

Farm Size and the Determinants of Productivity in the Brazilian Agricultural Sector: Spatial Econometric Models Using Municipal Level Data

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1. Introduction and Objectives

The purpose of this project is to analyze the factors that influence differences in the levels of productivity, and the rate of productivity growth over time, in the Brazilian agricultural sector. The project will focus on three principal factors: public policies, farm size, and geographical location. First, because increased productivity is key to raising incomes in agriculture, the project will seek to identify the most effective public policies for influencing productivity in the Brazilian agricultural sector. Among others, the project will analyze the relative importance of policies related to technology and inputs (irrigation, machines, fertilizers), policies related to access to institutions and public goods (credit institutions, agricultural extension, rural electrification, paved and unpaved roads), and policies related to alternative forms of land tenure (owners, renters, sharecroppers, and occupants). Second, given the predominance of family farms in Brazil, and the high priority placed by the current government on land reform, a focus on farm size is of paramount importance.¹ If small farms are more productive than large farms, as suggested by a large body of international research,² then land reform in Brazil has the potential to increase both efficiency and equity in the agricultural sector. Alternatively, even if small farms are not more productive, an analysis that distinguishes between farms of different sizes will permit me to explore the determinants of successful productivity growth for all types of farms. Finally, the analysis will be conducted using municipal level data and econometric models that explicitly account for the spatial dependence in the data that results from geographical location.³ These models will contribute to an understanding of the spatial effects of policy, and to a more appropriate spatial design of policies.

2. Methodology

The project has two phases. The first phase will utilize two alternative methodologies--Data Envelopment Analysis (DEA) and stochastic frontier production functions (SF)--to measure productivity across farm sizes, types of land tenure, and municipalities with data from the 1995/96 Agricultural Census.⁴ The advantage of using two methodologies is to test the sensitivity of the empirical results to the use of alternative approaches. Once measures of productivity are obtained from the DEA and SF approaches, these can then be regressed on a set

¹ On family farming in Brazil, see Guanziroli et al. (2001). The authors estimate that about 85% of the agricultural establishments in Brazil are family farms.

² See Berry and Cline (1979) and Barrett (1996) for reviews of the international literature. For Brazil, most recent research on total factor productivity has been conducted at an aggregate level and has not examined the question of farm size. One exception is Helfand (2003), who finds a nonlinear relationship between productivity and farm size in the Brazilian Center-West, with productivity first falling and then rising with farm size.

³ On spatial econometric techniques, see Anselin (1988) and Anselin and Bera (1998).

⁴ On Data Envelopment Analysis, see Färe et al. (1994) and Coelli et al. (1998). On stochastic frontier production functions, see Coelli et al. (1998) and Kumbhakar and Lovell (2000).

of explanatory variables which includes farm size, type of land tenure, composition of output, access to institutions, and indicators of technology and input usage. A preliminary version of this approach was successfully employed in Helfand (2003) with 1995/96 Census data from the Center-West, and can be extended to data for the rest of country.

The second phase of the project involves the use of the DEA and SF approaches to analyze total factor productivity growth over time in the Brazilian agricultural sector with data from the Agricultural Censuses of 1985 and 1995/96. Thus, this phase of the project will involve constructing a panel of census data disaggregated by farm size, type of land tenure, and municipality. This data is available in IPEA as a result of our previous NEMESIS/PRONEX project, but due to the work involved in make the two Censuses comparable, it has yet to be analyzed. Both the DEA and SF approaches permit decomposing the growth in productivity into components that are attributable to changes in efficiency, changes in the scale of production, and changes in technology. As in phase one of the project, once I obtain estimates of changes in productivity, efficiency, and technology, I can then explore their determinants over space and time using spatial econometric techniques. This phase of the project will be especially important for analyzing the impact of the policy reforms of the late 1980s and early 1990s on productivity in the Brazilian agricultural sector, and will overlap with the research being proposed by Gervásio Castro de Rezende who is also a co-principal investigator in this project.

This project seeks to advance state of the art techniques for measuring the determinants of productivity in agriculture, and seeks to extend the recent Brazilian literature on total factor productivity. To date, the international literature that uses DEA and SF has not incorporated spatial econometric techniques. Thus, in addition to providing empirical results that will be useful for the formulation of policy in Brazil, I am proposing a methodological innovation that should be of interest to international researchers who work on productivity analysis and agriculture. Similarly, the recent Brazilian literature on productivity growth has not incorporated an analysis of farm size.⁵ A key limitation has been its reliance on national or state level data. Thus, the research being proposed here will provide a much richer and more disaggregated analysis of productivity growth in Brazil.

3. Expected Results and Relevance

The project will contribute to a better understanding of the spatial determinants of productivity across different size farms and over time. It will also contribute to the design of more effective public policies for increasing agricultural productivity. Specific results will include the estimation of:

- the distribution of agricultural productivity across farm sizes and municipalities in 1995/96.
- the determinants of productivity across farm sizes and municipalities in 1995/96.
- the differences in the growth of productivity across farm sizes and municipalities between 1985 and 1995/96.
- the extent of technological change in the period 1985-95/96, along with its spatial distribution.
- the factors associated with increased productivity and technological change, including the most effective policies and the most important obstacles.

⁵ See Gasques and Conceição (2001), Vicente et al. (2001), and Barros (1999).

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