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Efficiency change and productivity growth in agriculture: A comparative analysis for selected East Asian economies

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ABSTRACT

This study focuses on identifying the sources of agricultural growth for eight East Asian economies – with special emphasis on factors that can better explain different components of growth. The Malmquist productivity growth index and its two components are calculated and regressed on variables including the human capital endowment, domestic R&D, international spillovers, and country-specific farming characteristics to characterize the differential patterns of growth. Our empirical evidence suggests that domestic R&D and its interaction with human capital constitute the major determinant of individual economy's progress in agricultural technology, whereas the human capital endowment is crucial for the catching up effect. Furthermore, for foreign knowledge to contribute to productivity growth either through innovation or through catching up, the host economy has to develop a sufficient learning capacity from education. Countries that do not attempt to develop the learning capability to assimilate and exploit the freely available knowledge may not benefit from international spillovers of agricultural R&D.

1. Introduction

In the literature on development, the difference in agricultural productivity across countries is constantly attributed to three general characteristics of supply, namely, the advancement of production technology, the exploitation of scale economies, and the inducement of biased technical change. Recent developments in endogenous growth models stress the importance of human capital and knowledge acquisition (Romer, 1990). However, despite the long and rich history of agricultural productivity analysis, there have not been many studies that sought to identify the endogenous sources of growth in East Asian agriculture.

Among the few, the group of endogenous growth models that succeeded in explaining the growth of the newly industrializing Asian countries (Grossman & Helpman, 1991; Rivera-Batiz & Romer, 1991; Romer, 1990) has emphasized the role of international trade. Although those models posit the potential international trade has in increasing specialized inputs, most of the empirical evidence points to the exchange of intangible ideas through different modes of transfer facilitated by bilateral trade. Along with this line of conjecture, the benefits of innovation or R&D can spill across countries in the form of foreign direct investment, patenting, or international alliances such as joint ventures, and even freely available spillovers that go beyond the geographical boundaries.

By linking foreign direct investment to international spillovers, for instance, Lichtenberg & Pottelsberghe, 1996 found that although the impacts are not instantaneous, spillovers that go beyond the geographical boundaries have significant impacts

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on growth. Nevertheless, the studies of Aitken and Harrison (1999), Damijan, Majcen, Knell, and Rojec (2001), Djankov and Hoekman (2000), Konings (2001) and Zukowska-Gagelmann (2002) found evidence for the negative spillover effects brought about by the presence of multinationals on the domestic firms' productivity. Coe and Helpman (1993), on the other hand, used trade flows as carriers of international spillovers to find that both domestic and foreign R&D capital stocks have important effects on total factor productivity. Because foreign R&D capital stocks are likely to have stronger effects when import flows account for a larger share of GDP, Coe and Helpman's results also suggested that a more open economy will extract larger productivity benefits. By hypothesizing foreign patenting as the channel to transmit, Eaton and Kortum (1996) and Branstetter (2000) found that foreign research stimulates domestic private research, providing empirical support for arguments in favor of international science and technological coordination.

As in any other sectors of the economy, research and extension investments are closely linked to the growth of the agricultural sector. This can be clearly seen from much work that has been devoted to measuring the rates of return on agricultural R&D. However, the findings in a couple of recent studies suggest the existence of international spillovers as well as its contribution to the agricultural sector (Gutierrez & Gutierrez, 2003; Johnson & Evenson, 1999; Schimmelpfennig & Thirtle, 1999). Therefore, without properly taking into account the effect of international spillovers, previous estimates of rates of return on R&D may end up overstating the effects of domestic R&D on agricultural growth. Accordingly, identifying the linkages between international spillovers and the growth of agriculture is important in the sense that it may help explain agricultural growth, and what is more important, it will help characterize the differential patterns of growth in multilateral comparison.

This study focuses on identifying the sources of agricultural growth for eight East Asian economies – China, Indonesia, Japan, Malaysia, the Philippines, South Korea, Thailand and Taiwan. To characterize the differential patterns of growth, the Malmquist productivity growth index and its two components were calculated and regressed on variables including the human capital endowment, domestic R&D, knowledge spillovers going beyond geographical boundaries, and country-specific farming characteristics. The effects of R&D spillovers were proxied by constructing an import-weighted sum of trade partners' R&D stock. This spillover index hypothesizes that a country receives relatively more knowledge spillovers from countries from which it imports relatively more goods and services. In some sense, this proxy variable indicates that the country's capacity to adopt foreign technologies is dependent upon its degree of trade openness. Although the proxy variable is likely to capture only the impact of foreign knowledge channeled through trade flows, it accounts for the impact of international technology spillover based on a major channel of knowledge diffusion exploited in existing research.

The remainder of the paper is organized as follows. In the next section, we briefly introduce the model and the empirical specifications. The data are described in the third section. This is followed by a presentation of the empirical estimates and a discussion of the results, while the final section consists of our conclusions.

2. Identifying and explaining agricultural growth

The Malmquist index has gained considerable popularity in recent years due to its appealing feature of allowing a further decomposition of productivity variation. Therefore, to examine the sources of agricultural growth for the eight East Asian economies, we calculate the Malmquist productivity-change indexes as well as the technical-change and efficiency-change components using the mathematical programming procedure outlined in Färe, Grosskopf, Norris, and Zhang (1994). The linkages between the growth of total factor productivity and domestic R&D as well as international spillovers are identified by regressing the productivity-change indexes and the two components on cumulative R&D spending.

2.1. Decomposition of the Malmquist index

Following Färe et al. (1994), the Malmquist productivity-change index defined as the geometric mean of two distance function-based Malmquist productivity indexes is of the following form,

$$M_0(x^{t+1},y^{t+1},x^t,y^t) = \left[\left(\frac{D_0^t(x^{t+1},y^{t+1})}{D_0^t(x^t,y^t)}\right)\left(\frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^t,y^t)}\right)\right]^{1/2} \tag{1}$$

In the above equation, the first term in the brackets is the Malmquist productivity index with technology in period t as the reference technology. The distance function in the numerator, $D_0^t(x^{t+1},y^{t+1})$, measures the maximal proportional change in output required to make (x^{t+1},y^{t+1}) feasible in relation to the technology in period t. $D_0^t(x^t,y^t)$, the distance function in the denominator, measures the reciprocal of the maximum proportional expansion of the output vector y^t given input vector x^t. Similarly, the second term in the brackets represents the Malmquist productivity index with technology in period $t+1$ as the reference technology. The distance function in the denominator, $D_0^{t+1}(x^t,y^t)$, measures the maximal proportional change in output required to make (x^t, y^t) feasible in relation to the technology in period $t+1$, whereas the distance function in the numerator, $D_0^{t+1}(x^{t+1},y^{t+1})$, measures the reciprocal of the maximum proportional expansion of the output vector y^{t+1} given x^{t+1}.