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Chinese Consumer Demand for Animal Products and Implications for U.S. Pork and Poultry Exports

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ABSTRACT

This paper examines Chinese consumer preference for major animal products and assesses the potential impacts of a reduction in China's import tariff on its pork and poultry demand and net import. Our analysis suggests that China's demand for animal products will continue to grow as income increases. Using a trade model, results of our scenario analysis indicate that a reduction in China's import tariffs will significantly increase its net pork and poultry imports and the U.S. will capture most of the increases. Nevertheless, the impact on the market price in China and the U.S. is likely to be very small.

Key Words: Almost Ideal Demand System, China, consumer demand, demand elasticity, food demand, partial equilibrium model, two-stage budgeting, U.S. meat export.

China's rapid economic growth and gradual transition toward a market economy have brought about significant changes in its food consumption patterns and trade behavior. With increased income and improved market accessibility, Chinese consumers, especially those in urban areas, are shifting their food consumption from grains to meats and other high-value food products (Wang, Jensen, and Johnson). Between 1984 and 1996, China's per capita grain consumption declined from 142 kg to 94 kg in urban areas, and from 267 kg to 256 kg in rural areas, whereas the per capita consumption of meats, eggs, milk, vegetable oils, and fruits increased significantly in both urban and rural areas (State Statistical Bureau of China). As a result of the ongoing transition in food consumption patterns, extremely limited per capita arable land, and significant reductions in import restrictions, China's food imports have increased dramatically in recent years. For example, China's corn trade reversed from a net export of 11.1 million metric tons (MMT) in 1993 to a net import of 5.2 MMT in 1995, while total grain imports increased from 7.3 MMT to 20.4 MMT over the same period. China has also substantially expanded its imports of high-value food products such as edible oils—which jumped from 1.1 MMT in 1993 to 3.7 MMT in 1995 [U.S. Department of Agriculture (USDA) 1996].

Changes in China's food situation and trade behavior have important implications for U.S. agricultural exports. China has been a large buyer of U.S. wheat since the late 1970s, and

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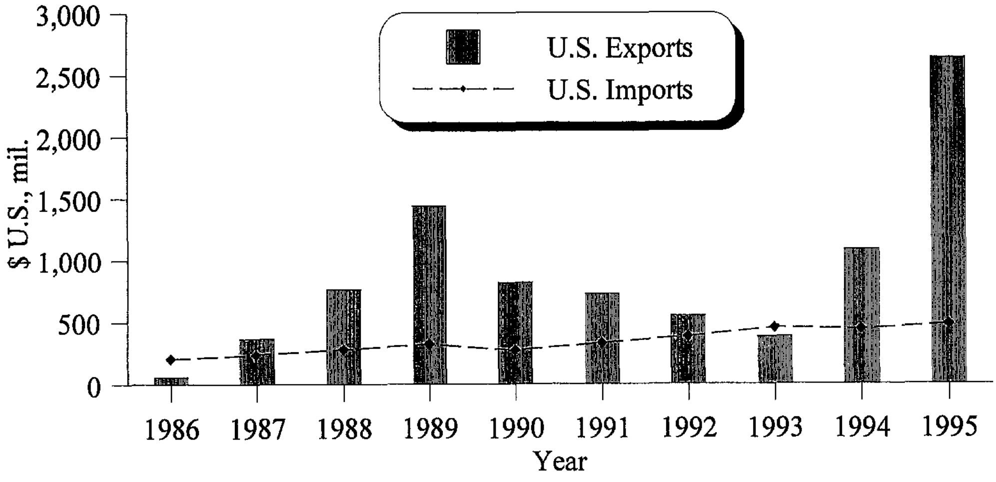

