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China's Agricultural Modernisation Program:

an assessment of its sustainability and impacts in the case of the high-value beef chain

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Abstract

China has embarked on a major program to modernise agricultural and agribusiness structures with far reaching implications for rural development, international competitiveness / trade and food safety. There are, however, few studies that examine in detail how the modernisation program has proceeded, its' sustainability and impacts. This paper aims to provide such an assessment through a series of integrated budget analyses of participants in the modern, high-value beef chain. The paper concludes that rather than attempting to skip development phases by fast-tracking the development of modern structures in high-value agrifood chains, China should pursue a more incremental and facilitative approach based around developing structures in mid value agrifood chains.

Keywords: China, agriculture, modernisation

JEL codes: O12, Q13, Q18

1. Introduction

Liberalisation measures applied to the production, marketing and enterprise sectors over the 1980s and 1990s have led to what are often described in China as fragmented (*san*), small-scale (*xiao*) and weak (*ruo*) agricultural structures. In response, various Chinese leadership regimes have attempted to build agricultural structures that exhibit opposing characteristics. The most high-profile and significant expression of these attempts is the Number One Document of 2007 titled “Modern Agriculture”, which stipulates that modern equipment, science and technology, industrial systems, management and development ideas shall be used to improve the quality, economic returns and competitiveness of agriculture (Central Committee of the Chinese Communist Party and State Council, 2007). Edicts from the highest echelons result in tangible policies at lower levels that influence economic activity.

Recognition of the significance of agricultural modernisation movement in China has generated enormous attention from researchers and development agencies. A large number of Chinese studies define China's agricultural modernisation movement (see for example Jiang and Huang, 2007; Jiang, 2007; Wang, 2007). Development agencies (for example World Bank, 2007) are optimistic about a series of agricultural “revolutions” sweeping the developing world,¹ led in many cases by China. Sinologists are highly interested in the organisational structures and the role of the State that underpins China's modernisation process (Lingohr, 2007; Zhang and Donaldson, 2008; Alpermann, 2006).

Understanding China's agricultural modernisation process can be aided by analysis of “modern” supply chains. Fabiosa *et al.* (2005) budget parts of the “commercial” pork chain, though based on limited data.

¹ Amongst the revolutions cited by the World Bank (2007) are the high-value agriculture revolution, the agribusiness revolution, the productivity revolution, the biotechnology revolution and the livestock revolution, while biofuels are a “revolution in the making”.

Brown *et al.* (2005) examine the modernisation of wool supply chains and Waldron, Brown, Longworth *et al.* (2007) examine sheep meat supply chains through detailed quantitative analysis. Longworth *et al.* (2001), Waldron, Brown and Zhang (2007) and Waldron (2009) draw on budget and policy analyses to analyse in detail low, mid and high value beef chains.

In order to highlight the modernisation aspect of the industry, the paper focuses specifically on the high-value beef chain. Following initial growth of the beef industry in the 1990s, the beef industry has only recently begun to modernise and, as key part of the modernisation process, to segment into different (low, mid and high) value chains. Within the high-value beef chain, the paper examines high-value beef consumption, modern abattoirs, modern cattle marketing systems (contracts), and large scale producers (especially feedlots) to allow for an integrated analysis of the modernisation process over a value chain.

The paper draws primarily on budget analyses of “modern” industry participants. The budget analyses are integrated insofar as inputs into one participant (e.g. modern abattoirs) have the same values (e.g. product attributes and prices) as the outputs from another chain participant (e.g. feedlots), thus allowing relationships between the structures to be examined. Qualitative information is drawn from extensive fieldwork and a detailed understanding of industry policies.²

Through this approach, the paper aims to provide a micro-level insight into the sustainability and impacts of China’s agricultural modernisation program. The paper finds that the main constraint to the development of the high-value beef chains is the small size and the limited growth prospects of high-value beef markets. The absence of a significant high-value market has, however, not deterred policy makers and investors from pursuing the development of modern facilities and systems, thus creating an over-crowded and over-supplied modern slaughter sector. The consequent unviability of the abattoirs puts pressure on them to reduce input costs, especially by discounting the grades and prices of cattle inputs. This practice impacts negatively on the returns of cattle producers and their incentives to participate in the high-value chains and further undermines the sustainable development of the modern, high-value beef chain. Downward cycling cause-and-effect relationships such as these suggests a discord between the objectives and the outcomes of China’s agricultural modernisation strategy in the case of beef, which needs to be reassessed along the lines discussed in the conclusions section of the paper.

