Production Structure and Trends in the U.S. Meat and Poultry Products Industries

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The U.S. meat products industries have experienced increasing consolidation. It has been speculated that this has resulted from cost economies, perhaps associated with technical change or trade factors. It has also been asserted that increased concentration in these industries may be allowing the exploitation of market power in the input (livestock) and output (meat product) industries. These issues are addressed for the four-digit SIC meat and poultry industries. Findings show that the beef and pork products industries tend to have similar structures, which differ from the poultry industries. None of the industries, however, appear to have exhibited excessive market power, particularly when scale economies (diseconomies), and resulting reductions (increases) in marginal cost from output expansion, are taken into account. Also, technical change and trade (especially export market) trend impacts seem overall to have contributed to cost efficiency.

Key words: cost structure, market structure, production structure, scale economies, technical change, trade effects

Introduction

The U.S. meat products industries have historically exhibited high concentration levels. However, further consolidation of these industries has occurred in the past few decades. Concerns about the causes and results of such market structure changes have stimulated policy debate about the associated potential for market power exploitation. Questions also have been raised about the efficiency of increasingly large plants or firms in these industries, and whether plant size is determined by production structure characteristics such as cost economies, technical change over time, or increased import and export competition.

In particular, if increasing concentration allows firms to abuse their monopoly power by marking up output prices over production costs, this impacts consumers of the products. On the input side, suppliers are affected if firms are able to use their monopsony power to hold prices at artificially low levels. This has especially been a concern for livestock inputs, since they comprise such a large share of input costs, and the exercise of monopsony power in this market could seriously harm the agricultural sector.

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The many studies addressing these issues primarily focus on patterns in the meat packing industry,[1] rather than looking at structural differences across the meat products industries. They also tend to emphasize either patterns of production costs (cost or technological structure) *or* output demand/input supply conditions (market structure), rather than their interaction—although both "sides" are fundamental for the evaluation of production structure and market power exploitation.[2] Finally, although technical change is sometimes considered, little attention has been paid to other exogenous forces driving trends in these industries, such as increased import/export competition.

Evaluation and comparison of the production and market structure underlying observed patterns in the meat products industries, and measurement of the resulting cost structure and pricing behavior, are better founded on a more general model that incorporates these different parts of the puzzle. In order to address the issues raised, the model must distinguish between short- and long-run behavior, so that utilization changes and their input-specific nature may be explicitly addressed. The model also must recognize the potential for firms to affect prices in the output and input markets (noncompetitive pricing), incorporate time (or technical change) and trade trend effects,[3] and accommodate cost (scale) economies and input substitution.

In this study, I outline such a model and use it to construct and compare measures of scale economies, cost shifts, pricing behavior, and input demand for the four Standard Industrial Classification (SIC) four-digit U.S. meat products industries.[4] These measures provide insights about production structure characteristics such as cost economies (and trends) and price markups (markdowns) in these industries, their underlying determinants such as adjustment processes (utilization) and input substitution, and their results in terms of market power exploitation. The empirical results indicate little exploitation of market power. Pricing discrepancies that *are* apparent seem associated with the existence of cost economies in the meat industries and diseconomies in the poultry industries.

[1] Azzam and Anderson present a useful overview of the large literature in this area.

[2] See Ball and Chambers for one of the few examples of a cost structure-based analysis of the meat packing industry, and Azzam and Pagoulatos, and Azzam and Schroeter for two studies in the larger literature focusing on market structure and power patterns in this industry.

[3] It is standard to use time (t) as a proxy for technical change that drives "unexplained" productivity growth in this type of study. However, other more explicit variables representing exogenous technological changes, such as research expenditures (Lambert and Shonkwiler; Lim and Shumway) or changes in input "quality" (high-tech or human capital, as in Morrison and Siegel), may provide more justifiable and interpretable measures of structural changes embodied in the technology. Also, there is a potential for spurious results from estimation with t as an independent variable (as noted by Nelson and Kang, and evaluated empirically by Lambert and Shonkwiler and by Lim and Shumway), due to stationarity issues. However, such techniques are not straightforward to accommodate in a detailed structural model such as the one used here. Although including trade variables as separate indicators of exogenous forces driving productivity or efficiency patterns allows for a somewhat more specific interpretation of trends, we also include t as a technical change variable here to capture trends over time not explained by other factors, while recognizing these qualifications.