Figure 1. U.S. agricultural trade with China, 1986–95

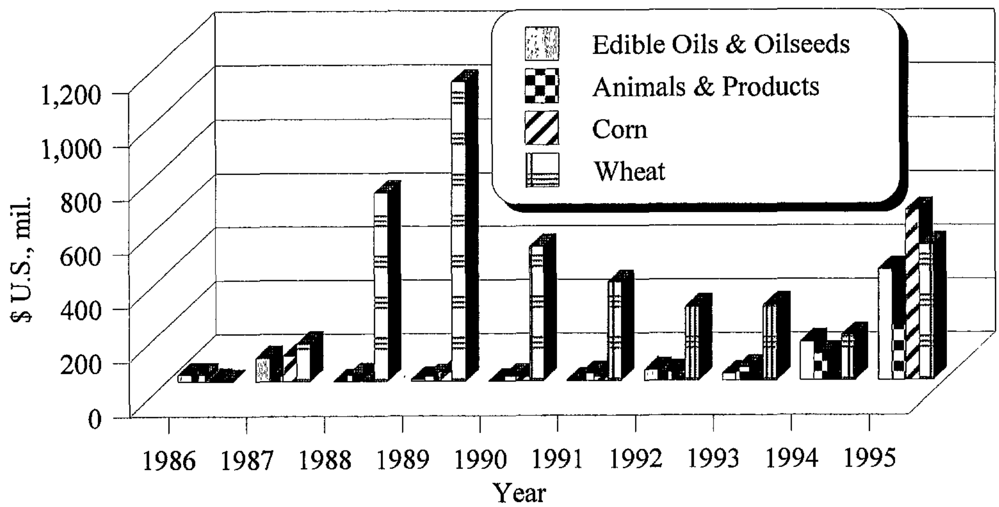

Figure 2. U.S. agricultural exports to China, 1986–95

is gradually becoming a major importer of many other U.S. food products such as corn, vegetable oils, and broiler meat. Figure 1 indicates that U.S. agricultural trade balance with China reversed from a deficit of $74 million in 1993 to a surplus of $640 million in 1994, and then jumped to a record surplus of $2,154 million in 1995. This significant turnaround in U.S. agricultural trade with China is important for the U.S. to narrow its trade deficit with China, which increased from $1.7 billion in 1986 to $34 billion in 1995. Figure 2 shows the changes in U.S. agricultural exports to China for four products: wheat, corn, edible oils and oilseeds, and animals and products. While U.S. wheat exports to China have declined since 1989, exports of the other three products have increased dramatically in recent years. Between 1993 and 1995, U.S. exports to China increased from $26.2 million to $409.6 million for edible oils and oilseeds, from $48.7 million to $204 million for animals and products, and from zero to $629 million for corn (USDA 1996).

In spite of the rapid growth in U.S. agricultural exports to China in recent years, China is still viewed as a tough market by many U.S. food marketers because of its many nuances and subtleties that are not well understood by U.S. producers and marketers. Institutional barriers such as import quotas and tariffs are partly to blame, but it cannot be denied that a simple lack of information and study of the underlying mechanisms of the Chinese market also contribute to the difficulty faced by U.S. traders. China's trade liberation has been limited in many respects, but there is evidence that China's food demand and trade behavior are increasingly determined by consumers.

The major objective of this study is to examine Chinese consumer preference for major animal products and to assess the potential impacts of a reduction in China's import tariff on its pork and poultry demand and net import. The following sections review the trends in China's meat markets, present the results of an empirical demand analysis and a scenario analysis of the impact of a liberalization of Chinese pork and poultry markets, and summarize major conclusions.

Trends in China's Meat Market and Implications for U.S. Exports

Data on China's annual meat production since 1984, presented in figure 3, suggest two major trends. First, total meat production has increased gradually from 16.946 MMT in 1984 to 59.151 MMT in 1996. Second, the growth rates for poultry, beef, mutton, and other meats have been significantly higher than that for pork. The share of pork has declined from 85.25% in 1984 to 68.26% in 1996.

The gradual shift from pork to beef and poultry is motivated by an income-driven desire for variety and an increased availability of beef and poultry products at urban markets. Beef consumption in China continues to be extremely low. Most urban consumers must choose between the expensive beef that is generally sold to restaurants and tourists and a less expensive local product that typically comes from draft animals. Per capita beef consumption is much higher in the pastoral provinces in the western regions, but the lack of a suitable and affordable transportation system has kept these interior supplies out of the prosperous coastal cities.

One very interesting aspect of Chinese meat demand is that Chinese consumers tend to discount those cuts most in demand in the U.S. and to favor those cuts that are less desired in the U.S. and European markets. For example, the white internal organs and the reproductive tracts typically sell at a price that is equal to or greater than muscle meat prices in the same markets in China. Also, bone-in chicken feet are generally sold at a premium price as compared to chicken breast meat (see Hayes and Clemens for a detailed cut-by-cut price comparison). If this taste difference continues into the future, then a very large market for U.S. variety would emerge even if U.S. muscle meats were too expensive for Chinese tastes. This type of export demand would allow the U.S. livestock industry to add values to carcasses while at the same time reducing U.S. muscle meat prices.

A second difference between U.S. and Chinese tastes involves the amount of external fat acceptable to consumers. About 80% of Chinese pork comes from "backyard" production. These animals are fed with household and farm waste, a diet that is low in some essential amino acids. As a result, animal growth rates are slow and the amount of exterior fat is extremely high. In urban markets, however, this meat sells at as much as a 30% discount to leaner meat from modern production units (Hayes and Clemens). This would seem to indicate that the presence of so much exterior fat is driven more by the needs of producers than by the will of consumers.

