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*Chapter 9*

# INTERACTIONS BETWEEN ECONOMIC GROWTH, INNOVATION, FINANCIAL DEVELOPMENT AND SUSTAINABILITY IN EMERGING COUNTRIES

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**Abstract**

Combining different data sets, this study examines possible linkages between economic growth, innovation and energy and environmental efficiency. In the related literature, previous studies had looked for the link between: (1) financial development and economic growth; (2) energy consumption (or $CO_2$ emissions) and economic growth; (3) innovation (or research and development) and economic growth. However, we believe that a larger and more detailed study is needed to provide insight into the possible interrelatedness and interaction between these variables. To do this work in this chapter, we carry out an empirical study employing the Arellano-Bond estimator. The results will increase our understanding of empirical relationships among the variables involved, thus having important implications for environmental, economic and innovation policies.

**Keywords:** Economic growth, Innovation, Financial development, Energy and environmental efficiency.

## 1. Introduction

During the past two decades the sustainability and environmental degradation issues have gained importance in both political and academic circles. Several conferences have been organized in order to reach some agreements on the subject. Mainly, starting from the Earth

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Summit (Rio de Janeiro, June 3-14, 1992) the negative effects of global warming have been accounted for more accurately. The Earth Summit succeeded by an agreement on the Climate Change Convention which have evolved into the Kyoto Protocol (Kyoto, December, 11, 1997). Article 2 of this protocol defines the "ultimate" objective of the Climate Change Convention as "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992). This reflects clearly the will of countries that have signed and ratified the protocol, to reduce greenhouse gases (GHG) emissions.[1] Recently at the United Nations Climate Change Conference (Copenhagen, December, 7-18, 2009), 115 world leaders including heads of state, heads of government and ministers worked, once again, on the Climate Change Convention in order to make an account of energy and environmental policies implemented so far. We would like to mention here some sections of the Copenhagen Accord, which can provide the motivation of the present chapter.

Article 1 of this accord defines the climate change as one of the today's greatest challenges. According to this accord, participating leaders emphasize their "strong political will to urgently combat climate change in accordance with the principle of common but differentiated responsibilities and respective capabilities". From this statement we can deduce two arguments: first, each country has different responsibility for the current state of the climate change and second, each country has different capabilities to combat it. How to do so, although not very precise, is explained in the following articles of the accord. Article 2 focuses on the cooperation issue citing that countries "should cooperate in achieving the peaking of global and national emissions as soon as possible, recognizing that the time frame for peaking will be longer in developing countries and bearing in mind that social and economic development and poverty eradication are the first and overriding priorities of developing countries and that a low-emission development strategy is indispensable to sustainable development". It is seen clearly that the accord recognizes the fact that developing countries have other priorities than GHG emissions, such as economic development and poverty. However, it is also mentioned that development strategies in these countries should be designed in accordance with the global stabilization of GHG emissions. This is in fact a *sine qua non* condition of sustainable development. For this purpose, according to Article 7 of the accord, "developing countries, especially those with low emitting economies should be provided incentives to continue to develop on a low emission pathway". It is not clear what kind of incentives are envisaged, although in Article 3, it is stated that the parties "agree that developed countries shall provide adequate, predictable and sustainable financial resources, technology and capacity-building to support the implementation of adaptation action in developing countries". This final statement puts in evidence the impact of other non environmental factors in the GHG emissions scheme. Implicitly the statement assumes also that there are some linkages between the level of financial development, the technology and the polluting emissions. To test for the validity of this assumption is the main motivation of this chapter. We believe that detailed study are needed in this research area in order to provide insight into the possible interrelatedness and interaction between these variables. The results of such studies will increase our understanding of empirical

[1]A more detailed discussion on both the Earth Summit and the Kyoto Protocol goes beyond the purpose of this chapter. Detailed documentations and reports are provided on line by United Nations Framework Convention on Climate Change (http://unfccc.int).

relationships among the variables involved, thus having important implications for environmental, economic and innovation policies.

The rest of the chapter is organized as follows. In Section 2, we provide a brief literature survey to position our research in the existing literature. In Section 3, we describe the data used in the study and discuss the methodologies employed. Section 4 presents the main results obtained and Section 5 concludes the chapter.

