The role of financial deepening and green technology on carbon emissions

Paramati, Sudharshan Reddy; Mo, Di; Huang, Ruixian

Published in:
Finance Research Letters

DOI:
10.1016/j.frl.2020.101794

Publication date:
2020

The role of financial deepening and green technology on carbon emissions: Evidence from major OECD economies

Sudharshan Reddy Paramati
School of Business,
University of Dundee, the United Kingdom – DD1 4HN
s.paramati@dundee.ac.uk

Di Mo
School of Economics, Finance and Marketing
RMIT University, Australia
di.mo@rmit.edu.au

Ruixian Huang*
Business School,
East China University of Political Science and Law,
Shanghai, China; raycoo7@163.com

* **Correspondence**: S.R. Paramati (s.paramati@dundee.ac.uk); R. Huang (raycoo7@163.com).

The role of financial deepening and green technology on carbon emissions: Evidence from major OECD economies

Abstract

This paper investigates the role of financial deepening, green technology, foreign direct investment (FDI), per capita income and trade openness on carbon emissions in a panel of 25 OECD economies. The paper uses robust panel econometric techniques and yearly data, 1991–2016. The empirical evidences from augmented mean group and group-mean estimators reveal that green technology, FDI inflows and trade openness reduce carbon emissions, while financial deepening and per capita income positively contribute. Overall, it implies that green technology, along with FDI and trade, is the major factor that helps to reduce the carbon emissions in the OECD economies.

JEL classification: D53; G20; O32; O33; Q56

Keywords: Financial deepening; green technology; FDI; per capita income; OECD economies

1. Introduction:

In recent time, the issue of carbon dioxide (CO_2) emissions has attracted the considerable attention among the policy makers, environmental scientists, national and international organizations. According to the Organisation for Economic Co-operation and Development (OECD, 2015) report, the global CO_2 emissions, energy-related, reached a record high of 32.2 billion tonnes in 2013, and accounted for 75% of the global Green House Gas (GHG) emissions in 2010. In addition, the GHG emissions are expected to increase another 50% by 2050, and the increase will be primarily driven by a projected growth in CO_2 emissions from energy use.[1]

It is widely acknowledged that human activities are one of the prime factors causing the increase in emissions and consequently global warming. The report of International Panel on Climate Change (IPCC) indicates that human activities have caused approximately 1.0ºC increase in global temperature compared to the pre-industrial levels. Undoubtedly, economic development has been accompanied by the significant use of energy. The trend of CO_2 emissions also reflects energy-related human activities which were determined by economic development (Sadorsky, 2010). In 2013, the OECD countries accounted for 85% of global GDP and were responsible for 76% of global CO_2 emissions.[2] In terms of the share of market capitalization, OECD countries contained 81.32% based on the statistics of World Bank (2015). In addition, with the fast growing of some emerging countries, the emissions began to increase dramatically in non-OECD countries. Given this fact, there is an urgent need to reduce the CO_2 emissions from energy consumption while maintaining the economic development and prosperity.

The green technology refers to the use of technologies in the energy production and consumption to improve energy efficiency and reduce the negative impacts on the environment. A report from International Energy Agency (IEA) (2012) documents that world's energy systems need to be transformed to a sustainable and clean one. Thus, technology innovations are becoming increasingly critical in reducing carbon emissions and transiting to more sustainable and greener economy (Hashmi & Alam, 2019). There are a number of emerging papers argue the importance of improving the role of innovation in this transition (Du, Li, & Yan, 2019; Ganda, 2019; Ghisetti & Quatraro, 2014).[3] They claim that the development of

[1] The figures are based on the OECD environmental outlook to 2050, see https://www.oecd.org/env/cc/49082173.pdf
[2] OECD Fact Book 2013 and, the EU in the World 2015.
[3] Liddle (2015) also accounted for energy intensity indicators (such as non-fossil fuels' energy consumption and industrial energy intensity) in the carbon emission model to see their impact, along with income and population, and compared the estimates between OECD and non-OECD economies.

