STEPHAN J. GOETZ, DAVID L. DEBERTIN AND ANGELOS PAGOULATOS*

Linkages Between Human Capital and the Environment: Implications for Sustainable Economic Development

Abstract: An empirical analysis reveals that US states with a more highly educated population have better environmental conditions, after controlling for income and industrial composition. The strategy of raising human capital stocks to maintain or improve environmental quality is proposed as a complement, if not an alternative, to direct government intervention which consists of command and control, market incentives and moral suasion. Under this approach, general education becomes the control variable which guides economic behaviour in a manner consistent with long-term environmental sustainability.

INTRODUCTION

Past public efforts to guide economic activity in directions compatible with environmental quality have involved one of two strategies. The first has been to internalize externalities using a combination of tax and market incentives. Originating in the work of Pigou (1920), and developed primarily by resource economists, this strategy is exemplified by trading of pollution rights between two or more polluting firms. The second strategy has been to educate private sector decision-makers about harmful effects of specific chemicals and pollutants including fertilizers, pesticides, herbicides and, more recently, refrigerator coolants. This strategy relies on moral suasion rather than explicit market incentives, and generally falls into the domain of consumer and home economics.

Our paper is motivated by the question of whether there are public policies that complement these narrowly conceived strategies for addressing issues of environmental quality. We propose that economic agents with larger human capital endowments derive greater utility from a clean environment and, when confronted with multiple options, will most likely choose the option consistent with environmental quality. This hypothesis is developed conceptually and tested empirically. The focus is on environmental impacts of additional general education, not issues-specific education about the environment by public or private agencies. This distinction is analogous to that between general and specific human capital in the earnings literature. Increasing the population's general education, while an indirect and medium- to long-run approach, may increase the efficiency of market intervention — that is, employing tax penalties for polluting and rewards for not polluting — and spending on educational campaigns directed at specific types of pollution and their probable consequences. While the importance of human capital has been widely recognized in economics, including the economic development, wage-earnings and health economics literatures, its potential role in maintaining environmental quality has largely been ignored. We argue that this approach may be particularly effective in developing countries, where enforcement of pollution standards is difficult and sometimes impossible. Literacy is, of course, a prerequisite to using printed media for disseminating information about pollutants and environmental hazards.

* University of Kentucky, USA.

PUBLIC POLICY TOWARD THE ENVIRONMENT

Examples of US legislation designed to maintain or improve environmental quality include the Clean Air and Water Acts, the Toxic Substance Control Act, the Federal Insecticide and Rodenticide Acts, and the Comprehensive Environmental Response, Compensation and Liability Act (the 'Superfund'), which contributes public monies as a last resort to clean up toxic sites (e.g., Cropper *et al.*, 1992). In agriculture, Turvey (1991, p.1399, citing Hamilton, 1990) writes:

> ...legislatures and courts now recognize that it is the responsibility of farmers to establish and maintain soil and water conservation practices as well as erosion control practices, and these practices are in the interest of the public good and within the domain of state power.

Clearly, direct public intervention to control environmental quality is widespread, and under the 'New Federalism' the burden of intervention is falling increasingly onto states. At the same time, pollution is a global rather than a national problem, and it is unclear whether incentive-based programmes will succeed in developing nations, which do not have a '... reasonably sophisticated environmental control agency' (Hahn and Stavins, 1992, p.467).

Educational campaigns directed at improving environmental conditions include activities by consumer awareness groups, labels on hazardous materials indicating how they should be disposed of, and chemical-specific educational efforts by the USDA's Cooperative Extension Service for farmers and farm workers. The National Research Council (1991) recently published a volume addressing educational aspects of specific topics in sustainable agriculture. McConnell (1983, p.88) suggests 'that information about soil depth and its economic value be disseminated' to farmers so soil loss can be reduced and land values maintained. Braden *et al.* (1989) argue that reducing the movement of agricultural pollutants can be as effective as containing emissions; this requires education of and co-operation among farmers. These indirect approaches to influencing behaviour appeal to producers' moral responsibility; they affect market outcomes by influencing decision-makers' tastes and preferences. In addition, they influence profit-maximizing calculations by changing decision-makers' knowledge about how to combine specific inputs optimally (that is, the production function). Producer education about potentially hazardous environmental effects of their actions is complemented with consumer information about benefits of using chemicals. Babcock *et al.* (1992, p.171), for example, write that 'improved information about damage control agent productivity is vital' to balance 'public concerns about chemical residues and ecological damage with the need to maintain food and fiber production'.

