# China's Accession to World Trade Organization and its Impact on the US Pork Industry: A General Equilibrium Modeling.


| **Authors** | Contact Information |
|---|---|
| **Osei-Agyeman Yeboah** | Department of Agribusiness,<br>Applied Economics & Agriscience Education<br>N.C A&T State University<br>A-25 C.H. Moore Agricultural Research Facility.<br>1601 E. Market St. Greensboro, NC 27411<br>Phone (336) 344 - 7056<br>Fax (336) 344 - 7658<br>E-mail oyeboah@ncat.edu |
| **Victor Ofori Boadu** | Department of Agribusiness,<br>Applied Economics & Agriscience Education<br>N.C A&T State University<br>A- 29 C.H. Moore Agricultural Research Facility.<br>1601 E. Market St. Greensboro, NC 27411<br>Phone (336) 256-2259<br>Fax (336) 344 - 7658<br>E-mail vo993131@ncat.edu |
| **Henry Thompson** | Department of Agricultural Economics & Rural Sociology<br>Auburn University<br>309 Comer Hall<br>Auburn., AL 36849<br>Tel: (334) 844-2910<br>Fax: (334) 844-5639<br>Email: thomps1@auburn.edu |

## Introduction

On December 11, 2001, China concluded bilateral negotiations with World Trade Organization (WTO) members and gained entry into the WTO in January 2002. This event was preceded by a major break-through in trade negotiations between China and the U.S. on October 10, 2000 where President Clinton signed the U.S. China Relations Act into law. Under the terms of the pact, China will accept pork from any Food Safety and Inspection Service approved packing plant, phase out its restrictive import and distribution procedures, lower tariffs, and eliminate export subsidies. Accession of China to the WTO would potentially add $1.6 billion by 2005 to the annual tally of global U.S. exports of grains, oilseeds and oilseed products, and cotton. Much of the $1.6 billion represents direct U.S. sales to China; these commodities would enjoy significantly greater access to the immense Chinese market. This figure does not take into account other U.S. commodities such as fruit and vegetables, animal products, and tree nuts, which would also enjoy increased access once Chinese duty reductions, are implemented. U.S. farm income stands to gain considerably from the rise in exports. Higher foreign demand for field crops and related products would lead to an increase in U.S. major crop prices, which would boost farm income, Average price increases for corn, wheat, upland cotton, and soybeans would be 1.5 to 4.5 percent above Baseline levels over the 2000-09 period (ERS/USDA, 2000).

Most analysts expect pork demand in China to increase by 6 to 7 percent per (%) per year, based on a tariff reduction from 43% to 12% by 2004; implying that China's incremental growth in pork consumption would be three times greater than the 529,000 metric tons of pork exported in 1998. U.S. pork exports to China have been growing through the 1990s. Especially, from 1994 through 1998, pork export value to China increased by more than 61 times. Moreover, China's market share of total U.S. export is less than 7% (USDA-FAS, 2003).

In 2004, U.S. pork exports set another export record, exceeding $2 billion in total value and 995,000 metric tons in volume for the first year. This was an increase of over 35 percent by volume and 40 percent by value compared to 2003 year exports (National Pork Producers Council- NPPC, 2005). China's 1.2 billion people consume over half of all pork consumed in the world. China's incremental annual pork consumption increase of about 3 percent is twice the amount of total U.S. pork exports in 19990.

According the NPPC, what makes trade with China so important, was its potential to add value to each animal raised in the U.S. Chinese consumers prefer variety meats, such as stomachs, kidneys, hearts and tongues, which traditionally have little value in America. In fact, according to USDA, cutout values for U.S. hogs have fallen recently because of a drop in price being paid for variety meats. Increased exports to China, therefore, would bolster prices to pork producers without raising domestic prices for the American consumer. In 2004, U.S. live hog prices would have been about 30 percent lower if the amount of U.S. pork exported had instead been sold in the domestic market. Demand for pork by 1.2 billion Chinese consumers could easily boost the value of hogs by $5 per head when the agreement is fully implemented (Hayes, 2005; 2001).

With regards to the rest of the economy, there have been many estimates formulated in regards to what impact China's accession into the World Trade Organization (WTO) will have, but there is one that is eye catching. Goldman Sachs states that by taking into account the effects, such as increases in foreign direct investment that China's accession into the WTO could translate into an estimated $13 billion in additional U.S. exports by 2005. Many sectors of U.S. businesses will prosper, such as information technology, services, and most of all agriculture. This will enable the U.S. to begin to decrease the trade deficit it currently has with China.

