

Structural Changes in China's Livestock and Feed Production: Trade Implications

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1. Introduction

China's rural economy has undergone substantial changes in the last 20 years and the livestock sector is no exception to this transition. China's statistical publications reported rapid and steady growth of livestock production, higher level consumption of meat and dairy output, and continued trade of animal products. In China, historical records trace domesticated livestock back more than 6,000 years (Cheng, 1999). Despite this long history, China's livestock industry only began to develop rapidly in the mid-1980s. Even today, most meat is produced with traditional "backyard" methods -- rural households raising animals on a very small scale to supplement their farm income.

As recently as the early 1980s, most of China's domestic animals, including hogs, cattle, goats, sheep, and chickens were fed in the backyards of farm households. Hogs ran free or were kept in small pigsties that were partially roofed and held at best a few hogs. Cattle, goats, and sheep were either fed in small pens or herded along the sides of roads and edges of fields, where they could eat weeds. Before the 1980's, cattle were raised primarily for plowing, and manure was a valuable by-product of animal husbandry since manufactured fertilizer was scarce.

Under the circumstances prior to 1980's, the composition of feed in China was quite different from the formula feed used in more developed countries. Depending on the type of animal, feed ingredients generally included low-quality grains, tubers, grain byproducts, table scraps, brewery residues, green silage, melons, water plants, and other vegetation. Oilseed meals were not used extensively; then were employed mainly as fertilizer for crops. Large amount of feed grains, together with soybean and rapeseed meal, were put to use as animal feed only later, and then only gradually, beginning around the mid-1980s.

Livestock feeding in China has changed significantly since the mid-1980s, because of market liberalization and because the objectives of raising livestock have shifted. The rapid growth, induced mainly by increases in income and population, has magnified demand for all livestock products, but particularly for pork. Although meat and eggs are still produced predominantly by farmers raising a few pigs or chickens as a sideline, an increasing share is provided by households specializing in livestock as their principal occupation. These so-called specialized households rely far less on homegrown grain and farm byproducts, and are more responsive to grain prices, than traditional backyard operations. Nowadays, meat quality and feed efficiency are increasingly important goals. These goals will become even more critical as China prepares to join the WTO.

China's feed manufacturing industry is now the world's second largest, with an output of almost 68 million tons in 1999, after growing at an average annual rate of more than 10 percent since 1990. Producers are switching from traditional feeding techniques to purchasing mixed feeds as commercial chicken and hog farms gain larger market shares. A modest increase in per capita meat consumption in China could translate into large additional demands for manufactured feeds, and more feed production or more feed ingredient imports from foreign sources (Fang et al., 2000).

This study briefly reviews the growth and structural change of China's livestock production, consumption, and trade for the last 15 or 20 years, together with the development of the related feed industry. The paper also summarizes the policies that facilitated the developments in the livestock and feed industries. Then, the study evaluates and analyzes the comparative advantages and disadvantages of China's livestock production, mainly meat, based on some preliminary estimated indicators such as domestic resource costs, net social profitability, and effective rate of protection. Finally, the paper concludes with a summary and some trade implications.

2. China's Livestock Production

China's livestock production since the early 1980's can be characterized by its steady and rapid growth, although it slowed somewhat in 1999 and 2000. Table 1 shows changes of major livestock output levels since 1983. Despite the statistical correction of meat output levels in 1997, based on agricultural census results, there is no doubt that China's livestock production has trended up from the early 1980's.

Table 1 – China's major livestock output, 1983-99

Year	Total meat output	Red meat	Pork	Beef	Mutton	Poultry meat	Eggs	Cow milk
1,000 tons								
1983	14,020	14,020	13,160	320	550	na	3,320	1,845
1984	16,900	15,410	14,450	370	590	1,490	4,320	2,186
1985	19,270	17,610	16,550	470	590	1,600	5,350	2,499
1986	21,120	19,170	17,960	590	620	1,880	5,550	2,899
1987	22,160	19,860	18,350	790	720	2,190	5,900	3,301
1988	24,800	21,940	20,180	960	800	2,740	6,960	3,660
1989	26,290	23,260	21,230	1,070	960	2,820	7,200	3,813
1990	28,570	25,140	22,810	1,260	1,070	3,230	7,950	4,157
1991	31,440	27,240	24,520	1,540	1,080	3,950	9,220	4,644
1992	34,310	29,410	26,350	1,800	1,250	4,540	10,200	5,031
1993	38,420	32,250	28,540	2,340	1,370	2,740	11,800	4,986
1994	44,990	36,930	32,050	3,270	1,010	7,550	14,790	5,288
1995	52,600	42,650	36,480	4,150	2,020	9,350	16,770	5,764
1996	59,150	47,730	40,380	4,950	2,400	10,750	18,540	6,294
1997	52,690	42,500	35,960	4,410	2,130	9,790	18,950	6,011
1998	57,240	45,980	38,840	4,800	2,350	10,560	20,190	6,629
1999	59,490	47,620	40,060	5,050	2,510	11,160	21,350	7,176

