The Environmental Kuznets Curve Under a New framework:

Role of Social Capital in Water Pollution

Hassan Marzoughi

Krishna P. Paudel

Mark J. Schafer

Department of Agricultural Economics and Agribusiness
101 Agricultural Administration Building
Louisiana State University
Baton Rouge, LA 70803
E-mail: kpaudel@agcenter.lsu.edu
Phone: 1-225-578-7363
Fax: 1-225-578-2716

Selected paper prepared for presentation at the Southern Agricultural Economics Association annual meeting, February, 2005

The authors are Graduate Research Assistant and Assistant Professors in the Department of Agricultural Economics and Agribusiness, Louisiana State University, Baton Rouge, LA.

The Environmental Kuznets Curve Under a New framework:

Role of Social Capital in Water Pollution

Abstract

We advance a case for an inclusion of social capital in the environmental Kuznets curve analysis using highly disaggregated data on water pollution in Louisiana. A social capital index and other variables are used in parametric and spatial panel regression models to explain water pollution dynamics.

Keywords: social capital, principal component analysis, environmental Kuznets curve, spatial regression

The Environmental Kuznets Curve Under a New framework: Role of Social Capital in Water pollution

The Environmental Kuznets Curve (EKC) suggests an inverted-U shaped relationship between economic growth and pollution. The shape of this curve implies that pollution initially rises with economic growth and then falls as country or region reaches an advanced stage of industrialization. In the early stage especially before the turning point, people focus attention on economic development, jobs, and income, while tolerating increased pollution levels. After the country reaches a certain level of welfare and economic growth (commonly referred to as a threshold point), people pay more attention to the pollution, and initiate programs to clean up air and water resources.

Empirical evidence on EKC is mixed. A few studies have supported inverted-U shape curve for the EKC (Paudel *et al.;* McConnell; Selden and Song; John and Pecchenino). On the other hand Grossman and Krueger found water quality declined monotonically with income. Stern's review of the empirical EKC literature with respect to air and water quality concluded the inverted-U curve relationship applies only to certain types of pollution. This inconsistency in the shape of the EKC has been a motivation to continue studying the income pollution relationship.

Most research in the EKC involves regression models with air and/or water quality measures as a dependent variable and per capita income, population density, and other economic and demographic variables as the independent variables. Per capita income alone may not be the optimum determinant of pollution levels in the EKC framework. Some researchers have incorporated other variables along with per capita income to investigate economic–environmental analysis (Bhattarai and Hammig; Dasgupta *et al*). For example, Dasgupta *et al.* used measures of governance, geographic vulnerability, and the pollution-intensity of industrial activity along with per capita income to estimate EKC. The results suggest the importance of governance and geographic vulnerability in EKC analysis.

We incorporate "social capital" into a traditional framework EKC to explore whether social capital enhances our understanding of the pollution-income relationship. We demonstrate the case using highly disaggregated water pollution data available from Louisiana watersheds.

Social Capital

In the past two decades "social capital" has become an influential concept within sociology and the social sciences. From sociologists point of view, cultural, economic, functional, linguistic, personal, political, symbolic, and social capital are different kind of existence capital. Although social capital has been noted in economics text decades ago, there have been a lot of arguments about its nature and existence for many decades (Falk and Kilpatrick).

Putnam defines "social capital" as: "features of social life – networks, norms, and trust – that enable participants to act together more effectively to pursue shared objectives." There is a direct relation between trust and connection among people so that increase in connection among people increase the trust among them and vice versa. This states that we can expect a positive strong correlation between civic engagements and trust (Putnam). Fukuyama in his book defines the social capital as “a capability that arises from the prevalence of trust in a society or in a certain part of it.” He also says that “trust is the expectation that arises with in a community of regular, honest, and cooperative behavior, based on commonly shared norms, on the part of other members of that community”.

Different studies including Diego Gambetta , James Coleman, Robert Putnam, and Francis Fukuyama have shown that performance of a society’s institutions is linked to the level of trust and social capital. These studies argue that trust or social capital create cooperation between people to produce more efficiently and to prevent inefficient matter (like crime) in society (La Porta *et al.*). Woolcock defines social capital as “a broad term encompassing the norms and networks facilitating collective action for mutual benefit. Ceteris paribus, one would expect communities blessed with high stocks of social capital to be faster, cleaner, wealthier, more literate, better governed, and generally happier than those with low stocks, because their members are able to find and keep good jobs, initiate projects serving public interests, costlessly monitor one another’s behavior, enforce contractual agreements, use existing resources more efficiently, resolve disputes more amicably, and respond to citizens’ concerns more promptly.”

According to Bremh *et al*. “social capital is an aggregate concept that has its basis in individual behavior, attitudes, and predisposition. Recently, scholars in sociology, economics, and political science have converged on the concept of social capital as a comprehensive explanation for why some communities are able to resolve collective problems cooperatively while others are unable to bring people together for common purposes. Scholarly interest in the development of social capital is motivated primarily by the linkage between levels of social capital and collective outcomes; high levels of social capital appear to be crucial for such measures of collective well-being as economic development, effective political institutions, low crime rates, and lower incidences of other social problems." Putnam argues that provided public services by government in central and northern of Italy has been more effective in regions that have had more civic minded (Knack *et al*).

As we see social capital influences almost all aspects of society from individual behavior to government performance. A society with a good stock of social capital has less selfish behavior and more cooperative individual, more efficient institutions, and better performance government.

Social Capital and Economic Performance

Economic, sociology, and regional science literature review show that 'non-economic" factors influence economic growth. Sometimes higher level of social capital and stronger civic organization can create more capacity for local economic development than markets and political institutions.

Coffey and Polese argue that socio-cultural and behavioral attributes of the local population along with other variables have an important role in economic development. From Putnam's point of view, social capital is a set of "horizontal associations" among people or "networks of civic engagement". In his study of Italian region, he demonstrated that northern Italy in compare to southern Italy is relatively more successful because horizontal associations are more frequent in northern Italy. Rupasingha *et al*. estimated the effect of social capital on economic growth for U.S. counties and found that social capital has a significant positive effect on the rate of per capita income growth. They state "social and institutional variables explain some of the differences in convergence rates among counties. In particular, (i) ethnic diversity is associated with faster rates of economic growth; (ii) higher levels of income inequality are associated with lower rates; and (iii) higher level of social capital has a positive effect on economic growth rates". Narayan and Prichett study for Tanzania show that there is a positive relation between income and membership levels in various associations. Kenak and Keefer showed that nations with higher and more equal incomes have stronger trust and civic norms. Helliwell and Putnam showed in regions that have a higher level social capital, per capita GDP convergence is faster and equilibrium levels of income are higher (Rupasingha *et al.*). Knack and Keefer found that social capital variables have a strong and significant relationship to growth so that a 10% point rise in trust is associated with an increase in growth of 0.8% point (Knak and Keefer).

