Production, Manufacturing and Logistics

Impact of liquidity risk on variations in efficiency and productivity: A panel gamma simulated maximum likelihood estimation

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A B S T R A C T

The objective of this study is to assess the importance of short- and long-run liquidity or debt risk on technical inefficiency and productivity. An alternative panel estimator of normal-gamma stochastic frontier model is proposed using a simulated maximum likelihood estimation technique. Empirical estimates indicate a difference in the parameter coefficients of gamma stochastic production function, and heterogeneity function variables between the pooled and the Swamy–Arora panel models. The results from this study show short and long run risk or variations in liquidity or debt-servicing ratio play an important role in explaining the variance in efficiency and productivity.

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1. Introduction

The importance of the financial crisis on the world and regional economies including the banking sector, fixed-income markets, markets/regulations and risk analysis have been addressed (Andersen, Häger, Maberg, Naess, & Tungland, 2012; Aouni, Colapinto, & Torre, 2014; Claessens, Demirgüç-Kunt, & Moshirian, 2009; Demyanyk & Hasan, 2010; Dwyer & Tkac, 2009; Grundke & Polle, 2012; Moshirian, 2011). The crisis is also expected to take its toll on efficiency as well as the productivity and income growth of countries, industry and individual firms. Agriculture efficiency and productivity is not immune from recent financial crises facing the economy. In particular, changes in the working capital requirements and greater use of external financing (debt capital) as reflected in financial ratios have been noticed in the agriculture sector through time.[1] These financial ratios compliment producers' efforts at realizing economics of production for better financial performance of farms. Further, the financial ratios are used by farmers and managers to make sound financial,

production, and marketing decisions to be efficient and productive. In this study, the focus is to evaluate the importance of liquidity or debt-servicing ratio on efficiency and productivity using an alternative two-way random effects panel stochastic frontier analysis.[2]

Liquidity or debt-servicing ratio, defined as the ratio of interest payments plus principal to gross cash farm income, is a measure of liquidity risk.[3] In particular, the debt-servicing ratio reflecting liquidity measures the share of the farm business's gross income needed to service the debt. Lenders, to determine whether one is creditworthy for a mortgage, operating loan, machinery loans, debt restructuring, and charge accounts commonly use liquidity or debt-servicing ratio. It has been argued that debt can alter the selection of enterprise, production level, and income. In addition, according to Barry, Baker, and Sanint (1981), "liquidity management is a principal means by which farmers cope with variations in cash flows that arise of uncertain commodity prices, yields and production costs." Trends in liquidity or debt, along with short- and long-term variations in liquidity or

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[1] The financial ratios are developed from relationships of variables within an income statement and balance sheet as well as relationships between variables from an income statement and balance sheet. A number of ratios related to liquidity, solvency, efficiency and profitability financial measures have been found to be useful indicators of farm financial progress and risk-bearing ability. According to United States Department of Agriculture's Economic Research Service, the liquidity ratio measures the farm business' ability to pay its debts as they become due. The solvency ratio measures debt pledged against farm business assets, indicating overall financial risk. The efficiency ratios measure the proportion of gross cash farm income absorbed by fixed expenses. Finally, the profitability ratios measure how efficiently the farm business uses its assets.

[2] The authors have also examined the importance of other financial liquidity, solvency, profitability and efficiency financial ratios. As Andy Swenson, faculty member in our department with over 20 years of experience would call it *sweet sixteen* financial ratios.

