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Price Elasticities of Key Agricultural Commodities in China

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SHORT SUMMARY

We estimate a simultaneous equations model of Chinese markets for wheat, rice, corn, pork, and poultry. Elasticities for consumption, feed demand, production, stocks demand, and foreign trade fall within the range of results from previous studies, and are reasonable magnitudes. China has market power in the trade for all commodities.

ABSTRACT

We estimate a simultaneous equations model of Chinese agricultural markets which treats China as a large trading country, and is built around supply-utilization tables for Chinese wheat, rice, corn, pork, and poultry meat. Elasticities are estimated for consumption, feed demand, production, stocks demand, and foreign demand or supply faced in China. While commodity models are estimated using ITSUR in a single commodity simultaneous equations framework, an LA/AIDS model of food demand is estimated using ITSUR as a system covering all commodities. Results fall within the wide range of results from previous studies, and are quite reasonable magnitudes. China has market power in the trade for all five commodities under study.

Price Elasticities of Key Agricultural Commodities in China

INTRODUCTION

Both market events of the mid-1990s and China's entry into the WTO have sparked a lively debate on the future role of China in agricultural markets. Widely divergent opinions on whether China would emerge as a significant grain or meat importer have been voiced, based on forecasts by USDA, IFPRI, the Chinese government, and many others (Carter and Rozelle; Han and Hertel). Lester Brown's projections in 1995 suggested China could need imports close to the current volume of international grain trade (200-370 million metric tons). Western influenced forecasts (Rozelle et al 1996; Huang 1998; Wang et al 1998; Geng et al 1998; ERS, USDA 1997, 2002, and 2004) have been much lower, and highly variable, both across forecasters and over time, but tend to suggest grain imports by China could reach 20-40 million metric tons in the next decade. Chinese government forecasts (Song 1997, Lin 1998, IOSC 1996) have indicated China would remain relatively self-sufficient. Market outcomes since 1995 have been more consistent with the Chinese forecasts, in spite of Chinese entry into the WTO in 2002.

While some of the differences in forecasts stem from differences in assumptions on future Chinese production, population and income growth, differences in estimated and assumed supply and demand elasticities, and treatment of price effects (or lack thereof) on trade, also help account for these widely divergent projections. Better understanding of Chinese commodity markets, and specifically better estimates of supply and demand elasticities, would permit construction of better models to predict trade flows, to analyze agricultural policies, and to test hypotheses on the structure and performance of those markets.

One particular problem is that China may be a large country in world agricultural markets (Carter and Schmitz, 1979), yet virtually all studies treat China as a small country (e.g. Chern et al 1999, Mitchell and Ingco 1993). If China is a large country in international markets, not only must simultaneous equation methods be used to estimate supply and demand parameters, but also assessment of Chinese policy must take into account this potential market power in trade. For example, Chinese restriction of imports following the 1995 world grain price increases may be explained within an optimal tariff framework. Chinese limitations on imports may have helped to keep world prices lower than they would have otherwise been after 1996, reducing Chinese import costs. Hence, self-sufficiency may be defended not only on political economy grounds, but also for reasons of trade policy efficacy. To analyze this, we must know better the relevant domestic and trade elasticities for the Chinese market.

In this study we estimate a simultaneous equations model of Chinese agricultural markets which treats China as a large trading country. The model structure is built around China's supply-utilization tables for Chinese grains and meats. Elasticities are estimated for domestic consumption, feed demand, domestic production, stocks demand, and foreign demand or supply faced in China. Chinese behavior in foreign markets may then be derived from the domestic market parameters and trade policy assumptions.

The commodities under study include wheat, rice, corn, pork, and poultry meat. China's domestically produced wheat, rice, and corn and the corresponding foreign commodity (regardless of origin) are assumed to be homogenous goods or perfect substitutes. While imported pork and poultry meat are assumed to be differentiated from China's domestically produced pork and poultry meat, China's exported pork and poultry meat are assumed to be similar to its domestically produced goods.

An LA/AIDS model is used to estimate consumption covering all commodities as a sub-system, so that constraints from demand theory may be imposed in estimation. Variables for household income, per capita consumption, and prices are all at the national level, and are estimated using time series data. Previous studies have used either rural or urban household survey data or household survey data from a province covering a period of 2 to 5 years (Lewis and Andrews; He and Tian).

Supply and feed demand equations are specified within a profit maximization structure for farms. A single commodity simultaneous equations model is then estimated as another sub-system (hereinafter refers to as the supply sub-system) for all equations except for food consumption.

Instrumental variables estimation methods are used to correct for simultaneity bias in the demand sub-system and in each commodity sub-system. Potential instrumental variables are the exogenous variables that appear in the whole system of supply and demand equations. ITSUR is used to correct for cross equation error correlation in both the LA/AIDS sub-system and the supply sub-system for each commodity model.

MODELS AND ESTIMATION METHOD

In this study it is assumed that there are two regions in the world, China and the rest of the world (ROW). Substantial two way trade is observed for poultry meat, and must be accounted for in estimating a trade model. A CES nest of demand for poultry meat is used to help explain the substantial two-way trade observed in China. While there is now also two way trade in pork, no CES nest will be estimated since there were virtually no observations for pork imports prior to 1998, and the imports afterwards are very small relative to China's domestic

demand. Thus, the imported pork is treated as a substitute for China's domestic pork consumption. Exports of both pork and poultry meat are assumed homogenous substitutes for the domestic goods.

While supply sub-system is estimated in a single commodity simultaneous equations model, an LA/AIDS model with a CES nest for poultry meat is estimated as a food demand sub-system covering all commodities. Figure 1 depicts our LA/AIDS model with a CES nest for poultry meat.

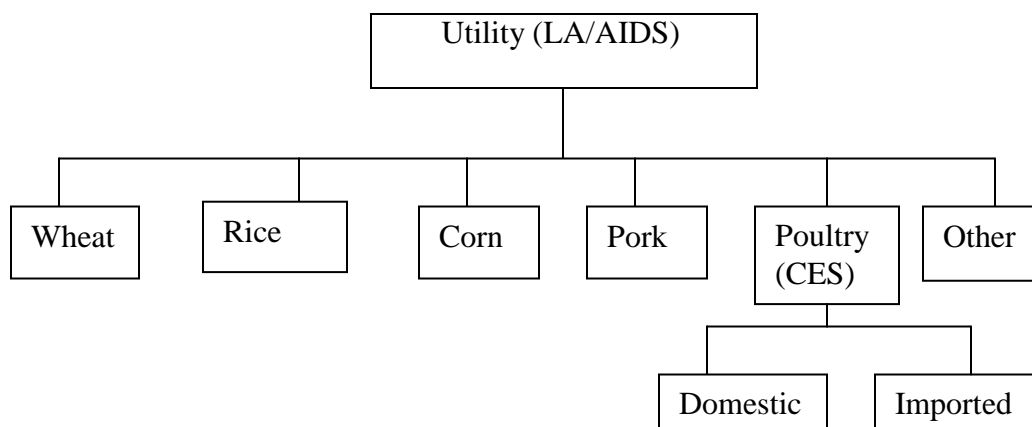


Figure 1: LA/AIDS Model with a CES Nest for Poultry Meat

What follows is a discussion of the LA/AIDS model for the estimation of food demand sub-system equations and the single commodity simultaneous equations model for the estimation of supply sub-system of all other equations.