The present paper examines the potential impact of trade liberalization on U.S. pork industry in a comparative statics of a general equilibrium model of production and trade. The model generates comparative static adjustments in outputs and factor prices to changing output prices. Input substitution is the key, and the paper examines sensitivity of results to constant elasticity substitution. While there is no doubt that trade liberalization will expose U.S pork producers and processors to international competition, increasing overall efficiency and stimulating economic growth, there is concern about how trade liberalization will redistribute factor income and affect income inequality.

**The Computable General Equilibrium Model of Production and Trade**

Computable general equilibrium (CGE) models are based on a microeconomic structure of production. The model in the present paper assumes constant returns, full employment, nonjoint production, competitive pricing, cost minimization, and perfect factor mobility across sectors. It is an application of the long run competitive model of production and trade summarized by Jones and Scheinkman (1977); Chang (1979); and Thompson (1995).

Full employment of labor, capital, and energy is described by

$$v = Ax \qquad \textbf{(1)}$$

where $v$ is a vector of inputs, $A$ is a matrix of cost minimizing unit inputs, and $x$ is a vector of outputs. Factor endowments are exogenous with perfectly inelastic supplies ensuring the full employment in (1). Competitive pricing in each industry leads to the other major relationship in the model

$$p = A'w \qquad \textbf{(2)}$$

where $p$ is the vector of product prices and $w$ factor prices. The whole U.S. economy is assumed to be a price taker in markets for finished products including pork and pork products.

Emphasis is upon comparative statics starting in equilibrium. Endowment changes are considered, but short or medium run adjustment process and the dynamics of growth are not. Taking the differential of (2),

$$dv = xdA + Adx \qquad \textbf{(3)}$$

Aggregate economy wide substitution terms $S_{ik}$ are introduced, $S_{ik} \equiv \sum_j x_j a_{ij}^h$,

where $\partial a_{ij} / \partial w_h \equiv a_{ij}^h$. This substitution term summarizes how cost minimizing firms across the economy alter their input mix in the face of changing factor prices. If $S_{ik}$ is positive (negative), factors *i* and *h* are aggregate substitutes (complements). For every factor i, $dAx = \sum_k s_{ik} dw$, and (3) becomes

$$dv = Sdw + Adx. \qquad \textbf{(4)}$$

Considering small changes, cost-minimizing behavior insures that

$$wdA' = 0. \qquad \textbf{(5)}$$

Using (5) and taking the differential of (2),

$$dp = A'dw. \qquad \textbf{(6)}$$

Putting (5) and (6) together into matrix form,

$$\begin{pmatrix} S & A \\ A & 0 \end{pmatrix} \begin{pmatrix} dw \\ dx \end{pmatrix} = \begin{pmatrix} dv \\ dp \end{pmatrix}. \qquad \textbf{(7)}$$

In elasticity form, the model is written

$$\begin{bmatrix} \sigma & \lambda \\ \theta' & 0 \end{bmatrix} \begin{bmatrix} \hat{w} \\ \hat{x} \end{bmatrix} = \begin{bmatrix} \hat{v} \\ \hat{p} \end{bmatrix} \qquad \textbf{(8)}$$

where $\sigma$ is the 13x13 matrix of substitution elasticities, $\lambda$ is 8x6 industry shares, and $\theta'$ is 6x8 matrix of factor shares. The variables are written in vectors: w represents endogenous factor

prices, x endogenous outputs, v exogenous factor endowments, and p exogenous world prices of goods facing the economy. The ^ represents percent changes.

**U.S. Factor Shares and Industry Shares**

The first step in building an applied specific factors model is to calculate factor shares $\theta$ and industry shares,$\lambda$, as in Thompson (1996). Factor shares are the portions each productive factor receives from industry revenue, and industry shares are portions of productive factors employed in each industry. Labor is disaggregated into six skilled groups:

Managers
Professionals
Service Workers
Clerks
Agricultural Workers
Production Workers.

