FAERE

French Association
of Environmental and Resource Economists

Working papers

The impact of renewable versus non-renewable natural capital on economic growth

Laura Recuero Virto - Denis Couvet

WP 2017.15

Suggested citation:

L. Recuero Virto, D. Couvet *(2017) The impact of renewable versus non-renewable natural capital on economic growth. FAERE Working Paper, 2017.15.*

ISSN number: **2274-5556**

www.faere.fr

The impact of renewable versus non-renewable natural capital on economic growth

Laura Recuero Virto
Museum National d'Histoire Naturelle and
Autorité de régulation des activités ferroviaires et routières
33 avenue du Maine, 75015 Paris, France
laura.recuero-virto@arafer.fr

Denis Couvet
Museum National d'Histoire Naturelle
43 rue Buffon, 75005 Paris, France
denis.couvet@mnhn.fr

Abstract

This paper examines whether natural capital is a robust determinant of economic growth, distinguishing the contribution of direct and indirect effects in renewable and non-renewable natural capital. Our hypothesis is that renewable natural capital may have a rather indirect but more important impact on economic growth than non-renewable natural capital, particularly through human well-being. In contrast, non-renewable natural capital can be a source of immediate financial wealth, but can have adverse social and environmental effects. To test this hypothesis we use a data set on 83 countries for the period 1960-2009 to compare the relevance of proximate and fundamental theories to explain economic growth. We find some evidence of an indirect negative impact of the share of renewable natural capital in wealth on economic growth through human well-being and, more precisely, through population growth rates and fertility. This is particularly the case for countries with higher levels of human development. In contrast, the share of non-renewable natural capital in wealth has a direct positive impact on economic growth in countries with lower income inequality and higher institutional quality. This finding reflects the effect of capital accumulation in the domestic economy, as capacity constraints are relaxed. Finally, countries with higher income per capita, higher human development and higher institutional quality have a higher share of renewable natural capital per capita, although they also have a lower share of renewable natural capital in wealth. Such result emphasises that renewable natural capital is very necessary for people (per capita), and hence is a primary concern for empowered countries, although such capital contributes less to wealth and economic growth in these countries. Our results question the way 'wealth' and economic growth are defined in economics when the effect of natural capital is examined.

JEL-codes: O10, O13, Q20, Q30, Q32.

Key words: Natural capital, economic growth, renewable and non-renewable.

August 2017

Introduction

The concept of 'natural capital' aims to underline the role of nature on supporting the economy and human well-being (Pearce et al., 1989). In this framework, two components of natural capital ought to be distinguished, differing on their renewability and social contribution: renewable natural capital, including biodiversity, ecosystems and their associated services which mainly provide non-market services, and also air and water; non-renewable natural capital, including mineral deposits and fossil fuels which do not generate direct services but only financial rents.1 Both types of natural capital provide people with exploitable resources (Petersen and Gocheva, 2015). In this paper, we use the World Bank definition of such a capital, based on a subset of renewable and non-renewable natural capital to derive a cross-country analysis (World Bank, 2006). For renewable natural capital, we take into account timber and non-timber forest resources, protected areas, cropland and pastureland. For non-renewable natural capital, we consider subsoil assets, namely, oil, natural gas, hard and soft coal, and minerals.

Both components of natural capital are steadily decreasing. Concerning renewable natural capital, Costanza et al. (2014) estimate, for instance, that the loss of ecosystem services between 1997 and 2011 was between 4 and 18% of the 1997 value. Using ecosystem productivity data, the loss was estimated at about 10%, with large geographical differences, within and between countries, the three top countries being Tunisia, Haiti and Libya with a loss above 40% (Sutton et al., 2016). Regarding non-renewable natural capital, its available amount has to be compared to the potential demand of a growing and increasingly affluent society (Andersson and Råde, 2002). For fossil energy carriers, oil and gas are scarcer than coal. For metals, platinum, gold and rhodium are the least abundant (Goedkoop et al., 2008; Wegener Sleeswijk et al., 2008).2 However, the amount of identified reserves usually increases with technological improvements, so that scarcity cannot be assessed based on presently identified reserves, phosphate being a possible exception (Reynolds, 1999).

Within such a context of natural capital depletion, the efforts hence costs of financing natural capital conservation, although not sufficient to avoid losses, can be considered as significant. For example, the resources currently being allocated to preserve and maintain biodiversity (around US 50 billion dollars per year) would, at best, cover one third of the lowest needs estimate. Current finance to protect biodiversity is mainly government-funded, insufficient and poorly distributed (MAEDI, 2014). As protection costs of natural capital are far from negligible from both financial and political standpoints, stakeholders, from local people to governments, are often reluctant to engage on such a protection, in the absence of strong socio-economic arguments. Thus, it is crucial to estimate, in a comprehensible manner for all stakeholders, the social importance of the protection, especially in regards to a most important social concern, economic growth.3

Natural capital, social benefits and economic growth

The dependence of the world population on natural capital is a much disputed topic. Dependence on natural capital has been sometimes argued to negatively affect economic growth, under the so-called 'natural resource curse' hypothesis. In this case, higher levels of natural capital can benefit a minority who controls access to natural resources by developing an extractive (often poorly functioning) political regime (Acemoglu and Robinson, 2012). There is an alternative hypothesis whereby abundance replaces dependence and positively affects economic growth (Brunnschweiler and Bulte,

1 Taxonomies of resources are always controversial. The dictinction between renewable and non-renewable natural capital stresses that using resources may be irreversible or not. Alternatively, the degree of exhaustibility could be considered to reflect the rate of use whereby a resource may be non-renewable but abundant. A classification could also be based on the capacity to generate economic rents through the explotation of the resource.

2 There might also be a limit concerning the maximum usable amount, due to planetaries limits to absorb the associated residues. Regarding fossil energies, for instance, 80% of fossil energy identified reserves should not be used in order to contain climate change (McGlade and Ekins, 2015).

3 This is the reason why the concept of ecosystem services was developed (Daily et al. 1997) and the associated monetary value was estimated (Costanza et al., 1997) although the exact meaning of giving a monetary value to ecosystem services for which there are no markets has often been questioned.

2008). This latter hypothesis is closer to the basic tenet that humans are highly reliant on a finite and non-growing ecosystem (Daly and Farley, 2004).4

One reason for these widely different conclusions is that one ought to define more precisely what natural capital is, and how it matters for economic growth. Therefore, to understand how natural capital contributes to economic growth, there is a need to distinguish renewables and non-renewables, direct and indirect social effects on economic growth, as well as to integrate the effect of international trade. In this regard, natural capital depreciation has been higher in poor countries compared to richer countries (Barbier, 2014), although poor countries currently compensate by higher capital growth, while rich countries do not (Barbier, 2015).

Our hypothesis is that these two types of natural capital affect economic growth in a different manner. Renewable natural capital, beyond contributing to food provisioning, provides local climate regulation, controls air and water quality, mitigates natural hazards, and hence contributes indirectly but strongly to local wealth, quality of social relationships, health and aesthetics (MA, 2005). Therefore, renewable natural capital may have a rather large indirect economic contribution to economic growth, particularly through health and, more generally, human well-being (MA, 2005).

Non-renewable natural capital is necessary for industry and agriculture, and can be a source of immediate financial wealth, but can have adverse social (Acemoglu and Robinson, 2012) and environmental effects through pollution, depending on state regulations. Thus, the benefits might depend on the quality of the institutions. Especially since such resources can also be more easily exchanged through international trade than renewables, a consequence of such a trade being that the negative local effects of extraction associated with pollution can be a source of competitive advantage for countries with low institutional quality. Companies, and indirectly governments, can promote exports of non-renewable natural capital, with the help of certain territories' low social and environmental regulations associated with spillage effects (Barbier, 2014; Lenzen et al., 2012).

Related to direct and indirect effects, social benefits linked to both kinds of natural capital also ought to be defined precisely. Concerning renewable natural capital, there is a need to identify the different human benefits of natural capital. These benefits depend on human life-styles, representations and values (Chan et al., 2012). It is also necessary to identify the natural entities necessary to provide these benefits. In this regard, biologists barely know how biological diversity (genetic and species diversity) affects the quantity and quality of ecosystem services (MA, 2005). For non-renewable natural capital, the degree of substitutability, hence the discount rate is a critical parameter to be considered (ten Brink et al., 2015). In particular, lower discount rates are more appropriate to account for intergenerational equity and ethical responsibilities to the world's poorest that depend directly on natural capital (Gowdy et al., 2009).

Finally, it is most important to distinguish between the share of natural capital in wealth (or natural capital dependence) and natural capital per capita (or natural capital abundance). The share of natural capital in wealth indicates the stage of development, with a higher share indicating societies at the first stage of development, where the economy is mainly based on agriculture and natural resource extraction. In contrast, natural capital per capita indicates whether the country is rich in terms of natural resources, or if it needs to import them. For renewables, lower availability might impact health and life of quality. These two variables do not usually have the same impact on economic growth, as a too strong dependence on agriculture and natural resource extraction is typically correlated with low economic growth, while a high ecological abundance in per capita terms contributes positively to growth (Gylfason, 2011).

Testing the impact of natural capital on economic growth

To our knowledge, this is a first attempt to have a better understanding of the role natural capital's dependence and abundance, distinguishing direct and indirect effects in renewable and non-renewable

4 See Rockström et al. (2009) for a set of nine planetary boundaries.

natural capital. To test these direct and indirect effects, we compare the relevance of proximate and fundamental theories to explain economic growth. We share the results of natural capital on economic growth for country typologies based on investment in physical capital, income per capita, income inequality, human development and institutional quality, as we further explain in the paper. Our analysis on the role of natural capital on economic growth controls for the existence of multiple growth regimes under a Bayesian Model Averaging (BMA) method that accounts for theory and specification uncertainty.

The remainder of this paper is structured as follows. In section 2, we describe the existing empirical evidence on the role of natural capital on economic growth, and we explain how we attempt to contribute to this literature. In section 3, we describe the econometric model and some preliminary tests to explore whether there are multiple economic growth regimes. We also explain how we compare the relevance of proximate and fundamental theories to explain economic growth. We then describe the data and share the results, including those for the full set of country typologies. In section 4, we conclude. The appendices provide a detailed description of the data and the estimations.

2. Natural Capital as a Determinant of Economic Growth - What Have We Learned?

Progress in the accounting and macroeconomic frameworks that integrate natural capital are necessary, especially for policy makers (Laurans et al., 2013; WWF, 2015; Recuero Virto et al., 2017). Early macroeconometric models uncover a negative relationship between resource dependence and economic growth. Sachs and Warner (1995) find evidence that resource rich countries underperform resource poor countries regarding export-led growth, after controlling for a number of other factors. Most of the analyses in the late 1900s and early 2000s also find evidence of such a negative relationship. However, such analyses are usually based on cross-sectional regressions, and authors frequently consider proxying resource dependence only through the share of primary exports in total exports or in the GDP (van der Ploeg, 2010). These analyses where mostly inspired by the difficulties of countries rich in non-renewable resources to transform this source of wealth on economic development (van der Ploeg, 2010; Ross, 2014).

Many of these studies attempt to explain the causes of such a negative relationship although there is no universally accepted theory of the curse of natural resources (Sachs and Warner, 2001; Torres et al., 2013). Many potential causes of the negative relationship between resource dependence and economic growth have been proposed, for instance, the crowding-out of manufacturing activities and the temporarily loss in learning-by-doing, the political capture of rent, unsustainable government policies, poor investment in human resources, economic shocks, low institutional quality, armed conflicts, lack of effective property rights and high transaction costs, or volatility of world resource prices.5

Since about the mid-2000s, however, there are a number of analyses that challenge the existence of a resource curse by providing evidence of a non-negative impact of natural resources on economic growth (Dinh and Dinh, 2016). For instance, several papers suggest that the negative relationship between natural resource dependence and economic growth can be reversed if institutional quality is high enough (Boschini et al., 2013). Natural resource-dependent countries constitute both growth losers and growth winners, and some authors argue that the main difference between the success cases and the cases of failure would lie in the quality of institutions and in the political economy (Melhum et al., 2006; Torvik, 2009).

Lederman and Maloney (2002) argue that the negative effect of natural resources on economic growth may be due to the use of inadequate indicators for natural resources and to international heterogeneity. Concerning indicators, the adverse effect of resource dependence on institutional quality and economic growth would be particularly strong for easily appropriable 'point-source' rents with concentrated production and revenues and large rents such as minerals, oil and plantation crops (coffee, sugar, banana, tobacco) compared to agriculture (rice, wheat, animals) whose rents are more dispersed and

5 See Frankel (2010) and Torres et al. (2013) for an exhaustive review of this literature.

less easily appropriated by state institutions.67 Cross-country regressions suggest that natural resources stimulate corruption amongst bureaucrats and politicians (Ades and Di Tella, 1999).

In addition, although natural resource dependence (measured through the share of exports of primary products in the GDP, and through other indicators in relative terms) may retard economic growth, natural resource abundance (often measured through per capita values of production and reserves or stocks) may be positively correlated or have no significant impact on economic growth.8 Gylfason (2011) finds that larger natural capital assets per capita enhance economic growth, while a large ratio of natural capital assets in national wealth has the reverse effect.

Ding and Field (2005) find similar results to Gylfason (2011) but that are contingent on the type of model used. According to Cerny and Filer (2007) although a large ratio of natural capital assets in national wealth is associated with slow economic growth, there is no evidence that natural capital assets per capita are negatively related to growth. The supposed (negative) link between resource dependence and economic growth would arise because of the inherent relationship between slow growth and a small non-resource sector caused by other undetermined characteristics of the economy.

According to Stijns (2005) the data on fuel and minerals reserves shows that natural resource abundance has not been a significant structural determinant of economic growth between 1970 and 1989, probably because of the existence of both positive and negative transmission channels. When a natural resource has high transportation costs, then its physical availability within the economy is important for the development of industries (De Long and Williamson, 1994; Bardini, 1997). Coal and iron ore deposits were a prerequisite for the development of a steel industry in the 19th century, for instance.4

Van der Ploeg (2010) does not find evidence of an impact of neither resource exports in the GDP nor subsoil assets in economic growth, and he concludes that this is probably due to the divergent impact of these variables on growth depending on the degree of volatility of commodity prices and exchange rates. Concerning production dependence, Hall and Jones (1999) and Sala-i-Martin et al. (2004) find instead a positive relationship between the mining share in GDP and economic growth. In Sala-i-Martin et al. (2004) mining requires conditioning on other variables to show its full impact.

In terms of the presence of international heterogeneity when analyzing the impact of natural resources on economic growth, the academic literature based on fixed-effects estimations provides evidence that natural resource export dependence variables are not significant determinants of economic growth (Mansano and Rigobon, 2001; Lederman and Maloney, 2002). However, such fixed-effects methods leave unexplained exactly the long-run cross-country growth variation originally motivating the research (Durlauf and Quah, 1999). To account for international heterogeneity in the effects of the determinants of growth, controlling for mean shifters by including regional dummies can be an alternative to fixed-effects estimations (Lederman and Maloney, 2008).

<u>Other variables and growth regimes in determining economic growth</u>

From an econometric perspective, regression analyses show that a large number of variables are correlated with economic growth but this does not imply a direction of causation. The lack of agreed theoretical bases for empirical work and for a reduced form to apply in empirical analyses, has led researchers to abandon any a priori models and to let the data show which variables are correlated with economic growth through model uncertainty (Capolupo, 2009). In order to estimate accurately the role

6 See van der Ploeg (2010) for a more detailed discussion.

7 Regarding as well the choice of natural resource indicators, when Lederman and Maloney (2008) use net exports of primary products per worker as a natural resource indicator, Sachs and Warner's (1995) negative impact of natural resources on economic growth based on gross exports of primary products in the GDP disappears due to the possibility of re-exportation.

8 There are alternative definitions. Norman (2009), for instance, defines resource abundance as the share of resources stocks in the GDP or as resource stocks in per capita terms and resource intensity as the rate of resource exports in the GDP.

of the so-called new growth theories such as natural capital in determining economic growth, Durlauf et al. (2005), Durlauf et al. (2008a) and Sala-i-Martin et al. (2004) propose the BMA methodology.9

An additional difficulty is that there might be multiple growth regimes, each regime with economies that tend to converge to one another (Durlauf and Johnson, 1995). Under such circumstances, the sample is divided based upon a cut-off point in a certain variable within the database either relying on the results of methodologies, or making an ad-hoc choice, for example using income per capita, human development, income inequality, and institutional quality.10 Konte (2013), for instance, allows for multiple growth regimes, and finds that democracy favors the contribution of natural resources to economic growth, while education has no effect.

