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Technology, Trade and Economic Performance in the Food Industries: The case of U. S and Australian Meat Processing

Catherine J. Morrison

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DISCUSSION PAPER

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ABSTRACT

The food processing industries have recently experienced significant structural and economic performance changes, which have in turn had important impacts on the food system overall. In this paper I examine the cost structure of the 3- and 4-digit SIC level meat product industries in the U.S. and Australia from 1970-91. Further, I incorporate a demand structure to allow for trade and technological impacts on output demand and pricing. I evaluate scale, technological, trade, capital adjustment and markup effects using short and long run input cost and input and output demand elasticities. I find that input cost and composition patterns in the meat product industries indicate surprisingly consistent cost and demand structures across the industries and countries. The most important technological impacts seem to stem from significant scale economies, which involve capital investment and materials saving in the long run. Import competition appears further to motivate capital expansion. Although the tendency over time independently of these tech/ trade factors is to increase materials use, on balance these factors motivate capital deepening and materials and labor saving. Finally, although large markups of price over marginal cost are found, they are consistent with small markups over average costs (and thus profitability) due to the substantial underlying scale economies.

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INTRODUCTION

The impacts of technology and trade on the structure of production and pricing behavior are important concerns that have been addressed for many industries and from many perspectives. This is a particularly critical focus for the meat products industries, where the demand structure has changed, concentration in the industry is high, scale economies seem prevalent, and competition from foreign producers is potentially strong.

Assessing these production characteristics and patterns requires serious consideration of the associated implications for scale economies, market power and competitiveness in these industries. These issues have stimulated discussion (not only in the academic literature but also in policy circles and the popular press) addressing cost and demand conditions in the U.S. meat products industries. Clearly, specialization and concentration, and movement toward very large scale enterprises (horizontal and vertical integration) may be supported in the U.S. by a large population and a high level of technology. However, U.S. industries have until recently been little affected by trade penetration. By contrast, although the meat products industries comprise quite a large proportion of the food processing industry in Australia, the market is relatively small (and therefore less likely to be able to support large entreprises). It is also more heavily affected by international competitiveness due to Australia's greater dependence on trade.

In this study I carry out an exploratory analysis of scale economies and markup behavior in the (3- and 4-digit SIC) U.S. and Australian meat products industries for 1970-1991, and their underlying input-specific and short/long run determinants. I focus particularly on technological and trade (tech/trade) impacts on input costs and output pricing. As a basis for analysis I use a detailed cost and demand specification (using general cost and inverse demand functions) that facilitates "untangling" different types of production characteristics.

I find some evidence of differential input demand patterns stemming from tech/trade factors, but overall a surprising degree of consistency among scale and markup estimates across countries and industries. The extensive measured scale economies in these industries tend to be (relatively) materials and labor saving, although slightly materials using in the short run for the U.S. These scale economies appear to represent crucial facets of the cost/technological structure, that support large markups over marginal cost (but small markups over average cost, and thus profitability).

Other technical change impacts seem less definitive concerning cost/input patterns. Although including a measure of high-tech capital as a technological indicator generates less reasonable results overall than does a simple trend ("disembodied technical change") term, the resulting tendency for secular cost changes has a perverse sign. Allowing for techological advancement "embodied" in the technology underlying observed scale economies, and import competitiveness impacts, materials use/costs seem to be slightly increasing over time.

Increasing trade penetration also seems a quite important determinant of costs in both countries. However, some statistical insignificance of these effects is found, and the competitive forces appear to lowers costs in the U.S. while increasing costs in Australia (both largely stemming from changes in materials use). On the output demand side, changing prices of imported competing products seems to have a negligible effect on demand. Thus the trade patterns are not as definitive as those arising from scale economies, and the associated output pricing behavior.

MODEL SPECIFICATION

The analysis is based on a system of factor demand, capital investment, and output pricing and demand equations derived from a variable cost function and output demand function.[1] The structure is dynamic (incorporates adjustment costs on capital investment), allows for nonconstant (nonhomothetic) scale economies, and incorporates tech/trade factors in the cost and demand functions. The flexible functional forms represent interactions and cross effects among all scale, price, technological and trade factors affecting input demand and output supply/pricing decisions. Thus, a rich specification of these decisions, their determinants and their economic performance implications is possible to model, measure and evaluate.

The variable cost function allowing for external trade and technological factors, nonconstant returns to scale and short run capital fixities resulting from adjustment costs is assumed to be approximated by a generalized Leontief (GL) function of the form:

$$1)\quad G(p,Y,\mathbf{x},\Delta\mathbf{x},T) = Y\,[\Sigma_i\Sigma_j\,\alpha_{ij}\,p_i^{.5}\,p_j^{.5} + \Sigma_i\Sigma_m\,\delta_{im}\,p_i\,s_m^{.5} + \Sigma_i p_i\,\Sigma_m\Sigma_n\,\gamma_{mn}\,s_m^{.5}\,s_n^{.5}]$$

$$+\,Y^{.5}\,[\Sigma_i\Sigma_k\,\delta_{ik}\,p_i x_k^{.5} + \Sigma_i p_i\,\Sigma_m\Sigma_k\,\gamma_{mk}\,s_m^{.5}\,x_k^{.5}] + \Sigma_i p_i\,\Sigma_k\Sigma_l\,\gamma_{lk}\,x_k^{.5}\,x_l^{.5}\,,$$

where the only x_k variable in this study is the private capital stock [K]; p_i and p_j index the prices of variable inputs (labor [L], energy [E] and intermediate materials [M] for the U.S. and [L,M] for Australia); and s_m, s_n depict the remaining arguments (Y, $\Delta K=K_t-K_{t-1}$, and the tech/trade factors **T**). For this treatment the **T** vector includes an import penetration variable [import/output ratio IY] and a standard time trend t. These variables can be interpreted as external or exogenous shift factors, or environmental variables.

The second function used as a basis for representation of the cost and demand structure is the output demand function. Following Morrison [1992a,b;1993], this function is constructed similarly to a GL form as:

$$2a)\quad D(p_Y,\gamma,\mu) = Y(p_Y,\gamma,\mu) = \beta_{YY} + \beta_{Yt}\,t^{.5} + \beta_{YYL}\,Y_L^{.5} + \beta_{YC}\,(CPI/p_Y)^{.5}$$

$$+\,\beta_{YpIM}\,(p_{IM}/p_Y)^{.5} + \beta_{YEXP}\,(EXP/p_Y)^{.5}\,,$$

with the corresponding inverse demand function:

$$2b)\quad p_Y(Y,\gamma,\mu) = [(\beta_{YC}\,CPI^{.5} + \beta_{YpIM}\,p_{IM}^{.5} + \beta_{YEXP}\,EXP^{.5})$$

$$/\,(Y-\beta_{YY} + \beta_{Yt}\,t^{.5} + \beta_{YYL}\,Y_L^{.5})]^{2}\,,$$

where the γ vector includes indicators of domestic and foreign prices and expenditure (the price of competing import products [pIM], the price of "other" goods overall [CPI], and expenditure on goods and services [EXP]), and the μ vector includes other factors not be subject to homogeneity conditions (such as the lagged value of output [Y_L], and a time trend representing changing tastes [t]).