Model Specification for Estimation of Food Demand Elasticities

The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) is one of the most widely used flexible demand system specifications. It gives an arbitrary first order

approximation to any demand system and satisfies the axioms of choices exactly. It aggregates perfectly over consumers and has a functional form that is consistent with known household-budget data. The AIDS demand functions in budget share form is as follows:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{Y}{P} \right) \quad (1)$$

Where w_i is the budget share for good i , and Y is the total expenditure or income, and $\ln P$ is a price index defined by $\ln P = \alpha_0 + \sum_{k=1}^n \alpha_k \ln p_k + \frac{1}{2} \sum_{k=1}^n \sum_{j=1}^n \gamma_{kj} \ln p_k \ln p_j$.

Because the AIDS model constitutes a non-linear system of equations, and it is tedious to estimate the constant term in the price index, many previous studies (Deaton and Muellbauer 1980, Alston et al 1994, Halbrendt et al 1994) have used $\ln P^* = \sum_{k=1}^n w_k \ln p_k$ (Stone's price index) instead of $\ln P$. The model that uses Stone's index is called the "linear approximate AIDS" or LA/AIDS model. If prices are highly collinear, P may be well approximated as proportional to P^* , i.e. $P^* \cong \phi P$, and the LA/AIDS model is a good approximation to the AIDS model. Empirically, LA/AIDS is often used in the existing literature to estimate China's agricultural commodity demand functions (e.g. Lewis et al 1989, Cai et al 1998, Liu et al 2001, Wu et al 1995).

After incorporating dummy variables and other demographic variables, the LA/AIDS model looks as follows:

$$w_i = \alpha_i^* + \sum_{j=1}^n \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{M}{P^*} \right) + \sum_{k=1}^m \lambda_{ik} D_k + \varepsilon_i \quad (2)$$

Where $\alpha_i^* = \alpha_i - \beta_i \ln \phi$, $\ln P^* = \sum_{k=1}^n w_k \ln p_k$, D_k 's ($k = 1, 2, \dots, m$) are dummy and/or

demographic variables, λ_{ik} 's are parameters to be estimated, and ε_i is the error term associated with equation i. In this study, D_k 's include an urbanization index and two dummy variables that capture the effects of the rationing system. Since In 1993, China further liberalized the grain market and abolished the 40-year old grain rationing system (Fan and Cohen, 1999).

For the LA/AIDS model to be consistent with consumer theory, the parameters in the demand system must satisfy the following restrictions:

$$\sum_{i=1}^n \alpha_i^* = 1 \quad \sum_{i=1}^n \beta_i = 0 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad (\text{Adding up})$$

$$\sum_{j=1}^n \gamma_{ij} = 0 \quad (\text{Homogeneity})$$

$$\gamma_{ij} = \gamma_{ji} \quad (\text{Symmetry})$$

The income and price elasticities derived based on this model are:

$$\eta_i = 1 + \frac{\beta_i}{w_i} \quad (\text{Expenditure or income elasticity})$$

$$E = [BC + I]^{-1} [A + I] - I \quad (\text{Price elasticities in matrix form})$$

Where $a_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \beta_i \frac{w_j}{w_i}$ in A (a $n \times n$ matrix, here $n = 6$), and $\delta_{ij} = 1$ if $i = j$, $\delta_{ij} = 0$ if $i \neq j$;

$b_i = \frac{\beta_i}{w_i}$ in B (a $n \times 1$ vector); $c_j = w_j \ln P_j$ in C (a $1 \times n$ vector) (Green and Alston, 1990).

As depicted in the above Figure 1, per capita household income is assumed to be spent on six commodities, namely, wheat, rice, corn, pork, poultry meat, and other goods. Commodity 'Other' represents all other goods aggregated, excluding pork, poultry, wheat, rice, and corn. This 'Other' good is included so that all income (expenditure) is exhausted. Note that poultry

meat in the LA/AIDS layer is an aggregated good in the sense that it includes differentiated imported and domestically produced poultry meat, respectively.

The CES utility function for poultry meat is as follows:

$$U = \left(\alpha X_1^{\frac{\sigma-1}{\sigma}} + (1-\alpha) X_2^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (3)$$

Where X_1 is the quantity of domestic poultry meat consumed and X_2 is imported poultry meat consumed, α and $(1-\alpha)$ are the share parameters and σ is the constant elasticity of substitution between the two goods. Note that $0 < \alpha < 1$ and $\sigma > 0$.

Maximizing (1) subject to the budget constraint $C = P_1 X_1 + P_2 X_2$ results in the following demand functions:

$$X_i = \alpha^\sigma (X) \left(\frac{P_i}{P} \right)^{-\sigma} \quad i = 1, 2 \quad (4)$$

Where $P = \left(\frac{P_1 X_1 + P_2 X_2}{X_1 + X_2} \right)$ is the weighted average price and X is aggregate demand (i.e. $X = X_1 + X_2$) from the LA/AIDS model. Note that $C = PX$.

Taking the natural logarithm form of (4), we get:

$$\ln X_i = \sigma \ln \alpha + \ln X - \sigma (\ln P_i - \ln P) \quad i = 1, 2 \quad (5)$$

Note that $\sigma \ln \alpha$ and $\sigma \ln(1-\alpha)$ are constants since both α and σ are constant parameters.

Thus, equation (5) can be readily used in regression to determine the magnitude of σ .

Model Specification for Estimation of Other Elasticities

Other elasticities to be estimated include China's domestic supply, feed demand, stocks demand, and foreign import demand (or export supply) elasticities. The following single

commodity simultaneous equations model is used for estimation of these other elasticities:

$$Q_s = Q_s(p^d, Z_s) \quad (6)$$

$$Q_d = Q_d(p^d, Z_d) \quad (7)$$

$$Q_{feed} = Q_{feed}(p^d, Z_{feed}) \quad (8)$$

$$Q_{st} = Q_{st}(p^d, Z_{st}) \quad (9)$$

$$Q_m = Q_d + Q_{feed} + Q_{st} - Q_s - \bar{Q}_{st-1} \quad (10)$$

$$p^w = p^w(Q_f^x, Z_f^x) \quad (11)$$

$$Q_m = Q_f^x \quad (12)$$

$$p^d = p^w + t \quad (13)$$

Equation (6) is China's domestic supply function. It is a function of domestic price p^d and a vector of supply shifters Z_s . The potential supply shifters include labor input, land input, fertilizer input, pesticides input, and capital.

