

## REPORT ON:

### Cross-Country Growth Empirics and Model Uncertainty: an Overview

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The paper written by the author is a survey on the empirics of cross-country growth regressions. The objectives of the paper are threefold. The first one is to provide a theoretical framework generally used to test empirical growth models. Second, it remarks the importance of the model uncertainty problem, that has to be taken into account by growth economists, and finally it considers the importance of model uncertainty for policy evaluation.

The paper is composed by five sections and its structure is fairly good. However, paragraphs could be clearer and language could be improved in terms of precision. Moreover, important references are omitted and the space dedicated to some important issues and techniques is too small while too much space is dedicated to techniques and issues that later in the survey are considered either obsolete or not efficient. In particular, the aim of the author is to survey various aspects, both theoretical and empirical, of cross-country growth empirics but in each section some important and complementary growth theories/empirical perspectives are totally omitted from the review and this is something that should not be done in a survey whose aim is supposed to review the main theories/techniques used to analyze growth dynamics. In addition, I would not consider innovative a review where the Solow/human capital augmented Solow growth model are described in a way that can be hardly distinguished from a standard textbook Solow model described in any standard growth article/book. The most interesting part of the survey is in the second part of the survey, but the space dedicated to each argument is not proportional to the relevance of the topic and the techniques mentioned are not all explained with accuracy. Furthermore, the survey lacks in accuracy also in the decision of the titles given to the sections: in particular, the section titled “empirical framework” is half dedicated to the theoretical description of the model and the part dedicated to the empirics is far from being exhaustive. There are also some typos and mistakes along the text that the author should try to correct and if possible to avoid before sending the paper to a journal. For this reason I regret to say that I do not consider the survey appropriate and accurate enough for scientific publishing. In order to favor the improving of the survey for future publication here below I mention some advices on how the work can be improved and made more complete and rigorous.

#### **Introduction**

In the introduction the author revises the growth empirics starting from the pioneering work by Solow (1956) and Swan (1956) till the most recent growth advances.

The introduction is clear and it provides an overview of the theories that have been worked out and used in order to estimate growth empirics and test the convergence hypothesis. Moreover, classical problems (e.g. measurement errors and proxies) typical of

growth models and their implications for empirical analysis are mentioned. The author also states that while growth theories are open-ended, the neoclassical model à la Solow (1956) is still the main reference for empirical growth economists. Finally, it is remarked that given the large number of variables that can be used to explain cross-country differences in rates of growth and the small sample of growth regressions a problem of model uncertainty arises in growth regressions. The introduction concludes with the list of objectives of the paper and the structure of the whole paper.

However, there are some relevant limitations/imperfections in the section, listed here below.

- 1- Overall: Since in the introduction the author is making a comparison between neoclassical and endogenous growth models, it would be good to have some of the “classical” endogenous growth models cited, as he does for the neoclassical models. Citations should not be many because this is just an introductory section, but it is good to have some citations from all theories mentioned. It would also be worth citing the unified growth theory (see Galor’s [2005] handbook chapter and related literature). It is important to cite all the theories and since Galor is one of the leading growth economists and plays an important role in the advances of economic growth, the omission of this reference is not ideal in a survey on the theory and empirics of economic growth.
- 2- “The recent empirical .. growth studies”. This part, at page 2, could be rephrased and could be made clearer. The second sentence is too long and grammatically incorrect. In addition, I would suggest to move the first sentence after the second, because the first and third sentences express a similar concept.
- 3- “It is obvious .. as well as the proximate determinants”. Is the diversion on what are called *proximate determinants* really useful for the aim of the paper? I would suggest dropping this paragraph. In general I would drop everywhere along the text the concept of “proximate determinant” and I would rather express the concept in a couple of lines.
- 4- “The most outstanding .. Brock and Durlauf (2001).” Rather than writing “does not preclude that the causal role of others”, I would just say that does not preclude the validity of others.
- 5- “As a consequence .. the ultimate goal of the literature”. The sentence “that is the number of countries in the world is limited” does not clarify the whole concept expressed before the comma, but just the last part (the small number of observations). The author must provide an econometric explanation of why having too many variables and a small sample observation is not appropriate, so that this justifies the use of “that is”. In addition, I would move note 3 where the small sample problems are discussed. It is true that missing observations imply a further reduction of the sample, but the small sample econometrics are mainly to be referred to the fact that the number of countries is small and cannot be considered a large sample (see other works on this literature, e.g. Soto 2009).  
In the last two sentences “Under these circumstances .. the ultimate goal of the literature” I would suggest to rephrase and be more precise about the terminology

used. Does the author mean that all the growth regressions lack in robustness? This is a strong statement and need to be specified.