Sources: *China's Statistical Yearbook*, various issues. All statistics after 1996 have been corrected by the National Bureau of Statistics according to China's Agricultural Census results.

Table 1 shows that pork production is clearly the core of China's livestock industry. In 1999, pork still contributed about 84 percent of China's red meat production and over 65 percent of

total meat output. However, there have been structural changes in the hog production sector. At present, about 80 percent of China's pork output comes from backyard feeding, 15 percent from specialized households, and 5 percent from large-scale commercial operations. This compares with about 95 percent of hogs raised as backyard enterprises by rural households in the mid-1980s. The structural changes in hog production led China's hog producers to improve feeding efficiency and increase output significantly (Fang et al., 2000).

Several government policies have facilitated the development of China's livestock sector. One of the critical programs China's government implemented in the early 1980's was a concerted effort to enhance the country's manufactured feed industry.

3. China's Feed Industry Development

China's feed manufacturing industry has expanded rapidly, particularly since the early 1980's. The industry is now the world's second largest, with an output of 67.6 million tons in 1999, after growing at an average double-digit rate a year since 1990. Table 2 lays out the changes in feed output, particularly for the 1990's and indicates that concentrate feed output grew markedly in the last several years.

Table 2 – China's feed production, 1982-99

Year	Compound and Mixed feed	Concentrate feed	Feed additives
Million tons			
1982	5.10	na	na
1985	15.00	na	na
1991	32.00	na	na
1992	34.92	0.59	0.30
1993	43.00	2.00	0.50
1994	39.50	2.00	0.50
1995	45.00	2.60	0.70
1996	51.00	3.80	0.75
1997	55.00	5.00	0.83
1998	53.50	8.87	1.38
1999	56.00	10.00	1.60

Sources: *China's Agricultural Statistical Yearbook*, various issues.

In 1984, the State Economic Commission drafted a feed industry development program entitled "A Draft of an Outline for the Development of the National Feed Industry for the Period 1984-2000. The program called for 100 to 120 million tons of mixed and compound feed to be produced by year 2000. The goal is indeed achieved as China begins the new century, although total feed output reached only about 68 million tons as shown in the above table. This is because manufactured concentrate feed produces 10-15 times as much mixed feed when feed grains, oilseed meals, and additives are added to the concentrate feed.

Largely because of the feed development program, the number of feed mills in China expanded from practically none before 1975 to over 14,000 in 1985, although many were quite small, producing less than 1 ton per hour. By the 1990's authorities began counting only firms meeting minimum milling capacities such as 1 or 5 tons per hour. These kinds of mills totaled about 12,500 in 1999, with one-fourth owned by the Ministry of Commerce, one-fourth by the Ministry of Agriculture, and the rest by township and village enterprises and others. Most of the feed mills are established in coastal and eastern provinces, including Shangdong, Guangdong, Hebei, Jiangsu, Zhejiang, with some in central provinces, including Sichuan, Hubei and Henan.

In the 1980's, mills sponsored by the Ministry of Commerce and the Ministry of Agriculture tended to have more modern equipment than other mills and production capacities of more than 1 ton per hour. However, by the late 1980s and early 1990s, the old and aging equipment at these enterprises meant they faced increasing competition from township and joint venture mills. For instance, the Ministry of Foreign Trade cooperated with foreign firms in establishing joint venture feed mills. The number of mills controlled by this Ministry doubled in the 1990's.

Mills with capacity of 5 tons per hour have increased substantially over the past two decades. In 1980, China had only 44 such mills, but by 1985, the number had more than doubled to 110. It rose to 555 by 1990, and increased further to 1,896 in 1999. Ten-ton-per-hour mills first came on line in the mid-1980s and by 1997 China had 62 such mills (Hsu and Crook, 2000).