The system of estimating equations is derived directly from these input cost and (inverse) output demand functions. First, three (two for Australia) variable input demand equations are obtained from Shephard's lemma $v_i = \partial G/\partial p_i$, where v_i is the short run cost minimizing demand for variable input i ([L,E,M] or [L,M], respectively). These equations thus have the general form:

$$3)\quad v_i = \partial G/\partial p_i = Y\,[\Sigma_j\, \alpha_{ij}\, (p_j/p_i)^{.5} + \Sigma_m\, \delta_{im}\, s_m^{.5} + \Sigma_m\Sigma_n\, \gamma_{mn}\, s_m^{.5}\, s_n^{.5}$$

$$+\, Y^{.5}\, [\delta_{iK}\, K^{.5} + \Sigma_m\Sigma_K\, \gamma_{mk}\, s_m^{.5}\, K^{.5}] + \gamma_{KK}\, K\ .$$

The (implicit) investment equation for K is specified as an Euler equation representing the investment response to the deviation between the marginal cost of investment (the sum of the ex ante market price p_K and the marginal adjustment costs) and the marginal benefits for the quasi-fixed capital input. This equation is expressed as:

$$4)\ p_K = -\partial G/\partial K - r\partial G/\partial \Delta K + \Delta K \partial^2 G/\partial K\, \partial \Delta K + \Delta\Delta K \partial^2 G/\partial(\Delta K)^2,$$

where $\Delta\Delta K$ is the second difference of K, $\Delta(\Delta K)$, r is the discount rate, and the derivatives $-\partial G/\partial K$ (the instantaneous shadow value of K [Z_K]), and $r\partial G/\partial \Delta K$ (amortized adjustment costs) are computed directly from G(.) and substituted.

Finally, the system is completed by adding the inverse demand equation [2b] and a price determination equation (derived from the usual marginal revenue (MR) equal to marginal cost (MC) requirement for profit maximization). This last equation is of the form

$p_Y = -Y\ \partial p_Y/\partial Y + \partial C/\partial Y$, and is constructed by substituting the derivatives from the definitions of total cost [$C(.) = G(.) + p_K K$ so $MC = \partial C/\partial Y = \partial G/\partial Y$] and total revenue [$R = p_Y(Y,.)Y$, so $MR = p_Y + Y\ \partial p_Y/\partial Y$].

The parameters estimated from this system of equations are used to measure scale economies, markup behavior, and the the underlying tech/trade and price determinants of these production characteristics. These measures rely on cost and input/output elasticities of various types. For example, both the scale economy and markup measures are based on the specification of short and long run marginal cost $MC^S = \partial C/\partial Y = \partial G/\partial Y$ and $MC^L = \partial C^*/\partial Y$, where C is total costs evaluated at the short run level of the capital stock ,$C=G(.)+p_K K$, and C* is instead evaluated at the "desired" long run level of capital K*, (defined as the point where the shadow value of capital $Z_K = -\partial G/\partial K$ is equal to the market price of capital), $C^*=G(.)+p_K K^*(.)$.[2] These measures can be specified as cost elasticities with respect to output (the inverse of scale economies) by constructing the measures in terms of proportional changes; $\varepsilon_{CY}{}^S = \partial \ln C/\partial \ln Y = \partial \ln G/\partial \ln Y$, and $\varepsilon_{CY}{}^L = \partial \ln C^*/\partial \ln Y$.

Technical change (t) and trade (IY) impacts on costs (and thus ultimately on input demand) can be similarly specified via the cost derivatives $\partial C/\partial t$ and $\partial C/\partial IY$ and the associated elasticities $\varepsilon_{Ct} = \partial \ln C/\partial t$ and $\varepsilon_{CIY} = \partial \ln C/\partial \ln IY$. These derivatives can be interpreted analogously to shadow values if t and IY are considered external or environmental tech/trade factors with cost-side marginal benefits; $Z_t = -\partial C/\partial t$ and $Z_{IY} = -\partial C/\partial IY$. The elasticities thus indicate how technological development and competitiveness affect cost efficiency in terms of the use of variable inputs. Again, long run measures taking capital adjustment into account can be computed as $\varepsilon^L{}_{Ct} = \partial \ln C^*/\partial t$ and $\varepsilon^L{}_{CIY} = \partial \ln C^*/\partial \ln IY$.

Note also that these scale (output) and tech/trade elasticities in combination provide important information about productivity growth, since the primal-side productivity growth measure generally measured as $\varepsilon_{Yt} = \partial \ln Y/\partial t$ (where t denotes time, Y(.) is the production function, and this measure may be constructed parametrically or nonparametrically), is a combination of the cost side technology measure ε_{Ct} and the long run scale economy measure $1/\varepsilon_{CY}{}^L$; $\varepsilon_{Yt} = -\varepsilon_{Ct}/\varepsilon_{CY}{}^L$ (see Ohta [1975]).

The measured cost effects developed in terms of total cost elasticities above can be allocated into their input specific components by analyzing the implicit input demands in the long and short run. For example, the existence of scale economies ultimately depends on the different "pieces" of the puzzle motivated by relative labor, materials and capital use. This in turn involves both scale biases and the complementary/substitutable relationships among the inputs.

For example, the elasticity of labor demand with respect to output changes can be espressed as $\varepsilon_{LY} = \partial \ln L/\partial \ln Y$. This is a second derivative of the cost function, as is evident from the construction of the input demand measures from Shephard's lemma. It therefore provides second order information underlying the cost effects. The resulting scale "bias" (the change of the share of labor in total costs $[S_L = p_L L/C]$ when scale changes) can therefore be specified in terms of the relative cost and input-specific responses; $B_{LY} = S_L(\varepsilon_{CY}-\varepsilon_{LY})$.[3]

Further, this measure can be specified in terms of long run adjustment by evaluating the measure in terms of the "desired" level of capital; $\varepsilon^L_{LY} = \partial \ln L^*/\partial \ln Y$. In this case L* (like C* above) is evaluated in terms of the long run "desired" level of capital by substituting the K*(.) measure (derived by setting $Z_K=p_K$ and substituting for the implied level of capital) into the labor demand expression (from equation [3]) before taking the required derivative.

This measure in turn depends on the relationship between labor and capital demand (the substitutability/complementarity of L and K implied by either the $\varepsilon_{LK} = \partial \ln L/\partial \ln K$ or the $\varepsilon_{KL} = \partial \ln K^*/\partial \ln p_L$ measure) combined with information on the capital-scale relationship ($\varepsilon_{KY} = \partial \ln K^*/\partial \ln Y$). I.e., this elasticity can essentially be written as $\varepsilon^L_{LY} = \partial \ln L^*/\partial \ln Y = Y/L\ [\partial L/\partial Y + \partial L/\partial K\ (\partial K^*/\partial Y)]$, which reflects the initial labor demand response to output expansion/contraction, adapted by the resulting capital investment and the secondary (long run) labor response to this change in capital.

Tech/trade elasticities and biases can be specified analogously to the labor/output scale elasticities from the measures: $\varepsilon_{Lt} = \partial \ln L/\partial t$, $\varepsilon^L_{Lt} = \partial \ln L^*/\partial t$, $\varepsilon_{LIY} = \partial \ln L/\partial \ln IY$, and $\varepsilon^L_{LIY} = \partial \ln L^*/\partial \ln IY$. Finally, all these types of elasticities can also be computed for other variable inputs to generate detailed information on materials (farm animal input and energy) use, and short/long run input demand and composition patterns in response to scale changes (given the potential of the existing technology to generate scale economies), technical change, and expanding import competitiveness.

In addition to this rich set of measures summarizing the cost and input demand structure, output demand conditions are represented by the inverse demand equation $p_Y(Y,\gamma,\mu)$ (from equation [2b]). This expression can be used to measure "market power" via the markup ratio $p_Y/MC=PRAT_M$ [where "M" denotes "marginal", and an alternative equivalent Lerner-type measure can be computed as $(p_Y-MC)/MC=PRAT_M-1$]. In addition, the impact of trade on output demand can be measured in terms of the elasticity of output demand with respect to the price of imported goods.

