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The determinants of economic growth in countries with high marine biodiversity: Effects of potential anthropogenic pressures on the marine environment[1]

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Abstract

In this paper, we explore the economic growth determinants in 74 countries with high marine biodiversity for the period 1960-2009 to identify the effects of potential anthropogenic pressures on the marine environment. In contrast with previous analyses on a worldwide sample of countries, macroeconomic policies, natural capital and education are additional robust determinants of economic growth. Compared to an average country, countries with high marine biodiversity are characterized, among other features, by higher international trade exchanges, lower institutional endowments and higher fertility rates. International trade and natural capital exploitation, together with a particularly high fertility rate, can be potential high anthropogenic pressures on marine biodiversity through coastal construction and public works, land conversion for natural capital exploitation, over-exploitation of marine resources, urbanization, uncontrolled sewage and farming and other run-offs which, in turn, affect growth. Besides, we find that the rate of economic convergence between countries with high marine biodiversity increases with the level of education. Altogether, our results are consistent with previous empirical findings whereby diversifying away from the dependence on natural capital exploitation within a country by investing in education can enhance its economic growth rate. This structural change can contribute to remove potential anthropogenic pressures from national marine biodiversity hotspots, mainly by decreasing the rate of coastal construction and public works, land conversion, farming and other run-offs, as well as by decreasing the rate of marine resources exploitation, urbanization, and uncontrolled sewage, with lower fertility rates as the degree of education raises. At the global scale, the marine ecological footprint will, however, depend on how the delocalization of these natural resource activities is done within the context of raising national economic growth rates.

JEL-codes: O10, O13, Q20, Q22

Key-words: Economic growth, marine biodiversity conservation

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1. Introduction

A major subject of social concern in regards to marine biodiversity is the extent and quality of coral reefs. The 'rainforests of the ocean', coral reefs, are biodiversity hotspots being home to about 25 per cent of the ocean's marine life, on less than one per cent of the area of marine environments. Coral reefs are known as one of the most complex and species-rich ecosystems in the world, with vital connections to many other ecosystems and a global-scale importance. They play a central role in many ecosystem services, such as coastal protection, water chemical balance, CO2 cycles and marine biomass and biodiversity production (Hicks and Cinner, 2014). However, such marine biodiversity is threatened. About 50 per cent of the area covered by coral reefs has been lost in the past 30 years, and an estimated 83 per cent of reefs have lost more than half of their expected fish biomass (WWF, 2015 and MacNeil *et al.,* 2015). It is a research question how the specific economic growth determinants in countries with high levels of such marine biodiversity exert pressure on the marine environment.

Human threats regarding the marine environment and, more specifically, coral reefs consist of many different types of pressures. Pressures can be indirect and diffuse, such as global change, or direct and local, such as pollution (Carpenter *et al.,* 2008). Due to global threats, perturbations like massive bleaching are now observed worldwide. Local threats include most notably pollution, overpopulation overfishing and even direct reef destruction through construction works, destructive fishing gears and limestone exploitation. Small-scale threats such as destructive fishing, watershed-based pollution, or direct extractions are considered to be more closely linked to developing countries (in particular, in the "Coral Triangle" in South-East Asia or in East Africa), whereas long-term stressors such as shifts in water quality or species assemblage are more linked to rich countries (such as the US, outer sea France and Japan). Coastal development and pollution are observed worldwide as soon as coasts get populated (WRI, 2011).

To our knowledge, this paper is a first contribution to analyze the determinants of economic growth in countries with high marine biodiversity, to explore how potential anthropogenic pressures on the marine environment might affect economic growth. In order to perform this analysis, we proxy marine biodiversity through the extent of coral reefs.[2] Our analysis controls for the existence of multiple growth regimes under a Bayesian Model Averaging (BMA) method that accounts for theory and specification uncertainty.

In the following section, we detail our contribution to the empirical academic literature on economic growth. In subsection 3.1, we describe the econometric model and some preliminary analyses to explore whether there are multiple economic growth regimes. In subsection 3.2, we present the data used in our analysis. The results are presented in subsections 3.3 and 3.4, the discussion in section 4. The appendix provides a detailed description of the data and the estimations.

2. The determinants of economic growth

According to neoclassical growth theory output per worker will converge around the world, with areas under low capital-labor ratios having higher rates of return to capital and attracting capital until they would eventually catch-up with more advanced economies (Solow, 1956). However, evidence highlights that rapid productivity growth was never sustained in the poorer regions of the world. Indeed, there has been little unconditional convergence in output around the world and most capital investment has gone to developed countries. Under these premises, conditional convergence was defined such that output per worker would not converge to a common level unless other factors coincide.

[2] The economic impact of marine biodiversity is a different research question to the one addressed in this paper which is better captured through microeconomic analyses (see, for instance, McClanahan *et al.,* 2008).

In order hence to increase the explanatory power of the neoclassical growth models to show how growth rates differ across time and countries, new factors or 'new growth theories' were introduced on empirical models to address the unexplained part of growth. Durlauf *et al*. (2008a) have developed an exhaustive survey of the empirical growth literature and identified a total of 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). There is therefore empirical evidence in favor of conditional convergence where less favored countries would growth at faster rates until they have reached a steady state under the assumption of decreasing returns to scale. In addition, there may be multiple growth regimes, each one with economies that tend to converge to one another (Durlauf and Johnson, 1995), which requires dividing the sample through the use of several methodologies.[3]

Given the potentially unlimited number of new growth theories, uncertainty is a fundamental problem when analyzing the determinants of economic growth. From an econometric perspective, regression analyses show that a large number of variables are correlated with economic growth but this is far from implying the 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 relevance of new growth theories in determining economic growth, Durlauf *et al*. (2005, 2008a) and Sala-i-Martin *et al*. (2004) propose the BMA methodology which is a Bayesian model averaging method that accounts for uncertainty.[4]

In Table 1, we see that new growth theories can be classified into two classes of theories: proximate and fundamental or deep theories (Rodrik, 2003). According to Durlauf *et al*. (2008a), neoclassical, demography, macroeconomic policy, regional heterogeneity are proximate theories, and religion, natural capital, geography, fractionalization and institutions are fundamental theories, the latter theories broadly corresponding to cultural and natural determinants. Proximate theories are associated 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 (Rodrik, 2003). They can also 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).

A proxy variable is used to represent an unobserved metric, that is, the growth theories, 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 will rarely be perfect estimations for the unobserved variable, they still provide a worthwhile approximation for a necessary variable in the growth model. When there are several proxies within a theory, one can examine separately the effect of each proxy. For example, it is possible to explore whether the eastern religion has a significant impact on economic growth, relative to the other religions examined.

To our knowledge, we propose in this paper a first contribution to have a better understanding of determinants of economic growth in countries with relatively high marine biodiversity, to explore how potential anthropogenic pressures on the marine environment affect economic growth. Using a sample of

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[3] See Owen *et al*. (2007) and Konte (2013) for a summary on how the question of multiple growth regimes has been addressed in the academic literature. 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).

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

countries with high marine biodiversity, we estimate the augmented Solow model including new growth theories. We control for the existence of multiple convergence regimes under a BMA method that accounts for uncertainty. Such an analysis enables to compare our results with those of worldwide data sets (Recuero Virto and Couvet, 2017). The latter analysis finds the robust determinants of economic growth are neoclassical (initial income), demography, religion and institutions theories (with a direct impact on economic growth), as well as the fractionalization theory (with an indirect impact on economic growth through demography variables).