An Analysis of Urban Chinese Household Demand for Animal Products

Considering that most of the previous estimates of household demand for animal products in China are for highly aggregated commodity groups such as red meats, this study contributes to the literature by estimating demand elasticities for disaggregated animal products in urban China. Although our analysis is based on survey data of Chinese urban

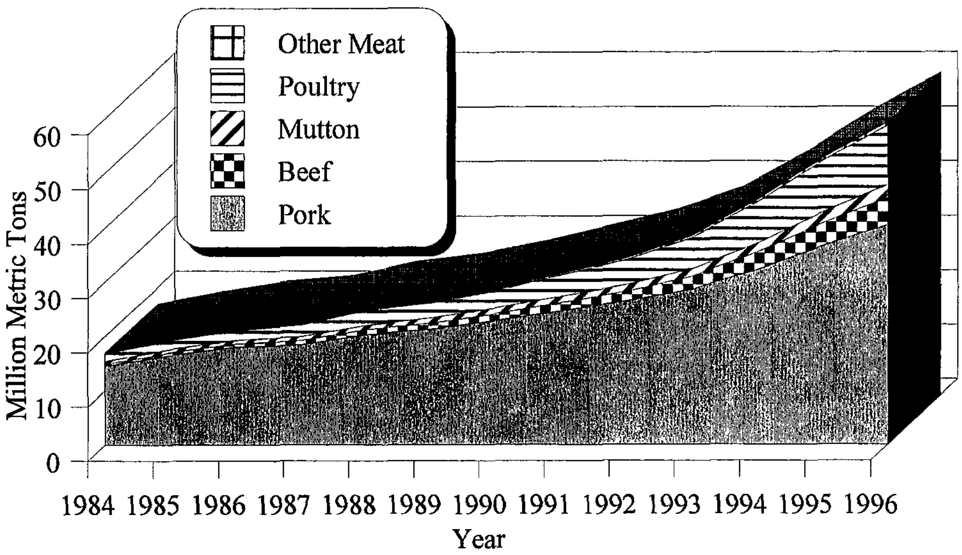

Figure 3. China's production of major animal products, 1984–96

households, the study is expected to shed some light on the general trends of consumer demand for animal products in China as rural residents follow the urban income growth patterns.

Two commonly used demand systems, the almost ideal demand system (AIDS) (Deaton and Muellbauer) and the translog demand system (Christensen, Jorgenson, and Lau), are used to estimate the demand elasticities for six animal products: pork, beef and mutton (B&M), poultry, eggs, fish, and milk in urban China. A test procedure for nonnested hypotheses proposed by Vuong is used to compare the two demand systems. Compared with the traditional nonnested test procedure through an artificial nesting model, this test procedure not only avoids the estimation of an artificial model, but also guarantees a unique conclusion regarding the relative explanatory power of the two demand models.

This study uses the most recently available data from China's National Urban Household Survey. The survey has been administered by the State Statistical Bureau of China (SSB) and implemented at the provincial level since the early 1980s. Sample households were selected by using a three-stage stratified sampling scheme: (*a*) cities were first selected from each province, (*b*) enterprises and institutions were then selected from each selected city, and finally, (*c*) households were selected from each selected enterprise and institution. The participating households were requested to keep detailed records of their daily income and expenditures by using the account books provided by the SSB. The account books were collected, examined, aggregated, and reported by local statistical agencies every month.

The data used to estimate the proposed demand models are the pooled data of sample means by seven income groups and two city groups (small versus medium and large) from 1986–92. Because the data for 1986 are available for only medium and large cities, our data set includes 91 observations (seven observations for 1986, and 14 observations for each year from 1987 through 1992). Similar data sets by income groups or provinces, but with greater product aggregation and shorter periods, have been used in several previous studies (e.g., Lewis and Andrews; Wang and Chern). The nominal expenditures are converted into real ones by using the *Urban Living Cost Index* published by the SSB. As noted, six animal products are included in the demand models: pork, beef and mutton (B&M), poultry, eggs, fish, and milk. Beef and mutton always have been aggregated into one meat group in China's statistical system. Like many other empirical demand studies using household survey data (e.g., Cheng and Capps; Gao, Wailes, and Cramer), unit values derived from expenditures and quantities are used as prices in the estimation. City size and household size are incorporated into the demand models as two demographic variables.

The maximum-likelihood estimates of the AIDS and translog demand system with homogeneity and symmetry restrictions imposed are derived using the iterated seemingly unrelated regression technique. Test results of the two demand systems based on the nonnested test procedure suggest that these two demand models are not significantly different in explanatory power for the Chinese data at the 1% significance level.