Prediction of long-run rates of economic growth is always not easy. So it is not surprising why the prediction of East Asian miracle or sub-Saharan Africa in 1960's was not correct. World Bank teams and researchers thought that Burma, Sri Lanka, and The Philippines would have stronger growth rates and more development progress than South Korea. In contrary with the prediction of World Bank, seven African countries that suppose to have a high economic growth rates, had negative per capita Growth rates between 1970 - 1988. Temple and Johnson's predictions were wrong because "researchers sought the origins of long-run growth in the wrong places. In particular, they neglected the role of "social capability" in economic development." In their paper they show that researchers could have better predictions for growth rates if they used the index of socioeconomic that was created by Irma Adelman and Cynthia Taft Morris in the early 1960s. This paper demonstrates a strong correlation (0.60) between social development and growth rate for more than 45 countries between 1960 and 1985. Regression analysis also approves this result (Temple *et al*.). The result of this paper shows that economists that want to forecast economic growth should consider non-economic factors in addition to economic variables. According to Libby and Sharp “social capital is not just an input into human development, but a “shift factor” affecting other inputs, since it tends to enhance the benefits of investment in human and physical capital. For example, investments in training can be multiplied by the input of social capital as the strengthening of social ties enables people to better learn from others” (Warschauer).

Stating Rupasingha *et al.* “a major economic effect of social capital is that it reduces information and transaction costs. When transaction costs and the costs of gathering and disseminating information are reduced, less risk is involved and more exchange takes place, thus enlarging the scope of transactions and interactions. Conversely, a lack of social capital results demand for more external controls such as tougher law enforcement, security systems, monitoring and enforcement. Another contribution of social capital is that it affects the supply of certain public goods. The provision of public goods is subject to free riding or shirking if most users do not participate in joint actions to make the provision of public good a success. In these situations conventional theories of collective action have concluded that individuals will resort to strategic behavior by refusing to contribute toward the public good in order to obtain a benefit far greater than the cost they have to pay. When social capital is present, externalities are internalized, which has the effect of eliminating or reducing the free rider problem and the misuse of public goods while at the same time increasing investments in public goods." The result of these studies suggest that social capital has an significant influence on economic growth so it can has impact on environmental quality such as water quality too.

Measuring of social capital

One way of measuring social capital is measuring activities and strengths of civic organization by the number of organization per capita. Following Rupasingha *et al.* in this paper we use a secondary data set for 53 Louisiana parishes by using the Country Business Patterns (CBP) compiled by the Census Bureau, which includes an extensive and comprehensive set of variables representing membership organizations. Associations such as sports clubs, labor unions and religious organizations are direct means of community interaction and their frequency is considered a measure of social capital (Ruspasingha *et al*.). Our main measure is the density per 10,000 persons from 1988 to 1997 for following establishment in each county:

1- Total amusing and recreation services

a- Dance studios, schools, and halls

b- Bowling centers

c- Music, amusement, recreation services.

d- Public golf courses

e- Membership sports and recreation clubs

2- Total membership organizations

a- Business associations

b- Professional organization

c- Labor organization

d- Civic and social organization

e- Political organization

f- Religious organization

Methods

Social capital indexing

To create a composite social capital index and relate it to individual pollutants in the EKC framework, we choose the essential variables and determine the relative weights to consolidate them into a single index. We follow Jha and Murthy's procedure to develop social capital index and methodology used to develop this index. Principal component analysis (PCA) is an appropriate methodology because it maximizes the variance rather than minimizes the least square distance. PCA is capable of providing the original set of variables into a smaller set of uncorrelated variables containing most of the information. The transformation of original variable to new index is presented as

$$y_1 = a_{11}x_1 + a_{12}x_2 + ... + a_{1p}x_p = \sum_{i=1}^{p} a_{1i}x_i \qquad (1)$$

PCA determines the optimal vector of weights (a_{11}, a_{12}, ….. , a_{1p}) and the associated variance of y_1 which is denoted by .

Based on the Cattell's scree plot, we chose the variables that have the highest loading on a component. Following this procedure, we define the social capital for the ith parish as $SC_i = \sum w_j x_{ji}$, where w_j is the jth component score and x_{ji} is the value of the jth variable for the ith country given j equal to variable used in the regression. Social capital index is calculated by dividing each SC value thus calculated with the highest SC value. Therefore SCINDEX ranges from 0 to 1.

Panel data regression

Data that have both time series and cross sections, usually referred to as panel data, are common in economics. Many recent studies of the Kuznets curve have used panel data because it provides a rich source of information about the economy and allows researchers great flexibility in modeling differences in behavior across individuals. In our study, we used panel data covering three different water pollutants in 53 Louisiana parishes over a 14-year period.

Kuznets curve models have been estimated either in quadratic or in cubic specifications between pollutant concentration and per capita income. We adopt both of these specifications in our analysis. The general form of the panel data model used to describe the relationship between pollution and income in this study is given in equation (2).

$$p_{it} = a + \sum_{k=1}^{m} b_k SC_{it}^{k} + b_{m+1} D_{it} + u_{it} \qquad (2)$$

Here, p is a water pollutant (nitrogen, phosphorus or dissolved oxygen), SC is per capita income, i and t represent indices of parish and time, respectively. Population density (persons per square mile) is accounted by D. We estimated the model with quadratic and cubic specifications so m=2 when income pollution relationship is specified as quadratic and m=3 if income pollution relationship is specified as cubic. Population density is used in the model as a proxy for human behavior on water pollution. The hypothesis underlying this variable is that the more populated parishes are likely to be more concerned about reducing water pollution. Hence, population density is expected to have a negative sign[1].