2. The consumption and retailing of high-value agricultural products

The sustainable modernisation of agricultural industries such as beef depends on the existence of high-value markets (see Tables 1 and 2). Policy makers and investors in China usually pursue modernisation on the assumption that high-value markets will expand with increasing incomes, urbanisation or access to high-

² The modernisation of the Chinese beef industry has been tracked closely through four projects between 1997 and 2007 in 18 provinces, regions and cities of China and involving more than 500 interviews with the full range of industry participants (see www.nrsm.uq.edu.au/caeg).

value export markets. However, an examination of the consumption of beef in differentiated market segments – rather than as a broad product class – calls this assumption into question.

Ascertaining the relative importance and consumption patterns of differentiated market segments is confounded by a lack of disaggregated data. However, several patterns are identifiable from the official data and other survey-based studies. Like other foods, the vast majority (80-85%) of the Chinese beef market is comprised of low-value, generic beef (defined as beef sold ex-abattoir for Rmb15/kg average of all cuts over the carcass in 2006).³ Based on official statistics of consumable surpluses of beef,⁴ beef consumption grew at around 4.8% per year between 1999 and 2006, driven entirely by urban consumers. However, average per capita urban consumption is still low at just four kilograms per year. Beef makes up a part – but not an especially important part – of the increasingly diversified urban Chinese diet.

Within the broader beef market, there has been growth in the consumption of mid-value beef (average price of Rmb21/kg ex-abattoir in 2006), which comprises between 10 to 15% of the total beef market. Urban per capita beef consumption increase as incomes increase until incomes becomes “high” (the wealthiest 10% of the population), at which point marginal growth rates decline (State Statistical Bureau, 2003).⁵ One of the reasons for this consumption pattern is that more affluent consumers are prepared to pay modest premiums for safety-assured beef (Longworth *et al.*, 2001, Chapters 13 and 14).⁶ Another factor in the growth of mid-value beef markets is the increase in out-of-home consumption, which may account for about half the growth in beef consumption between 1999 and 2005.⁷ Beef plays a role in an increasingly diversified Chinese menus (such as “sizzling iron beef”), and is a major item on the menus of regional dishes (hot pot, Xinjiang skewers, Hui noodles) and in foreign restaurants in China (Japanese/Korean barbeque, Brazilian beef, American fattened beef).

While there is some evidence to suggest a significant and growing mid-value beef market, there is little evidence to suggest a significant market for high-value beef (average price of Rmb21/kg ex-abattoir in 2006), which accounts for less than 5% of the beef market. Beef demanded by the premium beef market is not only safety-assured but exhibits quality characteristics including colour, tenderness, marbling, and must be delivered in large cuts. The domestic high-value market is confined largely to five-star restaurants and hotels (and very few supermarkets) for the Japanese, Korean and western expatriate and tourist market.

³ The average price of all cuts over the entire carcass ex-abattoir is a better reflection of “value” categories of beef than are the prices of different cuts (which vary enormously) at retail level (which includes the cost of retail facilities, services and margins).

⁴ Consumable surpluses are estimated from official beef production statistics (Editorial Board of the China Animal Husbandry Yearbook, Various years), revised down by 20% to account for the degree of over-statement estimated by the Animal Husbandry Bureau, and adjusting for net trade.

⁵ This conforms to survey results for beef from Longworth *et al.* (2001, Chapters 13 and 14) and Gale and Huang (2007).

⁶ This was also found for other food types (Wang, 2006; Wang *et al.*, 2008; Yang, 2005).

⁷ Out-of home consumption was derived by subtracting official in-home beef consumption from (adjusted) consumable surpluses of beef. The Beijing Animal Husbandry Bureau estimates that of the official beef consumption in Beijing (3.8 kilograms per person per year), an additional 40% is consumed out of home. Ma *et al.* (2006) and Gale and Huang (2007) also find that more meat is consumed out of home than any other food group.