While the estimated parameters and significance tests are not reported in this paper, the expenditure and uncompensated price elasticities estimated from sample means and the estimated model parameters are reported in table 1. The estimated expenditure elasticities suggest that household demand for animal products in urban China is quite elastic for poultry, milk, and fish, but inelastic for red meats (pork, and beef and mutton) with respect to the total expenditure. Note that the estimated expenditure elasticity is very close to one for eggs. Table 1 also presents the marginal budget shares derived from the estimated expenditure elasticities and sample means of budget shares. The results suggest that Chinese urban households are likely to allocate their additional expenditure on animal products as follows: 39.1% to pork, 7.3% to beef and mutton, 17.1% to poultry, 14% to eggs, 20% to fish, and 2.5% to milk. It seems that pork will remain as the major animal product in urban China, although the demand for pork is relatively income inelastic. Furthermore, the marginal expenditure on poultry and fish in urban China is likely to increase as a result of their relatively high expenditure elasticities. Such empirical findings are quite consistent with our expectations and previous studies. For Chinese consumers, pork has been the most commonly available meat product with relatively low price, whereas poultry, milk, and fish are generally considered luxury food items with relatively high prices.

The estimated uncompensated own- and cross-price elasticities also are reported in table 1. As expected, all the own-price elasticities are negative and most of them are inelastic. The demand for animal products in urban China is likely to be elastic for poultry and fish, but inelastic for other products with respect to their own prices. One explanation for milk as the most inelastic animal product is that milk consumption in urban China has been determined basically by local supply due to extremely poor transportation and storage facilities rather than by market price. On the other hand, poultry and fish are the most price-elastic animal products because their consumption as luxury food items is highly affected by market prices.

Chinese Pork and Poultry Imports Following Tariff Reductions

It is likely that China will join the World Trade Organization (WTO) in the very near future. Given the potential for growth in China's consumption of animal products indicated in the analysis above, this event will undoubtedly send ripples across the ocean that will significantly impact U.S. export demand for meat products. The purpose of this section is to briefly explore the potential changes in China's pork and poultry trade following a significant reduction in import tariffs for these products.

In preparation for WTO accession, the Chinese government recently reduced the tariffs on pork and poultry meat imports from 45% to 20% (*China Daily*). In addition to the import tariff, the government collects a 17% value-added tax on all imported meat products, making the new effective tariff rate of 40.4%. In addition to lowering tariffs, the Chinese government's animal health agency has approved a number of slaughterhouses in Canada, Australia, and the U.S. for export of beef, pork, and poultry products to approved Chinese import companies in 1997 and 1998 (Fuell and Zhang 1997a). Despite these efforts

Table 1. Estimated Demand Elasticities for Chinese Urban Households

Animal Products	Expenditure Elasticities	Marginal Budget (%)	Marshallian Price Elasticity of Good *i* with Respect to Good *j*					
			Pork	B&M	Poultry	Eggs	Fish	Milk
Pork	0.8327	39.14	−0.8503	−0.1305	0.0876	0.0844	−0.0130	−0.0227
B&M	0.8492	7.26	−0.7002	−0.6745	0.0907	0.2301	0.1736	0.0717
Poultry	1.4895	17.11	0.0549	0.0092	−1.3362	−0.5057	0.2939	−0.0068
Eggs	0.9858	14.00	0.2380	0.1281	−0.3448	−0.7766	−0.1902	0.0132
Fish	1.1909	19.99	−0.2067	0.0544	0.2337	−0.2000	−1.0253	−0.0629
Milk	1.2689	2.50	−0.8070	0.2608	−0.0303	0.0281	−0.5703	−0.2884

to diminish the barriers to meat imports, official trade in meat products has not grown significantly in recent months. The industry perception in the U.S. is that, even at the reduced tariff rates, it is still too costly to import meat products through official channels. Unofficial transshipments and smuggling of pork products into China through Hong Kong is estimated to be as much as seven times greater than official imports (Fuell and Zhang 1997b). These "grey channels" are a viable, less expensive alternative to direct imports. However, this trade is not reflected in reported trade statistics. Lowering import tariffs to a level that makes direct import of meat products cheaper than illegal alternatives could cause a notable increase in official trade, not only due to lower import costs, but also as a result of trade shifting from "grey" to official import channels.

