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Forecasting Chinese Pork Demand

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Zusammenfassung

Im sich schnell entwickelnden globalen Kontext der Fleischproduktion spielt China als grösster Markt eine Schlüsselrolle. Weltweit wird die Hälfte allen Schweinefleischs in China produziert. Gleichzeitig konsumiert China 50 % der weltweiten Produktion. Drei Jahrzehnte ökonomischen Wachstums und der Beitritt der Volksrepublik zur Welthandelsorganisation (WTO) im Jahr 2001 brachten wichtige Veränderungen für den chinesischen Fleischmarkt. Veränderte Ernährungsgewohnheiten, ausgelöst durch wachsende Einkommen und die Urbanisierung haben die Fleischnachfrage erhöht. Die langfristigen Folgen des Beitritts Chinas zur WTO und dessen Auswirkungen auf den chinesischen und den globalen Fleischmarkt werden sich im nächsten Jahrzehnt zeigen.

Die Einflüsse auf die chinesische Schweinefleischnachfrage werden anhand einer Nachfrageprognose modelliert. Diese Prognose zeigt, dass die Nachfrage nach chinesischem Schweinefleisch in den nächsten zehn Jahren weiter wachsen wird, und bis ins Jahr 2015 80 Millionen Tonnen erreichen wird. Ob China in Zukunft zum Nettoimporteur oder Nettoexporteur wird hängt von der Fähigkeit des chinesischen Fleischsektors ab, neue Technologien einzusetzen, die Lebensmittelsicherheit zu verbessern, und seine allgemeine Konkurrenzfähigkeit zu verstärken.

Abstract

In the dynamic global context of livestock production, China plays a key role as the largest market. Half of the worldwide pork production takes place in China. The last three decades of economic growth and the China's accession to the World Trade Organisation (WTO) in 2001 have brought about important changes in the Chinese livestock market. Changing food consumption patterns, due to increasing incomes and urbanisation have increased the demand for meat. The longer-term consequences of China's acces-

sion to the WTO and its direct impact on the Chinese and global meat market will become apparent over the next decade. To assess the potential impacts on the Chinese and global meat markets a demand forecasting model for pork is developed (Pork is the most consumed meat in China). Key factors such as rural to urban migration, rural income and regional diversity of demand are investigated. These forecasts show that the Chinese demand for pork will increase further in the next decade, reaching about 80 million tons. Whether China will become a net exporter or a net importer of meat depends on the capacity of the Chinese livestock sector to adopt new technologies, increase food safety and the competitiveness of the sector.

Keywords: China, pork, demand forecasting, province, rural-urban

1. Introduction

China is the world's largest pork producer and consumer, with 50 % of worldwide production and very little trade, when compared to its 50 million tons' market. In 2004, China was the World's sixth largest net importer of pork, with over 270 thousand tons trade deficit (FAOSTAT 2006). Pork is the most important meat type in the Chinese diet with 80 % of the total meat consumption.

With the systematic liberalization of the Chinese economy as a whole and the subsequent accession to the World Trade Organization (WTO) in 2001, the country experienced a steady yearly gross domestic product (GDP) growth of almost 10 % for now 30 years. Due to the increased income of a large fraction of the urban population and changing food consumption patterns, pork has increased dramatically, while staple food consumption decreased. This increased demand of pork is almost completely satisfied by a steadily growing domestic livestock sector. Pork production is also an important provider of cash income for rural households, which represent 800 million people (FAOSTAT 2006). In regard of recent events in the rural areas of China, future developments affecting the situation of these populations should be investigated carefully (Schoettli 2006a-d). Because pork is a demand driven market, predicting the demand for meat in the future is important for policy decisions, therefore scientists and renowned institutions use to make such forecasts regularly (Fangquan 1998; FAPRI 2006b; OECD 2006; Simpson 2005).

2. Theoretical Background

The demand for pork (D) depends on a number of factors. The most important are income (Y) and price (P). High income classes spend more money on meat than low income classes (Seale Jr. et al. 2003). Regional consumption of pork is further influenced by cultural habits: for example, there are regions in China with a high percentage of muslims, thus with a very low consumption of pork. This effect is taken into account by including regional effects (G). The rural and the urban areas have differing consumption patterns that are due both to economic and cultural factors, which translate into effect (A). The population of the various regions differs greatly, too. Certain provinces have a very large urban share (R), such as Shanghai, others are mostly rural, such as Yunnan.