Furthermore, high-value export markets are likely to remain inaccessible at least into the medium-term due to disease protocols. Policies and investment decisions based on the assumption that high-value beef markets will develop along the lines of those seen in the West, Japan or Korea are not well supported and, as discussed below, have often led to inappropriate policy and investment decisions.

3. *Modern processing*

The small premium beef market is supplied by modern abattoirs that are large by Chinese standards, use international-level technology and are highly capitalised. There are at least 20 such cattle abattoirs in China, which is far more than the number required to service the small premium beef market. Surplus capacity in the modern abattoir exists largely because investors are attracted to preferential policies. All modern abattoirs, without exception, receive preferential treatment in one form or another,⁸ and all but a few are operating well under-capacity and are unviable in the absence of the preferential policies.

In order to assess the structures, incentives and pressures facing the modern abattoir sector, a budget of a representative modern abattoir was developed.⁹ This budget was used to test sensitivities to various scenarios (labour costs, throughput, technical efficiencies), of which the most important is the alignment of input (cattle) prices and attributes relative to output (beef) prices.¹⁰ The matrix of results is reported in Table 1.

Table 1: Net returns to the representative large modern abattoir per beast slaughtered under various input-output scenarios – 2006

Cattle input attributes and prices	Beef output prices, average all cuts bone-out (Rmb/kg) – and value segment		
	15 — low-value	21 — mid-value	27 — high-value
312kg, Rmb8.7/kg, 52% dressing %	-365	**	**
416kg, Rmb9/kg, 53% dressing %	-641	91	**
500kg, Rmb9.3/kg, 54% dressing %	-908	-12	885
600kg, Rmb9.6/kg, 55% dressing %	-1244	-149	947
All returns are expressed in Rmb net return per head slaughtered.			
** Denotes cattle inputs where it is technically infeasible to produce given beef outputs.			

The sensitivity analysis suggests that modern abattoirs can not operate viably if they are forced to dump beef onto the low value beef market (for Rmb15/kg average over all cuts in the carcass). They can only operate

⁸ The broader edicts and programs that “activate” preferential policies include the State Council “Opinion of accelerating the development of agricultural processing” of 2003, plans to develop the mechanised slaughter sector in the Tenth Five Year Plan of the State Economic and Trade Commission, and lists and awards for dragon head enterprises (of the Ministry of Agriculture). Preferential treatment afforded to modern abattoirs include low-interest loans, the underwriting of loans by government, tax breaks on profits, preferential market access including local monopoly status, participation in major technical programs, and assistance in the development of cattle supply bases. For more specific details see Waldron 2009, Table 7.4.

⁹ The economics of the Chinese slaughter sector is examined in Longworth *et al.* (2001, Chapter 9), Waldron, Brown and Zhang (2007) and Waldron (2009, Section 7.3). Data was drawn from visits to more than 40 abattoirs in the late 1990s, and updated in visits to another 15 abattoirs throughout China in the 2000s. Four different categories of slaughter operations were examined, of which this section reports only on a representative “modern abattoir” with a slaughter capacity of 70,000 head per year, capacity utilisation of 80%, slaughtering crossbred cattle at 450 kilograms liveweight, and selling 30% of beef into the premium market.

¹⁰ Cattle input costs constitute 70-80% of all abattoir costs, while beef outputs constitute 75-80% of all revenues.

viably in the mid-value beef market (Rmb21/kg) if they are able to source cattle at low prices. However, the beef of the lowest priced cattle (312kg, Rmb8.7/kg) will not have the quality attributes required by customers in mid-value markets. Modern abattoirs may be viable in mid-value markets if they source 416kg cattle (for Rmb9/kg), in which case these will be sourced from specialised fattening households (see Table 3) rather than large scale, modern feedlots (Table 2). Abattoirs will be viable if they can sell product onto the high-value market (Rmb27/kg) even if they purchase heavy, expensive cattle (600kg, Rmb9.6/kg), which will be purchased from feedlots. As discussed in Section 2 above, however, few abattoirs can consistently sell beef onto the small and overcrowded premium beef market.