The moral suasion/information-based strategy and the incentive-based strategy both assume that externalities can be reduced through carefully directed public interventions and, more importantly, that social benefits exceed the long-run costs. The question is whether and how markets can be made to function more perfectly with respect to the pricing of environmental services (Howarth and Norgaard, 1992). In terms of globally reducing environmental pollution, Batie (1989, p.1096) warns of 'the enormity of the transactions costs of orchestrating a coordinated international response to achieve sustainability goals through programs such as the reduction of certain gas emissions or the

reforestation of vast areas.' We are unaware of any studies that have evaluated or compared the long-run relative effectiveness of either of these two strategies.

HUMAN CAPITAL AND ENVIRONMENT: CONCEPTUAL ASPECTS

Casual empiricism in both developing and developed countries suggests that countries, regions, and communities with lower educational attainment often experience greater environmental problems. This link could mask a more fundamental causality: that higher incomes obtained through more education increase economic agents' willingness and ability to pay for a clean environment (given a positive income elasticity of demand), and vice versa. Thus, when the Environmental Protection Authority recently coined the term 'environmental racism' in reporting that US minorities bear a disproportionate share of environmental decay and health hazards from pollution, some argued that the problem was one of poverty rather than race.

We suggest that human capital has a positive relationship to environmental quality that is independent of income. Higher education levels are associated with environmental awareness, which leads to improved long-term environmental quality for a number of reasons. They can be separated into: (a) those affecting perceived benefits of environmental quality; and (b) the costs of achieving the quality (including learning about alternatives). In terms of perceived benefits, investment in education requires sacrificing present benefits for higher expected future returns. That is, educated decision-makers are also more likely to attach greater utility to future environmental pay-offs (they have longer time horizons and lower discount rates). This includes reducing pollution along highways and in parks and other recreational areas, which can otherwise deter tourists and reduce earnings from tourism in the future. Similarly, the highly educated are more likely to be aware of detrimental consequences of environmental degradation to their health. For these reasons, educated decision-makers may be more likely to become involved in community activities designed to improve the environment, more likely to pressure state legislators to commit proportionately more funds to environmental programmes, and more likely to persuade manufacturers to reduce pollution. On the cost side of achieving environmental protection, educated decision-makers may be better able to absorb, interpret and comprehend information (Nelson and Phelps, 1966; and Schultz, 1975), particularly abstract concepts such as those related to long-term harmful effects of depleting the ozone layer, or consequences of global warming, acid rain and soil erosion. They are also more likely to learn about and understand complex, long-term issues associated with environmental conditions. Thus, economic agents with a higher general education level face lower transaction costs of collecting and assimilating information about which activities result in various degrees of environmental damage. Because the (perceived) benefits of environmental protection are higher, and the costs of acting accordingly lower, a more highly educated agent faces a higher benefit–cost ratio than a less highly educated agent, and is therefore more likely to choose options that are consistent with environmental protection. These effects are in addition to any impacts of special educational programmes created by federal and state governments that specifically target environmental awareness.