Therefore, the demand for pork can be expressed as follows: $D = f(Y, P, G, A, R...)$. We assume that the price stays constant for the next decade, based on the forecast by the Food and Agriculture Policy Research Institute (FAPRI 2006b), while, due to differing assumptions, the Organisation for Economic Cooperation and Development (OECD) forecasts a price increase of 20 % to 30 % for the same period (OECD 2006).

The income elasticity is critical for demand projections. It measures the consumer responsiveness to changes of the quantity demanded to a unit change in income (Regmi et al. 2001). Elasticity estimates for Chinese pork vary greatly among studies, due to differing data sources, computing methods and quality of data (Cai et al. 1998; FAPRI 2006a; Gould and Villarreal 2006; Hansen et al. 2005; Huang and Rozelle 1998; Katchova and Chern 2004; Ma et al. 2003; Tuan et al. 2001). The income elasticity of meat decreases with increasing income (Seale Jr. et al. 2003). This inverted relationship of income and elasticity for pork makes it crucial for demand estimates to characterize the population and income structure as precisely as possible, and to include population predictions in demand forecasts. Average per capita income in China has grown proportionately to the GDP growth, while the income distribution has become more unequal (Perkins et al. 2001). This means that the income did not increase equally for every person, and thus, the food consumption pattern did not change uniformly. Because reliable income and economic forecasts are made only at the national level, it is necessary to keep in mind the distribution component.

There are differences between urban and rural populations, especially regarding income, but also with regard of cultural and thus product preferences. Therefore, it is necessary to look at the two areas separately. At the same time, the large rural to urban migration, which is expected in the coming decade, distorts population estimates (Mevenkamp 2002; Toth et al. 2003). Because the eastern, coastal provinces (such as Shandong, Jinagsu, Shanghai, Zheijiang, Fujian and Guangdong) of China are developing at a much higher rate than the more western, landlocked provinces (such as Sichuan or Hubei), they are likely to experience a much faster growth in urban population (Arayama and Miyoshi 2004). Moreover, the eastern provinces are the destinations of most of inter provincial migration, which is at the same time rural to urban migration. This discrepancy between single provinces and regions of China led us to create five "macro-regions"[1]. These regions allow investigating developments at a larger scale than at provincial level, also taking into account aspects such as the access to the sea, the climate and the economic situation.

The massive change in population structure influences the change in demand because people with an urban lifestyle eat more meat than rural people. At the same time, many people in rural areas are self-sufficient. When they move to the city, they begin to buy meat and other foodstuffs, while they weren't participating in the marketplace before.

The five factors described above can be measured using available statistical data. For a forecast, though, they must be estimated. Our approach excludes variations in price[2], while it uses the income elasticity (ε_I) and the income change (ΔY), using provincial, urban and rural datasets. Furthermore, population changes (ΔPop) are accounted for at the same levels. Therefore, for each province and area, we have the following: $\Delta D = f(\Delta Y, \varepsilon_I, \Delta Pop)$.

[1] North: Beijing, Tianjin, Hebei, Shanxi, Inner-Mongolia, Liaoning, Jilin, Heilongjiang, Jiangxi, Shandong, Henan. East: Shanghai, Jiangsu, Zheijiang, Anhui, Fujian. Central: Shaanxi, Hubei, Hunan. South: Guangdong, Guangxi, Hainan. Southwest: Sichuan, Guizhou, Yunnan, Tibet, Gansu, Qinghai, Ningxia, Xinjiang, Chonqing.

[2] We assume that the prices stay constant over the next decade, based on the FAPRI forecast and open markets in China. Price increases are immediately compensated by cheaper imports, while price decreases lead to increased exports.

How do population and income changes affect the rural and the urban demand for pork in China? How can these changes be accounted for in a demand forecasting model? These questions constitute the core of this article and are analyzed in the following.

First, the methodology of the forecasting model is described. Second, the main results are presented and discussed, and third, conclusions are drawn about the future of the Chinese pork market.