Payments to each group in manufacturing, services, and agriculture are from the 2002 Economic Census data by the U.S. Census Bureau (http://www.census.gov/econ/census02/data/us/us000.htm). Data on each skilled labor group in Manufacturing, Service and Agricultural sectors were obtained from the 2002 NAICS industry-specific estimates on labor by the Bureau of Labor Statistics, (http://www.bls.gov/oes/oes_dl.htm). Energy spending for the Manufacturing and Service sectors are from U.S. Department of Energy (2001), (http://www.eia.doe.gov/emeu/states/sep_prices/ind/pr_ind_us.html) while total receipts, Labor and Energy in Agriculture and Pork are from the 2002 Census of Agriculture "Summary by NAICS:2002." Also, total receipts from pork variety (Exports) were obtained from the U.S. Meat Export Federation. http://www.usmef.org. Data on labor and each skilled labor group for Pork Variety is based on equal percentages obtained from the Bureau of Labor Statistics estimates under the Animal Slaughtering and Processing industry. The total labor for pork

variety was estimated to be10.4% of total receipts. Energy used in the pork variety industry is estimated as 3.6% of the total receipts. Capital receives the residual in each industry after the labor and energy bills. Agricultural workers in pork and pork varieties receive 40% and 1.7% of the labor bill in the two industries.

The dollar value of factor *i* input in sector *j* is $w_{ij} \equiv w_i v_{ij}$, where $w_i$ is the price of factor *i* and $v_{ij}$ the quantity of factor *i* used in sector *j*. The share of factor *i* in sector *j* is then

$$q_{ij} \equiv w_{ij} / y_j , \qquad \textbf{(9)}$$

where $y_j$ is the value added by sector *j*. The data are static, taken at a single point in time as nominal values for factor payments and value added. Index *i* runs across capital *k*, energy *e*, and the six skilled labor groups. Value added by manufacturing industry comes from the US Census of Manufacturers (2002) and for agriculture from the US Department of Agriculture (2002). Value added in services is the residual of gross state product.

Table 1 is the total payment matrix, used to derive factor shares and industry shares.

. Industries are:

Manufacturing
Service
Agriculture
Agric Less Pork
Pork
Pork Variety

Inputs in the model are:

Managers
Professionals
Service
Clerks
Agriculture
Production

*** Table 1 ***

Table 2 presents the factor shares, the share of each factor in the revenue of each sector. Summing down a column in Table 1 gives total sector revenue. For instance, the total revenue of services is $7,641,046 billion and the capital share is $4,662,228/7,641,045 = 61%. Capital has the largest factor share in each sector or industry. Production workers have the largest share in pork and pork varieties, 8.3%, and 10.4 % in pork and pork variety processing, respectively.

*** Table 2 ***

Industry shares are in Table 3. Summing across rows in Table 1 gives total factor incomes. Assuming perfect labor mobility, the wage is the same across sectors leading to the share of each factor in each sector. For instance, total income of service workers in all sectors is $1,216,860 billion and $1,117,781/$1,216,860 = 91.8% of service workers are in the service sector.

*** Table 3 ***

Capital is sector specific and its industry share is 1 in each industry. Very large shares of service workers, clerks, professionals, and managers are in the service sector and agricultural workers in agriculture. The pork and pork variety industry employs about 2% of agricultural workers in the country.

**Specific Factor Model of Production**

Substitution elasticities summarize adjustment in cost minimizing inputs when factor prices change as developed by Jones (1965) and Takayama (1982). Following Allen (1938), the cross price elasticity between the input factor *i* and the payment to factor *k* in sector *j* is written

$$E_{ij}^{k} = \hat{a}_{ij} / \hat{w}_{k} = \theta_{kj} S_{ij}^{k} \qquad \textbf{(10)}$$

where $S_{ij}^{k}$ is the Allen partial elasticity of substitution. Cobb-Douglas production implies $S_{ij}^{k} =$ 1. With constant elasticity of substitution (CES) production, the Allen partial elasticity can have

any positive value. Given linear homogeneity, $\Sigma_k \; E_{ij}^k = 0$ and the own price elasticities $E_{ij}^i$ are the negative sum of cross price elasticities.

Substitution elasticities are the weighted average of cross price elasticities for each sector,

$$\sigma_{ik} \equiv \hat{a} / \hat{w}_k = \sum_j \lambda_{ij} E_{ij}^k = \sum_j \lambda_{ij} \theta_{kj} S_{ij}^k \qquad \textbf{(11)}$$

Factor shares and industry shares are used to derive the Cobb-Douglas substitution elasticities in Table 4. Constant elasticity of substitution (CES) would scale the elasticities in Table 4. With CES 0.5, for instance, elasticities would be half those in Table 4.