In agriculture, highly educated farmers may be more likely to follow label recommendations for pesticide applications and understand the need for adopting production practices to reduce harmful effects of wind and water on soil, even though

conservation benefits may not appear for many years (Pagoulatos *et al.*, 1989). Several farm-level studies reveal a positive relationship between education and adoption of new technology. Lin (1991), for example, shows that educated Chinese farmers more rapidly adopt hybrid rice varieties. Rahm and Huffman (1984) demonstrate that greater schooling facilitates the adoption of erosion control practices by farmers, while Norris and Batie (1987, p.87) write: 'education will continue to be an important component of a successful conservation program'. Similarly, Ervin and Ervin (1982) find positive relationships between farmers' educational attainment and the perception that erosion is a problem, number of control practices adopted, and effort made to conserve soil. Lynne *et al.* (1988) stress the importance of fostering attitudes favourable towards conservation as alternatives to farm income-increasing programmes and taxation.

We test the following hypothesis: US states with larger stocks of human capital perform better on a variety of environmental quality measures. More specifically, the condition of the environment in state i (E_i) at any moment in time can be thought to depend on the stock of human capital h_i, state income per person y_i and the percentage of the population that is a minority m_i. In addition, we control for industrial mixes in each state using the relative contribution of different economic sectors j to gross state product G_j. Finally, we add a random error term, ε_i which is assumed to exhibit standard Gaussian properties:

$$(1) \quad E_i = \Phi(h_i, y_i, m_i, G_{ji}) + \varepsilon_i$$

The percentage of population 25 years or older with a high school diploma is used to measure human capital.

EMPIRICAL EVIDENCE

The relationship between water pollution scores and the percentage of residents 25 years and older having a high school diploma for the 50 states is illustrated in Figure 1; the scores are based on Hall and Kerr (1991) and represent different measures of water pollution, most of which are observed in the year 1988. States with a more highly educated population tend to have fewer pollution problems. Clearly, water pollution depends not only on residents' education, but also on other features such as population density and its geographic distribution, major types of industry, and general geophysical conditions. Thus, it is not surprising that Western states are below the trend line whereas mid-Western industrial states, and certain states where chemical-intensive farming patterns prevail, are above.

Figure 2 shows how overall environmental conditions in each state relate to human capital. These conditions are the sum of each state's ranking on 179 environmental indicators, including water pollution (a higher rank indicates better environmental conditions). However, additional factors such as the number of farms per 1000 population, number of farms gained or lost between 1974 and 1987, workplace deaths per 100 000 jobs, population share without health insurance, etc., are included so the index has to be viewed with some caution for the purposes of this study. Nevertheless, the general conclusion about the effect of human capital on environmental quality remains valid when disaggregate measures (such as water or air pollution) are used.