Difficulty in accessing high-value markets, low levels of capacity utilisation, a lack of working capital generated from beef sales, and the pressure for the enterprises to pay back loans on over-capitalised facilities puts enormous pressure on abattoirs to seek more profitable alignments of inputs and outputs. One way for modern abattoirs to do so is to reduce cattle input costs through opportunistic purchasing practices, as discussed below in Section 4.

Another way for modern abattoirs to improve input-output alignments is to buy low-value inputs (cattle) but to market the outputs as high-value beef by taking “short cuts” in the transformation and marketing of beef. With regard to transformation, modern abattoirs very often infuse fat into the muscle area to make it appear to contain intra-muscular fat or marbling, and inject water to make it appear more juicy and to increase the weight (and therefore price) of the beef. With regard to marketing, abattoirs will very often market their beef as “A grade” or “high quality beef” (*gaodeng niurou*) but deliver mixed-quality product. While there are national beef quality standards in China¹¹, they are rarely used because abattoirs seek to differentiate their product through their own in-house, subjective grading systems. The variability in the quality of the beef delivered by abattoirs entails high purchase risks for customers (mainly five-star restaurants and hotels) who respond by taking beef off the menu or turning to overseas suppliers for quality-assured product. This, together with variable eating experiences by consumers, inhibits the growth of the premium beef market and the sustainable development of the modern, high-value beef chain.

4. Modern marketing systems

One of the most important considerations of investors when establishing a large agro-processing enterprise is to secure a source of “raw materials”. Large abattoirs require up to 70,000 head of cattle to be supplied to specification consistently over the course of the year (though with some seasonal variation). Local governments are very interested in attracting enterprises like abattoirs into their areas because they provide tax and fee revenues that can be retained locally, a sales channel for local “high-value” agricultural products, local employment, and benefits for the officials themselves. As a major means of attracting investors to establish in their area, local government very often over-state the availability of raw materials, and then go

¹¹ “Beef quality grades” (NY/T 676-2003) issued on July 30, 2003 by the Ministry of Agriculture and enacted on October 1, 2003.

about building a “production base” (*shengchan jidi*) by mobilising the extension system (through breeding, feeding and veterinary services), by “encouraging” households (through subsidised infrastructure and loans) and by “organising” households administratively (through townships, villages, associations and co-operatives).

Another crucial aspect of securing raw material supply is to formalise marketing arrangements. Modern abattoirs are not confident in the capacity of the “traditional” or decentralised marketing system (dominated by local rural markets and dealers) to consistently supply large homogeneous lines of cattle to specification. They therefore seek to establish more formal and direct relationships with producers, especially through contracts. Contracts typically specify the age, weight, sex, body conformation, fat cover and other attributes required by the abattoir, which are linked to a pricing schedule, and contain clauses on the use of company-approved veterinary products and feed additives.

In order to determine the incentives for households to enter into and adhere to contract production systems, contract parameters were run through a model of a specialised cattle producing household (described in Section 5 below). The models suggest that contract specifications are within the technical capacities of specialised households and that households have strong economic incentives to enter into and meet the contracts terms. Together with local government “encouragement” and “organisation”, this explains why some newly-established large abattoirs (with a slaughter capacity of 70,000 head) have been able to establish contracts with up to 10,000 cattle producing households in a supply area.

While some survey-based studies suggest that contract farming is proceeding relatively smoothly from the perspective of both households and enterprises (Guo *et al.*, 2007), a very different picture emerges in the beef industry. Return visits, highly knowledgeable industry observers and officials, and indeed an industry consensus suggest very strongly that formal supply contracts in the beef industry have been replaced with more flexible and informal supply arrangements. Furthermore, nearly all large modern abattoirs complain about not been able to source enough cattle to specification, and must therefore make up shortfalls through the purchase of variable product on the open market. Factors such as these may help to explain the low incidence of contract farming in surveys such as Shen *et al.* (2005).

