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# Summaries

## Development, trade, and the environment: how robust is the Environmental Kuznets Curve?

MATTHEW A. COLE

A large number of studies have claimed to find evidence of an inverted-U-shaped relationship between pollution and per capita income, generally referred to as an Environmental Kuznets Curve (EKC) (see for example Shafik, 1994; Grossman and Krueger, 1995; Cole, Rayner, and Bates, 1997). This relationship is potentially of great significance since it implies that countries can 'grow out' of environmental problems.

However, several recent studies have criticized the EKC relationship and the methodology used to estimate it on a number of grounds (see for example Arrow *et al*., 1995; Ekins, 1997; Stern, 1998; Stern and Common, 2001). In the light of these criticisms, this paper assesses the strength of the Environmental Kuznets Curve. Specifically, answers are sought to the following related questions: (1) How robust is the EKC relationship? (2) To what extent can the EKC relationship be explained by changing trade patterns as opposed to growth-induced pollution abatement?

With regard to question (1), the alleged weaknesses with the EKC are assessed and the sensitivity of EKC results is examined, with particular attention paid to the choice of functional form, to the inclusion of additional covariates and to the income range of the countries in the sample. Issues of stationarity and simultaneity between income and emissions are also considered. Turning to question (2), it is argued that previous studies that have incorporated trade into the EKC have done so in an inappropriate manner by assuming a unique relationship between trade and emissions. Instead, following Antweiler, Copeland, and Taylor (2001), it is here argued that the impact of trade liberalization on the environment will differ from country to country depending on whether or not they have a comparative advantage in pollution-intensive production. In turn, it is argued that this depends on a country's relative factor endowments and/or its relative environmental regulations. EKCs are therefore estimated in a manner that allows the impact of trade liberalization on pollution to depend on these country characteristics.

The results indicate that, firstly, the inverted-U relationship between per capita income and emissions is reasonably robust. Estimated turning points for each pollutant, for instance, show little variation across the

variety of estimations that are undertaken. Secondly, the impact of trade on emissions appears to be small, particularly relative to the impact of income. There is little evidence to suggest that changing trade patterns are responsible for the shape of the EKC.

## Environmental Kuznets Curve for sulfur: evidence using GMM estimation and random coefficient panel data models

GEORGE E. HALKOS

In this paper we examine the concept of an environmental Kuznets Curve in a critical way, aiming to propose policies compatible with sustainable development. During the various economic development stages, income disparities first rise and then begin to fall. Degradation tends to be lower among most of the developed countries in comparison to higher indicators among developing countries. At the same time, these indicators are higher among developing countries compared to those of less developed countries. The EKC indicates an inverted-U-shaped relation between degradation and per capita income. For sulfur emissions and concentrations there is evidence that an inverted-U-shaped EKC exists.

The EKC estimates for any dependent variable (for example $SO_2$, $NO_x$, deforestation, etc.) peak at income levels, which are around the world's mean income per capita. In a random sampling, it is usually expected that income distribution will not be normally distributed, with many countries below mean income per capita and thus positively skewed. As the majority of countries are below their estimated peak levels for air pollutants, economic growth may not reduce air pollution or deforestation. This implies that estimating the left-hand part of EKC is easier than estimating the right-hand part. Thus, use of OLS is not likely to yield accurate estimate of the peak levels.

In this paper, we make use of a large and globally representative dataset, which consists of 73 countries over a 31 year time period. The number of countries considered is almost proportionally allocated to low-, middle- and high-income countries. As there is evidence of dynamics in the data it is implied that the validity of previous studies is questioned as being dynamically misspecified.

Thus, for this balanced panel database, we set up a dynamic model and apply for the first time random coefficients and Generalized Method of Moments (GMM) econometric methods. The GMM estimators considered

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here exploit optimally all the linear moment restrictions that follow from particular specifications and offer significant efficiency gains compared to simpler instrumental variables alternatives. However, for the random coefficients model we assume that each parameter is a random variable. Countries are heterogeneous with different stochastic regression coefficients.