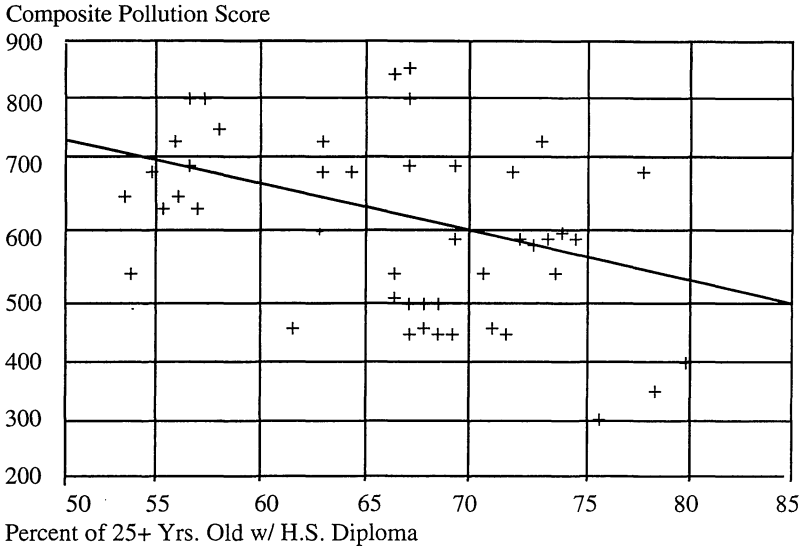

Figure 1 *Composite Water Pollution as a Function of Human Capital, US States*

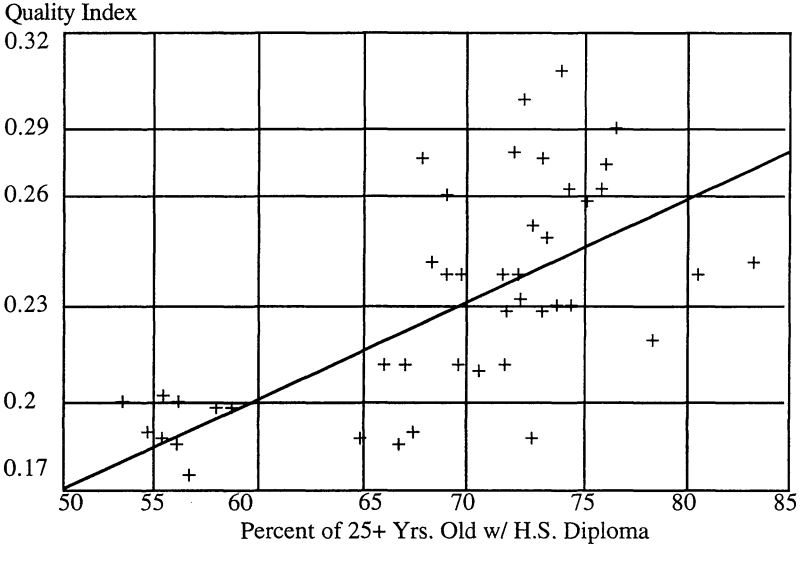

Figure 2 *Environmental Quality versus Human Capital, US States*

Regression results for Equation (1) are reported in Table 1. Higher levels of h_i are associated with significantly better environmental conditions. The coefficient for income

per person does not differ significantly from zero, conceivably reflecting the offsetting effects of greater willingness and ability to pay for a clean environment, on the one hand, and consumption of polluting goods such as large and inefficient automobiles, on the other. Table 1 also suggests states with proportionally more minorities have worse environmental conditions, other things being equal. These results hold even when the percentage of gross state product derived from different sectors is included in the regression. Greater shares of farming, mining, construction, manufacturing, transportation and services (relative to government), are associated with worse environmental conditions in a statistically significant manner. With the possible exception

Table 1 *Determinants of States' Environmental Conditions*[a]

Variable	Parameter estimates (*t*-statistic)
Constant	−433.1
	(0.14)
1988 income/capita	−0.0278
	(0.62)
Percent minority	−14.8*
	(1.95)
1980 Human capital[b]	32.2*
	(2.66)
1988 Gross State Product (%) from:[c]	
Farming	−80.3*
	(2.03)
Mining	83.6*
	(2.29)
Construction	96.3*
	(1.68)
Manufacturing	−101.8*
	(3.29)
Transportation	−225.8*
	(3.58)
Wholesaling	−106.2
	(1.53)
Retailing	−70.8
	(0.69)
Fire, insurance and retail services	23.0
	(0.51)
Services	−61.7*
	(1.84)
Adjusted R-squared	61.5

Notes: [a] Environmental conditions are based on each state's ranking — a higher index value indicates better environmental conditions. [b] Percentage of population 25 years and older with a high school diploma. [c] Government is the excluded category. * Significant at 10 percent or lower.

of services, these latter results are not surprising. The coefficient estimates for education retain the expected signs and remain significant when air pollution, air quality control and fish, wildlife and forestry spending per capita are used as dependent variables in Equation (1).

CONCLUSION

Increasing the human capital endowment of economic agents has four advantages over conventional methods for addressing environmental problems. First, it would be supported by those arguing that environmental policies which increase environmental quality with less government intervention are superior. Because there is no intervention via pollution taxes or specific economic incentives for not polluting, market signals and solutions are not distorted; market outcomes change *endogenously* as tastes and preferences of private decision-makers change.