4. Policies Enhanced Development of China's Livestock and Feed Industries

Several government policies played critical roles in enhancing China's livestock production over the last twenty years following the introduction of rural reforms in 1979. The major policies that facilitated the development of livestock and feed production can be briefly described as follows:

- a. The revival of family farms and markets in the early 1980's – Rural households were allowed to raise livestock and products on a farm or household basis after rural communes were abolished in 1984. Farmers were again permitted to sell animal products at rural markets. This policy revived farmers' incentives to raise animals, because sales of animal products provided an important source of cash income for rural households at that time.
- b. Elimination of fixed procurement prices and procurement quota system -- China's government liberalized its livestock sector in the mid-1980s by eliminating procurement quotas and fixed procurement prices for livestock products sold to the central government. This policy change was critical since it provided farmers opportunities to increase production efficiency and hence additional income. More importantly, the policy change encouraged farmers to form specialized households focusing on livestock raising activities.
- c. Promoted specialized household production units – In the early 1980's, the central government encouraged livestock production by farm households and helped develop livestock operations run by collectives and state breeding farms. Collective farms were allowed to contract with specialized households to produce larger hogs and state breeding

farms were able to supply bigger and better young animals to specialized households. As mentioned previously specialized livestock households currently contribute about 15 percent of total pork output in China.

- d. Initiating the “Vegetable Basket (actually non-staple food, including meat, vegetables, eggs, fruits) Program” in 1989 – Under this special program, which was formulated and implemented by the Ministry of Agriculture, municipal governments encouraged farmers around big cities to provide more and better quality meat, milk, eggs, fruits, and vegetables for urban residents. The central government and local governments funded many projects and production bases through subsidies and direct investment in suburban counties around big cities for animal production. The program has contributed to increasing meat supplies to major urban areas and to the overall output of animal protein products.
- e. Expanded the feed industry – In the early 1980’s, China’s feed industry produced only minimal amounts of compound and mixed feed. In 1999, after encouraging domestic investment and allowing foreign joint ventures involving in feed manufacturing in the mid-1980’s, China produced almost 68 million tons of compound feed, mixed feed, concentrate feed and feed additives. Concentrate feed production is especially useful in China because of the poor rural transportation system. Concentrates can be used as the basis for producing mixed feed by adding feed grains, oilseed meals, and additives. This process of mixing feed has been widely used in rural areas where manufactured compound feed is considered too expensive or too difficult to obtain. As a result, different types of manufactured feed are nowadays available widely in rural and suburban areas in China.

All the above policies have been critical to reforms of China’s livestock and feed production at different times during the course of the reform period. Changes in institutional policies tended to be critical in the earlier period of the rural reforms, particularly in changing the basic setting of China’s livestock production. Other policy changes, such as the “Vegetable Basket Program,” played an important role in the more recent period of development of the livestock sector.

5. Consumption and Trade of Livestock Products

Despite the rapid growth in livestock production (measured by increased per capita availability of livestock products), per capita consumption of livestock products, except pork, is still low compared with Japan, Hong Kong, Taiwan and Korea (Crook, 1998). Table 3 lays out changes in per capita meat consumption levels and shows the inverse relationship between changes in per capita meat consumption and per capita food grain consumption for rural and urban household residents. The table shows that, over the past two decades, rural and urban per capita meat consumption have generally increased. However, the increasing rates of per capita meat consumption appear to have significantly lagged behind growth of meat output when statistics in tables 2 and 3 are compared. A major reason for the discrepancies between the output and the consumption of meat is because of the exclusion of away from home or restaurant consumption of meat. The incidence of urban residents eating away from home has grown markedly over the past 10 years as per capita income has grown.

Another reason for the discrepancy between consumption and production is most likely a result of the statistical over-reporting of meat output. Since 1997, however, this discrepancy has been reduced as hog inventory numbers have been reduced based on the results of China's first agricultural census (details can be seen in Colby et al., 1999). China's meat output statistics were adjusted downward by about 20 percent since 1997 (table 2). Nevertheless, it is interesting to note that after the correction of meat output statistics in 1997, a pattern of rapid growth of the meat output series can once again be observed (see table 1).

