous observations in a time series that will be used as predictors in the VAR model. Typically, a large number of lags will be used to generate a model and then a restriction applied to select a more parsimonious model. Lütkepohl (2005) indicated that using too few lags can result in autocorrelated errors whereas using too many lags results in over-fitting, causing an increase in mean-square-forecast errors of the VAR model. Selection of an appropriate lag is critical to inference in VARs. The lag length for the VAR (p) model can be determined using model selection criteria. The most common approach is to fit VAR (p) models with orders p = 0, 1, . . . pmax and choose the value of p which minimizes some model selection criteria. The three most commonly used criteria used are the Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (BIC), and the Hannan-Quinn criterion (HQ). The lag associated with the minimum value of a criterion is selected (Lütkepohl, 2005).

Chapter 4

Data and Variables

4.1 Source of data

The source of our data is from enerdata database. Enerdata refers to collecting, compiling, analyzing and disseminating data on commodities such as coal, crude oil, natural gas, electricity, or renewable energy sources (biomass, geothermal, wind or solar energy), when they are used for the energy they contain. Energy is the capability of some substances, resulting from their physico-chemical properties, to do work or produce heat. Some energy commodities, called fuels, release their energy content as heat when they burn. This heat could be used to run an internal or external combustion engine.

The flows of and trade in energy commodities are measured both in physical units (e.g., metric tons), and, when energy balances are calculated, in energy units (e.g., terajoules or tons of oil equivalent). What makes energy statistics specific and different from other fields of economic statistics is the fact that energy commodities undergo greater number of transformations (flows) than other commodities.

We constructed a balanced panel data of 24 European Countries in 9 different sectors of manufacturing industry.Austria 9 sectors, Belgium 9 sectors, Bulgaria 9 sectors, Czech Republic 9 sectors, Denmark 9 sectors, Estonia 9 sectors, Finland 9 sectors, France 8 sectors, Germany 9 sectors, Greece 9 sectors, Hungary

9 sectors, Ireland 9 sectors, Italy 7 sectors, Latvia 9 sectors, Lithuania 9 sectors, Netherlands 9 sectors, Poland 9 sectors, Portugal 8 sectors, Romania 9 sectors, Slovakia 8 sectors, Slovenia 9 sectors, Spain 9 sectors Sweden 9 sectors, UK 8 sectors EU countries over a fifteen-year period from 1995 to 2009. The dataset used to measure the causal effect of our 3 variables:Gross Value Added (GVA), Energy consumption (EC), CO2 Emissions(CO2).

4.2 Data Management

Initially our sample consisted of 29 European countries 12 industry sectors for the period 1995-2015 . Because we had to deal with the problem of missing values we had to limit our sample. At the beginning we removed from our sample some countries such as Croatia and Norway, which had many missing items, but also Malta and Luxembourg as they had many zero data that would not affect the reliability of our sample. So we were limited to 25 countries, also we removed some sectors like (optical equipment, plastics and leather) cause we haven't enough data for all countries and for the same period.

From the countries that made it to our analysis, there were also cases where we had to drop out some sectors due to lack of data. These countries are Italy we have not data for sectors wood and transport so we dropped them off, United kingdom France and Slovakia we have not data for wood sector,and Portugal that we have not data for transport sector. In other cases we have countries that we have not data for small periods like Finland,Latvia,Slovakia 1995-2000 missing values so we used the command ipolate on STATA to fill the missing gaps.

Finally we have a strongly balanced panel data consisted of 3,285 observations that have data from 9 different sectors of manufacturing industry for 3 different variables that we study (GVA,EC,CO2) for the fifteen years period 1995-2009.

4.2.1 Descriptive statistics

Now we will be able to take a look at the descriptive statistics of our variables and examine if they are well structured because it will help us to have a better insight in our analysis.

Table 1. *Summary of the variables*

Variable	Obs	Mean	Std. Dev.	Min	Max
GVA	3285	6426.315	16329.68	0.2	214145.7
EC	3285	1.123163	1.970154	0	15.99
CO2	3285	3944.492	8255.844	0.28	67864.28

Table 1 it is a brief summary of the variables and their basic properties. As we can observe our sample has great heterogeneity in the values of the variables . Also it is important to underline that in energy consumption variable there are many Countries that have zero consumption so we expect that it will affect our research.

Table 2. *Summary statistics by country*

	Variable	Mean	Std. Dev.	Min	Max
Austria	GVA	4013.467	3751.231	1006.23	18955.07
	EC	0.6191111	0.5493625	0.09	1.87
	CO2	2465.358	3386.309	34.81	13160.77
Belgium	GVA	4557.523	3479.248	492.35	12412.41
	EC	1.061333	1.27013	0.05	4.88
	CO2	4479.768	5338.283	52.03146	17254.62
Bulgaria	GVA	287.9665	213.0541	33.93	835.48
	EC	0.329037	0.416379	0	2.1
	CO2	1580.294	2082.875	38.52736	8747.7
Cyprus	GVA	97.26496	101.4969	5.93	411.13
	EC	0.0034815	.0092493	0	0.04
	CO2	161.4809	241.0919	2.36	908.64
Czech Rep	GVA	2216.674	2193.654	388.55	12181
	EC	0.7914074	0.9040243	0.05	3.48
	CO2	2798.921	3875.85	109.6679	14140.3
Denmark	GVA	2521.906	2875.134	285.93	11070.33
	EC	0.2013333	0.21483	0.01	0.84
	CO2	758.1941	1080.591	46.37532	3794.73
Estonia	GVA	126.5944	111.8296	0.2	617.01
	EC	0.0508889	0.0541483	0	0.27
	CO2	124.1479	172.1129	6.51	678.37
Finland	GVA	3119.575	3980.019	468.94	23222.4
	EC	1.269926	1.709104	0.04	7.57
	CO2	1602.585	2089.704	24.61	6998.04
France	GVA	22160.66	18860.52	4726.47	73469.78
	EC	3.800333	2.547482	0.36	8.71
	CO2	11967.01	9374.876	807.6723	26186.43
Germany	GVA	45243.17	51370.49	5018.31	214145.7
	EC	5.38637	4.564445	0.44	15.99
	CO2	18482.23	20884.16	818.2162	67864.28
Greece	GVA	1511.458	967.8682	243.6	4356.9
	EC	0.252963	0.247121	0.01	0.86
	CO2	1541.984	2944.546	21.99496	10385.73
Hungary	GVA	1376.693	1394.08	107	6831.5
	EC	0.3019259	0.2528273	0.02	1.08
	CO2	1168.39	1350.494	23.05367	4170.37

In Table 2, Table 3 we can see the summary statistics of our sample divided by country. From this table it is good to note that there are countries such as Germany, France, Italy, Spain and the United Kingdom that are holding the biggest values of economic growth in Europe.It is worthwhile to notice that the same countries have the biggest percentages of pollutant emissions.