Equation (7) is China's domestic demand function. It is a function of domestic price p^d and a vector of demand shifters Z_d . The potential demand shifters include income and population. Note that demand functions are estimated using the LA/AIDS model. The food demand equation is included here to identify other equations.

Equation (8) is China's domestic feed demand equation. It is a function of China's domestic price p^d and a vector of feed demand shifters Z_{feed} . The potential feed demand shifters include production of pork and poultry. For corn, feed demand is estimated using the pork model, while this equation is directly estimated for wheat.

Equation (9) is China's domestic stocks demand function. It is a function of domestic consumer price p^d and a vector of stock shifters Z_{st} . The potential stock shifters include beginning stocks and production.

Equation (10) is an identity yielding China's import demand (or export supply if $Q_m < 0$). It simply states that China's net import demand equals to China's excess demand ($Q_d + Q_{feed} - Q_s$) plus the change of its stocks ($Q_{st}^t - Q_{st}^{t-1}$). Equation (10) implies that all shifters Z_s, Z_d, Z_{feed} , and Z_{st} would affect China's import demand through equations (6), (7), (8), and (9).

Equation (11) is the foreign inverse export supply (or inverse import demand if $Q_f^x < 0$) function. It represents the behavior of ROW. It is assumed that the world price faced by China p^w is a function of foreign exports Q_f^x (to China) and a vector of foreign export shifters Z_f^x . The potential foreign export shifters include foreign production and beginning stocks. This equation is estimated in the inverse form so that hypotheses on Chinese market power in trade can be formally tested.

Equation (12) is an identity, which states that China's net import demand or export supply is equal to foreign net export supply or import demand. This condition implies that the world markets for wheat, rice, corn, pork, and poultry meat clear at the Chinese border. Equation (13) is another identity, which states that China's domestic price p^d equals to world price p^w plus the equivalent specific tariff imposed on imported good.

While a simultaneous equations model has been used in previous studies to estimate China's agricultural commodity supply function (e.g. Seale 1999, Wang 2000), they only look at the supply side and ignore the demand side. Simultaneity problems could arise in that case. Moreover, the specifications of each equation in their simultaneous equation system do not follow strictly production theory.

In this study, producers are assumed to behave as profit maximizers and price takers. Thus, a neo-classical economic profit maximization approach will be used to

derive a supply specification for each commodity under study. That is, producers

$$\text{Max } \Pi(p, w) = py - \mathbf{r}'\mathbf{x} \quad \text{subject to } (y, \mathbf{x}) \in \Omega$$

Where y is output, p is the output price, \mathbf{x} is a vector of inputs, \mathbf{r} is a vector of input prices, and Ω represents technology. Suppose the profit function is well defined, and its first derivatives exist everywhere. Then, according to Hotelling's lemma, the supply function is $\frac{\partial \Pi(p, \mathbf{r})}{\partial p} = S(p, \mathbf{r})$.

It is assumed that producers have full information about the prices and their expectations about prices are rational and are assumed to be realized. In other words, all the prices determining supply are current prices rather than lagged prices. The reasons behind this include: a) We are using procurement prices as proxy variables for China's domestic producer and consumer prices. b) The procurement prices and farm input prices are in fact set by the Chinese government and are typically announced in advance (before sowing and planting). c) While the Chinese government has adjusted its procurement prices and farm input prices over time, farmers' expectations for prices do not vary much from the officially promulgated prices for a specific year.

A Cobb-Douglas production function is assumed for the technology. However, since data on input quantities such as labor, fertilizers, and pesticide are not available by crop, the following Cobb-Douglas restricted profit function is often used empirically to derive output supply and input demand functions (Lau and Yotopoulos 1971, 1972).

$$\ln \pi = \alpha_0 + \alpha_1 \ln p + \sum_i \beta_i \ln r_i + \gamma \ln Z \quad (14)$$

Where π is the profit, p is the output price, r_i is the price of input i , (i = labor, fertilizers, pesticides, capital), and Z is the fixed input of land (i.e. cultivated acreage) in use for the crop under study.

Homogeneity of degree one in prices for the profit function implies that $\alpha_1 = 1 - \sum_i \beta_i$. By

(14), taking partial differentiation with respect to $\ln p$ and $\ln r_i$, respectively, we get,

$$\frac{\partial \ln \pi}{\partial \ln p} = \frac{\partial \pi}{\partial p} \frac{p}{\pi} = 1 - \sum_i \beta_i \quad \text{and}$$

$$\frac{\partial \ln \pi}{\partial \ln r_i} = \frac{\partial \pi}{\partial r_i} \frac{r_i}{\pi} = \beta_i$$

By Hotellings Lemma, $\frac{\partial \pi}{\partial p} = Q_s(p, r)$ and $\frac{\partial \pi}{\partial r_i} = -X_i(p, r)$. Thus, the output supply function is

$$Q_s(p, r) = (1 - \sum_i \beta_i) \frac{\pi}{p}$$

Hence, $\ln Q_s(p, r) = \ln(1 - \sum_i \beta_i) + \ln \pi - \ln p$

Taking partial differentiation with respect to $\ln p$, we get

$$\frac{\partial \ln Q_s}{\partial \ln p} = \frac{\partial \ln \pi}{\partial \ln p} - \frac{\partial \ln p}{\partial \ln p} = - \sum_i \beta_i$$

Thus, the own price elasticity of output supply function is $-\sum_i \beta_i$, where β_i are the parameters to

be estimated in the Cobb-Douglas restricted profit function (14).

Similarly, the factor demand function for each i is,

$$X_i(p, r) = -\beta_i \frac{\pi}{r_i}$$

Hence, $\ln X_i(p, r) = \ln(-\beta_i) + \ln \pi - \ln r_i$

Taking partial differentiation with respect to $\ln r_i$, we get

$$\frac{\partial \ln X_i}{\partial \ln r_i} = \frac{\partial \ln \pi}{\partial \ln r_i} - \frac{\partial \ln r_i}{\partial \ln r_i} = \beta_i - 1.$$

Thus, the own price demand elasticity for factor i is $\beta_i - 1$. Note that corn feed is used as a proxy variable for feed input in pork production in China. Formula $\beta_i - 1$ ($i = \text{corn}$) will give us the feed demand elasticity for corn in China.