The error components, u_{it} , can take different structures. The specification of error components can depend solely on the cross section to which the observation belongs or on both the cross section and time series. If the specification depends on the cross section, then we have $u_{it} = v_i + e_{it}$; and if the specification is assumed to be dependent on both cross section and time series, then the error components follow $u_{it} = v_i + e_t + e_{it}$. The term v_i is intended to capture the heterogeneity across individual parishes and the term e_t is to represent the heterogeneity over time. Furthermore, v_i and e_t can either be random or nonrandom, and e_{it} is the classical error term with zero mean and homoscedastic covariance matrix. The nature of the error structures leads to different estimation procedures depending on the specification. For this study, we estimated the models using one-way and two-way fixed and random effects models with F-tests and Hausman tests used to evaluate the appropriateness of the model specifications.

Spatial panels

Cross sectional correlation can be an important factor in panel data model of parish level pollution differences. Pollution and social capital relationship can be modeled using the spatial correlation as well as the heterogeneity across parish using a spatial error component regression model. The model is (Baltagi 2001):

---

[1] Relationship between population density and water pollution may be positive or negative depending on where the data come from. The hypothesis is open to an empirical testing.

$$y_{ti} = X_{ti}^{'} b + u_{ti} \qquad\qquad i = 1,....N; t = 1,..........,T$$
$$u_t = m + e_t \qquad\qquad (3)$$
$$e_t = l We_t + v_t$$

Here u_{ti} is the regression disturbance. In a vector form, the disturbance vector of (3) is assumed to have random parish effects as well as spatially autocorrelated remainder disturbances. denotes the vector of random parish effects which are assumed to be IIN. is the scalar spatial autoregressive coefficient with | |<1. W is a known N X N spatial weight matrix whose diagonal elements are zero.

Data

The dataset used is the same as the one used by Paudel *et al.* except for the social capital. The disaggregated nature of the water pollution data used in our study is a first attempt to study whether previous aggregated findings with the EKC hold for Louisiana. We used data on nitrogen, phosphorus, and dissolved oxygen concentration in water from each watershed collected by the Louisiana Department of Environmental Quality. The pooled data consisted of observations from 1985 to 1999 for 53 parishes in Louisiana.

We focused on three kinds of ambient quality data for conventional pollutants: dissolved oxygen (DO), phosphorus (P), and nitrogen (N). DO is a direct indicator of water quality. Contamination of watersheds by human sewage or industrial discharges increases the demand for dissolved oxygen, resulting in less oxygen for fish and other forms of aquatic life. At a considerably high level of contamination, one would expect that fish populations start to decline because of pollution. A similar problem may arise when water is enriched with nutrients such as nitrogen and phosphorus through runoff and leachates from intensively fertilized agricultural areas (Grossman and Krueger, 1995). This has been commonly observed in Louisiana, where prolonged uses of agricultural fertilizers and broiler litters have caused P and N buildup in waterbodies.

Population density is measured in people per square mile and is calculated by dividing the population in a parish by its corresponding area. Social capital variable is calculated using the approach described in the method section. It is used in stead of traditional income variable commonly used in the EKC analysis.

Summary statistics of the sample data are presented in Table 1. Water pollutants (N, P, and DO) are measured in milligrams per liter of water, per capita income is in U.S. dollars, and population density is measured in people per square mile. As shown in Table 1a, the range of N, P, and DO is quite dispersed. Social capital was highest for East Baton Rouge parish in 1996 and lowest for St. Helena parish 1989-90, with the average value across the parish for all 13 years being 0.13. Population density ranged from a minimum of 5 people per square mile (Cameron Parish) to a maximum of 2572 people per square mile (Orleans Parish).

Results and Discussions

The regression results for the fixed effects models are presented in Tables 2 and 3. As shown in Table 2, the signs of the estimated coefficients for one-way fixed effects quadratic and cubic specification were contrary to general belief for social capital, although statistical significance was found only in the N (quadratic and cubic) and phosphorus (quadratic) pollutant equation. The estimated turning points were 0.11(quadratic) for N and 0 (quadratic) and 0.19 (cubic) for P pollutants. In contrast, results from the dissolved oxygen indicated a relatively higher turning point, 3.79

(quadratic). The F-statistics for testing the joint significance of the individual effects are given under the F-value column of Table 2. The results strongly suggest the presence of an individual heterogeneity in the data. The values associated with upper turning points in the cubic function are slightly higher for P and slightly lower for the N and DO pollutants.

Table 3 shows the two-way fixed effects model. Notice that in some cases, the parameter estimates produced by the two-way model are higher compared to the one-way model; in other cases, however, these numbers are smaller. We also found that almost all the coefficients of all SC variables are significant in the N equation. The F-statistics indicated the presence of both individual and time specific effects. The turning points produced by the two-way method are higher than those produced by one-way model, especially for N. The EKC curves associated with the cubic functional form of all these pollutants for both one way and two way fixed effect models are shown in Figure 3.

The regression results for the random effects model are given in Tables 4 and 5. The Hausman statistics reported in Tables 4 and 5 are lower than the critical values from a chi-squared table, except for N of the one-way random effects model and for N and DO in two-way random effect models. Thus, the hypothesis that the individual effects are uncorrelated with the other regressors in the model cannot be rejected.

As shown for the nitrogen equation in Table 4, the coefficients for social capital in both quadratic and cubic forms are statistically significant at the 1% level for N. These empirical results provide evidence of an U-curve relationship between social capital and nitrogen level. Using the quadratic specification, we obtained a turning point of 0.03. Although the coefficients on population density associated with all pollutants possessed the expected sign, they are not significant. This result is consistent with the study by Selden and Song (1994). Generally speaking the values of upper turning points obtained from the cubic function are slightly higher than the turning points identified by the quadratic functional form for N. The significance of the cubic social capital variable indicates that we cannot reject the cubic functional form in the nitrogen-social capital relationship in all fixed and random effect models.

In the one way random effects formulation for the phosphorus equation, we found a similar pattern as observed for the nitrogen-social capital relationship. The coefficients were not, however, statistically significant. The estimated turning point generated by the P equation is lower than the N equation. Estimated coefficients for the DO equation have the expected sign for social capital variable only in the quadratic equation

The results from two-way random effect models for nitrogen, phosphorus and DO are very similar to the one-way random effects models. In both models, coefficients associated with phosphorus and DO equations were found to be insignificant.

The turning points for all three pollutants in two functional forms and four different models indicated that for all pollutants except dissolve oxygen in one way fixed effect model, it is around 0.5. This value indicates that all of the parishes are now reducing pollution because of societal concern about water pollution.