To our knowledge, we propose a first attempt to have a better understanding of the role of renewable and non-renewable natural capital dependence and abundance in economic growth. Using a worldwide sample of countries, we estimate the augmented Solow model including new growth theories, among which the natural capital theory. We control for the existence of multiple convergence regimes under a BMA method that accounts for uncertainty.

3. Empirical Analysis on the Impact of Renewable versus Non-Renewable Natural Capital and Economic Growth

3.1. Econometric Methodology

In this section, we first present the baseline model based on the augmented Solow model and a set of new growth theories. Secondly, we explain how we integrate theory and specification uncertainty through the BMA. Lastly, we explain how we perform our preliminary analysis on the existence of multiple convergence regimes.

Economic growth model: Baseline model with eight fundamental and proximate theories

Since the variation of economic growth rates at annual frequency rates may give very misleading information about the long-term growth process, we average data over five year periods.11 Based on Durlauf and Quah (1999), we use the following augmented Solow model with a set of new growth theories (Solow, 1956; Durlauf et al., 2005; Durlauf et al., 2008a):

$$\log(y_{i,r}) = \gamma_0 \log(y_{i,r-T}) + \gamma_1 \log(s^k_{i,r}) + \gamma_2 \log(s^h_{i,r}) + \gamma_3 \log(n_{i,r} + g + \delta) + z_{i,r} + \alpha_i + \theta_r + \varepsilon_{i,r} \quad [1]$$

$$\gamma_1 = e^{\lambda T} \quad \gamma_2 = \left(1 - e^{\lambda T}\right)\frac{\alpha_k}{1-\alpha_k-\alpha_h} \quad \gamma_3 = \left(1 - e^{\lambda T}\right)\frac{\alpha_h}{1-\alpha_k-\alpha_h} \quad \gamma_4 = -\left(1 - e^{\lambda T}\right)\frac{\alpha_k+\alpha_h}{1-\alpha_k-\alpha_h}$$

where y_{ir} is the real per capita GDP for country i = [1,.. N] across a time period r = [r, r+T], T being 5 years, $s^k_{i,r}$, $s^h_{i,r}$ and $\log(n_{i,r} + g + \delta)$ denote the variables that measure the net factor accumulation in the neoclassical growth theory, that is, the saving rates of physical capital accumulation ($s^k_{i,r}$) and human capital accumulation ($s^h_{i,r}$) and population growth rates ($n_{i,r}$), the rate of labour augmenting technical progress (g) and the physical capital depreciation rate (δ). Moreover, $z_{i,r}$ denotes a set of

9 Fernandez et al. (2001) show the superiority of BMA over other techniques in selecting regressors to explain cross-country growth.

10 There are a number of studies that employ a wide variety of statistical methods in attempting to identify multiple growth regimes (Durlauf et al., 2005). See Owen et al. (2007) and Konte (2013) for an overview of how the presence of multiple growth regimes has been addressed by dividing the sample according to different theories, mainly, neoclassical, geography, demography and institutions.

11 We have replicated the analysis with 10 year periods but the sample size is too small given the nature of our data (presence of heteroskedasticity and serial correlation). Even though averaging over the longest time horizon possible should better deal with eliminating business cycle effects that probably dominate per capita income fluctuations at higher frequencies, it comes at the cost of reducing the sample size (Durlauf et al., 2008b). In turn, when the sample size is too limited and the number of explanatory variables large, estimation methods can be of limited use to distinguish robust from irrelevant variables.

variables proxying eight new growth theories described in the data subsection and in the appendices (Tables A.1 and A.2), α_i is a country-specific effect, θ_r is a time-specific effect and $\varepsilon_{i,r}$ is the error term.12

Note that typically $g + \delta$ = 0.05 (Mankiw *et al.,* 1992). α_k and α_h are the parameters associated with the Cobb-Douglas production function on physical and human capital input variables, such that $\alpha_k > 0, \alpha_h > 0$ and $\alpha_k + \alpha_h < 1$. λ is a parameter that denotes the rate of convergence, such that $\lambda < 0$. Saving rates of physical capital accumulation and saving rates of human capital accumulation are referred to hereafter as investment in physical capital and schooling, respectively.

Each growth theory can be proxied by several variables within $z_{i,r}$ (Table 1). A proxy variable is used to represent an unobserved metric and should be strongly correlated with the unobserved corresponding variable. For example, life expectancy and fertility rate are proxy variables strongly correlated with the demography theory. While proxy variables are rarely perfect estimations of the unobserved variable, they still provide a worthwhile approximation for a necessary variable in our model. When there are several proxies within a theory, one can examine separately the effect of each proxy. Some may be more important than others, clarifying what are the variables which matter, within a theory. For example, one can examine the impact of fertility in the demography theory, or the impact of the eastern religion in the religion theory.

Table 1
Proximate and fundamental growth theories and their proxies.

PROXIMATE THEORIES	**PROXIES**
Neoclassical	Initial income, population growth rates, investment in physical capital and schooling (Solow, 1956)
Demography	Life expectancy and fertility rate (Shastry and Weil, 2003; Weil, 2005)
Macroeconomic policy	Openness, government consumption and inflation (Barro, 1997)
Regional heterogeneity	Latin America and Caribbean, Sub-Saharan Africa, East Asia and the Pacific and South-East Asia(Brock and Durlauf, 2001)
FUNDAMENTAL THEORIES	**PROXIES**
Religion	Buddhism, catholic, eastern religion, hindu, jew, muslim, orthodox, protestant and other (Barro and McCleary, 2003; Durlauf et al., 2012)
Natural capital	Natural capital in wealth (total, renewable and non-renewable) and natural capital per capita (total, renewable and non-renewable) (Sachs and Warner, 1995; Gylfason, 2011)
Geography	Coastline, landlocked (Sachs, 2003)
Fractionalisation	Language and ethnic (Alesina et. al., 2003; Easterly and Levine, 1997)
Institutions	Liberal democracy, public sector corruption, legal formalism, governance and executive constraints (Djankov et al., 2002; 2003)

We work with the following set of new eight growth theories, in addition to the neoclassical theory. These can be classified into proximate and fundamental or deep theories. Neoclassical, demography, macroeconomic policy, regional heterogeneity are four proximate theories. Religion, natural capital, geography, fractionalisation and institutions are five fundamental theories. Proximate theories are sometimes only associated with proxy variables included in the growth accounting framework of equation [1], that is, the production factor inputs, which are human and physical capital, and the productivity with which these endowments are deployed to produce a flow of goods and services

12 In our economic growth regressions, we replace the country-specific effect variables by the regional heterogeneity variables included in the new growth theories which enables us to take into account regional heterogenity while decreasing the number of variables in the regression given the short number of observations typically associated with these estimations.

(Rodrik, 2003). Other analyses, as in our case, would include additional determinants that can be rapidly influenced by policy measures (Durlauf et al., 2008b). The fundamental or deep sources of growth relate to those variables that have an important influence on a country's ability to accumulate factors of production and invest in the production of knowledge (Acemoglu et al., 2005). In contrast with proximate determinants, fundamental determinants tend to depend on slow-moving parameters (Durlauf et al., 2008b). Our economic growth regressions include both proximate and fundamental theories.

A theory is considered to be explanatory for growth when there the variables belonging to this theory have a significant effect on growth (see more explanations below). Fundamental variables, associated to corresponding theories, can have direct and/or indirect effects on economic growth. To analyse this matter, we first develop estimations including both proximate and fundamental variables. If fundamental theories are significant in these estimations, this implies that the corresponding variables have a direct impact on economic growth. It may also be the case that fundamental theories are not significant in these estimations, and yet may have an indirect impact on economic growth.

To test this hypothesis, we develop estimations only including fundamental theories. If some of the fundamental theories in these latter estimations are significant, while they were not significant in the estimations with proximate and fundamental theories, we can infer that such fundamental theories have an indirect impact on economic growth through proximate theories. In fine, we analyse whether fundamental theories exert a direct influence on economic growth, or an indirect influence through their correlation with proximate theories. Correlations between proximate and fundamental theories are also explored, to provide some preliminary evidence that may be corroborated by the results of the estimations.

Economic growth model: Uncertainties associated with theories and proxy variables

In regards to the contribution of any theory to economic growth, there is a problem of model uncertainty when performing economic growth estimations following the regression model [1] (Brock and Durlauf, 2001; Brock et al., 2003). More precisely, the statement that a theory is relevant does not preclude others from being relevant as well. Moreover, there is specification uncertainty since growth theories do not translate naturally into specific regressors, proxy variables ought to be used (see above). To deal with these two model uncertainties, we employ a BMA estimator.

In model averaging models, we treat the growth model as an unobservable variable. To account for this variable, each model specification m in the model space M is associated with a posterior model probability $\mu(m|D) \propto \mu(D|m)\,\mu(m)$, where D is the available data, $\mu(D|m)$ is the likelihood of the data given the model and $\mu(m)$ is the prior model probability. We set the prior probability that a particular theory is in the true model to 0,5 to reflect non-information across theories (Durlauf et al., 2008a).[13] The posterior model probability is the probability that model m is the true model given the data and we can hence calculate whether a theory is in the true model by computing $\sum \{m \in M\}\ \mu(m|D, m \in A)$, where A is the event that at least one proxy variable is in the true model. A specific theory is robust when the posterior model probability is higher than the prior probability of 0,5. A specific variable is significant if its posterior mean of the probability is at least twice the posterior standard deviation (Brock and Durlauf, 2001).

Preliminary analysis: Presence of multiple convergence regimes

We apply a preliminary analysis to the augmented Solow model to explore whether there are multiple convergence regimes, depending on certain determinants of growth. The so-called conditional beta-convergence is interpreted as evidence that poorer countries are converging with richer ones after controlling for heterogeneity.[14] Alternatively, there can be evidence of multiple convergence regimes

13 Assigning equal prior probability to each possible model can have odd implications for linear regressions with a large number of potential regressors. However, the number of variables we are including is not very large compared to other analyses, since we are building over Durlauf et al. (2008a) results.

14 There is evidence against unconditional beta-convergence, where the latter implies that countries that are poorer and have higher marginal productivity of capital should grow faster in the transition to the long-run steady state,

if there is no single regime model for global convergence (Durlauf and Johnson, 1995). That is, even after controlling for structural heterogeneity there is a role for initial conditions in explaining variation in cross-country growth behaviour.15

To analyse whether there are multiple convergence regimes we proceed in two steps. Based on Durlauf and Johnson (1995), we use the Classification Analysis and Regression Tree (CART) model applied to Solow variables to identify those that are most likely to provide a more 'reasonable' separation of observations. We then perform some preliminary estimations for the full sample and for the identified sub-samples, and we test the hypothesis that the full set of countries in the sample follows the same convergence dynamics through a Chow test.16 This test enables to derive whether we should perform our economic growth regressions on one sample or whether we should work with several sub-samples.

To perform these preliminary estimations, since the country-specific effect α_i is not distributed independently with respect to $\log(y_{i,r-T})$, we can use a fixed-effects method rather than a random effects method. Another alternative is to difference the model to eliminate fixed-effects and then use the Differenced Generalised Method of Moments (DIF-GMM) method developed by Arellano and Bond (1991) to address the contemporaneous correlation between the differenced lagged dependent variable $\log(y_{i,r-T})$ component of $\Delta\log(y_{i,r-T})$ and the $\Delta\varepsilon_{i,r-T}$ component of the new error term:

$$\Delta\log(y_{i,r}) = \gamma_0\Delta\log(y_{i,r-T}) + \gamma_1\Delta\log(s_{i,r}^k) + \gamma_2\Delta\log(s_{i,r}^h) + \gamma_3\Delta\log(n_{i,r} + g + \delta) + \Delta z_{i,r} + \Delta\theta_r + \Delta\varepsilon_{i,r} \quad [2]$$

We follow the standard approach where lagged values of the potentially endogenous regressors in levels are used as instruments. However, if the explanatory variables have highly persistent effects, lagged variables in levels can be weak instruments to capture such effects, and the estimator can be biased. To check for the consistency of the DIF-GMM results, we propose to compare the estimates of the rate of convergence of the Ordinary Least Squares (OLS) and the within-group methods with that of the DIF-GMM. If the explanatory variables other than lagged output are exogenous then a consistent DIF-GMM parameter estimate should lie between OLS and within-group estimates which are biased in opposite directions (Caselli et al., 1996).

Besides, lagged variables in levels can also be inappropriate instruments if there is serial correlation in the error terms of the growth equation before differencing. Due to these drawbacks associated with the DIF-GMM method, we estimate as well equation [2] through the system GMM (SYS-GMM) method derived by Arellano and Bover (1995). This estimator uses, in addition to the moment conditions used in the DIF-GMM method, instruments in first differences for the equation in levels and hence offers higher robustness.

3.2. Data

The unbalanced panel data set constructed for this study contains observations for 10 five-year periods from 1960 to 2009 on 83 countries. The choice of the eight growth theories and the associated variables is largely inspired by the work of Durlauf et al. (2008a). There are some differences in the choice of variables, though. We include our variables of interest, that is, the share of natural capital in

independently of structural heterogeneity. In contrast, in conditional convergence countries will tend to different levels of income in the long run. The evidence of unconditional convergence among manufacturing industries rather than in entire economies suggests that the lack of convergence is due to the factors that influence the speed of reallocation from non-convergence to convergence activities (Rodrik, 2012).

15 Note that multiple regimes may represent evidence of multiple steady-states as well as evidence of non-linearity in the growth process.

16 The F-statistic of the Chow test is $(rss_r-(rss_1+rss_2))/K(rss_1+rss_2)/(n-2K)$ where rss_r is the residual sum of squares from the full-sample model, rss_1 and rss_2 are the residual sum of squares of the two sub-sample models, and K is the total number of independent variables (including the constant).

wealth and the natural capital per capita suggested by Gylfasson (2011).17 Natural capital consists on timber resources, non-timber forest resources, protected areas, cropland and pastureland and subsoil assets. We distinguish renewable (timber, non-timber forest resources, protected areas cropland and pastureland) and non-renewable (oil, natural gas, hard coal, soft coal, coal and minerals) natural capital. National wealth is approximated by the present value of sustainable consumption using a social discount rate of four (World Bank, 2006).

Compared to Durlauf et al. (2008a), we use the average growth rate of real per capita GDP instead of the average growth rate of real per worker GDP since the dataset from Caselli (2005) does not cover our period of study. For the geography theory, we use some variables suggested by Durlauf et al. (2005) since those used by Durlauf et al. (2008a) were often not available for our sample of countries. For the institutions theory, we use individual and minority rights and public sector corruption, instead of expropriation risks since the latter was not available for our period of study. The detailed definition of the variables, their designation and the data sources are given in Tables A.1-A.2 in the appendices.

3.3. Preliminary analysis results

In this subsection, we summarise the preliminary analysis results in Tables A.3-A.9 in the appendices. Data shows heteroskedasticity and serial correlation, effects which need to be taken into account. Moreover, we find some evidence of the existence of multiple convergence regimes among our panel of countries based on the CART model, depending on the median level of investment in physical capital. Given this result, we develop the regressions on the economic growth determinants for the whole sample and for the two sub-samples defined by the cut-off point in the median level of investment in physical capital which determines the two economic growth regimes.

The ratio of renewable natural capital in wealth is larger for countries with investment in physical capital below the median cut-off point than for countries with investment in physical capital above the median cut-off point. The share of renewable natural capital in wealth is correlated with neoclassical (population growth rates), demography (life expectancy and fertility rate) and regional heterogeneity (Sub-Saharan Africa) proximate theories. The 'natural capital' fundamental theory has no direct influence on economic growth, particularly so for the sub-sample of countries with lower levels of investment in physical capital. We analyse further in the next subsection whether fundamental theories (renewable natural capital, but also religion, fractionalisation and institutions) impact economic growth, beyond the influence exerted through proximate theories' variables.