Table 1. Proximate and fundamental growth theories and some proxies

PROXIMATE THEORIES	PROXIES
Neoclassical	Initial income, population growth rates, investment in physical capital and schooling (Solow, 1956)
Demography	Life expectancy, fertility rate (Shastry and Weil, 2003 and 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 and Gylfason, 2011)
Geography	Coastline, landlocked (Sachs, 2003)
Fractionalization	Language and ethnic (Alesina *et. al.,* 2003 and Easterly and Levine, 1997)
Institutions	Liberal democracy, public sector corruption, legal formalism, governance and executive constraints (Djankov *et al*., 2002, 2003)

3. Empirical analysis

3.1. Econometric methodology

In section three, we firstly 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. Lastly, we explain how we perform our preliminary analysis on the existence of multiple convergence regimes.

Economic growth model: Baseline 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.[5] Based on Durlauf

[5] 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.

and Quah (1999), we use the following augmented Solow model with a set of new growth theories (Solow, 1956 and Durlauf *et al.,* 2005, 2008a):

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

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

where y_{ir} is the real per capita GDP for country i (i = [1,.. N]) across a time period [r, r+T], T being 5 years, $s_{i,r}^k$, $s_{i,r}^h$ and $\log(n_{i,r} + g + \delta)$ denote the variables that measure net factor accumulation in the neoclassical growth theory with the saving rates of physical ($s_{i,r}^k$) and human capital accumulation ($s_{i,r}^h$) and population growth rates ($n_{i,r}$) plus the rate of labor augmenting technical progress (g) and the physical capital depreciation rate (δ), $z_{i,r}$ denotes a set of variables proxying eight new growth theories that go beyond the neoclassical model as described in the data section and in the appendix (Tables A2 and A3), α_i is a country-specific effect, θ_r is a time-specific effect and $\varepsilon_{i,r}$ is the error term.[6]

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 $z_{i,r}$ (see Table 1).

Our economic growth regressions include both proximate and fundamental theories. A theory will be said to be explanatory for growth when there is at least one variable belonging to this theory which has a significant effect on growth. Fundamental variables, associated to corresponding theories, can have direct and/or indirect effects on economic growth. To examine direct effects, we first develop estimations including both proximate and fundamental variables. If fundamental theories are significant in these estimations, this implies that corresponding variables have a direct impact on economic growth.

To examine indirect effects of fundamental theories on economic growth, we develop estimations including only fundamental theories. When fundamental theories 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. Correlations between proximate and fundamental theories are also explored, to provide some alternative evidence of relationships between these two kinds of theories. Such results should help to describe more precisely the different theories, in particular, to explore how they relate to complementary theories (belonging to a different class of theories, see Table 1). However, the interpretation of such multiplicity of significance tests based on correlations is difficult. Moreover, this same theory might be more or less able to account for the observations because of degree of correlation between variables without necessarily implying a causal relationship.

Economic growth model: Uncertainty

To get a clearer picture of the relevance of the different theories, our approach is to estimate the probability that the different growth theories are relevant through model uncertainty. Such probability contributes to hierarchize their relevance. Notice the advantages compared to the approach where one

[6] We note that 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 economic growth estimations.

examines crudely if a theory, through the associated proxies, is significant or not, with a 'yes' or 'no' answer and no hierarchy (Brock and Durlauf, 2001, Brock *et al.*, 2003).

In our approach, 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 μ(m|D) ∝ μ(D|m) μ(m), where D is the available data, μ(D|m) is the likelihood of the data given the model and μ(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).[7] 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.

Preliminary analysis: Presence of multiple convergence regimes

We apply a preliminary analysis to the augmented Solow model to explore whether there are different growth regimes, with varying 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.[8] Alternatively, there can be evidence of multiple convergence regimes 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 behavior.[9]

To analyze whether there are multiple growth 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 preliminary estimations for the full sample and for the identified sub-samples, and we test the hypothesis that all the countries in the sample follow the same convergence dynamics through a Chow test.[10] 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 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 Generalized 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:

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

[7] Assigning equal prior probability to each possible model can have odd implications for linear regressions with a large number of potential regressors, though. 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.

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

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

[10] 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 from the two sub-sample models and K is the total number of independent variables (including the constant).

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 OLS and the within-group models with those of DIF-GMM methods. 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. For instance, education variables can influence output with a considerable delay. 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 DIF-GMM, instruments in first differences for the equation in levels and offers higher robustness.

3.2. Data and preliminary results

The unbalanced panel data set covers 80 countries and geographical locations with coral reefs for 10 five-year periods from 1960 to 2009 (see appendix for more details). The choice of the eight growth theories and the associated variables is largely inspired by the work of Durlauf *et al*. (2008a) and enables to compare results with those of Recuero Virto and Couvet (2017) based on a worldwide data set. The detailed definition of the variables, their designation and the data sources are given in Tables A2-A3 in the appendix.

The preliminary analysis results are discussed in detail in the appendix (see Tables A4-A12). Compared with Recuero Virto and Couvet (2007)'s worldwide data set, the sample in this paper based on countries with high marine biodiversity is characterized by higher fertility rates, higher international trade exchanges, greater government consumption, lower inflation and lower institutional endowments (Table A5). Indeed, we have mean values of 1,28 for fertility (compared to 1,41 in this paper), 0,62 for openness (compared to 0,75), 0,09 for government consumption (compared to 0,14), 0,23 for inflation (compared to 0,14) and 0,28 in kkz96 or governance (compared to 0,14). Such demography, macroeconomic policy and institutional results provide some preliminary evidence on the specificities of the determinants of economic growth in countries with high marine biodiversity.

Smith (1776) already stressed the relationship between the geographical location, international trade and economic growth in coastal countries. The rapid development of civilizations around the Mediterranean basin was helped by the relative ease of sea-based trade in the region (Braudel, 1972, McNeill, 1974, Jones, 1981 and Crosby, 1986). Countries with a longer coastline are likely to have more ports, a larger share of the population with relatively easy access to the sea, and a greater proportion of economic activity grounded in international trade (Bloom and Sachs, 1998, Masters and Sachs, 2001, Bloom *et al*., 2003). Economic policy choices also depend on geography. A coastal economy, for example, may face a higher elasticity of output response with respect to trade taxes than a landlocked economy (Gallup *et al*., 1998). The early liberalizers, on the whole, were the coastal economies**.** In addition, more ocean-accessible regions in the world are more urbanized and have lower transport costs (Gallup *et al*., 1998).

In our preliminary analysis, we also find that the data shows heteroskedasticity and serial correlation which need to be taken into account in our analyses. Moreover, we find some evidence of the existence of multiple convergence regimes among our panel of countries based on the CART model. The rate of economic convergence is higher for those countries with higher rates of schooling and lower for the countries with lower rates of schooling. 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 near-median level of schooling which determines the two growth regimes. Finally, the correlation matrix conveys some useful information on the explanatory power of fundamental theories in the economic growth regression. It may be the case that the influence of some of the fundamental theories (religion, fractionalization and institutions) on economic growth is exerted through proximate theories, and that these fundamental theories may have no direct impact on economic growth.

3.3. Economic growth regression results: Countries with high marine biodiversity versus a worldwide data set

In the following lines, we present our findings for the augmented Solow model and eight new growth theories based on equation [1], in relative terms to Recuero Virto and Couvet (2017)'s results based on a worldwide data set.[11][12]

Economic growth determinants: The results that differ in the two samples of countries

In Tables 2, 3 and A13, we see that there are two additional robust new growth theories for the full sample in the sample of countries with high marine biodiversity compared to the worldwide data set: macroeconomic policy and natural capital. Indeed, in terms of the fundamental theories, the posterior probability of inclusion is close to one, both for the estimation with proximate and fundamental theories and for fundamental theories alone. With respect to macroeconomic policy, *gov_consu* is negatively and significantly correlated with economic growth, in line with previous findings (Barro, 1991, 1996 and 1997 and Sachs and Warner, 1995). In particular, if we compare the two sub-samples according to the near-median level of schooling in Tables 2 and A14-A15 with the results for the full sample, we see that macroeconomic policy is a robust determinant of economic growth in the sub-sample with schooling values below the near-median cut-off point.