Using a partial equilibrium model of China's livestock and grain sectors, we have examined the impact of a 100% reduction in the official tariff rate on Chinese pork and poultry imports. The 17% value-added tax is assumed to remain in place, making the effective tariff rate in the scenario 17%. The demand side of the simulation model is divided into urban and rural components for both livestock products and grains. As in the demand analysis above, Chinese consumers are assumed to maximize a weakly separable utility function subject to their income constraint. Consequently, consumption is modeled as a two-stage budgeting process in which consumers allocate their income to broad commodity groups in the first stage, and then divide group expenditures among individual commodities in the second stage. The model does not contain a complete representation of the first-stage decision process; rather, each commodity group's share of consumer expenditures is determined by an Engle curve augmented by a price term. The livestock product group is the largest commodity group, containing beef, pork, mutton, poultry, eggs, aquatic products, and milk. The grain group includes wheat, rice, soybeans, corn, and barley. The second-stage allocations for the two commodity groups are modeled by separate almost ideal demand systems (AIDS) (Deaton and Muellbauer).

Given the importance of the elasticities to the quality of the model's projections, a synthetic approach was taken for specifying the demand system. Expenditure and own-price elasticities were collected from a number of studies (see footnotes to tables 2 and 3). These were used in conjunction with the parameter restrictions implied by the symmetry, homogeneity, and adding-up properties of demand to determine the appropriate cross-price elasticities that maintain a net substitution relationship for all goods. The resulting urban and rural elasticity matrices are given in tables 2 and 3, respectively. Income elasticities were calculated by multiplying individual commodity and commodity group expenditure elasticities by an income elasticity for food expenditures. The income elasticity for food expenditures by urban households was 0.76 (Lewis and Andrews), and the value for rural households was slightly lower at 0.707 (Fan, Wailes, and Cramer). The urban expenditure

Table 2. Urban Marshallian Demand Elasticities

	FIRST STAGE		SECOND STAGE										
	Meats	Grains	Beef	Pork	Poultry	Mutton	Eggs	Fish	Dairy	Rice	Wheat	Soybeans	Coarse Grains
Meats	**−0.288**[a]												
Grains		**−0.430**[a]											
Beef			**−0.430**[b]	−0.040	−0.060	−0.040	0.060	−0.078	−0.104				
Pork			−0.279	**−0.970**[b]	0.190	−0.045	−0.050	−0.100	0.050				
Poultry			−0.089	0.094	**−1.333**[a]	−0.083	0.100	−0.070	0.050				
Mutton			−0.028	−0.009	−0.041	**−0.430**[b]	−0.022	−0.040	−0.060				
Eggs			0.161	−0.075	0.026	−0.134	**−1.084**[a]	0.284	0.050				
Fish			−0.108	0.047	−0.040	−0.051	0.353	**−1.480**[a]	−0.087				
Dairy			−0.015	0.036	0.036	−0.005	0.050	0.002	**−2.095**[a]				
Rice										**−0.570**[c]	−0.470	0.026	0.030
Wheat										−0.412	**−0.580**[d]	0.232	0.200
Soybeans										−0.029	−0.017	**−0.270**[e]	0.060
Coarse Grains										−0.029	−0.020	0.062	**−0.240**[f]
Income	0.735[a]	0.055[a]	0.579[a]	0.673[a]	0.898[a]	0.579[a]	0.437[g]	1.089[a]	1.614[a]	0.057[d]	0.060[g]	−0.003[g]	−0.003[g]

[a] Huang and Bouis.
[b] Chern and Wang.
[c] Fan, Cramer, and Wailes.
[d] Huang and David.
[e] Sullivan, Roningen, and Leetmaa.
[f] Fan, Wailes, and Cramer.
[g] Assumed.

Table 3. Rural Marshallian Demand Elasticities

	FIRST STAGE		SECOND STAGE										
	Meats	Grains	Beef	Pork	Poultry	Mutton	Eggs	Fish	Dairy	Rice	Wheat	Soybeans	Coarse Grains
Meats	**−0.268**[a]												
Grains		**−0.448**[a]											
Beef			**−1.040**[b]	−0.005	0.010	−0.010	0.010	−0.010	0.175				
Pork			0.140	**−0.980**[b]	−0.334	−0.050	0.300	−0.229	−0.350				
Poultry			0.102	−0.032	**−0.530**[b]	0.297	−0.050	−0.120	−0.150				
Mutton			−0.011	−0.011	0.054	**−1.040**[b]	0.034	−0.015	0.020				
Eggs			0.125	0.020	−0.156	0.313	**−0.900**[b]	−0.172	−0.200				
Fish			0.015	−0.012	−0.156	−0.009	−0.069	**−0.810**[b]	0.532				
Dairy			0.215	0.008	−0.017	0.045	−0.001	0.092	**−2.085**[a]				
Rice										**−0.695**[c]	−0.616	0.018	0.110
Wheat										−0.214	**−0.640**[c]	0.045	0.130
Soybeans										−0.044	−0.055	**−0.270**[d]	0.100
Coarse Grains										−0.087	−0.098	0.197	**−0.240**[e]
Income	0.595[a]	0.174[a]	0.270[a]	0.602[a]	0.672[a]	0.270[a]	0.402[a]	0.866[c]	1.224[a]	0.181[f]	0.245[c]	0.002[c]	−0.017[c]