Table 3. *Summary statistics by country*

	Variable	Mean	Std. Dev.	Min	Max
Ireland	GVA	2852.852	3884.944	119.12	16177.75
	EC	0.1899259	0.1851079	0	0.6
	CO2	741.1984	761.2786	27.42	2727.79
Italy	GVA	27844.85	28766.04	6724.14	113115.7
	EC	3.808095	1.990241	0.82	7.52
	CO2	15758.48	13186.53	2773.93	50281.02
Latvia	GVA	123.9243	96.49658	23.04	426.67
	EC	0.0579259	0.0573429	0	0.24
	CO2	171.383	182.0735	5.772203	695.62
Lithuania	GVA	242.583	215.3529	5.6	884.5
	EC	0.0726667	0.0798618	0	0.34
	CO2	340.4458	484.1821	5.01	2487.38
Netherlands	GVA	5693.096	5300.6	850.02	20616.64
	EC	1.372	1.577208	0.07	5.61
	CO2	3648.258	4914.332	166.9	16986.86
Poland	GVA	3295.945	2987.569	812.3	19902.5
	EC	1.422	1.132725	0.13	4.39
	CO2	7287.117	7326.33	512.1375	28097.24
Portugal	GVA	2011.32	1339.39	262.69	4900.9
	EC	.3923333	0.2936892	0	1.09
	CO2	2049.296	2589.911	210.7	9038.1
Romania	GVA	1451.863	1268.664	193.75	5561.42
	EC	0.9506667	1.171641	0	4.49
	CO2	2086.003	2658.105	24.90139	9302.72
Slovakia	GVA	612.5535	501.1013	146.5925	2617.77
	EC	0.4643333	0.6251248	0.03	2.37
	CO2	2072.636	2526.929	45.28735	9635.69
Slovenia	GVA	523.3066	511.0165	125.55	2599.4
	EC	0.1094074	0.0585109	0	0.28
	CO2	314.7686	359.5045	0.28	1433.4
Spain	GVA	11880.34	7902.002	2182.74	33117.56
	EC	1.862815	1.27005	0.14	5.09
	CO2	8799.943	13506.45	465.81	51812.73
Sweden	GVA	4651.359	4027.466	418.12	17790.17
	EC	1.315481	1.928763	0.03	6.97
	CO2	1659.776	1902.837	40.66427	6587.3
U.Kingdom	GVA	19010.58	6699.893	5309.81	34135.71
	EC	2.93425	2.02389	0.67	8.17
	CO2	10364.1	9269.704	1381.475	36546.03

Secondly we could observe that there are countries like Bulgaria, Cyprus, Estonia, Ireland, Latvia, Lithuania, Portugal, Romania and Slovenia that have pasted years of zero energy consumption(EC) and also have smaller scores on Gross Value

Table 4. *Summary statistics by sector*

	Variable	Mean	Std. Dev.	Min	Max
Chemicals	GVA	7048.064	10800.09	39.89	58918.17
	EC	2.310521	2.978457	0	13.17
	CO2	6378.466	7957.183	2.36	36337.18
Food	GVA	8403.31	11458.03	82.20444	40634.9
	EC	1.267241	1.455101	0	5.38
	CO2	3400.778	4299.477	24.90139	17343.49
Machinery	GVA	19702.37	38645.61	12.13	214145.7
	EC	0.9412948	1.399454	0	5.58
	CO2	702.7367	1008.542	5.772203	4449.59
Metals	GVA	3575.706	5961.615	0.2	24354.41
	EC	2.521375	3.264564	0	15.99
	CO2	10329.72	13826	19.9035	67864.28
Non-Metalic	GVA	3284.491	4900.886	24.49	18885.89
	EC	0.4513215	.5999252	0	2.65
	CO2	9887.493	13666.67	290.6	51812.73
Paper	GVA	3792.579	5387.166	29.61	20541.79
	EC	1.389828	1.916772	0	7.57
	CO2	1963.371	2307.106	5.01	9024.81
Textiles	GVA	3115.627	5627.033	24.1	31660.7
	EC	0.3722815	.5314656	0	2.72
	CO2	933.7128	2052.995	6.51	12949.03
Transport	GVA	7039.755	16037.03	5.93	97494.12
	EC	0.396132	0.6917134	0	3.34
	CO2	801.9772	1257.437	0.28	5439.49
Wood	GVA	1066.418	1415.953	33.93	7155.66
	EC	0.2626208	0.3335037	0	2.04
	CO2	261.4941	367.594	7.75	1882.17

Added(GVA) from the other countries that we spoke before.

To analyze our problem in-depth it is essential to separate the 9 different sectors and take the summary statistics of all 25 European countries. Table 4 presenting the summary statistics divided by sector. We could observe that transport sector is one of the most important and anchor sectors in manufacturing industry because it owns the biggest GVA values from the sample and also Chemicals sector is one of the most pollutants sectors with the biggest CO2 emissions.

Chapter 5

Empirical results

5.1 Long run relationship

Now moving to the next step and use Granger Causality method we assume that our three time series variables are stationary to begin our analysis. The minimum value of AIC criterion suggests us to use 2 lags for our analysis. After that using Granger causality method we performed for 9 different sectors separately tests to examine the causal relationship of GDP, EC and CO2 to 24 countries. Our purpose is to find out this relation and make a deeper analysis for the biggest European countries such as Germany, Italy, France, United Kingdom and Spain who have the biggest sources of energy and GDP per capita so they affect most our sample.

5.1.1 Chemical sector

As we can see on the **table 5** below in chemicals energy consumption affects gross value added and also GVA affects CO2 emmisions in most countries of the table. To have a better insight view we have taken five effective countries to analyze

them. We could observe that Germany, France, Spain and Netherlands have the biggest F-statistic with zero p-value when energy affects GVA and also when GVA affects CO2 emmisions. We could conclude that we find out a unidirectional cause of EC on GVA and also a unidirectional cause of GVA on CO2 in the biggest part of chemical sector in Europe.

Table 5. *Most effective on chemicals*

Dep.var	Inde.var	GERMANY	ITALY	FRANCE	SPAIN	NETHERLANDS
GVA	EC	16.353***	2.7723	12.873	25.346	28.848
		0	0.25	0.002	0	0
	CO2	8.3983	0.85491	0.46979	3.8795	31.772
		0.015	0.652	0.791	0.144	0
EC	GVA	1.2627	8.6239	11.691	4.2331	9.5373
		0.532	0.013	0.003	0.12	0.008
	CO2	0.50155	0.87467	5.18	2.6788	2.5237
		0.778	0.646	0.075	0.262	0.283
CO2	GVA	8.1194	27.29	23.365	1.0171	30.029
		0.017	0	0	0.601	0
	EC	0.73324	7.0284	9.1026	2.5901	13.711
		0.693	0.03	0.011	0.274	0.001

5.1.2 Food sector

Moving to the next sector Food sector is one of the most importants in the manufacturing industry. Here in **table 6** we include Spain, U.Kingdom, France, Italy and Belgium as the most effective countries on this sector and a remarkable observation could be that all 5 countries when EC affects CO2 are statistically significant in a significance level of 1%. It is obvious that we have an unidirectional relationship between EC and CO2 that means increasing or decreasing EC causes changes on CO2 value in Food sector.

Table 6. *Most effective on Food*

Dep.var	Inde.var	SPAIN	U.KINGDOM	FRANCE	ITALY	BELGIUM
GVA	EC	2.0014	0.2876	2.5698	0.66306	1.5369
		0.368	0.866	0.277	0.718	0.464
	CO2	6.0832	0.20162	1.5279	0.32292	0.24181
		0.048	0.904	0.466	0.851	0.886
EC	GVA	8.1011	0.44897	4.0111	13.712	3.4585
		0.017	0.799	0.135	0.001	0.177
	CO2	3.4891	9.1442	0.48856	20.42	2.1183
		0.175	0.01	0.783	0	0.347
CO2	GVA	3.7514	5.9597	3.9452	3.5011	0.05152
		0.153	0.051	0.139	0.174	0.975
	EC	19.981	14.622	7.1233	6.9715	6.8958
		0	0.001	0.028	0.031	0.032

5.1.3 Machinery sector

Continuing our analysis we have machinery sector and we also select the most effective countries which are Czech Republic, France, Italy, Sweden and the United Kingdom. In **table 7** we could see the F-statistic level of countries and below the p-value scores. Also here we have a significance of 1% for Czech Republic and United Kingdom and 5% for France, Sweden when GVA affects CO2. It is an important sample of existence unidirectional cause relation between GVA and CO2.

