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Determinants of total factor productivity in former Soviet Union economies: A stochastic frontier approach

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ABSTRACT

This paper investigates the process of GDP generation in former Soviet Union (FSU) economies to provide an understanding of the impact of technology channels on countries' efficiency. We apply a stochastic frontier approach to 15 FSU economies over the period 1995–2008 and find that FDI and human capital improve countries' technical efficiency. Furthermore, we show that these factors also have a positive impact on total factor productivity (TFP), which, in turn, improves real GDP growth. Hence, our results suggest that FSU countries should promote public policies that provide incentives to attract foreign investment and enhance domestic education in order to improve their economic growth. Additionally, our empirical evidence argues against the resource curse hypothesis. We also show, by computing efficiency change and technological change indices at the country level, that FSU economies benefit more from exploiting technological progress than from catching up to the best practice frontier.

1. Introduction

Post-communist countries are challenged by complex tasks, which are, essentially, improving economic growth and reallocating resources to their best uses (Campos and Coricelli, 2002). This mandate is also pertinent to fifteen former Soviet Union (FSU) economies.[1] FSU countries are

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[1] The FSU economies in our study are: Armenia (ARM), Azerbaijan (AZE), Belarus (BLR), Estonia (EST), Georgia (GEO), Kazakhstan (KAZ), Kyrgyzstan (KGZ), Lithuania (LTU), Latvia (LVA), Moldova (MDA), Russian Federation (RUS), Tajikistan (TJK), Turkmenistan (TKM), Ukraine (UKR) and Uzbekistan (UZB). The country nomenclature and country codes in brackets are from the World Bank.

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transition economies with a considerable disparity in economic output.[2] As faster economic growth is achieved when countries' productivity is improved, there is a need to identify which channels help to increase it. However, no robust econometric studies have investigated the process of generating output across different FSU countries and its determinants, with the relevant exception of Deliktas and Balcilar (2005). The majority of previous contributions provide either single-country or agricultural studies estimating total factor productivity (TFP) through growth accounting and neoclassical production modeling (Zhang, 1997; De Broeck and Koen, 2000; Iradian, 2007), parametric stochastic frontier analysis (SFA) (Danilin et al., 1985; Deliktas and Balcilar, 2005) or non-parametric data envelopment analysis (DEA) (Deliktas and Balcilar, 2005; Deliktas, 2008). These approaches present some drawbacks. Those applying the Solow residual (Solow, 1956) neoclassical approach assume that all countries operate on the efficient frontier and under constant returns to scale, but these assumptions seem to be too restrictive. The SFA/DEA studies are applied to either a single sector or a single country, and they do not investigate which factors affect countries' productivity.[3] The paper by Deliktas and Balcilar (2005) represents a first step in fixing these drawbacks, since the authors investigate the impact of some factors (e.g., socioeconomic and political factors, reforms, etc.) on the estimated efficiency scores of FSU countries. However, they analyze the determinants of countries' efficiencies in a two-stage model, i.e., they estimate efficiency in a first stage applying DEA and then run an OLS regression in the second stage using the first-stage estimated inefficiency scores as the dependent variable. As shown by Simar and Wilson (2007), this type of second-stage analysis leads to biased results.[4] This paper aims to expand Deliktas and Balcilar's contribution by applying an SFA model where the impact of environmental factors affecting the efficiency of FSU economies is estimated in a single equation (Battese and Coelli, 1995), hence the coefficients measuring the impact of these factors on efficiency and the coefficients of variables shaping the production frontier are computed simultaneously. This procedure allows obtaining unbiased estimates of the determinants of countries' efficiency. Among the different factors that might affect efficiency, we focus on the impact of different technology transfer channels and human capital.

Many previous contributions emphasize the importance of technology transfer channels for improving economic growth, especially in developing countries such as the FSU economies. They consider two technology transfer channels: foreign direct investment (FDI) and trade in goods and services (Rivera-Batiz and Romer, 1991; Hoekman et al., 2004).[5] In this contribution, as in Mastromarco and Ghosh (2009), we consider FDI and, as a proxy for transferring technology through trade, imports of machinery and equipment. However, differently from us, Mastromarco and Ghosh study 57 developing countries, but not FSU ones. Furthermore, we also consider human capital following some notable contributions in economic growth theory (Nelson and Phelps, 1966; Romer, 1986, 1990; Lucas, 1988; Barro, 1991, 2001; Benhabib and Spiegel, 1994; Barro and Sala-i-Martin, 1995) that point out the importance of human capital for economic growth.[6] Hence, our goal is to test the impact of these channels (i.e., FDI, imports of machinery and equipment, and human capital) on countries' efficiency levels by applying a time-varying stochastic production frontier model (Battese

[2] The World Bank online database (2010) reports that the average yearly value of real GDP per capita in thousands of U.S. dollars for the period 1993–2007 of Estonia (6153.58, highest) is twenty-seven times higher than that of Tajikistan (192.43, lowest).

[3] Furthermore, the non-parametric approach is deterministic and hence does not take into account the impact of random shocks in the production model.

[4] They demonstrate that the first-stage efficiency scores estimated with a DEA model are serially correlated in a complicated and unknown way, since they depend on all observations on inputs and outputs in the dataset (through the production function). Consequently, the error terms in the second-stage (Tobit) regression are also serially correlated.

[5] The findings of Hoekman et al. (2004) identify three channels of technology transfer that could boost economic growth and convergence of poor countries toward developed economies: (1) trade in goods and services, (2) foreign domestic investment (FDI), and (3) trade in knowledge via technology licensing. The theoretical foundations of international technology transfer were established by Romer (1990), Grossman and Helpman (1991, 1993), and Aghion and Howitt (1992). FDI is associated with fostering economic growth in the presence of certain economic, financial, and institutional characteristics of recipient countries (Ellingstad, 1997; Dunning, 1993, 1998; Borensztein et al., 1998; Barrell and Holland, 2000; Blomström et al., 2001; Konings, 2001; Lipsey, 2002; Jensen, 2006; Navaretti and Venables, 2004; Büthe, 2008).

[6] Economists' notable early contributions to the theory and formation of human capital at the micro level were made by Mincer (1958), Schultz (1960), Denison (1962), and Becker (1975).