Our results are completely different compared to the results derived in Stern and Common (2001) using the same database and fixed and random effects models. Our findings imply that the econometric technique adopted is really crucial in the extraction of turning points and the associated policy implications. Thus, if we allow for a dynamic adjustment in our model then we may see that we derive results quite different. The speed with which emissions adjust to the equilibrium values is approximately 38 per cent per annum implying that the adjustment of emissions is effected with almost three periods.

# Policy implications and analysis of the determinants of travel mode choice: an application of choice experiments to metropolitan Costa Rica

FRANCISCO ALPIZAR and FREDRIK CARLSSON

The dramatic increase in urban populations in most developing countries, in combination with a lack of urban planning and an inefficient transportation system, is causing serious problems of decreased air quality in urban environments.

The main objective of this study is to contribute to the design of policies dealing with the problem of congestion and air pollution in the urban context of a typical developing country. We study the determinants of the choice of transport mode, bus versus car, for work trips in the short run, where we treat the number of trips as exogenously given. This is done with a choice experiment conducted on car commuters. This short-run perspective is particularly relevant in the policy-making context of many developing countries, where uncertainty about the permanence of environmental regulations causes an inefficient adaptation to the long-run incentives of any given policy. The weak political commitment to environmental issues requires the identification of ways to reduce the potential resistance against policies to control the use of private transportation and reduce congestion.

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We explore a combination of policies aimed at increasing the cost of private transportation, specifically increased fuel and parking costs, and policies to improve public transportation, in this case, reduced travel time, subsidized fares, and improved quality of the service. The joint implementation of these policies aims at reducing congestion and pollution, especially during peak hours, by restraining demand for private transportation while providing a suitable substitute.

Since most of the characteristics of interest are not present now, we resort to a mode choice experiment analysis, where individuals reveal their preference for the attributes of the different transport modes by choosing in hypothetical situations. Based on a general type of model called Random Parameter Models, where taste variation among individuals is explicitly treated, the results indicate that mode substitution is sensitive to the characteristics and performance of each mode. In particular, travel time for both modes and travel cost for car are the most important determinants of mode choice. We estimate the willingness to pay for reduced travel time to be around 1,000 colones per hour. This result can be regarded as an indication that large benefits can be obtained from a program to reduce congestion and travel time.

We therefore conclude that a program to reduce congestion and possibly pollution during peak hours should focus on increased cost of private transportation and faster, more reliable, public transportation.

## The linkages between property rights, migration, and productivity: the case of Kajiado District, Kenya

JANE KABUBO-MARIARA

Since the seminal work on the 'tragedy of the commons' theory by Hardin (1968), focus on the role of property rights and other institutional arrangements such as norms on resource degradation has increased especially in recent years. Some authors have argued that common property resources may be more degraded than private property, while others argue that common property is not the only cause of the 'tragedy of the commons'. Given the limited literature on the impact of institutional factors such as property rights on productivity and environmental degradation in Kenya, it is important to investigate this link as well as the factors conditioning it.

The study used panel data collected from households in an arid and semi-arid district in Kenya. A detailed questionnaire and focus group discussions

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were used to collect the required data. To achieve the study objectives, migration and productivity equations were estimated. Environmental capital was predicted from the migration equation and used to explain productivity. Binary and conditional logit models, ordinary least squares, and fixed effects models were used to derive the parameter estimates.

The results indicated that the amount of land owned, household size, gender, number of cattle owned, and favourable perceptions concerning the value of environmental conservation favour the migration decision. This decision was negatively influenced by property rights regimes, transfers, non-farm incomes, age and education attainment. The results also showed that non-farm incomes, number of cattle owned, value of livestock inputs, property rights regimes, household size, education attainment and the predicted probability of migration increase productivity, while total land owned and transfer incomes reduce productivity.

