Regional analysis of the relationship between CO₂ emissions and financial development

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Abstract: This study reappraises the relationships between financial development and carbon dioxide emissions by using 25 OECD countries during 1971–2007 as observations. It introduces the panel transition regression (PSTR) model. We found that strong evidence of the relationship between financial development and carbon dioxide emissions is non-linear and the trade-off correlation between these ratios and the carbon dioxide emissions. The carbon dioxide emissions will be different under the financial development threshold value and the control variables of energy consumption, GDP and GDP². What is more, the different financial development attributes produce completely different carbon dioxide emissions. In sum, the threshold effect of financial development will be an important index to control carbon dioxide emissions.

Keywords: energy consumption; non-linear; threshold effect; financial development; carbon dioxide emissions; PSTR model.


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Chiao-Ming Li is a PhD student. He is majoring in econometric methods, strategic management, and energy management courses. In terms of research, he studies the comparison of energy management, energy and finance, and energy transnationals. At the same time, he also investigates energy and industry and environmental issues. The development of international renewable energy will be a new topic for his research at this stage.
1 Introduction

The global effects of climate change are already apparent in increasing the frequency of extreme weather events, altering precipitation patterns, heightening storm intensity, reversing ocean currents and a rising sea level. These changes, in turn, can have significant impacts on the functioning of ecosystems, the viability of wildlife, and the wellbeing of humans. The increasing threat of global warming and climate change has focused attention on the relationship between economic growth and environmental pollutants. Increased attention in recent years has been directed towards carbon dioxide emissions, as industrialised countries have had to find ways of reducing energy use in order to meet Kyoto targets. In contrast with developed countries, the demand for energy in developing countries has risen sharply alongside their economic growth. Until relatively recently there have been two parallel literatures on the relationship between economic growth and environmental pollution. The first set of studies has focused on the economic growth-environmental pollutants nexus and has been closely allied to testing the Environmental Kuznets Curve (EKC) hypothesis. The EKC hypothesis specifies emissions as a function of income, which presumes unidirectional causality runs from income to emissions. However, it is conceivable that causation could run from emissions to income whereby emissions occur in the production process and, as a consequence, income increases.

Energy consumption depends on the stage of economic growth. Economic growth is a necessary condition to insure better standards of living. The heightened interest by the major economic powers at gaining a firm foothold on energy rich regions across the globe is a testimony to the fact that energy will remain a major focus for the foreseeable future. The battle for such control will also intensify as more energy will be needed to meet the demand for economic growth. Energy-related greenhouse gases (GHG) make up the bulk of pollutants. Knowledge of the determinants of energy demand can help manage global emissions of GHGs. World Resources Institute reports that developed countries once were the major emitters of most of world’s GHG but the emerging nations have now taken that spot. The latter nations have set long-run economic growth as their core mission. The situation may be exacerbated due to higher population growth in many parts of the world.

Recent studies have demonstrated that financial development can affect demand for energy, an increasing number of research studies agree that financial development can promote economic growth and reduce environmental pollution at the same time. Frankel and Romer (1999) pointed out, developed financial markets can help boost inflows of foreign direct investment and stimulate the economic growth rates of the receiving nations. Financial development serves as a conduit for modern environmentally-friendly technology (Frankel and Rose, 2002), while some studies show that financial development directly impacts energy consumption and thus CO₂ emissions (Tamazian
Furthermore, a developed financial sector could lower borrowing costs, promote investment in the energy sector, and reduce energy emissions (Shahbaz, 2009; Shahbaz et al., 2010).

The foregoing discussion shows a lack of consensus on the effect of the financial development on CO₂ emissions. This may be due to country specific conditions which need to be considered and analysed. It is against this backdrop that the present study is undertaken to better understand the relationship in the context of OECD countries.

2 Literature reviews

2.1 Review of the CO₂ emissions-related literature

In the literature, studies interested in evaluating CO₂ emissions are abundant. Purely from the aspect of financial development, at least three strands can be distinguished from the paper pool. The first consider the financial development potential effect on CO₂ emissions and the issue of threshold effects in the relationships between financial development and CO₂ emissions. The features of such a line of study usually aim at refining or extending the estimation approach, or at discussing specific policies. The EKC phenomenon was introduced by the World Bank and by Grossman and Krueger (1995) as presenting an inverse U-shaped relationship between environmental pressure and income. Apergis and Payne (2009) examined the causal relationship between carbon dioxide emissions, energy consumption, and output within a panel vector error correction model for six Central American countries over the period 1971–2004. They found that in the long-run equilibrium energy consumption has a positive and statistically significant impact on emissions while real output exhibits the inverted U-shape pattern associated with the Environmental Kuznets Curve (EKC) hypothesis.