## 2. Literature Survey

Environmental and energy economics literature, as in many other domains, consists of both theoretical and empirical researches. So far, in the field of theoretical economics an increasing number of papers have introduced the sustainability issue in such a way that they analyze the conditions under which economy could have a positive long-run growth in the presence of a non-renewable (in most cases, also exhaustible) natural resources. Furthermore, the problem is mostly posed in the standard utilitarian framework and solved for an optimal depletion policy. A very general formulation of the problem to be solved by the decision maker is the following.

$$\begin{aligned}
&max \int_0^{\infty} e^{\rho t} u(C_t) dt \\
&\dot{K}_t = F(K_t, R_t) - C_t \\
&\dot{S}_t = -R_t \\
&C_t; K_t; R_t; S_t \geq 0 \\
&K_0; S_0 \text{ given.}
\end{aligned}$$

where the decision maker discounts future utility, $u$ that is increasing function of consumption $C$, at rate $\rho$. Production factors are capital $K$ and natural ressource $R$. While the accumulation of capital stock $\dot{K}_t$ is given by the difference between production and consumption, the stock of the resource is depleted $\dot{S}_t$ with its extraction and its use in the production. The solution of this dynamic system gives the conditions for the durability of the optimal consumption path (that is, $\frac{\dot{C}}{C} > 0$).

The aforementioned system of equations has been further developed in order to introduce other economic environmental and economic variables and thus to consider a more realistic framework. For example, since the pioneering studies of Solow (1956), Stiglitz (1974) and Dasgupta and Heal (1974), many theoretical papers have investigated the impact of technological change (or more specifically, energy saving technical progress) on both the use of natural resource in the production (production side) and, in the form of air quality or pollution for instance, the consumers utility (consumption side). Other directions in this field, such as environmental taxation, human capital and knowledge have also been studied.[2]

Although the results depend largely on the model specifications, this kind of theoretical works have provided useful insights into the sustainability problem. In parallel with the developments in the theoretical literature, empirical research in environmental economics has

[2]Since it is not possible to review in detail all studies in this field, we refer the reader to more comprehensive reviews in Loschel (2002) and Ricci (2007).

gained impetus in recent years and today there is a large number of published work in this field, even more abundant than the theoretical one. Empirical studies employing time-series or panel data and cross-country regressions constitute the majority of this literature. Among the main subjects studied, (1) the economy-environment relationship, more specifically, the impact of economic development on environmental degradation and (2) the investigation of the causal linkages between economy-related variables and energy-related variables, are those which are dominant subjects in this field and related to this chapter.

The first group of literature is about estimating for different countries the relationship between economic development and pollution (or pollutant emissions) employing econometric techniques. Since the pioneering study by Grossmann and Krueger (1993), representation of economic development and pollutant emissions (i.e. carbon dioxide, $CO_2$) or energy consumption by an inverted-U curve became popular among the environmental economists.[3] The intuition behind such a relationship, that is called environmental Kuznets curve (EKC) hypothesis[4], is that in the early stages of economic development, both economic growth and polluting emissions may increase and there may exist a "turning point" income beyond which economic growth may lead to a decrease in emissions. More specifically, we may formalize this intuition in the following fashion:

$$\ln e_t = \alpha + \delta_1 \ln y_t + \delta_2 (\ln y_t)^2 + \epsilon_t$$

where ln indicates natural logarithms, $e_t$ is an indicator of environmental degradation (for example per capita $CO_2$ emissions), $y$ denotes income per capita (for example per capita GDP) and $\epsilon_t$ and $\alpha$ represent respectively the stochastic error term and the constant. The shape of a possible curve is determined by the parameters $\delta_1$ and $\delta_2$. The simple idea is that the relationship between per capita $CO_2$ emissions and per capita GDP may have an inverted U-shape if $\delta_1 > 0$ and $\delta_2 < 0$. On the other hand the "turning point" income, where $CO_2$ emissions reach their maximum level, can simply calculated by $\ln y_t = -\delta_1/2\delta_2$, hence $y_t = \exp(-\delta_1/2\delta_2)$.

Estimating the equation above using time-series data (in the case of country-specific analysis) or panel data shows whether the EKC hypothesis is supported or not.

Still in the first group, one should also consider convergence studies which discuss the issue of cross-country $CO_2$ emission convergence. In these studies, absolute convergence (only emissions are considered) or conditional convergence (other explanatory variables, such as GDP, population, industrial value added, are also accounted for) hypothesis has been tested using econometric tools. The contribution of such studies is that time paths of emissions of different countries are analyzed together and that the effectiveness of environmental policies, aiming at having a sustainable economic growth, in a multinational approach can be discussed more accurately.[5]

The second group of literature focuses on the causal relationship between the variables of interest. The standard Granger (1969) causality test has been used in the related literature

[3] See Stern (2004) for an excellent literature review on this subject.