*** Table 4 ***

The largest own substitution occurs for wages for clerks and the smallest is the capital returns pork industry. Every 10% increase in wages for clerks causes 6.8% decline in their employment. Every 10% increase in the return to capital decreases capital input in production 1.33%. Own labor substitution elasticities are larger than own capital elasticities.

**Comparative Static Elasticities**

The present focus is on adjustments to the likely range of price changes due to tariff reduction. Using Cramer's rule, the comparative static elasticities of the system are in the inverse of the system matrix in (11). Table 5 shows elasticities of factor prices with respect to prices of goods in the general equilibrium comparative statics. Every 10% increase in agricultural prices would raise wages of agricultural workers other than pork and pork varieties by 9.83%, no change in the wages of any of the remaining skilled labor groups, and the return to capital in agriculture by 12.2%. Higher agricultural prices increase agricultural output, attracting labor from other sectors that raises the productivity and return to capital.

*** Table 5 ***

Every 10% increase in the price of other manufactures would raise production wages by 7.45%, managers by 1.1%, and returns to capital in that sector 11.58%. Wages depend heavily on the price in services but very little on the prices of pork and especially pork varieties. Some factors benefit and others lose with any price change, and the effects are uneven.

Thompson and Toledo (2000) prove that the comparative static effects of price changes on factor prices are the same for all CES production functions. The degree of substitution, constant along isoquants, does not affect general equilibrium elasticities of prices in competitive models of production. The comparative static elasticities in Table 5 extend to all CES production functions.

Table 6 reports the price elasticities of outputs along the production frontier, with a higher price raising output in its sector as it draws labor away from other sectors. The largest own output effect occurs in agriculture other than pork and pork varieties, where every 10% price increase raises output 2.2%. Every 10% price increase in pork price results in no change in pork output but raises the output of pork varieties by 1.6%. The smallest own effect is in service.

* Table 6 *

**Projected Adjustments with FTAA**

The U.S.-China WTO agreement covers all agricultural products, all industrial goods, and all service areas. On U.S. priority agricultural products (Beef, Grapes, Wine, Cheese, Poultry, Pork) tariffs will be reduced from overall average of 31.5% to 14.5% by January 2004, at the latest (The White U.S. House, 1999).

China's industrial tariffs will fall from overall average of 24.6% in 1997 to overall average of 9.4% by 2005 (The U.S. White House, 1999). However, the there are studies that have raised concerns with regards to the manufacturing sector and trade with china. According

to the Chicago Fed Letter, 2003, the growth in imports, in particular, has raised challenges for domestic manufacturers competing against lower-cost Chinese production. China's imports into the U.S. have easily outpaced U.S. exports to China. U.S. manufacturing output has been weak and year-over-year job growth in manufacturing has been negative over three years.

In the service sector, China has made commitments in all service categories with reasonable transitions to eliminate most foreign equity restrictions (especially in areas where the U.S. has a strong commercial interest) agreeing to accede to the Basic Telecommunications and Financial Services Agreements, and granting market access to securities, audio visual and professional services, to name a few.

Based on the literature, our assumption is that the prices agricultural products (including pork and pork varieties) will rise along with prices in services e while manufacturing will fall. The effect of changing prices on factor prices depends on the interplay of factor intensity and substitution as output adjust. Sensitivity analysis is discussed.

**Predicted Price Changes**

We assume the U.S. be the excess supplier for agricultural and service goods, China the excess demander. Using average tariff reduction from 43% to 24%, Pc = 1.43Pus in the original situation; where Pc = price in China and Pus = price in the U.S. Then with new tariff Pc* = 1.24Pus*; Pus* > Pus and the level of trade increases. Production in the US increases also. Higher prices are expected for exporting industries in the move to free trade. Using export and import elasticities of 1 and -1, respectively, a price increased of 15% was predicted for pork, pork varieties, and the rest of agriculture along with service while a fall of 15% in price was predicted for the manufacturing sector.

Multiply a vector of predicted price changes by the matrices of factor price elasticities in Tables 5 to find a vector of price adjustments. Table 7 assumes price changes of 15%. The results are scaled according to the level of price changes. For instance, 30% price changes would double the adjustments. Also, Table 8 reports adjustments with a higher level of substitution. Wages rise except in manufacturing. Capital in pork and pork varieties along with the rest of agriculture and service rise in its returns on the order of 30%. Capital returns fall 39% in manufacture. Wages rise on the order of 20% except in manufacturing, where they fall about 14.7%.