[4] The four-digit meat products sectors include two meat industries and two poultry industries. The materials share in these industries ranges from 75% to nearly 90%. The actual proportion of livestock inputs is not obtainable from the available aggregate data, but MacDonald and Paul found that when plant-level data are used to disaggregate the materials input into its "agricultural" and "other" components, the agricultural input components are very large [agricultural materials and meat inputs comprise 90.3% of materials in industry 2011, 72.9% in industry 2013, and 80.7% in industry 2015 (a combination of 2016 and 2017)]. They clearly dominate any other fluctuations in overall materials inputs for these meat products industries, although this is not the case for some other food processing industries for which the agricultural component is not as significant.

The Model

The goal of this study is to examine the extent, determinants, and results of cost economies, cost impacts from technical and trade changes, and markups (markdowns) of prices over their marginal costs (or benefits in terms of cost savings) in the meat products industries. A full representation of the cost structure is thus fundamental to this task. The incorporation of pricing behavior in the input (materials) and output (production) markets also must be dealt with. Within such a model, the construction of appropriate measures to represent the production (cost and market) structure then may be developed.

A restricted cost function with materials (M) as well as output (Y) included in terms of quantity levels provides the basis for analysis. This framework incorporates adjustment of M and Y according to pricing equations with both quantities and prices endogenous. It thus accommodates the sequential adjustment process in the meat industries that results from the livestock input comprising such a large proportion of costs.[5] Since optimization over both the output and materials input is incorporated as part of the system of estimating equations, this adjustment is recognized to be contemporaneous, rather than constrained by adjustment costs.

In addition, capital (K) is included as a quasi-fixed input since in these markets the existence of large plants that are costly (and thus slow) to adjust suggests that short-run behavior (determining the utilization of the existing capital) is important to recognize. The potential for adjustment of K is also recognized in the model by including investment as an argument of the cost function to characterize the underlying adjustment costs, thus facilitating the representation of movement toward long-run equilibrium capital levels.

The desirability of a detailed representation of technological aspects—such as scale economies, substitution, and exogenous trend or shift factors, which involves a complex system of cross-effects or interactions among inputs—suggests that a flexible function is appropriate as a foundation for the analysis. The functional form assumed for the restricted cost function is thus based on a variant of the generalized Leontief (GL) function presented in Morrison (1988). This function, with a symmetric structure that may accommodate both multiple output and input levels, has the form:

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\begin{aligned}
VC(Y,M,K,\mathbf{p},\mathbf{r}) = &\ \Sigma_i \Sigma_j \alpha_{ij} p_i^{0.5} p_j^{0.5} + \Sigma_i \delta_{iY} p_i Y^{0.5} + \Sigma_i \Sigma_n \delta_{in} p_i r_n \\
&+ \Sigma_i \Sigma_k \delta_{ik} p_i x_k^{0.5} + \Sigma_i p_i \big(\gamma_{YY} Y + \gamma_{MM} M + \gamma_{KK} K \\
&+ \Sigma_n \gamma_{Yn} Y^{0.5} r_n + \gamma_{YM} Y^{0.5} M^{0.5} + \gamma_{YK} Y^{0.5} K^{0.5} \\
&+ \Sigma_n \gamma_{Mn} M^{0.5} r_n + \gamma_{MK} M^{0.5} K^{0.5} + \Sigma_n \gamma_{nk} K^{0.5} r_n \\
&+ \Sigma_m \Sigma_n \gamma_{mn} r_m r_n \big).
\end{aligned}
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Flexibility of the function is embodied by inclusion of all cross-terms, so nonconstant returns to scale, nonneutral technical and trade impacts, and a general specification of substitution patterns may be represented. As alluded to above, Y, M, and K are

[5] See Paul (1999a) for further elaboration of this in the context of the beef packing industry.

incorporated as quantity levels to facilitate analysis of pricing behavior, or to accommodate quasi-fixity and resulting utilization changes, respectively. The remaining (variable) inputs, labor (L) and energy (E), appear in the function in a more standard fashion through their prices (p_L and p_E), and the $\Sigma_i p_i$ term (along with the square root form of the GL function) preserves linear homogeneity in these input prices.

Specification of the arguments in the **r** vector is important for furthering the dynamic specification and the representation of technical and trade trend or shift impacts. These arguments include ΔK, t, IY, and EY.[6] ΔK is the change in the capital stock, which represents adjustment costs and thus facilitates specifying their impact on investment (the difference between short- and long-run behavior, or utilization variations) through a Euler equation; t is a standard time counter representing disembodied or general technical change or time trend effects not captured in input measures or other external impacts. The two other external or shift trend factors are the trade effects, reflected by import-to-output and export-to-output ratios, IY and EY, respectively.

