Determinants of environmental regulation and the role of environmental regulation for the diffusion of environmental management systems

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Abstract:

Using a measure of perceived stringency of environmental regulation, we contribute to the empirical analysis of the relationship of income and environmental regulation and of the impact of environmental regulation on technology diffusion, with a special focus on its relevance for developing middle income countries. Based on theoretical EKC models, we analyse in a cross-country regression the effect of income level and income distribution on environmental regulation. Determining the median income level, income level and income distribution play a role for the explanation of the stringency level, with an additional positive income inequality effect within the developing middle income countries that we ascribe to an undemocratic skew of the political process. We value the results as a confirmation of the explanatory power of the theoretical models, consequently expecting the demand for environmental quality to increase with growing incomes. Starting off from this assumption, we discuss the possibility of a relaxation of the traditional growth-environment trade-off. We analyse the impact of environmental regulation on the diffusion of environmental management systems that may be considered meta-innovations preparing the ground for the adoption of environmental innovations. We find a significantly positive effect of the stringency level on the diffusion rate for the sample of developing middle income countries.

1. Introduction

The relationship between income and environment has been the subject of a rapidly expanding literature. There have been several empirical investigations linking a specific measure of environmental quality to per capita income levels. It was found that for some pollutants, pollution declines monotonically, while for others, pollution tends to rise with per capita income. However, estimates that describe a hump-shaped curve: pollution first rises and then falls with income per capita, have captured the most attention.

Because of its similarity to the pattern of income inequality documented by Simon Kuznets, this inverted U-shaped pollution-income pattern became known as Environmental Kuznets Curve (EKC). The popularity of the EKC most probably derives from its convenient interpretability: If the EKC hypothesis is held generally, it implies that instead of being a threat to the environment, economic growth would solve environmental problems.

This conclusion is highly problematic, since - apart from the weak empirical evidence for the EKC - its (apparent) existence does not mean that at a global level environmental problems will improve with economic growth. It is not clear whether developing countries can replicate the development path highly industrialized countries have taken in the past. For a variety of reasons, historical experiences cannot easily be extrapolated to the future. As Stern and Common (Stern et al. 1996) point out, the concept and empirical implementation of the EKC restrict its usefulness to the role of a descriptive statistic.

The impact of growth on environment can be radically altered, considering the interdependence of countries within the world economy. The access to world markets still offers countries with stricter environmental regulation an easy abatement alternative. Instead of innovating and applying cleaner technologies which would require considerable investments, countries with stringent regulation may simply encourage dirty industries to migrate to countries with laxer regulation, so called pollution havens.

Developing countries later tightening their environmental regulation to similar levels may have no other places to shift their pollution-intensive production, facing the more difficult task of abating these activities. If this mechanism is actually shaping the income-pollution pattern, the experience of developed countries may not be replicated for newly industrializing countries.

The interpretation of the empirical results is difficult, as long as there is no clarity as to the causal mechanisms that determine the inverted U-shaped relationship between income levels and environmental degradation. However, theory has played a limited role in the development of the EKC hypothesis and too little effort has gone into evaluating the potential causes.

A prominent explanation for the shape of the EKC is that it reflects changes in the demand for environmental quality. It has been argued that environmental regulations impose significant costs on the regulated firms, deviate resources from alternative investments, and thereby restrict the competitiveness in international markets. Within this trade-off between economic growth and environment, regulation policy is supposed to reflect the social preference for environment over consumption. Environmental legislation thereby restricts the potential output to the desired level of the joint production of consumption goods and pollution.

Based on theoretical models of Stokey (Stokey 1998) and Eriksson and Persson (Eriksson, Persson 2003), we derive expectations about the role of income level and income distribution for the determination of the stringency level of environmental regulation and present an empirical model to test our predictions. The results show that income-driven demand for environmental quality can explain a large part of the differences in the stringency of environmental regulation across countries.

Given the heterogeneity in demand for environmental quality a worldwide harmonization of environmental standards that might put a barrier on pollution shifts and force industries to effectively invest in cleaner technologies appears as an ambitious goal, the achievement of which may require substantial transfer payments.