In view of the preceding discussion, this strand of literature has an appealing point of view in terms of the methodological induction, the elaborating theme, the experimental design or explanations for a real economic phenomenon. However, we are concerned about the extent of environmental pollution can be reduced through market forces, such as financial development may be an important force to resist environmental pollution. Increased attention in recent years has been directed towards carbon dioxide emissions, as industrialised countries have had to find ways of reducing energy use in order to meet Kyoto targets. The second strand of literature considers that the financial markets in which environmental trends, in addition to providing funds to the industry, there are likely to be able to assist in the reduction of environmental pollution through industrial policy measures.

2.2 Financial development and CO₂ emissions

Jalil and Feridun (2010) investigated the impact of financial development, economic growth and energy consumption on CO₂ emissions in the case of China from 1953 to 2006. The results of the analysis revealed a negative sign for the coefficient of financial development, suggesting that financial development in China has not taken place at the expense of environmental pollution. On the contrary, it is found that financial development save environment from degradation. Moreover, the results confirm
the existence of a long-run relationship between carbon emissions, income, energy consumption and trade openness while supporting the presence of EKC hypothesis.

Tadesse (2005) found that financial development encourages technological progress – a major determinant of productivity, while financial development stimulates investment by risk sharing (Shahbaz et al., 2010). Tamazian et al. (2009) examined the impact of economic and financial development on CO$_2$ emissions for BRIC nations plus the USA and Japan, finding that both factors help reduce CO$_2$ emissions. The authors also noted that trade liberalisation and financial sector reforms help reduce CO$_2$ emissions.

There is indeed an extensive amount of literature in the past looking at the causal relationship between environmental pollution and financial developments. First, Soytas et al. (2007) applied the Granger causality test and found that energy consumption directly causes carbon emissions. Lotfalipour et al. (2010) indicated a unidirectional short-run Granger-cause relationship among economic growth, petroleum products, natural gas consumption, and CO$_2$ emissions in Iran, but no long-run causal relationship between fuel consumption and CO$_2$ emissions. Zhang and Cheng (2009) examined the direction of Granger causality among economic growth, energy depletion, and CO$_2$ emissions in China during the period of 1960 to 2007. Their results did not support that CO$_2$ emissions and energy consumption lead to economic growth. Second, Shahbaz (2012) showed that financial development attracts investors to come to invest in a country, which then stimulates the operational efficiency of the local stock market as well as domestic economic activity, thereby affecting CO$_2$ emissions. They also found bidirectional causality between financial development and CO$_2$ emissions, indicating that financial development may help reduce CO$_2$ emissions. Frankel and Romer (1999) stated that during the process of financial development, developing countries become more motivated to adopt new energy technologies, which is a move to reduce the environmental effects caused by developing countries. Finally, our findings denote that the literature has found a relationship between financial development and CO$_2$ emissions. The effect is positive or negative, thus raising a considerable degree of discussion among scholars. However, a theoretical basis for these two variables is still lacking, which is the limitation of this study.

Differently from the previous paper, this study consider most economic variables change regimes in a smooth manner, with transition from one regime to another taking some time. Testing parameter constancy in panel data models has not received as much attention as it has in the time series literature. The second, in exploring non-linear relationship between financial development and CO$_2$ emissions, the third, examine the threshold effect and analyse different levels of financial development impact of CO$_2$ emissions and energy consumption.

### 3 Methodology, model specifications and variable constructions

The model used for the EKC is derived within the standard conventional theory and is expressed as:

$$ C_i = f(E_i, Y_i, Y_i^2, FD_i) $$

where CO$_2$ emissions per capita ($C_i$) is a function of energy use per capita ($E_i$), real gross domestic income per capita ($Y_i$), the square of real gross domestic income per
capita \( (Y^2_i) \), and financial development \( (FD_i) \). In order to investigate the relationships among pollution, energy consumption, and income, we express the log equation as follows:

\[
\ln C_i = \alpha_{it} + \delta t + \beta_1 \ln E_i + \beta_2 \ln Y_i + \beta_3 \ln Y_i^2 + \beta_4 \ln FD_i + \epsilon_i
\]