[4] Simon Kuznets, who received the Nobel Prize in Economics in 1971, introduced first the inverted-U curve relationship between economic development and degree of inequality. Then the same idea has been used to identify the development-environment nexus, which is thus called EKC hypothesis.

[5] In a very recent study, Jobert et al. (Forthcoming) analyzes the convergence issue in the European Union context and provides also a nice overview of the literature in this field.

to test the causality hypothesis between two variables. The idea of this causality is given by Granger (1988, p.200) who states that "if $y_t$ causes $x_t$, then $x_{t+1}$ is better forecast if the information in $y_{t-j}$ is used than if it is not used". In a more technical fashion we can rewrite this statement as follows. Consider two variables (time-series) $X_1$ and $X_2$. The variable $X_2$ does not Granger cause the variable $X_1$ if

$$E(X_{1t}/I_{t-1}(X_1), I_{t-1}(X_2)) = E(X_{1t}/I_{t-1}(X_1))$$

where $I_{t-1}(X_i)$ is the space generated by the linear combinations of the past values of $X_i$.

As in the EKC hypothesis testing, the causality hypothesis can be tested for a country (using time series data) or for a group of country (using panel data). The results of this kind of causality studies address the sustainability issue in the sense that if there is a causal relationship running from economic growth to energy consumption (or $CO_2$ emissions) environmental policies should be implemented in order to prevent environmental degradation caused by the pollution and depletion of natural resources. However, if the causality runs in the opposite direction, then environmental policies may impede economic growth. [6]

As pointed out by Karanfil (2009), more reflections in this research area are needed and new techniques and new variables should be used in order to increase our understanding of the economy-environment relationship. In this view, for example, recently Sadorsky (2010) provided a study for 22 emerging countries covering the period 1990-2006, and showed that there exist some relationships between financial development and energy consumption.

This chapter considers the sustainability issue by analyzing the long-run relationships between emissions, energy consumption, economic and financial variables, technology and communication indicators. Passing from a bivariate to a multivariate frameworks, it extends the environment-economy relationship and aims at providing useful insights in this context. A relatively novel approach, the Arellano-Bond estimator is employed to do this work.

## 3. Data and Methodology

We have chosen nine emerging economies to compare the cross-country pattern of the sustainable development perspective which gained momentum with the second half of 1980s. We know that countries like Argentina, Brazil, Chile, Korea Republic, Malaysia, Mexico, Poland, South Africa and Turkey have undergone similar course of liberalization of international trade which led to a growing use of technology under the export-promoting development strategy. Throughout the two decades, it is possible that the diffusion of technological adaptation produces similar externality effects on the energy use and on the environmental pollution as in early developed countries, though these countries differ by their economic and political institutions. We will try to combine some of the institutional indicators with the development indicators reflecting the production and use of information and communication technologies to have a more comprehensive model.

Our dataset are gathered from two different sets of indicators supplied by the World Bank. Most of the data are selected from the World Development Indicators (WDI) which

[6] More discussion on this subject can be found in Jobert and Karanfil (2007) and Karanfil (2008) who provide a literature survey and review methodological issues in the Granger causality testing procedure.

**Table 1. Description of variables**

| Variable name | Variable definition |
|---|---|
| gdp | GDP per capita (constant 2000 US$) |
| rural | Rural population (% of total population) |
| co2 | Per capita $CO_2$ emissions (metric tons per capita) |
| alter | Alternative and nuclear energy (% of total energy use) |
| en | Per capita energy use (kg of oil equivalent per capita) |
| el | Per capita electric power consumption (kWh per capita) |
| credit | Domestic credit provided by banking sector (% of GDP) |
| ict | ICT goods trade volume (% of total goods traded) |
| ict_spend | Information and communication technology expenditure (% of GDP ) |
| merch_ex | Manufactures exports (% of merchandise exports) |
| trade | Merchandise trade (% of GDP) |
| internet | Internet users (per 100 people) |
| cell_phone | Mobile cellular subscriptions (per 100 people) |
| tphone | Telephone lines (per 100 people) |
| regulation | Regulatory quality index |
| political | Political stability and no violence index |