green technology is distinct from countries to countries. As a result, it is important to examine the influence of green technology based on specific social or economic circumstances. Du et al. (2019) cover 71 economies and analyse the impact of green technology innovations on carbon emissions. In particular, the authors interested in analysing whether the income level matters for the green technology innovation. Similarly, Ganda (2019) use a sample of 26 OCED countries to examine the relationship between innovation and technology investments and carbon emissions. Author uses four factors to proxy the innovation and technology investments that cover three aspects including renewable energy, research and triadic patent.[4]

The existing studies either focus only the impact of green technology on emissions (Du et al., 2019; Ganda, 2019) or the performance of environmental regulation and green technology on reducing emissions (Hashmi & Alam, 2019). The effect of green technology on carbon emissions can also be influenced by other factors. For instance, green technology requires significant research & development (R&D) investments and innovations. To enhance the technological progress, a well-functioning financial market is essential. The increase in size and structure of the financial sector on one hand provides essential capital for green technology investments and reduce financial costs (Bello & Abimbola, 2010; Hsu, Tian, & Xu, 2014); on the other hand, it may improve allocation efficiency and manage risks (Hsu et al., 2014; Paramati, Ummalla, & Apergis, 2016). Le, Le, and Taghizadeh-Hesary (2020) also argue that well-developed financial markets play a key role in adopting energy conserving and green technologies. Furthermore, Paramati et al. (2016, 2017) conclude that FDI and stock market developments play a vital role in promoting the use of clean energy. While, Du et al. (2019) argue that the level of trade openness helps transferring the technology from advanced economies to the backward economies. As a result, we believe that it is necessary to consider other potential factors in the model.

The OECD countries provide an important setting for exploring the linkage among financial deepening, green technology, FDI, per capita income, trade openness and carbon emissions. Firstly, OECD countries have been responsible for most of the carbon emissions. Though, the energy related CO_2 emissions are slowing down in OECD countries, they still emit around 40% of global CO_2 emissions from energy use. Further, on a per capita basis, the OECD countries have an average 8.9 tonnes of CO_2 emission, which is still far more than the 4.3

[4] A number of recent studies (e.g. Sun et al., 2020; Taghizadeh-Hesary & Yoshino (2019) highlight the green investments.

tonnes of CO_2 emissions in rest of the world. The rate of progress across the OECD countries varies significantly, regardless of absolute numbers, per capita amounts or per unit of GDP. Taking Switzerland and Australia as examples, greenhouse gas emissions is 7.2t CO_2 equivalent/capita in Switzerland, whereas it is 26.8 t/capita in Australia.

Secondly, financial developments are far more advanced in OECD countries than any other regions in the world. The financial sectors in the OECD economies constitute approximately 80% of the global, and the global share of FDI inflows is 63.36% (World Bank, 2015). Consequently, the green technology is booming in many OECD economies. The governments of major OECD economies and IEA have agreed to coordinate the investments in low carbon research and clean energy development (Al Mamun, Sohag, Shahbaz, & Hammoudeh, 2018; Paramati et al., 2016, 2017). Thus, it is crucial to examine the role of financial deepening, green technology, FDI, per capita income and trade openness on carbon emissions in the OECD economies.

The findings of this research will help these economies to design more appropriate policies which may play crucial role in mitigating the growth of carbon emissions by encouraging the adaptation of green and energy saving technologies in all forms of economic activities. Therefore, our paper adds an important value not only to the empirical literature but also offers important policy implications, particularly to meet climate change targets.

The rest of this paper is presented as follows: Section 2 presents details on data measurement, sample countries, models and empirical methodology; Section 3 presents empirical results and their relevant discussions; finally Section 4 reports summary of the findings and their relevant policy suggestions.

2. Data and empirical methods

In this study, we choose OECD economies because these countries have made significant progress in adopting environmental friendly policies and have also devoted substantial financial resources for technologies innovations. Therefore, we aim to understand to what extent green technology has helped these countries to meet their climate change targets i.e. reducing their share of global carbon dioxide emissions. For this reason, we collect yearly data from 1991 to 2016 on 25 major OECD economies. The selected countries are Australia, Austria, Canada, Chile, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom (UK) and the United States (US). The selection of the sample countries from the OECD group and study period are due to the availability of data.