[a] Huang and Bouis.
[b] Gao, Wailes, and Cramer.
[c] Assumed.
[d] Sullivan, Roningen, and Leetmaa.
[e] Fan, Wailes, and Cramer.
[f] Huang and David.

Table 4. Livestock Product Supply Elasticities

	Beef	Pork	Poultry	Mutton	Eggs	Aquaculture	Milk
Impact	0.640	0.300	0.713	1.138	0.934	0.303	0.000
5-Year	0.922	1.704	1.175	1.776	0.934	0.303	0.267
10-Year	1.170	2.305	1.175	1.864	0.934	0.303	0.764

Note: Output-feed price ratios measured at 1996 levels.

elasticities are very close to those found using the urban cross-sectional data described above. The elasticities are not identical to those presented in table 1 partially because of the differences in original data sources.

The supply side of the model is divided into two major components according to commodity groupings. Two general structures are used to specify production functions in the livestock sector. First, pork, beef, milk, and mutton productions are modeled in the standard stock and flow paradigm to ensure the viability of meat and milk output relative to slaughter, births, animal inventory, and breeding herd growth. Consequently, reduced-form equations and identities are included for each of the important elements in the production process. Equations for flow variables, such as additions to breeding inventory, slaughter, and births, are estimated as functions of meat-to-feed price ratios and lagged inventories. As much as possible, biological restrictions are incorporated into the estimated equations through the use of a logistic function to place an upper bound on births and slaughter (Chavas and Klemme). Finally, meat production is calculated as the product of total slaughter and slaughter weight, and milk production is computed at an annual rate of 1.8 metric tons of milk per dairy cow.

In the second general structure, production equations for poultry meat, eggs, and cultured aquatic output are estimated as functions of current and lagged output-feed price ratios. Supply elasticities for poultry, eggs, and aquaculture may be calculated easily from the estimated equations, but elasticities for other livestock products are more easily calculated by simulating price shocks with the model while holding all other variables constant. The resulting elasticities of supply with respect to the output-feed price ratio measured at 1996 levels are given in table 4.

China's demand for feed grains and protein meals is calculated from beef, pork, poultry, eggs, aquaculture, and milk production. It is assumed that sheep and goats are grazed in China and that cattle receive only a small quantity of grain per head to supplement their primary diets of straw and forage. It is also assumed that dairy cattle require a fixed quantity of grain feed to produce a kilogram of milk. Consequently, the predominant share of grain feed demand is derived from swine, poultry, egg, and aquaculture production. The linkage between livestock output and feed grain demand is described by the relationship in equation (1). The equation states that the total demand for feed i (d_i) is the sum over all meats of the per unit input of feed i (c_{ij}) to produce meat j, times the output of meat j (X_j):

$$(1) \qquad d_i = \sum_j c_{ij} X_j.$$

It is evident from equation (1) that changes in either the level of meat production or the per unit feed requirement will cause total feed demand to change. Meat output levels originate in the livestock model, and changes in these levels generated by that model are used in calculating feed demand changes. For simplicity, it is assumed that input coefficients are invariant to price changes, but the impact of technological change is incorporated into the feed demand system. Consequently, feed demands are segregated in the model by production technology as well as product type. The total demand for any given feed used in the production of a particular meat product is the sum of the demands created by each type of production technology. For example, the de-

Table 5. Grain and Oilseed Supply Elasticities

	FIRST STAGE				SECOND STAGE		
	Coarse Grains	Wheat	Oilseed	Rice	Soybeans	Rapeseed	Sunflower
Coarse Grains	0.195	0.033	−0.113	−0.073			
Wheat	0.029	0.112	−0.113	−0.080			
Oilseed	−0.070	−0.081	0.112	0.021			
Rice	−0.048	−0.061	0.022	0.112			
Soybeans					0.406		
Rapeseed						0.144	
Sunflower							0.201

mand for corn derived from pork production will be the sum of corn used by backyard producers, specialized household producers, and large-scale intensive growers. As the technological mix of production changes in China, the level and composition of total feed grain demand also will be altered. Likewise, improvements in production methods, genetic breeding stock, and management practices will have an impact on the demand for feed. In order to capture these effects, feed demands are generated by equation (2):

$$(2) \qquad d_i = \sum_{\text{meat}} \left\{ \left(\frac{\text{Meat Production}}{\text{Meat to Liveweight Conversion}} \right) \times (\text{FCR}) \times (\text{Industry Share}) \times (\text{Grain's Share of Total Feed}) \times (\text{Grain } i\text{'s Share of Grain Feed}) \right\}.$$