* Table 7 *

The effects of China's accession in WTO on outputs are found by multiplying the output elasticities in Table 6 by projected vector price changes. Output increases by 1.08% in service; 0.87% in the rest of agriculture; and an average of about 1% in pork and pork variety industry. Manufacturing output declines about 4.73%. These effects are not large but in the long run the lower return to capital will lower investment and the stock of productive capital.

Regarding sensitivity, factor price changes are proportional to the vector of price changes. For instance, if prices change twice as much factor price adjustments would be twice as large as in Table 7. Further, factor price adjustments are identical with any degree of CES production and outputs are scaled accordingly. For instance, CES = 2, implies output adjustment twice as large in Table 7.

*** Table 8 ***

A further assumption leads to long run output adjustments. Suppose capital changes in proportion to the change in its return. Every 1% increase in the return to capital causes a 1% long run adjustment in the capital stock. Under price changes of 15% (Table 7), for example, the

capital stock in Services will rise by 16.08%%; rest of agriculture will rise 15.87%; and pork and pork varieties will rise by 15.41% and 16.73%, respectively. On the other hand, manufacturing will fall by approximately 19.73%. Outputs adjust whenever the levels of capital adjust. In the specific-factors model with constant return to scale, the percentage adjustment in output and the percentage change in the industry's capital stock are about equal. Table 9, shows the approximate long run output changes with 15% price change.

Outputs in service, rest of agriculture, pork, and pork varieties are projected to increase in the long run by 16.08%, 15.87%, 15.41%, and 16.73% respectively. Output in manufacturing is projected to fall by 19.73% in the long run.

With the exception of manufacturing wages that are projected to fall by 7.36%, all labor wages are projected to increase with the largest 14.73% in services and the smallest 11.66% in managerial positions.

*** Table 9 ***

**Conclusion**

The adjustments due to increased trade with China can be broken down into factor income redistribution using applied models of production and trade. The specific factors model provides insight into potential income redistribution in the U.S. The main lesson is that markets adjust as the economy moves along its production frontier toward a new production pattern caused by changing prices. U.S. service industry and agriculture, especially pork and pork varieties, will enjoy higher prices and expanded opportunity, while the manufacturing industry will suffer falling prices and import competition.

Predicted output and wage adjustments are not large in percentage terms with the assumption of lower substitution elasticities. Wages of all but production workers rise in the

model, and so does the returns to capital in service, agriculture, and especially pork and pork varieties rise. This rise in capital returns increases investment, resulting in larger output increase in the long run. Short run output adjustment will be negligible in pork production 0.40% and the rest of agriculture 0.87%, while service and pork varieties will increase by 1.08 and 1.73, respectively. Manufacturing output will decline by 4.73% in the short run, and roughly quadrupled in the long run 19.73%. Output in services, rest of agriculture, pork, and pork varieties will increase to 16.08%, 15.87%, 15.41%, and 16.73%, respectively, in the long run.

**References**


Allen, R.G.D. (1938) *Mathematical Analysis for Economist*, MacMillan, 1938.

Bureau of Labor Statistics (2002) (http://www.bls.gov/oes/oes_dl.htm.

Chang, W.W. (1979) "Some Theorems of Trade and General Equilibrium with Many Goods and Factors. "*Econometrica* 47; pp 709-726.

ERS-USDA (2000) "World Agriculture & Trade" *Agricultural Outlook*, March 2000.

-------- (2002) "The Economics of Food, Farming, Natural Resources, and Rural America, Net Value-Added (http://www.ers.usda.gov/data/farmincome/finfidmu.htm).

Jones, Ronald W. (1965) "The Structure of Simple General Equilibrium Models, *Journal of Political Economy*, pp. 557-572.

Hayes, Dermott (2005) "Increased Market Access Drives Record U.S. Pork Exports" (www.nppc.org/wm/show.php)

--------- (2005) "Increased Market Access Drives Record U.S. Pork Exports" (www.nppc.org/wm/show.php)

Jones, R.W. and J.A. Scheinkman (1977) "The Relevance of the Two-Sector Production Model in Trade Theory." *The Journal of Political Economics* 15; pp. 65-99.

National Pork Producers Council- NPPC (2005) "Increased Market Access Drives Record U.S. Pork Exports" (www.nppc.org/wm/show.php)

--------- (2001) "NPPC Applauds Agreement Paving Way for China to Join World Trade Organization" (www.nppc.org/wm/show.php).