Concerning the natural capital theory, it is a robust determinant of economic growth for countries with marine biodiversity. In Table A13, we see that the share of natural capital in wealth variable has almost a significant (and negative) impact on economic growth when considering fundamental theories alone. As we see in Table A2, our natural capital variable is composed of renewable (timber, non-timber forest resources, protected areas, cropland and pastureland) and renewable (oil, natural gas, hard coal, soft coal and minerals) resources. Therefore, our results provide some evidence that a too strong dependence on agriculture and natural resource extraction is correlated with low economic growth, as previously observed in the empirical literature (Gylfason, 2011).[13] Finally, in the previous subsection we found that the rate of

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[11] 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 A4 (some religion variables: buddhism, catholic, jew and orthodox). We check for multicollinearity whereby additional variables are also excluded 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).

[12] The results can be found in Table A13 for the full sample and in Tables A14 and A15 for the two sub-samples defined by the cut-off point in the near-median level of schooling. Tables A13-A15 show results for the case where we include both proximate and fundamental determinants in the model space (columns 1-3) as well as the case where only fundamental growth determinants are in the model space (columns 4-6). Columns 1 and 4 of Tables A13-A15 provide the posterior probability that each theory is in the 'true' model under BMA. In Tables 4 and 5 below, we share the summary findings for the BMA posterior inclusion probability results and for the BMA posterior mean results for the full set of eight theories.

[13] The variable natural capital per capita is not significant. We use variables that proxy natural capital dependence and abundance suggested by Gylfasson (2011), that is, natural capital in wealth and natural capital per capita, respectively (World Bank, 2006).13 These two variables usually do not have the same impact on economic growth, as a too strong

economic convergence in countries with high marine biodiversity increases with the level of education. In addition, education has a significant and positive impact on economic growth in countries with very high levels of marine biodiversity.[14]

Table 2. Economic growth determinants in countries with high marine biodiversity: BMA posterior inclusion probability results

	Proximate and fundamental theories			**Fundamental theories**		
	Full sample	***school* ≥ 3,50**	***school* < 3,50**	**Full sample**	***school* ≥ 3,50**	***school* < 3,50**
DEMOGRAPHY	**1,000**	**1,000**	**0,995**			
MACROEC. POLICY	**1,000**	0,276	**1,000**			
REGIONAL HETERO.	0,046	0,048	0,063			
RELIGION	0,085	0,523	0,025	**0,997**	**1,000**	**0,019**
NATURAL CAPITAL	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
GEOGRAPHY	0,110	0,071	0,181	0,046	0,064	0,060
FRACTIONALISATION	**0,999**	0,059	**0,994**	**0,990**	0,085	**0,996**
INSTITUTIONS	**1,000**	**1,000**	**0,997**	**1,000**	**1,000**	**0,999**

Note: Summary results for the eight growth theories for the growth regression exercise in equation (1) of the text. 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 schooling. The value in bold indicates that the variable is a relatively robust determinants of economic growth.

Table 3. Economic growth determinants with Recuero Virto and Couvet (2007)'s worldwide data set: 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			
MACROEC. POLICY	0,028	**0,973**	0,041			
REGIONAL HETERO.	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 for the eight growth theories for the growth regression exercise in Recuero Virto and Couvet (2017). 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 worldwide 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 determinants of economic growth.

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dependence on agriculture and natural resource extraction is typically correlated with low economic growth, while a high ecological abundance in per capita terms should contribute positively to wealth (Gylfason, 2011).

[14] Results are available upon request.

Economic growth determinants: The results that are common to the two samples of countries

With regards to demography variables, in Tables 4 and A13, we see that the effect of *fertility* is detrimental to economic growth and significant as in Barro (1991, 1996 and 1997) and Barro and Lee (1994). We note that fertility might not impact (negatively) growth directly, but might be a proxy, for example, for the (in)efficiency of social policies such as the absence of social security for the elders. In terms of the fractionalization theory, the associated variable matters for economic growth in countries with high marine biodiversity confirming previous work in the empirical literature suggesting an important role for fractionalization in growth (Easterly and Levine, 1997 and Alesina et *al.,* 2003). Concerning the presence of multiple growth regimes, the fractionalization theory is a robust theory in the sub-sample with schooling values below the near-median cut-off point, with the *ethnic* variable being significant in Table 4. This is consistent with our preliminary analysis where the *ethnic* variable has a higher value in the sub-sample with schooling values below the near-median cut-off point. In comparison, fractionalization would matter for economic growth when using the worldwide data set, only when fundamental growth theories are considered (Table 3). In this case, the impact of fractionalization on economic growth would be exerted indirectly, mainly through demography variables.

With the sample of countries with high marine biodiversity, eastern religion would favor economic growth only when fundamental growth theories are considered. When we included the demography variables in the fundamentals only model space, the religion variables that were found to be robust determinants in column 4 of Table 2 become non-robust with a posterior probability of 0,0448.[17] This is consistent with our preliminary results where, among fundamental theories, religion is correlated with proximate theories' variables (Table A11). As in Durlauf *et al*. (2008a), our results indicate that previous findings on the direct importance of religion to economic growth are fragile.

Table 4. Economic growth determinants in countries with high marine biodiversity: BMA posterior mean results

	Proximate and fundamental theories			**Fundamental theories**		
	Full sample	***school*** **≥ 3,50**	***school*** **< 3,50**	**Full sample**	***school*** **≥ 3,50**	***school*** **< 3,50**
NEOCLASSICAL						
income_ini	-	-	-	-	-	NS
DEMOGRAPHY						
fertility	-	-	-	NA	NA	NA
MACROEC. POLICY						
gov_consu	NS	NS	-	NA	NA	NA
RELIGION						
eastern	NS	NS	NS	+	+	NS
FRACTIONALISATION						
ethnic	NS	NS	+	NS	NS	NS
INSTITUTIONS						
executive_constraints	-	NS	-	NS	NS	NS

Note: Summary results for the eight growth theories for the growth regression exercise in equation (1) of the text that have variables that are significant. 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 schooling. '+' stands for a positive and significant impact on average growth rates of pc GDP, '-' stands for a negative and significant impact, 'NS' stands for a non-significant impact and 'NA' stands for non-applicable. The value in bold indicates that the variable is a relatively robust determinants of economic growth.

[17] Results are available upon request.