Including all these arguments of the $VC(\cdot)$ function, which in extended general form may therefore be expressed as $VC(Y, M, K, p_E, p_L, \Delta K, t, IY, EY)$, allows analysis of how changes in any of these factors affect costs and underlying input demand and pricing behavior. The resulting production structure and performance measures that may be constructed from the cost function are elaborated below. First, however, we must specify the system of estimating equations implied by the cost function-based model. Construction of this equation system involves formalizing the cost structure, the sequential optimization processes underlying output and input pricing, and the resulting characterization of markup or markdown behavior.

The estimating equations representing demand for the labor and energy variable inputs are specified as is standard in the cost function literature via Shephard's lemma:

(2) $$L = \partial VC / \partial p_L$$

and

(3) $$E = \partial VC / \partial p_E.$$

These functions depend not only on the existing levels of capital (since the data reflect short-run behavior) and output (by construction of the cost function base for analysis), but also on the measured M level (due to the focus on pricing behavior). The endogeneity of M demand (and also Y supply) is accommodated in the estimating procedure by forming instruments for both prices and input (output) levels in the pricing equations for M and Y. However, the construction of elasticity measures (with, for example,

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[6] Morrison and Siegel, and Paul (1999b) discuss the inclusion of these terms in more detail. In those studies only the import/output ratio was included to accommodate import penetration impacts, since with the aggregate data used, import and export trends were correlated closely enough that including both did not provide additional explanatory power and results varied little depending on whether the IY or EY ratio was used. In the current study, both ratios appear to have empirically important impacts, from the statistically significant parameter estimates and the more plausible elasticity estimates overall when both were included. One would think, also, that import penetration would have somewhat different impacts on firms than export potential, since import competition would stimulate competitiveness within the U.S. industry, and expanding export markets would allow firms to produce (possibly joint) products that may not have as strong a U.S. market. A case in point for the poultry market would be the current push to produce large tender breast meat for the U.S. industry, while exporting (at very low prices) much of the associated dark meat that does not have as great a demand in the U.S.

M demand changes included) must explicitly accommodate this adjustment, as seen below.

Shephard's lemma does not hold for M and Y due to the potential for noncompetitive pricing behavior in these markets. However, demand for M (supply of Y) again may be represented using a cost derivative.[7] The derivative that is relevant for the M demand decision is the shadow value of M, or $Z_M = -\partial VC/\partial M$. If competitiveness prevailed in the M market, so that p_M were exogenous, the equilibrium condition in this market would be $p_M = Z_M = -\partial VC/\partial M$, which may be considered an "inverse" Shephard's lemma.[8] However, with market power in the M market, the input pricing (and implicitly quantity) decision of the firm may be written as $p_M + \partial p_M/\partial M \cdot M = -\partial VC/\partial M$, or

(4) $$p_M = -\partial p_M/\partial M \cdot M - \partial VC/\partial M,$$

where the (average) price function $p_M(M)$ is assumed here to be $p_M(M) = \alpha_M + \beta_M M + \gamma_M M^{0.5}$. The wedge between the cost (p_M) and marginal benefit (Z_M) of M in the input demand (pricing) estimating equation (4) is due to the $p_M(M)$ dependence; the marginal factor cost (MFC) on which optimization decisions are based is $p_M + \partial p_M/\partial M \cdot M = p_M + (\beta_M + 0.5\gamma_M/M^{1.5}) \cdot M$.

Note that the simple form of the average price equation $p_M(M)$ (in square roots to be symmetric with the cost specification) means that the wedge $\partial p_M/\partial M \cdot M$, and thus implicitly the slope of the input supply equation, depends only on M. The optimal M pricing equation therefore is not a function of other potential determinants of livestock supply. This is consistent, however, with any functional representation of $p_M(M)$ for which there are no cross-terms between M and other arguments of the supply relationship (shift factors appear in a linear fashion). Alternative functional forms for this and the analogous output price relationship discussed below were tried, but the simpler forms seemed empirically justified.[9]

The treatment of M optimization is similar to the familiar representation of the firm's output (price and implicitly quantity) decision based on an $MR = MC$ equation in a noncompetitive output market, where MR is marginal revenue and MC is marginal cost. We can write this as the (profit-maximizing) pricing equation for Y, $p_Y + \partial p_Y/\partial Y \cdot Y = \partial VC/\partial Y$, or

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[7] See Morrison (1997a) and Paul (1999a) for more detailed discussion of the monopsony specification used, and the types of measures constructed, for this analysis.