Table 7. *Most effective on Machinery*

Dep.var	Inde.var	CZE.REPU	FRANCE	ITALY	SWEDEN	U.KINGDOM
GVA	EC	4.7802	14.514	7.7244	4.8317	53.041
		0.092	0.001	0.021	0.089	0
	CO2	1.7515	5.402	2.0059	0.11177	24.4
		0.417	0.067	0.367	0.946	0
EC	GVA	13.165	1.1114	32.161	1.9472	1.5357
		0.001	0.574	0	0.378	0.464
	CO2	2.0108	4.4766	2.7865	0.2361	2.8373
		0.366	0.107	0.248	0.889	0.242
CO2	GVA	15.724	6.031	4.8092	6.3903	15.646
		0	0.049	0.09	0.041	0
	EC	0.67604	2.2739	0.36962	2.1265	8.0604
		0.713	0.321	0.831	0.345	0.018

5.1.4 Metals sector

In Metals sector we have selected for our analysis France, Spain, Sweden, U.Kingdom and Netherlands as we can see on **table 8**. Here we can observe that CO2 value affects in two cases GVA and EC. In table below it is obvious that the powerful significance of 1% at most countries shows that we have causal relationship between our variables meaning that increasing or decreasing CO2 emissions affect GVA and EC. So we could say that we have a unidirectional relation between CO2 and GVA, and also CO2 with EC.

Table 8. *Most effective on Metals*

Dep.var	Inde.var	FRANCE	SPAIN	SWEDEN	U.KINGDOM	NETHERLANDS
GVA	EC	7.6942	8.1198	0.38338	7.2817	4.0759
		0.021	0.017	0.826	0.026	0.13
	CO2	9.3491	19.515	9.7879	7.5371	6.0755
		0.009	0	0.007	0.023	0.048
EC	GVA	0.72526	21.627	1.2032	12.754	9.4113
		0.696	0	0.548	0.002	0.009
	CO2	8.8788	14.731	13.319	19.264	8.117
		0.012	0.001	0.001	0	0.017
CO2	GVA	3.2939	4.3289	10.3	4.4537	2.7213
		0.193	0.115	0.006	0.108	0.256
	EC	2.4871	2.9402	0.77286	12.804	1.2335
		0.288	0.23	0.679	0.002	0.54

5.1.5 Non-Metalic sector

Another sector of manufacturing industry is Non-Metalic sector and we collect information from Wald test for Granger Causality to 5 countries as France, Germany, Greece, Austria and Spain. The observations below on **table 9** show us an effect between CO2, EC and GVA, CO2. With significance of 1% to all five countries CO2 affects EC also increasing or decreasing GVA value affects CO2 exception is Spain which it seems that there is no impact in this case. Induction is that there is a unidirectional cause from CO2 to EC and from GVA to CO2.

Table 9. *Most effective on Non-metalic*

Dep.var	Inde.var	GERMANY	GREECE	FRANCE	AYSTRIA	SPAIN
GVA	EC	30.813	4.3603	7.1008	2.0642	0.9936
		0	0.113	0.029	0.356	0.608
	CO2	41.559	0.29483	0.5165	3.4795	29.16
		0	0.863	0.772	0.176	0
EC	GVA	10.417	9.1439	10.369	10.434	26.002
		0.005	0.01	0.006	0.005	0
	CO2	18.12	17.182	12.925	11.443	22.959
		0	0	0.002	0.003	0
CO2	GVA	48.208	24.03	9.7532	18.581	3.1049
		0	0	0.008	0	0.212
	EC	46.578	15.168	0.87106	21.599	5.4839
		0	0.001	0.647	0	0.064

5.1.6 Paper sector

Continuing with paper sector we have the most effective countries that are France, Finland, Germany, Denmark and Ireland that participate the most in this industry. Wald test analysis shows us to **table 10** how CO2 and GVA behaves to EC and CO2 respectively. Excepting Germany all other countries seems to have an effect of CO2 on EC from the big F-statistic value and significance of 1%. In the other hand GVA has a big impact on CO2 with significance level of 1% to all countries. To conclude here we have a unidirectional causal relation between CO2, EC and GVA, CO2 respectively.

Table 10. *Most effective on Paper*

Dep.var	Inde.var	GERMANY	DENMARK	FINLAND	FRANCE	IRELAND
GVA	EC	7.707	5.4208	1.176	1.3372	17.31
		0.021	0.067	0.555	0.512	0
	CO2	9.2728	2.6807	15.118	3.5977	2.2411
		0.01	0.262	0.001	0.165	0.326
EC	GVA	12.968	4.7641	4.3532	2.7817	0.81228
		0.002	0.092	0.113	0.249	0.666
	CO2	1.8482	41.816	10.939	28.617	11.596
		0.397	0	0.004	0	0.003
CO2	GVA	21.078	24.289	26.866	14.014	7.6101
		0	0	0	0.001	0.022
	EC	0.94091	84.29	17.785	3.564	26.149
		0.625	0	0	0.168	0

5.1.7 Textiles sector

Here we have selected for our analysis France, Germany, Finland, Hungary and the United Kingdom to find out the treatment between our three variables. On **table11** we could see the Walt test results which shows us an impact of GVA on EC and also EC on GVA. We have four countries except U.K that shows that GVA affects EC with significance of 1% and all five countries shows an affection of EC on GVA with powerful significance of 1%. We mention that in this case it is a bidirectional cause of GVA on EC and EC on GVA.

Table 11. *Most effective on Textiles*

Dep.var	Inde.var	FINLAND	FRANCE	GERMANY	HUNGARY	U.KINGDOM
GVA	EC	22.459	13.666	15.19	16.376	10.291
		0	0.001	0.001	0	0.006
	CO2	4.8878	8.4301	7.2509	14.149	19.672
		0.087	0.015	0.027	0.001	0
EC	GVA	26.433	12.175	16.84	13.723	4.7
		0	0.002	0	0.001	0.095
	CO2	4.7715	0.26282	15.744	0.0702	5.5186
		0.092	0.877	0	0.966	0.063
CO2	GVA	1.3871	1.7025	17.07	12.29	11.844
		0.5	0.427	0	0.002	0.003
	EC	1.4672	6.1309	8.1461	4.5181	5.2307
		0.48	0.047	0.017	0.104	0.073

5.1.8 Transport sector

Transport sector is one of the most active sectors in manufacturing industry so it has weight to analyze in detail it's aspects. First of all to begin we have included five countries to analyze Germany, France, Ireland, Spain and Belgium. As we can observe from the **table 12** below we have signs of causality between GVA to CO2 and EC to CO2. It is obvious that statistical significance of 1% and 5% respectively shows that we mentioned before. Finally in our case on transport sector it seems to have a unidirectional cause of GVA on CO2 and EC on CO2,it's something that we expecting for because transport sector is also very pollutant for the environment.

