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The evolution of hog production and potential sources for future growth in China

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ABSTRACT

Following reforms to the market, China's hog industry has developed rapidly, however, with social and economic transitions, China's hog industry is facing challenges which might restrict long-term growth in production. This paper analyzes the changes in regional scale, organization, input factors, and technological progress for China's hog production over the last few decades. The paper seeks to reveal the sources of hog production growth and provide some suggestions for future development of the hog industry. To achieve these aims, the paper uses stochastic frontier production functions and the Malmquist index to measure total factor productivity (TFP) in the hog industry and decompose TFP into technical efficiency; technological progress; scale efficiency; and allocative efficiency using data for 25 provinces from 1980 to 2008. The results show firstly that; the TFP of hog production increased by 64.3% from 1980 to 2008, and allocative efficiency and scale efficiency improvements played a key role in this TFP growth. In contrast, technical efficiency and technical progress have changed little over this period. Secondly, TFP's contribution to output was 39.7%, it being less than that of factor inputs to output. Thirdly, the results suggest that the growth of China's pork production depends mostly on the increase in the quantity of factor inputs, especially feed. As a consequence, the key to ensuring long-term and stable development of China's hog production would seem to involve focusing on enhancing total factor productivity and changing the pattern of production growth.

Introduction

Total pork consumption has increased strongly as income has grown and the market for pork as a staple food has developed in China (Huang and Rozelle, 1998; Zhang et al., 2005) for example, urban per capita pork consumption increased significantly from 16.7 kg in 2000 to 20.5 kg in 2009 – an increase of 22.8% (CSY, 2010). The role of urbanization can be seen clearly when we consider that the urban population increased from 459.06 million in 2000 to 621.86 million in 2009 and the effect on total urban pork consumption was an increase from 7.67 million metric tones in 2000 to 12.75 million metric tones in 2009, an increase of 66.3%. Furthermore, rural meat consumption may have also increased with income growth and the development of markets see Huang and Rozelle (1998) who found that market development has an impact on food consumption behavior. They conclude that if rural households purchased 100% of their foodstuffs via markets, the income elasticity for grain would fall from 0.85 to 0.51 and for meat would rise from 0.35 to 0.85. This suggests that market development is an important factor in increasing meat consumption in China. By way of example, rural per capita rural pork consumption has increased from 5.2 kg in 1978 to 13.6 kg in 2009 (CSY, 2010).

As a consequence, hog production sector has struggled to meet the local demand, but it now seems to have stabilized in the 2000s at a historically high level. Pork output increased rapidly in the 1980s with an annual growth of 7.2% falling slightly to 5.9% in the 1990s. By 2000, however, total pork output had reached 403.1 million metric tonnes. As we entered the 2000s, however, hog production growth weakened for example, pork output reached only 489 million metric tonnes by 2009, which represented a 2.2% annual growth for the 2000s. The total growth of pork production was unable to match the total growth (66.3%) of even urban pork consumption per capita over the same period. As a consequence, current pork production growth might be unable to meet the future growth of pork consumption in China.

China's hog production has faced a series of challenges and difficulties in the 2000s and as a consequence, further hog production growth will likely be severely affected see Xiao and Wang (2008, 2007). One such challenge is hog farm size which is generally small where, in 2009, backyard farms still account for 38.8% of total hog slaughters by 2009. Furthermore, a large number of hog farms are

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outdated where the technological level and production efficiency are generally low (MOA, 2006). Feed conversion coefficients on small hog farms are 3.6–3.8:1, which are 0.3–0.4 higher than that in developed countries. On average, each sow produces only 16–17 piglets, which is 4–5 fewer than in developed countries (Yao, 2009). The challenges and difficulties for hog production have further intensified as a consequence of economic and social development and transition in China. For example, wages and feed prices have been increasing consistently into the 2000s. According to the NDRC, real labor costs (based on 2000 price index) per hog slaughtered, increased from 26.65 Yuan in 2000 to 52.16 Yuan in 2010 on large hog farms, which indicates that labor input costs increased by 95.7% in the 2000s. Similar growth of labor input costs can be observed for medium and small hog farms. From the same data source, between 2005 and 2010, feed input costs increased by 46.8%, while actual feed input quantity increased by only 11.1% due to rising feed grain prices.

Furthermore, many agricultural economists and researchers have become increasingly concerned by the impact of grain-based biofuel development and consequently maize prices, on China's agriculture and livestock economy (Qiu et al., 2008, 2010, Yang et al., 2009). Combined with rising wages, feed grain prices have pushed-up pork prices across China for example, urban pork retail prices were more doubled from approximately 5–7 Yuan per kg in 2000 to around 12–14 Yuan per kg in 2010 in most of provincial capital cities (NDRC, 2010).