Takayama, Akira (1982) "On the Theorems of General Competitive Equilibrium of Production and Trade – A Survey of Some Recent Developments in the Theory of International Trade," *Kieo Economic Studies*, pp. 1-37.

Thompson, Henry (1996) "NAFTA and Industrial Adjustment: Specific Factor Model of Production in Alabama, *Growth and Change*, Winter, 3-28.

Thompson, Henry and Hugo Toledo (2000) "A Note on General Equilibrium Price Elasticities with CES Production, Unpublished.

Thompson, Henry (1995) "Factor Intensity Versus Factor Substitution in a Specified General Equilibrium Model.' *Journal of Economic Integration;* 10 (3): 283-297.

United States Department of Agriculture (USDA), Foreign Agriculture Service (FAS). www.fas.usda.gove, 2003.

U.S. Census Bureau (2002) "Economic Census Data" (http://www.census.gov/econ/census02/data/us/us000.htm).

U.S. Census of Manufacturing (2002) (http://www.census.gov/mcd/)

U.S. Department of Energy (2001) (http://www.eia.doe.gov/emeu/states/sep_prices/ind/pr_ind_us.html).

U.S. Meat Export Federation (2002) (http://www.usmef.org).

U.S. White House Office of Public Liaison, (1999) "Briefing Clinton Administration Agenda for the World Trade Organization Material: Summary of U.S.-China Bilateral WTO Agreement." November 17 (www.uschina.org/public/991115a.html)

**Table 1. Factor Payment Matrix ($'000): 2002**

| | Manufacturing | Service | Agriculture | Agric. Less Pork | Pork | Pork Variety | Total |
|---|---|---|---|---|---|---|---|
| **Managers** | 108,751,550 | 354,459,309 | 2,890,281 | 2,770,228 | 117,891 | 2,162 | **466,101,139** |
| **Professionals** | 88,123,101 | 640,946,147 | 455,398 | 404,693 | 50,290 | 415 | **729,524,646** |
| **Service** | 95,311,210 | 1,117,781,548 | 3,767,635 | 3,524,828 | 239,327 | 3,479 | **1,216,860,394** |
| **Clerks** | 44,348,796 | 425,705,359 | 1,490,338 | 1,415,343 | 74,264 | 731 | **471,544,493** |
| **Agriculture** | 879,964 | 1,177,735 | 12,384,720 | 12,105,961 | 278,485 | 274 | **14,442,419** |
| **Production** | 213,591,040 | 51,584,830 | 711,628 | 664,964 | 37,720 | 8,945 | **265,887,499** |
| **Capital** | 3,142,434,749 | 4,662,228,714 | 170,000,000 | 161,523,691 | 8,343,374 | 132,935 | **7,974,663,463** |
| **Energy** | 137,820,000 | 387,162,000 | 28,000,000 | 27,508,159 | 486,283 | 5,558 | **552,982,000** |
| **Total** | **3,831,260,410** | **7,641,045,643** | **219,700,000** | **209,917,868** | **9,627,634** | **154,498** | **11,692,006,053** |

**Table 2. Factor Shares, $\theta_{ij}$ : 2002**

| | Mfg | Service | Agriculture | Agric. Less Pork | Pork | Pork Variety |
|---|---|---|---|---|---|---|
| **Managers** | 0.0284 | 0.0464 | 0.0132 | 0.0132 | 0.0122 | 0.0140 |
| **Professionals** | 0.0230 | 0.0839 | 0.0021 | 0.0019 | 0.0052 | 0.0027 |
| **Service** | 0.0249 | 0.1463 | 0.0171 | 0.0168 | 0.0249 | 0.0225 |
| **Clerks** | 0.0116 | 0.0557 | 0.0068 | 0.0067 | 0.0077 | 0.0047 |
| **Agriculture** | 0.0002 | 0.0002 | 0.0564 | 0.0577 | 0.0289 | 0.0018 |
| **Production** | 0.1438 | 0.3392 | 0.0988 | 0.0995 | 0.0829 | 0.1036 |
| **Capital** | 0.8202 | 0.6102 | 0.7738 | 0.7695 | 0.8666 | 0.8604 |
| **Energy** | 0.0360 | 0.0507 | 0.1274 | 0.1310 | 0.0505 | 0.0360 |