More specifically, decisions about output price are represented by the price setting equation specified above; $p_Y = -Y\ \partial p_Y/\partial Y + \partial C/\partial Y$. Using the estimated parameters, the implied price can be directly computed and compared to the estimated marginal cost $MC^S = \partial C/\partial Y = \partial G/\partial Y$ to generate a measure of markup behavior. The "gap" between output price and MC^S obviously depends on $\partial p_Y/\partial Y$. Thus it represents the deviation between the demand and marginal revenue curve, or the extent of "market power".

This exercise can also be carried out for the implied long run marginal costs by computing $MC^L = \partial C^*/\partial Y$, to determine if any implied "profitability" may be due simply to short run fixities. The price can also be compared with average rather than marginal costs to assess whether the implied markup is due to excess profitability or stems from the existence of significant scale economies that cause MC>AC, thus necessitating marginal markups just to cover costs. This p_Y/AC measure can be denoted $PRAT_A$.

This measure may be computed by multiplying the markup measure by the scale economy measure, since the former measure compares price (average revenue) with marginal costs (p_Y/MC), and the latter measure represents the deviation between marginal and average costs ($\varepsilon_{CY}=\partial \ln C/\partial \ln Y = \partial C/\partial Y\ [Y/C]=MC\ Y/C = MC/AC$). Using the short or long run measure of marginal costs (as appropriate) therefore facilitates assessment of the profitability of the firm and of what factors might underlie evidence of market power.

Finally, the impact of trade/competitiveness on the demand structure is reflected in this model by the dependence of the output demand equation on the price of imported (competing) products. This can be measured in terms of the (inverse) output demand elasticity $\varepsilon_{pYpIM}=\partial \ln p_Y/\partial \ln p_{IM}$.

EMPIRICAL IMPLEMENTATION AND RESULTS

The data for this study are 3-digit data for the *Meat Products* (SIC 201/211) industries of the U.S. and Australia, respectively, and their 4-digit components (2011/*Meat Packing Plants*, 2016/ *Poultry Dressing Plants*, 2017/*Poultry and Egg Processing*, and 2013/*Sausages and Other Prepared Meat Products* for the U.S. and 2115/*Meat*, 2116/*Poultry* and 2117/*Bacon, Ham and Small Goods* for Australia). (See Data Appendix A for further discussion of the required data.)

Estimation was carried out separately for each industry and sub-industry, for 1960-91 for the U.S. and 1970-91 for Australia (although data were available from 1958 for the U.S. for Australia, generating second order investment terms curtailed the relevant data set). The six equation system (five equations for Australia since data for energy and other materials were not separately available) discussed above was estimated using the generalized method of moments (GMM) procedure in TSP.

This procedure, as discussed by Pindyck and Rotemberg [1983], allows potential errors in forming expectations about future price paths (for investment decisions) to be accommodated by instrumenting these prices. It also permits the endogeneity of output price and quantity (in the output demand specification) to be incorporated through instruments. The instruments used here include all exogenous (cost and demand) variables, the lagged values of input prices and capital and output levels, (similarly to Pindyck and Rotemberg), and an output composition variable (the proportion of white to red meat produced). The possibility of autocorrelation was also considered, although the estimation was robust to the autocorrelation specification.

The parameter estimates from this estimation process were used to compute fitted values of the estimated equations and to construct the required derivatives for measurement of the elasticities discussed in the previous section. The estimated values of these cost and demand elasticities (representing the overall and input-specific impacts of scale, technology, trade, and capital fixities, and output pricing behavior), are presented in Tables U1-U5 and A1-A5 for the U.S. and Australia, respectively.

The measures are provided for five years between the beginning and end of the period of analysis (1971-1991), in order to highlight time trends.[4] Although it is possible to obtain standard errors for these estimates, they are not provided on the tables for the sake of brevity. However, most measures were significantly different from zero (or one, depending on the "base" value of the elasticity measure), as discussed briefly below.

A useful jumping-off-point for motivation and interpretation of these tables is to link the results to the existing literature. In this case (although Lopez [1985], Huang [1991], Goodwin and Brester [1995] and Morrison [1996a,b] have done analyses of technology and structural change in food processing industries as a whole, Howard and Shumway [1988] have discussed dynamic adjustment in the dairy industry and and Fernandez-Cornejo *et al* [1992] have considered technology and scale in German agriculture), the only study I am aware of which carries out a comparable analysis for the meat products industry is that of Ball and Chambers [1982] (B-C).

Ball and Chambers emphasize the trend toward centralization and concentration in the meat products industry, which "prompted congressional inquiry into the possible existence of monopoly power, the existence of excess capacity in regions of high firm concentration, and the potential for firm dominance". These characteristics of the industry may be motivated by the existence of significant scale economies.

The Ball and Chambers study provides measures of scale economies and technical change similar to those discussed in the previous section (ε_{CY} and ε_{Ct} and their input specific components are a focus of their analysis, for example). However, important differences do exist in addition to the obviously different sample period; the B-C model is based on the assumption of instantaneous adjustment of all inputs (no short run/long run distinction or adjustment cost recognition), ignores the output supply/pricing dimension of the problem and trade impacts, and assumes a different functional form (a translog).

The B-C study finds evidence of increasing returns to scale, nonhomothetic scale effects, and nonneutral technical change (labor saving and materials using). The model and measures in the current study , combined with the detailed 4-digit data for both the U.S. and Australia allow reevaluation of these characteristics from a broader basis, and essentially confirm these findings. Further, they also allow a much more detailed analysis of the patterns found by B-C, including consideration of trade and pricing effects, short- long run differentials, industry components, and different countries.

Support for the basic B-C findings may be found initially from the results for the U.S. Meat Products industry (SIC 201). From Table U1, for example, it is clear that scale economies are very large in both the short and long run, have been increasing over time, and have become slightly larger in the long- than the short- run by the end of the sample. Note, however, that the short-long run differential is negligible; fixities may not be critical in terms of overall costs, although input composition could still be affected.

The input specific effects (nonhomotheticity) underlying these measures are evident from Table U2 for the variable inputs, and Table U4 for capital. It appears that short run scale economies are motivated by both increasing returns to labor and materials (and in the beginning of the sample also for energy, although this is such a small share of costs that it has little effect on overall costs). In terms of *relative* effects, however -- which is the basis for the bias notions of input-using and -saving -- scale economies are relatively labor saving ($\varepsilon_{LY}<\varepsilon_{CY}$) and materials using ($\varepsilon_{MY}>\varepsilon_{CY}$). This tendency reverses in the long run, however; scale is not only relatively materials saving and labor using, it is absolutely labor using ($\varepsilon^{L}_{LY}>1$). This arises from a complex combination of technical and substitution/complementarity relationships, since capital appears complementary with labor ($\varepsilon_{KL}<0$ from Table U4) but substitutable with materials ($\varepsilon_{KM}>0$), so capital investment ($\varepsilon_{KY}>0$) occuring as a result of scale expansion further increases labor use.

These technological relationships are confounded further by the "technical change" (ε_{Ct}, ε_{it},ε_{Kt}) elasticity measures presented in Tables U1, U3 and U4. These measures represent responses to "disembodied" technical development over time independent from other forces captured in the model (relative price changes, scale effects, and trade factors). The numbers are somewhat diffficult to interpret since they indicate a decline in productivity as "t" increases (ε_{Ct}>0 implies cost increases for a given output level). It is also worth noting (although they are not presented in the tables) that the long run values of these elasticities are quite similar to those found for the short run.