However, against the background of a growing world demand for environmental quality, the traditional trade-off between consumption and environment may be framed differently. Anticipating the market development, stringent regulation may create early-mover-advantages of the regulated firms over firms in countries that introduce regulations at a later date. Additionally, since environmental pollution often goes along with economic waste, regulated firms may obtain productivity gains that offset the initial costs of compliance by investing in environmental innovations and adopting cleaner technologies. The traditional consumption-environment trade-off is thus relaxed, allowing for win-win-situations in which stringent regulation would favour both environment *and* economic growth. This hypothesis was first suggested by Porter (Porter 1990; Porter, Vanderlinde 1995) and has since then been subject to a controversial debate.

Opponents to the Porter hypothesis claim, in a neoclassical reasoning, that rationally profit-maximizing companies in a perfectly competitive economy would do profitable innovations under any given conditions, so that the impact of environmental regulation can but be costly. Supporters of the hypothesis emphasize that there are market imperfections which induce inefficiencies that can be overcome by regulation. Within the evolutionary theory, bounded rational firms are assumed to operate according to “rules of thumb” or “routines” that might be checked and improved when exposed to regulatory pressure. Jaffe et al. (Jaffe et al. 2002) give an overview on the theoretical debate.

If the Porter hypothesis holds, environmental regulation becomes an industrial policy instrument. In the struggle for an international harmonization of environmental standards, this would yield arguments to tighten environmental regulations above the levels that are justified by the traditional consumption-environment trade-off. In this context it is of special interest, whether developing countries offer the necessary conditions that would allow them to integrate the innovation offset of environmental regulation into their catching-up strategies.

Tightening environmental regulation may catalyse the catching-up process of developing countries by forcing firms to modernise, that is to innovate or to adopt more efficient technologies. The strong interest of the developed world in environmental quality could, moreover, facilitate the technological transfer. Furthermore, the relatively low infrastructure may allow the adoption of radical system-transforming innovations that, although theoretically profitable, have not been applied in developed countries due to strong lock-in effects. Employing environmental regulatory pressure, developing countries may accelerate economic growth taking a less environmentally-damaging path of development by “tunneling through the Kuznets curve” (Munasinghe 1999).

Nevertheless, empirical evidence for the validity of the Porter hypothesis is still inconclusive, often anecdotal and usually restricted to developed economies. Porter and van der Linde (Porter, Vanderlinde 1995) cite several case studies supporting their hypothesis. Jaffe et al. (Jaffe et al. 1995) review 16 empirical studies on the effect of environmental regulation on competitiveness with particular focus on the U.S. and conclude that there is relatively little evidence that environmental regulations have had a large *adverse* effect on competitiveness. Mulatu et al. (Mulatu et al. 2001), using a meta-analysis technique to analyse empirical studies on the effect of stringent environmental regulation on international trade, conclude that empirical literature does not strongly indicate a *negative* effect of environmental regulation on competitiveness. An overview on these studies is provided by Wagner (Wagner 2003) who concludes that empirical evidence overall indicates a small positive effect.

Jaffe et al. (Jaffe et al. 2002) distinguish between induced innovation and technology diffusion when discussing the possible innovation offsets of environmental regulation and state that the analytical distinction between innovation and diffusion is blurred in practice. However, both ways may actually lead to efficiency improvements. An innovating firm may create and/or introduce a completely new technology, thereby expanding the macroeconomic production frontier, or it may improve its productivity by adopting an already existing technology, thereby moving towards the production frontier.

Nevertheless, since the requirements concerning the innovation system for an adoption are less exigent and the potentials for efficiency improvement by the application of existing technologies are likely to be high, we expect this type of productivity gain to play a more important role for the innovation offset of environmental regulation within developing countries.

By including middle income developing countries in the analysis and by focussing explicitly on the voluntary implementation of environmental practices that raise the probability for the adoption of environmental technologies, new empirical evidence on the relationship of environmental regulation and innovation could be provided.

