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*Research Highlights*

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# Efficient but getting wet feet: A not-entirely-frivolous note on the side-effects of growth-promoting institutions[*]

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### Abstract

Using data covering 38 countries across the 1965–2005 period, this paper shows that former British colonies tend to exhibit higher levels of carbon dioxide emission than other countries.

**JEL Classification:** F54; 043; Q50.

**Keywords:** Institutions; Colony; Carbon dioxide.

## 1 Hypothesis: the importance of being English

Many people believe that the prospect of dramatic climate change is the single most important challenge facing our societies today (Stern, 2006). One of the main culprits is the emission of carbon dioxide ($CO_2$). It is feared that it will cause temperatures to rise, which will melt the glaciers, raise the level of the high seas, and put large parts of the inhabited world under water.

Looking at some descriptive statistics, we noted that the United States, Australia and Canada were among the worst offenders in terms of $CO_2$ emissions. For an institutional economist, two facts stand out. Firstly, these are all former British colonies. Secondly, it

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has been argued that precisely such countries have experienced high growth rates and have efficient economies because they have inherited growth-promoting institutions from the United Kingdom (North, 1990).[1]

These observations suggest an interesting hypothesis: perhaps some growth-enhancing institutions make it less likely that a country will reduce the emission of $CO_2$? An economically efficient institutional set-up is usually thought to include the protection of private property rights, the rule of law and credible commitments of the state not to abuse property rights (Greif, 2005). Reductions in $CO_2$ emissions inevitably entail regulating industry and individual behavior, and are conceivably less likely to be achieved in countries with institutions that otherwise are considered conducive to good economic performance. This would explain why being a former British colony may have a positive effect on the level of GDP per capita, while at the same time the ex-colony status implies that this level of GDP will be achieved with a relatively high level of $CO_2$ emission.

Another important aspect of the relative efficiency of institutions is cultural background and homogeneity. Both belief system and social norms may be inherited from earlier generations, and may be even more important for economic performance than formal rules (Greif 1994; North, 1990). Now, what is the English attitude to climate? A foreigner to the country will have to be excused if the overwhelming impression is one of ignoring the climatic realities. Consequently, a complementary hypothesis is that a culturally inherited attitude to ignore weather and climate spills over to environmental policy, once again causing former British colonies to stand out.

## 2 The econometric approach

The discussion above suggests a relationship not only between the log per-capita $CO_2$ emissions of country $i$ in period $t$, $y_{it}$, and the log per-capita GDP in the same period, $x_{it}$, but also a role for former British colonies, here represented by the dummy variable $D_i$ taking the value one if country $i$ is a former British colony and zero otherwise. Our first model is:

$$y_{it} = \alpha + \delta t + \gamma D_i + \beta x_{it} + \phi x_{it}^2 + u_{it}, \tag{1}$$

where the trend has been included to account for the fact that the emissions are usually growing over time, and $u_{it}$ is a random disturbance term. It is expected that $\beta > 0$; as GDP

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[1]Later modifications to this theory include the suggestion by Acemoglu et al. (2001) that the transfer of efficient institutions was contingent upon the climate in the colony.

increases, $CO_2$ emissions will also increase. The coefficient of GDP squared, $\phi$, measures the acceleration or deceleration of changes as income increases. The inverted U-shape predicted by the environmental Kuznets curve (Dinda, 2004) arises when $\beta > 0$ and $\phi < 0$. We expect former British colonies to be associated with a general increase in emissions, and hence $\gamma > 0$.

The second model is more general and allows for the possibility that economic growth in former British colonies is associated with relatively high levels of emission. It is given by

$$y_{it} \;=\; \alpha + \delta t + \gamma D_i + \beta x_{it} + \phi x_{it}^2 + \theta D_i x_{it} + \rho D_i x_{it}^2 + u_{it}, \tag{2}$$

where $\beta$ now represents the slope for those countries that are not former British colonies, $\theta$ represents the change in the slope for the former British colonies, and $\rho$ represents the change in the rate of change in the same slope coefficient. It is expected that emissions will increase faster with GDP for ex-colonies than for other countries, and $\theta > 0$.