(2)

We estimate equation (2) using the panel approach that takes into consideration both country \( i \) and year \( t \), while \( \alpha_{it}, \delta t, \) and \( \epsilon_i \) are the fixed effects, deterministic trends, and error terms, respectively. According to the conventional EKC hypothesis, positive signs of \( \beta_1 \) and negative signs of \( \beta_3 \) should be expected. The results reveal that there is an inverted U-shape between CO2 emissions and income. Furthermore, more energy use may create more pollution simultaneously, and the signs of should be positive. In terms of financial development, the signs of \( \beta_4 \) are uncertain. Al-mulali and Sab (2012) found that when economic growth and energy consumption increase demand, there is a higher demand for services in the financial sector, which in turn results in the financial sector setting up sound financial policies to control the amount of CO2 emissions.

In this paper we consider four variables: CO2 emissions, energy use, gross domestic income, and financial development. We gather the data used in the paper from world development indicators. Energy consumption (EC) is measured in kg of oil equivalent per capita. Economic growth is proxied by the rise in real GDP, and private credit extended by deposit money in banks to GDP is used to measure financial development (PC). Moreover, in order to test the robust relationships between CO2 and financial development, we provide other financial development variables in the regression analysis. Specifically, we extract bank deposits to GDP as a financial deep variable (BD).

In this paper we distinguish model 1 (PC as financial development) and model 2 (BD as a financial development variable) in order to investigate equation (3).

Most economic variables change regimes in a smooth manner, with the transition from one regime to another taking some time. Testing for parameter constancy in panel data models has not received as much attention as it has in the time series literature. On the one hand, PSTR can be thought of as a regime-switching model that allows for a small number of extreme regimes to be associated with the extreme value of a transition function and where the transition from one regime to another is smooth. Second, we follow Chiu (2012), who applied the PSTR model to examine the Environmental Kuznets Curve (EKC) for 52 developing countries from 1972 to 2003. Duarte et al. (2013) also employed the PSTR model to analyse the relationship between water use per capita and income per capita of 65 countries over the period of 1962 to 2008. They found that the relationship between water withdrawal per person and GDP per capita is non-linear, displaying a negative connection between the two variables. In another strand of the literature, there are many empirical studies about the PSTR model. Some studies use the PSTR model to explore for non-linear relationships, while some examine the threshold effect in the PSTR model and other aspects. For example, Fouquau et al. (2008) determined the relative influence of five factors on the Feldstein and Horicoka result of OECD countries over the period 1960–2000, based on PSTR models, by presenting a strong saving-investment correlation. Their findings show that degree of openness, country assets, and current account to GDP ratio have the greatest influence on this correlation. Chakroun (2009) used a PSTR model to investigate the potential threshold effects in the relationship between national expenditures on health and national income for 17 OECD countries over the period 1975–2003. The results of that empirical study
showed that health care is a necessity rather than a luxury, in contrast to many previous analyses. Furthermore, the relationship between health expenditure and income seems rather non-linear, changing over time and across countries. Cheng et al. (2010) explored whether there exists an efficient investment regime for a panel of S&P100 companies over the period 1986–2007.

Finally, we follow González et al. (2005) to adopt a three-step procedure in order to estimate our constructed model of CO2 emissions. First, we test for linearity against the smooth transition models. Second, when the null hypothesis (linearity) is rejected, we determine the number of transition functions by conducting tests of no remaining non-linearity. Finally, we remove the individual effects and then utilise non-linear least squares upon the transformed model, the basic PSTR model with two extreme regimes is defined as follows:

$$y_i = \mu + \beta_0 x_{it} + \beta_1 x_{it} g(q_{it}; \gamma, c) + u_i$$

Transition function $g(q_{it}; \gamma, c)$ is a continuous function of the observable variable $q_{it}$ and is normalised to be bounded between 0 and 1, and these extreme values are associated with regression coefficients $\beta_0$ and $\beta_0 + \beta_1$. More generally, the value of $q_{it}$ determines the value of $g(q_{it}; \gamma, c)$ and thus the effective regression coefficients $\beta_0 + \beta_1 g(q_{it}; \gamma, c)$ for individual $i$ at time $t$. The widely used transition function is a logistic specification as in equation (4):

$$g(q_{it}; \gamma, c) = \left(1 + \exp\left(-\gamma \sum_{j=1}^{\infty} (q_{it} - c_j)\right)\right)$$

with $\gamma > 0$ and $c_1 \leq c_2 \leq \cdots \leq c_m$ (4)