Lack of significance of estimated parameters questions the validity of cubic or quadratic functional forms in the parametric approach, especially in the case of phosphorus and DO pollutants. It also indicates a need to estimate the social capital-pollution relationship using a more flexible approach. Therefore, our strategy is to further the analysis using a spatial panel fixed effect approach.

The results estimated based on the spatial one way fixed effect are shown in Table 6. The parameter coefficients did not change as we move from one way fixed effect panel data model to the one way fixed spatial effect model. The results show significant decline in R^2 in the spatial model. A spatial effect was present in quadratic specification of phosphorus and quadratic and cubic specification of dissolved oxygen.

Conclusions

We estimated panel (regular and spatial) data models to determine whether the quantifiable amount of social capital as used through social capital index can explain the pollution differences across parishes. We used highly disaggregated water pollution data collected at the watershed level. Results show significant role of social capital in explaining nitrogen pollution but not phosphorus and dissolved oxygen. We did not find an inverted U-shaped curve between pollutants and social capital. Rather, most of the effects were U-shaped indicating higher nitrogen pollution is associated with both low and high levels of social capital. The turning points for all pollutants were around 0.5 value of the social capital index. This indicates that the "middle amount" of social capital is good for the environment. Spatial effects were found in phosphorus and dissolved oxygen but parameter insignificance in these pollutants raises questions about the validity of the models. Results indicated the need to further analyzed the data using a nonparametric regression approach.

References

Andreoni, James and Levinson, Arik. "The Simple Analytics of the Environmental Kuznets Curve". National Bureau of Economic Research, Working Paper 6739 (Sep., 1998).

Belliveau, Maura A.; O'Reilly, Charles A.; and Wade, James B. "Social Capital at the Top: Effects of Social Similarity and Status on CEO Compensation". The Academy of Management Journal, Vol. 39, No. 6 (Dec., 1996).

Bhattarai, Madhusudan and Hammig, Michael. "Governance, Economic Policy, and the Environmental Kuznets Curve for Natural Tropical Forests". *Environment and Development Economics* 9 (2004): 367-382

Boix, Carles and Posner, Daniel N. "Social Capital: Explaining Its Origins and Effects on Government Performance". British Journal of Political Science, Vol. 28, No. 4 (Oct., 1998).

Brehm, John and Rahn, Wendy. "Individual-Level Evidence for the Causes and Consequences of Social Capital". American Journal of Social Science. Vol. 41, No. 3 (Jul., 1997).

Burt, Ronald S. "The Contingent of Social Capital". Administrative Science Quarterly, Vol. 42, No. 2 (Jun., 1997).

Carrol, Michael C. and Stanfield, James R.. "Social Capital, Karl Polanyi, and American Social and Institutional Economics". Journal of Economic Issues, Vol. xxxvii, No.2 (June 2003).

Castle, Emery N. "The Social Capital Paradigm: Bridging Across Disciplines – An Overview". American Journal Of Agricultural Economics, 85 (2003).

Cordes, Sam; Allen, John; Bishop, Richard C.; Lenne, Gary D.; Robison, Lindon J.; Ryan, Vernon D.; and Shaffer Ron. "Social Capital, Attachment Value, and Rural Development: A Conceptual Framework and Application of Contingent Valuation". American Journal of Agricultural Economics, 85 (2003).

Cropper, Maureen and Griffiths, Charles. "The Intraction of Population Growth and Environmental Quality". The American Aconomic Review, Vol. 84, No. 2 (May., 1994).

Dasgupta, Susmita; Hamilton, Kirk; Pandey, Kiran; and Wheeler, David. "Air Pollution During Growth: Accounting for Governance and vulnerability". World Bank Policy Research working paper 3383 (Aug., 2004).

Dolfsma, Wilfred and Dannreuther, Charlie. "Subjects and Boundaries: Contesting Social Capital- Based Policies". Journal of Economic Issues, Vol. xxxvii, No.2 (June., 2003).

Frank, Kenneth A. and Yasumoto, Jeffrey Y. “Linking Action to Social Structure Within a System: Social Capital Within and Between Subgroops”. The American Journal Of sociology, Vol. 104, No. 3 (Nov., 1998).

Grimsley, Michael: Meehan, Anthony; Green, Green; and Stafford, Bernard. “Social Capital, Community Trust, and E-government Services”.

Grossman, Gene M. and Krueger, Alan B. “Economic Growth and the Environment”. The Quarterly Journal of Economics, Vol. 110, No.2 (May., 1995).

Grootaert, Christian; Narayan, Deepa; Jones, Veronica; and Woolcock, Michael. “Measuring Social Capital. An Integrated Questionnaire”. World Bank working paper no. 18 (Nov., 2003).

Harbaugh, William T.; Levinson, Arik; and Wilson, David M. “Reexamining the Empirical Evidence for an Environmental Kuznets Curve”. The Review of Economics and Statistics, 84 (3) (Aug., 2002).

Jha, R. and K.V.B. Murthy, "An inverse global environmental Kuznets curve" Journal of Comparative Economics. 31, No. 2 (2003): 352-368.

John A. and Pecchenino R. “An Overlapping Generations Model of Growth and the Environmental”. The Economic Journal, Vol. 104, No. 427 (Nov., 1994).

Keefer, Philip and Knack, Stephen. “Does Social Capital Have an Economic Payoff? A Cross-Country Investigation”. The Quarterly Journal of Economics, Vol. 112, No. 4 (Nov., 1997).

Kolankiewiez, George. “Social Capital and Social Change”. The British Journal of Sociology, Vol. 47, No. 3, (Sep., 1996).

Lin, Nan. “ Inequality in Social Capital”. Contemporary Sociology, Vol. 29, No. 6 (Nov., 2000).

Nielsen, Francois and Alderson, Arthur S. “Income Inequality, Development, and Dualism: Results from an Unbalanced Cross-National Panel”. American Sociological Review, Vol. 60, No. 5 (Oct., 1995).

Nielsen, Francois and Alderson, Arthur S. “The Kuznets Curve and the Great U-Turn: Income inequality in U.S. Counties, 1970 to 1990”. American Sociological Review, Vol. 62, No. 1 (Feb., 1997).

Nielsen, Francois and Alderson, Arthur S. “Income Inequality, Development, and Dependence: A Reconsideration”. American Sociological Review, Vol. 64, No. 4 (Aug., 1999).