The variables of this study are defined as follows: the carbon dioxide emissions (CDE) are measured using total energy based CO_2 emissions in million metric tons (MMTons); the financial deepening (FDP) indicators are measured using three broad indices. Specifically, the construction of financial institution (FI) index and financial market (FM) index is based on the information of '*access to, depth and efficiency*' of financial institutions and markets, respectively, while overall financial development (FD) index is constructed using the information of FI and FM; the foreign direct investment (FDI) is the net inflows as a percentage of GDP; the green technology (GRNTE) is proxied with total innovations *("only the higher-value inventions that have sought patent protection in at least two jurisdiction")* that are related to '*environmental management, water-related adaption and climate change mitigation*'; the GDP per capita (constant 2010 US$) is a proxy for per capita income (PI); and finally, the trade openness (TO) is measured using information on total exports and imports as a percentage of GDP. The data on CDE is sourced from the US Energy Information Administration (EIA) online data bank, while data on financial deepening (FI, FM and FD) indicators are obtained from the International Monetary Fund (IMF). The green technology (GRNTE) is acquired from the OECD statistics, and finally data on FDI, PI and TO are attained from the World Development Indicators (WDI). By following existing literature (e.g. Kutan et al., 2018; Paramati et al., 2017) all variables were transformed into natural logarithms, except FDI[5], before we began our investigation.

We build the following empirical models to attain the study objectives:

$$CDE_{i,t} = f\,(FDP_{i,t}, GRNTE_{i,t}, PI_{i,t}, TO_{i,t}) \qquad (1)$$

$$CDE_{i,t} = f\,(FDP_{i,t}, FDI_{i,t}, GRNTE_{i,t}, PI_{i,t}, TO_{i,t}) \qquad (2)$$

where CDE, FDP, FDI, GRNTE, PI, and TO represent carbon dioxide emissions, financial deepening (FI, FM, and FD) indicators, foreign direct investment, green technology, per capita income and trade openness; whereas subscripts *i* and *t* denote for country and study period, respectively.

[5] Due to the presence of negative values.

To investigate the determinants of carbon emissions, this study begins by investigating the issue of cross-sectional dependence (CD) using the CD test of Pesaran (2004), while unit root properties are examined by making use of Pesaran (2007) cross-sectionally augmented panel unit root test (CIPS). The long-run parameters are estimated using the augmented mean group (AMG) estimator (Eberhardt and Bond, 2009; Eberhardt and Teal, 2010), and group-mean FMOLS estimator (Pedroni, 2000, 2001).

3. Results and discussion

We start our investigation by employing CD and CIPS tests and their results are presented in **Table 1**[6]. The CD test results on all the variables unanimously reject the '*null hypothesis of cross-sectional independence*' at the 1% significance level. Hence, it clearly implies that the selected variables follow the cross-sectional dependence. The evidences from CIPS test reveal that all the variables are non-stationary at the level data and stationary in their first order differences. All these indicators are statically significant. These results, overall, indicate that the selected variables have CD and are integrated of the same order.

[Insert Table 1 here]

In the next step, we explore the long-run impacts of financial indicators, green technology, per capita income, trade openness and FDI on carbon emissions using the AMG estimator.[7] These long-run results are presented in **Table 2**. The estimates show that an increase in green technology reduces carbon emissions. The nature of impact from green technology on carbon emissions remains same across three models but statistically significant only in one model, where overall financial development is considered. The impact from financial indicators and trade openness seem to have an insignificant role on carbon emissions. However, an increase in per capita income further raises carbon emissions in these economies. We further estimate these models by incorporating FDI, and the results are again displayed in **Table 2**. The results suggest that an increase in FDI net inflows seem to have an adverse impact on carbon emissions but its' coefficients are not statistically significant. Likewise, the nature of impacts from other variables in the models seems to be consistent with the previous estimates.

[Insert Table 2 about here]

[6] The descriptive statistics are presented in **Appendix-I**.

[7] Paramati and Roca (2019) highlight the significance of AMG estimator, particularly in the presence of cross-sectional dependence in the data series.