Our results also suggest a negative role for institutions on economic growth directly and indirectly –considering only fundamental theories - in contrast with the result of Acemoglu *et al*. (2002) (see Table 2). One interpretation of our results is that greater checks and balances may depress growth by blocking policy decisions (Barro, 1994). An alternative hypothesis is that countries with poor institutions are catching up other countries with better institutions, in terms of economic growth, but possibly not in terms of other important social indicators, that is, indicators which matter for stake-holders whose preferences improve with better institutions. To the extent that our measure of institutional quality correlates positively with political instability, there is also significant evidence in the empirical literature of a negative relationship with respect to economic growth.[18]

The results related to the neoclassical theory in countries with high marine biodiversity coincide with those of the worldwide data set. In Table 3, we see 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 and Easterly and Levine, 1997). Our findings are overall consistent with those in the conditional convergence literature as well as previous studies that have used BMA methods. There is no evidence, however, that investment in physical capital is positively and significantly correlated to 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 and Barro, 1997). The effect of schooling is not significant, but this result remains largely consistent with the literature (Durlauf *et al*., 2008a). In exercises where we drop demography from the model space, we find that population growth rates are negatively and significantly related to growth (Mankiw *et al*., 1992, Kelley and Schmidt, 1995 and Blooms and Sachs, 1998).[19]

4. Discussion

In this paper, we explore the determinants of economic growth in countries with high marine biodiversity, to explore how potential anthropogenic pressures on the marine environment might affect economic growth. In fact, marine substrate complexity can buffer, to some extent, the impacts on reef systems related to anthropogenic activities (Cinner *et al*., 2009). Maldives, The Bahamas and some archipelagos in the Pacific may be examples of marine-rich developing areas. In contrast, in Florida, in the Antilles and in certain African coastal countries, since coral reefs are more fragile and hence less resilient to external pressures, which could be due to natural or social causes related to past economic development, economic development presently induces a loss in marine biodiversity. What are then the determinants of economic growth in countries with high marine biodiversity that can contribute to explain the potential anthropogenic pressures on the marine environment?

When we compare our results with those of Recuero Virto and Couvet (2017) based on the same methodology and using a worldwide data set, we find that macroeconomic policy, natural capital and education are additional robust determinants of economic growth in countries with high marine biodiversity. Our interpretation of these results will use the observation that compared to an average country, countries with high marine biodiversity are characterized, among other features, by higher international trade exchanges. International trade and natural capital exploitation, together with a

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[18] Our 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 such 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 and Castelli *et al*., 1996).

[19] Results are available upon request.

particularly high fertility rate, can be potential high anthropogenic pressures on marine biodiversity. A strong dependence on agriculture and on the export of non-renewable natural resources to foster economic growth in these countries can potentially lead to coastal construction and public works, land conversion for natural capital exploitation, and farming and other run-offs.

There is strong historical evidence on the role of macroeconomic policies in trade flows and economic growth in coastal countries. Trade-oriented macroeconomic policies can exert pressure on marine ecosystems (Dahuri and Dutton, 2000). Policies such as increases in money supply and government expenditures, and decreases in taxes, cause the aggregate demand to grow. Despite higher prices of consumer goods and higher demand for labor in the formal sector, wages need not increase when there is labor surplus. Hence, expansionary policies may place more pressure on marine ecosystems and lead to faster depletion and degradation (Francisco and Sajise, 1992). Thus, one might question the sustainability of such economic growth.

The role of demography is an additional subject of concern, with countries with high marine biodiversity having particularly high fertility rates. In fact, many of the world's coasts are becoming increasingly urban, with strong increases in coastal population, which in turn damages coastal ecosystems. Many studies show that an increasing population increases the anthropogenic pressure on ecosystems (Cinner *et al.,* 2009a and Bond Estes *et al.,* 2012), through direct exploitation (implying effects such as 'Malthusian overfishing', McClanahan *et al.,* 2008) as well as indirect effects such as uncontrolled sewage or farming runoffs. In terms of policies, short-term gain is still often preferred to ecosystem services management (MEA, 2005).

In our analysis, we also find that education plays an important role in countries with high marine biodiversity. According to our results, the rate of economic convergence in these countries increases with the level of education. In addition, education has a significant and positive impact on economic growth in countries with very high levels of marine biodiversity. Overall, our results appear to suggest that diversifying away from national natural capital by investing in education can enhance national economic growth, particularly in countries with very high levels of marine biodiversity.

According to Gylfason (2011), low-income countries will show a negative dependence with respect to national natural resources, this dependence being strongly linked to non-renewable natural capital exports in the empirical literature (Sachs and Warner, 2001). As countries develop from an economic standpoint, they become less dependent on the (negative) influence of national natural capital and more reliant on the positive impact of national intangible capital. This structural change can contribute to remove potential anthropogenic pressures from national marine biodiversity hotspots, mainly by decreasing the rate of coastal construction and public works, land conversion, farming and other run-offs, as well as by decreasing over-marine resources exploitation, urbanization, and uncontrolled sewage with lower fertility rates as the degree of education raises. At the global scale, however, the marine ecological footprint will depend on how the delocalization of these natural resource activities is done within the context of raising national economic growth rates.

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6. Appendix

Data

The data set constructed for this study contains observations for the period 1965-2009 on the following countries listed in Table A1 for which we have sufficient data on neoclassical variables.[20] We have data on 74 countries with coral reefs. Reef areas have been rounded to the nearest 10 sq km, while for those countries with small areas of coral reefs, the terms <100, <50 and <10 sq km have been used.

Table A1. Countries and geographical locations with coral reefs

Country and geographical locations	Reef Area (sq km)	Percentage of world total
Indonesia	51.020	17,95
Australia	48.960	17,22
Philippines	25.060	8,81
France including: Clipperton, Mayotte, Réunion, Guadeloupe, Martinique, New Caledonia, French Polynesia, Wallis and Futuna Islands	14.280	5,02
Papua New Guinea	13.840	4,87
Fiji	10.020	3,52
Maldives	8.920	3,14
Saudi Arabia	6.660	2,34
Marshall Islands	6.110	2,15
India	5.790	2,04
Solomon Islands	5.750	2,02
United Kingdom including: British Indian Ocean Territory, Anguilla, Bermuda, Cayman Islands, Pitcairn, Turks and Caicos Islands, British Virgin Islands	5.510	1,94
Vanuatu, Republic of	4.110	1,45
Egypt	3.800	1,34
United States of America including: Florida and Gulf of Mexico, Hawaii, United States Minor Outlying Islands, American Samoa, Puerto Rico, US Virgin Islands, Guam	3.770	1,33
Malaysia	3.600	1,27
Tanzania	3.580	1,26
Eritrea	3.260	1,15
Bahamas	3.150	1,11
Cuba	3.020	1,06
Kiribati	2.940	1,03
Japan	2.900	1,02
Sudan	2.720	0,96

[20] The following 6 countries with coral reefs were excluded from the analysis : Kenya, Micronesia, Myanmar, Nauru, Tuvalu and Spratly Islands.

Madagascar	2.230	0,78
Thailand	2.130	0,75
Mozambique	1.860	0,65
Mexico	1.780	0,63
Seychelles	1.690	0,59
China	1.510	0,53
Tonga	1.500	0,53
Belize	1.330	0,47
New Zealand including: Cook Islands, Niue, Tokelau	1.310	0,46
Viet Nam	1.270	0,45
Jamaica	1.240	0,44
Brazil	1.200	0,42
United Arab Emirates	1.190	0,42
Palau	1.150	0,40
Costa Rica	970	0,34
Colombia	940	0,33
Taiwan	940	0,33
Mauritius	870	0,31
Honduras	810	0,28
Panama	720	0,25
Nicaragua	710	0,25
Somali Democratic Republic	710	0,25
Iran	700	0,25
Qatar	700	0,25
Yemen	700	0,25
Sri Lanka	680	0,24
Dominican Republic	610	0,21
Bahrain	570	0,20
Oman	530	0,19
Independent State of Western Samoa	490	0,17
Venezuela	480	0,17
Netherlands including: Aruba, Netherlands Antilles	470	0,17
Djibouti	450	0,16
Haiti	450	0,16
Comoros	430	0,15
Antigua and Barbuda	240	0,08
Brunei Darussalam	210	0,07
Saint Kitts and Nevis	180	0,06
Saint Lucia	160	0,06
Grenade	150	0,05
Saint Vincent and the Grenadines	140	0,05

Kuwait	110	0,04
Barbados	<100	
Singapore	<100	
Trinidad and Tobago	<100	
Bangladesh	<50	
Cambodia	<50	
Ecuador	<50	
Jordan	<50	
Israel	<10	
GLOBAL TOTAL	**284,300**	

Source: Spalding et al. (2001).