Table 12. *Most effective on Transport*

Dep.var	Inde.var	GERMANY	IRELAND	FRANCE	BELGIUM	SPAIN
GVA	EC	21.753	11.909	3.7804	1.9873	16.532
		0	0.003	0.151	0.37	0
	CO2	7.4772	3.5187	7.5345	1.6245	5.232
		0.024	0.172	0.023	0.444	0.073
EC	GVA	4.5372	6.7294	1.5811	44.546	26.856
		0.103	0.035	0.454	0	0
	CO2	3.315	106	11.723	16.392	14.133
		0.191	0	0.003	0	0.001
CO2	GVA	6.3184	7.941	6.1009	6.3738	13.659
		0.042	0.019	0.047	0.041	0.001
	EC	19.29	9.5287	3.0419	5.4231	27.498
		0	0.009	0.219	0.066	0

5.1.9 Wood sector

For the final step of our analysis we have observations from Wood sector describing data for five basic countries which are Netherlands, Hungary, Czech Republic, Sweden and Austria. From **table 13** below we could get informations how EC and CO2 emissions behave among GVA. All five countries have statistical significance in 1% and big level scores of F-statistic. That means the two variables EC and CO2 have instant impact on GVA so the result of our analysis is that we have to deal with a unidirectional causal relationship of CO2 and EC on GVA values.

Table 13. *Most effective on Wood*

Dep.var	Inde.var	HUNGARY	AYSTRIA	CZE.REPU	SWEDEN	NETHERLANDS
GVA	EC	52.538	60.377	6.1663	19.279	8.4748
		0	0	0.046	0	0.014
	CO2	38.242	38.185	16.135	12.414	18.66
		0	0	0	0.002	0
EC	GVA	3.9229	1.1334	4.8426	7.1158	0.7582
		0.141	0.567	0.089	0.028	0.684
	CO2	17.96	0.17927	3.5111	9.159	2.2041
		0	0.914	0.173	0.01	0.332
CO2	GVA	2.2035	8.4899	2.0338	32.602	1.3177
		0.332	0.014	0.362	0	0.517
	EC	1.8449	8.1139	1.5851	4.9287	0.09102
		0.398	0.017	0.453	0.085	0.956

Chapter 6

Conclusion

This study investigated the causal relationship between energy consumption CO2 emission and Gross value added of manufacturing industry in twenty four European economies, namely Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland , Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom. The panel model was used taking the period 1995-2009. We have repeated the same Granger causality test to every sector separately for all the twenty four countries. The results concerned to every sector separately and we have to discuss the main idea from these findings. We have found that there are five sectors from nine that appeared to have a strong relationship between GVA and CO2. The point is that we could expect something like that because sectors like chemicals and transport which are the most pollutant in manufacturing industry is often to affect CO2 emissions on the environment. So our analysis confirms our initial claim that a change in GVA can cause direct effect on pollutant emissions.

In addition, this study found that the economic development GVA had a positive or negative causal relationship with the total CO2 emission. To conclude depending on the nature and relative importance of energy sources in an economy, the results may change from country to country. Furthermore, the technological improvements may allow economies to increase the utilization rate of environment friendly sources. Hence, the relationship between income, energy use, and emissions may change through time.

Appendix A

Wald test Causality by Country

Table A.1. *Sector of Chemicals by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	13.749	3.6995	0.27768	16.598	13.349	3.8197	3.2156	12.873
		0.001	0.157	0.87	0	0.001	0.148	0.2	0.002
	CO2	11.119	0.65208	1.1411	2.5836	5.2739	0.17459	1.4373	0.46979
		0.004	0.722	0.565	0.275	0.072	0.916	0.487	0.791
EC	GVA	3.807	4.0994	0.29399	1.0232	10.708	3.3444	6.6983	11.691
		0.149	0.129	0.863	0.6	0.005	0.188	0.035	0.003
	CO2	2.4522	15.195	2.8619	5.655	26.971	0.9707	0.3886	5.18
		0.293	0.001	0.239	0.059	0	0.615	0.823	0.075
CO2	GVA	4.0946	0.35947	0.55981	34.219	2.0598	11.195	0.27327	23.365
		0.129	0.835	0.756	0	0.357	0.004	0.872	0
	EC	5.5044	3.4364	5.9921	34.079	6.8484	15.79	0.17465	9.1026
		0.064	0.179	0.05	0	0.033	0	0.916	0.011
Number of Observations: 375									

Table A.2. *Sector of Chemicals by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	16.353	2.3511	4.7892	1.8867	2.7723	16.964	18.682	28.848
		0	0.309	0.091	0.389	0.25	0	0	0
	CO2	8.3983	9.6595	0.4578	1.6805	0.85491	22.444	28.71	31.772
		0.015	0.008	0.795	0.432	0.652	0	0	0
EC	GVA	1.2627	0.80544	8.8682	10.349	8.6239	6.2151	3.1011	9.5373
		0.532	0.669	0.012	0.006	0.013	0.045	0.212	0.008
	CO2	0.50155	0.82741	9.1016	12.016	0.87467	104.62	2.276	2.5237
		0.778	0.661	0.011	0.002	0.646	0	0.32	0.283
CO2	GVA	8.1194	6.095	0.52335	18.46	27.29	25.93	11.246	30.029
		0.017	0.047	0.77	0	0	0	0.004	0
	EC	0.73324	6.6741	3.7366	7.0304	7.0284	233.23	3.7646	13.711
		0.693	0.036	0.154	0.03	0.03	0	0.152	0.001
Number of Observations: 375									

Table A.3. *Sector of Chemicals by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	66.989	10.379	9.2425	3.2613	1.0497	25.346	7.3314	2.5297
		0	0.006	0.01	0.196	0.592	0	0.026	0.282
	CO2	5.7002	1.5512	4.2557	6.6358	0.17071	3.8795	6.3494	2.7441
		0.058	0.46	0.119	0.036	0.918	0.144	0.042	0.254
EC	GVA	0.21421	1.0796	0.4498	1.706	0.90122	4.2331	12.487	10.036
		0.898	0.583	0.799	0.426	0.637	0.12	0.002	0.007
	CO2	17.202	12.371	0.07446	15.072	1.4236	2.6788	3.5638	73.813
		0	0.002	0.963	0.001	0.491	0.262	0.168	0
CO2	GVA	1.0228	2.6708	12.825	0.1987	16.972	1.0171	5.8959	1.1625
		0.6	0.263	0.002	0.905	0	0.601	0.052	0.559
	EC	0.48846	0.70421	0.78252	4.0216	11.049	2.5901	1.8588	2.0457
		0.783	0.703	0.676	0.134	0.004	0.274	0.395	0.36
Number of Observations: 375									

Table A.4. *Sector of Food by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	6.473	1.5369	3.2021	3.8267	2.1499	16.801	0.29516	2.5698
		0.039	0.464	0.202	0.148	0.341	0	0.863	0.277
	CO2	0.12457	0.24181	3.1575	0.97478	0.35795	5.1297	3.0798	1.5279
		0.94	0.886	0.206	0.614	0.836	0.077	0.214	0.466
EC	GVA	0.78808	3.4585	9.1985	5.7223	0.6722	0.94373	1.3095	4.0111
		0.674	0.177	0.01	0.057	0.715	0.624	0.52	0.135
	CO2	17.479	2.1183	17.222	6.3178	6.8838	0.8603	1.8009	0.48856
		0	0.347	0	0.042	0.032	0.65	0.406	0.783
CO2	GVA	0.41175	0.05152	13.578	10.189	6.8553	0.25584	5.073	3.9452
		0.814	0.975	0.001	0.006	0.032	0.88	0.079	0.139
	EC	5.9059	6.8958	11.683	33.715	8.7191	6.4495	1.988	7.1233
		0.052	0.032	0.003	0	0.013	0.04	0.37	0.028
Number of Observations: 375									