Second, the long-term benefit–cost ratio of public expenditures for general education may be greater than benefit–cost ratios for public spending to alleviate specific environmental problems. Third, while we are uncertain of the comparative effectiveness of expenditures on education directed toward upgrading the population's general educational level, reducing high school drop-out rates, etc. versus expenditures for educating (not-in-school) adults about specific environmental problems, it appears that education about environmental issues is not independent of general public education. For example, discussion and instruction about environmental issues could take place in elementary and secondary natural sciences courses.

Fourth, positive externalities accrue to efforts designed to increase educational levels that have implications for economic growth and development. Unemployment in depressed rural regions of the United States is often associated with low human capital stocks. Communities and states with high average human capital stocks will be more capable of attracting high technology, skill-intensive firms and industry that are less polluting. This is consistent with the position that economic development can be compatible with long-run environmental quality (e.g., Hutchinson, 1990, p.xvi; and Bromley, 1992). More generally, increasing human capital stocks will entail additional tangible and intangible benefits which need to be incorporated into long-run benefit–cost calculations involving environmental benefits.

This analysis can be extended to a cross section of countries or regions within countries at different stages of development. An hypothesis is that environmental problems increase as countries make the transition from hunting and gathering to agrarian and industrial societies. Later, as incomes and education increase, the willingness and ability of residents to reduce pollution levels also increase. Eastern European countries face similar transitional problems as they introduce market reforms. More generally, in deciding whether to use specific educational programmes or market-based incentive schemes to improve environmental conditions, governments may consider allocating incremental funds to increasing the population's general education as a more cost-effective alternative.

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DISCUSSION OPENING — Chamhuri Siwar *(University Kebangsaan, Malaysia)*

This paper deals with the relationship between human capital and the environment. In general, it concludes that better environmental conditions are positively related with a more highly educated population. More specifically, the writers test the hypothesis that 'US states with larger stocks of human capital perform better on a variety of environmental quality measures'. The writers tested environmental conditions (E_i) with stock of human capital (h_i) represented by the percentage of residents 25 years and older having a high school diploma, state per capita income (Y_i), minorities as a percentage of the population (m_i) and the relative contribution of different economic sectors to gross state product (G_i). The result showing a positive relationship between human capital and environmental quality is expected. One may question the use of the percentage of residents 25 years and older having a high school diploma as a proxy for human capital. It seems that the larger the population, the higher will be the percentage of residents having a high school diploma. It may be useful to use the quality of human capital variable intead of just the stock of human capital. The percentage of residents with college or university degrees or the state expenditure on higher education may be a proxy for quality of human capital.

The association between higher per capita income and better environmental conditions is not very significant. One would expect the result to be significant, probably due to higher expenditures for environmental protection, enforcement measures and environmental awareness programmes. The assumption that higher incomes bring along higher consumption of polluting goods such as large, inefficient automobiles, offsetting the effects of greater willingness and ability to pay for a clean environment, seems to be contrary to the initial results that educated residents (higher human capital stock) are related to better environmental conditions. The association between minorities and worse environmental conditions may be disturbing for minorities. One would have thought that environmental problems are race neutral. The association between minorities and worse environmental conditions may be traced to poverty and lower educational levels. It is not surprising also that the major industries (farming, mining, construction, manufacturing and transportation) are the major contributors to worse environmental conditions.

Three questions may be raised here. What is the role of higher human capital in offsetting these effects? Have higher per capita incomes not been translated into improved environmental measures, enforcements and other direct measures to improve the environment? What is the contribution of the major industries (farming, mining, manufacturing, construction and transportation) to conservation, improving the enviromental and sustainable economic development. Are not the industries more concerned for environmental and sustainable development?

Finally, there is no denying that higher educational and human capital levels contribute to better environmental conditions in the long run. But it is also the educated, prompted by greed and profit motives, who plunder and exploit valuable resources (timber, mining) causing environmental degradation. The result of long-term educational programmes on environmental awareness may be less tangible than continuous efforts and measures to deter industries and consumers from polluting the environment. At best, the role of education and human capital towards a more sustainable economic development is complementary.