3. Forecasting Model - Methodology

Prices are assumed to stay constant over the forecasting period of ten years. Consumption data was retrieved from the Chinese National Bureau of Statistics (NBS) and the Food and Agriculture Organization (FAO) statistics division. Several institutions provide surveys that are relevant for the demand model. Data is often conflicting and thus correction factors must be used to compensate for inconsistencies. In this study, elasticity estimates are regionalized, based on the data by Ma et al. (2004), where for most Chinese provinces elasticity estimates exist. For the ones without an estimate, the national average of 0.62 is used. The national average urban per capita pork consumption is 19.19 kg. This figure is based on 12 Western province statistics (NBS 2005), where 17.43 kg represent 91 % of the national average. Urban food expenditure is available for each province and was transformed arithmetically into per capita demand. Pork demand was modelled as follows:

$$D_{(t+1)} = \sum_{j=1}^{31} D_{j,(t+1)} \quad \text{for } j = 1, 2, \ldots, 31.$$

$$D_{j,(t+1)} = \sum_{k=1}^{2} (D_{jk,(t+1)} * Pop_{jk,(t+1)}) \quad \text{for } j = 1, 2, \ldots, 31 \text{ and } k = 1, 2$$

$$D_{jk,(t+1)} = D_{jk,(t)} + \Delta Inc_{k,(t)} * e_{jk} * D_{jk,(t)} \quad j = 1, 2, \ldots, 31 \text{ and } k = 1, 2.$$

Where: $D_{(t+1)}$ is the total demand for pork in China in year t+1; $D_{j,(t+1)}$ is the total demand for pork in province *j* in year t+1; $D_{jk,(t+1)}$ is the per

capita demand for pork in year t + 1 in region *j* for area *k*; $Pop_{jk,(t+1)}$ is the population in year t+1 in region *j* for area *k*; $D_{jk,(t)}$ is the per capita demand for pork in year *t* in region *j* for area *k*; $\Delta Inc_{k,(t)}$ = change in per capita income in area *k* for year t; e_{jk} = income elasticity of demand for pork in region *j* for area *k*; *k* = Rural or urban area; *j* = 31 provinces of China. Rural development policies and income growth affect meat consumption. In order to investigate the effects of some policies on the future demand of pork, scenarios are calculated for the rural to urban migration and population development (based on Toth et al. 2003) and for the income distribution between urban and rural areas.

The population scenarios are retrieved from an in depth study by Toth et al. (2003), which included fertility (expressed in total fertility rate, TFR), life expectancy, and rural to urban migration parameters (see Table 1). Furthermore, the scenarios are divided between the rural and urban area, which allows taking into account migration. Not surprisingly, the scenarios do not vary much, as Chinese fertility is at a very low level and large proportional changes do not cause a large absolute change. Rural to urban migration is assumed to be at least 250 million over 30 years. For 2015, the expected figures vary less. The different scenarios are based on the changing conditions of rural inhabitants, mostly based on economic development. The “Central” scenario is the baseline, with a slightly increased fertility, life expectancy, and rural to urban migration of 287 million until 2030. Another scenario (Low1) stipulates strong growth of income, both in rural and in urban areas, which causes fertility and migration to decrease. The “Low 2” scenario describes increased incomes in urban areas, without redistribution to rural areas that causes an increased migration, while the other parameters stay the same. An increase in migration can also be due to, say, a liberalization of the Chinese migratory policy. Another scenario (High 1) assumes lower economic development, increased TFR, but declining life expectancy and rural to urban migration. The “High 2” scenario suggests uneven economic growth between urban and rural areas, or a more liberal migratory policy, that would in turn lead to an increased migration.

Table 1: Population scenario parameters

	Urban		Rural	
Scenario	**2000**	**2030**	**2000**	**2030**
Central				
TFR	1.58	1.58	1.98	1.98
Life expectancy	♀: 75.58	♀: 78.93	♀: 71.00	♀: 75.44
	♂: 71.57	♂: 75.32	♂: 67.89	♂: 72.39
R-U. Migration (Million)	287.831		-287.831	
Low 1				
TFR	1.58	1.42	1.98	1.85
Life expectancy	♀: 75.58	♀: 79.54	♀: 71.00	♀: 75.44
	♂: 71.57	♂: 76.14	♂: 67.89	♂: 72.39
R-U. Migration (Million)	250.286		-250.286	
Low 2				
TFR	1.58	1.42	1.98	1.85
Life expectancy	♀: 75.58	♀: 79.54	♀: 71.00	♀: 75.44
	♂: 71.57	♂: 76.14	♂: 67.89	♂: 72.39
R-U. Migration (Million)	360.571		-360.571	
High 1				
TFR	1.58	1.64	1.98	2.11
Life expectancy	♀: 75.58	♀: 78.21	♀: 71.00	♀: 74.87
	♂: 71.57	♂: 74.5	♂: 67.89	♂: 71.79
R-U. Migration (Million)	249.201		-249.201	
High 2				
TFR	1.58	1.64	1.98	2.11
Life expectancy	♀: 75.58	♀: 78.21	♀: 71.00	♀: 74.87
	♂: 71.57	♂: 74.5	♂: 67.89	♂: 71.79
R-U. Migration (Million)	363.772		-363.772	