Paudel, Krishna P., Hector Zapata, and Dwi Susanto. "An empirical test of environmental Kuznets curve for water pollution." Forthcoming *Environmental and Resource Economics*

Paxton, Pamela. "Is Social Capital Declining in the United States? A Multiple Indicator Assessment". The American Journal Of sociology, Vol. 105, No. 1 (Jul., 1999).
26- Pennings, Johannes M.; Lee, Kyungmook; and Witteloostuijn, Arjen V. "Human Capital, Social Capital, and Firm Dissolution". The Academy of Management Journal, Vol. 41, No. 4 (Aug., 1998).

Porta, Rafael La; Lopez-de-Silanes, Florencio; Sheleifer, Andrei; and Vishny, Robert W. "Trust in Larg Organizations".

Portes, Alejandro. "Social Capital: Its Origins and Applications in Modern Sociology". Annual Review of Sociology, Vol. 24 (1998).

Putnam, Robert D. "Tuning In, Tuning Out: The Strange Disappearance of Social Capital in America". Political science and Politics, Vol. 28, No. 4 (Dec., 1995).

Robinson, Lindon J.; Schmid, Allan A.; and Siles, Marcelo E.. "Is Social Capital Really Capital?". Review of Social Economy, Vol. ix, No. 1 (Mar., 2002).

Robison, Lindon J. and Flora, Jan L. "The Social Capital Paradigm: Bridging Across Disciplines". American Journal Of Agricultural Economics, 85 (2003).

Rupasingha, Anil; Goetz, Stephan J.; and Freshwater, David. "Social and Institutional Factors as Determinants of Economic Growth: Evidence from the United States Counties". Regional Science, (Aug., 2000).

Rupasingha, Anil; Goetz, Stephan J; and Freshwater, David. "Social Capital and Economic Growth: A County-Level Analysis". Journal of Agricultural and Applied Economics, 32.3 (Dec., 2003).

Schmid, Allan A. "Using Motive to Distinguish Social Capital from its Outputs". Journal of Economic Issues, Vol. xxxv1, No. 3 (Sep., 2002).

Schneider, Mark; Teske, Paul; Marschall, Melissa; and Roach, Christine. "Institutional Arrangements and the Creation of Social Capital: The Effects of Public Schools Cho ice". The American Political Science Review, Vol. 91, No. 1. (Mar., 1997).

Sharp, Jeff S. and Libby, Lawrence W.. "Land-Use Compatibility, Change, and Policy at the Rural-Urban Fringe: Insights from Social Capital". American Journal of Agricultural Economics, 85 (2003).

Staveren, Irene V. "Beyond Social Capital in Poverty Research" Journal of Economic Issues, Vol. xxxvii, No. 2 (Jun., 2003).

Teachman, Jay D.; Paasch, Kathleen; And Carver, Karen. “Social Capital and Dropping Out of School Early”. Journal of Marriage and the Family, Vol. 58, No. 3 (Aug., 1996).

Teachman, Jay D.; Paasch, Kathleen; And Carver, Karen. “Social Capital and the Generation of Human Capital”. Social Forces, Vol. 75, No. 4 (Jun., 1997).

Temple, Jonathan and Johnson, Paul A. “Social Capability and Economic Growth”. The Quarterly Journal of Economics, Vol. 113, No. 3 (Aug., 1998).

Tsai, Wenpin and Ghoshal, Sumantra. “Social Cpital and Value Creation: The role of Intrafirm Networks” The Academy of Management Journal, Vol. 41, No. 4 (Aug., 1998).

Warschauer, Mark. “Social Capital and access”. Dept. of Education and Dept. of Information & Computer Science, University of California, (2003).

Woolcock, Michael. “Social Capital and Economic Development: Toward a Theoretical Synthesis and Policy Framework”. Theory and Society, Vol. 27, No.2 (Apr., 1998).

Zanden, J. L. Van. “Tracing the Beginning of The Kuznets Curve: Western Euorope During the Early Modern Period”. The Economic History Review, New Series, Vol. 48, No. 4 (Nov., 1995).

Table 1. Characteristics of Sample Data

	Mean	Standard Deviation	Minimum	Maximum
Nitrogen (mg/l)	0.3092790	0.2922508	0.0291670	1.8592000
Phosphorus (mg/l)	0.1941010	0.1195424	0.0316670	0.8141700
Dissolved Oxygen (DO) (mg/l)	6.6561608	1.3555932	2.5400000	9.7342000
Social Capital Index	0.13	0.20	0.004	1
Population Density (persons/squares miles)	160	370	5	2428.00
Number of observations	530			

Table 2. Estimated parameters values associated with three pollutants obtained from the one way fixed effects model.

	Specification	SCI	SCI square	SCI Cube	Population Density	F-Value	R^2
Nitrogen	Quadratic	-0.615	2.774*	N/A	.00063	16.75**	.685
		(0.74)	(4.20)		(.84)		
	Cubic	3.460*	-8.428*	7.050*	0.0008	14.74**	0.694
		(2.55)	(2.77)	(3.76)	(1.09)		
Phosphorus	Quadratic	-0.615*	0.496*	N/A	0.00009	25.87**	0.74
		(1.99)	(2.03)		(0.32)		
	Cubic	-0.257	-0.488	0.619	0.0001	25.76**	0.743
		(0.50)	(0.43)	(0.88)	(0.38)		
Dissolved	Quadratic	0.878	0.116	N/A	-0.0026	26.27**	0.769
		(0.27)	(0.04)		(0.86)		
Oxygen	Cubic	1.544	-1.716	1.153	-0.0026	26.22**	0.769
		(0.28)	(0.14)	(0.15)	(0.84)		

[1] Values inside the parentheses indicate t-statistics. * represents value is significant at 5%.

Table 3. Estimated parameters values and turning points associated with three pollutants obtained from the two way fixed effect model.

	Specification	Social Capital	S.Capital Square	S.Capital Cube	Population Density	F-Value	R^2
Nitrogen	Quadratic	-2.765	3.895	N/A	0.001	14.95**	0.699
		(-2.62)	(5.28)		(1.40)		
	Cubic	1.282	-5.694	5.813	0.001	12.97**	0.704
		(0.74)	(1.70)	(2.94)	(1.50)		
Phosphorus	Quadratic	-0.587	0.500	N/A	0.0001	23.38**	0.757
		(-1.51)	(1.85)		(.36)		
	Cubic	-0.069	-0.728	0.745	0.0001	23.29**	0.757
		(0.11)	(0.59)	(1.02)	(0.39)		
Dissolved	Quadratic	8.43	-3.79	N/A	-0.004	24.57**	0.788
		(2.05)	(1.32)		(1.44)		
Oxygen	Cubic	14.263	-17.607	8.373	-0.004	24.60**	0.788
		(2.10)	(1.34)	(1.08)	(1.40)		

[1] Values inside the parentheses indicate t-value. * represents value is significant at 5%.