In practice it is usually sufficient to consider $m = 1$ or $m = 2$, as these values allow for commonly encountered types of variation in the parameters. A generalisation of the PSTR model to allow for more than two different regimes is the additive model:

$$y_i = \mu + \beta_0 x_{it} + \sum_{j=1}^{r} \beta_j x_{it} g_j(q_{it}; \gamma_j, c_j) + u_i$$

where the transition functions $g_j(q_{it}; \gamma_j, c_j), j = 1, \cdots, r$, are of the logistic type. If $m = 1$, $q_{it}^{(1)} = q_{it}$ and $\gamma_j \to \infty$, for all $j = 1, \cdots, r$, the model in equation (5) becomes a PTR model with $r + 1$ regimes. Consequently, the additive PSTR model can be viewed as a generalisation of the multiple regime panel threshold model in Hansen (1999).

4 Empirical estimation and analysis

Table 1 reports the descriptive statistics of the average ratios of CO2, EC, GDP, GDP², BD and PC. The CO2 between 0.2150 to 1.6052 and the mean is 0.9423, which shows that CO2 emission has great changes in trading patterns. We see the EC is −0.2834 between 1.1961, which means that Energy consumption has great differences in OECD countries, the different factors that affect energy consumption, we will further explore the reasons for empirical analysis, the GDP are 2.4803% between 5.0290%, the different GDP of OECD countries, we are concerned about the situation for CO2 emissions as well
as changes in the structure. Whereas the BD is between −1.0612% and 0.5666% and the PC is between −1.0395% and 0.5905%, which OECD countries is important for financial development, especially in order to expand the industrial scale. Financial development can promote the development of the power industry, therefore, how different levels of financial development impact of CO2 emissions, we will to explore in this article. In addition, all of the Jarque-Berra (J-B) statistics reject the null hypotheses of normality distribution.

Table 1  Summary statistics

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>EC</th>
<th>GDP</th>
<th>GDP²</th>
<th>BD</th>
<th>PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.9423</td>
<td>0.5698</td>
<td>4.1030</td>
<td>16.993</td>
<td>−0.2282</td>
<td>−0.2407</td>
</tr>
<tr>
<td>Std</td>
<td>0.2150</td>
<td>0.2405</td>
<td>0.3983</td>
<td>3.1617</td>
<td>0.2665</td>
<td>0.2452</td>
</tr>
<tr>
<td>Max</td>
<td>1.6052</td>
<td>1.1961</td>
<td>5.0290</td>
<td>25.291</td>
<td>0.5666</td>
<td>0.5905</td>
</tr>
<tr>
<td>Min</td>
<td>0.2150</td>
<td>−0.2834</td>
<td>2.4803</td>
<td>6.1521</td>
<td>−1.0612</td>
<td>−1.0395</td>
</tr>
<tr>
<td>Skewness</td>
<td>−0.0696</td>
<td>−0.5746</td>
<td>−0.7254</td>
<td>−0.4471</td>
<td>−0.3901</td>
<td>0.4054</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>0.6502</td>
<td>0.5287</td>
<td>0.4637</td>
<td>0.1576</td>
<td>−0.1558</td>
<td>0.8391</td>
</tr>
<tr>
<td>J-B</td>
<td>17.0455***</td>
<td>61.6861***</td>
<td>89.4112***</td>
<td>31.7796***</td>
<td>24.4024***</td>
<td>52.4873***</td>
</tr>
</tbody>
</table>

Note: P-value is the probability that the data come from the normal distribution, according to the Jarque-Berra normality test.

Table 2  Estimated coefficients of fix effected results

<table>
<thead>
<tr>
<th>Panel A: with consideration of BD</th>
<th>Panel B: with consideration of PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>p-value</td>
</tr>
<tr>
<td>EC</td>
<td>0.8067</td>
</tr>
<tr>
<td>GDP</td>
<td>0.5576</td>
</tr>
<tr>
<td>GDP²</td>
<td>−0.0784</td>
</tr>
<tr>
<td>FD</td>
<td>−0.0189</td>
</tr>
</tbody>
</table>

Notes: The numbers in brackets indicate p-values. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 level, respectively. We have tested Pool OLS, Random effect, and select the most suitable fixed effect model.