provide a comprehensive selection of economic, social and environmental indicators, drawing on data from the World Bank and more than 30 partner agencies. Other data source that our study uses is the new 2009 update of the Worldwide Governance Indicators (WGI) research project, measuring six dimensions of governance between 1996 and 2008. These aggregate indicators are based on hundreds of specific and disaggregated individual variables measuring various dimensions of governance and they are taken from 35 data sources provided by 33 different organizations. These indicators are constructed using an unobserved components methodology. The six governance indicators are measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes. We only used two of them which are more relevant for our model namely Political Stability and Absence of Violence/Terrorism and Regulatory Quality. Table 1 gives the definition of each variable used in the estimations. Our observation period covers the years between 1985 and 2006 providing enough information about the development trajectory of the mentioned countries.

To conduct our econometric study, we employ the Arellano-Bond dynamic panel General Method of Moments (GMM) estimator (Arellano and Bond, 1991). The idea behind the Arellano-Bond estimator is to estimate a fixed-effects model for a short panel when lagged values of dependent variables are also regressors. The fixed-effect is eliminated by first-differencing. To obtain consistent estimates for this first-differenced model, we need to use appropriate lags of regressors as the instruments. This estimator is called Arellano-Bond estimator.

The typical equation to be estimated is the following:

$$y_{i,t} = \beta_1 y_{i,t-1} + \cdots + \beta_p y_{i,t-p} + \mathcal{X}'_{it}\alpha + a_i + e_{i,t}, \quad t = p+1, \ldots, T \tag{1}$$

where $y$ denotes per capita $CO_2$ emissions, $\mathcal{X}$ is a covariate vector including different variables depending on the model specification. Moreover, $\mathcal{X}$ is assumed to be uncorrelated with error term $e_{it}$. From Eq. (1), our aim is to consistently estimate the parameters $\beta$ and $\alpha$ when $a_i$ is a fixed effect.

There are several reasons that cause correlation in $y$ over time: true state dependence (through $y$ in preceding periods); observed heterogeneity (through $\mathcal{X}$); and finally unobserved heterogeneity (through unobserved time-invariant individual effect $a_i$).

It is known that the fixed-effect estimator is inconsistent if lagged variables are used as covariates. The reason is that the time demeaned regressors $y_{i,t-1} - \bar{y}_i$ are correlated with the time demeaned error term, $e_{i,t} - \bar{e}_i$ (Cameron and Trivedi, 2009, pp. 287-8). Given that, one can not use instrumental variable (IV) estimation based on lagged variables because any lag of the dependent variables will also be correlated with the average error term. However, IV estimators of the first-differenced (FD) estimators using appropriate lags of the dependent variables as instruments yield consistent estimators in spite of the fact that the first-differenced OLS estimators are inconsistent.

The FD model can be written as follows.

$$\Delta y_{i,t} = \beta_1 \Delta y_{i,t-1} + \cdots + \beta_p \Delta y_{i,t-p} + \Delta \mathcal{X}'_{it}\alpha + \Delta e_{i,t}, \quad t = p+1, \ldots, T \qquad (2)$$

The reason why he regressor $\Delta y_{i,t-1} = y_{i,t-1} - y_{i,t-2}$ is correlated with $\Delta e_{i,t-1} = e_{i,t-1} - e_{i,t-2}$ is that $y_{i,t-1}$ is correlated with $e_{i,t-1}$. But $\Delta e_{i,t}$ will be uncorrelated with $y_{i,t-k}$ if $k \geq 2$.

One of the crucial assumption of the Arellano-Bond estimator is that $e_{i,t}$ are serially uncorrelated. Modern statistical packages implement Arellano-Bond estimator and their proposed tests for this crucial assumption (i.e. the error terms are serially uncorrelated).

# 4. Results and Discussion

In this section, three different model specifications will be considered in order to obtain an accurate view of the relationships between the variables involved in the analysis. The models are specified as follows.

- Model 1: The only endogenous variable is **lgdp**. We instrument this variable by its second lag.
- Model 2: We continue with Model 1 but assume **ict, ict_spend, credit, trade, merch_ex** to be endogenous also. As above we use their second lags as their instruments.
- Model 3: This is similar to Model 2. The only difference is that **political**, **regulation** and **rural** are assumed to be predetermined variables. Both their current level and their first lags are used as regressors and only two additional lags are used as their instruments.