The following illustrates the specific commodity model to be estimated for the case of wheat:

$$\begin{aligned} \ln \pi &= a_0 + a_1 \ln P_d + a_2 \ln \text{Wage} + a_3 \ln P_{\text{fert}} + a_4 \ln P_{\text{pesti}} + a_5 \ln P_{\text{1tool}} \\ &\quad + a_6 \ln P_{\text{oil}} + a_7 \ln A + a_8 \text{year} \quad \text{----- Cobb-Douglas restricted profit function} \\ Q_s &= (1 - a_2 - a_3 - a_4 - a_5 - a_6) \frac{\pi}{P_d} \quad \text{----- Wheat output supply} \\ Q_d &= b_0 + b_1 P_d + b_2 \text{Pop} + b_3 M + b_4 \text{urban} \quad \text{----- Food demand equation} \\ Q_{\text{feed}} &= c_0 + c_1 P_d + c_2 \text{QS}_{\text{pk}} + c_3 \text{QS}_{\text{py}} \quad \text{----- Feed demand equation} \\ Q_{st} &= d_0 + d_1 P_d + d_2 Q_s \quad \text{----- Stocks demand equation} \\ Q_m &= Q_d + Q_{\text{feed}} + Q_{st} - Q_s - \bar{Q}_{st-1} \quad \text{----- China's import demand} \\ p^w &= e_0 + e_1 Q_f^x + e_2 \text{BS}_{\text{fp}} + e_3 \text{QS}_{\text{fp}} + e_4 \text{Rer} \quad \text{----- Inverse foreign export supply} \\ Q_m &= Q_f^x \quad \text{----- World market clearing condition} \\ p^d &= ep^w + t \quad \text{----- Price linkage} \end{aligned}$$

Note that food demand equation will not be estimated here (it is estimated in the LA/AIDS model). It is included to identify other functions in the system. A is planted acreage for wheat, and Wage is farmers' annual wage. Pop , M , and urban represent China's population, household income, and urbanization index, respectively. P_{fert} , P_{pesti} , P_{1tool} , and P_{oil} are prices for fertilizers, pesticides, small farm tools, and farm machinery oil, respectively. All prices are in real terms and are deflated by China's national CPI. Year is a trending variable. QS_{pk} and QS_{py}

represent China's pork and poultry meat production, respectively. BS_{fp} and Q_{sfp} represent the ROW's per capita beginning stocks and per capita production, respectively. Rer and e are the real exchange rate and nominal exchange rate in Chinese Yuan per US dollar.

The expected sign for a_2 is negative since a higher wage means higher labor cost for the production. The expected signs for a_3 , a_4 , a_5 , and a_6 are negative. This is straightforward since an input demand function typically slopes downward. The expected sign for a_7 is positive since higher planted acreage leads to higher production, *ceteris paribus*. The expected sign for a_8 is positive since the production of wheat trends upward over the time. The expected sign for c_1 is negative since a demand function slopes downward. The expected signs for c_2 and c_3 are positive since higher production of pork and poultry lead to higher demand for feed. The expected sign for d_1 is negative since people tend to sell more and hold lower stocks when the market price is high. The expected sign for d_2 is positive since higher production leads to higher stocks, *ceteris paribus*. The expected sign for e_1 is positive since the higher the world price, the more the foreign exporter tends to supply. The expected signs for both e_2 and e_3 are positive since higher per capita foreign beginning stocks and production induce the foreign country to export more, *ceteris paribus*. The expected sign for e_4 is negative since a higher real exchange rate implies devaluation of Chinese Yuan, which leads to lower imports into China.

The above commodity model is used with minor modifications for the cases of rice, corn, pork, and poultry meat. The feed demand equation will be ignored in the case of rice (since there is no statistics for feed use of rice). The stocks demand equations will be ignored in the cases of pork and poultry meat since there are no statistics for stocks. Also, two-way trade is taken into consideration in the case of poultry meat. That is, there are two foreign behavioral equations. One is inverse foreign export supply function, and the other is an inverse foreign import demand

function. Corn is used as a factor input in pork production, and the expected sign for a factor input is negative.

Data

Time series data are obtained from various database sources, including FAOSTAT, USDA PS&D and various issues of *China Statistical Yearbook*. The data covers a period of 24 years from 1978 to 2001. Production, consumption, stocks, and feed demand data for wheat, rice, corn, and pork are obtained from the USDA PS&D database². For poultry meat, USDA PS&D does not report China's poultry production until 1987. Moreover, data from PS&D and FAOSTAT databases do not match each other. Data from FAOSTAT are used here.

Border prices of all commodities under study are unit value obtained from the FAOSTAT database. China's domestic prices are producer prices. Domestic prices of wheat, rice, and corn in 1991 -2001 are obtained from the FAOSTAT database, and those for the other years are estimated using a regression method based on the purchasing price indices in 1978 -2001 from *China Statistical Yearbook*. Domestic prices for poultry meat and pork for 1991 – 2001 are obtained from the FAOSTAT database. Domestic prices for pork in 1978 – 1990 and domestic prices for poultry meat in 1978 - 1987 are obtained from various issues of *China Statistical Yearbook*. Domestic prices of poultry meat for 1988-1990 are estimated using extrapolation. All other variables including wages, price indices of fertilizers, pesticides, and farm tools are obtained from various issues of *China Statistical Yearbook*. All prices are deflated by China national CPI obtained from various issues of *China Statistical Yearbook*.

² The data from the USDA PS&D and FAOSTAT databases are essentially the same for these commodities.

Estimation Method

Two-stage least squares (2SLS) or instrumental variables estimation has been widely used to address the simultaneity problem in trade models since the late 1970s. Regardless of the number of equations in a simultaneous equations model, each identified equation can be estimated by 2SLS. The instruments for a particular endogenous variable consist of the exogenous variables appearing anywhere else in the system. However, when a system with more than two equations is correctly specified, system estimation methods such as 3SLS are generally more efficient than estimating each equation by 2SLS. This is because 2SLS estimator does not take into account the cross-equation correlation of the errors.

The most commonly used system estimation method in the context of simultaneous equations model is three stage least squares (3SLS). The 2SLS estimates are used to estimate the error covariance matrix for the system of equations required for 3SLS. The 3SLS estimator is computed by applying the GLS-SUR (generalized least squares and seemingly unrelated regression) transformation to the simultaneous equation model.

In this research, demand equations and supply equations are estimated separately, as discussed earlier. 3SLS estimation method cannot be used directly in this case. Equivalently, instrumental variables estimation will be used to address the simultaneity problem while the iterative seemingly unrelated regression (ITSUR) method will be used to take into account the cross-equation correlations within the two sub-systems estimated in the study. The instrumental variables are virtually the exogenous variables that appear in the whole system of supply and demand equations.