Table A.5. *Sector of Food by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	2.0161	1.1493	14.364	100.44	0.66306	5.2748	1.1916	2.727
		0.365	0.563	0.001	0	0.718	0.072	0.551	0.256
	CO2	5.5705	0.59508	26.273	64.426	0.32292	3.3659	2.6439	1.0501
		0.062	0.743	0	0	0.851	0.186	0.267	0.592
EC	GVA	0.5036	6.8569	4.0881	9.8883	13.712	0.95482	5.5129	2.3768
		0.777	0.032	0.13	0.007	0.001	0.62	0.064	0.305
	CO2	2.8509	1.5992	2.5232	2.3761	20.42	2.6526	13.389	2.0463
		0.24	0.45	0.283	0.305	0	0.265	0.001	0.359
CO2	GVA	0.58969	32.97	5.2032	20.46	3.5011	11.033	2.6812	3.9575
		0.745	0	0.074	0	0.174	0.004	0.262	0.138
	EC	1.4907	26.782	5.7733	0.87982	6.9715	5.2504	4.7273	1.5524
		0.475	0	0.056	0.644	0.031	0.072	0.094	0.46
Number of Observations: 375									

Table A.6. *Sector of Food by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	7.0063	8.0766	51.271	6.745	1.4009	2.0014	0.82177	0.2876
		0.03	0.018	0	0.034	0.496	0.368	0.663	0.866
	CO2	7.1804	7.6272	13.519	3.0884	5.3339	6.0832	0.72845	0.20162
		0.028	0.022	0.001	0.213	0.069	0.048	0.695	0.904
EC	GVA	2.2855	17.872	2.4087	5.4666	1.4936	8.1011	4.628	0.44897
		0.319	0	0.3	0.065	0.474	0.017	0.099	0.799
	CO2	2.9236	2.4879	2.8328	3.7117	3.8772	3.4891	1.0493	9.1442
		0.232	0.288	0.243	0.156	0.144	0.175	0.592	0.01
CO2	GVA	3.4949	0.72785	16.199	9.2745	0.04611	3.7514	6.1573	5.9597
		0.174	0.695	0	0.01	0.977	0.153	0.046	0.051
	EC	1.3395	0.77277	6.4938	12.093	8.0676	19.981	3.5867	14.622
		0.512	0.68	0.039	0.002	0.018	0	0.166	0.001
Number of Observations: 375									

Table A.7. *Sector of Machinery by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	0.79757	0.57417	31.124	4.7802	4.5294	0.51872	7.581	14.514
		0.671	0.75	0	0.092	0.104	0.772	0.023	0.001
	CO2	8.2472	1.1316	16.789	1.7515	5.9888	20.258	6.2902	5.402
		0.016	0.568	0	0.417	0.05	0	0.043	0.067
EC	GVA	12.339	50.462	8.5572	13.165	9.3066	20.014	1.546	1.1114
		0.002	0	0.014	0.001	0.01	0	0.462	0.574
	CO2	3.6854	13.458	8.494	2.0108	24.202	7.3249	4.6707	4.4766
		0.158	0.001	0.014	0.366	0	0.026	0.097	0.107
CO2	GVA	0.34964	79.139	2.6464	15.724	4.0129	8.6917	0.15856	6.031
		0.84	0	0.266	0	0.134	0.013	0.924	0.049
	EC	2.1404	12.343	3.1599	0.67604	20.68	5.8037	1.0217	2.2739
		0.343	0.002	0.206	0.713	0	0.055	0.6	0.321
Number of Observations: 375									

Table A.8. *Sector of Machinery by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	1.7081	3.7671	3.3498	9.8683	7.7244	1.7121	3.6857	0.99757
		0.426	0.152	0.187	0.007	0.021	0.425	0.158	0.607
	CO2	4.5427	0.94284	11.701	6.7382	2.0059	12.417	4.9872	9.0188
		0.103	0.624	0.003	0.034	0.367	0.002	0.083	0.011
EC	GVA	1.2936	0.22103	16.612	9.1515	32.161	1.5547	3.3094	2.8977
		0.524	0.895	0	0.01	0	0.46	0.191	0.235
	CO2	4.6404	0.31857	15.911	18.297	2.7865	3.6883	9.5319	13.526
		0.098	0.853	0	0	0.248	0.158	0.009	0.001
CO2	GVA	3.6575	5.14	3.7526	2.5736	4.8092	13.102	18.237	1.0218
		0.161	0.077	0.153	0.276	0.09	0.001	0	0.6
	EC	1.2432	6.9943	4.6116	1.9486	0.36962	14.418	32.944	1.0518
		0.537	0.03	0.1	0.377	0.831	0.001	0	0.591
Number of Observations: 375									

Table A.9. *Sector of Machinery by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	2.8406	27.096	8.3178	0.84398	3.3824	8.1709	4.8317	53.041
		0.242	0	0.016	0.656	0.184	0.017	0.089	0
	CO2	2.9413	5.0758	1.51	7.342	4.094	1.8459	0.11177	24.4
		0.23	0.079	0.47	0.025	0.129	0.397	0.946	0
EC	GVA	2.8674	48.846	3.1486	3.1385	0.7131	6.8043	1.9472	1.5357
		0.238	0	0.207	0.208	0.7	0.033	0.378	0.464
	CO2	4.847	16.513	0.97939	2.9677	0.58027	5.3595	0.2361	2.8373
		0.089	0	0.613	0.227	0.748	0.069	0.889	0.242
CO2	GVA	7.9513	5.2649	43.985	25.428	3.2438	3.0261	6.3903	15.646
		0.019	0.072	0	0	0.198	0.22	0.041	0
	EC	8.5241	2.8384	19.275	10.837	6.8959	1.2728	2.1265	8.0604
		0.014	0.242	0	0.004	0.032	0.529	0.345	0.018
Number of Observations: 375									

Table A.10. *Sector of Metals by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	32.031	0.09032	4.6225	12.909	2.8586		4.8478	7.6942
		0	0.956	0.099	0.002	0.239		0.089	0.021
	CO2	40.863	0.31845	44.6	19.539	12.64	51.031	7.2861	9.3491
		0	0.853	0	0	0.002	0	0.026	0.009
EC	GVA	5.7385	9.3964	7.5718	42.071	1.8151		6.0442	0.72526
		0.057	0.009	0.023	0	0.404		0.049	0.696
	CO2	2.4326	1.8555	12.16	2.6503	11.924		0.49739	8.8788
		0.296	0.395	0.002	0.266	0.003		0.78	0.012
CO2	GVA	9.6923	14.839	39.832	25.242	0.69558	3.4149	7.8452	3.2939
		0.008	0.001	0	0	0.706	0.181	0.02	0.193
	EC	7.1875	3.0811	5.0327	0.29441	0.0762		2.0867	2.4871
		0.027	0.214	0.081	0.863	0.963		0.352	0.288
Number of Observations: 375									