[8] This property, which is discussed in more detail in Morrison (1985) in the context of the quasi-fixed capital input, is formalized in Lau.

[9] A more complete representation of the input supply (and output demand) relationships could potentially be included as part of the estimating system, as in Morrison (1992) for the output market. For the current study the model is already complex, and these relationships are not well enough defined to make this feasible. It turns out, however, that this seems to make little difference to the results. The "wedge" appears well characterized by this simple relationship in the sense that various other specifications tried resulted in insignificant estimates for other potential input supply and output demand determinants (as well as increased insignificance elsewhere in the system). It also should be emphasized that since estimation is based only on the $\partial p_M/\partial M$ and $\partial p_Y/\partial Y$ derivatives (not the "average price" equations), linear terms would drop out of the M and Y pricing specifications, so only cross-terms would have an impact on the measurement of market power impacts. This is consistent with the assumption that the $p_Y(Y)$ and $p_M(M)$ relationships are linear in any additional arguments of the functions.

(5) $$p_Y = -\partial p_Y/\partial Y \cdot Y + \partial VC/\partial Y.^{10}$$

The wedge between the price and marginal cost of Y is again based on the assumption of potential market power in this market, and thus a $p_Y(Y)$ dependence, where it is assumed that $p_Y(Y) = \alpha_Y + \beta_Y Y + \gamma_Y Y^{0.5}$.

Finally, demand for (investment in) capital also depends on cost derivatives—this time with respect to both K and ΔK as reflected in a Euler equation. The wedge between the observed market price and marginal or shadow valuation of capital in this case depends on adjustment costs, and the associated quasi-fixity of this factor. The resulting pricing equation for K, which completes the system of estimating equations, is based on a dynamic adjustment specification that has now become quite standard in the literature (see, for example, Morrison 1985). Optimal investment in K is represented by the Euler equation

(6) $$p_K = -\partial VC/\partial K - i\partial VC/\partial \Delta K + \Delta K \partial^2 VC/\partial K \partial \Delta K + \Delta\Delta K \partial^2 VC/\partial(\Delta K)^2,$$

where $\Delta\Delta K$ is the second difference of K, $\Delta(\Delta K)$, and i is a real rate of return specified as the Moody Baa bond yield. This equation characterizes the gap between the price (p_K) and shadow value ($Z_K = -\partial VC/\partial K$) of capital explicitly as a function of adjustment costs through the ΔK terms, and thus represents movement toward the long-run equilibrium level of K given current knowledge of input and output prices.[11]

The production structure framework characterized by equations (1)–(6) can in a sense be thought of as representing a sequential optimization process. The immediate decision of the firm is to minimize $VC(\cdot)$ by choice of L and E, given Y, M, and K levels. The "intermediate-run" decision, which may be made virtually instantaneously but conceptually can be thought of as a second stage, is to also choose the optimal (cost-minimizing) M level (M^*) according to the pricing equation $p_M = -(\partial p_M/\partial M \cdot M + \partial VC/\partial M)$ (as well as the profit-maximizing level of Y through the analogous output pricing equation). In the "long run," the firm also moves to its optimal capital level K^* according to the equality $p_K = -\partial VC/\partial K = Z_K$, although in the relevant decision period, full investment to this desired level is not reached due to adjustment costs. Utilization of the existing capital thus varies in the short term, as reflected in the Euler equation.

The system of estimating equations therefore includes the variable input demand equations [(2) and (3)], the two pricing equations for M and Y [(4) and (5)], and the Euler equation for capital (6). The cost function (1) was also estimated in the final specification, although it is not necessary to measure all the parameters of interest; in fact, the results changed little whether it was included or excluded. The full sequence of optimizing decisions is therefore taken into account, since L, E, Y, M, ΔK, p_M, and p_Y are all recognized as endogenous in the estimating model.

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[10] This type of model is often attributed to Appelbaum. Azzam and Pagoulatos, Azzam and Schroeter, and others also have used such a model in the context of the meat packing industry, with a conjectural variations parameter added. Note also that the expression for MC here is based on the $VC(\cdot)$ equation, although in general it relies on total costs, as incorporated below.

