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Total factor productivity differences: Appropriate technology vs. efficiency

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Abstract

Recent development and growth accounting studies have established that total factor productivity is an important source of cross-country differences in income levels and growth rates. This paper makes two contributions. First, it examines the sensitivity of the development accounting results to the Cobb–Douglas specification of the production function. Second, within the Cobb–Douglas framework, it weighs evidence of the two alternative explanations of total factor productivity differences: the inefficiency view and the appropriate technology view. To accomplish these tasks, the world production frontier is estimated using a nonparametric deterministic approach known as data envelopment analysis. I find that the fraction of income differences explained by physical and human capital increases from 32% to 55% when departing from the Cobb–Douglas assumption. There is also evidence consistent with the appropriate technology view; countries with an inadequate mix of inputs are unable to access the most productive technologies. Moreover, the world technology frontier appears to be shifting out faster at input combinations close to that of the R&D leader. However, inefficiency appears to be the main explanation for low incomes throughout the world; it explains 43% of output variation in 1995, and its importance has increased over time.

JEL classification: E23; O11; O33; O47

Keywords: TFP differences; Development accounting; Efficiency; Appropriate technology

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1. Introduction

Recent empirical literature on economic growth has investigated the proximate causes of the enormous differences in per-capita incomes across countries. In most cases, the motivating question is the role of measured factors of production, such as physical and human capital, relative to that of unobserved total factor productivity (TFP). Most researchers assume that output is given by the Cobb–Douglas production function, $y = Ak^{\alpha}h^{1-\alpha}$, and decompose cross-country variation in the levels of output per worker (y) into parts attributed to the variation in factors (k and h) and TFP (A). The results usually show that differences in incomes are largely a consequence of differences in TFP (Klenow and Rodriguez-Clare, 1997; Hall and Jones , 1999; Easterly and Levine, 2001; Caselli, 2005). Klenow and Rodriguez-Clare report that about 40% of income differences can be explained by human and physical capital, while the remaining 60% is due to TFP. When applied to growth rates, this decomposition is the cross-sectional version of familiar growth accounting (Solow, 1957), and the results are similar to those for income levels. Easterly and Levine (2001) report, among what they call "new stylized facts of growth," that around half of the average per-capita output growth and 90% of the cross-country variation in growth rates are explained by TFP. This leads them to conclude that "the residual (TFP) rather than factor accumulation accounts for most of the income and growth differences across nations."[1]

These studies uncover only the proximate causes of income differences in the sense that the ultimate causes are those that lead to different levels of inputs and productivity. The results are additionally unsatisfying for two reasons. First, if we accept that productivity differences are large, then we are left with a shortage of convincing explanations for this finding (Prescott, 1998). Several theories of TFP differences have been proposed, but they have yet to undergo careful empirical scrutiny. Second, because TFP is "backed out," using measured stocks of inputs together with a number of assumptions, rather than being directly observed, there is a possibility of measurement problems. In other words, researchers may be mis-measuring inputs or omitting some of them. Caselli (2005) uses the development accounting approach to examine a long list of possible explanations for the TFP gap, including mis-measured capital and quality of education, and differences in health, industrial composition, etc., and concludes that most of these explanations have limited power in accounting for the TFP gap. He points out that departures from the Cobb–Douglas production function might increase the importance of factors (and thus reduce that of unmeasured TFP).

This paper makes two contributions. First, in light of Caselli (2005), it performs a development accounting decomposition without assuming a Cobb–Douglas production function. Several papers have considered the constant elasticity of substitution (CES) production structure (Caselli, 2005; Caselli and Coleman, 2006).[2] This paper goes further by adopting a nonparametric approach and estimating the relative contributions of factors under the mild assumptions of free disposal and constant returns to scale. It follows recent

[1]Several growth accounting studies focus on individual East Asian countries and use more disaggregated data. In this literature, there is more disagreement about the role of TFP; see Young (1995) and Hsieh (2002).

[2]In fact, some evidence suggests that a production function with an elasticity of substitution between capital and labor that is constant, but less than one, provides a better fit in aggregate, cross-country data (Duffy and Papageorgiou, 2000).