In all models we use 6 lags of the dependent variable as regressor. The main reason for this choice is the requirement that $e_{i,t}$ should be serially uncorrelated in order to use

**Table 2. Results**

| VARIABLES | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| L.co2 | 0.13 | 0.10 | 0.96*** |
| L2.co2 | -0.24** | -0.27** | -0.03 |
| L3.co2 | 0.19* | 0.17** | 0.50*** |
| L4.co2 | -0.07 | -0.09 | -0.12* |
| L5.co2 | -0.07 | -0.06 | -0.35*** |
| L6.co2 | -0.34*** | -0.32*** | -0.41*** |
| political | 0.09 | 0.11* | 0.50*** |
| L.political | | | 1.15*** |
| regulation | -1.39*** | -1.28*** | -3.44*** |
| L.regulation | | | -2.87*** |
| rural | 0.08 | 0.05 | 0.77*** |
| L.rural | | | 0.45*** |
| lgdp | 8.21*** | 7.18** | 15.73*** |
| ict | 0.00 | 0.00 | -0.02* |
| ict_spend | -0.09 | -0.08 | -0.32*** |
| credit | 0.00 | -0.00 | -0.01*** |
| trade | 0.01 | 0.01 | -0.04*** |
| merch_ex | -0.01 | -0.00 | -0.10*** |
| alter | -0.12*** | -0.11*** | -0.33*** |
| len | 3.86*** | 3.83*** | 2.30*** |
| lel | -2.22 | -1.94 | -1.18* |
| tphone | -0.00 | -0.01 | -0.00 |
| cell_phone | -0.02*** | -0.02* | -0.04*** |
| internet | -0.03*** | -0.03*** | 0.02*** |
| D.lgdp | -2.87 | -2.67 | 1.60 |
| Constant | -72.72*** | -64.97*** | -152.82*** |

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Arellano-Bond estimator. With fewer lags this requirement could not be fulfilled. To overcome this problem we used 6 lags as suggested by Cameron and Trivedi (2009, p.297).

The results of the econometric estimation are presented in Table 2. According to the Sargan test (not reported here), all instruments used in the regressions are valid.

From Table 2, it follows that the second lag of per capita $CO_2$ emissions has negative coefficients in both Model 1 and Model 2 while the sixth lag is negative in all 3 models. These negative effects are partly mitigated by the third lag which is positive. The long term effect is expected to be negative globally. Furthermore, this finding may be in line with the EKC hypothesis. However, the fact that positive signs are found for **lgdp** in all of three model specifications indicates that for the nine emerging countries analyzed herein, the aforimentioned "turning point" income has not been reached yet.

On the other hand, "Political stability and no violence" and its first lag affect positively per capita $CO_2$ emissions while "regulation quality" and its first lag negatively. It is clear-cut that the institutional factors do affect the use of technology and its diffusion. Regulatory institutions could give incentive for the energy-efficient use of production technologies. Cost-push factors related to strict regulatory measures could also give rise to economy-wide externalities.

When the share of rural population increases, this is expected to raise per capita $CO_2$ emissions. This may be explained by the intensive use of coal for home heating in rural areas given that natural gas is not available. As known, natural gas is the cleanest fossil fuel, producing less per capita $CO_2$ per joule (derived unit of energy) delivered than either coal or oil. A similar argument may explain why and how the share of alternative energy in the total energy use diminishes per capita $CO_2$ emissions.

Not surprisingly, the variable **len**, log of energy use (kg of oil equivalent per capita), has a positive effect on per capita $CO_2$ emissions in all models. This implies that the energy use is not environmentally efficient. This is simply because, fossil fuels represent the biggest energy source in total energy consumption in emerging countries.

Considering other variables we obtain also interesting results. Electric consumption, **len**, has a significant and negative coefficient only in the Model 3. On the other hand, **ict, ict_spend, credit, trade, merch_ex** are all found to have significantly negative coefficients only in the Model 3. The intuition is that a higher value of any of these variables imply a higher economic activity level and thus more energy use and more $CO_2$ emissions. However, the variables used for proxy of technological development indicate that the use of **cell_phone**s diminishes per capita $CO_2$ emissions while **internet** use does not have a clear sign, although it is significant in all specifications.

From these results some policy implications may be drawn. In the next, final section of this chapter we deal with these implications and make our concluding remarks.