- 6- There are two typos in the first two lines. “Why are some countries are growing..?”. Here the second are must be dropped. “Do countries convergence or diverge..”. Here it must be *converge* rather than *convergence*.

## **Empirical Framework**

This section exposes the theoretical framework of growth models. It explains the main theoretical concepts key to the understanding of the textbook Solow growth model and its augmented version (MRW). In addition to this, it also explains the two main types of convergence that can be studies (beta and sigma convergence) and empirically tested. A brief introduction about the different types of convergence dynamics is also introduced. Then the section goes through the criticisms generally raised about the framework and appropriateness of the MRW model in order to study cross-country growth dynamics. Finally, the problem of the importance of additional covariates in order to explain growth processes is discussed and this is the prelude to the third section that discusses the model uncertainty problem.

This section has some limitations and some degree of imprecision along the text.

- 1- Title: The author should find a more appropriate title for section 2, since most of the section refers to the theoretical models and literature and only in the second part some issues related to the empirics are raised. The title does not fully reflect the content.
- 2- In the first part of the section the various kinds of convergence definitions are listed, but initially just the absolute and conditional convergence are mentioned. The club convergence hypothesis is mentioned, but later in the text and just in a footnote. I would suggest to provide a clear description of all the possible types of convergence in the same part of the text. The article by Galor (1996), for instance, provides a clear description of all such types of convergence. I would also suggest to drop footnote 6 and introduce the club convergence hypothesis in the main text.
- 3- In the list of criticisms raised, the author mentions the appropriateness of using panel data in cross-country growth regressions, but it is just briefly stated. Since the recent advances show that panel data, in particular dynamic panels, should be used in growth regressions, I would suggest to give more space to their explanation. I would also suggest, since the aim is (according to the title of the section) to describe the empirical framework, to make a distinction between the different estimation methods (difference versus system GMM). Even though an extensive explanation of differences across these methods is not required, at least it would be good to discuss their suitability. Islam (1995) is a good reference, but some reference (possibly more recent) for dynamic panels is also necessary.
- 4- In addition, the time series literature is missed. Citation of the three streams of the literature (cross-section, panel data and It would be worth citing articles (Bernard and Durlauf, [1995, 1996], Durlauf and Johnson [1995], Jones [1995a, 1995b] and

Caggiano and Leonida [2009] are some of the best published examples) and their content. It is very limitative to title a section “empirical framework” and omit citations of the main approaches that can be used for empirical testing of growth models.

- 5- Furthermore, when the concepts of beta and sigma convergence are introduced they are not defined and the innovation introduced by Danny Quah is just briefly mentioned without any particular emphasis, which is required in this kind of survey.
- 6- I would generally suggest either to drop all the references to the empirics of economic growth and make much more elaborate the theoretical framework, if this is the aim of the section; or, if the aim is presenting also the empirical framework, introducing, as stressed in the previous points, all the possible empirical approaches that can be used in order to investigate growth dynamics and test the convergence hypothesis. Otherwise the survey results very incomplete with just a couple of citations about the empirics of economic growth and not even carefully explained.
- 7- Since it is recognized that using a panel data framework can solve some of the drawbacks of the Solow and its human capital augmented version, I would advice to focus more on this rather than spending too much time to explain the theoretical framework of the Solow model first and MRW model later.
- 8- When the concerns about human capital are discussed, I would also emphasize that measures of human capital can be hardly compared in samples including worldwide economies whose educational systems are very different.
- 9- In page 14, at the bottom. “More clearly, .. everywhere”. I would suggest to make this statement more precise.
- 10- Page 15, at the top. “Even though .. in their critical steady state”. I would suggest to provide citations about the problems mentioned.
- 11- At page 16, I would drop “if new growth theories affect the rate of technological progress” and I would advice to say that the index on the technological progress is country-specific and allows some degree of heterogeneity across countries in the rate of technology.
- 12- There are also some omissions/typos in the text. Page 7. “If we assume that THE rate of technological progress,  $g$ , ”. Two lines below “That is why countries”, suggest dropping the comma after why. At the bottom of the page “If THE convergence hypothesis defined above”. At the top of page 8 “The only difference .. concept is that the LATTER”. In footnote 7. “The reader can REFER TO”. Page 10: “On the other hand, logarithm .. and TO be equal to the sum of a fixed parameter,  $a$ ,”. Page 12 “either are insignificant or have UNEXPECTED sign”. Wrong is an imprecise term. Page 15. “is a coefficient vector of additional COVARIATES” is probably the correct term the author wanted to use?. In footnote 14 “income per worker”. Finally, the last sentence of the section “Therefore, selecting .. one study to *another thus raising*”.