Table 2 exhibits the estimated coefficients of fix effected results. We apply nonlinear fixed effects models above to observe the CO2 emissions between EC, GDP, GDP², BD and PC. In order to robust of the relationship between CO2 emissions and finance development, we analyse individual CO2 emissions and BD, PC. From panel A (with consideration of BD), we see CO2 emissions and EC as a positive significant relationship, means that CO2 emissions from energy consumption has considerable impact, energy consumption increased because of industry in order to expand capacity and increase the size of the input element. Therefore, an increase in energy consumption, the impact of increased CO2 emissions. The second, we see that CO2 emissions and GDP, the relationship GDP², in line with environmental Kuznets curve, the third we find that the coefficient of financial development for the CO2 emissions is negative and statistically significant for OECD countries, between of CO2 emissions and financial development may boycott function. From panel B (with consideration of PC), we can see the results are consistent with the panel A.

In empirical design, we set the financial development as threshold variable and control variables include EC, GDP, and GDP². Table 3 presents the test of linearity
results between the financial development and CO₂ emissions. The LM, Fisher and LRT linearity tests clearly lead to the rejection of the null hypothesis of linearity for the model. This result implies that there is strong evidence that the relationship between financial development and CO₂ emissions is non-linear.

**Table 3**  Test of linearity

<table>
<thead>
<tr>
<th>Panel A: with consideration of BD</th>
<th>$H_0$: linear model against $H_1$: PSTR model with at least one threshold variable ($r \geq 1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics</td>
<td>$P$-value</td>
</tr>
<tr>
<td>Wald Tests (LM)</td>
<td>28.141</td>
</tr>
<tr>
<td>Fisher Tests (LMF)</td>
<td>6.934</td>
</tr>
<tr>
<td>LRT Tests (LRT)</td>
<td>28.578</td>
</tr>
</tbody>
</table>

Note: * Denote significant at 5% significance level. The LM and pseudo LR1 statistics have a chi-square distribution with $mK$ degrees of freedom, whereas the F statistics has a $F (mK; TN– N – K (m + r + 1))$ distribution. LM F is its $F$-version. Pseudo LRT can be computed according to the same definitions by adjusting the number of degree of freedom. For detail, see also Colletaz and Hurlin (2006).

**Table 4**  Sequence of homogeneity tests for selecting $m$

<table>
<thead>
<tr>
<th>Panel A: with consideration of BD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select $m = 2$ if the rejection of $H_{02}$ is the strongest one, otherwise select $m=1$</td>
</tr>
<tr>
<td>statistics</td>
</tr>
<tr>
<td>$H_{03}$: $B_3=0$</td>
</tr>
<tr>
<td>$H_{02}$: $B_2=0$ $B_3=0$</td>
</tr>
<tr>
<td>$H_{01}$: $B_1=0$ $B_2=0$ $B_3=0$</td>
</tr>
</tbody>
</table>

Note: Final model $m=2$.

**Table 5**  Testing the number of regimes: tests of no remaining non-linearity

<table>
<thead>
<tr>
<th>Panel A: with consideration of BD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$: PSTR with $r = 1$ against $H_1$: PSTR with at least $r = 2$</td>
</tr>
<tr>
<td>statistics</td>
</tr>
<tr>
<td>Wald Tests (LM)</td>
</tr>
<tr>
<td>Fisher Tests (LMF)</td>
</tr>
<tr>
<td>LRT Tests (LRT)</td>
</tr>
</tbody>
</table>

Note: 1. * Denote significant at 5% significance level.  
2. $\max r = 1, \ m = 1$, the reasonable numbers of threshold $r=1$.