Changes in technology and industry composition are affected through the feed conversion ratio (FCR), meat to liveweight conversion, industry share, and grain's share of total feed. The present specification incorporates a 1% annual improvement in feed efficiency for all swine and poultry technologies, 1.5% for aquaculture, and 3% for dairy. Swine production by backyard and state farm producers is expected to decline at annual rates of 1% and 3.2%, respectively. Specialized household production of swine is assumed to increase by 7% annually over the next decade. Commercial poultry and egg production is anticipated to grow by 3.5% annually, implying a 2.7% decline year-on-year in village poultry and egg production. Finally, grain's share of feed is expected to increase annually for specialized household swine producers, commercial poultry and egg producers, aquaculture, and village poultry and egg farmers by 0.5%, 1%, 1.5%, and 1%, respectively.

The production of grains and oilseeds is computed as the product of per hectare yields and the number of hectares planted to each crop. Sown area is modeled as a multi-stage decision process. Initially, total area sown to grains and oilseeds is determined as a function of expected trends in multi-cropping, loss of agricultural land to industry and urban uses, land degradation, and land reclamation. Once the total grain and oilseed area is determined, it is parceled out to various crop uses according to a system of share equations driven by relative changes in gross revenues for wheat, rice, coarse grains, and oilseeds. Yields are also a function of environmental factors, multi-cropping practices, and irrigation and fertilizer usage. Supply responsiveness to price changes is determined by the sown area equations. The share of grain and oilseed area allocated to oilseed production is further broken out into soybean, rapeseed, and sunflower seed area according to changes in gross revenues. The first-stage allocation includes both own-price and cross-price effects, but the allocation of oilseed area assumes there is no direct substitution among the oilseeds. The supply elasticities implied by the system of area allocation equations are given in table 5.

Table 6. Scenario Consumption, Trade, and Price Changes Following a 100% Reduction in the Chinese Pork Tariff

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
CHINA										
Demand					(000s metric tons)					
Scenario	43,872	45,594	47,900	50,190	52,379	54,745	56,946	59,257	61,521	62,863
Change from Base	0	285	314	336	332	323	347	368	355	349
Net Imports										
Scenario	−128	234	306	368	397	413	452	491	496	496
Change from Base	0	346	418	477	496	503	544	583	580	575
Farm-Level Price					($ U.S. per cwt)					
Scenario	55.77	60.66	63.67	68.25	73.77	79.74	85.44	91.04	96.94	97.10
Baseline	55.77	61.21	64.26	68.87	74.38	80.34	86.08	91.71	97.58	97.70
% Change	0.00	−0.91	−0.92	−0.91	−0.83	−0.74	−0.74	−0.73	−0.66	−0.62
UNITED STATES										
Net Exports					(000s metric tons)					
Scenario	315	836	872	898	1,128	1,371	1,269	1,205	1,452	1,748
Change from Base	0	338	406	464	485	494	535	573	570	566
Barrow-Gilt Price					($ U.S. per cwt)					
Scenario	45.83	44.87	47.26	49.15	45.20	42.09	47.07	51.01	47.08	43.49
Baseline	45.83	42.98	45.52	47.54	44.08	41.25	46.00	49.74	46.07	42.56
% Change	0.00	4.41	3.84	3.38	2.52	2.02	2.32	2.56	2.19	2.19

With the exception of rice, the market price for Chinese grains is calculated from the corresponding U.S. FOB grain and oilseed prices by adjusting these international prices for exchange rates, tariffs, and transportation costs. The assumed price transmission elasticity for grains is one. In the livestock sector, pork and poultry prices are also a function of U.S. prices, but the assumed price transmission elasticity is approximately 0.06. This low price transmission elasticity reflects the enormous difficulties facing U.S. exporters in trying to access some of China's internal markets, as well as some of the differences in tastes discussed above. This is an assumed value. Had we used a value that was twice as large, then the trade impact results shown below would have been approximately twice as large.