Source: Toth et al. 2003

For the purpose of the forecasting model, we developed a second set of scenarios, so-called "income scenarios" (see Table 2). They are based on the population scenario "Central", with average values for fertility, migration and life expectancy. The population values are held constant among all income scenarios. Furthermore, in all income scenarios, urban income is assumed to increase proportionally to the GDP forecasted by the OECD (2006). The baseline income scenario for the rural areas is that income is growing at this same pace (Average). In scenario "Income 1", a slight redistribution policy towards rural areas is assumed, which increases rural incomes by 10 %. In scenario "Income 2", we assume that the rural areas have an income growth that is 20 % slower than the urban areas. Scenarios "Income 3" and "Income 4" are extreme versions of the scenarios "Income 1" and "Income 2".

Table 2: Rural income growth scenario parameters

Scenario	Urban income growth	Rural income growth
Income 0		Average
Income 1		Higher (+10 %)
Income 2	Average	Lower (-20 %)
Income 3		Much higher (+20 %)
Income 4		Much lower (-50 %)

4. Results and Discussion

Population and income distribution have an effect on the demand forecast for 2015. The demand differs most between rural and urban areas and less between totals in the five population scenarios. The rural to urban migration compensates the decreases in rural consumption with an increase in urban consumption. The compensation happens through two main mechanisms. The first mechanism is the increased urban population, because of the higher life expectancy and, mainly, because of rural to urban migration. The second mechanism is the increased income of the new urban population compared with the income the migrants had in rural areas (see Figure 1). The "Low 2" and "High 2" scenario, which assume a high rural-urban migration, have a much lower rural consumption than the other three scenarios (33.31 million tons and 33.71 million tons, respectively). The low migration results in rural demand of 36.66 million tons for the "Low1" scenario and 36.82 million tons for the "High1" scenario. The average difference between the two low migration scenarios ("Low 1" and "High 1") and the two high migration scenarios ("Low 2" and "High 2") is of 3 million tons of pork. This represents 13 % of today's rural pork demand. For the urban areas, the two different migration scenarios result in a difference of pork demand of about 3.85 million tons between the "Low 1" and the "Low 2" scenario and 4.54 million tons between the "High1" and the "High 2" scenario. These differences represent 14 % of today's pork demand.