These effects can be "decomposed" into their input-specific components using the ε_{it} and ε_{Kt} elasticities. These elasticities indicate further materials-using and labor (and now energy)-saving tendencies; even in absolute terms t increases appear to augment materials demand. This could potentially arise from increased waste if less of the animal were ultimately used, or if demand for increasingly high quality meats caused disposal of less valuable cuts (independently from savings due to other factors).

In turn, t increases motivate capital investment (ε_{Kt}>0, perhaps suggesting capital deepening over time), which affects these patterns as movement toward the long run occurs. Although the long run elasticities are not presented (they vary so moderately that an additional Table does not seem justified), the ε_{Lt} value increases so that it slightly exceeds zero in the first two sample periods and the ε_{Mt} value declines toward zero, corresponding to their complementary/substitutable relationships with capital (although "t" changes remain relatively materials-using).

The additional "external" factor affecting input use and composition also included in this analysis provides further insights about what might be driving technological development. The import penetration (or "competitiveness") variable IY does have a negative impact on costs (ε_{CIY}<0), and therefore seems to be motivating cost efficiency (possibly via technological advance), and this effect is slightly increasing (whereas the positive t-impact is weakening over time).[5]

In terms of input-specific effects, this result is again driven largely by materials use; although all inputs appear to decline with increasing import competitiveness (ε_{iIY}<0 for variable input i except for energy early in the sample), materials declines are relatively large. This differential across inputs is more pronounced in the long run since capital increases along with import competition (ε_{KIY}>0). The large impact suggests that response to competitive pressure primarily consists of capital expansion. Adding this to the evidence involving scale effects supports the notion that capital deepening is likely.

The ultimate impact on the shares of inputs resulting from this complex combination of technological and trade impacts is useful to explore. Although overall input costs per unit of output will change when significant technological impacts such as scale economies exist, the associated balance across inputs (input composition) remains of interest. Computation of the cost shares for industry 201 indicates that the capital share has increased relative to both the labor and materials shares in the U.S. -- from .08 to 12 versus .09 to .08 for labor and .82 to .80 for (nonenergy) materials. In anticipation of the discussion of the Australian industries pursued below, it is also useful to recognize that these patterns are essentially maintained in the Australian data. However, the proportions of both capital and labor are slightly higher; the capital, labor and materials shares change from .11 to .15, .16 to .15 and .72 to .71, respectively for industry 211.

These measures emphasize the important contributions of scale effects and trade to input decisions. It appears that the combined impact of scale economies and import competitiveness is to motivate capital deepening and materials-saving in the long run, combatting the (relative) short run scale tendency and time trend (independent of other tech/trade factors) toward materials use. This highlights the importance of scale economies for overall technical advancement; it seems that increased technology and productivity may in a sense be "embodied" in or motivate scale expansion and economies.

Finally, it is interesting to append information about output pricing to the results summarizing the cost structure derived from the scale, technology and trade elasticities. The $PRAT_M$ elasticities presented in Table U5 indicate the extent of markups over marginal cost implied by the parameter estimates of the demand equation. These numbers significantly exceed one, and are increasing over time -- to the point where price seems nearly double marginal cost at the end of the sample.

However, this information should be combined with the evidence of significant scale economies to assess "effective profitability"; the $PRAT_A = PRAT_M \varepsilon_{CY}$ measures presented in the same Table show that price only exceeded average cost by two to nine percent (and fell short of average cost by 5% in 1976) during this time period. Thus, the observed (marginal) markups were "justified" by the existence of scale economies -- marginal markups appear necessary to cover overall costs.[6]

The last tech/trade relationship to consider is presented in Table U5 as the ε_{pYpIM} elasticity -- the elasticity of the inverse demand equation with respect to a change in import prices. The measure for Industry 201 overall is negative -- it appears that import price increases, which one would expect to reduce the impact of import competitivness and thus increase domestic demand/price at given output levels, instead cause slight declines. However, this measure is insignificantly different from zero, which it was throughout this study (this was the only measure which consistently turned out to be statistically insignificant). In addition -- looking ahead to the industry-specific measures -- these more narrowly defined estimates indicate a positive relationship between p_Y and p_{IM}. Since these findings are also statistically irrelevant, however, I will for the remainder of this section ignore trade impacts on output demand.

From the basis of the elasticity estimates for the overall U.S. meat products industry presented so far in this section, the industry- and country-specific estimates can be compared. Although there is too much information in the tables to summarize in depth, some points are useful to highlight.

First let us consider the comparable estimates for the Meat Products (SIC 211) industry in Australia. The initial estimates for Australia are surprisingly similar to those found for the U.S. In particular, the scale economy measures in Table A1 appear equally large and are similar across the short and long run. However, the input-specific patterns underlying these measure are somewhat different.

Although increasing returns are evident for both labor and materials inputs in Australia, labor adjustments are nearly proportional to output in the early part of the sample and drop to .75 (as compared to .56 for the U.S.) by 1991. Materials input use expands by an even smaller proportion than in the U.S., however -- scale effects appear relatively labor- instead of materials-using. This relationship is also maintained into the long run, although both values drop somewhat; capital seems to increase substantially along with scale, and the (strongly) substitutable relationships of K with both L and M mute the short run responses.

The "t" relationships are more analogous to those found for the U.S., although costs appear to increase with t in Australia by an even larger proportion![7] The input-specific responses are quite similar; the trend is to "save" on labor and increase materials use in both relative and absolute terms. This relationship is also essentially maintained into the long run, since t has a marginal impact on capital investment (ε_{Kt}<0 but is small).

Further, it is not surprising that increased competitiveness in (relatively small and open) Australia would have a different impact than that found in the U.S. However, the very positive ε_{CIY} values generated provide additional evidence of declining cost effectiveness. Although this is independent of the measured extensive and increasing scale economies, which may absorb much of the apparent technological (and other external) impacts, the implied cost changes seem overly large.

The input-specific effects also vary from those for the U.S. -- the import penetration effect is materials-using in Australia. This could support the possibility raised above that demand for higher quality meats causes waste from disposal of less valuable cuts, since this could easily be exacerbated by trade factors. For example, demand for Australian meat products from Japan might increase the value of very high quality meat products. Again, these relationships are maintained (although with somewhat smaller values) in the long run, since capital investment is motivated by import competitiveness but has little effect on the variable inputs.

Additional insights about the cost and demand structure may be gained by considering markup behavior in Australia. As for the scale economy results, the measures for the two countries are surprisingly similar. Markups over marginal cost again appear large -- but have been more constant over time at nearly twice marginal cost. The existence of significant scale economies also causes the markup over average cost to remain below 9% and drop to a negative value (by 5%) in 1981, suggesting that economic profits are close to zero on average over time.

Before moving to the industry-specific results, it is worth commenting on the statistical significance of the measures presented above. Although I am not focusing on the standard errors of the estimates, this decision is at least partly motivated by the fact that the elasticity values are almost invariably (very) significantly different from zero (or one if that is the appropriate comparison point, such as for the scale measures). There are, however, exceptions to this "rule".

For the U.S. meat products (201) industry the ε_{LIY} and ε_{EIY} elasticities tend to be statistically insignificant, as do the ε_{KE} measures for the last decade. For Australia, the ε_{KL} measures are insignificant for the first three observations presented (1971, 1976 and 1981) but then become significant. Also, ε_{LIY} is insignificant until the 1981 observation, whereas ε_{KM} becomes insignificant at the same time period. Since none of these measures are crucial for representing the cost and demand patterns, however, the significance issue seems somewhat "moot".