The above results tell that the green technology, FDI and trade openness have an adverse impact on carbon emissions but statistically insignificant in most cases. This might be due to the presence of endogeneity in the models due to their macro nature. Hence, to address the issues of endogeneity and serial correlation, as documented by earlier studies (e.g. Sadorsky, 2009), we employ group-mean FMOLS estimator[8] and the results of this technique are presented in **Table 3**. The first part of the results clearly demonstrates that the green technology is an important factor that helps these OECD economies to mitigate their growth of carbon emissions. Since, our variables were measured in natural logarithms, so the estimated coefficients can be interpreted as long-run elasticities, as argued by Sadorsky (2009). For instance, a 1% increase in green technology reduces carbon emissions, across the models, by -0.046% to -0.052%. These evidences further advice that increasing access to the green technology, by the firms and individuals, can further assists these economic to reduce their share of carbon emissions in the global context. The similar impact from trade openness to carbon emissions is also found. This evidence is an indication of policy outcome of the major developed economies. For instance, in the last few years, the developed economies have changed their international trade policies and began to import the goods that are energy and or carbon intensive in their production stage, as argued by Hu et al. (2020). Their new approach in international trade has resulted in reducing their overall carbon emissions.

The results also reveal that an increasing role of financial institutions, markets and overall their developments have a considerable positive impact on carbon emissions. Further, the results reveal that the financial institutions (0.082) have a greater impact on carbon emissions than that of their counterparts' i.e. financial markets (0.060). Though, the OECD economies have a major and significant stock markets but their impact on carbon emissions is less than their counterparts. It might be due to the fact that the listed firms in the stock markets might be engaging in more environmental friendly activities due to the strict regulations on carbon emission cap and environmental laws. It is also found that the growing per capita income raises carbon emissions. This evidence again confirms that as income grows, individuals tend to buy more energy intensive products and thus contribute for more carbon emissions.

[Insert Table 3 about here]

[8] We also applied panel cointegration tests and the results confirm that the selected variables in model-1 and -2 are cointegrated in the long-run and are statistically significant. The results are not reported in the paper to conserve the space.

Finally, we again estimate these models by adding FDI. The results from **Table 3** demonstrate that more FDI net inflows into the OECD economies lead to further reduction in their carbon emissions. It therefore suggests that FDI has an important role in mitigating the growth of carbon emissions. Specifically, the FDI might be helping the host countries to adopt new innovations and technologies in their production of goods and services, which eventually helping those countries to cut-down their share of carbon emissions.[9] This argument is aligned with the findings of Bello and Abimbola (2010). The rest of other results remain consistent and significant. Given these evidences from AMG and group-mean FMOLS, we advise that the researchers should not only consider the cross-sectional dependence in their estimation but also should pay attention to the issue of endogeneity; otherwise, the estimated results could be interpreted wrongly.

4. Conclusion with policy recommendations

The overall results showed that the green technology has a significant negative impact on carbon emissions. The similar impacts were also observed from the FDI and trade openness to carbon emissions. However, it is important to note that the increasing roles of financial deepening and per capita income further raised the carbon emissions.

Given the above outcomes, we provide important and significant policy recommendations to the OECD economies. More specifically, the policy authorities, and respective other agencies, should prioritize the allocation of resources for the green technology innovations. We also stress that the policies that were designed for international trade have to be further strengthened. For example, the international trade policies should aim to import the goods that are more energy and or carbon intensive in their production stage and aim to export the goods that are less energy/carbon intensive. Further, the policy authorities should also redesign their FDI policies to attract more FDI inflows from other major economies as it helps them to adapt more advanced green and energy efficient technologies in their production of goods and services. These revised policies may further assist their economies to minimize the growth of carbon emissions and meet their climate change targets. The future studies may aim to focus on country-specific analysis to draw more explicit policy recommendations once data become available for a longer time-period.

[9] The previous evidences (e.g. Kutan et al., 2018; Paramati et al., 2017) report that both stock markets and FDI inflows are the prominent drivers of clean/renewable energy.