We have collected data on variables regrouped in five categories: neoclassical, natural capital, demography, macroeconomic policy, regional heterogeneity, religion, geography, fractionalisation, institutions and other. The definition of these variables and the data sources are given below.

Table A2. 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 real 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.
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 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 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.
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.
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 total 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.
GEOGRAPHY	
Coastline	Coastline length in km, scaled to take values between zero and one.
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.
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	Djankov *et al*. (2003)
Mineral stocks	Norman (2009) and van der Ploeg and Poelhekke (2010)
System	Beck *et al*. (2001)

Table A3. 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)
NATURAL CAPITAL	
Natural capital in wealth	World Bank
Natural capital per capita	Idem
DEMOGRAPHY	
Life Expectancy	World Bank
Fertility rate	Idem
MACROECONOMIC POLICY	
Openness	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
RELIGION	
Buddhism	World Christian Encyclopedia (2001)
Catholic	Idem
Eastern Religion	Idem
Hindu	Idem
Jew	Idem
Muslim	Idem
Orthodox	Idem
Other	Idem
Protestant	Idem
GEOGRAPHY	
Latitude	Djankov *et al*. (2003)
Coastline	UNEP (2015)
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)

Descriptive statistics and preliminary results

We share the preliminary analysis results in Tables A4-A11 in the appendix. 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 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.

In this appendix, we share some descriptive statistics. In Table A7, 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 some fundamental theories (religion, fractionalization and institutions) present some degree of correlation with proximate theories' variables. Building on these results, in the next subsection we analyze whether the fundamental theories just mentioned 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.[21] 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: 3,61 for schooling, -2,40 for population growth rates and 10,08 for initial income. The subgroups are: *school* < 3,61 and *population* < -2,41 with 318 observations, *school* < 3,61 and *population* ≥ -2,41 with 33 observations, *school* ≥ 3,61 and *income_ini* < 10,08 with 53 observations and *school* ≥ 3,61 and *income_ini* ≥ 10,08 with 135 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 three of the four sub-samples.[22] To overcome this problem, for the most relevant variable in the CART procedure, *school*, we select a cut-off point, 3,50, closer to the median value of 3,36.[23] This choice enables us to have over 250 observations in each of the two sub-samples which are sufficient to verify the presence of convergence regimes. We see in Table A7 that there are no large differences in neoclassical variables when separating the sample according to the CART point and to the value closer to the median point.[24] In Table A8, 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 A8 includes the number of observations actually used, *Observations*, the F and the

[21] 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).

[22] With fewer than 5 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).

[23] The fact that, given the opportunity to split the sample according to different neoclassical variables, the regression tree shows a preference for schooling splits suggests that schooling dominates the other variables in identifying multiple regimes in the data.

[24] As the cut-off point for schooling gets closer from the median 3,36 to the CART value 3,61, there are larger differences between the rates of convergence in the sub-sample below the cut-off point and in the sub-sample above the cut-off point. We choose the near-median cut-off point 3,50 which enables to have more balanced sub-samples the the CART cut-off point and still finds some evidence of the presence of convergence clubs.

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.[25]

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 and which generally lie between two and three per cent (Barro and Sala-i-Martin, 1992). We can also appreciate in Table A8 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 schooling, we find that the rate of convergence is higher for those countries with higher rates of schooling and lower for the countries with lower rates of schooling.

In Table A8, we see that the estimates of the convergence rate for the DIF-GMM method do not stand between OLS and fixed-effects estimates. As in the case of Castelli *et al*. (1996), this large sample prediction is not valid raising the question about 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 see in Table A8 that there is overall compliance with the SYS-GMM assumptions. There is no second order serial autocorrelation except for *school* ≥ 3,50. In addition, the Hansen test accepts the validity of the instruments in the system GMM model.

In Table A9, we present countries with schooling values above and below the near-median cut-off point 3,50. In Table A10, we share the summary statistics above and below the near-median cut-off point in schooling for the variables that we use in our economic growth regressions. The most significant differences between the sub-samples with the schooling values above and below the near-median cut-off point are those associated with the macroeconomic policy (*open, inflation*), natural capital (*natural_w*), fractionalization (*ethnic*) and institutional endowments (*corruption*, *KZ96, exe_const*) variables.

In Tables A11 and A12, we present the correlation matrix between the proximate theories' variables and the variables associated with the fundamental theories, whenever the level of correlation of above or equal to 0,40 for the sub-samples above and below the near-median cut-off point in schooling. The variables associated with three fundamental theories, religion, fractionalization and institutions, are strongly correlated with variables most proximate theories in the sub-samples both above and below the near-median cut-off point in schooling. Building on these results, in the next subsection we analyze whether these fundamental theories have some explanatory power in the economic growth regression, beyond the influence exerted through proximate theories' variables.

[25] If DIF-GMM and SYS-GMM 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 whose instruments are only valid under non-trivial assumptions. We should hence take a conservative p-value of the Hansen test (Roodman, 2009).

Table A4. Summary statistics

Designation	Variable	Obs.	Mean	Median	Std. Dev.	Min.	Max.
NEOCLASSICAL							
Growth rates of pc GDP	*growth_pc*	658	0,02	0,02	0,03	-0,08	0,13
Initial income	*income_in*	653	8,46	8,47	1,22	5,71	11,37
Population growth rates	*population*	740	-2,69	-2,71	0,20	-3,18	-1,56
Investment in physical cap.	*invest*	653	3,04	3,11	0,55	0,26	4,53
Schooling	*school*	539	3,13	3,36	0,94	-3,21	4,47
DEMOGRAPHY							
Life Expectancy	*life_exp*	685	0,02	0,01	0,09	0,01	2,54
Fertility rate	*fertility*	686	1,41	1,50	0,47	0,01	2,21
MACROECONOMIC POLICY							
Openness	*open*	654	0,75	0,68	0,49	0,01	4,20
Government consumption	*gov_consu*	689	0,14	0,11	0,09	0,00	0,65
Inflation	*inflation*	516	0,14	0,06	0,79	-0,01	16,67
REGIONAL HETEROGENEITY							
Latin America and Caribbean	*lac*	740	0,31	0,00	0,46	0,00	1,00
Sub-Saharan Africa	*ssa*	740	0,13	0,00	0,34	0,00	1,00
East Asia and the Pacific	*eac*	740	0,28	0,00	0,45	0,00	1,00
South-East Asia	*sea*	740	0,05	0,00	0,22	0,00	1,00
RELIGION							
Buddhism	*buddhism*	730	0,05	0,00	0,18	0,00	0,92
Catholic	*catholic*	730	0,28	0,15	0,34	0,00	0,94
Eastern Religion	*eastern*	730	0,03	0,00	0,10	0,00	0,56
Hindu	*hindu*	730	0,03	0,00	0,11	0,00	0,76
Jew	*jew*	730	0,01	0,00	0,09	0,00	0,85
Muslim	*muslim*	730	0,23	0,00	0,37	0,00	0,99
Orthodox	*orthodox*	730	0,01	0,00	0,05	0,00	0,45
Other	*other*	730	0,03	0,00	0,10	-0,16	0,57
Protestant	*protestant*	730	0,17	0,00	0,23	0,00	0,78
NATURAL CAPITAL							
Natural capital in wealth	*natural_w*	560	0,24	0,18	0,21	0,00	0,88
Natural capital per capita	*natural_pc*	560	0,12	0,05	0,19	0,00	1,00
GEOGRAPHY							
Coastline	*coastaline*	710	0,03	0,01	0,07	0,00	0,50
FRACTIONALISATION							
Language	*language*	680	0,30	0,24	0,25	0,00	0,89
Ethnic tensions	*Ethnic*	720	0,38	0,40	0,23	0,00	0,87
INSTITUTIONS							
Liberal democracy	*democracy*	499	0,37	0,31	0,27	0,02	0,95
Public sector corruption	*corruption*	499	0,45	0,44	0,28	0,01	0,97
Legal formalism: Check (1)	*check(1)*	410	3,46	3,30	1,11	1,41	6,00
Legal formalism: Check (2)	*check(2)*	300	0,41	0,38	0,17	0,09	0,83
Complex	*Complex*	440	0,57	0,54	0,14	0,29	0,86
KKZ96	*KKZ96*	720	0,14	0,05	0,73	-1,68	1,92
Executive constraints	*exe_constr*	523	4,22	4,00	2,23	0,00	7,00
OTHER							
Time dummy variables	*year_dummy*						