The supply and demand framework approach has been widely used for predicting future trade of agricultural commodities. All other long term models are more or less patterned after

USDA or FAPRI baseline models (Baumel, 2001), which utilizes the supply and demand framework approach. A country's domestic supply and demand for a commodity are typically estimated separately, and the difference between supply and demand is taken to obtain the excess supply or excess demand for the commodity. For this study, if we estimate systematically the whole supply and demand equations system for all the five commodities under study, there would involve more than 22 equations. Since we have only 24 observations for the supply sub-system and 20 observations for the food demand sub-system (there were no statistics for China's imports of poultry meat until 1982), it does not allow us to estimate the whole system at one time. Therefore, like previous studies, we also estimate the supply (supply sub-system) and demand (food demand sub-system) separately.

We believe that cross equation error correlations are most likely within food demand, since that is a behavioral representation for consumers, and then across equations of a single commodity system, capturing within market effects, as modeled here. A much more cumbersome estimation approach would have been required to capture less likely cross commodity error correlations in relationships other than food demand.

ESTIMATION RESULTS AND DISCUSSION

First, estimation results for the LA/AIDS model of food demand are discussed. Second, estimation results for each single commodity simultaneous equations model are presented. Finally, our estimated elasticities are compared to those reported in the previous studies

Food Demand Elasticities in China

The estimation results for the LA/AIDS model using mean prices to convert estimated parameters to elasticity form are summarized in Table 1. Parameter estimation results including t statistics and p-values are summarized in Table 2.

As shown in Table 1, all the own price elasticities have expected negative signs and all income elasticities have expected positive signs. The mean price elasticities of demand for wheat, rice, corn, pork, and poultry meat are -0.298, -0.352, -0.477, -0.266, and -0.438, respectively. While the own price elasticities for all three goods are inelastic, the elasticity for corn is relatively high. The income elasticities of demand for wheat, rice, corn, pork, and poultry meat are about 0.519, 0.136, 0.852, 0.01, and 0.78, respectively.

The demand elasticity for poultry meat is the aggregate demand elasticity because of the CES nest used for poultry meat. That is, poultry meat consumed in the LA/AIDS model aggregates both China's domestically produced poultry meat and imported poultry meat. The CES nest is estimated to determine the elasticity of substitution between domestic and imported poultry meat.

Before estimating the CES nest, the estimated prices for domestically produced and imported poultry meat are obtained by regression of observed prices on the instrumental variables, respectively. The instrumental variables are the same as those used in the estimation of the LA/AIDS model. Using the ITSUR estimation method, the estimation results for the CES nest are summarized in Table 3:

The constant elasticity of substitution between China's domestically produced poultry and imported poultry is $\sigma = 0.810$ and is statistically significant at 10% alpha level. By (5)

$$\varepsilon_{ii} = \varepsilon_{aa} \varepsilon_{pti} - \sigma + \sigma \varepsilon_{pti} \quad i = 1, 2 \quad (15)$$

Where ε_{11} and ε_{22} are own price demand elasticities for X_1 and X_2 , respectively. ε_{aa} is demand elasticity for the aggregated poultry commodity obtained from the LA/AIDS model; ε_{pt1} and ε_{pt2} relate the responsiveness of aggregated price to the change of domestic price and imported price, respectively; And σ is the constant elasticity of substitution between domestic and imported poultry.

It can be shown that

$$\varepsilon_{ii} = \frac{a_i \varepsilon_{aa} \sigma}{(1 - a_i) \varepsilon_{aa} + \sigma} \quad i = 1, 2 \quad (16)$$

Where a_1 and a_2 are the estimated parameters for $\ln X$ that appear in (5).

Plugging $\varepsilon_{aa} = 0.4383$, $\sigma = 0.810$, $a_1 = 0.9809$, and $b_1 = 3.0863$ into (16), we get the price demand elasticity for domestically produced poultry meat $\varepsilon_{11} = 0.434$, and China's import demand elasticity for poultry meat $\varepsilon_{22} = 0.636$. The elasticities for both domestic and imported poultry meat are inelastic.

The above results imply that poultry meat is relatively more a “luxury” good (note that both poultry meat and pork are not luxury goods because of inelastic demand elasticities) as compared to pork for two reasons: first, the demand elasticity for poultry meat is higher than that for pork. Second, the substitution elasticity between domestic and imported poultry meat is low. In fact, most of the modern poultry factories are located in the suburbs of big cities and the poultry products are primarily sold to urban residents who have higher income than rural residents.

China's Supply, Stocks Demand, Feed Demand, and Trade Elasticities

This section presents the estimation results for the supply sub-system for wheat, rice, corn, pork, and poultry meat, respectively. As discussed earlier, the supply sub-system for each commodity under study is estimated using a single commodity simultaneous equations model.

Wheat

The estimation results for wheat are summarized in Table 3. All the estimated parameters except a_2 , a_3 , c_2 and e_3 have expected signs. China's supply elasticity is $-(a_2 + a_3 + a_4 + a_5 + a_6) = 0.311$. The slope of feed demand equation $c_1 = -0.01567$ has the expected negative sign and is statistically significant at a 5% alpha level. The corresponding mean price elasticity is about -1.493 using mean price and mean quantity for 1978 – 2001. The slope of the stocks demand equation $d_1 = -0.20398$ has expected negative sign and is statistically significant at a 1% alpha level. The corresponding mean price elasticity is about -1.214. The slope of inverse foreign export supply equation $e_1 = 3.664$ has expected positive sign and is statistically significant at a 1% alpha level. The corresponding mean price elasticity is about 3.183.

Does China have market power in wheat trade? A one-tail t test at a predetermined 5% significance level is conducted to test this hypothesis. The calculated t is 2.850 as shown in Table 3, which is greater than the critical t value, $t_{0.05,23} = 1.714$. Thus, we reject the null hypothesis. We are 95% confident that the slope of foreign export supply of wheat is strictly greater than zero. This implies that China has market power in wheat trade.

Rice

The estimation results for rice are summarized in Table 4. All the estimated parameters except a_2 , a_4 , a_7 , and e_4 have expected signs. China's domestic output supply elasticity is $-(a_2 + a_3 + a_4 + a_5 + a_6) = 0.273$. The slope of stocks demand equation, $d_1 = -0.2422$, has the expected

negative sign. The corresponding mean price elasticity is -1.102. The slope of the inverse foreign import demand equation, $e_1 = -23.43$ has the expected negative sign and is statistically significant at a 5% alpha level. Thus, we are 95% confident that China has market power in rice trade. The corresponding mean price elasticity is about -8.240.

