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ARE ANY GROWTH THEORIES ROBUST?*

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This article investigates the strength of empirical evidence for various growth theories when there is model uncertainty with respect to the correct growth model. Using model averaging methods, we find little evidence that so-called fundamental growth theories play an important role in explaining aggregate growth. In contrast, we find strong evidence for macroeconomic policy effects and a role for unexplained regional heterogeneity, as well as some evidence of parameter heterogeneity in the aggregate production function. We conclude that the ability of cross-country growth regressions to adjudicate the relative importance of alternative growth theories is limited.

Despite the vast amount of empirical research generated by new growth theories, there is remarkably little consensus on which mechanisms are most salient in explaining cross-country differences. This article is designed to provide some evidence on this question by examining the robustness of empirical support for different growth theories as determinants of both aggregate growth and its underlying components: total factor productivity (TFP) growth, and physical and human capital accumulation.

One reason for the lack of empirical consensus on growth determinants is that the main statistical tool in empirical studies, cross-country growth regressions, provides very different answers depending on how the regression is specified, which for this context typically amounts to the choice of control variables. Individual papers typically employ regressions that include modest subsets of the body of regressors that have been proposed in the literature as a whole. Others employ a 'kitchen sink' approach to evaluate the relative evidentiary support of competing growth theories. In such an exercise, a large number of variables are included in a regression and those variables that prove to be significant are then declared to be the important determinants of growth while the others are dismissed as unimportant (Rodrik *et al.*, 2002; Sachs, 2003).

These approaches suffer from the common problem that they do not systematically address the model uncertainty that is intrinsic in growth regressions. As argued by Brock and Durlauf (2001), empirical work in growth is especially challenging because of the nature of growth theories: these theories are open ended, so that one theory is logically consistent with another, so that each combination of plausible growth theories represents a legitimate statistical model for empirical analysis. Put differently, a given body of candidate growth theories defines a space of possible models rather than a single specification. In this article, we employ model averaging (MA) methods, pioneered in growth economics by Fernandez *et al.* (2001) and Sala-i-Martin *et al.* (2004) to evaluate evidence for different growth theories recognising the model uncertainty intrinsic in such an analysis.

Unlike previous authors, including Fernandez *et al.* and Sala-i-Martin *et al.*, our focus is on understanding broader growth theories rather than particular variables used to

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measure them. A major reason for the massive number of growth regressors that have appeared – over 140 are identified in Durlauf *et al.* (2005) – is that different authors choose different empirical proxies for the same growth theory, hence individual variables may be of little intrinsic interest. Further, we extend the evaluation of robust determinants to growth components. We provide evidence on how different growth theories play distinct roles with respect to factor accumulation and TFP growth, thereby extending previous studies such as Aiyar and Feyrer (2002), Bernanke and Gürkaynak (2001) and Wong (2003).

Our focus on growth theories also reflects much of current debate in growth economics, which has focused on the role of fundamental factors such as geography and institutions as opposed to proximate factors such as macroeconomic policy. The division between fundamental theories and proximate theories is not well defined, in the abstract, but in practice fundamental theories refer to slower moving factors that create an environment out of which neoclassical growth dynamics emerge. An additional goal of our work is to assess some of these fundamental theories against others.

Our empirical analysis finds evidentiary support for the canonical neoclassical growth variables; i.e., initial income, investment, and population growth, as well as macroeconomic policies in affecting growth, whereas it finds little evidence in favour of geography, institutions, religion and ethnic fractionalisation. Furthermore, we find that, even against the background of our candidate growth theories, there is robust evidence of unexplained region-specific heterogeneity. Similar results obtain for growth components. The analysis of growth components allows for an independent assessment of production externalities or other misspecifications in TFP growth. In this sense, our results suggest the presence of parameter heterogeneity in the aggregate production function, especially in the share of physical capital accumulation.

Section 1 of this article formalises our growth regression and growth accounting exercises. Section 2 details our strategy for addressing model uncertainty using model averaging. Section 3 describes our data. Section 4 presents our findings and Section 5 concludes.

1. Growth Regressions and Growth Accounting

We first consider the canonical cross-country growth regression

$$g_{y,i,t} = S_{i,t}\delta_y + \varepsilon_{i,t} \quad (1)$$

where $g_{y,i,t}$ is the average growth rate of output per worker for country i across a time period $[t, t+T]$ and $S_{i,t}$ is a set of growth regressors. Much of modern empirical growth research amounts to an effort to identify the variables that comprise $S_{i,t}$. Our goal is to identify evidence on the growth theories for which these regressors are proxies. Operationally, we consider a set of growth variables which are associated with 7 broad growth theories: neoclassical growth theory (Mankiw *et al.* 1992; Solow, 1956), demography/health (Shastry and Weil, 2003; Weil, 2005), macroeconomic policy (Barro, 1996), religion (Barro and McCleary, 2003; Durlauf *et al.* 2006), geography (Sachs, 2003), ethnic fractionalisation (Alesina *et al.*, 2003; Easterly and Levine, 1997), and institutions (Acemoglu *et al.* 2001; Acemoglu and Johnson, 2005; Djankov *et al.*, 2002; Kaufmann *et al.*, 2005). This choice of alternative theories is determined both by data restrictions and by how well they capture much of the current empirical disagreement in growth research.

Religion, geography, ethnic fractionalisation and institutions are sometimes distinguished as representing fundamental rather than proximate growth determinants, although the division between them and, for example, demography/health is not clear-cut. We will maintain this distinction in our discussion because these theories have received particular attention in the recent literature.

In addition to these seven classes of theories, we will also consider the possibility that growth is determined by unexplained regional heterogeneity, as captured via fixed effects. This heterogeneity is not so much a theory as an argument that countries in different continents may not represent draws from a common growth model; Brock and Durlauf (2001) discuss this problem in the context of exchangeability of growth regression errors. In the statistical analysis, this regional heterogeneity is treated as another growth theory.

The growth regression (1) mixes the effects of a given determinant on TFP growth and factor growth, i.e. growth in physical and human capital per worker. In order to understand how these components are separately affected, we follow the methodology of Caselli (2005), Hall and Jones (1999) and Klenow and Rodríguez-Clare (1997) and explicitly assume an aggregate Cobb-Douglas production function

$$y_{i,t} = A_{i,t} k_{i,t}^{\alpha} h_{i,t}^{1-\alpha} \quad (2)$$

where $k_{i,t}$ is the physical capital stock per worker, $h_{i,t}$ is human capital stock per worker, and $A_{i,t}$ is TFP. Assuming (2), one can decompose the growth rate of output per worker into the components of growth:

(*i*) growth rate of TFP, g_A,
(*ii*) growth rate of physical capital, g_k, and
(*iii*) growth rate of human capital, g_h.[1]

This decomposition allows us to examine the relative importance of each of these theories by regressing each of these components on the set of growth regressors, $S_{i,t}$.

