

The Malmquist Index and its Implications for International Business Cycle Analysis

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Abstract

Most International Real Business Cycle (IRBC) models use the Solow residual as a proxy for a measured aggregate productivity shock. This paper studies implications of the Malmquist productivity index for international business cycle analysis using a standard IRBC model. By doing so, the study seeks to broaden areas of macroeconomic applications for the Malmquist index. More specifically, this paper chooses aggregate productivity shock parameters primarily based on the Malmquist index without relying on the Solow residual and assesses its quantitative effectiveness of this approach. Then, this paper discusses potential benefits from using the Malmquist index in the IRBC research.

In this paper, the Malmquist productivity index based on the Data Envelopment Analysis (DEA) is presented as a candidate for a measured aggregate productivity shock in an IRBC model. Although the Malmquist index has been shown to be empirically compatible to the well-known aggregate productivity measure, the Solow residual, few researchers have used the Malmquist index in the business cycle research.

Aggregate productivity shocks are important in the RBC (Real Business Cycle) research. In a standard RBC model, the aggregate productivity shocks have been quite successful to generate artificial series, whose characteristics are similar to the ones of the U.S. macroeconomic series. Since the beginning of the RBC research from Kydland and Prescott (1982) and Long and Plosser (1983), Solow's growth accounting approach has been predominantly used to characterize the nature of the aggregate productivity shocks in the RBC models. In other words, the aggregate productivity shocks have been traditionally measured based on the Solow residual. In fact, Prescott (1986) pointed out the critical importance of the measured aggregate productivity shocks based on the Solow residual in the business cycle analysis. Although RBC researchers have made

slightly different assumptions about the stochastic process of the aggregate productivity shocks in their studies, they have not deviated from the traditional Solow's growth accounting framework when they estimated the aggregate productivity shocks.

In fact, the stochastic components of the aggregate productivity measured by the Solow residual appear critical for the success of the RBC models. Prescott (1986) made a random walk assumption on the aggregate productivity shock while King and Rebelo (1999) assumed that the it was trend stationary and estimated an AR(1) process. Ireland (2001) considered both specifications of the technology shocks and argued that the model of trend stationary shocks were better.

Standard IRBC models extend RBC research to explain fluctuations of key aggregate macroeconomic variables across countries. In IRBC models, comovements of the measured aggregate productivity shocks play non-trivial roles. In this case, the covariance matrix of the shocks is constructed based on each country's Solow residual, which is separately measured using each country's data. Notable examples include Kollmann (1996), Baxter and Crucini (1995), Backus, Kehoe, and Kydland (1992), Kehoe and Perri (2002).

In IRBC settings, the Solow residual may not be a perfect measure. This paper is not about correcting problems of the Solow residual but about presenting an alternative aggregate productivity measure based on the DEA. Since the work by Rölf, Grosskopf, Morris, and Zhang (1994), the Malmquist productivity index has been used in macroeconomic applications. This paper argues that the aggregate productivity shock parameters based on the Malmquist index could be as equally good as or even better than those based on the traditional approach in the IRBC models because the DEA constructs the reference technology frontier using *all* countries data and evaluates each country's distance function to the reference technology. Given the fact that the transmission of the shocks between countries are primarily characterized by the covariance matrix of the shocks, the Malmquist index, which is jointly estimated using *all* countries data, is an appropriate choice to use.

This study first presents a standard IRBC model and briefly illustrates the key aspects of the model. Then, aggregate productivity shock parameters are chosen solely based on the Malmquist index without using the Solow residual. This study shows that the model based on the Malmquist index successfully replicates the standard features of business cycles documented in the existing literature.

Keywords: IRBC Model; DEA; Malmquist Index; Solow Residual; Aggregate Productivity Shocks; Transmission; Calibration