[11] Some recognition of nonstatic expectations is accommodated in the model by instrumenting input prices, as noted below, which is a standard adaptation to this type of model from the assumption of static expectations. Typically (as discussed in Morrison 1986), the results of such estimation are roughly similar to models based on other expectations assumptions (such as adaptive or rational), although none differ dramatically from the assumption of static expectations.

Measurement of the Production
Structure Indicators

From this model framework, indicators of cost economies, time and trade shift (or trend) impacts, markup or markdown behavior, and their determinants, may be derived via a set of first- and second-order cost elasticities.

The first measures one might think of constructing are the cost-side scale economy and time (often interpreted as technical change) elasticities often measured in models of cost structure (e.g., Ball and Chambers; Morrison 1997b). These base measures represent the cost changes associated with Y and t changes, or the cost-output relationship on a given cost curve and a shift in the cost function between two time periods, respectively: $\varepsilon_{TCY} = \partial \ln(TC)/\partial \ln(Y)$ and $\varepsilon_{TCt} = \partial \ln(TC)/\partial t$, where $TC = VC(\cdot) + p_M(M)M + p_K K$ is total input costs.

In the current specification, however, additional complications and extensions of these standard measures must be taken into account. First, consider the scale economy measure, which may be conceptualized as representing internal (slope) scale economies as contrasted with external (shift) economies due to time or "technical change" and trade trends. A major issue for construction of these indicators in the current context is what level of the sequential optimizing process is relevant for computation and interpretation of the measures, as alluded to in the previous section.

In the empirical results reported below, I present measures for each "stage" of the process—the "short," "intermediate," and "long" runs, denoted S, I, and L, respectively. The measure ε_{TCY}^S is evaluated at existing M and K levels; ε_{TCY}^I is based on substituting the optimal M^* level solved from the M pricing equation into the cost function, so M adjustment in response to Y changes is accommodated in the cost economy elasticity; and finally, ε_{TCY}^L is computed after including full adjustment of the capital stock to the K^* level corresponding to the $p_K = Z_K = -\partial VC/\partial K$ equality.

The ε_{TCY}^I elasticity is the most representative of the optimization process one would consider valid for the annual data used, where M demand responses to Y changes are recognized but slow capital adjustment may still impose fixities (the firm may not be on the long-run cost curve). However, the different cost or scale economy measures imbedded in this model facilitate interpretation of adjustment processes and utilization.

Similarly, the ε_{TCt} elasticity seems most appropriately evaluated using the cost representation evaluated at M^*. This is also the case for cost measures based on the other external shift factors incorporated in our model—IY and EY. That is, cost elasticities representing the impact of increasing import penetration and export demand may be measured as $\varepsilon_{TCIY} = \partial \ln(TC)/\partial IY$ and $\varepsilon_{TCEY} = \partial \ln(TC)/\partial EY$.[12] These measures are of course subject to the same qualifications about the sequential optimization process as discussed above. Again, the most relevant measure for purposes of our analysis is the "intermediate-run" measure embodying M adjustment.

These first-order (based on first derivatives) cost elasticities may be combined with measures representing Y and M price-to-marginal cost or -benefit ratios to assess the

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[12] Note that these measures (as with the ε_{TCt} measure) are, strictly speaking, not in elasticity form. The denominator is not in logs, so the measure cannot be interpreted as a percentage change. This is typically justified for the ε_{TCt} measure since, as a time counter, percentage changes are not a relevant indicator. The IY and EY measures were constructed similarly, for consistency. This means, however, that the magnitudes of the measures are not directly comparable.

extent of market power in the market, and the potential for its abuse. Once the marginal cost measures $\partial TC/\partial Y$ [the basis for the $\varepsilon_{TCY} = \partial \ln(TC)/\partial \ln(Y)$ elasticities] are computed, for example, they may be used to construct $Prat_Y = p_Y/MC = (-\partial p_Y/\partial Y \cdot Y + \partial TC/\partial Y)/(\partial TC/\partial Y)$ markup ratios. These measures reflect the difference between average price and corresponding marginal cost that depends on the wedge from market power, $-\partial p_Y/\partial Y \cdot Y$. They therefore reflect the same information as a Lerner index.