Corn

As discussed earlier, feed demand for corn is derived from pork producer's profit maximization problem. The estimation results for corn are summarized in Table 5. All the estimated key parameters have expected signs. The output supply elasticity is about 0.230. The slope of the stocks demand equation $d_1 = -0.1924$ has expected negative sign and is statistically significant at a 10% alpha level. The corresponding mean price elasticity is about -0.612. The slope of the inverse foreign import demand equation $e_1 = -5.120$ has expected negative sign and is statistically significant at a 1% alpha level. This implies that China has market power on corn trade. The corresponding mean price elasticity of foreign import demand is about -3.781. The elasticity of feed demand for corn is -0.761 (from the pork model).

Pork

The estimation results for pork are summarized in Table 6. While not all the estimated parameters have the expected signs, all the key parameters have expected signs. The elasticity for China's domestic production function is $-(a_2 + a_3 + a_4) = 0.128$. The slope for the inverse foreign import demand function is $c_1 = -2.667$ and is statistically significant at 1% alpha level. This indicates that China has market power in its pork exports. The corresponding mean price elasticity for the foreign import demand curve is about -1.936. The own price factor demand elasticity for corn is $(a_3 - 1) = -0.761$.

China's domestic supply response to pork price is quite low. If the domestic pork price increases by 1%, the domestic supply will increase by only 0.13%. The foreign import demand elasticity that China faces is elastic.

Poultry

The estimation results for poultry meat are summarized in Table 7. While not all the estimated parameters have the expected signs, all the key parameters have expected signs. The elasticity for China's domestic production function is $-(a_2+a_3) = 0.306$. The slope for the inverse foreign import demand function is $b_1 = -0.593$ and is statistically significant at a 1% alpha level. This implies that China has market power in its exports of poultry meat. The slope for inverse foreign export supply function is $c_1 = 0.694$ and is statistically significant at a 5% alpha level. This suggests that China has market power in its imports of differentiated foreign poultry meat, as well. The corresponding mean price foreign import demand and foreign export supply elasticities are about -8.440 and 2.566, respectively.

We have also estimated the above models for each commodity with foreign export supply and/or foreign import demand equations specified ordinarily (i.e. $Q = Q(p, Z)$). Key estimation results for each commodity model estimated in ordinary form are summarized in Table 9. For wheat, foreign export supply elasticity becomes inelastic (0.785). For pork, foreign import demand elasticity becomes inelastic as well (-0.751). For poultry meat, foreign export supply elasticity becomes inelastic (0.668).

It is clear that foreign import demand or export supply elasticity tends to be more elastic when foreign behavior equation is specified inversely in each commodity model.

Moreover, the inverse specification not only allows directly testing for market power, but also yields greater statistical significance (or lower standard errors) on the trade elasticities. Other parameters change only slightly with variation in specific demand.

Our Estimates versus the Estimates in Previous Studies

This section compares our estimated elasticities to those reported in previous studies. The elasticities for grain commodities are discussed first, and then the elasticities for meat products are explored.

Grain

Rozelle and Huang (2000) estimated that the short-run output supply elasticities for wheat and corn in China were 0.049 and 0.343, respectively, and the long-run output supply elasticities were 0.043 and 0.289, respectively. Our estimated output supply elasticities as shown in Table 9 are 0.311, 0.273, and 0.230 for wheat, rice, and corn, respectively. These estimates are very close to the estimate by Rozelle and Huang in the case for corn, and their wheat elasticities are very low.

Huang and Rozelle (1995) estimated that the own price elasticity for grain in China was -0.52 and income elasticity for grain was 0.86. Hus et al (2002) estimated that the own price elasticity of demand for grain was -0.16 and -0.37 for China's urban consumers and China's rural consumers, respectively. Their estimates for income elasticities for urban and rural consumers were 0.11 and 0.32, respectively. Halbrendt et al (1994) estimated that the own price demand elasticity and for grain in Guangdong Province, China was -0.233, and the expenditure elasticity for grain was 0.575. Liu and Chern (2001) used different models to estimate food consumption in China's Jiangsu Province. Their estimates for the own price elasticity for rice

ranged from -0.894 to -1.203. And their expenditure elasticities for rice ranged from 1.107 to 1.345. Gao et al (1996) also estimated food demand using data for Jiangsu Province. Their estimated own price elasticity for grain was -0.988, and the expenditure elasticity was 0.516.

As shown in Table 9, our estimated own price demand elasticity for wheat, rice, and corn are -0.298, -0.352, and -0.476, respectively. And our estimated income elasticities for wheat, rice, and corn are 0.519, 0.136, and 0.852, respectively. It is clear that our estimated elasticities fall within the wide ranges of elasticity estimates in these previous studies.

Meat

Pudney and Wang (1991) estimated that the own price elasticities of demand for pork and poultry in China were -0.04 and -0.005, respectively. Their estimated income elasticities for pork and poultry were 0.923 and 0.716, respectively.

Hsu et al (2002) estimated that the own price demand elasticities for pork and poultry for urban residents were -1.59 and -1.28, respectively, and those for rural residents were -0.66 and -0.50, respectively. Their estimated income elasticities for pork and poultry for urban residents were 1.68 and 3.12, respectively, and those for rural residents were 0.67 and 0.70, respectively.

He and Tian (2000) reported that many other studies have estimated own price elasticities of demand for pork and poultry in China were within the above range. That is, own price demand elasticity for pork fell between -0.04 and -1.59. And the own price elasticity for poultry fell between -0.005 and -1.28. As shown earlier, our estimated demand elasticities for pork and poultry meat were about -0.27 and -0.44, respectively, which also fell in the range for elasticity estimates of previous studies.

CONCLUSION

Estimated elasticities for wheat, rice, corn, pork, and poultry meat are summarized in Table 8. These results fall within the wide range of results from prior studies, and are quite reasonable magnitudes relative to those earlier results. Foreign import demand or export supply elasticity tends to be more elastic and more significant statistically when the foreign behavioral equation is specified inversely in each commodity model. That specification also allows us to directly test the hypothesis on China's market power in trade, a motivating concern in this paper.

Previous studies showed that the own price demand elasticity for grain in China ranged from -0.16 to -1.203. While China's pork demand elasticity ranged from -0.04 to -1.59, its poultry meat demand elasticity ranged from -0.005 to -1.28. Our estimated own price demand elasticities for wheat, rice, corn, pork, and poultry meat are -0.298, -0.352, -0.476, -0.27, and -0.44, respectively. While our estimated income elasticities for wheat, rice, corn, and poultry meat fall within the range of estimated income (or expenditure) elasticities in previous studies, our estimated income elasticity for pork is only 0.01, which is extremely low. Other income elasticities are at more reasonable levels.