A final comparison exercise involves evaluation of the different sub-industries for the U.S. and Australia. Although space constraints preclude a detailed comparison of their patterns, it is worth noting that, if one assumes industries 2011 and 2115, 2016/2017 and 2116, and 2013 and 2117 are roughly equivalent for the U.S. and Australia, respectively, the patterns across industries are fairly consistent across countries.

For example, in terms of scale economies, the poultry industries (2016/2017 and 2116) have the least evidence of scale economies and markups, which could result from higher capacity utilization in these expanding industries. The scale economy levels in the 2013/2117 industries are also nearly equivalent, and the markups are similarly largest of any industry, at least on the margin.

In terms of t and IY effects, it appears in the U.S. that only the poultry industries have experienced productivity enhancement over time, independently of scale and import penetration effects (or even essentially zero effects, as seen in industry 2016). For Australia, however, the measures across industries are quite consistent. Also, the largest cost increases stemming from increasing IY appear in the poultry industry in Australia -- and industry 2017 is the only U.S. industry which was subject to such cost enhancement.

The input-specific response patterns also show some cross-country similarity. For example, labor increases in response to scale expansion in Australia are due primarily to industry 2117 ("small goods"), which also has a relatively large elasticity (at least for the early years), in the U.S., although industry 2017 (poultry and egg processing) is more closely related.[8] Also, the largest increases in scale-induced materials use (at least in the short run) emerge in the poultry industries. (This changes in the long run for Australia, although it should be emphasized that the long run values for the Australian poultry industry are very erratic between 1975 and 1979 for some as yet undetermined reason.)

The input specific t and IY elasticities maintain their relative similarities and differences across countries only for the Meat (packing) industries (2011/2115). The patterns otherwise range widely, with the main similarities being the shift from a negative to positive ε_{LIY} value from the total to "small goods" categories in both countries, and the similar (although reversed across countries) ε_{MIY} values across industries (except 2017).

One other comparison that is interesting to pursue is for the capital/variable input relationships reported in Tables U4 and A4. In particular, the substitutability of both K-L and K-M in Australia as compared to the complementarity of K-L in the U.S. that appears in the aggregate seems somewhat misleading when extended to the industry sub-groups. The substitutable relationship in Australia seems largely to be driven by the strongly positive (but somewhat perverse) ε_{KL} elasticities found for the poultry industry. Otherwise, the complementarity found in all U.S. industries is maintained throughout the Australian industries. Also, K-M complementarity appears in industries 2016 and 2117, although all other values are positive (indicating substitutability).

Finally, it is useful to consider the scale and "t" impacts on capital. The Australian measures imply a very high ε_{KY} elasticity (which is even greater [and unreasonably so] for the aggregate than for the subcomponents). This suggests expansion of the industry motivates capital deepening -- an even greater proportional increase in capital. This is only true in the U.S. for industry 2017; in fact some values are negative.

This may suggest that the similarities across short run scale economy measures for the two countries are somewhat misleading -- the Australian industry is still small enough that more extensive capital investment is necessary to maintain scale economies. The "t" relationship is similarly diverse -- it is always negative for Australia (suggesting capital is declining over time if the impacts of scale expansion or import penetration are represented separately), but positive for the U.S. except for industry 2016.

Although many more relationships and issues could be explored using the rich basis of elasticity measures presented in Tables U1-U5 and A1-A5, pursuing them further is beyond the scope of this paper. It is clear from the discussion above, however, that interesting and important patterns may be illuminated about input use, output pricing and supply, and technology, scale and trade effects over time using these measures.

CONCLUDING REMARKS

This study has presented evidence about the impacts of scale economies and other technological and trade determinants on input costs and output pricing behavior in the U.S. and Australian meat products industries. It has become clear that input demand and composition, short- and long-run behavior, and the difference between marginal and average markups are important to take into consideration for assessment of the cost and demand structures of these industries. In addition, it appears from the results generated that technology is closely related to the existence of scale economies in the meat sector, and that a combination of the scale effects and trade penetration (competitiveness) has motivated overall capital deepening and (relative) materials saving in these industries.

In particular, we have found that for both the U.S. and Australian industries scale economies are a crucial driving force of cost effectiveness and technological advance. These economies are largely derived (particularly in the long run) by materials savings, and (particularly in Australia) by increased capital intensity. Additional "technical change" occurring with the passage of time seems to counteract these patterns somewhat; when the impacts of scale economies and import competitiveness are controlled for, a time trend toward increased materials use (and thus costs) emerges.

Trade-induced changes in cost effectiveness also appear to have important implications for both countries but are more differentiated. In Australia, costs appear to increase with trade penetration, although increasing cost savings (particularly due to induced capital investment and thus deepening), appear in the U.S. The trade effects on costs are, however, at times statistically insignificant. In addition, the impacts of increased trade on output pricing seem negligible.

The complex interactions among these technological and trade forces suggests that technology and its biases -- resulting in an increased capital share and reduced materials and labor shares in both countries -- is closely connected with scale effects. Technology appears in some sense to be "embodied" in the input choices and capital investment underlying the extensive measured scale economies. It also appears that materials use is a critical determinant of observed scale, technological and trade impacts. Since "materials" in these industries are primarily farm-produced animal inputs, these results thus have important implications about the demand for agricultural products

In addition, these cost patterns are associated with large markups of output price over marginal cost. However, since marginal costs fall short of average costs when scale economies are sufficiently large, this evidence is also consistent with a low degree of profitability -- small markups over average cost. This seems contrary to the suggestion by Ball and Chambers [1982] that scale economies imply an inefficiency that should be eliminated. Increasing the scale of operations may stimulate additional technological advance, but the scale of operations is in turn determined by demand patterns. Thus, it appears that the existence of scale economies supports increasing concentration and the resulting increased cost effectiveness, but is not necessarily equivalent to encouraging the use of "market power" to increase profitability.

Is is also useful to recognize other potentially important impacts on the cost and demand structure of these industries that may be desirable to take into account in future work in this area. One particularly topical issue is that of monopsony in input supply markets. This notion is motivated by policy makers' concern and popular press allegations that prices charged by slaughterhouses are largely determined by demand from meat processors, and that increasing concentration in the meat products industry affects this relationship. Modeling and measuring this type "market power" may facilitate further understanding of conditions in these industries.

Alternative measures of "technological advancement" may also be important to incorporate. In this study productivity/technical change appears to be closely linked to the potential for scale economies. The standard disembodied "technical change" measure also included appears somewhat perverse, since unit costs appear to have *increased* over time once scale economies and trade factors are accounted for. The possibility that other technology measures may more appropriately measure technical change may therefore be useful to explore. However, when a measure of the proportion of high-tech capital in overall capital investment was used in this analysis, some of the results became less stable. Thus, further consideration of these issues may be important to pursue in subsequent work in this area.

In addition, there is a large literature on changing tastes for meat production and thus changes in output composition that may have useful implications for development and interpretation of this work. This was taken into account to a minor degree in this study -- although including a measure of the relative shares of poultry and red meat in the specification of the demand equation may not be appropriate (and made the results less plausible when attempted), including this as an instrument does seem to be useful for generating reasonable results. It may be, however, that this arises at least partly as a result of relative price differentials which are otherwise unexplained.

As a final comment I should note the apparent lack of "aggregation bias" in most of the measures presented here. This is an important issue since measures of production characteristics such as scale economies and markups are often thought to be inappropriately represented by aggregate estimation, raising questions about the common assertion that responses of a "representative firm" are being captured. Although the results presented here are by no means conclusive about this issue, the fact that most of the important results for the total meat product industry could reasonably be interpreted as some average of the subcomponents, even though estimation was carried out independently, provides some justification for defending the use of aggregated data.

