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The effects of external and internal shocks on total factor productivity

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ABSTRACT

This paper examines structural changes that occur in the total factor productivity (TFP) within countries. It is possible that some episodes of high economic growth or economic decline are associated with permanent productivity shocks; therefore, this research has two objectives. The first one is to estimate the structural changes present in TFP for a sample of 77 countries between 1950 (1960) and 2000. The second one is to identify possible explanations for breaks. Two sources were analyzed: (i) episodes in political and economic history; (ii) changes in international trade – a measure of absorption of technology. The results suggest that about one-third of the TFP time-series present at least one structural break. Downwards breaks are more common, indicating that after a break the TFP has much difficulty to recover. When we investigated factors related with structural change, developed countries presented a break near the first oil shock while the developing countries' breaks are more spread along the decades. Thus, external strikes seem to be more relevant for developed countries. However, for each country and break date, it was possible to find an event close to the break date endogenously detected. Last, the relevance of international trade, measured by trade share percentage of GDP, seems to be limited to explain abrupt changes in TFP.

1. Introduction

One of the main characteristics of modern economies is the large differences in per capita income among countries. Explaining these differences and their evolution over time is an extremely important issue. Economists have recognized that total factor productivity (TFP) acts as a determinant factor in the growth process. Hall and Jones (1999); Parente and Prescott (1999), Prescott (1998), Klenow and Rodriguez-Clare (1997), among others, show that there is strong evidence that TFP is considerably responsible for the differences in per capita income across countries.

A substantial part of the disparities in output levels can be partially explained by physical capital and education, but the largest part of these differences are explained by the Solow residual, that is, the TFP. In Hall and Jones (1999), for instance, the difference in capital accumulation, productivity and consequently in output per worker is the outcome of differences in institutions and governmental policies of the individual countries. The institutions and public policies structure that exist in each country are defined by the authors as the social infrastructure. Thus, this literature points to a strong correlation between output per worker and the social infrastructure indicator, in such a way that countries with public policies that are favorable to productive activities tend to produce more output per worker and to have larger TFP.

Using structural breaks technique, Ben-David and Papell (1998) proposed a test for determining the significance and the timing of slowdowns in economic growth, showing evidence that most industrialized countries experienced postwar growth slowdowns in the early 1970s, and that developing countries, in particular Latin American countries, tended to experience even more severe slowdowns.

More recently, Jones and Olken (2008) estimated structural breaks for income growth rates and employ growth accounting technique to investigate what occurs during various transitions. Their analysis suggests that changes in the rate of factor accumulation explain relatively little about the growth reversals. Instead, the growth reversals are largely due to shifts in the growth rate of productivity, and reallocations across sectors may be an important mechanism through which these productivity changes take place. Accelerations are coincident with major expansions in international trade, and relatively little change in investment, monetary policy or levels of conflict. Decelerations, on the other hand, are

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related with much sharper changes in investment, increases in monetary instability, and increases in conflict.

Motivated by the large disparity of economic performance in the medium and long term across countries and by the argument that differences in total factor productivity are in fact essential to explain these performance differences, this paper examines structural changes that occur in the TFP within countries. It is possible that some episodes of high economic growth or economic decline are associated with permanent productivity shocks; therefore, this research has two objectives. The first one is to estimate the structural changes present in the TFP for a sample of 77 countries between 1950 (1960) and 2000. The second one is to identify possible explanations for breaks. Two sources are analyzed. First, following Ben-David and Papell (1998), whenever possible, episodes in the political and economic history are examined. Second, analogously to Jones and Olken (2008), changes in the international trade are investigated, as this could be considered a measure of absorption of technology.[1] Therefore, this paper complements Jones and Olken (2008) and Ben-David and Papell (1998) by providing evidence of the type of shock that may have triggering the strikes in TFP and therefore in economic growth.

TFP is usually estimated as a residual using the index number technique.[2] This residual captures changes in the output that cannot be explained by variations in the quantities of inputs, capital and labor. Intuitively, the residual reflects an upward (or downward) shift in the production function. Many factors can cause this shift, such as technological innovation, organizational and institutional changes, demand fluctuations, changes in the factors composition, external shocks, omitted variables, measurement errors, among others.[3]

From the econometrical standpoint, these permanent shocks are represented by an alteration of the parameters of the model, i.e., a structural break. In order to determine the number of structural breaks and the dates on which they occurred, we follow the methodology of estimation and inference proposed by Bai and Perron (1998, 2003). The estimation method considers multiple structural breaks on unknown dates for a linear regression model. In our case the dependent variable is (log) TFP change while the regressor is a intercept; then, a structural break means a change in TFP growth rate.