Since TFP is calculated as a residual, it will contain any misspecification of the Cobb-Douglas production function. One can contrast (2) with a generalised Cobb-Douglas production function in which factor shares depend on initial conditions. Here we consider the dependence of these shares on initial human capital. The Appendix shows that for one version of human capital and physical capital externalities, the vector $\mathbf{E} = (g_k, g_h, h_0 \times g_k, h_0 \times g_h)'$ will determine TFP growth.[2] As an empirical analog to **E** may be constructed, this allows us to treat human capital externalities as an additional theory. A limitation of this approach is that this measure of externalities may proxy any other misspecification of (2). This caveat should be kept in mind in evaluating our results.

[1] We decompose the growth rate of output per worker as $g_y = \alpha g_k + (1-\alpha) g_h + g_A$ where $g_y = \dot{y}/y$, $g_k = \dot{k}/k$, $g_h = \dot{h}/h$, and $g_A = \dot{A}/A$. We assume that the share of capital (α) is equal to 1/3.
[2] See Mamuneas *et al.* (2006) for a similar idea.

We therefore examine the role of different theories on the components of growth via

$$g_{A,i,t} = \mathbf{S}_{i,t}\boldsymbol{\delta}_A + \mathbf{E}_{i,t}\boldsymbol{\pi} + u_{1,i,t} \tag{3}$$

$$g_{k,i,t} = \mathbf{S}_{i,t}\boldsymbol{\delta}_k + u_{2,i,t} \tag{4}$$

$$g_{h,i,t} = \mathbf{S}_{i,t}\boldsymbol{\delta}_h + u_{3,i,t}. \tag{5}$$

2. Model Uncertainty

We propose to evaluate the empirical evidence for alternative growth theories using model averaging methods. The true growth model, which in our context means the correct combination of theories and associated empirical proxies, is treated as an unknown. Different combinations of growth theories constitute distinct models; the set of possible combinations defines a model space. Given the model space, one can then determine the evidentiary support for a given growth theory by 'integrating out' the uncertainty with respect to the identity of the true model by taking an average of model-specific estimates. Letting $\hat{\theta}_m$ denote such an estimate, using model weights $\mu(m|D)$, model averaging computes

$$\hat{\theta}_M = \sum_{m \in M} \hat{\theta}_m \mu(m|D). \tag{6}$$

We treat the weights $\mu(m|D)$ as posterior probabilities; i.e., the probability that m is the 'true' model given the data. One can thus assess the probability that a given theory matters for growth by computing the posterior probability of inclusion of a given theory t via $\sum_{m \in A_t} \mu(m|D)$, where A_t is the event 'at least one proxy variable for theory t is included in the model'.

This approach to addressing model uncertainty uses frequentist parameter estimates and combines them with probabilities of unknowns (a standard Bayesian object) and as such is a frequentist/Bayes hybrid; Sala-i-Martin *et al.* (2004) call this Bayesian averaging of classical estimator (BACE). Hybrids of this type are controversial from the perspective of the philosophical foundations of statistics and we do not pursue such issues here. Our concern is exclusively with communicating the evidentiary support across regressions; our use of averaging is simply a way of combining cross-model information and our posterior probabilities are simply relative weights that combine prior weights with complexity-penalised goodness of fit considerations.

How does one implement model averaging? Letting $\mu(m)$ denote the prior model probability and $\mu(D|m)$ denote the likelihood of the data given the model, by Bayes rule,

$$\mu(m|D) \propto \mu(m)\mu(D|m) \tag{7}$$

so that construction of model weights requires construction of the two right-hand terms.

To construct $\mu(m)$, we start by setting the prior probability that a particular theory – that is, the set of proxy variables classified under that theory – is included in the 'true' model to 0.5 to reflect lack of prior information across theories. We further assume that theories are independent in the sense that the inclusion of one theory in a model does not affect the probability that some other theory is also included. This approach departs from conventional practice as previous growth studies have generally assumed that the probability that one *variable* enters a growth regression is conditionally independent of the presence or absence of others. As argued in Brock and Durlauf (2001) and Brock *et al.* (2003), this is difficult to reconcile with the nature of the variables under study, since they typically represent empirical proxies for a smaller set of growth theories. A uniform prior over variables in fact means that a researcher could arbitrarily increase or reduce the prior weights across theories simply by judiciously introducing 'redundant' proxy variables for some of these theories.

Once one has assigned priors to theories, one must also assign priors to the different ways the theory is captured empirically, i.e. assign priors to various combinations of the empirical proxies for the theory. To do this, we introduce a version of George's (1999) dilution priors. For each subset of variables s_τ associated with theory τ for $\tau = 1,\ldots,\mathcal{T}$, we assign the conditional prior probability, T

$$\mu(s_\tau) = |R_{s_\tau}| \prod_{j=1}^{p_\tau} \pi_j^{s_j} \left(1 - \pi_j^{s_j}\right)^{1-s_j} \tag{8}$$

where p_τ is the number of proxy variables for theory τ, $\pi_j = 0.5$ for $j = 1, \ldots, p_\tau$, and R_{s_τ} is the correlation matrix for the set of variables included in s_τ. As $|R_{s_\tau}|$ is 1 when the set of variables are orthogonal and 0 when the variables are collinear, this prior models with many 'redundant' variables. This prior accounts for the multicollinearity between empirical proxies, something the standard uniform prior fails to do.

The term $\mu(D|m)$ captures the relative goodness of fit of different models. Raftery (1995) provides a formal justification for approximating this quantity with BIC-adjusted goodness of fit in the case of the linear regression with normal errors. In this article we employ this same approximation in a 2SLS context. It appears possible to interpret our approach in the Bayesian context as a weighting of limited information maximum likelihood (LIML) estimators with limited information BIC (LIBIC) weights; see Kim (2002) and Tsangarides (2004). An outstanding research question concerns the formal justification for our weights for the 2SLS context. We therefore emphasise that our interpretation of the posterior model probabilities is heuristic. Finally, we employ Raftery's (1995) leaps-and-bound method for searching across models and generating posterior estimates.

3. Data

We employ an unbalanced panel dataset over three periods 1965–74 (53 countries), 1975–84 (54 countries) and 1985–94 (57 countries). We include time dummies for each of these periods in all exercises that follow. For the growth regression (1) the dependent variable is the average growth rate of real per worker GDP corresponding to the three periods. For the component growth regressions of TFP growth, physical capital accumulation, and human capital accumulation we use the data constructed in Section 1. Data for income are from PWT 6.1 (Penn World Tables) while data for capital per worker are from Caselli (2005). The schooling data used to calculate human capital stocks are based on average years of total schooling in the population 25 years and older obtained from Barro and Lee (2000).

As discussed above, we organise the determinants of growth into seven theories. We follow the existing literature as closely as possible in our choice of empirical proxies.