Table 3 – Per capita consumption of food grain, livestock products, and fishery products for rural and urban residents, 1983-99

Year	Food grain		Red meat		Poultry meat		Fishery products	
	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban
Kilograms								
1983	260.0	144.5	10.0	19.9	0.8	2.6	1.6	8.1
1984	267.0	142.5	10.6	19.9	0.9	2.9	1.7	7.8
1985	257.0	134.8	11.0	18.7	1.0	3.2	1.6	7.1
1986	259.0	137.9	11.8	21.6	1.1	3.7	1.9	8.2
1987	259.0	133.9	11.7	21.9	1.2	3.4	2.0	7.9
1988	260.0	137.2	10.7	19.8	1.3	4.0	1.9	7.1
1989	262.0	133.9	11.0	20.3	1.3	3.7	2.1	7.6
1990	262.0	130.7	11.3	21.7	1.3	3.4	2.1	7.7
1991	256.0	127.9	12.2	22.2	1.3	4.4	2.2	8.0
1992	251.0	111.5	11.8	21.4	1.5	5.1	2.3	8.2
1993	266.0	97.8	11.7	20.8	1.6	3.7	2.5	8.0
1994	257.0	102.0	11.0	20.2	1.6	4.1	3.0	8.5
1995	258.9	97.0	11.3	19.7	1.8	4.0	3.4	9.2
1996	256.2	94.7	11.9	20.4	1.9	5.4	3.7	9.3
1997	250.7	88.6	12.7	19.0	2.4	6.5	3.4	9.3
1998	249.3	86.7	13.2	19.2	2.2	6.3	3.6	9.8
1999	247.5	84.9	13.7	20.0	2.5	4.9	3.8	10.3

Note: Consumption statistics for urban residents are actual quantities purchased.

Sources: *China's Statistical Yearbook*, various issues.

China's imports and exports of livestock products, in both volume and value terms, are low when compared with the total production of livestock products and total agricultural trade values.

Until 1970, the export share of animal products, largely pork and live hogs, to total agricultural exports was around 10 percent in value terms. Beginning from the early 1980's, the quantities of exported meat and live animal, in general, were stable. But livestock products' share of total agricultural exports decreased as agricultural trade expanded after foreign trade liberalization and because the government promoted the expansion of other agricultural (such as grain, horticultural products, and processed food) exports.

Table 4 shows both volumes and values of trade of major livestock products (mainly meat) in recent years. China predominantly shipped live animals, pork, beef, and poultry to a small group of countries over the past four decades. Hong Kong and Macau were the major export destinations for China's live animal exports. Poultry meat was mainly shipped to Japan. Pork and beef were exported to Russia with a small portion also going to Hong Kong and the Middle East. China also imports specific poultry cuts, mainly feet and wings, through Hong Kong.

Table 4 – Volume and value of China's trade of major livestock products, 1992-99

Year	Live hogs	Live poultry	Frozen, fresh beef	Frozen, fresh pork	Poultry meat	Eggs
	-----1,000 head-----			-----1,000 tons-----		Million
<u>Exports:</u>						
1992	2,900	49,557	24	50	93	--
1993	2,720	51,150	22	60	107	611
1994	2,700	52,300	20	100	164	486
1995	2,530	52,630	20	150	249	358
1996	2,400	53,773	29	129	297	709
1997	2,270	52,675	31	103	291	948
1998	2,190	42,616	43	100	274	578
1999	1,960	45,000	20	50	301	466
<u>Imports:</u>						
1992	--	2,684	1	--	78	--
1993	--	1,710	2	--	99	4
1994	1	1,849	3	--	136	6
1995	97	1,788	3	3	261	5
1996	2	1,362	3	2	312	6
1997	13	1,077	3	3	210	6
1998	4	715	4	16	194	6
1999	na	na	4	na	na	na
Million U.S. \$						
<u>Exports:</u>						
1992	290	94	39	76	166	--
1993	272	90	28	63	185	28
1994	269	105	31	128	380	18
1995	278	125	34	245	621	17
1996	294	121	51	215	691	41
1997	302	114	54	195	608	41
1998	291	96	73	180	523	33
1999	237	99	26	67	539	12
<u>Imports:</u>						
1992	--	26	4	0	50	--
1993	--	11	5	0	58	1
1994	1	10	5	0	72	1

1995	2	15	4	1	80	2
1996	2	15	4	1	140	1
1997	2	14	3	2	129	1
1998	3	10	5	8	108	1
1999	4	11	6	24	410	1

Sources: *China's Customs Statistics* and *China Monthly Exports and Imports*, December issues.