Colonial (Spain or Portugal)	*colonial*	580	0,17	0,00	0,37	0,00	1,00
English legal origin	*english*	690	0,53	1,00	0,49	0,00	1,00
French legal origin	*french*	580	0,06	0,00	0,25	0,00	1,00
Latitude	*latitude*	720	0,20	0,17	0,12	0,01	0,60
Mineral stocks	*minerals*	510	-6,47	-6,27	3,38	-14,51	0,26
System	*system*	640	0,92	0,77	0,87	0,00	2,00

Table A5. Summary statistics: Countries with high marine biodiversity versus a worldwide data set

		Countries with high marine biodiversity		**Worldwide data set**	
Designation	**Variable**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
NEOCLASSICAL					
Growth rates of pc GDP	*growth_pc*	0,02	0,03	0,02	0,03
Initial income	*income_in*	8,46	1,22	8,55	1,26
Population growth rates	*population*	-2,69	0,20	-2,72	0,19
Investment	*invest*	3,04	0,55	3,04	0,52
Schooling	*school*	3,13	0,94	3,21	0,78
DEMOGRAPHY					
Life Expectancy	*life_exp*	0,02	0,09	0,02	0,08
Fertility rate	*fertility*	1,41	0,47	1,28	0,52
MACROECONOMIC POLICY					
Openness	*open*	0,75	0,49	0,62	0,45
Government consumption	*gov_consu*	0,14	0,09	0,09	0,06
Inflation	*inflation*	0,14	0,79	0,23	1,36
REGIONAL HETEROGENEITY					
Latin America and Caribbean	*lac*	0,31	0,46	0,24	0,42
Sub-Saharan Africa	*ssa*	0,13	0,34	0,18	0,38
South-East Asia	*sea*	0,05	0,22	0,06	0,23
RELIGION					
Buddhism	*buddhism*	0,05	0,18	0,03	0,14
Catholic	*catholic*	0,28	0,34	0,36	0,37
Eastern Religion	*eastern*	0,03	0,10	0,02	0,07
Hindu	*hindu*	0,03	0,11	0,03	0,11
Jew	*jew*	0,01	0,09	0,01	0,09
Muslim	*muslim*	0,23	0,37	0,20	0,34
Orthodox	*orthodox*	0,01	0,05	0,02	0,10
Other	*other*	0,03	0,10	0,04	0,13
Protestant	*protestant*	0,17	0,23	0,15	0,24
NATURAL CAPITAL					
Natural capital in wealth	*natural_w*	0,24	0,21	0,27	0,32
Natural capital per capita	*natural_pc*	0,12	0,19	0,11	0,23
GEOGRAPHY					
Coastline	*coastline*	0,03	0,07	0,05	0,19
FRACTIONALISATION					
Language	*language*	0,30	0,25	0,34	0,29
Ethnic tensions	*ethnic*	0,38	0,23	0,42	0,26
INSTITUTIONS					
Liberal democracy	*democracy*	0,37	0,27	0,43	0,29
Public sector corruption	*corruption*	0,45	0,28	0,41	0,29

Legal formalism: Check (1)	*check(1)*	3,46	1,11	3,54	1,10
Legal formalism: Check (2)	*check(2)*	0,41	0,17	0,42	0,18
Complex	*complex*	0,57	0,14	0,56	0,15
KKZ96	*KKZ96*	0,14	0,73	0,28	0,90
Executive constraints	*exe_constr*	4,22	2,23	4,73	2,22
OTHER					
Time dummy variables	*year_dummy*				
Colonial (Spain or Portugal)	*colonial*	0,17	0,37	0,19	0,39
English legal origin	*english*	0,53	0,49	0,44	0,49
French legal origin	*french*	0,06	0,25	0,08	0,28
Latitude	*latitude*	0,20	0,12	0,27	0,19
Mineral stocks	*minerals*	-6,47	3,38	-6,31	2,96
System	*system*	0,92	0,87	0,89	0,89

Table A6. Correlation matrix between proximate and fundamental theories

Fundamen. theories	Proximate theories										
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*sea*	*ssa*
RELIGION											
catholic	0,06	-0,17	-0,14	0,08	0,15	-0,10	-0,22	0,11	**0,68**	-0,25	-0,07
hindu	0,05	-0,01	-0,07	-0,01	0,14	-0,15	0,11	-0,03	-0,18	**0,82**	-0,04
muslim	**0,52**	0,03	-0,08	-0,02	0,31	**0,42**	0,10	-0,02	0,32	-0,04	-0,00
other	0,02	-0,12	-0,37	-0,05	-0,15	0,01	0,07	-0,02	0,00	0,02	**0,87**
FRACTIONALISATION											
ethnic	0,38	0,04	-0,37	-0,08	**0,47**	0,23	-0,07	0,10	0,39	0,01	0,20
INSTITUTIONS											
democracy	**-0,49**	-0,05	**0,47**	0,08	**-0,67**	-0,34	-0,07	0,02	-0,24	0,02	-0,12
corruption	0,36	-0,05	**-0,50**	-0,06	**0,52**	0,20	0,00	0,07	0,31	-0,05	0,12
check(1)	0,34	-0,08	-0,28	-0,01	**0,43**	0,22	0,07	-0,02	**0,47**	0,10	0,14
check(2)	0,34	-0,09	-0,31	-0,01	**0,45**	0,24	0,05	-0,00	**0,46**	0,01	0,14
KKZ96	**-0,42**	0,01	**0,47**	0,07	**-0,61**	-0,17	-0,03	-0,08	**-0,44**	-0,25	-0,20
exe_constr	**-0,43**	-0,08	**0,45**	0,02	**-0,52**	-0,27	-0,06	-0,00	-0,08	0,18	0,13

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 to authors.

Table A7. Neoclassical variables for CART and near-median cut-off points

	income_ini	*population*	*Invest*	*school*
CART cut-off point				
school ≥ 3,61	8,86	-2,74	3,10	3,92
school < 3,61	8,00	-2,63	2,97	2,71
Near-median cut-off point				
school ≥ 3,50	8,85	-2,74	3,11	3,85
school < 3,50	7,90	-2,62	2,94	2,61

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 schooling. See Tables A2-A3 for more details on data definitions and sources.