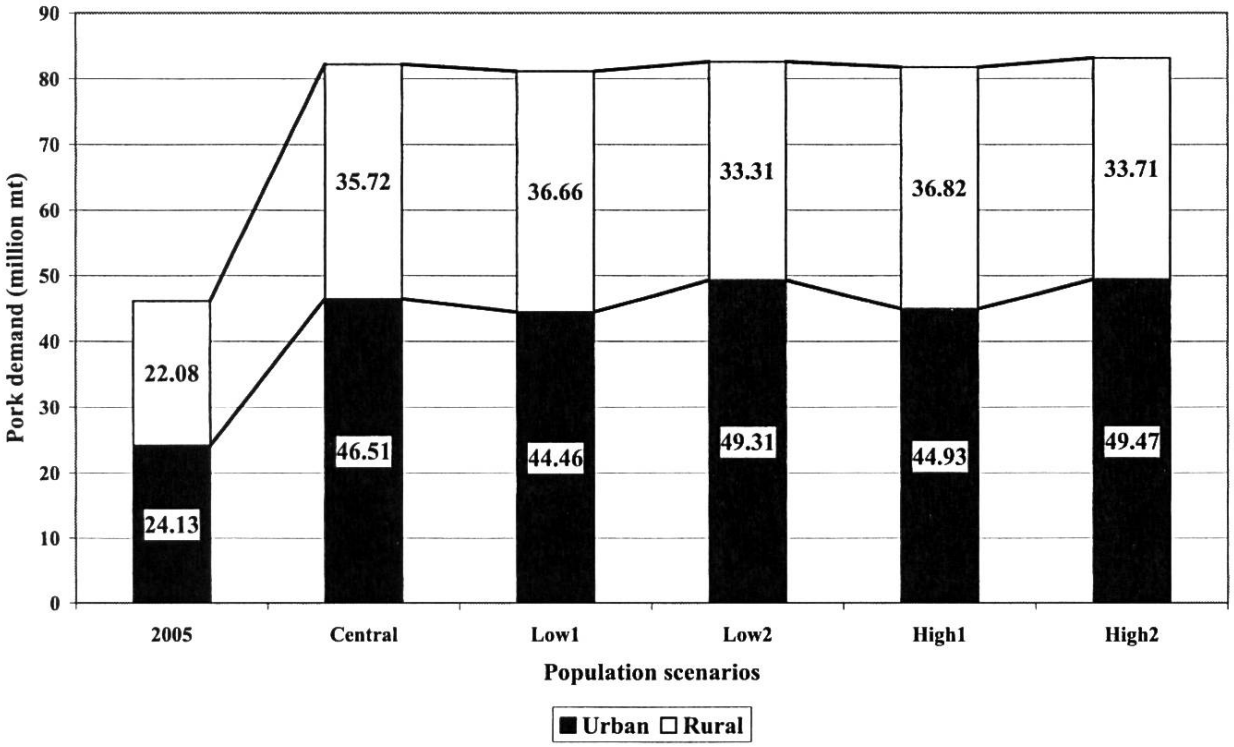

Figure 1: Chinese national demand for pork under varying population scenarios.

The difference in urban demand between the "Low1" and the "High 1" (0.47 million tons) scenario is due to different TFR and different life expectancy. These two factors also result in the small difference between the "Low 2" and the "High 2" scenario (0.16 million tons). The rural demand for pork is also slightly influenced by varying TFR and life expectancy. The difference between the "Low1" and the "High1" scenario is 0.16 million tons. The difference between the "Low2" and the "High2" scenario is 0.4 million tons. These differences are less than 2 % of today's rural demand for pork. The Central scenario lies in between the four scenarios mentioned earlier. The demand for pork equals 35.72 million tons in the rural areas and 46.51 million tons in the urban areas. This represents an increased pork demand of almost 100 % in the urban areas and 75 % in the rural areas over the next 10 years.

These results show that the rural to urban migration will have an important impact on future urban demand for pork. The migration has a slightly larger effect on urban demand than on rural demand. Therefore, the effects of policies on the economic development of the rural areas become highly relevant. The forecast of rural to urban migration should therefore be included in a demand forecasting model.

Regional effects on pork and poultry demand can also be observed in the model (see Figure 2). Differences arise mainly between the Southern region and the rest of the country. The South experiences a much more dynamic growth than the four other regions. It is quite surprising that there are not more differences between the five regions than this one, as the natural and demographic variations between regions would lead to expect. However, the 31 provinces of China have very differing growth rates of pork demand, even between provinces of the same region (Figure 3). As an example, the Southern region consisting of Guangdong, Guangxi and Hainan shows a wide range of demand growth rates. While Guangxi has about a 82 % growth rate over 10 years, Hainan's pork demand grows 96 % and Guangdong even 122 %. The same can be observed within the other four macro-regions. Liaoning, which is located in the North of China, shows the lowest expected pork demand increase. Three other provinces located in the North, namely Heilongjiang, Inner Mongolia and Tianjin have very low demand growth rates as well. At the same time, Hebei and Beijing in the Northern region are among the top 50 % growth rates. The province of Tibet shows the highest increase of pork demand (132 %). This increase is mainly due to the presently low demand for pork (115 thousand tons in 2005).