Overall, China has been a net exporter of livestock products. However, annual trade values of China's livestock products have generally been small. The exception has been exports of poultry meat, which have shown rapid growth, though the absolute quantity is still quite low. Neither the structural change in China's livestock production nor the growing discrepancy between China's livestock production and consumption levels has resulted in an increase in livestock product trade.

China's trade in livestock products has remained low, in spite of the apparent surplus, for a number of different reasons. One is the role of the government in agricultural trade. Through the 1980s (and even to a limited extent in the 1990s) the government managed trade, particularly imports, of livestock products relatively closely. The government has limited imports of meat products through high tariffs and quotas in order to insulate the domestic industry from foreign competition. Second, China faces a number of disease problems (foot and mouth, etc.) that limit its ability to export. And finally, China's poor infrastructure and transportation system limit its ability to trade. In particular, the lack of sufficient refrigeration facilities, both in terms of fixed storage and rail or truck, are limiting factors for the trade in fresh or frozen meat products.

6. Comparative Advantage and Trade Competitiveness of Livestock Products

As discussed in the previous sections, the increase in livestock production in China appeared greater than the rate of growth of urban and rural per capita consumption of livestock products. If true, and taking into account the small quantity of exports and imports, the oversupply of animal products should have depressed prices throughout the last 20 years or so. However, the prices of livestock products, along with almost all other major agricultural products, were only depressed between 1996 and 2000. Livestock product prices, like most grain products, plunged in 1996 and stayed at their depressed levels until last year. Many factors, including drastic housing and health reforms, the streamlining of government, and the reorganizing of state-owned enterprises, contributed to less robust growth in per capita disposable income and reduced consumer confidence, which reduced demand and lowered prices of agricultural products during this period.

Recently, Chinese government officials and scholars have begun to explore the potential to increase exports of livestock products to the international market, particularly as China is likely to join the World Trade Organization (WTO) in the near future. The possibility of exporting livestock products to the world markets depends on many factors, such as production costs, domestic and international market prices, exchange rates, transportation costs, disease control, and others. This paper will examine the issues of comparative advantage, resource allocation, and future or potential comparative advantage of livestock production based on calculations of

domestic resource cost coefficients (DRCC), net social profitability (NSP), and effective rate of protection (ERP). These indicators were introduced and developed by Pearson in 1976. All estimates of these indicators calculated in this paper cover the time period 1990 through 1998. The commodities included in the study are wheat, rice, and corn and three animal products, hogs, cattle, and broilers.

DRCC—Assuming free trade, DRCC of an agricultural commodity can be estimated by dividing its domestic resource costs (DRC) with shadow exchange rates, where DRC is the sum of opportunity costs of all domestic resources needed to produce (or to save) an additional unit of shadow income (or foreign exchange). If $DRCC < 1$, it indicates that the product generates an income higher than input costs used, and therefore the country has some comparative advantage in producing the commodity. On the contrary, $DRCC > 1$ indicates a disadvantage in producing the product because the additional unit of output is worth less than the total costs needed for producing such an output.

NSP—Net social profitability can be estimated by subtracting all input costs from the sum of their opportunity costs plus any externalities. NSP indicates the profit of producing a commodity by efficiently utilizing all foreign and domestic resources. Therefore, $NSP > 0$ indicate the positive production profitability of growing or raising a product. If $NSP < 0$, the output is not profitable, indicating an inefficient allocation of resources in production of the output.

ERP—As to the estimation of ERP, it reflects the increased percentage of added value of one commodity due to production policies rather than under free trade conditions. If $ERP > 0$, it reflects a positive protection, or current comparative advantage would be reduced if protection policies are removed, hence decreasing the trade competitiveness of the product in the international market. If $ERP < 0$, it indicates the product receives a negative protection. Removing the negative support of a product would increase its trade competitiveness in the international market.