1 Neoclassical growth variables consist of the logarithm of real GDP per worker in the initial year of each of the three periods (i.e., 1965, 1975, and 1985), the logarithm of the average percentage of a country's working age population in secondary school (Bernanke and Gurkaynak, 2001), the logarithm of the average investment to GDP ratio, and the logarithm of population growth plus 0.05 over the corresponding periods. The instruments for these variables are the logarithm of real GDP per worker in 1960, 1970 and 1980, and the logarithms of the averages of the other three neoclassical growth variables for 1960–5, 1970–5 and 1980–5.
2 Demography is measured using the reciprocal of life expectancy at age 1 (proxying for the mortality rate) in 1960, 1970 and 1980, and the log of the total fertility rate in 1960, 1970 and 1980. We treat both variables as predetermined.
3 Macroeconomic policy is measured using three proxies, see Barro (1996); within-period ratio of exports plus imports to GDP (filtered for the relation of this ratio to the logs of population and area), the inflation rate for each period, and within-period ratio of government consumption (net of outlays on defence and education) to GDP. Following Barro (1996), we instrument inflation using a colonial dummy for Spain or Portugal and use lagged values of the other two variables, i.e., the average exports plus imports to GDP ratios and the average of government consumption to GDP over 1960–5, 1970–5 and 1980–5 respectively, to instrument for the openness and government consumption proxies.
4 Religion is measured using religion shares for Eastern, Hindu, Jewish, Muslim, Orthodox, Protestant and other religions for the years 1970, 1980 and 1990 (Barrett, 1982; Barrett *et al.*, 2001). Religion share is defined as the fraction adhering to the specified religion among persons who expressed adherence to any religion. The Catholic fraction is omitted from the regressions and thus each coefficient should be interpreted relative to the Catholic share.[3] Religion shares in 1900 are used as instruments.
5 Geography is measured using a climate variable, the percentage of a country's land area classified as tropical and subtropical based on the Köppen-Geiger classification system for climate zones, and a geographic accessibility/isolation variable, the percentage of a country's land area within 100km of an ice-free coast. This follows Rodrik *et al.* (2002) and Sachs (2003). We treat both variables as exogenous.
6 Fractionalisation is measured by linguistic fractionalisation as constructed by Alesina *et al.* (2003) and a measure of 'the degree of tension within a country

[3] We deviate from previous studies (Barro and McCleary, 2003; Durlauf *et al.*, 2005) by not employing religiosity measures (i.e. measures of religious beliefs). We do this because
(*i*) Durlauf *et al.* (2005) find that religiosity is not a robust theory of growth, and
(*ii*) religiosity measures are only available for 35 countries and would unduly reduce our ability to evaluate the overall set of theories.

attributable to racial, nationality, or language divisions' from the International Country Risk Guide. We treat both variables as exogenous.

7 Institutions are measured using four variables: Following Acemoglu *et al.* (2001), the risk of expropriation of private investments (Acemoglu *et al.*, 2001), within-period average constraints on executive power institute, an index of legal formalism based on the number of procedures for collecting on a bounced cheque (CHEQUE) developed by Djankov *et al.* (2002) and an index for the quality of governance in 1996 using a composite governance index developed (KKZ96) by Kaufmann *et al.* (2005).[4] This index is the average of the following six indicators: voice and accountability, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and control of corruption. Following Acemoglu and Johnson (2005) we use dummies for British and French legal origins as an instrument for CHEQUE and the average over 1970–5, 1980–5, and 1990–5 to instrument constraints on executive power. Unfortunately, we are forced to treat the risk of expropriation and KKZ96 as exogenous due to data limitations. We also tried to use log settler mortality as an instrument for expropriation risk but again it severely restricts our sample so we opted not to use it.

8 To capture unexplained regional heterogeneity, we include a set of variables – dummy variables for East Asian countries, Sub-Saharan African countries, and Latin American and Caribbean countries.

9 In the regressions of TFP growth, physical capital accumulation, and human capital accumulation we also include the logarithms of initial income per worker and initial human capital in 1965, 1975 and 1985 to capture the effects of initial heterogeneity. As instrumental variables we use logarithms of initial income per worker and initial human capital in 1960, 1970 and 1980.

4. Results

4.1. *Aggregate Growth*

We first discuss our MA findings for the canonical linear growth regression (1) which are reported in columns 1 and 2 of Table 1. As argued above, given that the prior probability of a theory being in the true model is set at 0.5, a theory's robustness may be assessed in terms of how the data updates this prior; i.e., by a theory's posterior probability of inclusion in the true model. We refer to a specific variable as being important if the posterior mean of the coefficient is at least twice the posterior standard deviation; we employ this t-statistic rule-of-thumb for no other reason than because it mimics statistical significance at the 5% in the frequentist sense (Brock and Durlauf, 2001).[5]

[4] It is worth noting that here, we do not view the various aspects of institutions (such as property rights and contracting institutions) as separate theories but rather we view them as different measures of one theory. For a different treatment of the model space see Durlauf *et al.* (2006).

[5] For every exercise in the article, we performed two kinds of sensitivity analyses. One replaced our hierarchical priors with flat priors and another replaced BIC with AIC. In no case were the results qualitatively different. For all classical and model averaging specifications we also carried out both LS and 2SLS exercises but we only report the 2SLS findings due to space limitations and the fact that the 2SLS results turned out to be very similar to the LS ones. All the results are available from the authors upon request.