Similarly, markdown measures from monopsony power may be computed as $Prat_M = p_M/Z_M = (-\partial p_M/\partial M \cdot M - \partial VC/\partial M)/(-\partial VC/\partial M)$, where, as seen above, Z_M is the marginal or shadow value of M, $-\partial VC/\partial M > 0$. In reverse from the output-side market power measure, these measures would be expected to fall short of one $(-\partial p_M/\partial M \cdot M < 0)$ if monopsony power is evident; the input supply function is upward sloping. This is symmetric to the expectation that $p_Y/MC > 1$, because $\partial p_Y/\partial Y \cdot Y < 0$ in the output market if monopoly power prevails; the output demand function is downward sloping.

These measures may be compared to cost elasticities representing the cost structure [in particular, the $\varepsilon_{TCY} = \partial \ln(TC)/\partial \ln(Y) = \partial TC/\partial Y \cdot (Y/TC) = MC/AC$ measures capturing the deviation between marginal and average cost]. This allows evaluation of whether a shortfall of marginal to average costs from scale economies may underlie evidence of markups in the output market or markdowns in the input market. That is, markups of p_Y over measured MC (or markdowns of p_M below Z_M) may result from cost economies embodied in the technology rather than from abuse of market power. Output (input) price still may be consistent with average costs (or shadow values), in which case the market pressure generated by concentration does not necessarily imply inefficiency.[13]

In addition, measures representing substitution patterns and input-specific (or -compositional) impacts of changing economic factors may be computed as input demand elasticities. For L and E, such measures may be computed directly as elasticities of the variable input demand equations derived from Shephard's lemma, and thus are second-order cost elasticities. For example, $\varepsilon_{LY} = \partial \ln(L)/\partial \ln(Y) = \partial \ln(\partial TC/\partial p_L)/\partial \ln(Y) = \partial^2 TC/\partial p_L \partial Y \cdot (Y/L)$ indicates how changes in scale affect labor demand. If $\varepsilon_{LY} = \varepsilon_{TCY}$ (labor changes from output expansion are proportional to overall cost changes), no scale bias is evident for labor. As above for the cost elasticities, these elasticities may be evaluated at given M and K levels, or with the optimized M^* and K^* values imputed to generate ε_{LY}^S, ε_{LY}^I, and ε_{LY}^L measures.

Elasticities of desired M and K levels also may be computed by solving for M^* and K^* from the optimal M pricing equation $(p_M = -\partial p_M/\partial M \cdot M - \partial VC/\partial M)$ and the long-run capital equilibrium equation $(p_K = Z_K = -\partial VC/\partial K)$. These M^* and K^* demand expressions depend on all the arguments of the cost function; elasticities such as $\varepsilon_{M^*Y} = \partial \ln(M^*)/\partial \ln(Y)$ therefore may be computed to identify the M-Y relationship.

Empirical Implementation and Results

The model consisting of the equation system (1)–(6) discussed above, representing production structure in the meat product industries, was estimated using generalized method of moments (GMM) procedures, which essentially generates iterated three-stage

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[13] This is, for example, the notion underlying the comparison of market power and efficiency in Azzam and Schroeter, and their findings, which are comparable to those in this study for the meat packing industry.

least squares measures with autocorrelation accommodated. The instrumental variables methodology allows the levels of inputs (and changes in capital) to be treated as endogenous variables, and recognizes the combined endogeneity of the prices and quantities in the Y and M markets that may be characterized by noncompetitiveness.

Estimation was carried out separately for each four-digit SIC meat and poultry industry (2011/Meat Packing Plants, 2013/Sausages and Other Prepared Meat Products, 2016/Poultry Dressing Plants, and 2017/Poultry and Egg Processing) for 1960–91 (however, the elasticity estimates are presented as averages for 1970–91, and for the 1970–80 and 1981–91 subsamples to focus on more recent trends).[14] Parameter estimates for these models were largely significant, and estimates of the elasticity measures (discussed below) indicate their joint significance (since the elasticities are based on combinations of estimated coefficients).[15]

One important exception to this is reflected in the market power estimates, since the market power parameters tended to be statistically insignificant. Thus, in the final preferred specifications,[16] only "monopsony" power (market power in the material input market) was included, although for some model specifications even the monopsony parameters had a propensity toward insignificance. Overall, across specifications, it was not possible to identify both output and input market power parameters when all time and trade trend effects were incorporated.

More specifically, when both output and input market power were incorporated in the model, the estimated wedges between price and marginal cost (or benefit) due to market power were large. But evidence from the two (output and input) markets tended to counteract each other. The message appears to be that little market power exists overall, and what does exist is difficult to attribute to either (output) supply or (input) demand without additional structure on the output demand or input supply specification.