Table 4. Estimated parameters values and turning points associated with three pollutants obtained from the one way random effect model.

	Specification	Social Capital	Social Capital Square	Social Capital -Cube	Population Density	F-Value	R^2
Nitrogen	Quadratic	-1.360** (-3.52)	2.530** (5.97)		-0.002* (-2.86)	15.29**	0.0980
	Cubic	2.230** (2.95)	-7.940** (-4.03)	7.090** (5.40)	-0.0002* (2.26)	7.75	0.1449
Phosphorus	Quadratic	-0.236 (-1.46)	0.234 (1.38)		-0.00002 (-0.53)	2.33	0.0053
	Cubic	0.110 (0.33)	-0.750 (-0.90)	0.652 (1.20)	-0.00002 (-0.35)	1.78	0.0081
Dissolved	Quadratic	-2.355 (1.35)	3.300 (1.81)		0.0004 (0.88)	4.20	0.0097
Oxygen	Cubic	-4.273 (-1.19)	8.767 (0.97)	-3.629 (-0.62)	0.0004 (0.78)	3.86	0.0103

[1] Values inside the parentheses indicate t-stat for the parameters and. * represents value is significant at 5%, ** indicates value significant at 1%.

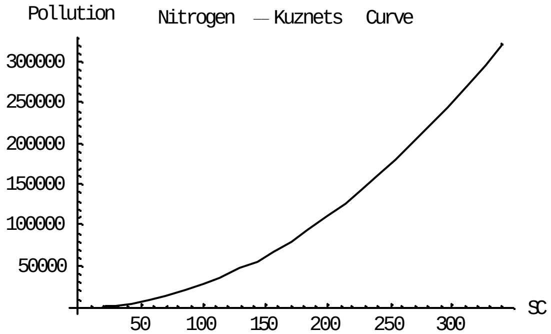
Table 5. Estimated parameters values and turning points associated with three pollutants obtained from the two way random effect model.

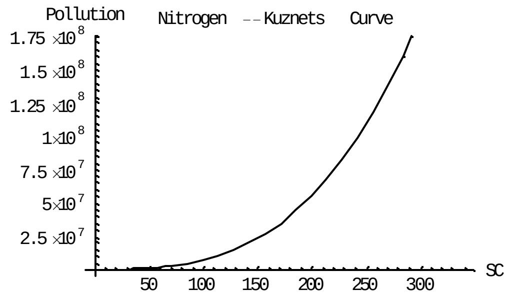
	Specification	Social Capital	Social Capital Square	Social Capital Cube	Population Density	F-Value	R^2
Nitrogen	Quadratic	-1.500** (-3.88)	2.590** (6.17)		-0.0003* (-2.65)	9.88**	0.09
	Cubic	2.020* (2.65)	-7.470** (-3.78)	6.790** (5.16)	-0.0002* (2.65)	4.90	0.14
Phosphorus	Quadratic	-0.226 (-1.39)	0.240 (1.43)		-0.00003 (-0.61)	1.78	0.01
	Cubic	0.188 (0.56)	-0.920 (-1.09)	0.765 (1.40)	-0.00002 (-0.42)	0.83	0.01
Dissolved Oxygen	Quadratic	-1.740 (-0.32)	3.000 (0.09)		0.0003 (0.50)	9.52*	0.01
	Cubic	-2.751 (-0.75)	5.868 (0.64)	-1.901 (-0.32)	0.0003 (0.62)	10.55*	0.01

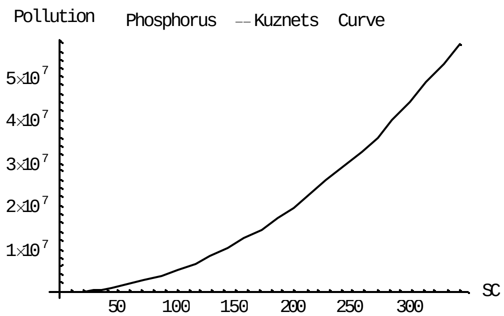
[1] Values inside the parentheses indicate t-stat for the parameters and. * represents value is significant at 5%, ** indicates value significant at 1%.

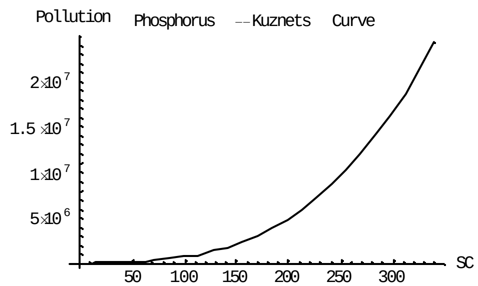
Table 6. One way fixed effect spatial model of pollution and social capital relationship

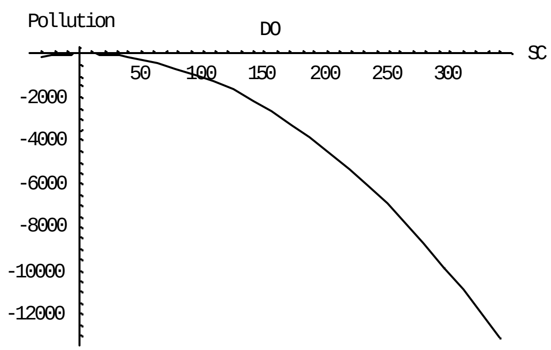
Pollutant	**Specification**	**Social Capital**	**Social Capital Square**	**Social Capital Cube**	**Population Density**	**Lambda**	**R^2**
Nitrogen	Quadratic	-1.784487 (0.424447)	22.30413** (0.000009)		0.000648 (0.367039)	0.006999 (0.899034)	0.0879
	Cubic	9.782264** (0.007504)	-68.33292** (0.003063)	161.9547** (0.000054)	0.000917 (0.196888)	0.033959 (0.535551)	0.0970
Phosphorus	Quadratic	-1.809160* (0.033715)	4.530204* (0.015245)		0.000073 (0.780746)	0.137995* (0.009302)	-0.012
	Cubic	-1.027316 (0.460015)	-1.441358 (0.866937)	10.597998 (0.477878)	0.000094 (0.723270)	0.134986* (0.011048)	-0.032
Dissolved Oxygen	Quadratic	2.599933 (0.774325)	6.670249 (0.726015)		-0.002201 (0.394792)	0.400965** (0.000000)	0.1157
	Cubic	17.996077 (0.215611)	-105.910369 (0.214574)	199.273404 (0.175831)	-0.001588 (0.543857)	0.407994** (0.000000)	0.1020