From the economical standpoint, structural breaks may be triggered by external shocks such as oil embargos and shocks in the international interest rates; or internal political–institutional changes such as a newly adopted constitution, the beginning or end of a war and return to democracy. As mentioned, abrupt changes in international trade may constitute a relevant shock too. Therefore, we analyzed two sources: (i) episodes in the political and economic history and (ii) changes in the international trade.

The results suggest that about one-third of the TFP time-series present at least one structural break, and downwards are more common. The majority of the breaks come from advanced countries, Latin America and the Caribbean regions, although most of our sample comes from these regions. In any case, this means that structural breaks are not a particular phenomenon of developing countries. When we investigated factors related with structural change, developed countries presented a break near the first oil shock while the developing countries' breaks are more spread across time. Thus, external strikes seem to be more relevant for developed countries. On the other hand, the internal factors potentially related with structural changes may be political, economic or any type of conflict. For each country and break date, it was possible to find a event close to the break date endogenously detected. Finally, the relevance of international trade, measured by trade share percentage of GDP, seems to be limited. in other words, trade share are not able to explain the structural breaks of TFP.

The work is structured as follows: Section 2 presents the methodology used in the construction of the TFP series. Section 3 presents the econometric methodology for estimation and testing. Section 4 presents the results and, finally, Section 5 concludes the paper.

2. Construction of total factor productivity

2.1. Main assumptions

The TFP time-series for the 77 countries is estimated as residual by using a mincerian production function. The countries are listed, by region, in Table A.1 in Appendix A. First, we consider the hypothesis used in this calculation.[4]

The Solow neoclassical growth model assumes that there is a technological frontier that grows at a constant rate. This frontier causes the labor productivity to grow continually at this same rate. Therefore, in the long-run equilibrium, does not only labor productivity grow at a constant rate, but also income, capital per worker and output per worker, in order to keep the capital–output relation constant. In this equilibrium where capital, output and worker productivity grow at the same rate, the marginal product of capital, and consequently the market interest rate, remains constant. These characteristics seem to describe the United States during the twentieth century. Therefore, we assume the following:

(1) The evolution of the technological frontier is given by the long-run growth rate of output per worker in the U.S.
(2) The growth rate represents, *ceteris paribus*, the evolution of labor productivity of the different economies.
(3) The production possibilities of the economies can be represented by a first degree homogeneous aggregated production function of capital and labor.
(4) The parameters of the production function and the physical depreciation rate of capital are the same for all economies, with the exception of a multiplier term in the production function which is specific to each country, called Total Factor Productivity.
(5) The impact of education on labor productivity is well described by the impact of education on wages. Similarly, the impact of capital on output is well described by the market remuneration of capital.

Hypothesis (1) follows from the observation of the U.S. economy growth path. Hypotheses (2) and (3) are intrinsic to the Solow growth model. Note that hypothesis (4) does not imply

[1] For a review, see Tybout (2000).

[2] Different approaches were proposed by Lagos (2006); Parente and Prescott (1999), and Krusell and Rios-Rull (1996). The first study proposes an aggregative model of TFP considering a frictional labor market where production units are subject to idiosyncratic shocks in which jobs are created and destroyed. Therefore, the level of TFP is explicitly shown to depend on the underlying distribution of shocks as well as on all the characteristics of the labor market as summarized by the job-destruction decision. The last two studies propose a theory to explain how institutional arrangements affect TFP, introducing elements of strategic behavior in dynamic general equilibrium models. These studies ultimately try to explain why societies chose these institutions, in an explicit attempt to endogenize this choice.

[3] See Hulten (2001) for a more detailed discussion.

[4] We use the following filters to select the countries: (i) at least 40 years of information until 2000, from PWT 6.2, and; (ii) educational attainment of the total population aged 25 and over, since 1950 (1960) until 2000, from Barro and Lee's data set. Only 77 countries satisfied both criteria.