3.4. Economic growth regression results

Based on equation [1], we present our findings first regarding the natural capital theory, then the other eight new growth theories, and finally the neo-classical theory, also called the augmented Solow model. In the remainder of the paper, when we do not specify the type of natural capital (as a share of wealth or in per capita terms), we refer to both of them.18,19

17 We acknowledge that this data is subject to certain limitations (van der Ploeg and Poelhekke, 2010). For instance, the data uses the same discount rate of four% per annum regardless of the rate of economic growth, and the same remaining lifetime of 20 years and the same elasticity of the cost of extraction independently of the type of resource, country and date. van der Ploeg (2010) also argues that there is a caveat in using World Bank data on resource stocks as a measure of abundance since it is based on rents.

18 The ratio of observations to independent variables should not fall below five (Bartlett et al., 2001). As in Durlauf et al. (2005), we therefore exclude from the BMA regressions the variables which have weaker explanatory power in our regressions with respect to those presented in Table A.3 (we exclude some religion variables: buddhism, catholic, jew and orthodox). We check for multicollinearity which leads to the exclusion of additional variables from the BMA regressions (some regional heterogeneity variables: East Asia and the Pacific and some institutional variables: liberal democracy, public sector corruption, legal formalism: Check (1), legal formalism: Check (2) and complex).

19 The results on the natural capital theory can be found in Tables A.10-A.12, those on renewable natural capital in Tables A.13-A.15, and those on non-renewable natural capital in Tables A.16-A.18. The BMA method results are available in Tables A.10, A.13 and A.16 for the full sample and in Tables A.11-A.12, A.14-A.15 and A.17-

The relevance of the natural capital theory

Natural capital does not impact economic growth when we consider both proximate and fundamental theories (Table 2, and Tables A.10-A.18 in the appendices). These results appear to contradict previous findings in the empirical literature where natural capital is a significant determinant of economic growth (Ding and Field, 2005; Cerny and Filer, 2007; Gylfason, 2011).

Table 2

Economic growth determinants: BMA posterior inclusion probability results for natural capital.

	Proximate and fundamental theories			**Fundamental theories**		
	Full sample	***invest* ≥ 3,10**	***invest* < 3,10**	**Full sample**	***invest* ≥ 3,10**	***invest* < 3,10**
NATURAL CAPITAL	0,250	0,170	0,096	0,227	0,084	0,341
NATURAL CAPITAL (renewable)	0,168	0,165	0,220	**0,605**	0,378	0,525
NATURAL CAPITAL (non-renewable)	0,277	0,153	0,079	0,059	0,038	0,124

Note. Summary results on the natural capital theory for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. Results are reported for the natural capital theory for renewable and non-renewable natural capital indicators separately, and for the full sample and for the sub-samples defined by the median cut-off point in investment in physical capital, *invest.* The value in bold indicates that the variable is a relatively robust determinant of economic growth, with robustness increasing as the probability gets close to 1.

When we consider only fundamental growth theories, renewable natural capital as a theory becomes relatively robust. Thus, such a capital would affect economic growth indirectly through its influence on proximate theories' variables. Our results may indicate why previous findings on the direct contribution of natural capital to economic growth based on standard methods without uncertainty are uncertain and fragile.

Our preliminary findings (subsection 3.3) show that, as a fundamental theory, the share of renewable natural capital in wealth is correlated with neoclassical (population growth rates), demography (fertility rate) and regional heterogeneity (Sub-Saharan Africa) proximate theories (Table A.9). Moreover, concerning the regressions, fertility is a robust (and negative) determinant of growth (Table A.13). Thus, we infer that the share of renewable natural capital in wealth contributes to economic growth indirectly through fertility rates.20

A.18 for the two sub-samples defined by the cut-off point in the median level of investment in physical capital. Tables A.10-A.18 show results when we include both proximate and fundamental determinants in the model space (columns 1-3) as well as when only fundamental growth determinants are in the model space (columns 4-6). Columns 1 and 4 provide the posterior probability that each theory is in the 'true' model under the BMA method. In Table 2, we put forward our results on the natural capital theory, the main focus of our research, when running the full model with eight theories. We share the summary findings of the BMA posterior inclusion probability results for the aggregated renewable and non-renewable natural capital variables, and for renewable and non-renewable natural capital variables separatedly. In Table 3, we share the findings related to the remaining seven economic growth theories. We share the summary findings of the BMA posterior inclusion probability results for the full set of eight theories when the model is ran with the aggregated renewable and non-renewable natural capital variables. The results in Table 3 do not differ for the seven growth theories (with the exception of natural capital) when running the model either with renewable or non-renewable natural capital variables separatedly.

20 When the demography variables are included in the model space that has only fundatmental theories, the renewable natural capital theory that is found to be a determinant in column 4 of Table 2 (0,605) becomes non relevant with a posterior probability of 0,174, while the posterior probability of the demography theory is 1,000. Results are available upon request.

The relevance of the other new growth theories

Beyond the effect of renewable natural capital as a share of wealth, demography, religion and institutions are the other variables affecting economic growth, in the context of the new growth theories (Tables 3 and A.10).21,22 The effect of *fertility* is detrimental to economic growth and significant (Table A.10) as in Barro (1991; 1996; 1997) and Barro and Lee (1994). In terms of religion, the eastern religion favors economic growth, directly and indirectly (Table 3), confirming previous results in the empirical literature (Barro and McCleary, 2003; Durlauf et al., 2008a).

Table 3
Economic growth determinants: BMA posterior inclusion probability results.

	Proximate and fundamental theories			**Fundamental theories**		
	Full sample	***invest* ≥ 3,10**	***invest* < 3,10**	**Full sample**	***invest* ≥ 3,10**	***invest* < 3,10**
DEMOGRAPHY	**1,000**	**1,000**	0,161			
MACROECONOMIC POLICY	0,028	**0,973**	0,041			
REGIONAL HETEROGENEITY	0,085	0,002	0,384			
RELIGION	**0,981**	**0,980**	0,241	**1,000**	**1,000**	0,116
NATURAL CAPITAL	0,250	0,170	0,096	0,227	0,084	0,341
GEOGRAPHY	0,056	0,078	0,065	0,035	0,037	0,088
FRACTIONALISATION	0,056	0,092	0,052	**0,964**	**0,992**	0,083
INSTITUTIONS	**1,000**	**1,000**	**0,999**	**1,000**	**0,999**	**1,000**

Note. This table provides the summary results on the eight growth theories for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. Results are given for the full sample, and for the sub-samples defined by the median cut-off point in investment in physical capital, *invest.* The text in bold indicates that the variable is a relatively robust determinant of economic growth.

Our results suggest a negative role of institutions on economic growth, directly and indirectly - considering only fundamental theories- (Table 3), in contrast with the result of Acemoglu et al. (2002). One interpretation of our results is that greater checks and balances may depress growth by blocking policy decisions (Barro, 1994). Another reason could be that our measure of institutional quality correlates positively with political instability, a variable for which there is also significant evidence in the empirical literature of a negative relationship with respect to economic growth.23

Fractionalisation would matter for economic growth, only when fundamental growth theories are considered (Table 3), explaining more precisely previous work in the empirical literature suggesting an important role for fractionalisation in growth (Easterly and Levine, 1997; Alesina et *al.,* 2003). Moreover, when we included the demography variables in the model space only with fundamental theories, the fractionalisation variables that were found to be robust determinants in column 4 of Table

---

21 With the exception of the natural capital theory findings, the results of the BMA analysis on the remaining determinants of economic growth are very similar when including in the estimation natural capital variables (Tables A.10-A.12), and renewable (Tables A.13-A.15) and non-renewable natural capital variables (Tables A.16-A.18).

22 Compared to Table 2, we cannot observe a robust impact of the renewable natural capital theory on economic growth in Table 3, since in Table 3 we are reporting the sum of renewable and non-renewable natural capital variables.

23Our executive constraints variable reflects the outcomes of most recent elections as a 'political institution' variable (Glaeser et al., 2004). Some authors suggest that this variable cannot be therefore interpreted as reflecting durable rules, procedures or norms. Given this view, Cox and Weingast (2015) find that in terms of moderating succession-related downturns and thereby promoting steadier economic growth, the quality of legislatures measured by the executive's horizontal accountability is more important than the existence of free and fair elections. In addition, to the extent that elections may correlate with political instability, there is significant evidence of negative relationship with respect to economic growth (see, for instance, Barro, 1991; Barro and Lee, 1994; Sachs and Warner, 1995; Alesina et al., 1996; Castelli et al., 1996).

3 become non-robust with a posterior probability of 0,06.[24] This is consistent with our preliminary results where, among fundamental theories, fractionalisation is correlated with neoclassical (population growth rates), demography (fertility rate) and regional heterogeneity (Sub-Saharan Africa) variables (Table A.4). As with the natural capital theory, our results indicate that previous findings on the importance of fractionalisation to economic growth are fragile.

The relevance of the neoclassical theory

Investment in physical capital is not a significant determinant of economic growth, in contrast with previous findings (see, for example, Barro, 1991; Barro and Lee, 1994; Sachs and Warner, 1995; Barro, 1996; Caselli *et al.,* 1996; Barro, 1997). The effect of schooling is not significant neither, but this result remains largely consistent with the empirical literature (Durlauf et al., 2008a). In exercises where we drop demography from the model space, we find that population growth rates are negatively though still not significantly related with growth (Mankiw *et al.,* 1992; Kelley and Schmidt, 1995; Blooms and Sachs, 1998).[25] This variable is instead significant for the sub-sample with investment in physical capital below the median cut-off point (see Tables A.11, A.14 and A.17).

In Table A.10, we can see that we find robust evidence of conditional convergence with a negative and significant coefficient on initial income as many previous studies (see, for instance, Barro, 1991; Sachs and Warner, 1995; Barro, 1997; Easterly and Levine, 1997). Our findings are overall consistent with those of the conditional convergence literature as well as with previous studies based on BMA methods.

The possibility of multiple convergences regimes

As there is evidence of the presence of different regimes depending on the level of investment in physical capital, when we compare the two sub-samples according to the median level of such an investment, two main differences arise between these sub-samples. Above the median cut-off point, beyond demography, religion and institutions, macroeconomic policy is also a robust determinant of economic growth. In particular, in Table A.11 we can see that inflation is negatively and significantly correlated with economic growth, a result that is consistent with the empirical literature (Barro, 1997; Bruno and Easterly, 1998). Below the median cut-off point, the institutions theory is the only robust theory, even though no specific institutional variable is significant (Table A.12). Most importantly, natural capital remains a non-robust determinant of economic growth when separating the countries in the sample according to the median level of investment in physical capital.

We also test the impact of renewable and non-renewable natural capital on economic growth, when we allow for the possibility of alternative growth regimes to the one defined by investment in physical capital. We focus on income per capita, income inequality, human development and institutional quality to distinguish different growth regimes, and hence to analyse the role of natural capital on economic growth. There are many reasons that explain the choice of these different growth regimes.

Richer countries may be specialized in services and/or be wealthy enough to protect their natural resources and import them from poorer countries, and as such may depend loosely on their local (renewable) natural capital, like Singapore, Netherlands, Japan and Switzerland which import most of their food. International trade allowing such a specialization (Lenzen et al. 2012), highly polluting activities can be displaced to poor countries. This specialization may also depend on the country's history, whether or not it is an ancient colony, especially when there are easily exportable and controllable products such as oil and diamonds rather than cereals, for example (Pomeranz, 2000).

Income inequality within countries could also matter, since different social groups might be differently affected by the loss of natural capital. In particular, the ones who benefit more from economic growth are not necessarily those who are more affected by natural capital degradation (TEEB, 2008). Such a context has been often associated with the granting of perverse subsidies (Edenhofer, 2015). Thus, we

24 Results are available upon request.

25 Results are available upon request.

should distinguish the dependence on local (renewable) and on global (non-renewable) natural capital depending on within country income inequality. In addition, human development might be an appropriate indicator to examine human dependence on natural capital, as it takes into account health, among other social effects of natural capital. The inverse relationship between dependence on natural capital and education has also been explored (Gylfason, 2001). Furthermore, the negative relationship between natural resource intensity and economic growth can depend on institutional quality (Melhum et al., 2006; Torvik, 2009; Boschini et al., 2013).

In Table 4, we can see our results on the natural capital theory, when running the full model with eight theories (as in Table 2). We share the summary findings of the BMA posterior inclusion probability results for the aggregated renewable and non-renewable natural capital variables, and for renewable and non-renewable natural capital variables separately. As in Table 2, we separate the sample according to the levels of investment in physical capital, but we also divide it according to income per capita, income inequality, human development and institutional quality median values, under the hypothesis that there are different growth regimes.26 Based on these additional country typologies, we find a direct positive impact of natural capital on economic growth in the sub-sample with lower income inequality, since it significantly impacts growth when analysing proximate and fundamental theories together.27

Table 4
Natural capital as determinants of economic growth according to different country typologies.

	Proximate and fundamental theories			**Fundamental theories**		
	Total	Renewable	Non-renewable	Total	Renewable	Non-renewable
Full model	0,250	0,168	0,277	0,277	**0,605**	0,059
Investment in physical capital						
invest < 3,10	0,096	0,220	0,079	0,341	0,525	0,124
invest ≥ 3,10	0,170	0,165	0,153	0,084	0,378	0,038
Income per capita						
income < 9	0,089	0,061	0,085	0,448	0,159	0,174
income ≥ 9	0,073	0,193	0,193	0,152	0,315	0,070
Income inequality						
GINI < 38,61	**0,701**	0,273	**0,802**	0,164	0,186	0,329
GINI ≥ 38,61	0,079	0,096	0,062	0,079	0,056	0,090
Human development						
HDI < 0,628	0,084	0,099	0,074	0,239	0,066	0,326
HDI ≥ 0,628	0,042	0,206	0,451	0,052	**0,732**	0,121
Institutional quality						
kkz96 < 0,07	0,087	0,056	0,079	0,098	0,093	0,060
kkz96 ≥ 0,07	0,124	0,383	**0,930**	0,043	0,187	0,353

Note. This table provides the summary results on the natural capital theory for the growth regression exercise in equation (1), in particular, the BMA posterior inclusion probability results. The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. Results are given for sub-samples whose threshold is defined by the median in investment in physical capital, income per capita, income inequality, human development and institutional quality. The text in bold indicates that the variable is a relatively robust determinant of economic growth.

26 An ex-post exploration of the data following the procedure of the preliminary analysis (see Table A.6), shows that we cannot reject the presence of different growth regimes for the sub-samples on income per capita (under fixed-effects estimation with the F statistic significant at the 1%), income inequality (under OLS and fixed-effects estimations both with the F statistic significant at the 1%), human development (under OLS and fixed effects estimations both with the F statistic significant at the 1%) and institutional quality (under fixed-effects estimation at with the F statistic significant at the 1%). Detailed results are available upon request.
27 The full set of results are available upon request.

Besides, when we analyse separately renewable and non-renewable natural capital, in Table 4 we can see that the share of renewable natural capital in wealth is positively correlated with fertility in the sub-sample with higher levels of human development and, in turn, we have found that fertility affects negatively economic growth. In contrast with the effects of the share of renewable natural capital in wealth, the share of non-renewable natural capital in wealth has a direct impact on economic growth. These results hold for two different sub-samples, those characterised by lower income inequality and by higher institutional quality, given that natural capital is a robust determinant of growth when both proximate and fundamental theories are analysed together. This impact is positive through the non-renewable natural capital in wealth variable in both sub-samples, and significant in the sub-sample characterised by higher institutional quality.

The relationship between natural capital and the other variables determining economic growth

Finally, to further interpret our results, we consider how natural capital is related to the different variables affecting economic growth, namely income per capita, income inequality, human well-being, especially human development, and institutional quality (Table 5). There are two major results. First, countries with higher income per capita, higher human development and higher institutional quality have higher renewable and non-renewable natural capital per capita (the results are more ambiguous in regards to inequalities). Such a result is consistent with our hypothesis, that is, renewable natural capital is very necessary for the quality of life, hence is a primary concern for wealthy, equitable and empowered countries. However, such differences between countries also hold for non-renewable natural capital, and could require a different explanation. We suggest that well empowered countries manage more efficient technologies to extract costly natural resources, with a preference for a large degree of autonomy, although they are more dependent, due to their higher consumption rate of such resources (Chen et al., 2011).28

Table 5
Characterisation of countries according to different typologies.