Table 1

MA 2SLS Estimates

	g_y		g_A		g_k		g_h	
Explanatory Variable	Posterior Inclusion Probability (1)	Posterior Mean (S.E.) (2)	Posterior Inclusion Probability (3)	Posterior Mean (S.E.) (4)	Posterior Inclusion Probability (5)	Posterior Mean (S.E.) (6)	Posterior Inclusion Probability (7)	Posterior Mean (S.E.) (8)
Neoclassical	*1.000**		–		–		–	
Log of Initial Income	1.000	−0.017 (0.003)	–	–	–	–	–	–
Log of Pop. Growth Rates plus 0.05	0.696	−0.027 (0.022)	–	–	–	–	–	–
Log of Schooling	0.019	0.000 (0.001)	–	–	–	–	–	–
Log of Investments	1.000	0.013 (0.003)	–	–	–	–	–	–
Initial Heterogeneity	–	–	*0.421**		*0.948**		*0.988**	
Log of Initial Income	–	–	0.408	−0.001 (0.002)	0.948	−0.015 (0.006)	0.979	0.003 (0.001)
Initial Human Capital	–	–	0.025	−0.000 (0.001)	0.000	0.000 (0.000)	0.983	−0.012 (0.003)
Externalities	–	–	*0.999**		–			
Growth of Physical Capital	–	–	0.006	−0.000 (0.007)	–	–	–	–
Growth of Human Capital	–	–	0.583	−0.438 (0.409)	–	–	–	–
Growth of Physical Cap. × Log of Human Capital	–	–	0.999	0.346 (0.061)	–	–	–	–
Growth of Human Cap. × Log of Human Capital	–	–	0.460	−0.503 (0.608)	–	–	–	–
Demography	*0.033**		*0.024**		*0.977**		*0.773**	
1/Life Expectancy at age 1	0.014	−0.000 (0.003)	0.012	−0.000 (0.001)	0.000	−0.000 (0.000)	0.141	−0.001 (0.003)
Log of Fertility Rate	0.019	−0.000 (0.002)	0.011	−0.000 (0.000)	0.976	−0.020 (0.008)	0.772	0.003 (0.002)
Macroeconomic Policy	*1.000**		*0.082**		*0.883**		*0.008**	
Openness (filtered)	0.417	0.006 (0.009)	0.018	0.000 (0.001)	0.696	0.017 (0.015)	0.005	0.000 (0.000)
Govt. Consumption (net)	1.000	−0.137 (0.034)	0.067	−0.004 (0.016)	0.848	−0.114 (0.068)	0.003	0.000 (0.001)
Inflation	0.988	−0.014 (0.007)	0.009	−0.000 (0.001)	0.409	−0.007 (0.010)	0.001	0.000 (0.000)
Regional Heterogeneity	*0.980**		*0.012**		*0.999**		*0.979**	
East Asia	0.944	0.011 (0.006)	0.0046	0.000 (0.000)	0.978	0.025 (0.009)	0.979	0.005 (0.001)
Sub-Saharan Africa	0.587	−0.009 (0.009)	0.0039	−0.000 (0.000)	0.941	−0.032 (0.012)	0.014	0.000 (0.000)
Latin America & Caribbean	0.030	−0.000 (0.001)	0.0041	−0.000 (0.000)	0.786	−0.013 (0.009)	0.020	−0.000 (0.000)
Religion	*0.668**		*0.002**		*0.035**		*0.107**	
East. Religion Share	0.020	0.000 (0.001)	0.000	0.000 (0.000)	0.004	0.000 (0.002)	0.001	0.000 (0.000)
Hindu Share	0.052	0.001 (0.005)	0.000	0.000 (0.000)	0.002	0.000 (0.002)	0.039	0.000 (0.001)
Jewish Share	0.037	0.001 (0.003)	0.000	0.000 (0.000)	0.000	0.000 (0.000)	0.001	0.000 (0.000)

Table 1

(Continued)

Explanatory Variable	g_y Posterior Inclusion Probability (1)	g_y Posterior Mean (S.E.) (2)	g_A Posterior Inclusion Probability (3)	g_A Posterior Mean (S.E.) (4)	g_k Posterior Inclusion Probability (5)	g_k Posterior Mean (S.E.) (6)	g_h Posterior Inclusion Probability (7)	g_h Posterior Mean (S.E.) (8)
Muslim Share	0.058	−0.001 (0.003)	0.001	−0.000 (0.000)	0.000	0.000 (0.000)	0.004	−0.000 (0.000)
Orthodox Share	0.019	−0.000 (0.001)	0.000	0.000 (0.000)	0.000	0.000 (0.000)	0.022	0.000 (0.001)
Protestant Share	0.087	−0.001 (0.003)	0.000	0.000 (0.000)	0.007	−0.000 (0.002)	0.107	0.001 (0.002)
Other Religion Share	0.647	−0.010 (0.011)	0.000	0.000 (0.000)	0.033	−0.001 (0.008)	0.018	0.000 (0.001)
Geography	*0.420**		*0.132**		*0.000**		*0.007**	
LCR100 km	0.010	0.000 (0.000)	0.008	0.000 (0.000)	0.000	0.000 (0.000)	0.005	−0.000 (0.000)
KGATRSTR	0.416	−0.006 (0.008)	0.124	−0.001 (0.003)	0.000	0.000 (0.000)	0.003	0.000 (0.000)
Fractionalisation	*0.420**		*0.032**		*0.272**		*0.006**	
Language	0.406	−0.005 (0.008)	0.014	−0.000 (0.001)	0.272	−0.005 (0.009)	0.003	0.000 (0.000)
Ethnic Tensions	0.133	−0.002 (0.006)	0.018	−0.000 (0.001)	0.003	−0.000 (0.001)	0.002	0.000 (0.000)
Institutions	*0.129**		*0.011**		*0.948**		*0.009**	
Exprop. Risk	0.002	0.000 (0.001)	0.003	0.000 (0.000)	0.147	0.004 (0.012)	0.001	0.000 (0.000)
Exec. Constraints	0.093	−0.001 (0.003)	0.002	0.000 (0.000)	0.939	−0.016 (0.008)	0.002	0.000 (0.000)
KKZ96	0.009	0.000 (0.001)	0.003	0.000 (0.000)	0.053	−0.001 (0.003)	0.005	0.000 (0.000)
CHEQUE	0.043	−0.001 (0.005)	0.003	−0.000 (0.000)	0.262	−0.006 (0.013)	0.001	0.000 (0.000)

This Table provides MA 2SLS estimates for the per worker income growth regression in (1) of the text, and the TFP, physical capital, and human capital component growth regressions given by (3)–(5) of the text. Time dummies (unreported) are included in each regression. Odd numbered columns provide results on the posterior probability of inclusion for theories and variables; where * denotes the posterior inclusion probability of each theory. Even numbered columns provide results on posterior means and standard deviations (the latter in brackets).

We find that the robust growth theories include neoclassical growth, macroeconomic policy, and religion. Within these theories, there is some difference in the strength of evidentiary support. While neoclassical growth and macroeconomic policy are found to have posterior probability of inclusion close to one, religion appears to be less robust with posterior probability of inclusion equal to 0.67. We also find that (unexplained) regional heterogeneity plays an important role in accounting for growth with posterior probability of inclusion equal to 0.98.

In terms of the neoclassical growth variables, our findings are largely consistent with those in the existing 'conditional convergence' literature as well as previous studies that have employed MA methods to growth. Consistent with Fernandez *et al.* (2001) and Sala-i-Martin *et al.* (2004), we find very strong posterior evidence in favour of an important negative coefficient to initial income per worker. We also find evidence for population growth and investment. The three coefficients have signs predicted by the neoclassical theory and all three have posterior inclusion probabilities greater than 0.5.

With regards to macroeconomic policy variables, we find that the effects of both government consumption (Barro, 1997; Sachs and Warner, 1995) and inflation (Bruno and Easterly, 1998; Kormendi and Meguire, 1985) are robust and detrimental to growth as both variables have posterior probabilities of inclusion close to 1.