**Table 3. Industry Shares, $\lambda_{ij}$**

| | Mfg | Service | Agriculture | Agric. Less Pork | Pork | Pork Variety |
|---|---|---|---|---|---|---|
| **Managers** | 0.2333 | 0.7605 | 0.0062 | 0.0059 | 0.0003 | 0.0000 |
| **Professionals** | 0.1208 | 0.8786 | 0.0006 | 0.0006 | 0.0001 | 0.0000 |
| **Service** | 0.0783 | 0.9186 | 0.0031 | 0.0029 | 0.0002 | 0.0000 |
| **Clerks** | 0.0941 | 0.9028 | 0.0032 | 0.0030 | 0.0002 | 0.0000 |
| **Agriculture** | 0.0609 | 0.0815 | 0.8575 | 0.8382 | 0.0193 | 0.0000 |
| **Production** | 0.1741 | 0.8190 | 0.0069 | 0.0066 | 0.0003 | 0.0000 |
| **Capital** | 0.3941 | 0.5846 | 0.0213 | 0.0203 | 0.0010 | 0.0000 |
| **Energy** | 0.2492 | 0.7001 | 0.0506 | 0.0497 | 0.0009 | 0.0000 |

## Table 4. Cobb-Douglas Substitution Elasticities, $\sigma_{ik}$

| | ŵMgr | ŵProf | ŵSer | ŵClrk | ŵAgr | ŵProd | ŵE | ŵMfg | ŵS | ŵAg.<P | ŵPork | ŵP.vty |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **âMgr** | **-0.6377** | 0.0692 | 0.1172 | 0.0451 | 0.0005 | 0.0182 | 0.0477 | 0.0419 | 0.2965 | 0.0014 | 0.0001 | 0.0000 |
| **âProf** | 0.0442 | **-0.6523** | 0.1315 | 0.0504 | 0.0002 | 0.0127 | 0.0489 | 0.0217 | 0.3425 | 0.0001 | 0.0000 | 0.0000 |
| **âSer** | 0.0449 | 0.0789 | **-0.6094** | 0.0521 | 0.0003 | 0.0106 | 0.0498 | 0.0141 | 0.3581 | 0.0007 | 0.0000 | 0.0000 |
| **âClrk** | 0.0446 | 0.0779 | 0.1345 | **-0.6877** | 0.0003 | 0.0113 | 0.0495 | 0.0169 | 0.3519 | 0.0007 | 0.0000 | 0.0000 |
| **âAgr** | 0.0168 | 0.0100 | 0.0280 | 0.0110 | **-0.4301** | 0.0067 | 0.1171 | 0.0110 | 0.0318 | 0.1932 | 0.0044 | 0.0000 |
| **âProd** | 0.0318 | 0.0348 | 0.0484 | 0.0201 | 0.0004 | **-0.3952** | 0.0391 | 0.1444 | 0.0756 | 0.0006 | 0.0000 | 0.0000 |
| **âE** | 0.0402 | 0.0646 | 0.1095 | 0.0422 | 0.0031 | 0.0188 | **-0.6078** | 0.0448 | 0.2729 | 0.0115 | 0.0002 | 0.0000 |
| **âMfg** | 0.0284 | 0.0230 | 0.0249 | 0.0116 | 0.0002 | 0.0557 | 0.0360 | **-0.1798** | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| **âS** | 0.0464 | 0.0839 | 0.1463 | 0.0557 | 0.0002 | 0.0068 | 0.0507 | 0.0000 | **-0.3898** | 0.0000 | 0.0000 | 0.0000 |
| **â Ag.<P** | 0.0132 | 0.0019 | 0.0168 | 0.0067 | 0.0577 | 0.0032 | 0.1310 | 0.0000 | 0.0000 | **-0.2305** | 0.0000 | 0.0000 |
| **âPork** | 0.0122 | 0.0052 | 0.0249 | 0.0077 | 0.0289 | 0.0039 | 0.0505 | 0.0000 | 0.0000 | 0.0000 | **-0.1334** | 0.0000 |
| **Âp.vty** | 0.0140 | 0.0027 | 0.0225 | 0.0047 | 0.0018 | 0.0579 | 0.0360 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | **-0.1396** |