Formal contract systems break down due to conduct from both contract parties – households and abattoirs. Household producers renege on contracts by selling cattle on the open market to take advantage of short-term price movements, rather than adhering to the discipline of a long-term feeding regime to meet contract terms. Abattoirs under enormous pressure to reduce cattle purchase costs (as established in Section 3) do so mainly by downgrading product. There is considerable scope to downgrade product using “on the hoof” purchasing methods because many attributes of the live animal are estimated subjectively “by eye”. In a bid to increase the specificity and objectivity of measurement, there has been an increase in “over the hooks” purchasing based on measurement of the carcass, especially in the pig industry. However, many beef

industry observers and interviewees believe that abattoirs systematically misreport slaughter results, in which case producers have no way of verifying the results. Slaughter results are not verified by a third party and producers are not allowed inside the abattoirs (for food safety reasons) to see for themselves. There are strong parallels in the pork and dairy industries. Grade-price discounting is so common in Chinese agriculture that a specific Chinese term (*yaji, yajia*) has evolved.

Using contract specifications and the specialised fattening household model described in Section 5, the impact of grade-price discounting on household returns can be estimated. If the household incurs the costs of producing a Grade A bull, but is paid Grade B prices (Rmb9.6 per kilogram liveweight rather than Rmb10), then the net returns of the household are halved (but are still positive). While the price differentials between Grade A and Grade B product appear to be small on a unit basis (Rmb0.4 per kilogram liveweight), the “savings” for abattoirs are very substantial when multiplied over 70,000 bulls, each weighing 600kgs, to total Rmb16.8 million over the year. This can make the difference between an abattoir reporting a profit or a loss over the year.

5. Modern production

The modernisation of agriculture extends down to production structures including large plantations, greenhouses, piggeries, broiler and layer plants and, in the case of cattle, feedlots. There are widespread concerns internationally that large-scale producers will grow in relative importance due to technical and scale efficiencies, quality control systems, and in response to tighter disease, food safety or environmental (effluent) regulations, and thereby crowd out smaller household producers (De Haen *et al.*, 2003; Pingali, 2007; Delgado *et al.*, 2003). This will not occur in the Chinese cattle production sector.

Scale of production data records only 200 “large” feedlots in China (which are small by international standards with a turnoff of just 1,000 head per year), which constitute an insignificant – and declining – proportion of the cattle turned off in China. In contrast, there are around half a million specialised households in China that turn off between 10 and 100 cattle per year, which turned off 27% of China’s cattle in 2005, up from 21% in 2003 (Editorial Board of the China Animal Husbandry Yearbook, Various years). These scale patterns for cattle fattening are not dissimilar to those in the pig and sheep/goat industries, although scales of production are much higher in the layer and broiler industries where technical and scale efficiencies have a greater impact on relative profitability. Another reason why small household producers will not be marginalised by “large modern producers” in the beef industry is that fattening units source their feeder cattle (or calves) from smaller unspecialised cow-calf households. Except in the extensive grazing systems of the pastoral region, there are no large-scale cow-calf farms in agricultural parts of China.

Further insights into the modernisation of production structures can be gained through the budgeting of various production structures, the most relevant to modern supply chains being feedlots and specialised

fattening households. Based on a synthetic budget of a representative feedlot, Table 2 presents the input-output choices of the feedlot and the impact on net returns.¹²

Table 2: Impact of input–output price relativities on net returns to representative medium sized feedlot, 2006

Inputs		Outputs			
		416kgLW, 83 days on feed Rmb8.7/kgLW	416kgLW, 83 days on feed Rmb9/kgLW	500kgLW, 150 days on feed Rmb9.3/kgLW	600kgLW, 230 days on feed Rmb9.6/kgLW
	Rmb8/kgLW	61	185	393	625
312kg LW,	Rmb8.7/kgLW	-158	-33	175	406
500 days old	Rmb9/kgLW	-251	-127	81	313
	Rmb9.3/kgLW	-345	-220	-13	219

All returns are expressed in Rmb net return per head turned off.

Table 2 indicates that feedlots have strong incentives to produce heavy (600kg) cattle on a long-term feed regime (230 days), in which it has a competitive advantage over other cattle production units due to the technical expertise and efficiencies involved. There are, however, limited sales outlets for these heavy cattle. As shown in Table 1 modern abattoirs can only buy heavy cattle at these prices (Rmb9.3–9.6/kg) if they are able to access high-value beef markets, an unlikely scenario for most modern abattoirs as argued in Sections 2 and 3. The lack of a viable sales outlet for heavy cattle means that the feedlot must produce lighter cattle (416kg or 500kg) on a shorter-term feed regime (90 or 150 days), which may be profitable if the per-unit input price of the feeder cattle inputs is lower than the per-unit output price of the finished cattle outputs. Budget analysis of a representative “small mechanised abattoir” reported in Waldron (2009) suggests that there is a ready market for this type of cattle and these sales prices.

