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A cross-country analysis of total factor productivity using micro-level data

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ABSTRACT

Total factor productivity (TFP) is a crucial measure of efficiency and thus an important tool for policy-makers. However, research on comparison of TFP performances using micro-level data across developing countries has been limited due to the unavailability of homogenous data sources. This study aims to fill this crucial gap by using a data set which has been collected through a large body of surveys conducted across 69 developing countries following the same methodology. The homogenous nature of the data and the diverse set of questions included in the surveys provide unique opportunity to compare average productivity performances of firms across a large set of characteristics and business environment factors. The analysis performed here provides the groundwork for testing various stylized facts about TFP and its related factors such as exporting, innovation, access to finance, foreign ownership, and regulations across developing countries.

1. Introduction

Since the seminal work of Solow (1957), Total Factor Productivity (TFP) has been regarded to play a major role in generating and predicting growth. TFP is defined as the portion of output not explained by the amount of inputs used in production. Its value represents how efficiently and intensely the inputs are utilized in production. Numerous studies using macro level data have shown that the differences in countries' growth patterns and income levels are associated with the differences in their productivity levels. Hsieh and Klenow (2010) and Jones and Romer (2010) find that differences in measured TFP explain more than half of the cross-country differences in output per worker. Prescott (1998) provides evidence on how physical and intangible capital cannot account for these cross-country differences.

Once the importance of TFP was established, the study of growth and development evolved into explaining the productivity differences across countries. For this purpose, the Penn World Tables (PWT) has been used as a source for reliable data for such macro-level, cross-country analysis. Hall and Jones (1999) and more recently Imrohoroğlu and Üngör (2016) have performed cross-country comparison with PWT. Yet, measuring TFP at the country level does exhibit disadvantages since it cannot account for firm-level heterogeneity.

The development of theoretical microeconomic models establishing the importance of TFP combined with the availability of rich firm level datasets allowed researchers to investigate the reasons behind vast dispersion in productivity performances across firms. Some early examples of firm-level productivity analyses are Bailey et al. (1992) and Bartelsman and Dhrymes (1998) for U.S. manufacturers and Roberts and Tybout (1996) for a number of developing countries. While firm-level TFP studies surveying developed countries are commonplace (Bartlesman and Doms, 2000), comprehensive comparisons of TFP across a large set of emerging economies have been limited due to the lack of a homogeneous data source.

The availability of microdata has not substantially altered the existing methods used for measuring productivity. However it has stimulated development of some innovative solutions to old empirical problems. If the interest is only to produce productivity, Bartelsman and Doms (2000) suggest that it is best not to take a dogmatic stance on methodology but rather to explore the

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sensitivity of productivity measures to variations in methodology. We follow their approach in this paper to the extent possible. TFP can be calculated using a wide variety of methods and the comparative advantage of each measure depends on the particular question at hand and the particular availability of the data.

In this study we assume that TFP is the unobserved firm-specific effect that is recovered from an estimated production function as the difference between actual and predicted output. We use various forms of Cobb-Douglas production function in the estimations. This approach raises econometric issues regarding the possible bias of coefficients on input variables due to simultaneity bias. The concern is that the productivity of the firm itself affects the input decisions, introducing correlation between the plant effect and the input coefficients. If there is simultaneity bias, simply running OLS might lead to biased estimates of the input coefficients. This issue could lead to sum of all factor coefficients deviate from one in the estimations.

Alternative approaches have been introduced to remedy the simultaneity problem most commonly known by Olley and Pakes (1996) which was used in microdata by Pavcnik (1998) and then further modified by Levinsohn and Petrin (2003). The novelty of these studies is that they use observable micro-level information to correct for the simultaneity bias and account for self-selection of exiting producers. Another alternative is using fixed-effect regressions. However, we could not perform any of these alternative approaches with cross-sectional data. In all these alternative specifications we need at least two periods of data for each firm.

Another popular method for computing a productivity with sectoral data was through estimating cost function and factor demand equations which was developed following Nadiri (1970). The main advantage of using this method is that the estimated parameters are not biased because of simultaneity of productivity and factor demand. However, the advantages over directly estimating production functions are questionable because identification of the factor demand equations requires variation in factor prices, which are not available at the micro level.