Table A8. Estimation results for the existence of multiple convergence clubs

	OLS	FE	GMM	System GMM
Full sample				
λ	-0,004	-0,015	-0.028	-0,015
Observations	491	491	383	434
F	5,83***	1,62		
Wald			-	5.352***
Hansen				16,42
m_1			-4,27***	-3,89***
m_2			-1,52	-1,63
Cut-off point in *school* ≥ 3,50				
Λ	-0,006	-0,031	-0.044	-0.024
Observations	224	224	199	204
F	8,24***	2,72**		
Wald			-	1.534***
Hansen				24,74
m_1			-3,32***	-2,94***
m_2			-1,’’’	-0,72*
Cut-off point in *school* < 3,50				
λ	-0,002	-0,021	-0.043	-0,017
Observations	267	267	184	223
F	1,92	4,25***		
Wald			-	601***
Hansen				6,25
m_1			-2,94***	-2,18**
m_2			-0,65	-0,66
Chow test	2,22**	11,01***	-	-

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 per cent levels. In system GMM, we use *english* in levels as instruments for the equation in first differences.

Table A9. Classification of countries according to the near-median cut-off point in schooling

***school* < 3,50**		***school* ≥ 3,50**	
Bangladesh	Nicaragua	Antigua and Barbuda	Marshall Islands
Bahrain	Panama*	Australia	Mauritius*
Belize	Papua New Guinea	Bahamas	The Netherlands
Brazil	Philippines*	Barbados	New Zealand
Cambodia	Qatar	Brunei Darussalam	Oman
Colombia	Saudi Arabia	China	Palau
Costa Rica	Sudan	Comoros	Panama*
Dominican Rep.	Tanzania	Cuba	Philippines*

Ecuador	Thailand	Djibouti	Saint Kitts and Nevis
Egypt	Trinidad and Tobago*	Dominica	Saint Lucia
Fiji*	United Arab Emirates	Eritrea	Saint Vincent and Gre.
France*	Venezuela	Fiji*	Seychelles
Haiti	Viet Nam*	France*	Singapore
Honduras	Yemen	Grenada	Solomon Islands
India		Samoa	Somali Democratic Rep.
Indonesia		Israel	Sri Lanka
Iran		Jamaica*	Taiwan
Jamaica*		Japan	Tonga
Jordan*		Jordan*	Trinidad and Tobago*
Kuwait		Kiribati	United Kingdom
Mauritius*		Madagascar	United States of America
Mexico		Malaysia	Vanuatu, Republic of
Mozambique		Maldives	Viet Nam*

Note: A country is designated under a classification when half of its sample or more belongs to it. * indicates that half of the country sample is under the classification.

Table A10. Summary statistics according to the near-median cut-off point in schooling

		school ≥ 3,50		*school* < 3,50	
Designation	**Variable**	**Obs.**	**Mean**	**Obs.**	**Mean**
NEOCLASSICAL					
Growth rates of pc GDP	*growth_pc*	386	0,02	272	0,02
Initial income	*income_in*	386	8,85	276	8,77
Population growth rates	*population*	427	-2,74	313	-2,62
Investment in physical capital	*invest*	386	3,11	267	2,94
Schooling	*School*	226	3,85	313	2,61
DEMOGRAPHY					
Life Expectancy	*life_exp*	375	0,02	310	0,01
Fertility rate	*Fertility*	376	1,24	310	1,61
MACROECONOMIC POLICY					
Openness	*Open*	386	0,85	268	0,60
Government consumption	*gov_consu*	405	0,16	284	0,11
Inflation	*Inflation*	295	0,07	221	0,24
REGIONAL HETEROGENEITY					
Latin America and Caribbean	*Lac*	427	0,26	313	0,37
Sub-Saharan Africa	*Ssa*	427	0,15	313	0,11
East Asia and The Pacific	*eac*	427	0,32	313	0,22
South-East Asia	*sea*	427	0,04	313	0,06
RELIGION					
Buddhism	*buddhism*	*417*	0,04	313	0,07
Catholic	*catholic*	417	0,23	313	0,35
Eastern Religion	*eastern*	417	0,03	313	0,02
Hindu	*hindu*	417	0,02	313	0,03
Jew	*Jew*	417	0,02	313	0,00
Muslim	*muslim*	417	0,20	313	0,28

Orthodox	*orthodox*	417	0,01	313	0,00
Other	*other*	417	0,02	313	0,04
Protestant	*protestant*	417	0,25	313	0,07
NATURAL CAPITAL					
Natural capital in wealth	*natural_w*	297	0,19	263	0,30
Natural capital per capita	*natural_pc*	297	0,12	263	0,11
GEOGRAPHY					
Coastline	*coastline*	400	0,03	310	0,03
FRACTIONALISATION					
Language	*language*	386	0,28	294	0,32
Ethnic tensions	*ethnic*	421	0,33	299	0,44
INSTITUTIONS					
Liberal democracy	*democracy*	241	0,44	258	0,30
Public sector corruption	*corruption*	241	0,36	258	0,53
Legal formalism: Check (1)	*check(1)*	198	3,13	212	3,76
Legal formalism: Check (2)	*check(2)*	146	0,35	154	0,47
Complex	*complex*	185	0,51	255	0,62
KKZ96	*KKZ96*	407	0,35	313	-0,13
Executive constraints	*exe_constr*	247	4,72	276	3,77
OTHER					
Time dummy variables	*year_dummy*				
Colonial (Spain or Portugal)	*colonial*	309	0,04	271	0,07
English legal origin	*english*	385	0,64	305	0,40
French legal origin	*french*	309	0,06	305	0,40
Latitude	*latitude*	407	0,21	313	0,18
Mineral stocks	*minerals*	239	-6,23	271	-6,68
System	*System*	327	1,15	313	0,69

Table A11. Correlation matrix between proximate and fundamental theories for countries above the near-median cut-off point in schooling

Fundamen. theories	Proximate theories									
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*sea*
RELIGION										
buddhism	-0,38	0,31	0,01	-0,04	-0,19	-0,08	-0,23	-0,06	-0,20	**0,49**
catholic	-0,02	-0,39	-0,23	0,16	-0,00	0,06	-0,23	-0,06	**0,55**	-0,21
eastern	-0,28	**0,46**	-0,01	-0,04	-0,23	-0,00	-0,06	-0,12	-0,20	-0,15
hindu	-0,05	0,07	-0,10	-0,02	0,19	-0,06	0,11	-0,02	-0,11	**0,77**
jew	0,35	-0,00	-0,13	-0,02	0,16	0,00	**0,44**	**0,49**	-0,12	-0,09
muslim	**0,64**	0,24	-0,03	-0,03	**0,51**	**0,49**	-0,04	-0,02	-0,19	-0,04
FRACTIONALISATION										
ethnic	**0,49**	-0,0	-0,27	-0,09	0,51	0,43	0,04	0,05	0,42	0,15
INSTITUTIONS										
democracy	**-0,49**	-0,24	0,21	0,09	**-0,53**	**-0,49**	-0,17	-0,04	-0,20	-0,16
check(1)	0,25	-0,12	**-0,45**	0,00	0,31	0,31	0,09	0,04	**0,45**	0,19
check(2)	0,25	0,13	**-0,46**	0,00	0,29	0,33	0,08	0,04	**0,45**	0,13
KKZ96	-0,38	-0,16	0,38	0,06	**-0,48**	-0,32	-0,12	-0,06	**-0,43**	**-0,41**
exe_constr	**-0,41**	-0,22	0,07	-0,00	-0,35	**-0,44**	-0,08	0,06	-0,05	-0,01

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 to authors. The variable *ssa* was dropped.