	Obs.	**Natural capital in wealth**			**Natural capital per capita**		
		Total	Renewable	Non-renewable	Total	Renewable	Non-renewable
Income per capita							
income per capita < 9	479	0,35	0,29	0,06	8	7	1
income per capita ≥ 9	351	0,14	0,06	0,08	32	13	19
Income inequality							
GINI < 38,61	320	0,15	0,15	0,01	16	11	3
GINI ≥ 38,61	510	0,33	0,23	0,10	21	8	13
Human development							
HDI < 0,628	322	0,44	0,38	0,08	7	6	1
HDI ≥ 0,628	500	0,16	0,10	0,07	26	12	14
Institutional quality							
kkz96 < 0,07	410	0,38	0,29	0,09	11	6	5
kkz96 ≥ 0,07	420	0,14	0,10	0,04	26	13	13

Note. This table reports mean values of natural capital theory variables. Natural capital per capita is expressed in 2000 K US dollars. The classification of countries is done according to median values in investment in physical capital, income per capita, income inequality, human development and institutional quality. The variable income per capita is measured by the logarithm of GDP per capita. The GINI indicator represents the income disparity with higher values indicating higher income disparities. The HDI indicator stands for the Human Development Index with higher values indicating higher human development. The institutional quality indicator is proxied through the *kkz96* variable (see Table A.2), with higher variables implying higher institutional quality. The observation unit corresponds to a time-series-cross-sectional data point.

28 We note there is a complex relationship between income growth, income and natural capital. For instance, some OPEC countries have very high income levels per capita, mainly linked to the oil sector, but have experienced a negative real growth over the past few decades.

Second, relative to these same indicators, income per capita, human development and institutional quality, renewable natural capital in wealth and per capita have an inverse ranking: Countries with higher income per capita, lower income inequalities, higher human development and higher institutional quality have higher renewable natural capital per capita, but lower renewable natural capital in wealth. For this last result, there is, as already stated, a lengthy empirical literature explaining the negative relationship between natural capital dependence and economic growth. The results on renewable natural capital per capita can be linked to the empirical analyses developed by Gylfason (2011), whereby these countries somehow succeed to maintain a larger availability of natural capital in per capita terms. Further exploration of such differences might be important, particularly concerning the fact that results on the inverse ranking when correlating renewable natural capital in wealth and per capita, with income per capita, human development and institutional quality, hold true only for renewable natural capital per capita, not for non-renewable, which is, to our knowledge, an original result.

7. Discussion

When developing the estimations for the whole sample under the hypothesis of having a unique growth regime, we find that the natural capital theory proxied through natural capital wealth dependence and per capita abundance variables is not a robust direct determinant economic growth unlike previous findings using standards methodologies without uncertainty (Ding and Field, 2005; Cerny and Filer, 2007; Gylfason, 2011). The share of renewable natural capital in wealth affects economic growth indirectly through its influence on proximate variables, more precisely though its influence on fertility.

Otherwise, we find that according to the BMA method the robust direct new growth theories include demography, religion and institutions for the full sample and, in addition, macroeconomic policy for the sub-sample with investment in physical capital above the median cut-off point. Fractionalisation also contributes indirectly to economic growth in the sub-sample with investment in physical capital above the median cut-off point through the demography theory. Our identification of the robust determinants of economic growth in the sub-sample with investment values below the median cut-off point is very poor, only the religion theory is relevant as a direct determinant of economic growth.

When taking into account the results when controlling for the presence of multiple growth regimes, we find some evidence that the share of renewable natural capital in wealth has a rather indirect impact on economic growth, since it impacts growth only when fundamental theories alone are examined. In particular, we find an indirect negative impact through human development and, more precisely, through fertility rates. The dependency effect (more dependent children relative to working adults) and, at longer horizons, the decrease in human capital, capital shallowing (Solow, 1956), and the effects of congestion of fixed resources (Malthus, 1798) are the most relevant channels to explain the role of fertility on economic growth (Ashraf et al., 2013). The so-called 'Dutch disease', that is, the negative impacts on the overall economy of the over-development of the natural resource sector, could be also a factor accounting for low economic growth, in those countries where the share of natural capital in wealth is very high (Bruno and Sachs, 1982). In contrast, we find a direct positive impact of non-renewable natural capital in wealth on economic growth when exploring proximate and fundamental theories together in the sub-samples with lower income inequality and higher institutional quality.29 This result is probably related to the effect of capital accumulation in the domestic economy, as capacity constraints are relaxed (van der Ploeg and Venables, 2010).30

29 Taking into account the numerous complementarities between the different sub-components of the variable natural capital, it would not be relevant to explore the separate role of each of these sub-components in explaining the final results of our analysis.

30Many countries find it hard to absorb windfall of foreign exchange, as it takes time for the non-traded sectors to accumulate capital. It is optimal to park the windfall revenue abroad until there is enough capacity to invest in the domestic economy.

Limits of our study

There are several reasons that explain the lack of a stronger impact of renewable natural capital on economic growth. We will mention four of them. Firstly, some important data components are poorly integrated in natural capital accounts. Variations in land-uses do not usually include losses of biological diversity, which depend on land-use intensity, human population density and road proximity (Newbold et al., 2016). The degradation of renewable natural capital productivity, which can be very high, and is also very variable among countries (Sutton et al., 2016) should also be taken into account. Examining such an effect might be especially important since the loss in terms of crossing biodiversity safe plenary limits would concern 58% of terrestrial areas, where more than 70% of humans live.

Secondly, the different components of natural capital should affect economic growth in widely different ways, depending on their time and spatial effects. For example, cropland has an immediate and local effect, whereas protected areas are supposed to have delayed and global benefits. Finally, the impact of natural capital on economic growth may also depend on the timeframe and country sample. Indeed, Aliyev (2011) and Lederman and Maloney (2002) argue that the results on the impact of natural resources on economic growth are contingent on the timeframe selected for the estimation. Aliyev (2011), for instance, finds that Sala-i-Martin et al. (2004) findings on the (non-robust) positive impact of the share of mining in GDP on economic growth during the period 1960-1996, no longer hold for the period 1960-2003.

Furthermore, when we compare our results with those of Durlauf et al. (2008a) who use a shorter period and a smaller sample of countries, we find different evidence in terms of the robust determinants of economic growth suggesting that the findings are contingent on the timeframe and country sample.31 Further work based on longer time-series and specific country samples could enable to provide more evidence on the nature of the effect of natural resources on economic growth in the long-run. In our work we seek to develop country typologies, as Konte (2013) where he tests whether neoclassical and institutional variables define country typologies in the presence of multiple growth regimes with specific implications in terms of natural capital. One research question would be then how can countries fall under the typologies that would enable them to benefit from natural capital.32

Moreover, there are limitations which are associated with our data on natural capital based on World Bank (2006) to which we have referred to previously in the data subsection (van der Ploeg and Poelhekke, 2010). Including time-varying data on natural capital, and relaxing the stringent constraints on interest rates, cost of extraction and time horizons to exhaustion, would be particularly relevant to verify the robustness of our results.

Finally, the importance of natural capital in economics might not be simply related to economic growth. On the one hand, other related economic indicators, like health, quality of life, might be important. On the other hand, the effect of renewable and non-renewable capital, in wealth and per capita terms, ought to be distinguished as they are associated with very different phenomena.

31 We can compare our results for the period 1960-2009 with respect to those of Durlauf et al. (2008a) for the period 1965-1994. The data set used by Durlauf et al. (2008a) consists of 57 countries, of which 54 are also present in our work. In particular, both analyses are based on 11 from Asia and Oceania, 13 from Latin America and Caribbean, 19 countries from North America and Europe and 11 from Middle East and Africa. In addition, we include one country from Europe, 14 from Middle East and Africa, seven from Latin America and Caribbean and seven from Asia and Oceania. While Durlauf et al. (2008a) find that among new growth theories, macroeconomic policy is a robust determinant, in our BMA analysis for the full sample demography, religion and institutions are instead the robust determinants suggesting that results are contingent on the time frame and country sample.

32 There is lengthy literature on natural capital and economic growth seeking to find the characteristics that enable to have a positive relationship between these two variables, with a special focus on institutional endowments (see, for instance, Omgba, 2015).

Acknowledgements

The views expressed in this paper are our own and do not necessarily reflect those of the Autorité de régulation des activités ferroviaires et routières. We are grateful to an anonymous referee from the FAERE (French Association of Environmental and Resource Economists), Carlos Romero, Antonio Casimiro Herruzo Martinez, Miguel Marchamalo Sacristan, Tiago Domingos, Emilio Jaime Cerda Tena and Alejandro Caparros Gass for their suggestions. We thank as well the participants at the Séminaire du Centre International de Recherche sur l'Environnement et le Développement (CIRED) on the 29th January 2017, at the Séminaire Développement Durable Environnement et Economie Publique (DDEEP-EconomiX, Paris Nanterre) on the 31st January 2017 and at the Séminaire café-scientifique du Centre d'Ecologie et des Sciences de la Conservation (CESCO, Museum National d'Histoire Naturelle) on the 13th March 2017. We would also like to thank Steven Durlauf and Grigoris Emvalomatis for insightful thoughts as well as for data and econometric programs shared at the 2nd Advanced summer school in economics and econometrics at the University of Crete, Rethymno on the 19th-26th of August 2007. We thank Enrique Moral-Benito for suggestions and data from Moral-Benito (2012), and Steven Poelhekke for data from van der Ploeg and Poelhekke (2010).

References

Acemoglu, D., Johnson, S., Robinson, J., 2002. The colonial origins of comparative development: An empirical investigation. American Economic Review 91, 5, 1369-1401.

Acemoglu, D., Johnson, S., Robinson, J., 2005. Institutions as a fundamental cause of long-run growth. In: Handbook of Economic Growth, Aghion, P., Durlauf, S. (eds.), Elsevier, Amsterdam, The Netherlands.

Acemoglu, D., Robinson, J., 2012. Why nations fail: The origins of power, prosperity and poverty. Crown publishers, New York, USA.

Ades, A., Di Tella, R., 1999. Rents, competition and corruption. American Economic Review 89, 4, 982-993.

Alesina, A., Ozler, S., Roubini, N., Swagel, P., 1996. Political instability and economic growth. Journal of Economic Growth 1, 2, 189-211.

Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S., Wacziarg, R., 2003. Fractionalization. Journal of Economic Growth 8, 155-194.

Aliyev, I., 2011. Understanding the resource impact using matching. CERGE-EI Working Papers, 451.

Andersson, B.A., Råde, I., 2002. Material constraints on technology evolution: The case of scarce metals and emerging energy technologies. In: A Handbook of Industrial Ecology, Ayres, R.U., Ayres, L.W. (eds.), Edward Elgar, Cheltenham, UK.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 2, 277-97.

Arellano, M., Bover, O., 1995. Another look at the instrumental variable estimation of error-components models. Journal of Econometrics 68, 29-51.

Ashraf, Q.H., Weil, D.N., Wilde, J., 2013. The effects of fertility reduction of economic growth. Population and Development Review 39, 1, 97-130.

Barbier, E.B., 2014. Accounting for depreciation of natural capital. Nature 515, 32-33.

Barbier, E.B., 2016. Natural capital and wealth in the 21st century. Eastern Economic Journal 1-15.

Bardini, C., 1997. Without coal in the age of steam: A factor-endowment explanation of the Italian industrial lag before World War I. Journal of Economic History 57, 633-653.

Barro, R., 1991. Economic growth in a cross section of countries. Quaterly Journal of Economics 106, 2, 407-43.

Barro, R.J., Sala-i-Martin, X., 1992. Convergence. Journal of Political Economy 100, 2, 223-251.
Barro, R., Lee, J.W., 1994. Sources of economic growth. Carnegie-Rochester Conference Series on Public Policy, Elsevier, 40, 1, 1-46.

Barro, R., 1996. Democracy and growth. Journal of Economic Growth 1, 1, 1-27.

Barro, R., 1997. Determinants of economic growth. MIT Press, Cambridge, USA.

Barro, R., McCleary, R., 2003. Religion and economic growth across countries. American Sociological Review 68, 5, 760-781.

Barro, R., Lee, J.W., 2014. A new data set of educational attainment in the world, 1950-2010. Journal of Development Economics 104, 184-198.

Bartlett, J.E., Kotrlik, J.W., Higgins, C.C., 2001. Organizational research: Determining appropriate sample size in survey research. Information Technology, Learning, and Performance Journal 19, 1, 43-50.

Beck, T., Clarke, G., Groff, A., Keefer, P.,Walsh, P., 2001. New tools in comparative political economy: The database of political institutions. World Bank Economic Review 15, 1, 165-176.

Bloom, D.E., Sachs, J.D., 1998. Geography, demography, and economic growth in Africa. Brookings Papers Economic Activity 2, 207–73.

Boschini, A., Pettersson, J., Roine, J., 2013. The resource curse and its potential reversal. World Development 43, 19-41.

Brock, W., Durlauf, S.N., 2001. Growth empirics and reality. World Bank Economic Review 15, 2, 229-272.

Brock, W., Durlauf, S.N., West, K., 2003. Policy analysis in uncertain economic environments (with discussion). Brookings Papers on Economic Activity 1, 235-322.

Brunnschweiler, C.N., Bulte, E.H., 2008. Linking natural resources to slow growth and more conflict. Science 320 (5876): 616-617.

Bruno, M., Sachs, J., 1982. Energy and resource allocation: A dynamic model of the “Dutch Disease”. The Review of Economic Studies 49, 5, 845-859.

Bruno, M., Easterly, W., 1998. Inflation crises and long-run growth. Journal of Monetary Economics 41, 1, 3-26.

Capolupo, R., 2009. The new growth theories and their empirics after twenty years. Open-Assessment E-Journal, Kiel Institute for the World Economy 3, 1-72.

Caselli, F., Esquivel, G., Lefort, F., 1996. Reopening the convergence debate: A new look at cross-country growth empirics. Journal of Economic Growth 1, 3, 363-8.

Caselli, F., 2005. Accounting for cross-country income differences. In: Handbook of Economic Growth, Aghion, P., Durlauf, S. (eds.), Elsevier, Amsterdam, The Netherlands.

Central Intelligence Agency, 2009. The World Factbook 2009, ISSN 1553-8133, Washington DC, USA.

Cerny, A., Filer, R.K., 2007. Natural resources: Are they really a curse?. CERGE-EI Working Paper 321.

Chan, K.M.A., Satterfield, T., Goldstein, J., 2011. Rethinking ecosystem services to better address and navigate cultural values. Ecological Economics 74, 8-18.

Chen, D. et al., 2010. The inequality of natural resources consumption and its relationship with the social development level based on the ecological footprint and the HDI. Journal of Environmental Assessment Policy and Management 12.01, 69-86.

Costanza, R. et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253-260.

Costanza, R. et al., 2014. Changes in the global value of ecosystem services. Global Environmental Change 26, 152-158.

Cox, G.W., Weingast, B.R., 2015. Executive constraint, political stability and economic growth. University of Stanford, USA.

Daily, G., 1997. Introduction: What are ecosystem services?. In: Daily, G. (eds), Nature's Services. Societal Dependence on Natural Ecosystems. Island Press, Washington DC, USA.

Daly, H.E., Farley, J., 2004. Ecological economics: Principles and applications. Island Press, Washington DC, USA.

De Long, J.B., Williamson, J.B., 1994. Natural resources and convergence, in the nineteenth and twentieth centuries. Harvard University, USA.

Ding, N., Field, B.C., 2005. Natural resource abundance and economic growth. Land Economics 81, 4, 496–502.

Dinh, H.T., Dinh, R., 2016. Managing natural resources for growth and prosperity in low income countries. OCP policy paper 16/01.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2002. The regulation of entry. Quarterly Journal of Economics 117, 1, 1-37.

Djankov, S., La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 2003. Courts. Quarterly Journal of Economics 118, 453–518.

Driscoll, J., Kraay, A.C., 1998. Consistent covariance matrix estimation with spatially dependent data. Review of Economics and Statistics 80, 549-560.