Being aware of the limitations of the empirical methodology implemented, we intend to perform a comprehensive cross-country analysis of TFP performances of manufacturing firms in 69 emerging economies. We also investigate how productivities vary across firms' characteristics such as size and age. The analysis shows high levels of heterogeneity in productivity levels across firms. Among countries with large samples of at least 200 manufacturing firms and surveyed after 2006, Brazil and Turkey emerge as the most productive countries. The surveys include questions that can help analyze a rich set of characteristics across which cross-country TFP comparisons can be made. Some of these characteristics are size, age, ownership of the firm, export orientation, financial access, gender of the owner, industry of operation as well as various investment climate obstacles.

We utilize the World Bank's Enterprise Surveys data which supplies firm-level data on a wide range of topics pertaining to the investment climate and firm operations. An additional advantage of the Enterprise Surveys is that all surveys included in this study were collected under a common global sampling methodology, yielding representative samples of private sector firms. Just like the PWT, we intend to produce a productivity database. However, our effort uses a large set of developing countries and provides estimates of firm level TFP levels in order to perform a cross-country analysis. Panel data is also available which provides a unique opportunity to study the evolution of productivity over time. Enterprise Surveys also include a large set of questions regarding the business environment, which is invaluable to gauge the impact of business climate and regulation onto firm productivities.

The paper is organized as follows; Section 2 discusses the Enterprise Surveys data and relevant variables. Section 3 outlines the estimation procedure used to calculate TFP. Section 4 discusses the results and compares productivities across countries, industries, and firm groups. Lastly, section 5 suggests areas for further research and concludes.

2. Data

The data used for the TFP analysis covers 69 countries from a rich set of emerging economies and the data is collected through the Enterprise Analysis Unit of the World Bank.[1] The sample includes countries where there are a sufficient number of manufacturing firms to conduct the analysis and where surveys followed a harmonized global sampling methodology. Although the surveys include firms from service sectors, the productivity analysis is conducted only for the firms in manufacturing sector. In some small countries, Indicator Surveys are conducted instead of the Enterprise Surveys.[2] These surveys include fewer questions than the full survey and have a smaller scope, thus productivity cannot be computed for firms in these countries. The economies where Indicator Survey is conducted are stratified into two groups: manufacturing and rest of the non-agricultural economy, with 75 interviews allocated to each group. In all remaining countries, the sample size changes between 150 and 1320 depending on the size of the economy.

In the surveys, a random sample of manufacturing firms is selected that is representative of the economy. The sample of firms is stratified by sector, size, and geographic region. Each firm is assigned a probability weight so that the inferences derived from the sample are representative for the all economy. In all the analysis performed in this study we use these probability weights.

Data used for the analysis is cross-sectional. Enterprise Surveys are collected in staggered waves by region.[3] In Latin America and Caribbean (LCR) region, surveys were conducted in 2010. Only Brazil was surveyed separately in 2009. In Eastern Europe and Central Asia (ECA) region, firms were surveyed in 2008 and 2009. Two exceptions in this region were Bulgaria and Croatia which were surveyed in 2007. The Sub-Saharan Africa (SSA) region yields the largest number of countries and most of them were surveyed in 2006 or 2007. East and South Asia region covers eight countries (ASIA). As the countries in the region are quite populous and diverse there has not been a regional survey roll-out. The countries were surveyed between 2006 and 2009. Surveys from the Middle East and North Africa (MNA) region are similar to East and South Asia. Four countries from this region were surveyed between 2006 and 2009. For the analysis, we separate the countries into two groups by the year of survey; 29 countries were surveyed in 2006 and 2007; and 40 countries were surveyed more recently between 2008 and 2010.

TFP is measured only for manufacturing firms. Industries are classified by major 2-digit manufacturing industries according to ISIC rev 3.1 classification (Table 3). Food industry has the largest coverage in the dataset, covering over 20 percent of the sample. Garments is the second largest industry. Some of the industries

[1] Enterprise Surveys restricts the universe of firms with at least 5 employees. Some sectors are excluded from the survey, such as agriculture and mining. The data used in this study as well as the methodology used in data collection and sample construction are available at www.enterprisesurveys.org.

[2] Indicator surveys are conducted in countries that have below 15 Billion USD Gross National Income.

[3] The survey coverage is in fact much larger than the 69 countries. In this study, we restricted the sample to countries that were surveyed between 2006 and 2009 so that reasonable cross-country comparisons could be made. Many new surveys where TFP could be estimated have been conducted since 2009.