In terms of religion shares 'other religion' appears to matter for growth in the sense that the posterior probability of inclusion is greater than the prior of 0.5 at 0.65. However, the posterior mean for other religion is small compared to its posterior standard deviation. These results appear to contradict previous work in the literature suggesting an important role for religion in growth (Barro and McCleary, 2003). We therefore investigated further to see if the religion variables may be acting as proxies for unexplained regional variations in growth when the latter variables are excluded from the model space. When the regional heterogeneity variables are omitted, we found that Eastern religion had an important positive partial correlation with growth while Protestant share had an important negative one. In this case, we also found that the posterior probability of inclusion of religion as a theory jumped from 0.67 (when regional heterogeneity was included) to close to 1 (when regional heterogeneity was excluded).

Our results for institutions (Table 1) suggest that the evidence for the robust importance of institutions is weak, when proximate theories are accounted for. Previous papers analysing the relationship between institutions and growth have often restricted the analysis to (competing) fundamental theories in isolation and used kitchen sink regressions for comparison. In unreported results where we dropped the proximate growth theories (notably macroeconomic policy) and regional heterogeneity from the model space, and retained only the fundamental growth theories, the posterior probability of inclusion for institutions as a theory is very high at 0.96 and the composite governance index (KKZ96) is important by our t-statistic rule of thumb.

One interpretation of these results is that institutions affect growth indirectly through their influence on proximate variables. For instance, our results are consistent with Acemoglu *et al.* (2003) who argue that good institutions influence growth through the promotion of better macroeconomic policies. Nevertheless, our results indicate that previous findings on the direct importance of institutions to growth are fragile.

To contrast our results with the standard methods for theory comparison, we report analogous kitchen sink findings in Table 2. When comparing our MA results with those obtained under a classical kitchen sink, the main finding is that many of the theories/variables found to be important in a classical horse race are not robust once we account for model uncertainty. For instance, we were not able to confirm the robustness of trade openness, as well as any of the fractionalisation variables that we found to be important in the kitchen sink regressions. What is more, the evidential support for East Asia and Protestant share appears to be much weaker in the model averaging results. In comparing the model averaging results with the kitchen sink results, it is important to keep in mind that the model weights used in averaging penalise larger models.

Table 2

Classical 2SLS ('Kitchen Sink') Estimates

Explanatory Variables	g_y (1)	g_A (2)	g_k (3)	g_h (4)
Neoclassical				
Log of Initial Income	−0.021***	–	–	–
	(0.005)			
Log of Pop. Growth Rates plus 0.05	−0.017	–	–	–
	(0.021)			
Log of Schooling	−0.009*	–	–	–
	(0.005)			
Log of Investments	0.009***	–	–	–
	(0.003)			
Initial Heterogeneity				
Log of Initial Income	–	−0.015***	−0.018**	0.004**
		(0.004)	(0.007)	(0.001)
Log of Initial Human Capital	–	−0.008	0.004	−0.022***
		(0.012)	(0.018)	(0.004)
Externalities				
Growth of Physical Capital	–	−0.052	–	–
		(0.100)		
Growth of Human Capital	–	−0.351**	–	–
		(0.159)		
Growth of Phys. Cap. × Log of Human Capital	–	0.181	–	–
		(0.140)		
Growth of Hum. Cap. × Log of Human Capital	–	−0.170*	–	–
		(0.092)		
Demography				
1/Life Expectancy at age 1	−0.026	−0.010	−0.008	−0.011**
	(0.018)	(0.0149)	(0.023)	(0.005)
Log of Fertility Rate	−0.008	−0.0087	−0.031***	0.007***
	(0.008)	(0.0054)	(0.010)	(0.002)
Macroeconomic Policy				
Openness (filtered)	0.022**	0.020***	0.019	0.004*
	(0.009)	(0.007)	(0.012)	(0.002)
Govt. Consumption (net)	−0.112***	−0.063*	−0.112*	0.011
	(0.035)	(0.035)	(0.060)	(0.013)
Inflation	−0.024**	−0.016**	−0.012	0.004
	(0.010)	(0.007)	(0.011)	(0.003)
Regional Heterogeneity				
East Asia	0.024***	0.011**	0.026**	0.006**
	(0.007)	(0.005)	(0.011)	(0.002)
Sub-Saharan Africa	−0.007	0.000	−0.018	−0.003
	(0.008)	(0.008)	(0.0012)	(0.003)
Latin America & Caribbean	0.000	0.005	−0.009	−0.002
	(0.006)	(0.004)	(0.009)	(0.001)
Religion				
Eastern Religion Share	−0.014	−0.008	−0.001	0.002
	(0.009)	(0.006)	(0.014)	(0.003)
Hindu Share	0.021	0.004	0.0135	0.006*
	(0.014)	(0.010)	(0.017)	(0.004)
Jewish Share	0.014	0.018**	0.008	0.006
	(0.010)	(0.007)	(0.014)	(0.004)
Muslim Share	−0.011	−0.018**	0.009	−0.004
	(0.009)	(0.018)	(0.018)	(0.004)
Orthodox Share	−0.010	−0.005	−0.004	0.005**
	(0.009)	(0.005)	(0.015)	(0.002)

Table 2

(Continued)

	g_y	g_A	g_k	g_h
Explanatory Variables	(1)	(2)	(3)	(4)
Protestant Share	−0.012**	−0.004	−0.011	0.007***
	(0.005)	(0.004)	(0.007)	(0.002)
Other Religion Share	−0.019	−0.014	−0.009	0.008
	(0.014)	(0.012)	(0.027)	(0.006)
Geography				
LCR100 km	−0.004	−0.004	−0.001	−0.001
	(0.005)	(0.004)	(0.007)	(0.001)
KGATRSTR	−0.010	−0.015**	0.004	−0.003
	(0.007)	(0.006)	(0.011)	(0.002)
Fractionalisation				
Language	−0.028***	−0.013*	−0.026**	0.001
	(0.008)	(0.007)	(0.011)	(0.002)
Ethnic Tensions	−0.014**	−0.008	−0.008	0.002
	(0.007)	(0.006)	(0.010)	(0.002)
Institutions				
Expropriation Risk	−0.020	−0.010	0.028	−0.003
	(0.016)	(0.016)	(0.027)	(0.005)
Executive Constraints	−0.006	−0.002	−0.015*	−0.001
	(0.005)	(0.005)	(0.008)	(0.001)
KKZ96	0.006	0.002	−0.006	0.001
	(0.006)	(0.005)	(0.009)	(0.002)
CHEQUE	−0.014	−0.008	−0.018	0.004
	(0.024)	(0.018)	(0.041)	(0.009)

This Table provides classical 'kitchen sink' 2SLS estimates for the per worker income growth regression in (1) of the text (column 1), and regressions of the components of growth, TFP growth (column 2), growth of physical capital (column 3), and growth of human capital given by (3)–(5) of the text. Time dummies (unreported) are included in each regression. ***,**, and * denote significance at 1%, 5%, and 10%, respectively.