As a consequence of the challenges faced hog production, both demand and supply, there have been several studies on productivity in China's hog farms. Zhou (1999) for example, analyzed hog production efficiency on specialized households and backyard households in China using the translog production function. Yang (2003) studied the technological progress and technical efficiency of hog production from 1997 to 2001 by estimating a stochastic frontier function and concluded that the growth of hog production was generally determined by feed input and scale expansion. Wang (2008) estimated the TFP of hog production in Sichuan Province using Data Envelopment Analysis (DEA) and found that the source of the production growth of free-range hogs was mainly due to input increases rather than efficiency improvements. Yang (2008) also decomposed the TFP of hog production into technical efficiency, pure technical efficiency, and scale efficiency from 2000 to 2005, using DEA approach and his results indicated that in most of provinces, technical efficiency was high, but technological change was low. Chen et al. (2008) estimated the TFP growth of backyard hog farms in China from 1991 to 2005 using DEA methods and concluded that hog production efficiency fluctuated and technological change was the major restricting factor for productivity growth. Zhang et al. (2003) measured the hog production efficiency, 1985–1996, across farm sizes and they found that production efficiency was generally low and the highest efficiency was found on the hog farms with over 500 head. However, when hog production is at the stage of increasing returns to scale, the highest return was found on hog farms with 31–100 head. Ma et al. (2007) estimate hog production TFP and decompose it into technical efficiency, technological progress and scale efficiency. Their results show that TFP and its components have changed significantly from the 1980s to the 1990s, with rapid technological change and low technical efficiency. Chen and Rozelle (2003) investigate the effects of different factors on the evolution of backyard hog production in China. They establish the inverted-U relationship between hog production and income growth and test the significance of market developments, wage rates, and household demographic structure on hog production. Chen et al. (2005) further analyze the between the emergence of markets and the backyard hog production patterns in China, by using both theoretical and econometrical approaches. Their results indicate that rural labor and grain market developments have had significant effects on household hog production. It appears that market developments may have resulted in the contraction of hog production in the rich coastal areas and lead to a rapid expansion of hog production in the poor inland areas.

It is clear from the literature briefly outlined above that there have been extensive studies of China's hog productivity and production efficiency however, all, to some extent, have shortcomings. For example, some used data that were limited to a certain region, while others covered a relatively short time period (Yang, 2003). Such studies, therefore, provide an incomplete picture of the dynamically changing hog productivity over time. In addition, some decompositions of total factor productivity (TFP) for China's hog farms are incomplete and focus only on part of TFP's components for example, Rae et al. (2006), Jin et al. (2010) and Ma et al. (2011) only focused on technological progress and technical efficiency, while Zhou (1999), Zhang et al. (2003) focused only on the technical efficiency of China's hog production. However, with the rapid development of the hog sector and the rising scarcity of resources, scale efficiency and allocative efficiency have begun to play an increasing role in hog production growth, however, most existing studies have failed to decompose TFP into scale efficiency and allocative efficiency.

To observe the dynamics of hog productivity and its contribution to pork growth and to identify more factors determining China's hog production so as to assess whether productivity can maintain stable hog production growth in China, we need to use a more complete data set and employ a full decomposition model. To achieve these goals, this paper is organized as follows: Section Two reviews the evolution of China's hog production over time, followed by an exploration of the determinants of the growth of hog productivity. Section Three introduces the decomposition model used in this paper. Section Four introduces the data and defines the variables to be used, to be followed in Section Five by the presentation of new results. The final Section provides conclusions and some policy implications.

The evolution of hog production in China

Increasing hog numbers and pork output

Since the beginning of the reform process in the late 1970s, hog production has entered the phase of rapid growth where hog numbers and pork output have significantly increased. For example, the supply of hogs and slaughters have increased substantially from 301.29 and 161.09 million in 1978 to 469.85 and 645.07 million heads in 2009, leading to an average annual growth rate of 1.4% and 4.6%, respectively (Table 1). Correspondingly, pork output also

Table 1
Changing hog numbers and pork output in China over time. *Source*: CSY (1979–2010).

Year	Inventory (1000 head)	Slaughter (1000 head)	Pork (1000 ton)
1978	301,290	161,090	8070
1980	305,430	198,610	11,340
1985	331,390	238,750	16,550
1990	362,410	309,910	22,810
1995	350,410	378,490	28,540
2000	446,820	526,730	40,310
2006	418,500	610,270	51,970
2007	439,900	565,080	42,880
2008	462,910	610,170	46,210
2009	469,850	645,070	48,890
Annual growth rate (%)			
1978–2009	1.4	4.6	6.0
1980–1990	1.7	4.6	7.2
1990–2000	2.1	5.4	5.9
2000–2009	0.6	2.3	2.2