In order to accommodate short-run effects, such as serial and cross-country correlations, it is assumed that $u_{it}$ has the following factor structure:

$$u_{it} \;=\; \lambda' \mathbf{f}_t + \epsilon_{it},$$

where $\mathbf{f}_t$ is a vector containing the unobserved common factors, which could represent environmental regulations, oil price shocks or any other feature affecting $CO_2$ emissions that is common for all countries. The disturbance $\epsilon_{it}$ is assumed to be mean zero and uncorrelated across $i$ but potentially correlated over time. The factors, which are also allowed to be serially correlated, are introduced to model the cross-country dependence in $u_{it}$. The extent of this dependence is determined by $\lambda$, which is a vector of loading parameters that measure the effect of the common factors.

We apply the common correlated effects (CCE) estimator of Pesaran (2006), which is basically OLS conditional on the cross-sectional averages of the observed data. Despite its simplicity the CCE estimator is surprisingly general. In fact, as Kapetanios et al. (2006) show, the CCE estimator is consistent regardless of whether the data are stationary or not, and one can even allow for some weak form of cross-country dependence in the idiosyncratic errors $\epsilon_{it}$. It has also been shown to perform very well in samples as small as ours.

# 3 Empirical Results

## 3.1 Data

The sample consists of 38 countries (Table 1), for which we have annual observations stretching the 1965–2005 period for per-capita GDP measured in United States dollars (fixed 2005 prices and adjusted for purchasing power parities), and per-capita $CO_2$ emissions measured in thousands of metric tons. The data, which were obtained from www.gapminder.org, originate with UNSTAT (United Nations Statistics Division). To determine the colonial heritage we adopt the definitions from La Porta et al. (1999), as in Acemoglu et al. (2001).

[**TABLE 1 HERE**]

## 3.2 Short-run dynamics

In order to assess the statistical significance of the cross-correlation problem in our regression, we compute the pair-wise cross-country correlation coefficients of the residuals from the OLS fit of (1). The simple average of these correlation coefficients across all the 703 country pairs, together with the associated CD test discussed in Pesaran et al. (2008), are given in Table 2. While there is significant cross-correlations in the variables, the residuals seem to be almost cross-correlation free with an average correlation coefficient of $-0.01$ and a $p$-value of 9%.

[**TABLE 2 HERE**]

To also test the $CO_2$ and GDP variables for unit roots, we apply both the IPS test of Im et al. (2003) and the CIPS test of Pesaran (2007). While the IPS test is simply an average of augmented Dickey–Fuller statistics and therefore only allows for serial correlation, the CIPS test also allows for the correlation to occur across countries. This is accomplished in much the same way as in the CCE approach, by conditioning on the cross-sectional averages of the observed data. All one need to do is to pick a large enough lag length, $p$ say, such that the remaining regression error is serial and cross-country correlation free. The two most common choices are to let $p$ increase with the sample size, which ensures that we obtain an increasingly good approximation of the true model, or to set it according to an information criterion such as the Schwarz Bayesian information criterion, henceforth BIC. We use both approaches.

The results reported in Table 3 show that for both variables the unit root hypothesis is convincingly rejected. The only exception is for GDP when using the CIPS test in combination

with the BIC criterion, in which case we end up accepting the unit root hypothesis at the 5% level. However, since the acceptance is only marginal, we chose to proceed taking both variables as trend-stationary.

[**TABLE 3 HERE**]

## 3.3 Estimation

We begin by considering some preliminary results based on the time series averages for each country. This is illustrated in Figure 1, which plots of the time-averaged $CO_2$ and GDP variables for each country. To these data we fit two regression lines, one for the former British colonies and one for the rest. In agreement with our hypotheses, we see that the regression line representing the former British colonies has a steeper slope compared to the regression line representing the rest of the countries.