Table 5. Elasticities of Factor Prices with Respect to Output Prices

| | **^pMfg** | **^pS** | **^pAg.<P** | **^pPork** | **^pP.vty** |
|---|---|---|---|---|---|
| **^wMgr** | 0.1114 | 0.8865 | 0.0020 | 0.0001 | 0.0000 |
| **^wProf** | 0.0352 | 0.9674 | -0.0026 | 0.0000 | 0.0000 |
| **^wSer** | 0.0091 | 0.9917 | -0.0008 | 0.0000 | 0.0000 |
| **^wClrk** | 0.0187 | 0.9821 | -0.0007 | 0.0000 | 0.0000 |
| **^wAgr** | 0.0247 | -0.0233 | 0.9827 | 0.0159 | 0.0000 |
| **^wProd** | 0.7452 | 0.2538 | 0.0008 | 0.0001 | 0.0000 |
| **^eE** | 0.1267 | 0.8333 | 0.0396 | 0.0005 | 0.0000 |
| **^rMfg** | 1.1576 | -0.1555 | -0.0020 | 0.0000 | 0.0000 |
| **^rS** | -0.0360 | 1.0391 | -0.0031 | -0.0001 | 0.0000 |
| **^rAg.<P** | -0.0289 | -0.1891 | 1.2192 | -0.0013 | 0.0000 |
| **^rPork** | -0.0138 | -0.1045 | -0.0351 | 1.1534 | 0.0000 |
| **^rP.vty** | -0.0578 | -0.1007 | -0.0037 | -0.0001 | 1.1622 |

Table 6. Elasticities of Output with Respect to Output Prices

| | **^pMfg** | **^pS** | **^pAg.<P** | **^pPork** | **^pP.vty** |
|---|---|---|---|---|---|
| **^xMfg** | 0.1576 | -0.1555 | -0.0020 | 0.0000 | 0.0000 |
| **^xS** | -0.0360 | 0.0391 | -0.0031 | -0.0001 | 0.0000 |
| **^xAg.<P** | -0.0289 | -0.1891 | 0.2192 | -0.0013 | 0.0000 |
| **^xPork** | -0.0138 | -0.1045 | -0.0351 | 0.1534 | 0.0000 |
| **^xP.vty** | -0.0578 | -0.1007 | -0.0037 | -0.0001 | 0.1622 |

**Table 7. Factor Prices and Outputs Adjustments (Cobb-Douglas)**

| | Projected Price Change | Factor Price Adjustments | | Output Adjustments | |
|---|---|---|---|---|---|
| | | **wMgr** | 11.66 | | |
| | | **wProf** | 13.94 | | |
| | | **wSer** | 14.73 | | |
| | | **wClrk** | 14.44 | | |
| | | **wAgr** | 14.26 | | |
| | | **wProd** | -7.36 | | |
| | | **eE** | 11.20 | | |
| **Mfg** | -15% | **rMfg** | -19.73 | **xMfg** | -4.73 |
| **Service** | 15% | **rS** | 16.08 | **xS** | 1.08 |
| **Agric.<Pork** | 15% | **rAg.<P** | 15.87 | **xAg.<P** | 0.87 |
| **Pork** | 15% | **rPork** | 15.41 | **xPork** | 0.41 |
| **Pork Variety** | 15% | **rP.vty** | 16.73 | **xP.vty** | 1.73 |

**Table 8. Factor Prices and Outputs Adjustments (CES=2.0)**

| | Projected Price Change | Factor Price Adjustments | | Output Adjustments | |
|---|---|---|---|---|---|
| | | **wMgr** | 23.32 | | |
| | | **wProf** | 27.89 | | |
| | | **wSer** | 29.45 | | |
| | | **wClrk** | 28.88 | | |
| | | **wAgr** | 28.52 | | |
| | | **wProd** | -14.71 | | |
| | | **eE** | 22.40 | | |
| **Mfg** | -15% | **rMfg** | -39.46 | **xMfg** | -9.46 |
| **Service** | 15% | **rS** | 32.16 | **xS** | 2.16 |
| **Agric.<Pork** | 15% | **rAg.<P** | 31.73 | **xAg.<P** | 1.73 |
| **Pork** | 15% | **rPork** | 30.83 | **xPork** | 0.83 |
| **Pork Variety** | 15% | **rP.vty** | 33.47 | **xP.vty** | 3.47 |

**Table 9. Long-run adjustment in output**

| | Projected Price Change | | Long-run Output Adjustments |
|---|---|---|---|
| **Mfg** | -15% | **xMfg** | -19.73 |
| **Service** | 15% | **xS** | 16.08 |
| **Agric.<Pork** | 15% | **xAg.<P** | 15.87 |
| **Pork** | 15% | **xPork** | 15.41 |
| **Pork Variety** | 15% | **xP.vty** | 16.73 |