Trade elasticities faced by China range from 3.183 to -8.440, and are significantly different from what would be expected for a small trader. The estimation results show that China has market power in the trade for all five commodities under study. Hence, the approach taken in this study is needed both for estimation and for subsequent policy analysis.

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Table 1 - Estimation Results for the LA/AIDS Model

Marshallian Price Elasticities of Demand						
	WHEAT	RICE	CORN	PORK	POULTRY	OTHER
WHEAT	-0.2978	-0.1853	-0.0289	0.0628	0.0641	-0.1610
RICE	-0.1444	-0.3524	-0.0099	0.1486	0.1625	0.0108
CORN	-0.1472	-0.0672	-0.4766	0.3765	-0.4326	-0.1133
PORK	0.0680	0.1807	0.0766	-0.2662	0.0249	-0.1503
POULTRY	0.2152	0.6796	-0.3040	0.0612	-0.4383	-1.0065
OTHER	-0.0296	-0.0461	-0.0025	-0.0505	-0.0172	-0.9714
Income Elasticities						
	WHEAT	0.5187				
	RICE	0.1357				
	CORN	0.8520				
	PORK	0.0100				
	POULTRY	0.7803				
	OTHER	1.1243				

Table 2 – Parameter Estimation Results for the LA/AIDS Model

Parameter	Variable	Estimates	Approx Std Err	t Value	Approx Pr > t
Wheat					
aw	intercept	0.22235	0.0758	2.930	0.0125
gww	lnPw	0.02798	0.0103	2.720	0.0187
gwr	lnPr	-0.00808	0.0039	-2.080	0.0594
gwc	lnPc	-0.00120	0.0059	-0.200	0.8427
gwk	lnPk	0.00190	0.0041	0.460	0.6530
gwy	lnPy	0.00241	0.0035	0.690	0.5004
bw	ln(Y/P*)	-0.01945	0.0132	-1.470	0.1665
wdel	urbanization index	-0.11402	0.0679	-1.680	0.1189
wd	dummy 1	-0.00624	0.0020	-3.060	0.0098
wd2	dummy 2	0.00408	0.0036	1.130	0.2820
Rice					
ar	intercept	0.36230	0.0924	3.920	0.0020
grr	lnPr	0.03097	0.0041	7.570	<.0001
grc	lnPc	-0.00057	0.0026	-0.230	0.8254
grk	lnPk	0.00600	0.0038	1.590	0.1370
gry	lnPy	0.00769	0.0015	5.310	0.0002
br	ln(Y/P*)	-0.04308	0.0165	-2.620	0.0225
rdel	urbanization index	-0.02436	0.0792	-0.310	0.7635
rd	dummy 1	-0.00572	0.0026	-2.180	0.0501
rd2	dummy 2	0.00839	0.0035	2.420	0.0321
Corn					
ac	intercept	0.04270	0.0416	1.030	0.3244
gcc	lnPc	0.00419	0.0042	1.000	0.3359
gck	lnPk	0.00298	0.0023	1.300	0.2180
gcy	lnPy	-0.00348	0.0020	-1.780	0.0997
bc	ln(Y/P*)	-0.00119	0.0071	-0.170	0.8709
cdel	urbanization index	-0.08018	0.0355	-2.260	0.0433
cd	dummy 1	-0.00001	0.0011	-0.010	0.9894
cd2	dummy 2	0.00334	0.0019	1.810	0.0960
Pork					
ak	intercept	0.22827	0.1166	1.960	0.0738
gkk	lnPk	0.02796	0.0065	4.310	0.0010
gky	lnPy	0.00062	0.0016	0.380	0.7089
bk	ln(Y/P*)	-0.03947	0.0206	-1.910	0.0801
kdel	urbanization index	0.31180	0.0967	3.220	0.0073
kd	dummy 1	-0.00262	0.0033	-0.810	0.4362
kd2	dummy 2	-0.00934	0.0047	-1.990	0.0694
Poultry Meat					
ay	intercept (poultry)	0.00898	0.0264	0.340	0.7400
gyy	lnPy	0.00639	0.0017	3.680	0.0031
by	ln(Y/P*)	-0.00251	0.0046	-0.550	0.5933
ydel	urbanization index	0.06901	0.0233	2.960	0.0120
yd	dummy 1	0.00223	0.0007	3.210	0.0074
yd2	dummy 2	0.00106	0.0014	0.760	0.4602

Note: Dummy 1 equals to 0 for years ≤ 1990 and equals to 1 for years > 1990 . Dummy 2 equals to 0 for years ≤ 1994 and equals to 1 for years > 1994 . The two dummy variables were introduced to capture the effects of China starting to abolish its rationing system beginning around 1990 and ending around 1994.

Table 3 – Estimation Results for the CES Nest for Poultry Meat

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
b2	ln(P2/P)	-0.8103	0.453	-1.79	0.092
a0	Intercept	0.0091	0.006	1.61	0.126
a1	lnX	0.9809	0.005	183.8	<.0001
b1	lnX	3.0863	0.296	10.41	<.0001
b0	Intercept	-7.7767	0.486	-16.00	<.0001

The parameter b_2 corresponds to $-\sigma$. X is aggregated poultry meat including both imported poultry meat and China's domestically produced poultry meat.

Table 4 – Estimation Results for the Wheat Commodity Supply Model

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
Supply					
a2	lnWage	0.159	0.137	1.160	0.261
a3	lnPfert	-0.015	0.127	-0.120	0.906
a4	lnPpesti	-0.245	0.075	-3.280	0.004
a5	lnP1tool	-0.180	0.158	-1.140	0.269
a6	lnPoil	-0.029	0.072	-0.410	0.689
a0	Intercept	-37.52	11.576	-3.240	0.005
a7	lnA	0.870	0.248	3.500	0.003
a8	Year	0.019	0.006	3.200	0.005
Feed Demand					
c0	Intercept	6.883	2.533	2.720	0.013
c1	Pd	-0.016	0.006	-2.590	0.017
c2	Qspk	-0.019	0.080	-0.230	0.819
c3	Qspy	0.430	0.215	2.000	0.060
Stocks Demand					
d0	Intercept	-7.915	21.619	-0.370	0.719
d1	Pd	-0.204	0.054	-3.790	0.001
d2	Qs	1.095	0.156	7.000	<.0001
Foreign Export					
e0	Intercept	-449.2	99.139	-4.530	0.0002
e1	Qxf	3.664	1.287	2.850	0.010
e2	BSfp	0.399	1.058	0.380	0.710
e3	Qsfp	4.724	0.895	5.280	<.0001
SUPPLY_ELASTICITY				0.311	
FEED_DEMAND_ELASTICITY				-1.493	
STOCK_DEMAND_ELASTICITY				-1.214	
FOREIGN_EXPORT_SUPPLY_ELASTICITY				3.183	

The supply elasticity is estimated directly. The feed demand, stocks demand, and foreign export supply elasticities are derived using the corresponding estimated slopes and mean prices and quantities.