Durlauf, S.N., Johnson, P.A., 1995. Multiple regimes and cross-country growth behaviour. Journal of Applied Econometrics 10, 4, 365–384.

Durlauf, S.N., Quah, D.T., 1999. The new empirics of economic growth. In: Handbook of Macroeconomics, vol. 1, Taylor, J.B., Woodford, M. (eds.), Elsevier, Amsterdam, The Netherlands.

Durlauf, S.N., Johnson, P.A., Temple, J.R.W., 2005. Growth econometrics. In: Durlauf, S.N., Aghion, P. (eds.), Handbook of Economic Growth, Elsevier, Amsterdam, The Netherlands.

Durlauf, S.N., Kourtellos, A., Tan, C.M., 2008a. Are any growth theories robust?. The Economic Journal 118, 527, 329-346.

Durlauf, S.N., Kourtellos, A., Tan, C.M., 2008b. Empirics of growth and development. In: Dutt, A.K., Ros, J. (eds.), International Handbook of Development Economics 1, Edward Elgar, Cheltenham, UK.

Durlauf, S.N, Kourtellos, A., Tan, C.M., 2012. Is God in the details? A re-examination of the role of religion in economic growth. Journal of Applied Econometrics 27, 7, 1059-1075.

Easterly, W., Levine, R., 1997. Africa's growth tragedy: Policies and ethnic divisions. Quarterly Journal of Economics 112, 4, 1203-50.

Easterly, W., 2001. The lost decades: Explaining developing countries' stagnation in spite of policy reform 1980-1998. Journal of Economic Growth 6, 2, 135-157.

Edenhofer, O., 2015. King coal and the queen of subsidies. Science 349, 6254, 1286-1287.

Fernandez, C., Ley, E., Steel, M.F.J., 2001. Model uncertainty in cross-country growth regressions. Journal of Applied Econometrics 16, 5, 563-576.

Frankel, 2010. The natural resource curse: A survey. National Bureau of Economic Research Working Paper 15836.

Glaeser, E.L., La Porta, R., Lopez-de-Silane, F., Shleifer, A., 2004. Do institutions cause growth?. National Bureau of Economic Research Working Paper 10568.

Goedkoop, M., Heijungs, R., Huijbregts, M., De Schryver, A., Struijs, J.,Van Zelm, R., 2008. ReCiPe 2008: A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level. First edition. Report I: Characterisation. Dutch Ministry of the Environment, The Hague, The Netherlands.

Gowdy, J.M., Howarth, R.B., Tisdell, C., 2009. Discounting, ethics and options for maintaining biodiversity and ecosystem integrity. In: The Economics of Ecosystems and Biodiversity (TEEB): Ecological and Economic Foundations, Kumar, P. (ed.), Abingdon: Routledge.

Gylfason, T., 2001. Natural resources, education, and economic development. European Economic Review 45, 4, 847-859.

Gylfason, T., 2011. Natural resource endowment: A mixed blessing?. CESifo Working Paper Series 3353, CESifo Group Munich.

Hall, R.E., Jones, C.I., 1999. Why do some countries produce so much more output per worker than others?. The Quarterly Journal of Economics 114, 1, 83-116.

Hox, J., 2002. Multilevel analysis. Techniques and applications. Lawrence Erlbaum, Mahwah, NJ, USA.

Hox, J., 2010. Multilevel analysis: Techniques and applications. Second edition. Routledge, New York, USA.

Jackson, T., 2009. Prosperity without growth, economics for a finite planet. Routledge, London, UK, New York, USA.

Kaufmann, D., Kraay, A., Mastruzzi, M., 2005. Governance matters IV: Governance indicators for 1996-2004. World Bank Policy Research Working Paper 3630.

Kelley, A.C., Schmidt, R.M., 1995. Aggregate population and economic growth correlations: The role of the components of demographic change. Economic Demography 32, 4, 543-555.

Konte, M., 2013. A curse or a blessing? Natural resources in a multiple growth regimes analysis. Applied Economics 45:26, 3760-3769.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1999. The quality of government. Journal of Law, Economics, and Organization 15, 1, 222-279.

Laurans Y., Rankovic A., Billé R., Pirard R., Mermet, L., 2013. Use of ecosystem services economic valuation for decision making: Questioning a literature blindspot. Journal of Environmental Management 15, 119, 208-19.

Lederman D., Maloney, W., 2002. Open questions about the link between natural resources and economic growth: Sachs and Warner revisited. Central Bank of Chile Working Paper 141.

Lederman D.,, Maloney, W., 2008. In search of the missing resource curse. World Bank Policy Research Working Paper Series 4766.

Lenzen, M. et al., 2012. International trade drives biodiversity threats in developing nations. Nature 486, 109–112.

MAEDI, 2014. Innovative financing mechanism for biodiversity and the identification of mechanisms with strong potential. French Ministry of Foreign Affairs and International Development, Paris, France.

Malthus, T.R., 1798. An essay on the principle of population. Oxford University Press, Oxford, UK.

Mankiw, N.G., Romer, D., Weil, D.N., 1992. A contribution to the empirics of economic growth. The Quarterly Journal of Economics 107, 2, 407-437.

Mansano, O., Ribogon, R., 2001. Resource curse or debt overhang?. National Bureau of Economic Research Working Paper 8390.

McGlade, C., Ekins, P., 2015. The geographical distribution of fossil fuels unused when limiting global warming to 2 [deg] C. Nature 517, 187-190.

Mehlum, H., Moene, K., Torvik, R., 2006. Institutions and the resource curse. The Economic Journal 116(508), 1-20.

Millennium Ecosystem Assessment (MA), 2005. Four Volumes: Current State and Trends; Scenarios; Policy Responses; Sub-Global Assessments. Island Press, Washington D.C., USA.

Moral-Benito, E., 2012. Determinants of economic growth: A Bayesian panel data approach. The Review of Economics and Statistics 94, 2, 566-579.

Norman, C., 2009. Rule of law and the resource curse: Abundance versus intensity. Environmental and Resource Economics 43, 2, 183-207.

Omgba, L.D., 2015. Why do some oil-producing countries succeed in democracy while other fail?. World Development 76, 180-189.

Owen, A., Videras, J., Davis, L., 2007. Do all countries follow the same growth process?. Journal of Economic Growth 14, 4.

Pearce, D.W., Markandya, A., Barbier, E., 1989. Blueprint for a Green Economy. Earthscan, London, United Kingdom.

Petersen, J.E., Gocheva, K., 2015. EU reference document on Natural Capital Accounting. Prepared as part of the EU MAES process (Mapping and Assessment of Ecosystems and their Services), revised draft for consultation, 6 January 2015.

Pomeranz, K., 2000. The great divergence: China, Europe, and the making of the modern world economy. Princeton University Press, Princeton, USA.

Recuero Virto, L., Weber, J.L., Jeantil, M., 2018. Natural capital accounts and public policy decisions: Findings from a survey. Ecological Economics 144 244–259.

Reynolds, D.B., 1999. The mineral economy: How prices and costs can falsely signal decreasing scarcity. Ecological Economics 31, 1, 155-166.

Rockström, J., Steffen, W., Noone, K., Persson, A. et al., 2009. A safe operating space for humanity. Nature 461, 472-475.

Rodrik, D., 2003. Search of prosperity: Analytic narratives on economic growth. Princeton University Press, Princeton, USA.

Rodrik, D., 2012. Unconditional convergence in manufacturing. The Quarterly Journal of Economics 128, 1, 165-204.

Roodman, D., 2009. A note on the theme of too many instruments. Oxford Bulletin of Economics and Statistics 71, 1, 135-158.

Ross, M., 2015. What have we learned from the resource curse. Annual Review of Political Science 18, 1-499.

Sachs, J., Warner, A., 1995. Economic reform and the process of global integration. Brooking Papers on Economic Activity 26, 1, 1–118.

Sachs, J., Warner, A., 1996. Natural resource abundance and economic growth. National Bureau of Economic Research Working Paper 5398.

Sachs, J., Warner, A., 2001. The curse of natural resources. European Economic Review 45, 4-6, 827-838.

Sachs, J., 2003. Institutions don't rule: Direct effects of geography on per capita income. National Bureau of Economic Research Working Paper 9490.

Sala-i-Martin, X., 1997a. I just ran 4 million regressions. National Bureau of Economic Research Working Paper 6252.

Sala-i-Martin, X., 1997b. I just ran 2 million regressions. American Economic Review 87, 2, 178–183.

Sala-i-Martin, X., Doppelhofer, G., Miller, R., 2004. Determinants of long-term growth: A Bayesian averaging of classical estimates (BACE) approach. American Economic Review 94, 4, 813-35.

Shastry, G.K., Weil, D.N., 2003. How much of cross-country income variation is explained by health. Journal of the European Economic Association 1, 387-396.

Snowdon, B., 2003. Conversations on growth, stability and trade: An historical perspective. Edward Elgar, Cheltenham, UK.

Solow, R.M., 1956. A contribution to the theory of economic growth. The Quarterly Journal of Economics 70, 1, 65-94.

Stijns, J.P., 2005. Natural resource abundance and economic growth revisited. Resources Policy 30, 2, 107-130.

Sutton et al., 2016. The ecological economics of land degradation: Impacts on ecosystem service values. Ecological Economics 129, 182–192.

ten Brink, P., Russi, D., Tinch, R., Schoumacher, C., Agarwala, M., Bateman, I., 2015. The use of (economic & social) values of NC/ES in national accounting. D3.4 Discussion Paper, European Commission (OPERA project).

The Economics of Ecosystems and Biodiversity (TEEB), 2008, An interim report, European Communities, Brussels, Belgium.

Torres, N., Afonso, O., Soares, I., 2013. A survey of literature on the resource curse: Critical analysis of the main explanations, empirical tests and resource proxies. CEF.UP Working Papers 1302, Faculdade de Economia do Port, Universidade do Porto.

Torvik, R., 2009. Why do some resource-abundant countries succeed while others do not?. Oxford Review of Economic Policy 25, 2, 241-256.

UNEP, 2015. The UNEP Environmental Data Explorer, as compiled from World Resources Institute. United Nations Environment Programme, Nairobi, Kenya.

van der Ploeg, F., 2010. Natural resources: Curse or blessing?. Journal of Economic Literature 49, 2, 366-420.

van der Ploeg, F., Poelhekke, S., 2010. The pungent smell of ‘red herrings’: Subsoil assets, rents, volatility and the resource curse. Journal of Environmental Economics and Management 60, 1, 44-55.

van der Ploeg, F., Venables, A.J., 2010. Absorbing a windfall of foreign exchange: Dutch disease dynamics. OxCarre Research Paper, University of Oxford, UK.

Victor, P., Jackson, T., 2013. Developing a demographic sub-model and input-output structure for the green economy macro-model and accounts (GEMMA) framework. Final report, CIGI-INET.

Wegener Sleeswijk, A., van Oers, L., Guinee, J.B., Struijs, J., Huijbregts, M.A.J., 2008. Normalisation in product life cycle assessment: An LCA of the global and European economic systems in the year 2000. Science of the Total Environment 390, 1, 227-240.

Weil, D.N., 2005. Accounting for the effect of health on economic growth. National Bureau of Economic Research Working Paper 11455.

World Bank, 2006. A guide to valuing natural resources wealth. Environment Department, World Bank, USA.

WWF, 2015. From obstacles to opportunities - Towards an action plan for improved natural capital and ecosystem accounting implementation. WWF, Brussels, Belgium.

Appendices

A.1. Data

The unbalanced panel data set constructed for this study contains observations for 10 five-year periods from 1960 to 2009 on 83 countries from the following regions for which we have data on our variables of interest, namely, neoclassical variables, natural capita in wealth and natural capital per capita:

- Latin America and the Caribbean (20): Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Trinidad and Tobago, Uruguay and Venezuela.
- Middle East and North Africa (10): Bahrain, Brunei, Egypt, Iran, Israel, Jordan, Kuwait, Saudi Arabia, Tunisia and United Arab Emirates.
- Sub-Saharan Africa (15): Cameroun, Congo, Gabon, Ghana, Kenya, Malawi, Mauritius, Mozambique, Senegal, Sierra Leone, South Africa, Sudan, Uganda, Zambia and Zimbabwe.
- East Asia and the Pacific (13): Australia, China, Fiji, Indonesia, Japan, Malaysia, New Zealand, Papua New Guinea, Philippines, Republic of Korea, Singapore, Thailand and Tonga.
- South Asia (5): Bangladesh, India, Maldives, Pakistan and Sri Lanka.
- North America, Europe and Central Asia (20): Austria, Belgium, Canada, Denmark, Finland, France, Greece, Hungary, Italy, Ireland, Norway, Poland, Portugal, Spain, Sweden, Switzerland, The Netherlands, Turkey, United Kingdom and United States.

We have collected data on variables regrouped in five categories: neoclassical, demography, macroeconomic policy, regional heterogeneity, religion, natural capital, geography, fractionalisation, institutions and other. The definition of these variables and the data sources are given below. The choice of the eight growth theories and the associated variables is largely inspired by the work of Durlauf et al. (2008a). The analysis of Durlauf et al. (2008a) is robust since they built their work over an exhaustive survey of the empirical growth literature which identifies 43 growth theories and 145 regressors. Each of these theories is found to be statistically significant in at least one study (Durlauf et al., 2005). Besides the eight growth theories, we also include a category named ‘other’ to account for some instruments and for time dummy variables.

We do not include variables such as the fraction of primary products in total exports or the fraction of mining in the gross GDP which have been often used as a proxy for the curse of natural resources (Sachs and Warner, 1996; Sala-i-Martin, 1997a; 1997b; Hall and Jones, 1999; Sala-i-Martin et al., 2004). Durlauf et al. (2008a) already rejected the robustness of these variables. Sala-i-Martin et al. (2004) by using the BMA method over 67 variables find that the fraction of mining in the GDP is a weak determinant of growth since its significance depends on the prior model size and requires conditioning on other variables to show its full impact.

Table A.1
Data description.

Designation	Source(s)
NEOCLASSICAL	
Growth rates of pc GDP	Average growth rates (constant 2005 USD prices) for the periods 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009.
Initial income	Logarithm of GDP per capita (constant 2005 USD prices) at 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000 and 2005. The instruments for the initial income include the values at 1955, 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, and 2000.

NEOCLASSICAL (continuation)	
Population growth rates	Logarithm of average population growth rates plus 0.05 for the periods 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1995, 2000-2004, 2005-2009. The instruments for populations growth rates include the average values of 1955-1959, 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1995, 2000-2004.
Investment in physical capital	Logarithm of average ratios over each period of investment in physical capital to GDP for the periods 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1995, 2000-2004, 2005-2009. The instruments for investment include the average values of 1955-1959, 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1995, 2000-2004.
Schooling	Logarithm of the ratio of male population enrolled in secondary school to total population in 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000 and 2005.
DEMOGRAPHY	
Life Expectancy	Reciprocals of life expectancy at age 1 in 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005.
Fertility rate	The log (LN) of the total fertility rate in 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005.
MACROECONOMIC POLICY	
Openness	Average ratios for each period of exports plus imports to GDP in 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009. The instruments include the average values of 1955-1959, 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1995, 2000-2004.
Government consumption	Average ratios for each period of government consumption to GDP in 1960-1964, 1965-1969, 1970-1974, 1975-1979, 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, 2005-2009.
Inflation	The consumer price inflation rate for the periods 1960-1969, 1970-1979, 1980-1989, 1990-1999, 2000-2009.
REGIONAL HETEROGENEITY	
Latin America and Caribbean	Dummy variable.
Sub-Saharan Africa	Idem.
East Asia and the Pacific	Idem.
South-East Asia	Idem.
RELIGION	
Buddhism	Buddhism share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the Buddhism share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Catholic	Catholic share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the catholic share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Eastern Religion	Eastern Religion share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the eastern religion share in 1900 expressed as a fraction of the population who expressed adherence to some religion.