Table 5 – The degree of comparative advantage, NSP, and ERP of China's major grain and animal products, 1990-98

Commodity/year	1990	1991	1992	1993	1994	1995	1996	1997	1998
<u>Degree of comparative advantage (DCA)</u>									
Hogs	0.45	0.59	0.55	0.61	0.58	0.47	0.39	0.37	0.55
Cattle	0.63	0.48	0.68	0.70	0.61	0.76	0.79	0.76	0.61
Broilers	0.43	0.41	0.24	0.49	0.47	0.51	0.45	0.39	0.60
Wheat	0.31	0.25	0.24	-0.20	-0.27	-0.28	-0.10	-0.18	-0.07
Rice	0.69	0.69	0.78	0.72	0.58	0.53	0.30	0.12	0.16
Corn	0.54	0.64	0.49	0.51	0.38	0.02	-0.09	-0.17	-0.20
<u>Net Social Profitability (NSP)</u>									
	Unit: Yuan/kg								
Hogs	0.79	1.57	1.27	1.71	2.44	1.83	1.39	1.32	0.91
Cattle	3.39	2.66	3.71	3.22	3.13	3.28	4.12	3.55	1.18
Broilers	1.58	1.41	0.54	2.16	2.43	2.84	1.99	1.79	0.64

Wheat	0.16	0.13	0.13	-0.09	-0.12	-0.16	-0.09	-0.15	-0.06
Rice	0.65	0.62	1.19	0.86	1.01	0.86	0.38	0.13	0.14
Corn	0.28	0.41	0.26	0.21	0.24	0.01	-0.06	-0.11	-0.11

Effective Rate of Protection (ERP)

Hogs	0.57	0.06	0.30	0.15	0.47	0.42	0.73	0.65	0.68
Cattle	-0.57	-0.53	-0.65	-0.58	-0.45	-0.36	-0.41	-0.37	-0.53
Broilers	-0.27	-0.34	-0.10	-0.43	-0.36	-0.49	-0.32	-0.43	-0.55
Wheat	0.49	0.25	0.21	0.36	1.67	1.58	0.55	0.34	0.23
Rice	-0.32	-0.47	-0.59	-0.46	0.02	0.17	0.08	0.09	0.48
Corn	-0.31	-0.46	-0.23	0.24	0.35	0.81	0.52	0.40	0.71

Note: 1. For straight forward interpretation of the results, the degree of comparative advantage (DCA)=1-DRCC is calculated and listed in this table. $DRCC=DRC/(NV*EX)$, where DRC denotes domestic resource costs, NV denotes the added value based on border prices, and EX denotes the opportunity cost of the foreign exchange, or shadow exchange rate. 2. $NSP=(U-M-R)*V-\sum FV+E$, where U denotes output value based on border prices, M denotes value of all importable intermediate input in c.i.f., R denotes the opportunity cost of all foreign used or produced inputs, V denotes shadow exchange rate in terms of domestic currency, FV denotes the opportunity cost of each input needed to produce a product, and E denotes the effect of externality. 3. $ERP=(t_p-\sum a_i t_i)/(1-\sum a_i)$, where t_p denotes the duty rate of output p and t_i denotes the duty rates for input i for producing p , a_i denotes the quantities of importable input i for producing output p . 4. Data used for the estimation includes production costs from the publication entitled *Compilation of Production Costs of China's Agricultural Commodities*, border prices and volume of imports and exports from the *China Customs Statistics*, commodity prices from the *China Price Yearbooks*, shadow prices from *Economic Evaluation Methods and Parameters on Development Projects*, input quantities and coefficients coming from the input-output tables published by the National Bureau of Statistics (or SSB), tariff rates coming from the *China Tax Collections*, and investment and interests from the *China Finance Yearbooks*.

Sources: See (Tuan, et al., 2001)

Table 5 lists the estimates for degree of comparative advantage (DCA), NSP, and ERP for three types of grain and three animal products for the time period 1990-98. Major findings from the estimated results can be briefly summarized as follows:

1. Based on the estimates, for the period of 1990-98, production of hogs (backyard production activities), beef cattle (rural household production), and broilers (specialized household production) was fairly competitive, because estimates of DCAs for hogs ranged between 0.37 and 0.61, beef cattle ranged between 0.48 and 0.79, and broilers ranged between 0.24 and 0.60. For instance, in 1990, DCAs for hogs, beef cattle, and broilers were estimated at 0.45, 0.63, and 0.43, respectively, implying production of 1 unit of shadow income for the respective animals requiring 0.55, 0.37, and 0.57 unit of inputs. Similarly, in 1998, producing a unit of shadow income from hogs, beef cattle, and broilers required 0.45, 0.39, and 0.40 units of inputs. The estimates indicate that China's comparative advantage in producing the three livestock animals remained strong.