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DATA APPENDIX A

Output and input price and quantity data for the 3- and 4-digit SIC Meat Products categories were obtained from the National Bureau of Economic Research (N.B.E.R.) Productivity database for the U.S. The base values for Sales, Wages, Value Added and Employment were found in the Industry Commission (I.C.) report Australian Manufacturing Industry and International Trade Data, 1968/69-1992/93 for Australia [supplementary data were found in various years of the Australian Bureau of Statistics (A.B.S.) publication Manufacturing Industry, Australia (ABS #8221)]. The trade data were obtained from Robert Feenstra (of UC Davis and the N.B.E.R. International Trade group) for the U.S., and from the I.C. document for Australia. Finally, the "macro" data necessary for construction of the output demand relationship, as well as the price deflators necessary to adapt the value data in the I.C. study to quantity measures were taken from the U.S. Economic Report of the President and the Yearbook Australia, respectively.

Although the U.S. data have been extensively used and documented, the Australian data presented some problems to put in a form appropriate for this type of analysis, and some of the difficulties have not yet been resolved satisfactorily. One problem that arises is missing years. The A.B.S. Manufacturing Census used as a basis for the numbers published in the I.C. study was apparently not carried out for 1970/71 or 1985/86 and since 1986/87 is available only for every third year. Thus, some of the data (in particular, the "value added" numbers) were not available for 1970, 1985, 1987-88, and 1990-91 (but were for 1992) and had to be interpolated. (The Sales, Employment, and Wages data are still available on a yearly basis.)

A related difficulty is that I have not as yet established how value added was computed in the Australian data. Thus the measure of capital used in this study is somewhat questionable; it was computed as Value Added less Wage bill, and then deflated by a user cost of capital (discussed below). This will also affect the measure of materials inputs, since their value was computed as total Sales less Value Added.

Finally, the appropriate price deflators for output, materials and capital are not clear. Specific price data for the different outputs were obtained from the Yearbook Australia as the average retail prices of meat (beef, lamb, chicken, and bacon/ham/smallgoods), and more general indexes (the overall food CPI and the "price of outputs in food manufacturing") were used for comparison. Input prices were constructed as average unit gross value from data on the "gross values of agricultural commodities" and indexes of "values at constant prices" (by type of animal) in the same publication (the measure for industry 2115 was an average of the cow, sheep and pig categories, weighted by tonnes of production that year) and a general measure of the price of materials used in manufacturing was used for comparison.

The capital investment price was assumed to be a weighted average (by expenditure levels) of the price of nondwelling structures (private) and the price of equipment (private). A corresponding market or user cost of capital was computed from this using the assumption of a 10% depreciation rate (which is roughly consistent with the "disposals" category in the available capital investment data from A.B.S.), the 10 year bond and 90 day treasury rates as alternative rates of return (the results were insensitive to which was used), and the procedures discussed in Harper, Berndt and Wood [1989].

Although alternative possibilities for all of these prices were tried for comparison, the results were somewhat sensitive to variations in these prices, as one would expect. The more "disaggregated" values were therefore used in the final analysis, since they seem conceptually more appropriate.

NOTES

[1] This specification was developed in Morrison [1992a] and used in Morrison [1992b, 1993].

[2] Note that construction of the long run derivative requires computing the expression for the long run equilibrium level of K, K*, substituting it into the cost expression and then taking the derivative of the resulting C* measure.

[3] See Morrison [1988] for further elaboration of these and other (technical change and utilization) bias measures.

[4] These time trends are of interest to explore, although they are not emphasized here since so many other issues require elaboration. In a few cases, however, particularly for the mid-1970s for the poultry industry in Australia, the estimated results become somewhat perverse rather than following a smooth pattern.

[5] The potential for interactions among trade and technological impacts was explored in more detail in Morrison and Siegel [1996]. Although the interaction terms were small, the study does suggest that trade factors motivate investment in high-tech capital, possibly in order to further competitiveness.

[6] Note that this suggests estimation based on a cost structure ignoring the impacts of demand factors could result in biased measures of scale economies (since the p_Y=MC equality is essentially assumed, so all impacts will be attributed to scale rather than a combination of pricing and scale factors). These implications were considered by estimating the cost system without the output demand equations. The resulting estimates still suggest scale economies exist overall, although the estimates were not as dramatic; ε_{CY} was approximately .8 and ε_{LY} exceeded one. However, in other industries -- such as the poultry industries for which measured scale economies and markups are not as large and $PRAT_A$ is smaller -- scale diseconomies appeared in this framework; ε_{CY} exceeded one by a small margin for industries 2016 and 2017. Similar patterns were found for Australia, although the results were much more volatile; including the demand structure seems to be crucial for generating reasonable results for Australia. The somewhat perverse positive t effects found in this model were also retained in this specification.

[7] This is consistent with declines in measured productivity found when computing traditional productivity growth measures for this sector in Australia. I believe at least some of this evidence may derive from problems with the computation of the capital stock in this preliminary specification for the Australian industry.

[8] It is worth noting here that I have not yet been able to establish whether eggs are included with poultry or "small goods" in Australia -- if the latter is true the comparison may be more definitive.

	U.S. Meat Processing Industries: Table U1							
201: Meat Products			εSCY	εLCY		εCt	εCIY	
1971			0.5982	0.6022		0.0060	-0.0125	
1976			0.5683	0.5621		0.0052	-0.0142	
1981			0.5777	0.5588		0.0043	-0.0159	
1986			0.5750	0.5694		0.0036	-0.0150	
1991			0.5467	0.5335		0.0034	-0.0154	
2011: Meat Packing Plants								
1971			0.5626	0.5606		0.0057	-0.0245	
1976			0.5130	0.5129		0.0048	-0.0268	
1981			0.5457	0.5368		0.0043	-0.0291	
1986			0.5789	0.5689		0.0037	-0.0269	
1991			0.6314	0.6112		0.0033	-0.0256	
2016: Poultry Dressing Plants								
1971			0.6522	0.7074		0.0000	-0.0646	
1976			0.6561	0.6669		0.0002	-0.0726	
1981			0.6229	0.5698		0.0016	-0.0504	
1986			0.5723	0.5469		0.0014	-0.0366	
1991			0.4513	0.4039		0.0025	0.0030	
2017: Poultry and Egg Processing								
1971			0.7961	0.8307		-0.0060	0.1405	
1976			0.8251	0.8188		-0.0058	0.1660	
1981			0.7903	0.7851		-0.0060	0.2061	
1986			0.7032	0.7496		-0.0057	0.1981	
1991			0.5851	0.5973		-0.0053	0.2687	
2013: Sausages and Other Prepared Meat Products								
1971			0.4697	0.5330		0.0148	-0.0073	
1976			0.4398	0.4882		0.0129	-0.0078	
1981			0.4005	0.4320		0.0135	-0.0088	
1986			0.3230	0.3748		0.0115	-0.0078	
1991			0.2544	0.2908		0.0107	-0.0083	