Table 5 – Estimation Results for Rice Commodity Supply Model

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
Supply					
a2	lnWage	0.1703	0.384	0.44	0.673
a3	lnPfert	-0.0318	0.322	-0.10	0.924
a4	lnPpesti	0.0642	0.144	0.45	0.672
a5	lnP1tool	-0.2756	0.449	-0.61	0.562
a6	lnPoil	-0.1997	0.195	-1.03	0.345
a0	Intercept	-6.553	30.203	-0.22	0.835
a7	lnA	-0.0079	0.026	-0.31	0.771
a8	Year	0.0054	0.016	0.35	0.741
Stocks Demand					
d0	Intercept	-138.0	69.774	-1.98	0.095
d1	Pd	-0.2422	0.131	-1.85	0.114
d2	Qs	1.748	0.526	3.32	0.016
Foreign Import					
e0	Intercept	1639.6	197.100	8.32	<.0001
e1	Qmf	-23.43	9.381	-2.50	0.041
e2	BSfp	-4.991	6.362	-0.78	0.458
e3	Qsfp	-23.81	4.085	-5.83	0.001
e4	Rer	-95.97	37.569	-2.55	0.038
SUPPLY_ELASTICITY				0.273	
STOCKS_DEMAND_ELASTICITY				-1.102	
FOREIGN_IMPORT_DEMAND_ELASTICITY				-8.240	

The supply elasticity is estimated directly. The stocks demand and foreign import demand elasticities are obtained by converting the estimated slopes into elasticity form using mean prices and quantities.

Table 6 – Estimation Results for the Corn Commodity Supply Model

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
Supply					
a2	lnWage	-0.049	0.195	-0.250	0.805
a3	lnPfert	0.308	0.190	1.620	0.122
a4	lnPpesti	-0.169	0.101	-1.670	0.111
a5	lnPltool	-0.048	0.231	-0.210	0.837
a6	lnPoil	-0.272	0.117	-2.330	0.032
a0	Intercept	-76.085	16.472	-4.620	0.000
a7	lnA	0.654	0.224	2.910	0.009
a8	Year	0.039	0.009	4.610	0.0002
Stocks Demand					
d0	Intercept	17.367	23.309	0.750	0.466
d1	Pd	-0.192	0.097	-1.980	0.063
d2	Qs	0.919	0.134	6.870	<.0001
Foreign Import					
e0	Intercept	-1.868	59.153	-0.030	0.975
e1	Qmf	-5.120	0.893	-5.730	<.0001
e2	BSfp	0.769	0.677	1.140	0.270
e3	Qsfp	1.659	0.512	3.240	0.004
e4	Rer	-42.479	13.386	-3.170	0.005
SUPPLY_ELASTICITY				0.230	
STOCK_DEMAND_ELASTICITY				-0.612	
FOREIGN_IMPORT_DEMAND_ELASTICITY				-3.781	

Note: The corn supply elasticity is estimated directly. The stocks demand and foreign import demand elasticities are obtained by converting the estimated slopes into elasticity form using mean prices and quantities.

Table 7 - Estimation Results for the Pork Supply Model

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
	Supply				
a2	lnWage	0.050	0.224	0.220	0.826
a3	lnPc	0.239	0.181	1.320	0.205
a4	lnPinput	-0.417	0.306	-1.360	0.189
a0	Intercept	-132.92	22.53	-5.900	<.0001
a5	lnZ	-0.207	0.395	-0.530	0.606
a6	Year	0.072	0.012	5.910	<.0001
	Foreign Import				
c0	Intercept	8391.4	1431.2	5.860	<.0001
c1	Qmf	-2.667	0.795	-3.360	0.003
c2	Qsf	-127.76	83.60	-1.530	0.142
c3	Rpop	-1372.2	168.50	-8.140	<.0001
DOMESTIC_SUPPY_ELASTICITY				0.128	
FOREIGN_IMPORT_DEMAND_ELASTICITY				-1.936	

Pork supply elasticity is estimated directly. The foreign import demand elasticity is obtained by converting the estimated inverse slope into elasticity form using mean prices and quantities.

Table 8 - Estimation Results for Poultry Meat Supply Model

Parameter	Variable	Estimate	Approx Std Err	t Value	Approx Pr > t
a2	Supply lnWage	-0.018	0.181	-0.100	0.923
a3	lnRir	-0.288	0.14	-2.08	0.055
a0	Intercept	-156.4	64.07	-2.44	0.028
a4	lnZ	0.472	0.268	1.760	0.099
a5	Year	0.080	0.033	2.400	0.030
b0	Foreign Import Intercept	3038.1	485.2	6.260	<.0001
b1	Qmf	-0.593	0.180	-3.300	0.005
b2	Qsf	152.3	96.35	1.580	0.134
b3	Rpop	-867.4	314.5	-2.760	0.014
c0	Foreign Exprot Intercept	2628.4	1283.8	2.050	0.057
c1	Qxf	0.694	0.267	2.600	0.020
c2	Qsf	-284.8	273.8	-1.040	0.314
c3	Rpop	72.4	895.8	0.080	0.937
DOMESTIC_SUPPLY_ELASTICITY				0.306	
FOREIGN_IMPORT_DEMAND_ELASTICITY				-8.440	
FOREIGN_EXPORT_SUPPLY_ELASTICITY				2.566	

The poultry meat supply elasticity is estimated directly. The foreign import demand and foreign export supply elasticities are obtained by converting the estimated inverse slopes into elasticity form using mean prices and quantities.

Table 9 - Elasticities for Wheat, Rice, Corn, Pork, and Poultry in China

	Wheat	Rice	Corn	Pork	Poultry
Consumption					
Own Price	-0.298	-0.352	-0.476	-0.266	-0.438
Income	0.519	0.136	0.852	0.010	0.780
China's import demand	na	na	na	na	-0.635
Feed demand	-1.493	na	-0.805	na	na
Commodity Model Using Inverse Form for Foreign Trade Behavior					
Output supply	0.311	0.273	0.230	0.128	0.306
Stock demand	-1.214	-1.102	-0.612	na	na
Foreign export supply	3.183	na	na	na	2.566
Foreign import demand	na	-8.240	-3.781	-1.936	-8.440
Commodity Model Using Ordinary Form for Foreign Trade Behavior					
Output supply	0.341	0.244	0.235	0.140	0.275
Stock demand	-0.870	-1.210	-0.595	na	na
Foreign export supply	0.785	na	na	na	0.668
Foreign import demand	na	-3.133	-1.633	-0.751	-3.503