Pollution
Nitrogen — Kuznets Curve
300000
250000
200000
150000
100000
50000
50 100 150 200 250 300
SC


Pollution
Nitrogen -- Kuznets Curve
1.75 ×10^8
1.5 ×10^8
1.25 ×10^8
1×10^8
7.5 ×10^7
5×10^7
2.5 ×10^7
50 100 150 200 250 300
SC


Pollution
Phosphorus -- Kuznets Curve
5×10^7
4×10^7
3×10^7
2×10^7
1×10^7
50 100 150 200 250 300
SC


Pollution
Phosphorus -- Kuznets Curve
2×10^7
1.5 ×10^7
1×10^7
5×10^6
50 100 150 200 250 300
SC


Pollution
DO
50 100 150 200 250 300
SC
-2000
-4000
-6000
-8000
-10000
-12000

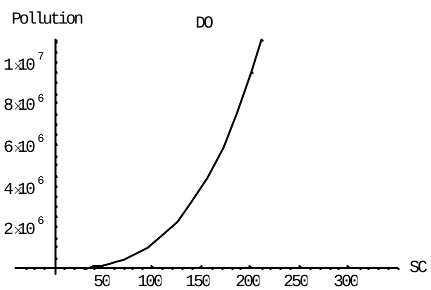

Pollution
DO
1×10^7
8×10^6
6×10^6
4×10^6
2×10^6
50 100 150 200 250 300
SC

Fig1: EKC for three pollutants as offered from One way Fixed Effect Panel Model

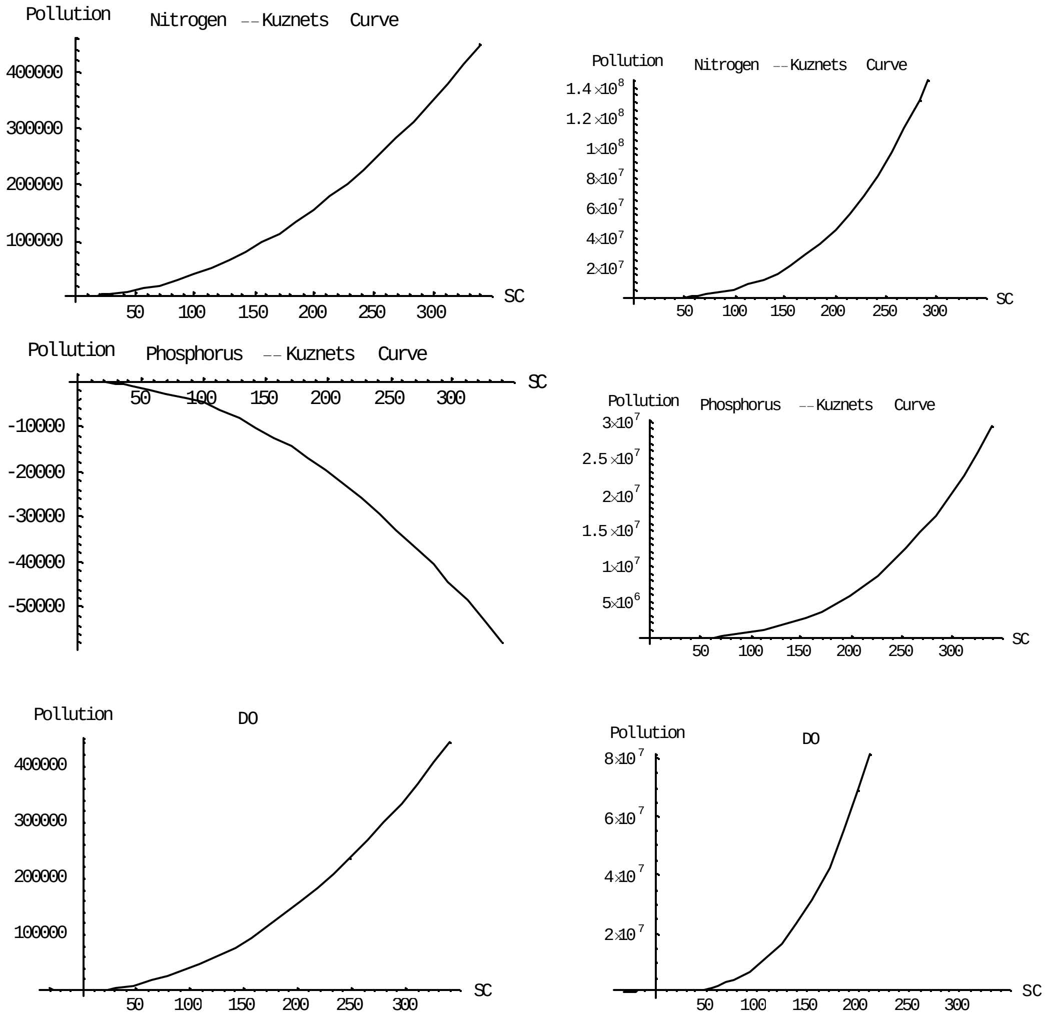
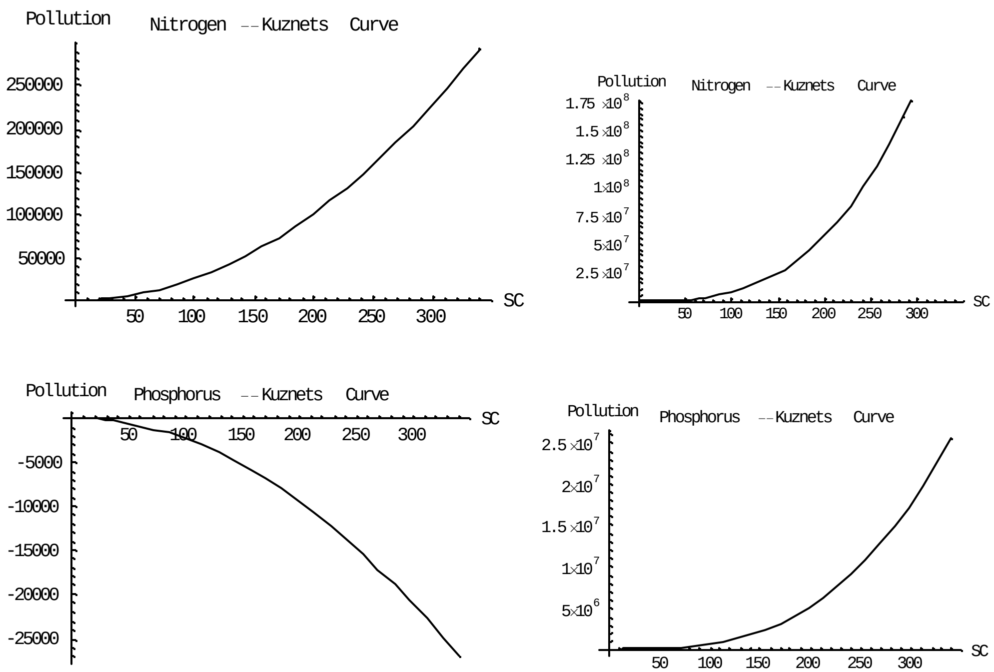