Also, the relative importance of the monopoly and monopsony specifications differed for the meat as compared to poultry industries. Both meat industries (2011 and 2013) exhibited generally significant monopoly parameters across specifications (especially with no monopsony recognized) and markup ratios that typically ranged between 1.03 and 1.10. However, with both monopsony and monopoly incorporated into the model, the results were often quite volatile. The monopsony-only specification ultimately seemed to fit the data most closely, and to be the most robust. By contrast, for both poultry industries (2016 and 2017), the insignificance of the monopoly parameters prevailed across most specifications.

Further differences between the meat and poultry industries emerged in the estimated market power measures. The $P^S rat_M$ and $P^I rat_M$ estimates presented in table 1 (averaged over 1970–91 and two subperiods to represent the time dimension) document the patterns. Note that since these measures are based on M changes, profit-maximizing

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[14] Four-digit SIC data on prices and quantities of output and capital, labor, energy, and materials inputs are available from the National Bureau of Economic Research/Center for Economic Studies (NBER/CES) "Census Manufacturing Industry Productivity Database," which is documented online at the NBER/CES website. Import and export quantity data [recently constructed by Robert Feenstra, and documented in Feenstra (1996)] are also available from the NBER/CES trade statistics.

[15] Although the parameter estimates are not reported here due to space constraints, they are available from the author upon request.

[16] The final reported results are "preferred" in the sense that various specifications were tried in preliminary empirical investigation to identify the strongest or most definitive patterns evident from the data. The final specifications are representative of these patterns.

Table 1. Cost Elasticities and Monopsony Measures, U.S. Meat and Poultry Products Industries (mean values for time periods)

Measures	Meat / Poultry Products Industry							
	No. 2011		No. 2013		No. 2016		No. 2017	
	Elasticity	Std. Error	Elasticity	Std. Error	Elasticity	Std. Error	Elasticity	Std. Error
FULL PERIOD 1970–91:								
ε_{CY}^{S}	0.8475	0.052	0.9304	0.032	0.9815	0.056	0.9976	0.052
ε_{CY}^{I}	0.9318	0.018	0.9552	0.016	1.0424	0.038	1.0993	0.032
ε_{CY}^{L}	0.9708	0.031	0.9507	0.018	1.1068	0.058	1.1079	0.040
ε_{Ct}^{I}	−0.0034	0.001	0.0042	0.002	−0.0279	0.004	−0.0276	0.005
ε_{CIY}^{I}	−0.0131	0.003	0.0081	0.009	0.2253	0.164	0.1598	0.148
ε_{CEY}^{I}	0.0266	0.005	−0.0470	0.006	−0.0141	0.009	0.0398	0.010
$P^{S}rat_{M}$	0.9369	0.031	0.9219	0.015	1.1810	0.062	1.0920	0.021
$P^{I}rat_{M}$	1.0436	0.013	1.0552	0.012	0.9290	0.038	0.9277	0.014
SUBPERIOD 1970–80:								
ε_{CY}^{S}	0.7150		0.8821		0.9420		1.0128	
ε_{CY}^{I}	0.9059		0.9884		0.9832		1.1050	
ε_{CY}^{L}	0.9608		0.9618		1.0113		1.1447	
ε_{Ct}^{I}	−0.0066		0.0022		−0.0170		−0.0122	
ε_{CIY}^{I}	−0.0038		0.0076		0.0803		0.1535	
ε_{CEY}^{I}	0.0257		−0.0338		0.0018		0.0239	
$P^{S}rat_{M}$	0.9366		0.9336		1.0727		1.0753	
$P^{I}rat_{M}$	1.0546		1.0389		0.9807		0.9326	
SUBPERIOD 1981–91:								
ε_{CY}^{S}	0.9800		0.9786		1.0209		0.9824	
ε_{CY}^{I}	0.9577		0.9219		1.1017		1.0936	
ε_{CY}^{L}	0.9809		0.9396		1.2023		1.0710	
ε_{Ct}^{I}	−0.0002		0.0062		−0.0389		−0.0430	
ε_{CIY}^{I}	−0.0225		0.0087		0.3703		0.1661	
ε_{CEY}^{I}	0.0275		−0.0602		−0.0301		0.0556	
$P^{S}rat_{M}$	0.9372		0.9102		1.2893		1.1087	
$P^{I}rat_{M}$	1.0326		1.0716		0.8773		0.9228	