	Table U2							
201: Meat Product		εLY	εEY	εMY		εLLY	εLEY	εLMY
1971		0.5148	0.0904	0.6946		1.0544	0.7549	0.5729
1976		0.6330	0.4056	0.6121		1.3465	1.3332	0.4782
1981		0.6375	1.0334	0.6283		1.5538	2.0565	0.4613
1986		0.5286	1.4860	0.6775		1.2442	1.6005	0.5247
1991		0.5582	2.0428	0.6064		1.2872	2.1341	0.4377
2011: Meat Packing Plants								
1971		0.1936	0.9214	0.6490		0.2629	0.5488	0.5742
1976		-0.1425	0.0990	0.5809		-0.0093	0.1545	0.5197
1981		-0.1922	0.4044	0.6376		-0.0171	0.4567	0.5652
1986		-0.1131	1.6053	0.6835		-0.0280	0.8071	0.6013
1991		0.0554	2.5349	0.6996		0.1070	1.1520	0.6084
2016: Poultry Dressing Plants								
1971		0.4228	1.5147	0.7866		0.6188	-2.6217	0.7351
1976		0.5605	1.7996	0.8712		0.6016	1.4663	0.8665
1981		0.5419	2.1072	0.6746		0.3152	5.6622	0.7258
1986		0.6576	1.7676	0.6927		0.5190	5.9803	0.8092
1991		0.7888	2.3196	0.4132		0.4867	18.7732	0.6846
2017: Poultry and Egg Processing								
1971		0.7646	0.4169	0.9777		1.0179	0.9455	0.8592
1976		0.7965	0.4418	1.0032		1.1800	-2.3098	0.4919
1981		0.8628	0.9236	1.0548		1.2508	-3.9456	0.4250
1986		1.0273	1.5527	1.0664		1.3393	1.3355	0.8871
1991		1.0923	2.6477	0.5666		0.8968	-2.6435	0.1779
2013: Sausages and Other Prepared Meat Products								
1971		0.7265	0.6348	0.5334		0.2347	-0.5081	0.6040
1976		0.6738	0.1552	0.4672		0.2105	-0.7772	0.5182
1981		0.5483	-0.1283	0.4837		0.1836	-0.9556	0.5231
1986		0.3492	-0.2765	0.4365		-0.0434	-0.7924	0.4865
1991		0.1282	0.0953	0.3482		-0.0346	0.0474	0.3763

	Table U3							
201: Meat Product		εLt	εEt	εMt		εLIY	εEIY	εMIY
1971		-0.6032	-0.4622	0.1756		-0.0207	0.0945	-0.0716
1976		-0.8259	-0.7178	0.1990		-0.0262	0.0596	-0.0633
1981		-1.0466	-1.1310	0.2279		-0.0421	-0.0588	-0.0651
1986		-1.2008	-1.0182	0.2574		-0.0468	-0.0553	-0.0702
1991		-1.2178	-1.2973	0.2781		-0.0435	-0.0692	-0.0685
2011: Meat Packing Plants								
1971		-0.2906	-0.0291	0.1232		-0.0621	0.3770	-0.1550
1976		-0.4064	-0.0777	0.1371		-0.0727	0.4193	-0.1341
1981		-0.5394	-0.2410	0.1553		-0.1152	0.1529	-0.1366
1986		-0.6519	-0.3137	0.1683		-0.1463	0.0628	-0.1450
1991		-0.6603	-0.5008	0.1676		-0.1578	-0.1344	-0.1362
2016: Poultry Dressing Plants								
1971		0.0659	2.2979	-0.0326		0.0057	0.0151	-0.0189
1976		0.1038	2.6472	-0.0450		0.0143	0.0748	-0.0223
1981		0.1665	3.6391	-0.0445		0.0279	0.1755	-0.0189
1986		0.2030	2.6339	-0.0544		0.0395	0.1531	-0.0258
1991		0.3357	5.7900	-0.0516		0.0611	0.3998	-0.0187
2017: Poultry and Egg Processing								
1971		-0.2911	0.2365	-0.0725		0.0724	-0.1396	0.0395
1976		-0.4167	0.1911	-0.0916		0.0711	-0.1524	0.0360
1981		-0.6020	0.3680	-0.1173		0.0935	-0.1601	0.0404
1986		-0.7567	0.5626	-0.1453		0.1523	-0.0855	0.0599
1991		-0.8124	0.8288	-0.1477		0.1336	-0.0125	0.0474
2013: Sausages and Other Prepared Meat Products								
1971		0.5571	1.7422	0.1746		0.0276	0.0576	-0.0604
1976		0.7976	2.5246	0.1903		0.0224	0.0019	-0.0488
1981		1.0112	3.7105	0.2431		0.0197	-0.0324	-0.0533
1986		1.1061	2.8662	0.2685		0.0276	0.0073	-0.0590
1991		1.1938	2.6902	0.3002		0.0327	0.0316	-0.0630

	Table U4							
201: Meat Product		εKL	εKE	εKM		εKY	εKt	εKIY
1971		-0.7386	-0.0469	1.4935		0.5166	0.0398	0.3246
1976		-0.6855	-0.0756	1.3785		0.4807	0.0340	0.2906
1981		-0.6317	-0.1006	1.2296		0.4695	0.0300	0.2810
1986		-0.5395	-0.0173	1.2165		0.4846	0.0261	0.2818
1991		-0.5322	-0.0177	1.2046		0.4756	0.0232	0.2644
2011: Meat Packing Plants								
1971		-0.0549	0.0119	0.5486		0.6691	0.0151	0.5089
1976		-0.0830	-0.0028	0.5061		0.6219	0.0138	0.4865
1981		-0.0948	-0.0212	0.4409		0.6302	0.0121	0.4738
1986		-0.0478	0.0173	0.4397		0.6601	0.0103	0.4758
1991		-0.0498	0.0098	0.4417		0.6906	0.0090	0.4522
2016: Poultry Dressing Plants								
1971		-0.1447	-0.4764	-0.7209		0.2892	-0.0211	-0.1536
1976		0.0686	-0.4725	-0.6455		0.0201	-0.0221	-0.1847
1981		0.3907	-0.5519	-0.3920		-0.6024	-0.0267	-0.2385
1986		0.2161	-0.8317	-0.7565		-1.0330	-0.0289	-0.3477
1991		0.8657	-1.3060	-1.0336		-4.0332	-0.0521	-0.5441
2017: Poultry and Egg Processing								
1971		-0.6939	0.0466	3.4483		2.4024	0.0216	0.3159
1976		-0.3825	0.2811	3.8722		2.4184	0.0192	0.2884
1981		-0.3242	0.5157	3.5872		2.7819	0.0189	0.3029
1986		-0.2309	0.3316	2.4492		2.5044	0.0117	0.2539
1991		0.1980	0.4862	1.7822		2.4106	0.0070	0.1318
2013: Sausages and Other Prepared Meat Products								
1971		-0.5511	-0.1360	0.1162		0.2479	0.0356	-0.0466
1976		-0.4634	-0.1407	0.1360		0.2270	0.0295	-0.0406
1981		-0.3832	-0.1515	0.1498		0.1829	0.0259	-0.0396
1986		-0.4616	-0.2096	0.0907		0.0993	0.0239	-0.0429
1991		-0.4753	-0.1843	0.1145		-0.0322	0.0229	-0.0446

	Table U5						
201: Meat Products			PRATM		PRATA		εpYpIM
1971			1.7079		1.0216		-0.0135
1976			1.6984		0.9652		-0.0138
1981			1.7579		1.0155		-0.0164
1986			1.8496		1.0636		-0.0164
1991			1.9910		1.0886		-0.0164
2011: Meat Packing Plants							
1971			1.7993		1.0123		0.1089
1976			1.8501		0.9492		0.1147
1981			1.8691		1.0199		0.1426
1986			1.7824		1.0318		0.1405
1991			1.6280		1.0278		0.1342
2016: Poultry Dressing Plants							
1971			1.4332		0.9347		0.4668
1976			1.5063		0.9883		0.5624
1981			1.7442		1.0864		0.6055
1986			1.7353		0.9932		0.4981
1991			2.1305		0.9614		0.4289
2017: Poultry and Egg Processing							
1971			1.2349		0.9831		0.3840
1976			1.1889		0.9810		0.4031
1981			1.2402		0.9802		0.4918
1986			1.3237		0.9308		0.3979
1991			1.6762		0.9807		0.3166
2013: Sausages and Other Prepared Meat Products							
1971			2.1032		0.9879		0.2369
1976			2.2196		0.9763		0.2455
1981			2.5351		1.0153		0.2930
1986			3.1291		1.0107		0.2675
1991			4.0453		1.0292		0.2609