[3] Trends in liquidity is commonly used and reported by financial institutions including the United States Department of Agriculture to track changes in the financial structure of the agricultural sector. For example, the United States Department of Agriculture's Economic Research Service publishes the Agricultural Income and Finance Outlook report of the agricultural sector each year. In addition the Board of Governors of the Federal Reserve System publishes the Agricultural Finance Databook that tracks the volume of commercial agriculture loans, interest rates, and farm credit conditions in the agricultural sector. These reports are used to gauge a pulse of the economic conditions in the farming sector.
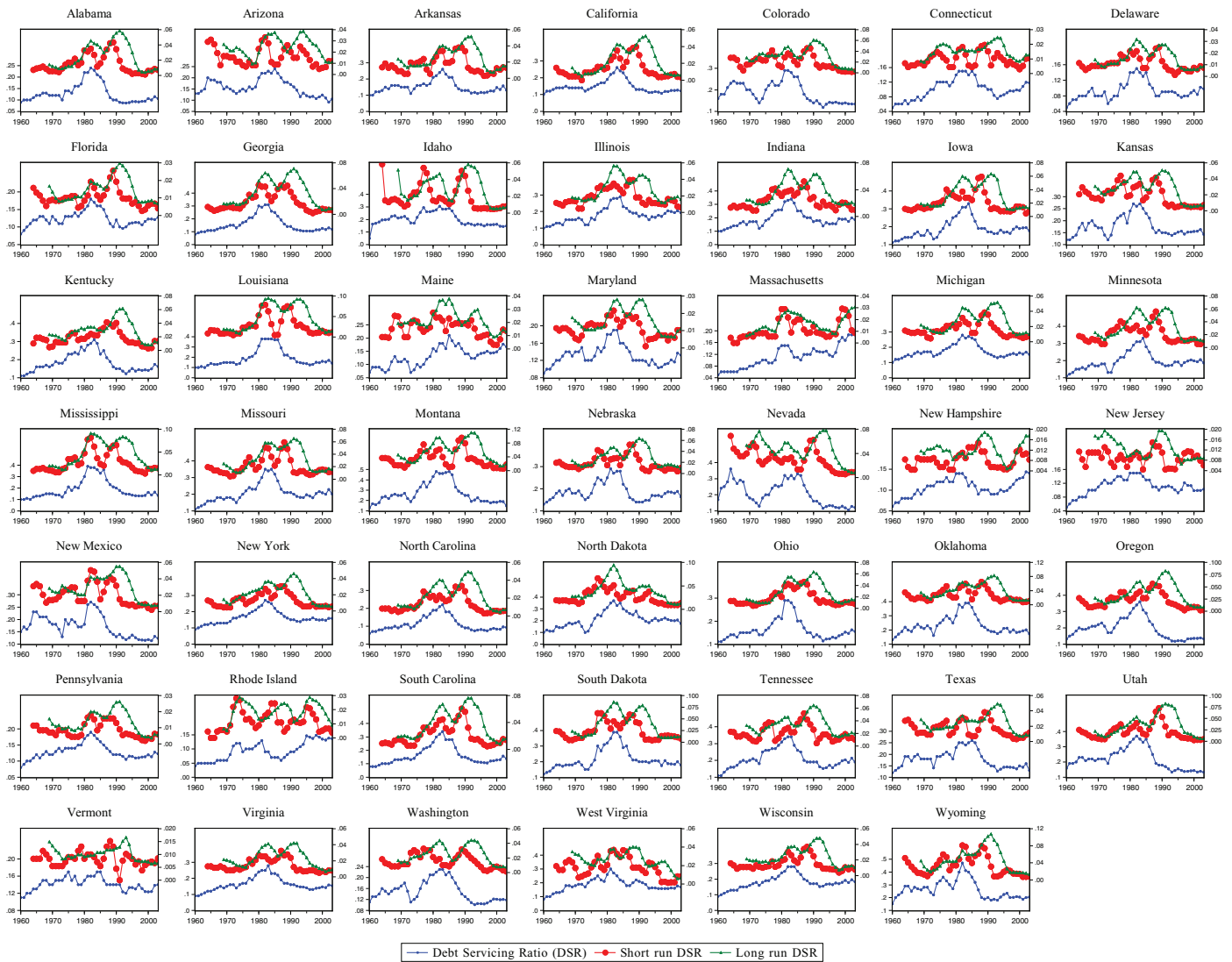
Fig. 1. Trends in the levels, short and long run variability in debt servicing ratio.

debt, are noticed in the agricultural sector across states through time (Fig. 1).

A small body of literature has been devoted to the study of the importance of financial ratios, financial characteristics and debt relative to assets on efficiency and productivity using stochastic frontier analysis and data envelopment analysis (Blancard, Boussemart, Briec, & Kerstens, 2006; Cooper, Kingyens, & Paradi, 2014; Valladao, Veiga, & Veiga, 2014). Past literature has examined the importance of financial variables on the volatility and returns to agriculture economic growth (Davidova & Latruffe, 2003; Paul, Johnston, & Frengley, 2000; Whittaker & Morehart, 1991). Further, past studies suggest a positive and negative results depending upon the methodology – stochastic frontier analysis or the data envelopment analysis; and the use of cross-section, time-series or panel data under primal or dual approach.

The importance of liquidity or debt risk on the variance of technical efficiency and variance of productivity has yet to be documented. Additionally, does the increased use of capital and debt as reflected in the short- and long-run variations in liquidity or debt-servicing ratio have differential effects on technical efficiency and productivity? Studies in the technical efficiency and productivity analyses have used two-stage linear programming followed by the discrete choice Tobit model to examine the relationship between the financial

variable and technical efficiency measures using primal production function. The two-step process has been the subject of analysis by earlier researchers. However, the two-step process might be biased due to omitted variables (see Wang & Schmidt, 2002) or heteroskedasticity (Greene, 2004). Hence, following Greene (2004), a heterogeneity stochastic frontier model is used to assess the impact of liquidity or debt-servicing ratio risk on the variation in technical inefficiency and productivity.

Second, the research extends the time-series normal-gamma stochastic frontier model to a two-way random effect panel stochastic frontier model to account for the cross-section time-series data. Panel statistical procedures have several advantages over conventional cross-section or time-series statistical methods (see Hsiao, 2003). The advantages include the reduction in collinearity among exogenous variables, allow complicated models, parsimonious, and finally account for temporal and spatial random variation. An alternative panel estimator of the normal-gamma stochastic frontier model is proposed using simulated maximum likelihood estimation techniques. In addition, a link is established between one-sided efficiency and random errors of the stochastic frontier analysis to inefficiency and productivity measures, respectively.

In Section 2, we first extend Greene (2003) normal-gamma Simulated Maximum Likelihood (SML) stochastic frontier methodology to