In chapter 2, we shall derive hypotheses concerning the link of income level and income distribution to the level of environmental regulation, based on two theoretical models. We test our expectations empirically and provide the estimation results. In chapter 3, we shall briefly describe an empirical model to analyse the impact of environmental regulation on the diffusion of environmental management systems and give our estimation results. Chapter 4 serves as a conclusion.

2. Determinants of environmental regulation

Stokey (Stokey 1998) suggests a simple static representative agent model that generates the inverted U-shaped relationship between per capita income and pollution which has been discussed in the EKC literature. Consumption goods and pollution are coupled in a joint production function. As income rises, the willingness to pay for environmental quality increases and larger sacrifices in consumption are accepted in exchange for greater environmental benefit. Environmental regulation thereby serves to restrict the potential output in order to achieve the optimal level of joint production.

Therefore, if the income effect plays a role for the explanation of the EKC income-pollution pattern, a strong policy response to income changes should be observed. To separate the income effect on pollution from other possible causal mechanisms that may shape the EKC, our analysis is concentrated on the relationship between income and the extent of environmental regulation.

Eriksson and Persson (Eriksson, Persson 2003) augment the Stokey model allowing for heterogeneity of individual incomes across and within countries and introduce a political decision mechanism. Allowing for heterogeneous agents raises the political question of how individual attitudes towards environmental regulation are aggregated to determine a country's stringency level of regulation. Eriksson and Persson suggest a simple majority rule, and discuss its implications for different levels of democracy. Whereas in a complete democracy the median citizen's preference determines the political outcome, the political process within less democratic societies is held to be skewed towards the economically more powerful part of the population.

If we take it for granted that individual income determines an agent's attitude towards environmental regulation a country's stringency of environmental regulation should, according Eriksson and Persson (Eriksson, Persson 2003), be influenced by the income distribution and the level of democracy, additionally to the per capita income.

Building on this model, we expect income inequality to have empirically two counteracting effects on environmental regulation. First, assuming a convex income distribution function by relying on the empirical fact that median income is typically lower than average income, inequality should, *ceteris paribus*, reduce the income of the median citizen, thereby reducing also environmental regulation. Second, since income inequality tends to be correlated with undemocratic political practices, it should, *ceteris paribus*, raise the income of the political decider, leading to a more stringent environmental regulation.