Net trade for these commodities is residually determined from supply and demand conditions. Prices for other commodities are endogenously determined by domestic market equilibrium conditions. Thus trade is either determined exogenously or by export supply and import demand functions. International price interaction is derived from a reduced-form specification of U.S. and rest-of-world trade. Elasticities were chosen to approximate price and trade responses generated by the Food and Agricultural Policy Research Institute's (FAPRI's) agricultural trade model. Quantity data for all components of the model were obtained from the USDA's Production, Supply, and Distribution Database (USDA 1997).

The simulation model was calibrated to the FAPRI November 1997 preliminary baseline (FAPRI). In a series of simulation runs, Chinese import tariffs for pork and poultry were individually reduced by 100% to represent the maximum possible trade impact from WTO accession. (A complete set of results is available from the authors on request.) Tables 6 and 7 summarize some of the more important results. By 2007, Chinese pork imports are more than 500,000 tons greater than those in the baseline, and U.S. pork exports rise by almost

Table 7. Scenario Consumption, Trade, and Price Changes Following a 100% Reduction in the Chinese Poultry Tariff

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
CHINA										
Demand					(000s metric tons)					
Scenario	14,450	15,032	15,780	16,612	17,338	18,131	18,835	19,536	20,261	20,548
Change from Base	0	173	176	178	175	172	171	170	168	177
Net Imports										
Scenario	450	706	784	826	872	913	951	989	1,031	1,062
Change from Base	0	235	282	289	285	281	280	280	277	285
Wholesale Price					(U.S. ¢ per lb.)					
Scenario	66.39	65.44	68.27	72.10	77.07	82.51	87.85	93.32	98.88	99.84
Baseline	66.39	66.22	69.05	72.89	77.85	83.30	88.64	94.12	99.68	100.64
% Change	0.00	−1.18	−1.14	−1.09	−1.01	−0.94	−0.90	−0.85	−0.81	−0.80
UNITED STATES										
Net Exports					(000s metric tons)					
Scenario	2,160	2,483	2,571	2,634	2,766	2,879	2,953	3,029	3,136	3,280
Change from Base	0	155	174	174	171	168	168	168	167	172
12-City Broiler Price					(U.S. ¢ per lb.)					
Scenario	58.07	59.11	59.91	60.37	59.63	59.47	60.19	60.85	60.92	60.94
Baseline	58.07	58.06	58.78	59.26	58.55	58.40	59.14	59.80	59.88	59.86
% Change	0.00	1.81	1.93	1.87	1.84	1.83	1.78	1.74	1.73	1.80

a similar amount. On the other hand, prices in both markets are almost unaffected. The maximum change in U.S. prices occurs in the first year after liberalization and is only 4.41% greater than the base. This small price impact reflects the low price transmission elasticity used in the model as well as the enormous size of both markets.

The poultry results in table 7 are very similar to the pork results in table 6. Chinese poultry imports increase by almost 300,000 tons, and again the U.S. captures the lion's share. Price effects are moderate. Because poultry trade in both countries is already well established, the trade impacts, as a percentage of existing levels, are much smaller in the poultry scenario, equaling only a 5–7% increase for the U.S., and a 30–50% increase for China.

Chinese pork and poultry prices start out at a level that is well above the U.S. price, and the difference widens as Chinese demand grows. Again, we see the impact of the low price transmission elasticity. Had we used a larger transmission elasticity, a proportionally larger change in trade volume would have reduced the price disparity.

Conclusions

The results from our scenario analysis suggest that liberalization of China's pork and poultry markets will cause a relatively large change in world trade levels without causing any serious price disruptions. The U.S. is in a good position to capture much of the benefits of such a liberalization, because it already dominates world trade in unsubsidized poultry products and because it is the low-cost producer of pork among countries that are free of foot-and-mouth disease.[1]

The results presented above are by neces-

[1] China claims to be free of foot-and-mouth disease, but this claim would be contradicted by any pork imports from countries where the disease is prevalent.

sity based on a simplified trade model. Were we to fully model the taste differences that exist across countries, it seems likely China would be an exporter of pork loins and chicken breasts and a large importer of less-expensive cuts and variety meats. Another simplification concerns the dollar-Yuan exchange rate. Casual observation would seem to suggest that the Yuan is undervalued relative to the dollar. The trade effects would have been much greater had we built in an appreciation of the Yuan. A third simplification is the arbitrarily low price transmission elasticity chosen for the study.

The key results from this study are the following. First, Chinese meat consumption will continue to be sensitive to per capita incomes. Continued growth in incomes at levels close to those seen recently will cause large increases in demand for meat products. Second, if markets are allowed to decide where these additional supplies should originate, U.S. exports of poultry and pork should increase dramatically. Third, so long as the trade increases generated by market liberalization are close to the levels projected in this study, the price impact in U.S. and Chinese markets will be relatively small.

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