Table A.11. *Sector of Metals by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	0.21853	0.30064	3.4985	5.984	13.092	28.167	4.4847	4.0759
		0.896	0.86	0.174	0.05	0.001	0	0.106	0.13
	CO2	0.68521	4.4881	4.1141	17.812	0.67569	27.483	13.106	6.0755
		0.71	0.106	0.128	0	0.713	0	0.001	0.048
EC	GVA	0.86617	1.3249	3.5683	0.58607	8.4451	15.91	40.335	9.4113
		0.649	0.516	0.168	0.746	0.015	0	0	0.009
	CO2	1.3313	5.0249	0.31628	10.37	0.19792	5.3442	3.3593	8.117
		0.514	0.081	0.854	0.006	0.906	0.069	0.186	0.017
CO2	GVA	0.58792	7.2501	18.838	3.2785	3.7385	8.6253	8.3619	2.7213
		0.745	0.027	0	0.194	0.154	0.013	0.015	0.256
	EC	0.81642	6.5966	9.8486	11.363	3.1131	6.0042	1.4296	1.2335
		0.665	0.037	0.007	0.003	0.211	0.05	0.489	0.54
Number of Observations: 375									

Table A.12. *Sector of Metals by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	4.1504	6.4215	40.985	8.5021	3.5627	8.1198	0.38338	7.2817
		0.126	0.04	0	0.014	0.168	0.017	0.826	0.026
	CO2	11.153	5.4401	4.8278	20.511	1.7038	19.515	9.7879	7.5371
		0.004	0.066	0.089	0	0.427	0	0.007	0.023
EC	GVA	1.5317	11.81	20.72	1.2035	2.973	21.627	1.2032	12.754
		0.465	0.003	0	0.548	0.226	0	0.548	0.002
	CO2	0.65352	5.9123	14.688	3.502	0.17358	14.731	13.319	19.264
		0.721	0.052	0.001	0.174	0.917	0.001	0.001	0
CO2	GVA	3.674	21.106	2.8665	1.6821	0.12996	4.3289	10.3	4.4537
		0.159	0	0.239	0.431	0.937	0.115	0.006	0.108
	EC	2.7569	126.05	29.484	2.8469	5.2125	2.9402	0.77286	12.804
		0.252	0	0	0.241	0.074	0.23	0.679	0.002
Number of Observations: 375									

Table A.13. *Sector of Non Metalic by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	2.0642	0.16934	4.0345	11.713			9.2788	7.1008
		0.356	0.919	0.133	0.003			0.01	0.029
	CO2	3.4795	12.617	2.0878	1.3657	25.577	79.993	5.4917	0.5165
		0.176	0.002	0.352	0.505	0	0	0.064	0.772
EC	GVA	10.434	0.37614	4.2329	0.81748			14.188	10.369
		0.005	0.829	0.12	0.664			0.001	0.006
	CO2	11.443	2.6696	13.052	14.121			11.881	12.925
		0.003	0.263	0.001	0.001			0.003	0.002
CO2	GVA	18.581	36.042	3.5108	3.3514	0.23593	7.3574	2.1094	9.7532
		0	0	0.173	0.187	0.889	0.025	0.348	0.008
	EC	21.599	1.5323	1.2462	3.2251			2.3822	0.87106
		0	0.465	0.536	0.199			0.304	0.647
Number of Observations: 375									

Table A.14. *Sector of Non Metalic by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	30.813	4.3603	4.8565		2.6732	6.6857		4.2666
		0	0.113	0.088		0.263	0.035		0.118
	CO2	41.559	0.29483	2.3392	0.17185	0.01142	13.824	1.866	5.9229
		0	0.863	0.31	0.918	0.994	0.001	0.393	0.052
EC	GVA	10.417	9.1439	86.702		3.2777	3.8042		23.018
		0.005	0.01	0		0.194	0.149		0
	CO2	18.12	17.182	31.162		3.6003	8.2548		3.0403
		0	0	0		0.165	0.016		0.219
CO2	GVA	48.208	24.03	46.836	2.0709	4.5426	56.391	10.942	8.8645
		0	0	0	0.355	0.103	0	0.004	0.012
	EC	46.578	15.168	16.765		0.39936	89.026		15.861
		0	0.001	0		0.819	0		0
Number of Observations: 375									

Table A.15. *Sector of Non Metalic by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	18.885	8.2451		19.19	5.6851	0.9936	1.2064	18.579
		0	0.016		0	0.058	0.608	0.547	0
	CO2	22.946	8.3865	32.481	5.1811	0.71502	29.16	0.64252	60.286
		0	0.015	0	0.075	0.699	0	0.725	0
EC	GVA	12.673	0.41076		35.062	2.8854	26.002	43.944	12.636
		0.002	0.814		0	0.236	0	0	0.002
	CO2	2.5258	0.63956		47.743	4.9932	22.959	30.175	32.505
		0.283	0.726		0	0.082	0	0	0
CO2	GVA	19.862	1.6433	1.6049	22.688	0.62936	3.1049	2.5914	3.4056
		0	0.44	0.448	0	0.73	0.212	0.274	0.182
	EC	13.769	0.67116		22.873	4.028	5.4839	1.0403	19.203
		0.001	0.715		0	0.133	0.064	0.594	0
Number of Observations: 375									

Table A.16. *Sector of Paper by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	10.339	0.10414	0.55255	1.8625	5.4208	4.8973	1.176	1.3372
		0.006	0.949	0.759	0.394	0.067	0.086	0.555	0.512
	CO2	1.797	14.905	0.17303	39.552	2.6807	5.9641	15.118	3.5977
		0.407	0.001	0.917	0	0.262	0.051	0.001	0.165
EC	GVA	2.8078	0.51793	8.5349	0.52	4.7641	2.0188	4.3532	2.7817
		0.246	0.772	0.014	0.771	0.092	0.364	0.113	0.249
	CO2	8.6683	5.2176	3.7673	0.31552	41.816	5.7706	10.939	28.617
		0.013	0.074	0.152	0.854	0	0.056	0.004	0
CO2	GVA	0.03491	11.437	0.38542	12.961	24.289	28.968	26.866	14.014
		0.983	0.003	0.825	0.002	0	0	0	0.001
	EC	18.492	10.693	0.92309	5.8219	84.29	3.8971	17.785	3.564
		0	0.005	0.63	0.054	0	0.142	0	0.168
Number of Observations: 375									

Table A.17. *Sector of Paper by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	7.707	2.5681	5.1648	17.31	3.1206		5.3622	6.3595
		0.021	0.277	0.076	0	0.21		0.068	0.042
	CO2	9.2728	2.8408	9.9308	2.2411	1.5345	3.5846	6.931	14.686
		0.01	0.242	0.007	0.326	0.464	0.167	0.031	0.001
EC	GVA	12.968	10.951	4.9184	0.81228	1.3528		0.8307	10.457
		0.002	0.004	0.086	0.666	0.508		0.66	0.005
	CO2	1.8482	11.775	18.399	11.596	7.9447		0.20547	3.676
		0.397	0.003	0	0.003	0.019		0.902	0.159
CO2	GVA	21.078	4.6419	0.56412	7.6101	0.91673	4.0112	3.3508	6.1491
		0	0.098	0.754	0.022	0.632	0.135	0.187	0.046
	EC	0.94091	7.7795	2.2649	26.149	6.6067		5.6916	14.435
		0.625	0.02	0.322	0	0.037		0.058	0.001
Number of Observations: 375									