The problem that the feedlot has in filling this market for lighter (416kg and 500kg) types of cattle is that it is uncompetitive with other types of producers. Based on budget analysis of a representative specialised fattening household¹³, the sensitivities of household returns to changing (feeder cattle) input and (finished cattle) outputs were tested and are presented in Table 3. The results show that the net returns to the

¹² Longworth *et al.* (2001, Chapter 7) examine feedlot economics in China in the late 1990s based on surveys of 30 Chinese cattle feedlots. Parameters from these initial surveys were updated through further fieldwork, technical and price data in 2006 and reported in Waldron (2009). A number of different categories of feedlots were identified, of which the largest scale category is reported in this paper. The representative feedlot has a design capacity of 100 head, 100% capacity utilisation, 434 head turnoff per year, feeder cattle enter at 312kgLW (at Rmb8.7/kgLW), are fed for 108 days at an average daily weight gain of 1.25kg, on feed regimes specified in Longworth *et al.* (2001, Table 7.2). Sensitivity analysis was performed on a range of variables (technical efficiencies, feed regimes and costs), of which the most important is the relationship between the prices and attributes of inputs (feeder cattle) and outputs (finished cattle) reported in Table 2.

¹³ The economics of specialised household fattening systems in China is examined in Longworth *et al.* (2001, Chapter 6) and Waldron (2009, Section 9.2). Data is drawn from surveys in the Central Plains and the Northeast of China in 1998, calibrated with data from livestock agencies and other technical data, and updated in 2006 to establish a representative specialised fattening household operation. The representative household turns off 36 head per year, with an average daily weight gain of 0.83 kilograms per day. The budgets detail costs, revenues and returns to major household activities including cattle production based on a reconciliation of items such feed, labour, manure and other inputs.

production of 416kg and 500kg finished cattle were higher than those of feedlots under a large range of scenarios.

Table 3: Impact of input-output price relativities on net returns to representative specialised cattle fattening household – Rmb/head, 2006

Inputs		Outputs			
		312kgLW, 135 days on feed Rmb8/kg LW	312kgLW, 135 days on feed Rmb8.7/kg LW	416kgLW, 260 days on feed Rmb9/kg LW	500kgLW, 362 days on feed Rmb9.3/kg LW
200kg LW, 12m.o	Rmb7.7/kg LW	-38	181	577	824
feeder (from	Rmb8/kg LW	-98	121	517	764
unspecialised cow-	Rmb8.4/kg LW	-178	41	437	684
calf household)	Rmb8.7/kg LW	-238	-19	377	624

All returns are expressed in Rmb net return per head turned off.

The comparison of the budgets of feedlots and specialised fattening households suggests that the household producers will not be displaced by larger feedlots. The lower (capital, labour and transport) costs structures of households are not offset by the higher technical efficiencies of feedlots for all but the production of very heavy cattle, for which there is a small and uncertain niche market. These findings suggest that policy measures to support feedlots will not be sustainable or cost-effective.

6. Conclusions

The logic behind China’s agricultural modernisation drive is discernable. Low-value agrifood chains generate very small margins and returns to chain participants and, especially in the case of the household slaughter sector, produce unhygienic and unsafe food (Brown *et al.*, 2002; Waldron, 2009, Chapter7). However, there are high risks in attempting to fast-track the development of modern, high-value and large-scale structures, as argued in this paper. Rather than attempting to “skip” development phases, more emphasis should be placed on the development of mid-value structures. When the series of budget exercises reported in this paper are repeated for mid-value structures, a much more optimistic and viable picture emerges (see Waldron 2009). The notion that China should take an incrementalist rather than fast-tracking approach to the development of the beef industry appears to be broadly applicable to other livestock industries including sheep meat, wool, dairy and perhaps pork where scale and technical efficiencies of large-scale structures are not offset by higher cost structures, but may not be relevant to industries such as poultry where large modern structures may hold a competitive advantage over other structures, even in the supply of mid- or low-value markets.

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