4.2. *Growth Component Analysis*

4.2.1. *Results for TFP growth*

We next turn to our findings for the three components of growth, beginning with the TFP growth regression (3). As in the income growth regression case above, we find that there are important differences between the MA and classical results for TFP growth.

The MA results for TFP growth (see columns 3 and 4 of Table 1) indicate the importance of our externalities measure E as the posterior inclusion probability of this theory is close to 1. No other growth theory robustly explains TFP growth. In particular there is strong support for the role of the interaction term between growth of physical capital and the logarithm of initial human capital – the coefficient to this externality variable is positive and the posterior mean is more than two times larger than the posterior standard deviation. The implied shares of physical capital for our data set lie between 0.37 and 0.75.[6] This suggests the presence of parameter heterogeneity in the

[6] When we used interaction terms based on the logarithm of initial income rather than the logarithm of initial human capital, the results are similar although the posterior inclusion probability of externalities was smaller.

aggregate production function; see Durlauf and Johnson (1995) for similar findings and interpretation.

In contrast, the kitchen sink approach, Table 2, column 2, finds that many theories potentially contribute toward explaining TFP growth. TFP growth is significantly and negatively dependent on production externalities (the growth of human capital, the interaction between the growth of human capital and initial human capital), macroeconomic policies (inflation, trade openness, and government consumption), religion (Muslim and Jewish religion shares), climate (KGATRSTR), and ethnolinguistic fractionalisation (language). TFP growth is also found to be significantly and positively correlated with being in East Asia, and starting out with a lower initial income.

The difference between the MA and kitchen sink regressions illustrates the importance of explicitly considering model uncertainty. Every one of the theories/variables found to be statistically significant in the classical kitchen sink regression turn out to have negligible posterior probability of being in the true model, with the exception of production externalities.

4.2.2. *Factor accumulation*

We next consider physical and human capital accumulation (refer to (4) and (5) above). Similar to the TFP growth case, there are significant differences between the classical kitchen sink and MA results, as expected. The classical results (columns 3 and 4 of Table 2) suggest the importance of religion, fractionalisation, geography and institutions. However, the MA results (last four columns of Table 1) suggest that these results are largely non-robust (with the exception of institutions).

None of the new growth theories are found to be important robust determinants of human capital accumulation except for demography. The posterior probability of theory inclusion for demography is larger than the prior of 0.5 at 0.77. The results suggest, in particular, that the fertility rate may have a positive impact on human capital accumulation although the effect is likely to be small. Otherwise, human capital accumulation appears best explained by being in East Asia and having higher initial levels of income and lower initial levels of human capital stock.

The MA results do find that institutions (constraints on the executive) have an important impact on physical capital accumulation. The posterior probability of inclusion for institutions is very high at 0.95. This result suggests yet again, as in the case of income growth above, that the effect of institutions on growth of income per worker is likely to be through their influence on proximate growth determinants (factor accumulation, in this case) rather than through their effects on technological innovation. Other theories that appear to explain physical capital accumulation well are demography (log fertility rate) and macroeconomic policy (government consumption). Countries that start at a lower initial income also tend to have higher rates of physical capital accumulation, as do countries in East Asia. The reverse is true for countries in Sub-Saharan Africa and those in Latin America and the Caribbean.

Collectively, our analysis of the three components of growth delivers a similar message to the analysis of growth as a whole. The evidence that any of the new fundamental growth theories proposed in the recent growth literature are robust determinants of any of these outcome variables is mixed at best. Our analysis suggests that the main factor that accounts for cross-country variations in TFP growth is interpretable as a production externality rather than any of the fundamental theories. Similarly, human capital accumulation rates appear to be driven by initial heterogeneity, demography, and unexplained variations in regional characteristics. The only case in which a fundamental theory matters is that of institutions for the case of physical capital accumulation.

In conjunction with the results in Section 4.1, therefore, we conclude that there is some evidence that institutions and/or religion play a role as determinants of growth rates. Our results suggest that their effect is likely to flow through their influence on physical capital accumulation rates and not via TFP growth directly. This finding is consistent with the literature since some studies have suggested that good institutions may be important in reducing macroeconomic volatility (Acemoglu *et al.* 2003) that conceivably affects incentives to invest. Studies arguing a role for religion in economic performance also emphasise religion's role in shaping attitudes such as saving behaviour (e.g., Guiso *et al.* 2003). There is little evidence that these factors affect growth directly as determinants of technological progress.

Finally, one would expect the results from Section 4.1 to reinforce those of Section 4.2 in the sense that theories that are important for the growth of income per worker are reflected in the components of growth, and *vice versa*. One reason why this is not the case is, as we have previously suggested, that the aggregate production function in (2) is, in fact, misspecified. For instance, in unreported exercises, we have conducted our analysis without the externalities measure E. In this case, we found that initial heterogeneity (initial income per worker), demography (fertility), as well as macroeconomic policy variables (government consumption and inflation) were the key robust determinants of TFP growth. Given our findings when we included externalities in the model space of the TFP growth regression, we conclude this evidentiary support is not robust and may be an artifact of misspecifications in the aggregate production function.

4.3. *Variance Decomposition*

To complete our investigation, we first develop a variance decomposition analysis in columns 1–3 of Table 3 to assess the contribution of each growth theory in explaining variation in the components of growth and second, in column 4 of Table 3 we map this evidence to overall growth of income per worker. This sort of exercise complements our evidence above based on regression analysis in that it allows one to assess the contribution of various growth theories in explaining variation in cross-country income growth rates, indirectly, via the components of growth. In essence, given the posterior mean values of growth parameters, this approach provides a systematic examination of the distribution of configurations of fundamental determinants and their collective ability to explain growth differences.

We first compute the posterior mean of each theory τ as $\hat{S}_{M,\tau} = X_{\tau,1}\hat{\delta}_{M,\tau,1} + X_{\tau,2}\hat{\delta}_{M,\tau,2} + \ldots + X_{\tau,p}\hat{\delta}_{M,\tau,p}$, where $\{\hat{\delta}_{M,\tau,j}\}_{j=1}^{p}$ is the set of MA estimates for the

Table 3

The Role of Growth Theories in the Components of Growth

	$Cov(g_A, \hat{S}_j)/Var(g_A)$	$Cov(g_k, \hat{S}_j)/Var(g_k)$	$Cov(g_h, \hat{S}_j)/Var(g_h)$	$Cov(g_y, \hat{S}_j)/Var(g_y)$
	(1)	(2)	(3)	(4)
Initial Heterogeneity	0.008	0.042	0.108	0.021
Neoclassical	–	–	–	–
Externalities	0.278	–	–	0.167
Demography	0.000	0.018	0.081	0.006
Macroeconomic Policy	0.003	0.088	0.000	0.038
Religion	0.000	0.003	−0.002	0.001
Regional Heterogeneity	0.000	0.267	0.063	0.109
Geography	0.003	0.000	0.000	0.002
Fractionalisation	0.000	0.002	0.000	0.001
Institutions	0.000	0.027	0.000	0.011