The next step is to determine the number of transitions in the model. Table 5 testing for non-remaining nonlinearity consists of checking whether there is one transition function ($H_0$: $r = 1$) or whether there are at least two transition functions ($H_1$: $r = 2$), the testing results show that the reasonable numbers of threshold $r =1$, which means that there are one regions. Each region has two regimes.
Table 6 shows the parameters estimate results of PSTR models and robust analysis of the relationship between the CO\textsubscript{2} emissions with individual BD and PC. The transition function is logistic specification ($m = 1$ with two regimes), C is location parameters, in the region, the value are 0.0611 with BD and the value are −0.2404 with PC, respectively. The above result shows that there are structure changes at the point (see also Figure 1 and 2). The transition function is logistic specification. With regard to the control parameters, we observe that the EC is Positive (0.8450), GDP is Positive (0.6961), GDP$^2$ is negative (−0.1059) and FD is positive (0.1524) if no any structure change for volatility. The explanations for this region are that when the value is below 0.0611, the EC increase then the net flow will increase, that is the trade-off between GDP, GDP$^2$ and CO\textsubscript{2} emissions. The FD indicates that the value increase will increase the CO\textsubscript{2} emissions. Whereas the value is greater than 0.0611, the EC decrease then the CO\textsubscript{2} emissions will also decrease. But we see significantly less than the coefficient of EC whereas financial development is low, the implied high financial development, it may
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enhance the technology can replace some of the energy consumption. The FD indicate that the value increase will decrease the CO$_2$ emissions, implied that when high financial development, have the boycott for CO$_2$ emissions function, so when the high financial development, financial development can help to reduce the use of CO$_2$ emissions, because of financial institutions consider environmental protection measures and giving more assistance for industry which belong to reduce the CO$_2$ emissions. Our robust analysis PC with consistent results. The above statement is based on the PSTR model of $m = 1, r=2$ is given. Equation (1) shows the full PSTR model for model 6, 7.

\[
\begin{align*}
CO_{2\text{emissions}}_u &= \mu_i + 0.8450EC_i + 0.6961GDP - 0.1059GDP^2 \\
&\quad + 0.1524FD_i \beta'_g(BD_i, 27.5199, 0.0611)0.5343EC_i \\
&\quad + 0.4043GDP - 0.0255GDP^2 - 0.5127FD_i + \varepsilon \\
\end{align*}
\]

Equation (6)

\[
\begin{align*}
CO_{2\text{emissions}}_u &= \mu_i + 0.6735EC_i + 0.8276GDP - 0.1216GDP^2 \\
&\quad + 0.4372FD_i \beta'_g(PC_i, 3.229, -0.2404)0.4479EC_i \\
&\quad + 0.6538GDP - 0.0938GDP^2 - 0.1770FD_i + \varepsilon \\
\end{align*}
\]

Equation (7)

Figure 1  Transition Function with $m = 2$

Figure 2  Transition Function with $m = 2$
5 Conclusions

In this article, we used the PSTR model to re-examine the nonlinear dynamic relationships between OECD countries’ financial development and CO₂ emissions. We found that strong evidence of the relationship between financial development and CO₂ emissions is non-linear and the trade-off correlation between these ratios and the CO₂ emissions. Our empirical results show that, the CO₂ emissions will be different under the financial development threshold value and the control variables of EC, GDP, GDP², BD and PC. What is more, the different financial development of OECD countries produces completely different CO₂ emissions. The BD indicate that the value increase will decrease the CO₂ emissions, implied that when high financial development, have the boycott for CO₂ emissions function, so when the high financial development, financial development can help to reduce the use of CO₂ emissions, because of financial institutions consider environmental protection measures and giving more assistance for industry which belong to reduce the CO₂ emissions.

This work also cautions policy makers when considering energy conservation and implementing energy-saving policies, whereby energy efficiency has to avoid the rebound effect. Our main results can be summed up as follows. First, in addition to showing advocacy for directly reducing CO₂ emissions as well as input costs to control such emissions, there is a better way to go about this through the management of financial institutions whereby OECD countries can formulate and guide industry initiatives to reduce these emissions and assist in the development of key technologies to reduce dependence on energy consumption; therefore, financial development is an important factor in reducing CO₂ emissions.

Second, the results suggest that while policy makers can certainly encourage economic development, at the same time they also have a duty to promote energy conservation and decrease CO₂ emissions. Hence, policy makers should implement an economic development plan that takes into account global climate warming and any relevant important environmental protection. Such a plan would reveal that increasing economic growth could also probably reduce energy consumption and emissions through environment friendly policies. The government can further take advantage of demand-side policies to control energy demand so as to reduce energy use. Finally, we suggest that EU governments continue to grow and enhance renewable energy sources as well as strengthen energy-related R&D development in order to replace some fossil fuels, which would also help cut CO₂ emissions. As mentioned above, OECD countries in addition to advocacy to reduce CO₂ emissions, as well as input costs to control CO₂ emissions, there is a better way, through the management of financial institutions, to guide the industry initiative to reduce CO₂ emissions and the development of key technologies to reduce dependence on energy consumption, and therefore financial development is an important factor in reducing CO₂ emissions. In sum, the threshold of financial development will be an important index to controlling CO₂ emissions.
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References