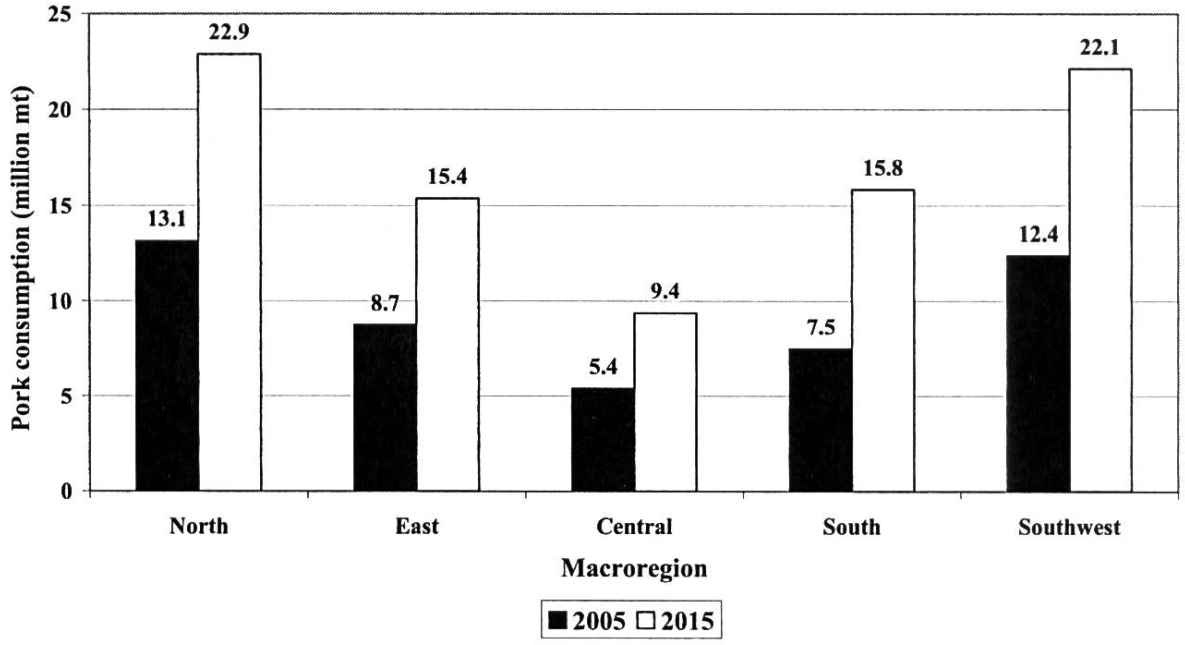

Figure 2: Regional effects on pork consumption forecast in five Chinese macro-regions.

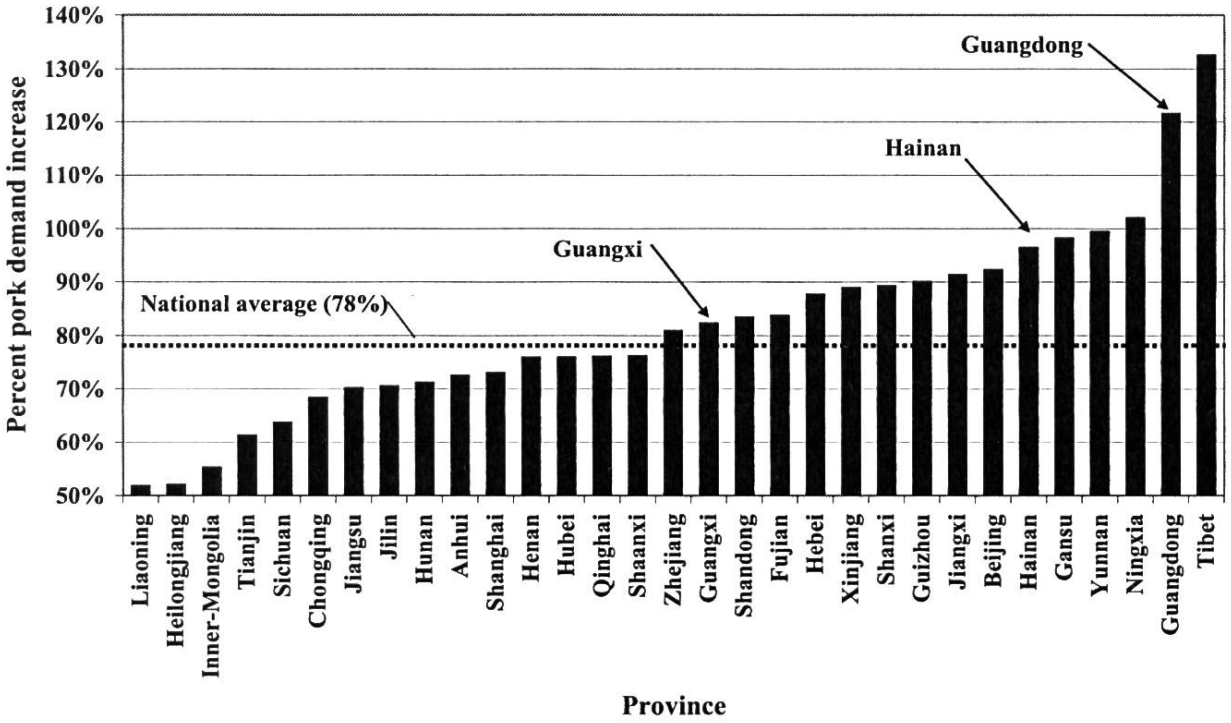

Figure 3: Pork demand growth in Chinese provinces.