RELIGION (continuation)	
Hindu	Hindu share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the Hindu share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Jew	Jew share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the Jew share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Muslim	Muslim share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the Muslim share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Orthodox	Orthodox share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the orthodox share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
Other	Other religion share in 1970. The instruments include the other religion share in 1990.
Protestant	Protestant share in 1970 expressed as a fraction of the population who expressed adherence to some religion. The instruments include the protestant share in 1900 expressed as a fraction of the population who expressed adherence to some religion.
NATURAL CAPITAL	
Natural capital in wealth	Time-invariant variable measuring the weight of natural capital in national wealth in 2000.
Natural capital in wealth (renewable)	Time-invariant variable measuring the weight of renewable natural capital in national wealth (crop, pasture land, timber, non-timber forest resources and protected areas) in 2000.
Natural capital in wealth (non-renewable)	Time-invariant variable measuring the weight of non-renewable natural capital (oil, natural gas, hard coal, soft coal, coal and minerals) in national wealth in 2000.
Natural capital per capita	Time-invariant variable measuring natural capital per capita in 2000. The variable is scaled to take values between zero and one.
Natural capital per capita (renewable)	Time-invariant variable measuring renewable natural capital per capita (crop, pasture land, timber, non-timber forest resources and protected areas) in 2000. The variable is scaled to take values between zero and one.
Natural capital per capita (non-renewable)	Time-invariant variable measuring non-renewable natural capital per capita (oil, natural gas, hard coal, soft coal, coal and minerals) in 2000. The variable is scaled to take values between zero and one.
GEOGRAPHY	
Coastline	Coastline length in km, scaled to take values between zero and one.
Landlocked	Binary variable where one indicates landlocked country.
FRACTIONALISATION	
Language	Time-invariant measure of linguistic fractionalization that reflects the probability that two randomly selected individuals from a population belong to different groups. The data ranges from zero to one.
Ethnic	Time-invariant measure of ethnic fractionalization that reflects the probability that two randomly selected individuals from the population belong to different groups. The data ranges from zero to one.

INSTITUTIONS	
Liberal democracy	Time variant-index that emphasizes the importance of protecting individual and minority rights against the tyranny of the state and the tyranny of the majority. This is achieved by constitutionally protected civil liberties, strong rule of law, an independent judiciary, and effective checks and balances that, together, limit the exercise of executive power. To make this a measure of liberal democracy, the index also takes the level of electoral democracy into account. This variable is calculated as the average for the periods 1960-1965, 1965-1970, 1970-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2009. It ranges from zero to one. Higher scores imply a more liberal democracy.
Public sector corruption	Time-variant variables that measures to what extent public sector employees grant favors in exchange for bribes, kickbacks, or other material inducements, and how often they steal, embezzle, or misappropriate public funds or other state resources for personal or family use. This variable is calculated as the average for the periods 1960-1965, 1965-1970, 1970-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2009. It ranges from zero to one. Higher scores imply a more corruption.
Legal formalism: Check (1)	Time-invariant index of the professionals vs. laymen, written vs. oral elements, legal justification, statutory regulation of evidence, control of superior review, and engagement formalities indices, and the normalized number of independent procedural actions for the case of collection of a check. The index ranges from zero to seven, where seven means a higher level of control or intervention in the judicial process.
Legal formalism: Check (2)	Time-invariant index of formality in legal procedures for collecting on a bounced check, rescaled to lie between zero to one for 2003. Lower scores imply a less legal formality.
Complex	Time-invariant index of complexity in collecting a commercial debt valued at 50% of annual GDP per capita, rescaled to lie between zero and one for 2003. Lower scores imply a less complexity.
KKZ96	Time-invariant composite governance index. It is calculated as the average of six variables: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption in 1996. It ranges from –2 to 2. Higher values imply better governance.
Executive constraints	Time varying variable that measures the extent of institutionalized constraints on the decision making powers of chief executives. This variable is calculated as the average for the periods 1960-1965, 1965-1970, 1970-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2009. This variable ranges from zero to seven where higher values equal a greater extent of institutionalized constraints on the power of chief executives.
OTHER	
Time dummy variables	Dummy variables for 1960-1965, 1965-1970, 1970-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000, 2000-2005 and 2005-2009
Colonial (Spain or Portugal)	Binary variable where one indicates that country was colonized by Spain or Portugal.
English legal origin	Binary variable where one indicates that country was colonized by The United Kingdom, and English legal code was transferred.

OTHER (continuation)	
French legal origin	Binary variable where one indicates that country was colonized by France, Spain, Belgium, Portugal or Germany and French legal code was transferred.
Latitude	The absolute value of the latitude of the capital of the country, scaled to take values between zero and one.
Mineral stocks	Time-invariant variable that takes the value of the logarithm of fuel and 35 non fossil fuel stocks estimated for 1970 at market prices, in US dollars per capita.
System	Time-invariant variable that takes the value of 0 if the country has a presidential system, 1 if it has an assembly-elected president and 2 if it has a parliamentary system (mean value between 1975 and 2010).

Table A.2
Data sources.

Designation	Source(s)
NEOCLASSICAL	
Growth rates of pc GDP	Penn World Tables 7.1
Initial income	Idem
Population growth rates	Idem
Investment in physical capital	Idem
Schooling	Barro and Lee (2014)
DEMOGRAPHY	
Life Expectancy	World Bank
Fertility rate	Idem
MACROECONOMIC POLICY	
Openess	Penn World Tables 7.1
Government consumption	Idem
Inflation	World Bank
REGIONAL HETEROGENEITY	
Latin America and Caribbean	World Bank country classification
Sub-Saharan Africa	Idem
East Asia and the Pacific	Idem
South-East Asia	Idem
RELIGION	
Buddhism	World Christian Encyclopedia (2001)
Catholic	Idem
Eastern Religion	Idem
Hindu	Idem
Jew	Idem
Muslim	Idem
Orthodox	Idem
Other	Idem
Protestant	Idem
NATURAL CAPITAL	
Natural capital in wealth	World Bank
Natural capital in wealth (renewable)	Idem
Natural capital in wealth (non-renewable)	Idem
Natural capital per capita	Idem
Natural capital per capita (renewable)	Idem
Natural capital per capita (non-renewable)	Idem

GEOGRAPHY	Idem
Coastline	UNEP (2015)
Landlocked	Central Intelligence Agency (2009)
FRACTIONALISATION	
Language	Alesina *et al.* (2003)
Ethnic	Idem
INSTITUTIONS	
Liberal democracy	The QOG Standard Dataset
Public sector corruption	Idem
Legal formalism: Check (1)	Djankov *et al.* (2003)
Legal formalism: Check (2)	Doing Business, World Bank
Complex	Idem
KKZ96	Kaufmann *et al.* (2005)
Executive constraints	Polity IV Project, 1946-2013
OTHER	
Time dummy variables	Own construction
Colonial (Spain or Portugal)	Barro and Lee (1994)
English legal origin	Easterly (2001)
French legal origin	La Porta *et al.* (1999) and Djankov *et al.* (2003)
Latitude	Djankov *et al.* (2003)
Mineral stocks	Norman (2009) and van der Ploeg and Poelhekke (2010)
System	Beck *et al.* (2001)

A.2. Descriptive statistics and preliminary results

We share the preliminary analysis results in Tables A.3-A.9. Firstly, we present the summary statistics and the correlation matrix between the variables that proxy proximate and fundamental economic growth theories. This correlation matrix conveys some information on whether fundamental theories and in particular renewable and non-renewable natural capital, may have some explanatory power in the economic growth regression, beyond the influence exerted through proximate theories.

Secondly, we perform some preliminary tests to prepare the data for the analyses. Thirdly, we test on our dataset whether there is evidence of multiple convergence regimes among our panel of countries through the CART model. We verify the robustness of these results through the OLS, the fixed-effects and the DIF-GMM and SYS-GMM methods. Finally, we present the summary statistics and the correlation matrix according to the results of the CART model.

We can first see some descriptive statistics. In Table A.3, we share the summary statistics for all the variables used in our estimations. In Table A.4, we present the correlation matrix between the proximate theories' variables and the variables associated with the fundamental theories, whenever the level of correlation is above or equal to 0,40. The variables associated with four fundamental theories, religion, natural capital (renewable), fractionalisation and institutions, are strongly correlated with variables from all proximate theories except for the macroeconomic policy theory.

In particular, renewable natural capital is correlated with the following proximate theories: demography (fertility) and regional heterogeneity (Sub-Saharan Africa). Building on these results, in the subsection 3.4 we analyse whether the fundamental theories just mentioned (religion, renewable natural capital, fractionalisation and institutions) have some explanatory power in the economic growth regression, beyond the influence exerted through proximate theories' variables.

Before proceeding with the CART model and the economic growth regressions, we perform a series of preliminary tests. We find that our dependent variable is stationary in levels, that panel data is preferred to pool data and that there is presence of heteroskedasticity and serial correlation, and we treat our data accordingly.33 We then perform the CART analysis to search for the presence of convergence regimes. The CART analysis identifies subgroups of countries that obey a common linear growth model based on neoclassical variables.

We identify four subgroups according to three different cut-off points by order of relevance: 2,75 and 1,29 for investment in physical capital, and -2,47 for population growth rates. The subgroups are: *invest* < 1,29 with 13 observations, 1,29 ≤ *invest* < 2,75 with 143 observations, *invest* ≥ 2,75 and *population* < -2,47 with 610 observations, and *invest* ≥ 2,75 and *population* ≥ -2,47 with 25 observations. To test the robustness of these results, we separate the data according to the subgroups, and we test the hypothesis that all the countries in the sample follow the same convergence dynamics.

Unfortunately, we are unable to compare subgroups according to the CART cut-off points since the number of observations is insufficient in two of the four sub-samples.34 To overcome this problem, for the most appropriate variable in the CART analysis given the sub-groups sample sizes, *invest*, we select a cut-off point at the median value 3,10.35 This choice enables us to have over 350 observations in each of the two sub-samples which are sufficient to verify the presence of convergence regimes. We can see in Table A.5 that there are no large differences in neoclassical variables when separating the sample according to the CART and median cut-off points.36 In Table A.6, we therefore explore whether we find evidence of the presence of two convergence regimes after accounting for variation in structural characteristics.

In addition to showing the convergence rate, λ, associated with the explanatory variables estimates of equation [2], Table A.6 includes the number of observations actually used, *Observations*, the F and the Wald statistics, *F* and *Wald*, to test the joint significance of the coefficients associated with the dependent and the explanatory variables, the Hansen statistic with the p-value in parentheses, *Hansen*, to test the validity of instruments, the first- and second-order autocorrelation coefficients of the residuals in first differences, *m1* and *m2* and the chow test, *Chow*, which tests the hypothesis that the coefficients of the two sub-samples are the same.37

---

33 Firstly, through the Fisher unit root test, we find that the dependent variable is stationary in levels. Secondly, we verify whether it is preferable to pool or not the data by testing the appropriateness of random and fixed-effects panel data compared to the pool analysis through the goodness-of-fit results. Panel data is preferred to pool data which implies that the parameters of the equation vary from one period to the other over the ten periods of available data. Thirdly, our data shows heteroskedasticity across panels through the Erlat LM-test and serial correlation through the Baltagi LM-test. The OLS and fixed-effects methods have adjusted standard errors for intragroup correlation which should hence be robust to heteroskedasticity and serial correlation. The GMM method also controls for heteroskedasticity and we test the presence of serial correlation of order one and two. This method assumes there is no second-order autocorrelation in the error term in levels. To perform the 2SLS method for the economic growth regressions, we use Driscoll and Kraay's approach which guarantees that the covariance matrix estimator is consistent, independently of the cross-sectional dimension, in contrast to Parks-Kmenta and the Panel-Corrected Standard Errors (PCSE) approaches, which typically become inappropriate when the cross-sectional dimension of a microeconometric panel gets large (Driscoll and Kraay, 1998).

34 With fewer than five cases per group and fewer than 50 groups, standard errors for fixed effects will be too small (increased Type I errors), and random effects (variances) and their standard errors may be underestimated (Hox, 2002; 2010).

35 The fact that, given the opportunity to split the sample according to different neoclassical variables, the regression tree shows a preference for investment in physical capital splits suggests that investment in physical capital dominates the other variables in identifying multiple regimes in the data.

36 Note that as the cut-off point for investment in physical capital gets closer from the median 3,10 to the CART value 2,75, there are larger differences between the rates of convergence of the sub-samples below and above the cut-off point.

37 The DIF-GMM and SYS-GMM methods generate instruments that grow quadratically with T which can bias the estimates when the number of instruments is too large with respect to the number of observations. The weakness of specification tests is a particular concern for the SYS-GMM method whose instruments are only valid under non-trivial assumptions. We should hence take a conservative p-value of the Hansen test (Roodman, 2009).

The results of the chow test reveal that we can find evidence of the presence of two convergence regimes according to the OLS and fixed-effects methods. This is consistent with the main findings in the empirical literature (Durlauf et al., 2005). Our global convergence rates are close to those typically estimated in the academic literature which generally lie between two and three % (Barro and Sala-i-Martin, 1992). We can also appreciate in Table A.6 that OLS and fixed-effects estimates are biased in opposite directions as expected. Moreover, when dividing the sample according to the cut-off point in investment in physical capital, we find that the rate of convergence is higher for those countries with higher rates of investment and lower for the countries with lower rates of investment.

In Table A.6, we can appreciate that the estimates of the convergence rate for the DIF-GMM method do not stand between OLS and fixed-effects estimates. As in Castelli et al. (1996), this large sample prediction is not valid raising the question of the validity of the DIF-GMM method. The SYS-GMM method is likely to be more robust in the presence of highly persistence series. Indeed, the estimates of the convergence rate for the SYS-GMM method stand between OLS and fixed-effects estimates. Besides, we can see in Table A.6 that there is compliance with the SYS-GMM assumptions. There is no second order serial autocorrelation. In addition, the Hansen test accepts the validity of the instruments.

In Table A.7, we share the summary statistics above and below the median cut-off point in investment in physical capital for the variables that we use in our economic growth regressions. When comparing the two sub-samples we can appreciate that the ratio of renewable natural capital in wealth is larger for countries with investment in physical capital below the median cut-off point than for countries with investment in physical capital above the median cut-off point. Otherwise, the most significant differences between the sub-samples with the investment values in physical capital above and below the median cut-off point are those associated with the initial income, fertility rate, openness, inflation, Sub-Saharan Africa, ethnic tensions and institutional endowments (*KKZ96*).

In Tables A.8 and A.9, we present the correlation matrix between the proximate theories' variables and the variables associated with the fundamental theories, whenever the level of correlation is above or equal to 0,40 for the sub-samples above and below the median cut-off point in investment in physical capital. The variables associated with four fundamental theories, religion, natural capital (renewable), fractionalisation and institutions, are strongly correlated with variables from all proximate theories except for the macroeconomic policy theory in the sub-samples both above and below the median cut-off point in investment in physical capital.

In particular, for the sub-sample above the median cut-off point in investment in physical capital, the amount of renewable natural capital is correlated with the demography proximate theory (fertility and life expectancy variables). For the sub-sample below the median cut-off point in investment in physical capital, the amount of renewable natural capital is correlated with neoclassical (population growth rates), demography (fertility), regional heterogeneity (Sub-Saharan Africa) proximate theories. Building on these results, in the subsection 3.4. we analyse whether the fundamental theories just mentioned (religion, renewable natural capital, fractionalisation and institutions) have some explanatory power in the economic growth regression, beyond the influence exerted through proximate theories' variables.

Table A.3
Summary statistics.