Unlike the case of livestock products, China's comparative advantage in grain production has gradually fallen. For example, in 1990, the DCA estimated for wheat production was 0.31, implying it was competitive and efficient in wheat growing. However, the same estimate

became -0.20 in 1993, indicating that to produce 1 unit of shadow income required 1.20 units of inputs. Since 1993, estimated DCAs for wheat have remained negative, explaining why Chinese researchers and government officials frequently indicate that China would likely import wheat in the future.

2. NSP estimates for hogs, beef cattle, and broilers are all positive and almost all generally greater than 1, although estimated NSP for hogs and broilers are declining in the late 1990's. Overall, estimated NSPs appear to indicate China's production of hogs, beef cattle, and broilers has been efficient and allocation of resources seemed reasonable.

On the contrary, NSP estimates in table 5 indicate that rice, wheat, and corn production in China currently are not competitive. For 1990, estimated NSPs for rice, wheat, and corn were 0.16, 0.65, or 0.28, respectively, implying producing 1 kilogram of rice, wheat, and corn could generate 0.16, 0.65 or 0.28 yuan of net profit. In 1998, NSPs for wheat and corn became -0.06 and -0.11 , indicating losses of 0.06 and 0.11 yuan for wheat and corn for each kilogram produced.

3. Estimated ERPs in table 5 reveal that hog production received positive protection over the entire study period in China, but production of beef cattle and broilers always received negative protection for the same time period. Freer trade such as China's accession to the WTO may reduce the trade competitiveness of China's pork trade in the future. In contrast, reduction or elimination of negative protection of beef cattle and broilers would increase the trade competitiveness of those two products.

As for the grains, ERPs for rice and corn became positive, reaching 0.48 and 0.71 in 1998. It implies that rice and corn trade became less competitive in the international market as compared with earlier years. In the future, if China accedes to the WTO, its trade of these commodities would face great competition if it chooses not to reduce or eliminate its support policy. Wheat, which has a positive ERP throughout the period, would also be affected, although its 1999 ERP is lower than rice and corn.

7. Summary and Trade Implications

China's livestock and feed production grew rapidly over the last twenty years. Rapid growth of income due to rural and economic reforms beginning from the late 1970's, together with favorable government policies that facilitated livestock production, steadily increased rural and urban per capita consumption of animal products.

Based on livestock statistics published by the Chinese government, China's per capita availability of livestock products, particularly meat, grew significantly faster than rural and urban per capita consumption. With only small quantities of meat products shipped to a few countries, including Hong Kong and Macau, parts of the country encountered regional surpluses of meat output over the last few years. China's government officials and scholars have begun to explore the possibility of shipping meat output to the international markets, but large export volumes have yet to be materialized.

This paper estimates indicators, incorporating the concepts of domestic resource costs, net social profitability, and effective rate of protection, to demonstrate the past trend and changes in comparative advantage and trade competitiveness of China's livestock products (hogs, beef cattle, and broilers). Unlike China's grain production, estimated results of these indicators appear to indicate that, in general, China's production of hogs, beef cattle, and broilers has been competitive in trade and hence had a comparative advantage in producing those products. This preliminary conclusion is also supported by the estimates of net social profitability (NSP) of the three products, because levels of net social profitability in producing the products were positive.

However, the estimated effective of protection (ERP) for the three products indicate that hog production has received positive protection and reduction or elimination of the support would decrease its comparative advantage in producing hogs and reduce its trade competitiveness in the international market trade. Beef cattle and broiler production, in contrast, received negative protection based on ERP estimates. China's government needs to reduce the negative protection to make the output of beef cattle and broiler more competitive in world markets, particularly as China is expected to join the WTO in the near future.

It is important to note that world meat and other livestock product trade is also constrained by issues such as sanitary standards. China's hog and chicken exports, for instance, are constrained because most countries prohibit the importation of livestock products from disease-endemic nations. This makes China's livestock product trade more difficult than non-animal product trade. Accession to the WTO will insure China's access and status on the "international platform" in terms of negotiating conflicts over trading issues with other countries, but sanitary and other livestock trade issues will take a long time to be resolved among all member countries.

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