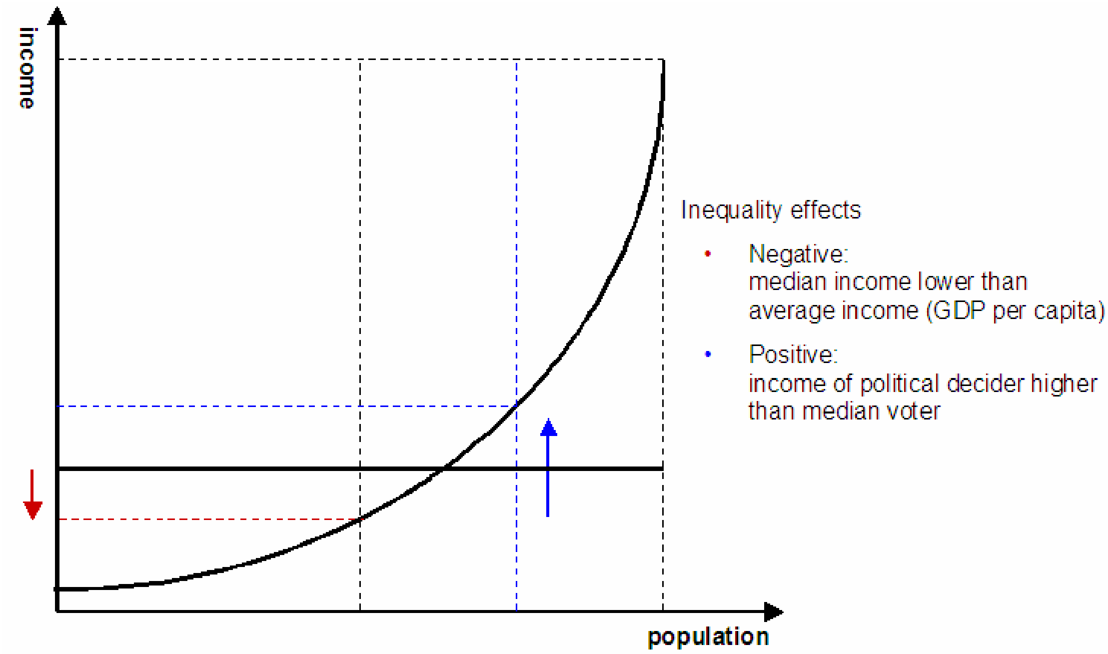

Figure 1: Income distribution and inequality effects

We form the following expectations about how income level and income distribution will affect the stringency of environmental regulation:

(1) We expect a country's stringency of environmental regulation to rise with the median citizen's income which depends positively on income per capita and negatively on income inequality.

(2) We expect a country's stringency of environmental regulation to rise along with the undemocratic bias in the political process which is positively related to income inequality.

Empirical model

In testing these hypotheses empirically, we draw data from a measure summarizing subjective evaluations of the stringency of environmental regulation, published in the *Global Competitiveness Report 2006-2007* of the World Economic Forum (WEF 2007), the GDP per capita (PPP) as indicated in *The World Competitiveness Yearbook 2006* of the Institute of Management Development (IMD 2006) and the Gini Index published in the *Human Development Report 2006* of the United Nations (UN 2006) for a sample of 52 high and middle income countries in the year 2005.

Assuming an underlying Pareto-distribution of income of the form:

$f(x) = k\frac{a^k}{x^{k+1}}$, with $k = \frac{1+G}{2G}$ and $a = \bar{x}\left(1-\frac{1}{k}\right)$, we calculate the median income (*median*), using per capita income $\bar{x}$ and the Gini coefficient $G \in [0,1]$:

$$median(\bar{x}, G) = \bar{x}\left(1 - \frac{2G}{1+G}\right)2^{\frac{2G}{1+G}}.$$

This parameter models our assumption that the median income depends positively on average income and negatively on income inequality. With the median income covering the negative effect, we can isolate it from the expected positive effect of income inequality. We now take the Gini index as a proxy for the political bias, since income inequality tends to be correlated with undemocratic political practices. Both parameters are used as covariates in a cross-country OLS regression on the stringency measure of environmental regulation:

$$str_i = \beta_0 + \beta_1 * median_i(\bar{x}, G) + \beta_2 * G_i + e_i$$

The estimates corroborate our hypotheses concerning the median income level: Within all conventional significance levels, the stringency of environmental regulation is positively related to the median income. The estimated coefficient for the Gini index shows the expected positive sign, but is not statistically significant.

Table 1: Regression results of public choice model

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                                    Ergebnis
. regress str median G

      Source |       SS       df       MS              Number of obs =      52
-------------+------------------------------           F(  2,    49) =   48.54
       Model |  41.8668042     2  20.9334021           Prob > F      =  0.0000
    Residual |  21.1337722    49  .431301474           R-squared     =  0.6645
-------------+------------------------------           Adj R-squared =  0.6509
       Total |  63.0005764    51  1.23530542           Root MSE      =  .65674

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         str |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      median |   .0001125   .0000127     8.89   0.000      .0000871     .000138
           G |   1.975302   1.217718     1.62   0.111     -.4717935    4.422397
       _cons |   2.520513    .582825     4.32   0.000      1.349282    3.691744
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Since the explained variance is above 65%, we find that the observed cross-country heterogeneity in the levels of environmental regulation can be explained by the heterogeneity in individual incomes leading to different attitudes towards environmental protection which are socially aggregated in a majority rule procedure.