Designation	Variable	Obs.	Mean	Median	Std. Dev.	Min.	Max.
NEOCLASSICAL							
Growth rates of pc GDP	*growth_pc*	797	0,02	0,02	0,03	-0,11	0,12
Initial income	*income_in*	791	8,55	8,61	1,26	5,65	11,37
Population growth rates	*population*	830	-2,72	-2,73	0,19	-3,22	-1,56
Investment in phy. capital	*invest*	791	3,04	3,11	0,52	0,26	4,20
Schooling	*school*	830	3,21	3,40	0,78	-0,05	4,41

DEMOGRAPHY							
Life Expectancy	*life_exp*	827	0,02	0,01	0,08	0,01	2,54
Fertility rate	*fertility*	828	1,28	1,32	0,52	0,01	2,10
MACROECONOMIC POLICY							
Openess	*open*	793	0,62	0,51	0,45	0,04	4,20
Government consumption	*gov_consu*	808	0,09	0,08	0,06	0,00	0,41
Inflation	*inflation*	671	0,23	0,06	1,36	-0,01	24,14
REGIONAL HETEROGENEITY							
Latin America and Caribbean	*lac*	830	0,24	0,00	0,42	0,00	1,00
Sub-Saharan Africa	*ssa*	830	0,18	0,00	0,38	0,00	1,00
East Asia and the Pacific	*eac*	830	0,15	0,00	0,36	0,00	1,00
South-East Asia	*sea*	830	0,06	0,00	0,23	0,00	1,00
RELIGION							
Buddhism	*buddhism*	830	0,03	0,00	0,14	0,00	0,92
Catholic	*catholic*	830	0,36	0,17	0,37	0,00	0,99
Eastern Religion	*eastern*	830	0,02	0,00	0,07	0,00	0,46
Hindu	*hindu*	830	0,03	0,00	0,11	0,00	0,77
Jew	*jew*	830	0,01	0,00	0,09	0,00	0,85
Muslim	*muslim*	830	0,20	0,01	0,34	0,00	0,99
Orthodox	*orthodox*	830	0,02	0,00	0,10	0,00	0,94
Other	*other*	830	0,04	0,00	0,13	-0,42	0,58
Protestant	*protestant*	830	0,15	0,04	0,24	0,00	1,09
NATURAL CAPITAL							
Natural capital in wealth	*natural_w*	830	0,27	0,17	0,32	0,00	2,22
Natutal capital in wealth (ren.)	*natural_w_r*	830	0,20	0,09	0,23	0,00	1,26
Natural capital in wealth (non-ren.)	*natural_w_nr*	830	0,06	0,01	0,19	0,00	2,21
Natural capita per capita	*natural_pc*	830	0,11	0,05	0,17	0,00	1,00
Natural capital per capita (ren.)	*natural_pc_r*	830	0,14	0,09	0,15	0,00	1,00
Natural capital per capita (non-ren.)	*natural_pc_nr*	830	0,05	0,00	0,16	0,00	1,00
GEOGRAPHY							
Coastline	*coastaline*	830	0,05	0,01	0,13	0,00	1,00
Landlocked	*landlock*	830	0,09	0,00	0,28	0,00	1,00
FRACTIONALISATION							
Language	*language*	810	0,34	0,33	0,29	0,00	0,92
Ethnic tensions	*ethnic*	820	0,42	0,42	0,26	0,00	0,93
INSTITUTIONS							
Liberal democracy	*democracy*	770	0,43	0,38	0,29	0,02	0,95
Public sector corruption	*corruption*	770	0,41	0,40	0,29	0,00	0,97
Legal formalism: Check (1)	*check(1)*	660	3,54	3,39	1,10	1,42	6,01
Legal formalism: Check (2)	*check(2)*	580	0,42	0,38	0,18	0,09	0,83
Complex	*complex*	710	0,56	0,53	0,15	0,29	0,86
KKZ96	*KKZ96*	830	0,28	0,08	0,90	-1,69	1,92
Executive constraints	*exe_constr*	770	4,73	5,00	2,22	0,80	7,00
OTHER							
Time dummy variables	*year_dummy*						
Colonial (Spain or Portugal)	*colonial*	790	0,19	0,00	0,39	0,00	1,00
English legal origin	*english*	830	0,44	0,00	0,49	0,00	1,00
French legal origin	*french*	790	0,08	0,00	0,28	0,00	1,00
Latitude	*latitude*	830	0,27	0,22	0,19	0,01	0,71
Mineral stocks	*minerals*	780	-6,31	-6,25	2,96	-14,51	0,26
System	*system*	820	0,89	0,55	0,89	0,00	2,00

Table A.4
Correlation matrix between proximate and fundamental theories.

Fundamen. theories	Proximate theories										
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*ssa*	*sea*
RELIGION											
catholic	-0,16	-0,07	-0,00	0,05	-0,07	-0,09	-0,23	0,13	**0,54**	-0,22	-0,22
hindu	0,06	0,00	-0,06	-0,00	0,11	-0,09	0,14	-0,02	-0,10	-0,06	**0,70**
muslim	**0,44**	-0,11	-0,24	-0,01	0,35	0,21	0,03	-0,03	-0,23	0,07	0,17
other	**0,41**	-0,14	-0,28	-0,01	**0,42**	0,03	0,12	-0,01	-0,10	**0,73**	-0,00
NATURAL CAPITAL											
natural_w	**0,53**	-0,18	-0,34	-0,02	**0,59**	-0,03	0,17	0,06	0,13	**0,48**	0,19
natural_w_r	0,27	-0,23	-0,26	-0,01	**0,50**	0,01	0,38	0,03	0,06	**0,40**	0,09
FRACTIONALISATION											
language	**0,43**	-0,15	-0,20	-0,02	**0,41**	0,11	0,10	-0,03	-0,32	**0,57**	0,27
ethnic	**0,60**	-0,23	-0,30	-0,04	**0,61**	0,13	0,06	0,11	0,26	**0,50**	0,09
INSTITUTIONS											
democracy	**-0,60**	0,08	**0,50**	0,04	**-0,72**	-0,11	-0,08	-0,03	-0,22	-0,28	-0,08
corruption	**0,55**	-0,20	-0,42	-0,02	**0,65**	0,12	0,08	0,08	0,28	0,32	0,02
check(1)	0,11	-0,09	-0,22	-0,08	0,21	0,07	-0,01	0,13	**0,50**	-0,16	0,08
check(2)	0,11	-0,09	-0,23	-0,08	0,22	0,08	-0,02	0,13	**0,50**	-0,17	0,02
KKZ96	**-0,63**	0,24	**0,45**	0,03	**-0,73**	-0,06	-0,14	-0,11	-0,36	-0,38	-0,27
exe_constr	**-0,48**	0,04	**0,47**	0,00	**-0,57**	-0,09	-0,09	-0,00	-0,11	-0,24	0,04

Note. Values are only reported for those variables with a correlation above or equal to 0,40. The correlation matrix with all variables is available upon request.

Table A.5
Neoclassical variables for CART and median cut-off points.

	income_ini	*population*	*invest*	*school*
CART cut-off point				
invest ≥ 2,75	8,82	-2.73	3,22	3,32
invest < 2,75	7,46	-2,64	2,25	2,70
Median cut-off point				
invest ≥ 3,10	8,86	-2,72	3,38	3,29
invest < 3,10	8,23	-2,71	2,66	3,11

Note. The table reports the mean values of the neoclassical variables (initial income, population growth rates, investment in physical capital and schooling) according to the CART and the median cut-off points in the investment in physical capital variable, *invest*. See Tables A.1-A.2 for more details on data definitions and sources.

Table A.6
Estimation results for the existence of multiple convergence clubs.

	OLS	**FE**	**DIF-GMM**	**SYS-GMM**
Full sample				
λ	-0,002	-0,021	-0.071	-0,012
Observations	791	791	599	678
F	13,45***	4,14***		
Wald			63,89	4.537***
Hansen				32,99
m_1			-3,54***	-3,97***
m_2			-0,99	-1,69*
Sub-sample: *invest* ≥ 3,10				
λ	-0,006	-0,021	-0.098	-0.014
Observations	401	401	304	346
F	10,36***	4,60***		
Wald			48,10	2.234***
Hansen				51,45
m_1			-2,85***	-3,97***
m_2			-0,14	-0,49
Sub-sample: *invest* < 3,10				
λ	-0,000	-0,015	-0.070	-0,005
Observations	390	390	295	342
F	6,16***	2,72***		
Wald			65,64	8.548***
Hansen				29,85
m_1			-2,57**	-3,48***
m_2			-1,08	-1.27
Chow test	2,56**	17,34***	-	-

Note. The table reports mean values of the convergence rate, λ, according to four estimation methods (OLS, fixed-effects, DIF-GMM and SYS-GMM). We report the F and the Wald statistics, *F* and *Wald*, that test the joint significance of the coefficients associated with the dependent and the explanatory variables, the Hansen statistic with the p-value in parentheses, *Hansen*, that tests the validity of instruments, the first- and second-order autocorrelation coefficients of the residuals in first differences, *m1* and *m2, and* the chow test, *Chow,* that tests the null hypothesis that the coefficients of the two sub-samples are the same and hence that there is only one convergence regime. ***/** stand for significance at the one and five % levels. In DIF-GMM, we use *french* in levels as additional instrument variable. In SYS-GMM, we use *colonial* and *french* in levels as instruments for the equation in first differences.

Table A.7
Summary statistics according to the median cut-off point in investment in physical capital.

		***invest* ≥ 3,10**		***invest* < 3,10**	
Designation	**Variable**	**Obs.**	**Mean**	**Obs.**	**Mean**
NEOCLASSICAL					
Growth rates of pc GDP	*growth_pc*	407	0,02	390	0,01
Initial income	*income_in*	401	8,86	390	8,23
Population growth rates	*population*	440	-2,72	390	-2,71
Investment in physical capital	*invest*	401	3,38	390	2,66
Schooling	*school*	440	3,29	390	3,11
DEMOGRAPHY					
Life Expectancy	*life_exp*	437	0,01	390	0,02
Fertility rate	*fertility*	438	1,20	390	1,36

MACROECONOMIC POLICY					
Openness	*open*	404	0,73	389	0,51
Government consumption	*gov_consu*	418	0,09	390	0,09
Inflation	*inflation*	353	0,08	318	0,38
REGIONAL HETEROGENEITY					
Latin America and Caribbean	*lac*	440	0,22	390	0,26
Sub-Saharan Africa	*ssa*	440	0,11	390	0,25
South-East Asia	*sea*	440	0,05	390	0,07
RELIGION					
Buddhism	*buddhism*	440	0,05	390	0,01
Catholic	*catholic*	440	0,35	390	0,36
Eastern Religion	*eastern*	440	0,03	390	0,01
Hindu	*hindu*	440	0,03	390	0,04
Jew	*jew*	440	0,01	390	0,01
Muslim	*muslim*	440	0,20	390	0,20
Orthodox	*orthodox*	440	0,02	390	0,01
Other	*other*	440	0,01	390	0,06
Protestant	*protestant*	440	0,14	390	0,15
NATURAL CAPITAL					
Natural capital in wealth	*natural_w*	440	0,14	390	0,28
Natural capital in wealth (ren.)	*natural_w_r*	440	0,16	390	0,23
Natural capital in wealth (non-ren.)	*natural_w_nr*	440	0,08	390	0,04
Natural capital per capita	*natural_pc*	440	0,12	390	0,08
Natural capital per capita (ren.)	*natural_pc_r*	440	0,15	390	0,13
Natural capital per capita (non-ren.)	*natural_pc_nr*	440	0,06	390	0,03
GEOGRAPHY					
Coastline	*coastline*	440	0,04	390	0,11
FRACTIONALISATION					
Language	*language*	429	0,31	381	0,38
Ethnic tensions	*ethnic*	430	0,37	390	0,46
INSTITUTIONS					
Liberal democracy	*democracy*	376	0,41	364	0,46
Public sector corruption	*corruption*	376	0,43	364	0,42
Legal formalism: Check (1)	*check(1)*	301	0,42	279	0,42
Legal formalism: Check (2)	*check(2)*	348	3,50	312	3,57
Complex	*complex*	357	0,56	353	0,55
KKZ96	*KKZ96*	440	0,44	390	0,11
Executive constraints	*exe_constr*	401	4,73	369	4,72
OTHER					
Time dummy variables	*year_dummy*				
Colonial (Spain or Portugal)	*colonial*	412	0,15	378	0,22
English legal origin	*english*	440	0,42	390	0,46
French legal origin	*french*	412	0,08	378	0,09
Latitude	*latitude*	440	0,29	390	0,26
Mineral stocks	*minerals*	404	-6,09	376	-6,54
System	*system*	431	1,02	389	0,75

Table A.8
Correlation matrix between proximate and fundamental theories for countries above the median cut-off point in investment in physical capital.

Fundamen. theories					Proximate theories						
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*ssa*	*sea*
RELIGION											
buddhism	-0,14	0,22	-0,04	0,00	-0,02	0,04	-0,04	-0,10	-0,16	-0,09	**0,41**
hindu	0,08	-0,01	0,08	0,09	0,09	0,04	0,12	-0,02	-0,08	-0,03	**0,75**
muslim	**0,51**	0,34	-0,05	0,14	0,31	**0,43**	0,00	-0,04	-0,18	0,08	-0,02
other	0,32	0,15	-0,20	**0,58**	0,36	0,14	0,19	0,09	-0,00	**0,72**	0,00
NATURAL CAPITAL											
natural_w	**0,42**	0,25	-0,38	**0,62**	**0,52**	0,05	0,16	0,19	0,26	0,38	0,08
natural_w_r	0,10	0,06	-0,17	**0,45**	**0,44**	0,04	0,38	0,13	0,20	0,25	0,04
FRACTIONALISATION											
language	0,34	-0,03	-0,15	**0,43**	0,35	0,21	0,01	-0,02	-0,22	**0,44**	0,18
ethnic	**0,54**	0,18	-0,32	**0,55**	**0,57**	0,35	0,06	0,21	0,32	**0,40**	0,05
INSTITUTIONS											
democracy	**-0,59**	-0,34	**0,43**	**-0,60**	**-0,69**	-0,20	-0,15	-0,23	-0,25	-0,26	-0,04
corruption	**0,42**	0,20	-0,37	**0,50**	**0,52**	0,16	0,11	0,22	0,29	0,20	-0,00
check(2)	0,08	-0,03	-0,22	0,08	0,15	-0,05	0,01	0,13	**0,40**	-0,17	0,07
KKZ96	**-0,57**	-0,21	0,35	**-0,64**	**-0,66**	-0,16	-0,27	-0,31	**-0,43**	-0,32	-0,26
exe_constr	**-0,50**	-0,38	**0,46**	**-0,51**	**-0,58**	-0,13	-0,11	-0,22	-0,16	-0,16	0,07

Note. Values are only reported for those variables with a correlation above or equal to 0,40. The correlation matrix with all variables is available upon requests.

Table A.9
Correlation matrix between proximate and fundamental theories for countries below the median cut-off point in investment in physical capital.

Fundamen. theories					Proximate theories						
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*ssa*	*sea*
RELIGION											
catholic	-0,18	0,05	0,07	0,07	-0,11	-0,01	-0,24	0,19	**0,71**	-0,29	-0,28
hindu	0,04	0,13	-0,12	-0,01	0,11	-0,20	0,16	-0,03	-0,12	-0,08	**0,69**
other	**0,48**	-0,26	-0,32	-0,03	**0,46**	-0,02	0,09	-0,03	-0,16	**0,74**	-0,01
protestant	-0,41	0,20	0,37	-0,04	**-0,45**	0,04	0,04	-0,09	-0,29	-0,05	-0,18
NATURAL CAPITAL											
natural_w	**0,60**	-0,30	-0,29	-0,05	**0,62**	-0,05	0,18	0,05	0,00	**0,53**	0,25
natural_w_r	**0,41**	-0,30	-0,29	-0,04	**0,53**	0,09	0,37	0,01	-0,08	**0,49**	0,11
FRACTIONALISATION											
language	**0,49**	-0,13	-0,21	-0,04	**0,44**	0,06	0,17	-0,06	**-0,42**	**0,64**	0,33
ethnic	**0,61**	-0,31	-0,26	-0,08	**0,61**	-0,02	0,04	0,11	0,18	**0,56**	0,09
INSTITUTIONS											
democracy	**-0,62**	0,39	**0,56**	0,07	**-0,77**	-0,03	0,00	-0,02	-0,19	-0,29	-0,11
corruption	**0,65**	**-0,41**	**-0,45**	-0,05	**0,70**	0,16	0,04	0,07	0,25	0,38	0,03
check(1)	0,13	-0,21	-0,23	-0,01	0,26	0,26	-0,06	0,17	**0,58**	-0,17	0,01
check(2)	0,13	-0,19	-0,21	-0,01	0,26	0,24	-0,04	0,16	**0,58**	-0,16	0,08
KKZ96	**-0,67**	**0,40**	**0,51**	0,06	**-0,77**	-0,03	-0,01	-0,11	-0,29	**-0,40**	0,27
exe_constr	**-0,47**	0,36	**0,48**	0,01	**-0,58**	-0,07	-0,08	0,02	-0,06	-0,31	0,03

Note. Values are only reported for those variables with a correlation above or equal to 0,40. The correlation matrix with all variables is available upon request.