This Table summarises the role of each theory in explaining the variation of growth of income per worker via its components; i.e., TFP growth and physical and human capital accumulation. It traces the contribution of each theory through each component and ultimately from there to per worker growth rates. Note that we can also express the variance decomposition of the variance of growth of income per worker in terms of the partial contribution of each growth component; respectively, TFP growth, growth in physical capital, and growth in human capital. In this case, we obtain the following: $Cov(g_y, g_A)/Var(g_y) = 0.6006, Cov(g_y, \alpha g_k)/Var(g_y) = 0.4099$, and $Cov(g_y, (1-\alpha)g_k)/Var(g_y) = -0.0106$.

coefficients to the variables for theory τ. As shown by Klenow and Rodriguez-Clare (1997) one can decompose the variance of each component via[7]

$$1 = \sum_{\tau=1}^{\mathcal{T}} \frac{Cov(g_l, \hat{S}_{M,\tau})}{Var(g_l)} + \frac{Cov(g_l, \hat{e})}{Var(g_l)}; \quad \text{for} \quad l = A, k, h, \tag{9}$$

Columns (1)–(3) of Table 3 present the results for the components of growth. We show results based on both MA estimates using hierarchical priors with dilution and MA estimates using flat priors. Column 1 of Table 3 shows the importance of externalities in explaining the variation in TFP growth. An increase of 1 standard deviation in externalities is associated with a 28% increase in TFP growth. As we noted above, the new growth theories – geography, institutions, and fractionalisation – that have been advanced (at least within the canonical neoclassical growth framework) as explanations for TFP growth perform poorly. Their disappointing performance extends to the case when these theories are used as explanations for variations in factors of accumulation.

The results for physical capital accumulation (column 2 of Table 3) show that only (unexplained) regional heterogeneity plays a major role in explaining the variation of physical capital accumulation (27%). Macroeconomic policy and initial heterogeneity are limited to explaining only 8% and 4%, respectively, of total variation. Institutions also play only a minor role: an increase of 1 standard deviation in institutions is associated with only a 2.7% increase in physical capital accumulation.

[7] Notice that there is a conceptual limitation in using covariances for variance decomposition. Ideally, one would like to express the decomposition in terms of variances of orthogonal components and also compute posterior standard errors. We follow the literature in using this imperfect measure.

In the case of human capital accumulation (columns 3 of Table 3), initial heterogeneity plays a major role in accounting for total variation (around 11%) while demography and regional heterogeneity account for about 8% and 6%, respectively.

These results on growth components can be aggregated to compute variance decompositions for overall growth. We do this exercise in column 4 of Table 3. To put it differently we trace the (indirect) influence of growth theories on growth of income per worker via the growth components. We find that externalities explain around 17% of income growth variation. This is to be expected since we know that externalities are important in explaining TFP growth, and a standard growth accounting exercise reveals that the variation in TFP growth accounts, in turn, for 60% of the total variation in growth of income per worker. This finding is consistent with Hall and Jones (1999) who show that productivity differences play a key role in explaining cross-country income differences. Similarly, we find that (unexplained) regional heterogeneity and macroeconomic policies explain roughly 11% and 4% of income growth variation, respectively. As discussed above, both these growth theories are important explanations for variation in physical capital accumulation which in turn is found to explain the remaining 40% of income growth variation. The new fundamental growth theories each account only for less than 1% of the total variation of growth of income per worker.

5. Conclusion

Our goal in this article was to assess the evidentiary support for various growth theories, recognising that a researcher does not have *ex ante* knowledge of the appropriate growth regression from which conclusions are to be drawn. We generally fail to find strong evidence that any of these new growth theories are robust direct determinants of growth once we account for model uncertainty, although there is some evidence that institutions and religion may affect growth indirectly via growth proximates. What we find instead is that variation in growth rates across countries are more robustly explained by differences in macroeconomic policies and unknown heterogeneity associated with regional groupings. We also find some evidence for parameter heterogeneity in the aggregate production function. That said, the main messages of our article are perhaps

(1) more work needs to be done in systematically uncovering potential nonlinearities and heterogeneity in growth processes across countries – see, for instance, Durlauf *et al.* (2001) and Tan (2005) – if one is to use regression analysis to evaluate growth theories and
(2) it is most likely the case that the limits to what information can be extracted from aggregate regressions requires more attention to microeconomic and historical studies.

Appendix: Derivation of the Proxy for Externalities

One may derive the proxy for externalities as follows. By assuming that the factor shares depend on an index of initial conditions $w_{0,i}$, one can generalise the standard Cobb-Douglas production function to

$$y_{i,t} = A_{i,t} k_{i,t}^{\beta_k(w_{i,0})} h_{i,t}^{\beta_h(w_{i,0})} \tag{A1}$$

where $\beta_k(w_{i,0})$ and $\beta_h(w_{i,0})$ are some functions of the elasticities of physical capital per worker and human capital per worker. Notice that (A1) can be rewritten as

$$y_{i,t} = A_{i,t} k_{i,t}^{\alpha} h_{i,t}^{1-\alpha} z_{i,t} \tag{A2}$$

where $z_{i,t} = k_{i,t}^{\gamma_k(w_{i,0})} h_{i,t}^{\gamma_h(w_{i,0})}$ with $\gamma_k(w_0)$ and $\gamma_h(w_0)$ are some unknown functions of the index w_0 that are related to the income per worker elasticity of the human and physical capital accumulations, respectively.

Here, we assume that the index, $w_{0,i}$, is the log of initial human capital, h_0 and for simplicity we assume that the $\gamma(\cdot)$ functions are linear. Thus, if one ignores the term $z_{i,t}$ and calculates the TFP growth under the standard Cobb-Douglas assumption then by construction the TFP growth rate will depend on the omitted term $(\gamma_{k,0} + \gamma_{k,1} h_0) g_k + (\gamma_{h,0} + \gamma_{h,1} h_0) g_h$. Given that the coefficients $\gamma_{k,0}, \gamma_{k,1}, \gamma_{h,0}$, and $\gamma_{h,1}$ are unknown one can estimate them by simply including in the TFP growth regression the vector $\mathbf{E} = (g_k, g_h, h_0 \times g_k, h_0 \times g_h)'$.

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References

Acemoglu, D. and Johnson, S. (2005). 'Unbundling institutions', *Journal of Political Economy*, vol. 113(5), pp. 949–95.

Acemoglu, D., Johnson, S. and Robinson, J. (2001). 'The colonial origins of comparative development: an empirical investigation', *American Economic Review*, vol. 91(5), pp. 1369–401.

Acemoglu, D., Johnson, S., Robinson, J. and Thaicharoen, Y. (2003). 'Institutional causes, macroeconomic symptoms: volatility, crises and growth', *Journal of Monetary Economics*, vol. 50, pp. 49–123.