Australian Meat Processing Industries: Table A1

	εSCY	εLCY	εCt	εCIY
211: Meat Products				
1971	0.5451	0.6111	0.0238	0.2028
1976	0.5522	0.6503	0.0123	0.2182
1981	0.5319	0.5881	0.0130	0.2011
1986	0.5507	0.6386	0.0080	0.1296
1991	0.5466	0.6632	0.0039	0.1006
2115: Meat (except smallgoods and poultry)				
1971	0.2734	0.4634	0.0266	0.0928
1976	0.3520	0.5856	0.0128	0.0905
1981	0.3655	0.5210	0.0149	0.0640
1986	0.3850	0.5611	0.0098	0.0329
1991	0.3989	0.6048	0.0038	0.0128
2116: Poultry				
1971	0.8167	0.8265	0.0242	0.2167
1976	0.7637	0.8032	0.0201	0.1018
1981	0.7495	0.7836	0.0154	0.1075
1986	0.7208	0.7919	0.0104	0.0759
1991	0.7281	0.7747	0.0095	0.0542
2117: Bacon, Ham and Small Goods				
1971	0.4373	0.4468	0.0217	0.0288
1976	0.4144	0.4267	0.0187	0.0678
1981	0.3923	0.4089	0.0150	0.0255
1986	0.5082	0.5377	0.0090	0.0194
1991	0.4729	0.4888	0.0078	0.0262

	Table A2							
211: Meat Products			εLY	εMY		εLLY	εLMY	
1971			0.9616	0.4208		0.8251	0.3096	
1976			0.9390	0.5603		0.6614	0.4137	
1981			0.8159	0.6091		0.6480	0.5172	
1986			0.7056	0.6558		0.5595	0.5960	
1991			0.7541	0.5307		0.5807	0.4813	
2115: Meat (except smallgoods and poultry)								
1971			0.7978	0.1249		0.9957	1.4065	
1976			0.6975	0.3670		0.6663	0.9995	
1981			0.6858	0.3661		0.7586	1.2782	
1986			0.3737	0.4604		0.6017	1.1068	
1991			0.3711	0.3991		0.4061	0.6536	
2116: Poultry								
1971			0.6559	0.8851		0.8393	0.3378	
1976			0.4317	0.9990		-80.5116	-23.6322	
1981			0.5540	0.9192		0.5987	0.1987	
1986			0.6289	1.0059		0.7264	0.7985	
1991			0.5286	0.8964		0.6193	0.4860	
2117: Bacon, Ham and Small Goods								
1971			1.2838	0.2451		0.6712	0.0827	
1976			1.4176	0.3031		0.5553	0.0654	
1981			1.6053	0.2723		0.3207	-0.0198	
1986			1.2978	0.3784		-3.4641	-0.3539	
1991			2.0297	0.2859		-0.3646	-0.0266	

	Table A3							
211: Meat Products			εLt	εMt		εLIY	εMIY	
1971			-0.1907	0.1818		-0.0286	0.1887	
1976			-0.3053	0.3162		-0.0243	0.1931	
1981			-0.5135	0.3712		-0.0953	0.1746	
1986			-0.6552	0.3547		-0.1181	0.1823	
1991			-0.8202	0.3030		-0.1007	0.1435	
2115: Meat (except smallgoods and poultry)								
1971			-0.1901	0.2018		-0.1420	0.1350	
1976			-0.2861	0.3597		-0.1064	0.1515	
1981			-0.5088	0.4190		-0.2493	0.1166	
1986			-0.6845	0.4022		-0.3733	0.1265	
1991			-0.8290	0.3059		-0.3390	0.0899	
2116: Poultry								
1971			0.0807	0.1181		-0.0525	0.0651	
1976			0.2598	0.1898		-0.1354	0.0963	
1981			0.3603	0.2201		-0.1326	0.0789	
1986			0.2819	0.2389		-0.1327	0.1013	
1991			0.3920	0.2366		-0.1733	0.0989	
2117: Bacon, Ham and Small Goods								
1971			-0.0293	0.1264		0.0276	0.0104	
1976			-0.0222	0.2512		0.0105	0.0045	
1981			-0.0165	0.2953		0.0245	0.0091	
1986			0.0108	0.2321		0.0155	0.0043	
1991			-0.0940	0.2799		0.0470	0.0090	

	Table A4							
211: Meat Products			εKL	εKM		εKY	εKt	εKIY
1971			2.1617	1.1008		8.1606	-0.0598	3.7336
1976			2.4060	0.4246		9.2440	-0.0440	3.6141
1981			2.0298	0.7932		7.5652	-0.0271	2.9407
1986			1.7568	0.8625		4.7042	-0.0131	2.0811
1991			1.9173	0.7212		4.3393	-0.0103	1.8295
2115: Meat (except smallgoods and poultry)								
1971			-0.0888	1.9329		1.3513	-0.0041	0.4424
1976			-0.1688	2.0522		1.4739	-0.0036	0.5165
1981			-0.1308	2.0105		1.4162	-0.0025	0.4603
1986			-0.0024	1.9028		1.3943	-0.0020	0.5733
1991			-0.0236	1.9274		1.5149	-0.0024	0.7309
2116: Poultry								
1971			-0.0973	-8.4601		1.6160	-0.3307	0.2433
1976			31.6214	30.4409		1.5263	-0.1622	0.2920
1981			10.1263	4.0510		1.8851	-0.1919	0.3841
1986			7.2208	0.3074		1.9047	-0.1576	0.4498
1991			9.3338	1.4867		2.0191	-0.1457	0.5477
2117: Bacon, Ham and Small Goods								
1971			-0.7674	-0.9280		1.6506	-0.0694	0.1197
1976			-1.1215	-1.1787		1.8296	-0.0554	0.0605
1981			-1.3729	-1.4506		1.8696	-0.0444	0.1420
1986			-4.1363	-2.9499		2.0001	-0.0461	0.1441
1991			-2.0892	-1.5423		2.0553	-0.0388	0.1744

	Table A5						
211: Meat Products			PRATM		PRATA		εpYpIM
1971			1.9980		1.0892		0.0422
1976			1.9109		1.0552		0.0502
1981			1.7917		0.9530		0.0493
1986			1.8247		1.0048		0.0573
1991			1.9921		1.0888		0.0538
2115: Meat (except smallgoods and poultry)							
1971			3.7340		1.0210		-0.1952
1976			2.8684		1.0096		-0.2390
1981			2.5825		0.9438		-0.2282
1986			2.6578		1.0232		-0.2716
1991			3.0877		1.2317		-0.2736
2116: Poultry							
1971			1.2404		1.0130		0.2992
1976			1.2917		0.9864		0.3431
1981			1.3325		0.9988		0.3237
1986			1.3700		0.9874		0.3470
1991			1.3852		1.0085		0.2979
2117: Bacon, Ham and Small Goods							
1971			2.6495		1.1586		0.1139
1976			2.3812		0.9868		0.1239
1981			2.2390		0.8783		0.1127
1986			2.0655		1.0497		0.1286
1991			2.0957		0.9910		0.1045

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