A.3. Results

These tables provide the results for the growth regression exercise in equation [1] under the BMA specification and model uncertainty. The dependent variable is the average growth rate of real per capita GDP corresponding to the periods 1960-64, 1965-69, 1970-74, 1975-79, 1980-84, 1985-89, 1990-94, 1995-99, 2000-04 and 2005-2009. Following Durlauf et al. (2008a), we use as instruments for endogenous variables earlier or initial values if available (with the exception of inflation, religion shares and natural capital) under the Two-Stage Least Squares (2SLS) estimation (without uncertainty). For inflation, we use as instruments the colonial dummy for Spain or Portugal and British and French legal origins, and for religion shares, we use the corresponding shares in 1900. Following van der Ploeg and Poelhekke (2010), we use a dummy for the existence of a presidential system and mineral resource stocks as instruments for natural capital variables. The 2SLS regression results are very similar to the BMA estimation results with uncertainty, results are available upon request. Please refer to the data appendices for details on the variables used.

Table A.10
BMA estimation results for average growth rates of per capita GDP: Full sample.

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,051*	0,008		-0,014*	0,006
population		-0,016	0,050			
invest		0,018	0,012			
school		-0,012	0,010			
DEMOGRAPHY	1,000					
life_exp		-0,006	0,024			
fertility		-0,159*	0,025			
MACROECONOMIC POLICY	0,028					
open		-0,000	0,001			
gov_consu		-0,000	0,013			
inflation		-0,001	0,000			
REGIONAL HETEROGENEITY	0,085					
lac		0,000	0,001			
ssa		-0,002	0,010			
sea		0,000	0,002			
RELIGION	0,981			1,000		
eastern		0,288*	0,076		0,433*	0,062
hindu		0,001	0,012		0,017	0,039
muslim		0,000	0,004		-0,001	0,007
other		0,001	0,013		0,000	0,011
protestant		-0,003	0,012		-0,003	0,012
NATURAL CAPITAL	0,250			0,227		
natural_w		-0,006	0,018		-0,012	0,026
natural_pc		0,000	0,000		0,000	0,000
GEOGRAPHY	0,056			0,035		
coastline		-0,000	0,004		0,000	0,005
landlocked		-0,001	0,006		-0,000	0,003
FRACTIONALISATION	0,056			0,964		
language		-0,001	0,006		-0,002	0,010
ethnic		-0,000	0,004		-0,089*	0,031
INSTITUTIONS	1,000			1,000		
KKZ96		-0,000	0,002		0,000	0,003
exe_constr		-0,006*	0,003		0,000	0,003
year_dummies		Yes			Yes	
observations		640			640	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.11
BMA estimation results for average growth rates of per capita GDP: *invest* ≥ 3,10.

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,073*	0,010		-0,032*	0,009
population		0,044	0,063			
invest		-0,053	0,033			
school		-0,014	0,015			
DEMOGRAPHY	1,000					
life_exp		0,116	1,485			
fertility		-0,199*	0,031			
MACROECONOMIC POLICY	0,973					
open		-0,001	0,006			
gov_consu		-0,007	0,052			
inflation		-0,303*	0,092			
REGIONAL HETEROGENEITY	0,002					
lac		0,000	0,002			
ssa		-0,000	0,003			
sea		-0,000	0,004			
RELIGION	0,980			1,000		
eastern		0,302*	0,083		0,433*	0,069
hindu		0,037	0,067		0,129	0,102
muslim		-0,000	0,007		-0,008	0,021
other		0,003	0,025		-0,000	0,021
protestant		-0,000	0,008		-0,000	0,007
NATURAL CAPITAL	0,170			0,084		
natural_w		-0,002	0,014		-0,003	0,016
natural_pc		0,000	0,000		0,000	0,000
GEOGRAPHY	0,078			0,037		
coastline		-0,000	0,010		0,000	0,003
landlocked		-0,002	0,010		0,000	0,003
FRACTIONALISATION	0,092			0,992		
language		-0,002	0,012		-0,000	0,009
ethnic		-0,001	0,008		-0,138*	0,036
INSTITUTIONS	1,000			0,999		
KKZ96		-0,000	0,004		0,000	0,004
exe_constr		-0,006	0,004		0,001	0,004
year_dummies		Yes			Yes	
observations		338			338	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.12
BMA estimation results for average growth rates of per capita GDP: *invest* < 3,10.

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		0,000	0,012		0,009	0,008
population		-0,151*	0,075			
invest		0,037	0,022			
school		-0,019	0,014			
DEMOGRAPHY	0,161					
life_exp		-0,001	0,011			
fertility		-0,011	0,032			
MACROECONOMIC POLICY	0,041					
open		-0,000	0,002			
gov_consu		-0,000	0,016			
inflation		-0,000	0,001			
REGIONAL HETEROGENEITY	0,384					
lac		-0,000	0,003			
ssa		-0,024	0,036			
sea		0,001	0,008			
RELIGION	0,241			0,116		
eastern		0,017	0,085		0,026	0,111
hindu		0,000	0,007		0,001	0,013
muslim		0,002	0,011		0,000	0,003
other		0,019	0,062		0,000	0,006
protestant		-0,010	0,030		-0,005	0,021
NATURAL CAPITAL	0,096			0,341		
natural_w		-0,003	0,014		-0,023	0,036
natural_pc		0,000	0,000		0,000	0,000
GEOGRAPHY	0,065			0,088		
coastline		0,000	0,006		0,000	0,006
landlocked		-0,001	0,008		-0,002	0,001
FRACTIONALISATION	0,052			0,083		
language		0,000	0,007		-0,000	0,006
ethnic		0,000	0,006		-0,002	0,012
INSTITUTIONS	0,999			1,000		
KKZ96		-0,001	0,006		0,000	0,003
exe_constr		-0,007	0,004		-0,004	0,004
year_dummies		Yes			Yes	
observations		308			308	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.13
BMA estimation results for average growth rates of per capita GDP: Full sample (renewable natural capital).

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,051*	0,008		-0,018*	0,008
population		-0,017	0,049			
invest		0,017	0,012			
school		-0,003	0,010			
DEMOGRAPHY	1,000					
life_exp		-0,007	0,025			
fertility		-0,162*	0,025			
MACROECONOMIC POLICY	0,024					
open		-0,000	0,001			
gov_consu		-0,000	0,010			
Inflation		-0,001	0,000			
REGIONAL HETEROGENEITY	0,053					
lac		0,000	0,001			
ssa		-0,001	0,006			
sea		0,000	0,002			
RELIGION	0,943			1,000		
eastern		0,258*	0,089		0,416*	0,063
hindu		0,002	0,013		0,025	0,047
muslim		0,000	0,005		-0,004	0,013
other		0,002	0,015		0,001	0,012
protestant		-0,001	0,008		-0,002	0,010
NATURAL CAPITAL	0,168			0,605		
natural_w_r		-0,015	0,038		-0,082	0,075
natural_pc_r		0,000	0,000		0,000	0,000
GEOGRAPHY	0,074			0,034		
coastline		-0,000	0,004		0,000	0,005
landlocked		-0,001	0,008		-0,000	0,003
FRACTIONALISATION	0,043			0,984		
language		-0,000	0,004		-0,004	0,015
ethnic		-0,000	0,003		-0,084*	0,031
INSTITUTIONS	1,000			1,000		
KKZ96		-0,000	0,004		0,000	0,002
exe_constr		-0,008*	0,003		-0,000	0,003
year_dummies		Yes			Yes	
observations		640			640	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.14
BMA estimation results for average growth rates of per capitaGDP: *invest* ≥ 3,10 (renewable natural capital).

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,071*	0,010		-0,036*	0,011
population		0,041	0,063			
invest		-0,058	0,032			
school		-0,007	0,015			
DEMOGRAPHY	1,000					
life_exp		0,197	1,621			
fertility		-0,197*	0,031			
MACROECONOMIC POLICY	0,924					
open		-0,000	0,005			
gov_consu		-0,005	0,049			
inflation		-0,275*	0,111			
REGIONAL HETEROGENEITY	0,029					
lac		0,000	0,002			
ssa		-0,000	0,003			
sea		-0,000	0,006			
RELIGION	0,971			1,000		
eastern		0,290*	0,087		0,423*	0,071
hindu		0,060	0,086		0,186	0,104
muslim		-0,001	0,008		-0,017	0,031
other		0,008	0,037		0,003	0,025
protestant		0,000	0,006		-0,001	0,008
NATURAL CAPITAL	0,165			0,378		
natural_w_r		-0,021	0,059		-0,073	0,113
natural_pc_r		0,000	0,000		0,000	0,000
GEOGRAPHY	0,094			0,039		
coastline		0,001	0,014		0,000	0,003
landlocked		-0,003	0,012		0,000	0,014
FRACTIONALISATION	0,076			0,984		
language		-0,002	0,010		-0,001	0,012
ethnic		-0,000	0,007		-0,129*	0,039
INSTITUTIONS	1,000			0,999		
KKZ96		-0,001	0,005		0,000	0,003
exe_constr		-0,008	0,004		-0,001	0,005
year_dummies		Yes			Yes	
observations		338			338	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.15
BMA estimation results for average growth rates of per capita GDP: *invest* < 3,10 (renewable natural capital).

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,006	0,013		0,003	0,009
population		-0,154*	0,086			
invest		0,035	0,022			
school		-0,010	0,014			
DEMOGRAPHY	0,286					
life_exp		-0,002	0,014			
fertility		-0,027	0,051			
MACROECONOMIC POLICY	0,042					
open		-0,000	0,002			
gov_consu		0,001	0,027			
inflation		-0,000	0,000			
REGIONAL HETEROGENEITY	0,218					
lac		0,000	0,003			
ssa		-0,011	0,027			
sea		0,000	0,007			
RELIGION	0,167			0,004		
eastern		0,065	0,050		0,007	0,058
hindu		0,000	0,006		0,000	0,008
muslim		0,024	0,011		0,000	0,021
other		0,012	0,050		0,000	0,005
protestant		-0,007	0,024		-0,001	0,012
NATURAL CAPITAL	0,220			0,524		
natural_w_r		-0,024	0,055		0,076	0,058
natural_pc_r		-0,000	0,000		-0,000	0,000
GEOGRAPHY	0,050			0,057		
coastline		0,000	0,006		-0,001	0,007
landlocked		-0,000	0,006		0,002	0,006
FRACTIONALISATION	0,045			0,089		
language		0,000	0,005		-0,000	0,007
ethnic		0,000	0,005		-0,002	0,012
INSTITUTIONS	0,999			1,000		
KKZ96		-0,005	0,013		0,000	0,003
exe_constr		-0,007	0,004		-0,002	0,004
year_dummies		Yes			Yes	
observations		308			308	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.16
BMA estimation results for average growth rates of per capita GDP: Full sample (non-renewable natural capital).

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,052*	0,008		-0,012*	0,005
population		-0,022	0,050			
invest		0,017	0,012			
school		-0,003	0,010			
DEMOGRAPHY	1,000					
life_exp		-0,007	0,025			
fertility		-0,164*	0,025			
MACROECONOMIC POLICY	0,024					
open		-0,000	0,001			
gov_consu		-0,000	0,009			
inflation		-0,000	0,000			
REGIONAL HETEROGENEITY	0,049					
lac		0,000	0,001			
ssa		-0,001	0,006			
sea		0,000	0,002			
RELIGION	0,958			1,000		
eastern		0,266*	0,084		0,432*	0,062
hindu		0,001	0,012		0,021	0,043
muslim		0,000	0,005		-0,001	0,006
other		0,002	0,015		0,001	0,013
protestant		-0,003	0,011		-0,003	0,013
NATURAL CAPITAL	0,277			0,059		
natural_w_nr		-0,000	0,006		-0,001	0,009
natural_pc_nr		0,000	0,000		0,000	0,000
GEOGRAPHY	0,074			0,036		
coastline		-0,000	0,004		0,000	0,005
landlocked		-0,001	0,008		-0,000	0,003
FRACTIONALISATION	0,044			0,993		
language		-0,000	0,004		-0,001	0,009
ethnic		-0,000	0,004		-0,093*	0,025
INSTITUTIONS	1,000			1,000		
KKZ96		-0,000	0,003		0,000	0,003
exe_constr		-0,007*	0,003		-0,000	0,003
year_dummies		Yes			Yes	
observations		640			640	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.17
BMA estimation results for average growth rates of per capita GDP: *invest* ≥ 3,10 (non-renewable natural capital).

	Proximate and fundamental theories			Fundamental theories		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,071*	0,010		-0,031*	0,008
population		0,043	0,063			
invest		-0,059	0,032			
school		-0,007	0,015			
DEMOGRAPHY	1,000					
life_exp		0,155	1,513			
fertility		-0,195*	0,031			
MACROECONOMIC POLICY	0,925					
open		-0,001	0,006			
gov_consu		-0,007	0,050			
inflation		-0,275*	0,110			
REGIONAL HETEROGENEITY	0,027					
lac		-0,000	0,002			
ssa		-0,000	0,003			
sea		-0,000	0,004			
RELIGION	0,976			1,000		
eastern		0,294*	0,084		0,428*	0,068
hindu		0,051	0,080		0,169	0,106
muslim		-0,001	0,008		-0,008	0,021
other		0,007	0,034		0,002	0,023
protestant		-0,000	0,006		-0,000	0,007
NATURAL CAPITAL	0,153			0,038		
natural_w_nr		0,004	0,020		0,000	0,007
natural_pc_nr		0,000	0,000		0,000	0,000
GEOGRAPHY	0,093			0,038		
coastline		0,000	0,014		0,000	0,014
landlocked		-0,002	0,012		0,000	0,003
FRACTIONALISATION	0,077			0,993		
language		-0,002	0,010		-0,000	0,009
ethnic		-0,001	0,007		-0,136*	0,036
INSTITUTIONS	1,000			0,999		
KKZ96		-0,001	0,004		0,000	0,004
exe_constr		-0,008*	0,004		-0,001	0,004
year_dummies		Yes			Yes	
observations		338			338	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).

Table A.18
BMA estimation results for average growth rates of per capita GDP: *invest* < 3,10 (non-renewable natural capital).

	Proximate and fundamental theories			**Fundamental theories**		
Explanatory variable	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**	**Posterior inclusion probability (#)**	**Posterior mean**	**Posterior standard deviation**
NEOCLASSICAL						
income_in		-0,005	0,013		0,010	0,007
population		-0,154*	0,090			
invest		0,037	0,022			
school		-0,010	0,014			
DEMOGRAPHY	0,317					
life_exp		-0,002	0,015			
fertility		-0,031	0,053			
MACROECONOMIC POLICY	0,039					
open		-0,000	0,002			
gov_consu		0,000	0,017			
inflation		-0,000	0,001			
REGIONAL HETEROGENEITY	0,190					
lac		0,000	0,003			
ssa		-0,009	0,025			
sea		0,000	0,007			
RELIGION	0,181			0,007		
eastern		0,007	0,053		0,012	0,974
hindu		0,000	0,006		0,001	0,009
muslim		0,002	0,012		0,000	0,003
other		0,012	0,050		0,000	0,006
protestant		-0,008	0,026		-0,003	0,016
NATURAL CAPITAL	0,079			0,124		
natural_w_nr		-0,001	0,010		-0,006	0,022
natural_pc_nr		0,000	0,000		0,000	0,000
GEOGRAPHY	0,051			0,068		
coastline		0,000	0,006		0,000	0,006
landlocked		-0,000	0,006		-0,002	0,009
FRACTIONALISATION	0,044			0,095		
language		0,000	0,005		-0,000	0,006
ethnic		-0,000	0,006		0,003	0,014
INSTITUTIONS	0,999			0,999		
KKZ96		-0,005	0,014		0,000	0,003
exe_constr		-0,007	0,004		-0,003	0,004
year_dummies		Yes			Yes	
observations		308			308	

Note. This table provides results for the growth regression exercise in equation (1). The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods from 1960 to 2009 for 83 countries. "*" denotes significance. Within BMA, a specific theory is important if the posterior mean of the probability is at least twice the posterior standard deviation (see Brock and Durlauf, 2001). "#" denotes the posterior inclusion probability of each theory (as opposed to each individual variable).