The positive impact of the migration variable implies that environmental conservation increases productivity. However, the positive impact of property right regimes implies that households who own individual parcels of land have higher productivity than those who rely on common land resources. This suggests the need to speed up privatization of the remaining schemes so that the community can enjoy the benefits of private property. However, given the setting of the study, we recommend that, if privatization is not feasible, the existing common rights systems should be strengthened through promotion of collective action and limiting of group sizes. The study recommends further research into two areas: investigation into the causal relationship between migration and environmental degradation, and investigation into livestock, human, and wildlife conflicts resulting from privatization of common property resources.

# Upgrading municipal environmental services to European Union levels: a case study of household willingness to pay in Lithuania

RANDALL BLUFFSTONE and J.R. DESHAZO

Lithuania is one of ten countries in Central and Eastern Europe that is currently aligning its environmental policies with those of the European Union (EU). The costs of implementing harmonized environmental policies in Lithuania are expected to be extremely high and to fall disproportionately on local governments. One policy option for financing these service upgrades is to use increased local tariffs. Indeed, in principle

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there are strong arguments for this approach, because often the majority of environmental benefits accrue to local residents.

We evaluate the feasibility of this cost recovery strategy by estimating household willingness to pay for upgraded landfill, sewerage and two recycling programs. We then compare these estimated benefits with the expected costs. We find that the absolute levels of household willingness to pay are substantial for upgraded landfill management and sewerage service, but virtually zero for the two recycling programs considered. Relative to the costs, households are willing to pay approximately 80–90 per cent of costs for landfill improvement, but less than 10 per cent of costs for upgraded sewerage service. These results suggest that targeted subsidies will be critical if Lithuania is to fund the municipal environmental expenditures required for it to join the EU.

## Development of techno-economic integrated models: LFSGR and aerobic composting for municipal waste management

SUDHAKAR YEDLA

Landfill system with gas recovery option (LFSGR) and aerobic composting are the two potential and widely used methods of waste disposal. In the present study, attempts are made to find out the true cost of a unit ton of municipal solid waste disposal. Costs and benefits that remained unaccounted for in conventional cost–benefit analysis are also considered. Integrated models are developed to determine the cost of a unit for both methods of disposal. By using these models one can successfully determine the 'complete' cost of disposal and also explain the influence of each systemic parameter over the other in the above model. This further provides a comparison between the potential of the two methods of disposal and aid in choosing better waste management methodology for a city.

These models predict the most appropriate cost (MAC) of waste disposal. While testing them it was found that inclusion of explicit costs and benefits, which in general remained unaccounted for resulted in interesting results. The proposed landfill system is based on natural process, but engineered to some extent. Preparation and installation of gas collection equipment in the case of landfill with a gas recovery system involves significant capital investment. However, it was found that methane generation and its value proves it worth the initial investment. Landfill proved to be the best disposal option when the waste generation is more than

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2,000 tons per day. When the waste generation is less than 1,000 tons per day, aerobic composting resulted in lower disposal cost. Waste management involves few key parameters, *viz*. rent on land, operation and maintenance cost, etc. and at waste generation of 2,000 tons per day and 1,000 tons per day respectively, methods of landfill and aerobic composting are cheaper over the other for a given range of these key systemic parameters.

For any model is it essential to undertake the sensitivity analysis for the set of key systemic parameters. In such attempts, influence of change in each parameter, *viz*. rent on land, landfill installation cost, etc., on the unit cost of disposal of waste is studied. This exercise helps in identifying the best range of values for each of these key parameters where the unit cost of disposal is low. In such simulation studies, for a waste generation rate less than 1,000 tons per day, aerobic composting (AC) showed some variation in the unit cost of waste disposal against the change in rent on land. All other key parameters showed insignificant influence on the unit cost of disposal. In the case of landfill (LFSGR), along with the changes in the rent on land, change in organic content also showed significant variation on the unit cost of disposal of waste. All other key systemic parameters remained insignificant. Thus, landfill was found to be a suitable waste disposal method for bigger cities whose population is above one million and waste generation more than 1,000 tons per day. The models developed in this study successfully predicted the behaviour and economic performance of the two potential waste management methodologies.

Further, these models can be applied to any geographical location or city. These could be successfully used to identify appropriate methods of waste disposal for any town or city where a waste management system exists.