### **Model Uncertainty and Cross-Country Growth Regressions**

In this section the author raises the problem of omitted variable bias in growth econometrics and model uncertainty. He describes the three main concepts of uncertainty that may arise in economic growth (e.g. theory uncertainty, specification uncertainty and

heterogeneity uncertainty). Then, the author introduces Extreme Bound Analysis explaining that it can be useful to face model uncertainty, but he also questions its efficiency due to the classical drawbacks of this technique. For this reason two different approaches are introduced: the general to specific modeling (GETS), which starting from the most general model searches the most appropriate model and has the drawback that the true model found by means of simplification is exactly the true model. The other approach is Bayesian Model Averaging, which is a technique designed in order to take into account model uncertainty when drawing conclusions about parameters and predictions. The section concludes mentioning that the appropriateness of these methods vary depending on the final aim of the analysis. This section and the next one are the two most innovative and original sections of the paper. Keep working on them would increase the likelihood of publishing the survey. They explain the most recent tools available to deal with economic growth issues. However, this section has to be improved in order to make reading more fluent and coherent with the content. Some suggestions are listed here below.

- 1- The section is interesting and well described, however the structure could be better organized. Indeed, most of the section is dedicated to the description of the EBA which is then criticized and less space is left to the methods that are used as alternative and described as more appropriate methods. Is there a reason for this? Probably the author should reduce the space dedicated to the EBA and give more space to the other methods, especially BMA that is becoming a very important method alternative/complementary to the classical approaches in economic growth.
- 2- Probably it would be more appropriate to provide a proper description of what BMA does and how. With respect to this, the review written by Zeugner (2011) could be helpful.
- 3- I agree that the GETS can be useful, but it is not a very appropriate method for growth models, given its drawback. For this reason, I would advice to reduce the space dedicated to GETS and dedicate more attention to the BMA for the same reason provided above. In addition, it would be more appropriate to describe the selection process used in the GETS described at pages 23-24 before mentioning its drawbacks.
- 4- Finally, the author should explain the sentence towards the bottom of page 24: "Therefore, differently from the GETS approach, the main aim of BMA is to provide a better parameter estimate of the variable of interest rather than to find the best model.", which could be misinterpreted.

### **Model Uncertainty and Policy Evaluation in Cross-Country Growth Regression**

In this section the author points out that taking into account model uncertainty when evaluating policies is important, as suggested by Brock and Durlauf (2001) and Brock et al. (2003). The author then discusses the implications of model uncertainty for policy evaluation. He points out the importance of taking into account the policy maker preferences and comparing utilities in order to evaluate policies. The section concludes stating that model averaging is a statistical tool useful in order to deal with both model uncertainty and policy evaluation. This section is also interesting and it would be worth

dedicating a larger part in the paper to it because the topic is actual, interesting and deserves more attention.

- 1- The section is linear and well explained. There are a couple of typos to revise. Page 28: before the end of the first paragraph, “a clear answer TO whether policy change should be implemented”. Page 29: “Hence, the second important message is that identifying (a) particular model(s)”.

## **Conclusions**

Some conclusions are drawn about what has been the object of the analysis under study. The survey ends with the desirable use of alternative and complementary tools that could account for model and parameter uncertainty and cope with some of the drawbacks of the “classical” analysis.

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