Fig2: EKC for three pollutants as offered from Two way Fixed Effect Panel Model



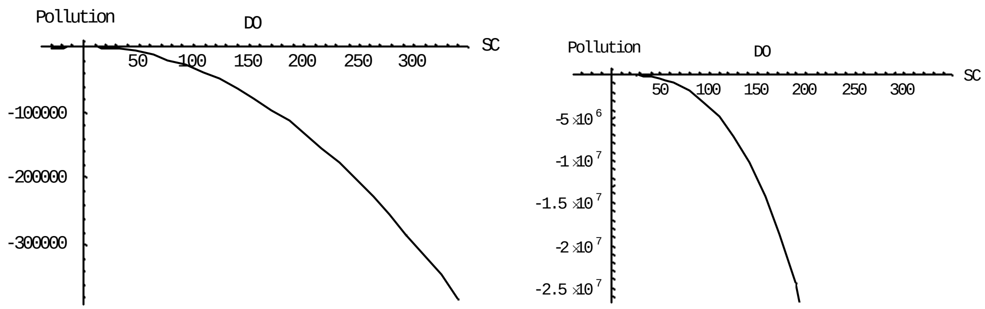
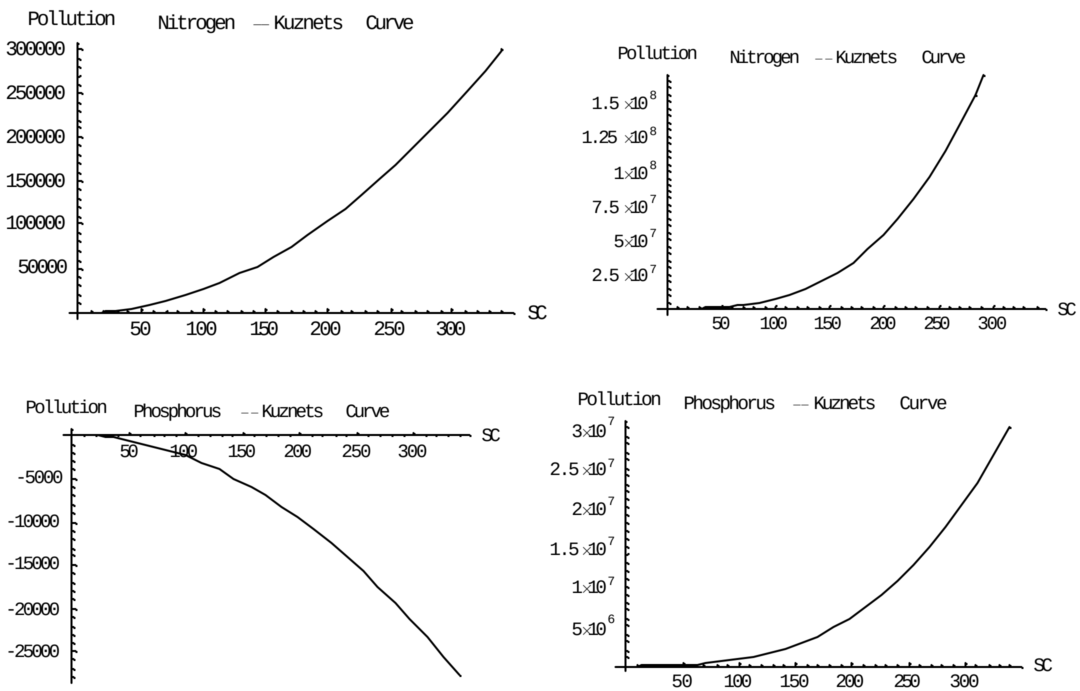


Fig 3: EKC for three pollutants as offered from One way Random Effect Panel Model



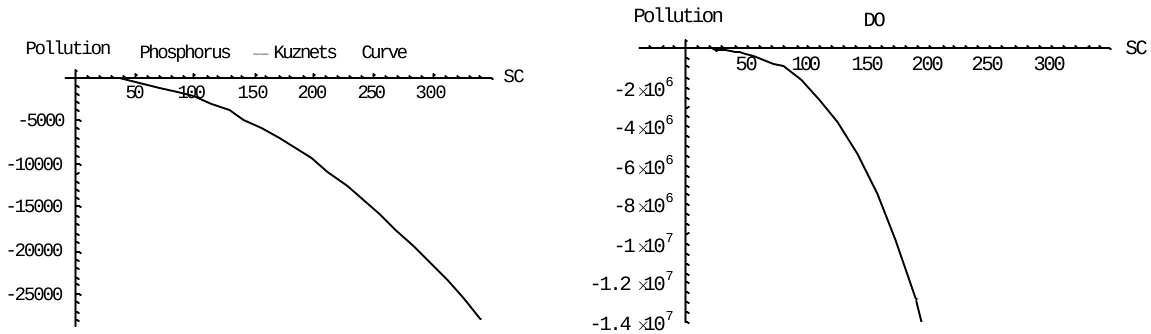


Fig 4: EKC for three pollutants as offered from Two way Random Effect Panel Model