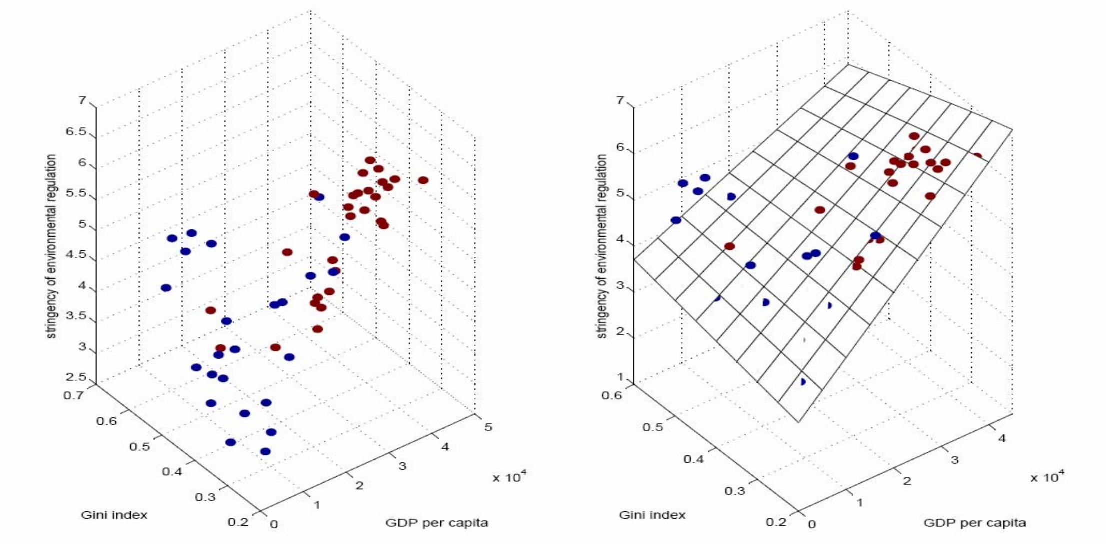

Figure 2: Graphical representation of regression results of public choice model

To get an idea of whether there are fundamental differences in this pattern between developed and developing countries, we perform a grouped regression by splitting up the original sample into OECD (developed) and None-OECD (developing) countries.

The estimates for both samples confirm the first result concerning the median income effect. Furthermore, the positive inequality effect related to the political bias can now be determined at a significance level of 5% for the sample of developing countries. However, this effect is not significant and yields the wrong sign for the sample of developed countries.

This result is not surprising, given that the median voter model should serve as a reliable description of the political processes within the most OECD countries (that, for the most part, can be considered well established democracies), whereas in the developing None-OECD countries political bias, that usually goes hand in hand with inequality, seems to play a major role.

The estimates confirm the expected strong environmental policy response to income levels. Therefore, the results suggest that demand for environmental quality is likely to increase worldwide as incomes rise with economic growth. The robust direct relation between median income and stringency of environmental regulation fuels the hope that along the development path developing countries will also tighten environmental standards when growing economically.

Table 2: Regression results (grouped) of public choice model

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. by oecd, sort : regress str median G

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----------------------------------------------------------------------
-> oecd = 0

      Source |       SS       df       MS              Number of obs =      24
-------------+------------------------------           F(  2,    21) =    7.38
       Model |  7.50413344     2  3.75206672           Prob > F      =  0.0037
    Residual |  10.6721159    21  .508195995           R-squared     =  0.4129
-------------+------------------------------           Adj R-squared =  0.3569
       Total |  18.1762493    23   .79027171           Root MSE      =  .71288

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         str |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      median |   .0000931   .0000272     3.43   0.003      .0000366    .0001496
           G |   3.918538   1.541277     2.54   0.019       .713277    7.123799
       _cons |   1.779826   .7424411     2.40   0.026       .235835    3.323817
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----------------------------------------------------------------------
-> oecd = 1

      Source |       SS       df       MS              Number of obs =      28
-------------+------------------------------           F(  2,    25) =   22.56
       Model |  12.6689521     2  6.33447605           Prob > F      =  0.0000
    Residual |  7.01961976    25   .28078479           R-squared     =  0.6435
-------------+------------------------------           Adj R-squared =  0.6149
       Total |  19.6885719    27  .729206365           Root MSE      =  .52989

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         str |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      median |   .0000842   .0000178     4.74   0.000      .0000476    .0001208
           G |  -2.903708   2.001028    -1.45   0.159     -7.024903    1.217487
       _cons |   4.768371   .9083318     5.25   0.000      2.897627    6.639115
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3. Impact of environmental regulation

The literature on technological diffusion theory suggests two main effects driving the adoption of new technologies (Karshenas, Stoneman 1993). Epidemic effects derive from the spreading of information and awareness within the diffusion process, while rank effects stem from inherent characteristics of potential adopters that result in different returns from the use of a new technology.