References

Al Mamun, M., Sohag, K., Shahbaz, M., & Hammoudeh, S. (2018). Financial markets, innovations and cleaner energy production in OECD countries. *Energy economics, 72,* 236-254.

Bello, A. K., & Abimbola, O. M. (2010). Does the level of economic growth influence environmental quality in Nigeria: a test of environmental Kuznets curve (EKC) hypothesis. *Pakistan Journal of Social Sciences, 7*(4), 325-329.

Du, K., Li, P., & Yan, Z. (2019). Do green technology innovations contribute to carbon dioxide emission reduction? Empirical evidence from patent data. *Technological Forecasting and Social Change, 146*, 297-303.

Eberhardt, M., & Bond, S. (2009). Cross-section dependence in nonstationary panel models: a novel estimator. MPRA paper 17870.

Eberhardt, M., & Teal, F. (2010). Productivity Analysis in Global Manufacturing Production.

Ganda, F. (2019). The impact of innovation and technology investments on carbon emissions in selected organisation for economic Co-operation and development countries. *Journal of cleaner production, 217,* 469-483.

Ghisetti, C., & Quatraro, F. (2014). Is green knowledge improving environmental productivity? Sectoral Evidence from Italian Regions. *SEEDS Working Papers, 10,* 2014.

Hashmi, R., & Alam, K. (2019). Dynamic relationship among environmental regulation, innovation, CO2 emissions, population, and economic growth in OECD countries: A panel investigation. *Journal of cleaner production, 231*, 1100-1109.

Hsu, P.-H., Tian, X., & Xu, Y. (2014). Financial development and innovation: Cross-country evidence. *Journal of Financial Economics, 112*(1), 116-135.

Hu, G., Can, M., Paramati, S. R., Doğan, B., & Fang, J. (2020). The effect of import product diversification on carbon emissions: New evidence for sustainable economic policies. *Economic Analysis and Policy*, *65*, 198-210.

International Energy Agency. (2012). *Energy technology perspectives 2012: pathways to a clean energy system*. Retrieved from: https://www.iea.org/reports/energy-technology-perspectives-2012.

Kutan, A. M., Paramati, S. R., Ummalla, M., & Zakari, A. (2018). Financing renewable energy projects in major emerging market economies: Evidence in the perspective of sustainable economic development. *Emerging Markets Finance and Trade*, *54*(8), 1761-1777.

Le, T.-H., Le, H.-C., & Taghizadeh-Hesary, F. (2020). Does financial inclusion impact CO2 emissions? Evidence from Asia. *Finance Research Letters*, 101451.

Liddle, B. (2015). What are the carbon emissions elasticities for income and population? Bridging STIRPAT and EKC via robust heterogeneous panel estimates. *Global Environmental Change, 31*, 62-73.

OECD. (2015). *Carbon dioxide (CO2) emissions", in Environment at a Glance 2015: OECD Indicators*. Retrieved from Paris:

Paramati, S. R., Apergis, N., & Ummalla, M. (2017). Financing clean energy projects through domestic and foreign capital: The role of political cooperation among the EU, the G20 and OECD countries. *Energy Economics*, *61*, 62-71.

Paramati, S. R., & Roca, E. (2019). Does tourism drive house prices in the OECD economies? Evidence from augmented mean group estimator. *Tourism Management, 74*, 392-395.

Paramati, S. R., Ummalla, M., & Apergis, N. (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. *Energy economics, 56*, 29-41.

Pedroni, P. (2000). Fully modified OLS for heterogeneous cointegrated panels, in Baltagi, B. H. ed., Nonstationary Panels, Panel Cointegration and Dynamic Panels, 15, Amsterdam: Elsevier, 93–130.

Pedroni, P. (2001). Purchasing power parity tests in cointegrated panels. *Review of Economics and Statistics, 83*(4), 727-731.

Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. Journal of applied econometrics, 22(2), 265-312.
Sadorsky, P. (2009). Renewable energy consumption, CO2 emissions and oil prices in the G7 countries. *Energy Economics*, *31*(3), 456-462.
Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy policy*, *38*(5), 2528-2535.
Sun, Y., Chen, L., Sun, H., & Taghizadeh-Hesary, F. (2020). Low-carbon financial risk factor correlation in the belt and road PPP project. *Finance Research Letters*, 101491.
Taghizadeh-Hesary, F., & Yoshino, N. (2019). The way to induce private participation in green finance and investment. *Finance Research Letters*, *31*, 98-103.
World Bank. (2015). World development indicators. Retrieved from http://data.worldbank.org/products/wdi (2015)

Table 1: Results on CD and CIPS tests

	CD test results				CIPS test results			
					Level		First difference	
Variable	CD-test	p-value	corr	abs(corr)	Zt-bar	p-value	Zt-bar	p-value
CDE	22.280***	0.000	0.252	0.535	-0.936	0.175	-7.735***	0.000
FI	43.120***	0.000	0.488	0.628	0.098	0.539	-8.314***	0.000
FM	64.310***	0.000	0.728	0.729	-0.357	0.360	-6.480***	0.000
FD	70.810***	0.000	0.802	0.802	-0.361	0.359	-5.728***	0.000
FDI	19.900***	0.000	0.225	0.305	1.995	0.977	-12.699***	0.000
GRNTE	78.240***	0.000	0.886	0.886	-0.134	0.447	-9.389***	0.000
PI	80.190***	0.000	0.908	0.908	-0.963	0.168	-2.161**	0.015
TO	56.080***	0.000	0.635	0.645	1.895	0.971	-5.302***	0.000

Notes: *** implies the rejection at the 1% significance level.

Table 2: Results on long-run estimates using Augmented Mean Group (AMG)

Model	Coef.	z	P>z	Coef.	z	P>z	Coef.	z	P>z
	CDE = f (FI, GRNTE, PI, TO)			CDE = f (FM, GRNTE, PI, TO)			CDE = f (FD, GRNTE, PI, TO)		
FI	0.033	0.370	0.712						
FM				-0.018	-0.600	0.549			
FD							-0.024	-0.440	0.660

GRNTE	-0.015	-1.310	0.189	-0.013	-1.030	0.302	-0.019*	-1.650	0.099
PI	0.772***	7.000	0.000	0.837***	7.540	0.000	0.842***	7.330	0.000
TO	-0.013	-0.230	0.820	-0.032	-0.460	0.642	-0.026	-0.380	0.703
Constant	-2.755**	-2.450	0.014	-3.176***	-2.900	0.004	-3.179***	-2.810	0.005
	CDE = f (FI, FDI, GRNTE, PI, TO)			CDE = f (FM, FDI, GRNTE, PI, TO)			CDE = f (FD, FDI, GRNTE, PI, TO)		
FI	0.009	0.100	0.921						
FM				-0.012	-0.440	0.657			
FD							-0.014	-0.290	0.775
FDI	-0.005	-1.210	0.226	-0.003	-0.880	0.380	-0.003	-0.980	0.327
GRNTE	-0.011	-0.830	0.406	-0.008	-0.590	0.558	-0.013	-1.010	0.313
PI	0.779***	6.500	0.000	0.830***	7.220	0.000	0.829***	6.860	0.000
TO	-0.001	-0.020	0.988	-0.011	-0.170	0.865	-0.006	-0.090	0.931
Constant	-2.809**	-2.280	0.022	-3.252***	-2.760	0.006	-3.210***	-2.610	0.009

Note: *, ** & *** imply the significance levels at the 10%, 5% and 1%, respectively.