Table A12. Correlation matrix between proximate and fundamental theories for countries below the near-median cut-off point in schooling

Fundamen. theories	Proximate theories										
	popu.	*invest*	*scho.*	*life.*	*fert.*	*open*	*gov_.*	*infl.*	*lac*	*ssa*	*sea*
RELIGION											
catholic	0,02	0,00	0,19	-0,30	0,00	-0,25	-0,21	0,11	**0,72**	-0,16	-0,29
hindu	0,04	-0,08	-0,07	0,38	0,11	-0,23	0,12	-0,04	-0,26	-0,06	**0,91**
other	0,03	-0,23	**-0,49**	**0,51**	0,17	0,02	0,00	-0,04	-0,11	**0,92**	0,00
NATURAL CAPITAL											
natural_pc	-0,21	0,11	0,28	**-0,43**	**-0,45**	-0,14	-0,15	0,00	0,07	-0,15	-0,17
FRACTIONALISATION											
language	0,00	0,06	-0,19	**0,43**	0,11	-0,01	-0,01	-0,09	**-0,64**	0,33	0,34
INSTITUTIONS											
democracy	-0,36	0,01	0,26	**-0,40**	**-0,62**	-0,26	-0,03	0,16	-0,05	-0,09	0,26
check(1)	0,34	-0,00	-0,03	0,20	**0,42**	0,14	0,09	-0,09	**0,42**	0,15	0,02
check(2)	0,33	-0,00	-0,03	0,21	**0,41**	0,16	0,08	-0,08	0,37	0,15	-0,11
KKZ96	-0,30	0,12	0,23	**-0,52**	**-0,52**	-0,02	-0,00	-0,05	-0,30	-0,26	-0,12

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 to authors.

Results

These tables provide results for the growth regression exercise in equation [1] of the text under BMA regressions with 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 instrument for endogenous variables using earlier or initial values if available with the exception of inflation, religion shares and natural capital under the Two-Stage Least Squares (2SLS) regressions (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 used a dummy for presidential system and mineral resource stocks as an instrument for natural capital variables. The 2SLS regression results are very similar to the BMA regression results with uncertainty and are available upon request. Please refer to the data appendix for details on the variables used.

Table A13. BMA estimation results for average growth rates of pc 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		-0,058*	0,009		-0,021*	0,009
Population		-0,077	0,066			
Invest		0,018	0,016			
school		0,003	0,015			
DEMOGRAPHY	1,000					
life_exp		-0,095	0,055			
fertility		-0,202*	0,003			
MACROECONOMIC POLICY	1,000					
Open		0,000	0,003			
gov_consu		-0,009	0,050			
inflation		-0,011	0,006			
REGIONAL HETEROGENEITY	0,046					
Lac		0,000	0,004			
Ssa		0,000	0,005			
Sea		-0,000	0,004			
RELIGION	0,085			0,997		
eastern		0,006	0,033		0,352*	0,077
hindu		0,000	0,004		0,007	0,027
muslim		-0,000	0,002		-0,002	0,012
other		0,007	0,039		-0,002	0,021
protestant		-0,002	0,016		-0,002	0,018
NATURAL CAPITAL	1,000			1,000		
natural_w		-0,023	0,038		-0,094	0,053
natural_pc		-0,001	0,036		-0,000	0,023
GEOGRAPHY	0,110			0,046		
coastline		-0,008	0,032		-0,000	0,016
FRACTIONALISATION	0,999			0,990		
language		0,007	0,027		0,037	0,029
ethnic		0,005	0,020		0,000	0,010
INSTITUTIONS	1,000			1,000		
KKZ96		0,000	0,003		0,007	0,016
exe_constr		-0,019*	0,004		-0,002	0,004
year_dummies		Yes			Yes	
observations		470			470	

Note: This table provides results for the growth regression exercise in equation [1] of the text. 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 for 74 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 A14. BMA estimation results for average growth rates of pc GDP: *school* ≥ 3,50

Explanatory variable	Proximate and fundamental theories			Fundamental theories		
	Posterior inclusion probability (#)	Posterior mean	Posterior standard deviation	Posterior inclusion probability (#)	Posterior mean	Posterior standard deviation
NEOCLASSICAL						
income_in		-0,079*	0,013		-0,051*	0,011
Population		0,028	0,092			
Invest		-0,007	0,039			
school		-0,033	0,053			
DEMOGRAPHY	1,000					
life_exp		-0,102	0,058			
fertility		-0,250*	0,058			
MACROECONOMIC POLICY	0,276					
Open		-0,000	0,003			
gov_consu		0,067	0,181			
inflation		0,007	0,031			
REGIONAL HETEROGENEITY	0,048					
Lac		0,000	0,003			
Ssa		0,001	0,013			
Sea		-0,000	0,006			
RELIGION	0,523			1,000		
eastern		0,150	0,170		0,488*	0,086
hindu		0,002	0,017		0,002	0,020
muslim		0,001	0,011		-0,005	0,021
other		0,015	0,084		0,012	0,069
protestant		-0,011	0,039		-0,001	0,016
NATURAL CAPITAL	1,000			1,000		
natural_w		0,004	0,056		0,019	0,055
natural_pc		0,034	0,059		0,054	0,065
GEOGRAPHY	0,071			0,064		
Coastline		-0,002	0,021		0,000	0,019
FRACTIONALISATION	0,059			0,085		
Language		0,000	0,007		-0,001	0,011
ethnic		0,001	0,011		-0,002	0,014
INSTITUTIONS	1,000			1,000		
KKZ96		0,001	0,010		0,001	0,007
exe_constr		-0,009	0,009		0,010	0,007
year_dummies		Yes			Yes	
observations		209			209	

Note: This table provides results for the growth regression exercise in equation (1) of the text. The dependent variable is the average growth rate of real per capita GDP corresponding to 10 five year periods, from 1960 to 2009 for 74 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 A15. BMA estimation results for average growth rates of pc GDP: *school* < 3,50

	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		-0,046*	0,019		0,015	0,016
Population		0,016	0,110			
Invest		0,004	0,024			
school		-0,027	0,030			
DEMOGRAPHY	0,995					
life_exp		-6,175	9,995			
fertility		-0,178*	0,058			
MACROECONOMIC POLICY	1,000					
Open		0,021	0,030			
gov_consu		-0,535*	0,257			
inflation		-0,011	0,007			
REGIONAL HETEROGENEITY	0,063					
Lac		0,001	0,010			
Ssa		0,000	0,005			
Sea		-0,000	0,008			
RELIGION	0,025			0,019		
eastern		0,000	0,009		0,006	0,013
hindu		-0,000	0,005		0,000	0,005
muslim		0,000	0,002		-0,000	0,002
other		0,003	0,029		-0,000	0,009
protestant		0,000	0,006		-0,000	0,011
NATURAL CAPITAL	1,000			1,000		
natural_w		-0,004	0,044		-0,064	0,077
natural_pc		-0,054	0,138		-0,067	0,136
GEOGRAPHY	0,181			0,060		
coastline		-0,034	0,094		-0,000	0,036
FRACTIONALISATION	0,994			0,996		
language		0,017	0,044		0,057	0,054
ethnic		0,058*	0,026		0,075	0,084
INSTITUTIONS	0,997			0,999		
KKZ96		0,000	0,007		0,050	0,034
exe_constr		-0,015*	0,006		-0,011*	0,005
year_dummies		Yes			Yes	
observations		260			260	

Note: This table provides results for the growth regression exercise in equation (1) of the text. 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).