These effects again are influenced systematically by a broad set of adoption factors. Epidemic effects are influenced by learning processes, growing social or competition pressures or uncertainty reductions from extensions in use. Rank effects are influenced by expected productivity gains, the ability to process information on the latest technologies, differences in risks and uncertainty related to the adoption of new technologies, and the technological readiness.

To link environmental regulation to environmental innovations, we analyze its impact on the diffusion of environmental management systems that are supposed to have an effect on the adoption factors that determine the diffusion process of environmental innovations.

Like ISO 9000, a series of voluntary quality management system standards, ISO 14000 is a series of voluntary environmental management system standards released by the International Organization for Standardization (ISO) in 1996. Up to 2005, more than 110,000 organizations in 138 countries have been certified by independent bodies, attesting a well documented consistent environmental management system.

The number of ISO 14001 certifications have differed remarkably between countries. This may be due to country-specific factors related to business culture, but also due to different costs for the implementation. If quality management systems have already been established, learning effects may reduce the implementation costs substantially. Albuquerque et al. (Albuquerque et al. 2007) found evidence that past certification lowers the perceived risk with current adoptions, leading to an increase in diffusion rates. They also identified strong culturally-driven cross-country contagious effects. However, we expect the level of environmental regulation to have an impact on its adoption as well. By regulatory pressure, companies may be pushed to reorganize in order to evaluate their environmental impact. In a study of Japanese survey data Uchida and Ferraro (Uchida, Ferraro 2007) found that regulatory pressures have the largest effect and that the magnitude of consumer pressures is affected by the level of regulatory pressures firms receive.

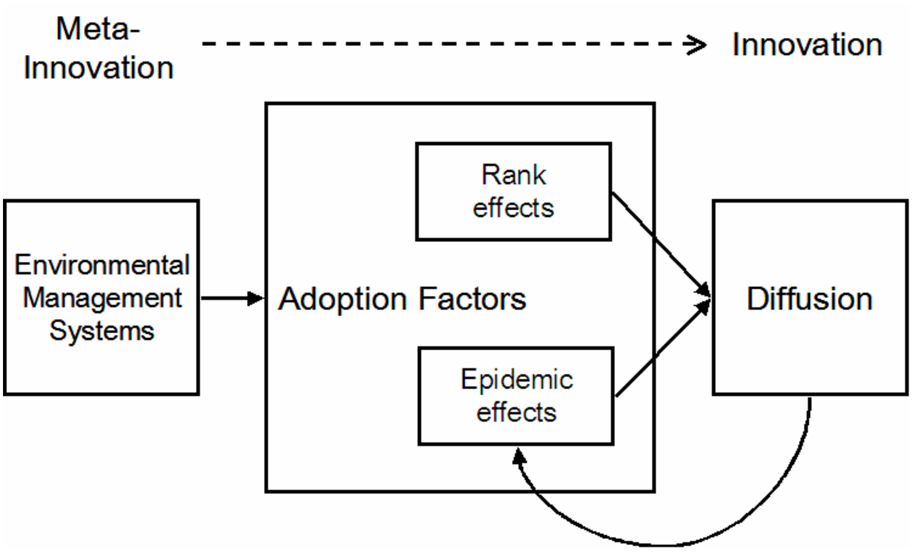

Figure 3: Environmental management systems as driver of innovation diffusion

About firms that have successfully certified on ISO 14000 we know that they have adopted practices that allow them to measure and monitor the environmental impact of their activity, to document and continuously improve their environmental performance.