## 5. Conclusion

In this chapter, we have conducted an econometric analysis employing relatively a non-conventional method in energy and environmental studies. In the related literature, earlier studies investigates the relationships between energy consumption, $CO_2$ emissions and economic variables in the bivariate framework. However, In more recent studies, trivariate and quadrivariate models are used to provide a more complete view of this kind of relationships. We have proposed in this chapter a more extended multivariate framework in order to include financial, technological and structural variables in the conventional energy-environment-economy nexus. The Arellano-Bond estimator technique, proposed by Areallano and Bond (1991), is used to do this work accurately.

The chapter contributes to the literature mainly in two ways. One is to use a relatively novel approach to study the sustainability issue in developing countries and the other is to account for different technological, financial, economic and structural variables in the econometric analysis. The results derived from the econometric study give useful insights into the impact of these variables on per capita $CO_2$ emissions which, as pointed out by Soz (1997), is a direct measure of human welfare.

One of the major findings of this research is that economic growth increases per capita $CO_2$ emissions. There is a direct effect which indicates that increases in GDP raise per capita $CO_2$ emissions. There is also another effect, which may be called indirect effect, and it is related to both financial development and trade performance. In other words, developments in financial markets and increasing trade opportunities create a situation very favorable for economic growth which, in turn, increase energy demand and, *in fine*, $CO_2$ emissions. This scheme has been supported by our study findings.

It is evident that for all countries, switching to cleaner energy sources and improving energy efficiency is the best way to decrease per capita $CO_2$ emissions. For this purpose, energy saving and environment friendly technologies should be developed and adopted. Regulatory measures may just as well be used in order to diminish pollutant emissions. Only combining energy, environment and economic policies can ensure the sustainability of economic growth in emerging countries.

# References

[1] Arellano, M., Bond, S.R., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 277-297.

[2] Cameron, A.C., Trivedi, P.K., 2009. Microeconometrics Using Stata, Stata Press, College Station, TX.

[3] Dasgupta, P., Heal, G., 1974. The optimal depletion of exhaustible resources. Review of Economic Studies 40, 328.

[4] Granger, C.W.J., 1969. Investigation causal relations by econometric models and cross-spectral methods. Econometrica 37, 424-438.

[5] Granger, C.W.J., 1988. Some recent developments in a concept of causality. Journal of Econometrics 39, 199-211.

[6] Grossman, G.M., Krueger, A.B. 1993. Environmental impacts of a North American free trade agreement. In : Garber, P.M. (Ed.), The U.S.-Mexico Free Trade Agreement, MIT Press, Cambridge, MA, pp. 13-56.

[7] Jobert, T., Karanfil, F., 2007. Sectoral energy consumption by source and economic growth in Turkey. Energy Policy 35, 5447-5456.

[8] Jobert, T., Karanfil, F., Tykhonenko, A., Forthcoming. Convergence of per capita carbon dioxide emissions in the EU: Legend or reality? Energy Economics doi:10.1016/j.eneco.2010.03.005.

[9] Karanfil, F., 2009. How many times again will we examine the energy-income nexus using a limited range of traditional econometric tools? Energy Policy 37, 1191-1194.

[10] Karanfil, F., 2008. Energy consumption and economic growth revisited : Does the size of unrecorded economy matter ? Energy Policy 36, 3019- 3025.

[11] Loschel, A., 2002. Technological change in economic models of environmental policy: a survey. Ecological Economics 43,1 05126.

[12] Sadorsky, P., 2010. The impact of financial development on energy consumption in emerging economies. Energy Policy 38, 2528-2535.

[13] Ricci, F., 2007. Channels of transmission of environmental policy to economic growth: A survey of the theory. Ecological Economics 60, 688699.

[14] Solow, R.M., 1956. A contribution to the theory of economic growth. The Quarterly Journal of Economics 70(1), 6594.

[15] Soz, S., 1997. India rejects incorporation of new environmental commitments for developing countries (transcript of speech). Presented at the 3rd Session of the Conference of the Parties to the Framework Convention on Climate Change, Kyoto, Japan, December 8. http://www.indianembassy.org/policy/Environment/soz.htm

[16] Stern, D.I. 2004. The Rise and Fall of the Environmental Kuznets Curve. World Development 32, 1419-1439.

[17] Stiglitz, J.E., 1974. Growth with exhaustible natural resources: efficient and optimal growth paths. Review of Economic Studies, Symposium on the Economics of Exhaustible Resources 41, 123137

[18] UNFCCC, 1992. The UN Framework Convention on Climate Change. http://unfccc.int/resource/docs/convkp/convfr.pdf