The heterogeneity of pork development in China is much higher between provinces than between regions. Why are there such large differences between provinces if it is not due to macro regional effects, such as the climate? The reason is that the forecasted growth of demand is much higher in the urban areas than in the rural areas. In total, the urban areas are expected to increase pork demand from today 24.13 million tons to 46.51 million tons in 2015, which is about as much as the present total Chinese meat demand. The urban meat demand would thus increase by 92 %.

The rural areas experience a slower demand growth. From today's 22.08 million tons, they increase demand to 35.72 million tons (a 61 % increase). A very large part of the difference in provincial demand for pork arises from differing urbanisation levels between provinces. The provinces with a larger share of the population living in urban areas most probably have a higher demand growth for pork than regions with low demand growth.

Given the increased share of urban demand in the total demand for pork, the question that arises is what effect the rural income will have on total demand.

Most of the pork demand increase will be in urban areas, especially in the already much urbanised provinces, e.g. Beijing, Shanghai and Guangdong. The present distribution of pork demand is almost equal: 22.08 million tons in the rural areas and 24.13 million tons in the urban areas. In the next ten years, with rural to urban migration and population growth, the distribution will change to 35.72 million tons in rural areas, while urban areas consume 46.51 million tons. This is a difference of almost 11 million tons. Scenario "Income 1" and "Income 3" show what happens if the rural areas had an increased GDP growth rate of 10 % and 20 %, respectively (see Figure 4). The total demand for meat increases by almost 1.89 million tons for "Income 1" and 3.87 million tons for "Income 3". This represents 4.3 % and 8.6 % of today's total demand for pork, respectively. "Income 2" and "Income 4" assume a lower GDP growth rate for rural areas of 20 % and 50 %, respectively. The quantitative decrease in total demand for pork compared with the base line is of 3.54 million tons for "Income 2" and 12.12 million tons for scenario "Income 4". This is comparable to the total demand of more than twice the province of Guangdong, the largest meat consumer in China today.