Table A.18. *Sector of Paper by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	45.693	30.675	0.02547	1.5403	90.555	1.4599	2.6597	22.275
		0	0	0.987	0.463	0	0.482	0.265	0
	CO2	17.284	0.11605	18.816	0.69763	0.86513	0.79871	1.7843	8.4534
		0	0.944	0	0.706	0.649	0.671	0.41	0.015
EC	GVA	4.5793	23.667	2.9574	7.4108	3.2234	0.79883	11.281	3.0755
		0.101	0	0.228	0.025	0.2	0.671	0.004	0.215
	CO2	3.4657	16.564	3.3326	1.4102	19.905	0.14276	3.9323	5.649
		0.177	0	0.189	0.494	0	0.931	0.14	0.059
CO2	GVA	4.78	10.328	7.6881	15.771	5.2065	0.57471	16.385	1.0134
		0.092	0.006	0.021	0	0.074	0.75	0	0.602
	EC	2.1849	2.0533	1.3984	2.3785	5.9527	1.7662	0.95232	7.1645
		0.335	0.358	0.497	0.304	0.051	0.414	0.621	0.028
Number of Observations: 375									

Table A.19. *Sector of Textiles by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	4.0843	65.394	3.3909	0.7985	0.41651	1.6046	22.459	13.666
		0.13	0	0.184	0.671	0.812	0.448	0	0.001
	CO2	7.8495	43.696	2.8926	4.7816	1.2268	3.8205	4.8878	8.4301
		0.02	0	0.235	0.092	0.542	0.148	0.087	0.015
EC	GVA	19.493	4.102	3.2178	20.584	6.306	2.318	26.433	12.175
		0	0.129	0.2	0	0.043	0.314	0	0.002
	CO2	1.0299	10.2	10.071	54.892	2.3145	19.438	4.7715	0.26282
		0.598	0.006	0.007	0	0.314	0	0.092	0.877
CO2	GVA	1.4092	2.8764	3.4508	15.755	11.308	0.92276	1.3871	1.7025
		0.494	0.237	0.178	0	0.004	0.63	0.5	0.427
	EC	1.1905	7.1584	2.8787	1.734	1.2819	0.18679	1.4672	6.1309
		0.551	0.028	0.237	0.42	0.527	0.911	0.48	0.047
Number of Observations: 375									

Table A.20. *Sector of Textiles by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	ITALY	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	15.19	14.859	16.376	2.4395	2.7109	53.581	4.6525	0.21272
		0.001	0.001	0	0.295	0.258	0	0.098	0.899
	CO2	7.2509	11.456	14.149	12.334	1.9987	3.0274	3.7014	1.8978
		0.027	0.003	0.001	0.002	0.368	0.22	0.157	0.387
EC	GVA	16.84	4.6021	13.723	5.7506	8.4499	2.9345	3.4383	1.1905
		0	0.1	0.001	0.056	0.015	0.231	0.179	0.551
	CO2	15.744	2.2621	0.0702	9.972	0.45923	3.8848	23.079	2.5832
		0	0.323	0.966	0.007	0.795	0.143	0	0.275
CO2	GVA	17.07	1.0286	12.29	9.1803	11.861	1.7794	2.9716	0.15952
		0	0.598	0.002	0.01	0.003	0.411	0.226	0.923
	EC	8.1461	0.55834	4.5181	2.7411	7.1028	9.8494	6.5723	0.05787
		0.017	0.756	0.104	0.254	0.029	0.007	0.037	0.971
Number of Observations: 375									

Table A.21. *Sector of Textiles by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	1.7349	3.4408	0.11645	0.32828	13.377	6.641	3.4589	10.291
		0.42	0.179	0.943	0.849	0.001	0.036	0.177	0.006
	CO2	1.5309	1.4971	3.6006	0.95047	0.36031	13.406	1.9228	19.672
		0.465	0.473	0.165	0.622	0.835	0.001	0.382	0
EC	GVA	33.707	105.98	3.381	10.863	2.4924	2.2163	6.6106	4.7
		0	0	0.184	0.004	0.288	0.33	0.037	0.095
	CO2	1.4518	63.693	7.5746	8.6974	6.3536	5.6663	1.4108	5.5186
		0.484	0	0.023	0.013	0.042	0.059	0.494	0.063
CO2	GVA	20.355	56.589	13.346	7.0276	8.3779	7.646	4.2716	11.844
		0	0	0.001	0.03	0.015	0.022	0.118	0.003
	EC	2.6111	1.1418	4.9626	1.2537	5.9693	0.31848	7.1354	5.2307
		0.271	0.565	0.084	0.534	0.051	0.853	0.028	0.073
Number of Observations: 375									

Table A.22. *Sector of Transport by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND	FRANCE
GVA	EC	14.154	1.9873	0.14272	2.1054	4.0758	2.1415	15.414	3.7804
		0.001	0.37	0.931	0.349	0.13	0.343	0	0.151
	CO2	3.5519	1.6245	1.8277	4.7205	2.4707	16.141	1.8474	7.5345
		0.169	0.444	0.401	0.094	0.291	0	0.397	0.023
EC	GVA	3.551	44.546	0.4838	1.2206	3.0182	1.7662	17.961	1.5811
		0.169	0	0.785	0.543	0.221	0.413	0	0.454
	CO2	8.3848	16.392	3.6336	0.59678	3.8776	2.3156	1.8981	11.723
		0.015	0	0.163	0.742	0.144	0.314	0.387	0.003
CO2	GVA	0.39646	6.3738	64.672	1.314	4.3367	3.7638	3.8765	6.1009
		0.82	0.041	0	0.518	0.114	0.152	0.144	0.047
	EC	4.164	5.4231	23.625	4.0317	0.45529	1.5821	6.0488	3.0419
		0.125	0.066	0	0.133	0.796	0.453	0.049	0.219
Number of observations:345									

Table A.23. *Sector of Transport by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	21.753	1.6808	3.2225	11.909		3.3918	5.0933
		0	0.432	0.2	0.003		0.183	0.078
	CO2	7.4772	1.8624	2.4873	3.5187	0.71697	19.479	6.6667
		0.024	0.394	0.288	0.172	0.699	0	0.036
EC	GVA	4.5372	25.625	1.2204	6.7294		14.69	4.0428
		0.103	0	0.543	0.035		0.001	0.132
	CO2	3.315	16.597	0.72148	106		9.2015	0.86168
		0.191	0	0.697	0		0.01	0.65
CO2	GVA	6.3184	89.736	31.262	7.941	6.9568	3.8701	2.0476
		0.042	0	0	0.019	0.031	0.144	0.359
	EC	19.29	73.075	37.296	9.5287		7.3785	1.6457
		0	0	0	0.009		0.025	0.439
Number of observations:345								

Table A.24. *Sector of Transport by Country*

Dep.var	Inde.var	POLAND	ROMANIA	SLOVAKIA	SLOVENIA	SPAIN	SWEDEN	U.KINGDOM
GVA	EC	40.121	25.467	1.8291	0.33532	16.532	15.887	6.1793
		0	0	0.401	0.846	0	0	0.046
	CO2	41.102	3.0998	4.4896	1.1112	5.232	28.217	3.4626
		0	0.212	0.106	0.574	0.073	0	0.177
EC	GVA	8.2493	4.2339	0.63007	6.6605	26.856	4.7256	11.228
		0.016	0.12	0.73	0.036	0	0.094	0.004
	CO2	6.4974	26.859	4.3011	0.95167	14.133	3.6249	11.569
		0.039	0	0.116	0.621	0.001	0.163	0.003
CO2	GVA	4.8699	8.5949	18.61	3.806	13.659	1.0124	0.64815
		0.088	0.014	0	0.149	0.001	0.603	0.723
	EC	3.7816	2.562	25.857	1.1353	27.498	1.2123	0.66784
		0.151	0.278	0	0.567	0	0.545	0.716
Number of observations:345								