[**FIGURE 1 HERE**]

With Figure 1 in mind we now continue to the regression results in Table 4. Three estimators are considered, cross-section OLS based on the time-averaged data, henceforth denoted CS, pooled OLS and CCE. Allowing the countries to correlate with each other leads to a more general estimator but our results suggest that there are no major violations of the cross-country independence assumption, which makes the more parsimonious CS and OLS estimators interesting despite their lesser flexibility.

[**TABLE 4 HERE**]

Our main hypothesis, that being a British colony is associated with higher emission of $CO_2$ is clearly supported. The results based on (1) show that $\gamma$ is estimated significantly positive, suggesting British ex-colonies do have higher $CO_2$ emissions, and that this should hold irrespectively of their level of GDP. However, if we look at the results based on (2) we see that a this is actually not the case. Indeed, since $\theta$ is estimated significantly positive (OLS and CCE), this means that the observed differences in $CO_2$ emissions are due to differences in the nature of economic growth. In a nutshell, the growth of ex-colonies is associated with more $CO_2$ emissions than the growth of other countries. The results are not sensitive to whether the period variable (t) is also interacted with the UK dummy.

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We also see that $\rho$ is significantly negative (OLS and CCE) suggesting the possibility of an environmental Kuznets curve for the former UK colonies only.[2] This requires that the slope of the relationship between the per-capita $CO_2$ emissions and per-capita GDP (i.e. $dy_{it}/dx_{it}$) becomes negative within the range of our data. This is however not the case which is perhaps not surprising since an environmental Kuznets curve is often not found for pollutants with little direct impact on health including $CO_2$ (Dinda, 2004). Finally, we remark that for almost all ex UK-colonies, the slope of the relationship between the per-capita $CO_2$ emissions and per-capita GDP associated only with the two UK dummy variables combined (i.e. $\theta + 2\rho x_{it}$) is negative in the relevant range of the data implying that former UK-colonies indeed have a significant influence on the inverted U-shape.

## 4  Conclusions

Judging by our results, being the United Kingdom or a former colony of the same is clearly associated with higher levels of $CO_2$ emission. Hence, we may have discovered a hitherto unnoticed side effect of having inherited institutions from the country of the Magna Charta. Growth-promoting institutions seem to co-exist with high levels of $CO_2$ emission.

## References

Acemouglu D., Johnson, S., Robinson, J. A. (2001). The colonial origins of comparative development: an empirical investigation. *American Economic Review* **91**, 1369–1401.

Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. *Ecological Economics* **49**, 431–455.

Greif, A. (1994). Cultural beliefs and the organization of society: A historical and theoretical reflection on collectivist and individualist societies. *Journal of Political Economy* **102**, 912-50.

Greif, A. (2005). Commitment, coercion, and markets: the nature and dynamics of institutions supporting exchange. In Ménard, C., Shirley, M. M. (Eds.). *Handbook of new institutional economics.* Dordrecht: Springer, 727–786.

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[2]It may be worth noting that while $\phi$ is not significant in (2), it becomes significantly negative if we exclude the term $\rho D_i x_{it}^2$ from the estimation.

Im, K. S., M. H. Peseran and Y. Shin (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics* **115**, 53–74.

Kapetanios, G., Pesaran, H. M., Yamagata, T. (2009) Panels with nonstationary multifactor error structures. Unpublished manuscript.

La Porta, R., Lopez-deSilanes, F., Shleifer, A., Vishny, R. (1999). The quality of government. *Journal of Law, Economics and Organization* **15**, 222-279.

North, D. C. (1990). *Institutions, institutional change and economic performance.* Cambridge, United Kingdom: Cambridge University Press.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica* **74**, 967–1012.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross section dependence. *Journal of Applied Econometrics* **22**, 265–312.