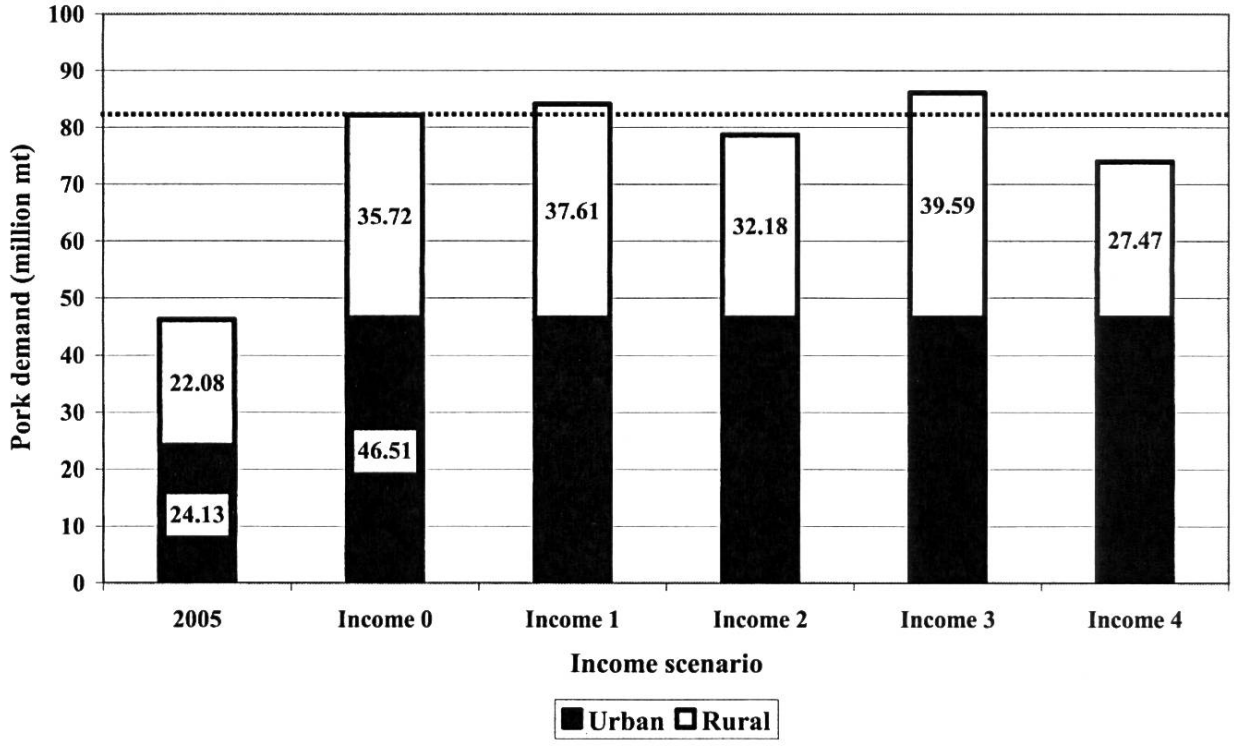

Figure 4: Effect of rural income variations on the demand for pork in China.

The effect on pork demand of a 20 % increase in rural income pork does not have the same magnitude as the effect of a 20 % decrease. If rural income increases 20 %, there is a smaller effect than if income decreases 20 %.

The effects of rural income growth on the total demand for pork are thus quite large. The reason can be that the income elasticity of the rural areas is quite high. Income distribution policies are receiving more awareness by the Chinese government (Huang et al. 2006). This will have an effect on the future demand for pork.

The effect of income variations on the urban demand for pork was not investigated further. It can be expected though, that the effects will be very similar because the underlying model is the same.

It is safe to state that by 2015, China will consume around 80 million tons of pork, which represents a 100 % increase compared to 2005[3]. Rural per capita consumption will increase around 120 %, under realistic income growth expectations, 50 % under pessimistic rural income growth expectations (scenario "Income 4"). Urban per capita consumption will grow 50 % under our assumptions. Urban demand share will increase to about 60 % compared with today's 55 %. In case the rural economic growth progresses slower than urban growth, urban share in pork demand may even reach 65 % of total demand. This may require adaptation of distribution infrastructures and probably modified production systems.

Overall, urban consumption stays larger than rural pork consumption and keeps growing faster. At provincial level, rural income growth does not have a large effect in comparison with urban consumption. Most of the pork consumption will definitely take place in urban areas.

5. Conclusions

The Chinese meat sector is one of great complexity. The demand is influenced by the changing population structure, rural to urban migration, increasing incomes and thus changing food consumption patterns. Regional factors also play an important role for demand. The data that

[3] Based on the assumptions regarding income elasticities and population change. See "Forecasting Model".

describes the various factors is mainly provided by the Chinese governmental agencies. Due to the intricacy of the data collection and sheer size of China, sound data is difficult to produce.

One of the key challenges of this study was to find reliable data in order to produce sound results. This was done in the demand forecasting model. Most of the data in the forecast is based on the statistics of the National Bureau of Statistics of China. The FAO statistics database and the USDA Economic Research Service are the two main foreign data sources. These two institutions are tributary of mostly official data regarding China.

Nonetheless, we can make some predictions regarding the Chinese demand for pork. Based on the results from this study, the Chinese demand for pork can be expected to grow almost 100 % within the next decade, without price increases. China and foreign investors should therefore further increase investments into the commercial livestock sector.

In light of these conclusions, the question that arises is if this increased demand will be satisfied by the international supply, maintaining

constant prices, or if global demand will outpace global supply and lead to price increases for livestock. World market prices for many raw materials and commodities have increased recently, mainly due to the Chinese economic growth. This could also happen in the worldwide pork market. The pressure on the world market may well increase in the medium term because of the expected increase in Chinese import demand.

One question mark is how the downstream industries (processors, wholesalers and retailers) will perform in the future. The case study by Fabiosa et al. (2005) could be a starting point with respect to this endeavour. The cold chain is a key feature for a functioning meat distribution network. Supermarkets are facing a healthy foreign competition and distribution networks are improving steadily. At the farm level sanitary issues, especially regarding animal health are yet to be addressed. Farm sizes need to increase dramatically, in order to achieve economies of scale, improve waste management and animal health issues. The next decade will show how the Chinese pork industry manages to keep pace with the fast growing demand for pork. Foreign suppliers might be at least as interested in these developments as the domestic policy makers, investors and producers.

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