Table A.25. *Sector of Wood by Country*

Dep.var	Inde.var	AYSTRIA	BELGIUM	BULGARIA	CZE.REPU	DENMARK	ESTONIA	FINLAND
GVA	EC	60.377	4.9123	4.4423	6.1663	3.7136	1.3628	8.6378
		0	0.086	0.108	0.046	0.156	0.506	0.013
	CO2	38.185	15.299	0.6768	16.135	3.2305	9.7084	0.20731
		0	0	0.713	0	0.199	0.008	0.902
EC	GVA	1.1334	6.3815	5.9214	4.8426	1.1915	32.878	14.478
		0.567	0.041	0.052	0.089	0.551	0	0.001
	CO2	0.17927	6.1207	5.0123	3.5111	24.377	28.067	0.02519
		0.914	0.047	0.082	0.173	0	0	0.987
CO2	GVA	8.4899	70.878	12.004	2.0338	3.7871	0.64595	1.2343
		0.014	0	0.002	0.362	0.151	0.724	0.539
	EC	8.1139	14.21	12.012	1.5851	1.0517	82.153	5.5303
		0.017	0.001	0.002	0.453	0.591	0	0.063
Number of observations:315								

Table A.26. *Sector of Wood by Country*

Dep.var	Inde.var	GERMANY	GREECE	HUNGARY	IRELAND	LATVIA	LITHUANIA	NETHERLANDS
GVA	EC	17.498	0.48829	52.538	0.11203	3.6817	5.5725	8.4748
		0	0.783	0	0.946	0.159	0.062	0.014
	CO2	1.5106	0.12746	38.242	6.4236	16.496	9.3328	18.66
		0.47	0.938	0	0.04	0	0.009	0
EC	GVA	4.6681	2.9085	3.9229	1.2943	23.266	8.3444	0.7582
		0.097	0.234	0.141	0.524	0	0.015	0.684
	CO2	2.9797	0.9681	17.96	4.6508	39.39	2.4219	2.2041
		0.225	0.616	0	0.098	0	0.298	0.332
CO2	GVA	8.0512	2.7324	2.2035	5.9261	3.6491	7.7496	1.3177
		0.018	0.255	0.332	0.052	0.161	0.021	0.517
	EC	7.4259	0.8505	1.8449	3.2017	13.443	1.6154	0.09102
		0.024	0.654	0.398	0.202	0.001	0.446	0.956
Number of observations:315								

Table A.27. *Sector of Wood by Country*

Dep.var	Inde.var	POLAND	PORTUGAL	ROMANIA	SLOVENIA	SPAIN	SWEDEN
GVA	EC	11.827	3.5188	52.655	1.4434	0.84821	19.279
		0.003	0.172	0	0.486	0.654	0
	CO2	1.2274	3.656	18.034	10.038	3.0656	12.414
		0.541	0.161	0	0.007	0.216	0.002
EC	GVA	8.662	1.5552	11.852	7.054	5.1343	7.1158
		0.013	0.46	0.003	0.029	0.077	0.028
	CO2	1.1798	3.3253	4.0169	13.44	2.9001	9.159
		0.554	0.19	0.134	0.001	0.235	0.01
CO2	GVA	10.8	2.7108	20.343	1.4326	4.1509	32.602
		0.005	0.258	0	0.489	0.125	0
	EC	2.7063	3.8322	1.4008	1.2828	1.219	4.9287
		0.258	0.147	0.496	0.527	0.544	0.085
Number of observations:315							

Bibliography

Chapter 7

Bibliography

Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO2 emissions and economic growth in Europe. Energy, 35(12), 5412-5420.

Al-Mulali, U., & Sab, C. N. B. C. (2012). The impact of energy consumption and CO2 emission on the economic growth and financial development in the Sub Saharan African countries. Energy, 39(1), 180-186.

Ang, J. B. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modeling, 30(2), 271-278.

Apergis, N., & Payne, J. E. (2009). CO2 emissions, energy usage, and output in Central America. Energy Policy, 37(8), 3282-3286.

Arouri, M. E. H., Youssef, A. B., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. Energy policy, 45, 342-349.

Barnett, L., & Seth, A. K. (2014). The MVGC multivariate Granger causality toolbox: a new approach to Granger-causal inference. Journal of neuroscience methods, 223, 50-68.

Bozkurt, C., & Akan, Y. (2014). Economic growth, CO2 emissions and energy consumption: the Turkish case. International Journal of Energy Economics and Policy, 4(3), 484-494.

Coondoo, D., & Dinda, S. (2002). Causality between income and emission: a country group-specific econometric analysis. Ecological Economics, 40(3), 351-367.

De Freitas, L. C., & Kaneko, S. (2011). Decomposing the decoupling of CO2 emissions and economic growth in Brazil. Ecological Economics, 70(8), 1459-1469.

Ghosh, S. (2010). Examining carbon emissions economic growth nexus for India: a multivariate cointegration approach. Energy Policy, 38(6), 3008-3014.

Hoffmann, R., Lee, C. G., Ramasamy, B., & Yeung, M. (2005). FDI and pollution: a granger causality test using panel data. Journal of International Development: The Journal of the Development Studies Association, 17(3), 311-317.

Lean, H. H., & Smyth, R. (2010). CO2 emissions, electricity consumption and output in ASEAN. Applied Energy, 87(6), 1858-1864.

Menyah, K., & Wolde-Rufael, Y. (2010). Energy consumption, pollutant emissions and economic growth in South Africa. Energy Economics, 32(6), 1374-1382.

Obradović, S., & Lojanica, N. (2017). Energy use, CO2 emissions and economic growth–causality on a sample of SEE countries. Economic research-Ekonomska istraživanja, 30(1), 511-526.

Omri, A. (2013). CO2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. Energy economics, 40, 657-664.

Pao, H. T., & Tsai, C. M. (2010). CO2 emissions, energy consumption and economic growth in BRIC countries. Energy policy, 38(12), 7850-7860.

Pao, H. T., & Tsai, C. M. (2011). Modeling and forecasting the CO2 emissions, energy consumption, and economic growth in Brazil. Energy, 36(5), 2450-2458.

Ramanathan, R. (2000). A holistic approach to compare energy efficiencies of different transport modes. Energy Policy, 28(11), 743-747.

Saboori, B., Sapri, M., & bin Baba, M. (2014). Economic growth, energy consumption and CO2 emissions in OECD (Organization for Economic Co-operation and Development)'s transport sector: A fully modified bi-directional relationship approach. Energy, 66, 150-161.

Saidi, K., & Hammami, S. (2015). The impact of CO 2 emissions and economic growth on energy consumption in 58 countries. Energy Reports, 1, 62-70.

Sbia, R., Shahbaz, M., & Hamdi, H. (2014). A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. Economic Modelling, 36, 191-197.

Soytas, U., & Sari, R. (2009). Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member. Ecological economics, 68(6), 1667-1675.

Wen, X., Rangarajan, G., & Ding, M. (2013). Multivariate Granger causality: an estimation framework based on factorization of the spectral density matrix. Phil. Trans. R. Soc. A, 371(1997), 20110610.

Zerbo, E. (2015). CO2 emissions, growth, energy consumption and foreign trade in Sub-Sahara African countries.

Zhang, X. P., & Cheng, X. M. (2009). Energy consumption, carbon emissions, and economic growth in China. Ecological Economics, 68(10), 2706-2712.