These practices influence the adoption factors discussed within the diffusion theory. By providing information about inefficiencies and improvement potentials within the organization and the possible impact of new technologies, they reduce the uncertainty and lower the economic risk associated with the adoption of environmental innovations. By staff training, raising the awareness, the knowledge and skills of the personnel, they tend to reduce the implementation costs and raise the value of a new environmental technology. The adoption of an environmental management system can therefore be considered a meta-innovation that raises the possibility of the adoption of new technologies.

Although the ISO standard does not specify any absolute environmental performance level, certified firms exhibit better absorption conditions for environmental innovations that in turn may result in a better performance. Furthermore, since the adoption of the standard is voluntary, we expect firms to undertake the implementation of an environmental management system only in the case that it is considered not to harm their competitiveness. The consequence of the standard adoption is therefore likely to be a win-win-situation.

We form the following expectations about determinants of the diffusion of environmental management systems:

(1) We expect the stringency of environmental regulation to have a positive effect on the diffusion, since it creates pressure on firms to reorganize.

(2) We expect the diffusion to depend on a variety of country-specific factors related to business culture, international integration, availability of production factors, domestic demand, certification experience, etc.

(3) We expect the technological readiness to effect the diffusion. It is however unclear, whether the effect of easier implementation in technologically advanced or the effect of greater productivity gain potentials in less advanced economies dominates the impact empirically.

Empirical model

To test these hypotheses empirically, we again recur to the subjective measure of the stringency of environmental regulation and a subjective measure of the technological readiness, published in the *Global Competitiveness Report 2006-2007* of the World Economic Forum (WEF 2007), we use the GDP (PPP) published in *The World Competitiveness Yearbook 2006* of the Institute of Management Development (IMD 2006) as a proxy for market size and the number of ISO 9000 and ISO 14000 certifications published in the *ISO Survey 2005* by the International Organization for Standardization (ISO 2005) for a sample of 55 high and middle income countries in the year 2005.

Dividing the numbers of certifications (*iso14, iso9*) by the GDP (PPP), we derive a measure for the diffusion rate of certifications within an economy. We use the ISO 9000 diffusion rate (*int9*) as a control variable for the country-specific factors driving certification in general, as well as the effect of experiences with the implementation of quality management system standards. We use the measure of technological readiness (*tech_read*), to estimate the effect of the degree of technological development on the diffusion rate of ISO 14000 standards (*int14*). Finally, we use the environmental regulation measure (*str*), to analyse the effect of regulatory pressure on the standard adoption.

We use the following regression model:

$$iso14_i / gdp_i = \beta_0 + \beta_1 * str_i + \beta_2 * iso9_i / gdp_i + \beta_3 * tec\_read_i + e_i$$

Table 3: Regression results of the diffusion model

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. regress int14 int9 tec_read str

      Source |       SS       df       MS              Number of obs =      55
-------------+------------------------------           F(  3,    51) =   13.68
       Model |  172.630468     3  57.5434894           Prob > F      =  0.0000
    Residual |  214.488896    51  4.20566462           R-squared     =  0.4459
-------------+------------------------------           Adj R-squared =  0.4133
       Total |  387.119364    54  7.16887711           Root MSE      =  2.0508

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       int14 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        int9 |   .0858411   .0166463     5.16   0.000     .0524222      .11926
    tec_read |   .3051835   .2746612     1.11   0.272    -.2462218     .8565888
         str |   .4203404   .4147999     1.01   0.316    -.4124052     1.253086
       _cons |  -2.200113   1.351808    -1.63   0.110    -4.913982     .5137553
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The estimation results yield no significant relation, except for the effect of the ISO 9000 diffusion rate. Not surprisingly, countries with widely diffused quality management standards also certify intensively on ISO 14000 environmental management systems. The coefficients for technological readiness and environmental regulation are positive, indicating a diffusion-enhancing effect, which is, however, not statistically significant. Moreover, the explained variance at 45% is relatively low. There seem to be several other influences on the diffusion of environmental management systems, as for example cross-country contagious effects, that are not accounted for in our model.