Table 3: Results on long-run estimates using Grouped-Mean FMOLS estimator

Model	Coef.	t-Stat.	Prob.	Coef.	t-Stat.	Prob.	Coef.	t-Stat.	Prob.
	CDE = f (FI, GRNTE, PI, TO)			CDE = f (FM, GRNTE, PI, TO)			CDE = f (FD, GRNTE, PI, TO)		
FI	0.082***	5.589	0.000						
FM				0.060***	16.495	0.000			
FD							0.116***	14.826	0.000
GRNTE	-0.046***	-19.312	0.000	-0.046***	-20.780	0.000	-0.052***	-24.640	0.000
PI	0.686***	48.309	0.000	0.610***	41.088	0.000	0.623***	40.283	0.000
TO	-0.050***	-5.875	0.000	-0.091***	-10.235	0.000	-0.071***	-8.084	0.000
	CDE = f (FI, FDI, GRNTE, PI, TO)			CDE = f (FM, FDI, GRNTE, PI, TO)			CDE = f (FD, FDI, GRNTE, PI, TO)		
FI	0.070***	5.481	0.000						
FM				0.060***	17.688	0.000			
FD							0.118***	16.589	0.000
FDI	-0.006***	-17.693	0.000	-0.005***	-13.241	0.000	-0.005***	-11.899	0.000
GRNTE	-0.044***	-21.230	0.000	-0.045***	-21.327	0.000	-0.049***	-24.379	0.000
PI	0.697***	52.879	0.000	0.625***	46.845	0.000	0.623***	45.270	0.000
TO	-0.049***	-6.310	0.000	-0.083***	-10.252	0.000	-0.065***	-8.080	0.000

Note: *** implies the significance level at the 1%.

Appendix –I: Descriptive statistics, 1991 – 2016

	CDE	FI	FM	FD	FDI	GRNTE	PI	TO
Average statistics								
Australia	356.15	87.39	70.47	79.79	2.80	229.23	46370.54	39.94
Austria	68.16	73.14	50.85	62.67	2.51	227.27	42840.20	87.49

Canada	554.28	85.64	64.94	76.10	2.85	430.51	42101.49	67.37
Chile	56.79	54.46	32.32	43.86	6.46	11.78	10770.71	63.08
Denmark	54.55	85.05	43.64	65.04	2.40	205.29	55323.35	85.61
Finland	53.17	59.03	53.15	56.70	3.15	155.05	41071.64	70.13
France	396.55	80.41	53.99	67.93	1.97	910.69	38339.10	52.29
Germany	833.20	75.77	67.01	72.16	1.82	3004.55	39177.62	65.55
Greece	88.70	57.17	45.97	52.12	0.75	16.89	23855.48	50.48
Hungary	54.07	42.33	42.33	42.79	9.98	22.32	11688.26	123.87
Ireland	36.27	83.70	55.78	70.50	15.61	28.91	44363.35	161.01
Israel	60.59	65.13	37.01	51.62	2.81	136.19	27983.43	67.34
Italy	425.67	73.98	61.08	68.26	0.88	383.61	35004.42	48.24
Japan	1193.61	86.81	59.10	73.74	0.17	5382.80	43118.34	24.75
Korea	516.41	74.55	72.67	74.41	0.88	1459.11	17471.43	73.39
Mexico	402.50	36.13	33.17	35.02	2.49	22.60	9052.15	53.34
Netherlands	234.88	80.43	63.68	72.83	18.99	286.08	46276.80	123.61
New Zealand	34.94	69.51	39.91	55.30	1.90	34.67	31094.14	58.46
Norway	41.12	56.58	67.27	62.60	2.16	76.58	81810.00	70.01
Portugal	55.55	80.96	42.49	62.39	3.23	14.76	20794.88	66.42
Spain	305.92	83.68	68.97	77.15	2.87	161.21	28239.57	53.03
Sweden	58.65	68.67	64.13	67.12	4.35	251.08	46691.58	77.09
Switzerland	43.90	93.56	84.96	90.23	4.22	225.32	69365.16	99.66
United Kingdom	559.97	88.31	71.27	80.65	3.81	731.74	36614.26	53.36
United States	5541.83	79.59	82.26	81.80	1.60	5149.56	45209.03	25.04
Consolidated statistics								
Mean	481.10	72.88	57.14	65.71	4.03	782.31	37385.08	70.42
Maximum	6002.07	100.00	100.00	100.00	86.61	10047.43	91565.73	226.04
Minimum	25.70	28.00	10.64	23.89	-15.96	0.83	6291.69	16.01
Std. Dev.	1075.50	15.83	21.10	16.54	7.88	1656.21	17556.09	33.29
Observations	650	650	650	650	650	650	650	650

Note: the descriptive statistics were calculated using non-log conversion data.