Aiyar, S. and Feyrer, J. (2002). 'A contribution to the empirics of total factor productivity', mimeo, Dartmouth College.

Alesina, A., Devleeschauwer, A., Easterly, W., Kurlat, S. and Wacziarg, R. (2003). 'Fractionalization', *Journal of Economic Growth*, vol. 8(2), pp. 155–94.

Barrett, D.B. (1982). *World Christian Encyclopedia*, 1st edn, Oxford: Oxford University Press.

Barrett, D.B., Kurian, G.T. and Johnson, T.M. (2001). *World Christian Encyclopedia*, 2nd edn, Oxford: Oxford University Press.

Barro, R. (1996). 'Democracy and growth', *Journal of Economic Growth*, vol. 1(1), pp. 1–27.

Barro, R. (1997). *Determinants of Economic Growth*. Cambridge MA: MIT Press.

Barro, R. and Lee, J.-W. (2000). 'International data on educational attainment: updates and implications', CID Working Paper No. 42.

Barro, R. and McCleary, R. (2003). 'Religion and economic growth across countries', *American Journal of Sociology*, vol. 68, pp. 760–81.

Bernanke, B.S. and Gürkaynak, R.S. (2001). 'Is growth exogenous? Taking Mankiw, Romer, and Weil seriously', in (B.S. Bernanke, and K. Rogoff, eds.), *NBER Macroeconomics Annual 2001*, pp. 58–82, Cambridge MA: MIT Press.

Brock, W. and Durlauf, S.N. (2001). 'Growth empirics and reality', *World Bank Economic Review*, vol. 15(2), pp. 229–72.

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

Bruno, M. and Easterly, W. (1998). 'Inflation crises and long-run growth', *Journal of Monetary Economics*, vol. 41(1), pp. 3–26.

Caselli, F. (2005). 'Accounting for cross-country income differences', in (P. Aghion and S. Durlauf, eds.), *Handbook of Economic Growth*, pp. 679–741, Amsterdam: Elsevier.

Djankov, S., La Porta, R., L.-de-Silanes, F. and Shleifer, A. (2002). 'The regulation of entry', *Quarterly Journal of Economics*, vol. 117(1), pp. 1–37.

Durlauf, S.N. and Johnson, P. (1995). 'Multiple regimes and cross country growth behavior', *Journal of Applied Econometrics*, vol. 10(4), pp. 365–84.

Durlauf, S.N., Johnson, P. and Temple, J. (2005). 'Growth econometrics', in (P. Aghion and S.N. Durlauf, eds.), *Handbook of Economic Growth*, Amsterdam: North Holland.
Durlauf, S.N., Kourtellos, A. and Minkin, A. (2001). 'The local Solow growth model', *European Economic Review*, vol. 45(4–6), pp. 928–40.
Durlauf, S.N, Kourtellos, A. and Tan, C.M. (2006). 'Is God in the details? A re-examination of the role of religion in economic growth', University of Wisconsin, mimeo.
Easterly, W. and Levine, R. (1997). 'Africa's growth tragedy: policies and ethnic divisions', *Quarterly Journal of Economics*, vol. 112(4), pp. 1203–50.
Fernandez, C., Ley, E. and Steel, M. (2001). 'Model uncertainty in cross-country growth regressions', *Journal of Applied Econometrics*, vol. 16(5), pp. 563–76.
George, E.I., (1999). 'Discussion of Bayesian model averaging and model search strategies by M.A, Clyde'. *Bayesian Statistics*, vol. 6, pp. 175–7.
Guiso, L., Sapienza, P. and Zingales, L. (2003). 'People's opium? Religion and economic attitudes', *Journal of Monetary Economics*, vol. 50, pp. 225–82.
Hall, R.E. and Jones, C.I. (1999). 'Why do some countries produce so much more output per worker than others?', *Quarterly Journal of Economics*, vol. 114(1), pp. 83–116.
Kaufmann D., Kraay, A. and Mastruzzi, M. (2005). 'Governance matters IV: governance indicators for 1996–2004', World Bank Policy Research no. 3630.
Kim, J.Y. (2002). 'Limited information likelihood and Bayesian analysis', *Journal of Econometrics*, vol. 107, pp. 175–93.
Klenow, P.J. and Rodriguez-Clare, A. (1997). 'The neoclassical revival in growth economics: has it gone too far?', in (B.S. Bernanke, and J.J. Rotemberg eds.), *NBER Macroeconomics Annual 1997*, pp. 73–103, Cambridge MA: MIT Press.
Kormendi, R. and Meguire, P. (1985). 'Macroeconomic determinants of growth: cross country evidence', *Journal of Monetary Economics*, vol. 16(2), pp. 141–63.
Mamuneas, T., Savvides, A. and Stengos, T. (2006). 'Economic development and the return to human capital: a smooth coefficient semiparametric approach', *Journal of Applied Econometrics*, vol. 21(1), pp. 111–32.
Mankiw, N.G., Romer, D. and Weil, D. (1992). 'A contribution to the empirics of economic growth', *Quarterly Journal of Economics*, vol. 107(2), pp. 407–37.
Raftery, A.E. (1995). 'Bayesian model selection in social research (with discussion)', *Sociological Methodology*, vol. 25, pp. 111–96.
Rodrik, D., Subramanian, A. and Trebbi, F. (2002). 'Institutions rule: the primacy of institutions over geography and integration in economic development', NBER Working Paper No. 9305.
Sachs, J. (2003). 'Institutions don't rule: direct effects of geography on per capita income', NBER Working Paper No. 9490.
Sachs, J. and Warner, A. (1995). 'Economic reform and the process of global integration (with discussion)', *Brookings Papers on Economic Activity*, vol. 1, pp. 1–118.
Sala-i-Martin, X., Doppelhofer, G. and Miller, R. (2004). 'Determinants of long-term growth: a Bayesian averaging of classical estimates (BACE) approach', *American Economic Review*, vol. 94(4), pp. 813-35.
Shastry, G.K. and Weil, D.N. (2003). 'How much of cross-country income variation is explained by health', *Journal of the European Economic Association*, vol. 1, pp. 387–96.
Solow, R. (1956). 'A contribution to the theory of economic growth', *Quarterly Journal of Economics*, vol. 70(1), pp. 65–94.
Tan, C.M., (2005). 'No one true path: uncovering the interplay between geography, institutions, and fractionalization in economic development', Tufts University, mimeo.
Tsangarides, C.G. (2004). 'A Bayesian approach to model uncertainty', IMF Working Paper, no. 0468.
Weil, D.N. (2005). 'Accounting for the effect of health on economic growth', NBER Working Paper 11455.
Wong, W.K. (2003). 'The channels of economic growth: a channel decomposition exercise', National University of Singapore, mimeo.