Again, we perform a grouped regression, splitting our sample in OECD high income (n=30) and None-OECD middle income (n=25) countries. The positive influence of ISO 9000 certifications is robust. Interestingly, the technological readiness measure now becomes significantly positive for the developed countries. Here, the lower implementation costs may explain this effect. However, for the developing countries, the technological readiness coefficient shows the opposite sign. Although it is not significant, here the productivity gain effect may have a stronger weight.

Finally, for the developing countries the effect of the stringency of environmental regulation is now significantly positive. This indicates that here environmental regulation may influence the diffusion of environmental management standards in the expected way, creating favourable conditions for the adoption of environmental innovations, as has been discussed before.

Table 4: Regression results (grouped) of the diffusion model

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. by oecd, sort : regress int14 int9 tec_read str

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-> oecd = 0

      Source |       SS       df       MS              Number of obs =      25
-------------+------------------------------           F(  3,    21) =   12.22
       Model |  85.5071051     3  28.5023684           Prob > F      =  0.0001
    Residual |  48.9754647    21  2.33216499           R-squared     =  0.6358
-------------+------------------------------           Adj R-squared =  0.5838
       Total |   134.48257    24  5.60344041           Root MSE      =  1.5271

------------------------------------------------------------------------------
       int14 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        int9 |   .1010951   .0239523     4.22   0.000     .0512835    .1509066
    tec_read |  -.3960871   .2916005    -1.36   0.189    -1.002504    .2103294
         str |   1.361046   .5117472     2.66   0.015       .29681    2.425283
       _cons |  -3.734445   1.568019    -2.38   0.027     -6.99532   -.4735709
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-----------------------------------------------------------------------
-> oecd = 1

      Source |       SS       df       MS              Number of obs =      30
-------------+------------------------------           F(  3,    26) =    6.06
       Model |  96.7813406     3  32.2604469           Prob > F      =  0.0029
    Residual |  138.433606    26  5.32436947           R-squared     =  0.4115
-------------+------------------------------           Adj R-squared =  0.3436
       Total |  235.214947    29  8.11086023           Root MSE      =  2.3075

------------------------------------------------------------------------------
       int14 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        int9 |   .0915045   .0234041     3.91   0.001     .0433967    .1396123
    tec_read |   .9562238   .4519749     2.12   0.044     .0271762    1.885272
         str |  -.2915073    .774838    -0.38   0.710     -1.88421    1.301195
       _cons |  -1.705983    3.16053    -0.54   0.594    -8.202546     4.79058
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4. Conclusion

The empirical relation of income and environmental degradation has been modelled theoretically as an outcome of an increasing demand for environmental quality. We tested the implications of these theoretical models concerning the relation of income and environmental regulation empirically, and found that they have been confirmed in our estimations.

Although we have to cast doubt on the assumption that this demand will directly translate into less pollution when incomes grow, we expect it to result in an increasing stringency of environmental regulation. However, as long as heterogeneity in income levels subsists, there will be differences in the socially desired level of environmental regulation.

Nevertheless, against the background of an increasing demand for environmental quality the underlying trade-off between consumption and environment may be relaxed if possible gains in productivity and competitiveness are considered that might arise from stringent regulation. In the struggle for an international harmonization of environmental standards, such effects would render industrial policy arguments to raise the stringency of environmental regulation in less developed countries, if their existence could be confirmed.

In a first attempt, we analysed the effect of environmental regulation on the diffusion rates of environmental practices that could prepare the ground for environmental technology adoptions to follow up. A positive diffusion effect of environmental regulation was found for developing countries, but not for developed economies. Therefore the diffusion-enhancing effect of environmental regulation may be dependent on the existence of improvement potential within firms that operate far from the efficiency frontier.

The first results are promising, but need to be further explored. Our diffusion model seems to be underspecified, not accounting for cross-country influences. The estimates could be improved employing time-series data that are not at our disposal. Moreover, since the mere diffusion of practices or even technologies does not guarantee productivity gains, it remains to be analysed whether environmental regulation spurs competitiveness-enhancing technological change.

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