Pesaran, H. M., Ullah, A., Yamagata, Y. (2008). A bias-adjusted LM test of error cross section independence. *Econometrics Journal* **11**, 105–127.

Stern, N. (2006). *Review on the economics of climate change.* London, United Kingdom: Her Majesty's Treasury.

Table 1: Included countries.

| Category | Countries |
|---|---|
| Colonies | Australia, Canada, Egypt, India, New Zealand, South Africa, Thailand, United Kingdom, United States |
| Non-colonies | Algeria, Argentina, Austria, Belgium, Brazil, Chile, China, Colombia, Denmark, Ecuador, Finland, France, Greece, Hungary, Iceland, Indonesia, Iran, Italy, Japan, Mexico, Netherlands, Norway, Peru, Philippines, Portugal, Spain, Sweden, Switzerland, Venezuela |

Table 2: Cross-country correlations.

| Test | GDP | $CO_2$ | Residuals |
|---|---|---|---|
| Average correlation | 0.12 | 0.10 | −0.01 |
| CD | 20.17 | 17.15 | −1.69 |
| $p$-value | 0.00 | 0.00 | 0.09 |

*Notes*: The CD statistic tests the null of no cross-correlation.
The $p$-values are from the asymptotic normal distribution.

Table 3: Panel unit root tests.

| Value | Function of $T$ | | BIC | |
|---|---|---|---|---|
| | $CO_2$ | GDP | $CO_2$ | GDP |
| CIPS | −2.973 | −2.711 | −3.173 | −2.457 |
| IPS | −3.947 | −3.839 | −5.650 | −4.787 |
| $p$-value | 0.000 | 0.000 | 0.000 | 0.000 |

*Notes*: The test regressions are fitted with an intercept and trend.
The lag length is set as a function if the number of time series
observations $T$, or according to the BIC. The $p$-values for the IPS
test are based on the normal distribution. The 5% critical value
for the CIPS test is −2.6.

Table 4: Panel estimation results.

| Variable | CS | | OLS | | CCE | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (1) | (2) | (1) | (2) |
| Constant ($\alpha$) | 2.925 | 5.369 | −0.093 | 1.035 | 1.299 | 3.533 |
| | (0.265) | (0.066) | (0.986) | (0.840) | (0.000) | (0.000) |
| UK Dummy ($\gamma$) | 0.380 | −5.421 | 0.394 | −5.855 | 0.394 | −5.842 |
| | (0.016) | (0.347) | (0.000) | (0.000) | (0.000) | (0.000) |
| Period ($t$) | | | 0.000 | −0.001 | 0.001 | 0.001 |
| | | | (1.000) | (0.734) | (0.000) | (0.000) |
| GDP ($\beta$) | 0.617 | 0.081 | 1.014 | 0.525 | 1.017 | 0.530 |
| | (0.345) | (0.910) | (0.000) | (0.000) | (0.000) | (0.000) |
| GDP$^2$ ($\phi$) | 0.000 | 0.029 | −0.024 | 0.002 | −0.024 | 0.002 |
| | (0.999) | (0.509) | (0.000) | (0.531) | (0.000) | (0.590) |
| UK×GDP interaction ($\theta$) | | 1.240 | | 1.368 | | 1.366 |
| | | (0.399) | | (0.000) | | (0.000) |
| UK×GDP$^2$ interaction ($\rho$) | | −0.064 | | −0.072 | | −0.072 |
| | | (0.483) | | (0.000) | | (0.000) |
| $R^2$ | 0.810 | 0.832 | 0.774 | 0.795 | 0.779 | 0.800 |

*Notes*: In column 1, GDP is used as an abbreviation for log per-capita GDP.
The standard errors of the panel estimators are robust against serial correlation.
The numbers within parentheses are the normal $p$-values of a double-sided $t$-test of a zero slope. The numbers (1) and (2) refer to the model being estimated.

Figure 1: Time series means of the detrended variables.