Note: The four-digit SIC industries are: 2011 = Meat Packing Plants, 2013 = Sausages and Other Prepared Meat Products, 2016 = Poultry Dressing Plants, and 2017 = Poultry and Egg Processing.

adjustment of Y (the firms' throughput) rather than M is incorporated in the inter-mediate-run specification denoted by I.[17] Standard errors for the market power and scale economy measures in table 1 are presented for the midpoint of the reported sample.[18]

For the meat industries, the $P^S rat_M$ measures—without the impacts of increasing throughput, and thus utilization incorporated—fall short of one. This suggests that firms would not pay the full value of their marginal benefit for increases in (livestock) materials inputs, thus implying a possible exploitation of monopsony power. However, when the indirect cost benefits from increasing utilization are taken into account to generate the more relevant and interpretable $P^I rat_M$ measure, firms seem willing to pay *more* than the direct marginal benefits of increasing materials demand.[19]

By contrast, in the poultry industries, the "immediate" response by the firms would be to pay more than the direct marginal benefit, possibly due to high output demand levels. However, increasing throughput in these industries imposes costs on the firm, so ultimately the marginal payment firms are willing to make for poultry is lower than directly justified by the firms' cost factors. This suggests less market pressure to expand operations than in the meat industries, based on a tendency toward overutilization of capacity resulting from strong demand in poultry markets.

To elaborate, note that interpretation of these indications of market power is facili-tated by considering the associated evidence of (short-run) utilization and (long-run) cost or scale economies from the ε_{TCY} measures. Cost economy measures for the three "runs" are presented in table 1, to help explore the implied adjustment processes.

The short-run ε_{TCY}^S measures indicate the *direct* impacts of increasing output, eval-uated at existing M levels. It appears from these measures that short-run average cost curves at given K and M levels have downward slopes in all these industries. The implied unit cost savings at higher output levels are greatest in the meat packing (2011) industry. The slope of the average cost curve appears nearly flat for the poultry indus-tries. The measures for the meat industries are also *statistically* different from one, although not for the poultry industries.

More interesting evidence stems, however, from the estimates when adjustment of the materials input to output changes is explicitly represented. The ε_{TCY}^I measures fall short of one for the meat industries, but exceed one for the poultry industries. These measures are also statistically significantly different from one, except for industry 2016. This indicates that firms in the poultry industries are operating on the increasing portion of the short-run average cost curve with capital fixed, or are overutilizing their capital. The evidence of such short-run "diseconomies" also prevails into the long run. Even with capital adjustment, there appears to be sufficient demand pressure in these industries to drive firms to the point of increasing costs.

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[17] That is, for scale measures where output increases are evaluated, the associated optimal increase in materials inputs must be accommodated to endogenize these responses and represent full adjustment of inputs and outputs at given capital levels. In reverse, if materials input changes are measured, full adjustment holding capital fixed (i.e., to the "intermediate run") requires recognition of associated profit-maximizing output changes.

[18] Note that these elasticities are not parameter values, but complex combinations of coefficients and data for each elasti-city computation. Therefore, standard errors were computed for each data point based on the ANALYZ command in TSP.

[19] It is particularly interesting to note that this evidence is consistent with that based on plant-level data for the beef packing industry for 1991, as documented in Paul (1999a). This suggests that these procedures and the resulting conclusions may not be significantly affected by aggregation biases.

In sum, scale economies are evident for the meat but not the poultry industries.[20] And, in fact, overutilization of existing capital, as well as long-run scale diseconomies, is implied by the measures for the poultry industries. This is consistent with the great expansion of demand for poultry products since the 1970s, as a consequence of increasing pressure on the poultry market due to changing tastes away from red meat.

Measures for the two subperiods (1970–80 and 1981–91) provide further indications of time trends in the measures (table 1). In the poultry dressing industry (2016), some evidence of scale economies appeared in the early subperiod. However, even greater diseconomies were apparent in the poultry and egg processing industry (2017) in the 1970s than in the 1980s, possibly due to the adjustment time needed to respond to great expansion in demand for processed products. Note also that less time variation is evident for the market power than for the scale economy measures, possibly at least partly due to greater simplicity of the market power specification, although the shadow values could potentially change over time.

Greater scale economies were also evident in the meat industries in the 1970s than in the 1980s, which may have driven the increased consolidation in these industries over the past couple of decades. These numbers suggest that the potential for taking advantage of scale economies has been largely "used up" by the 1990s, at least in the meat packing (2011) industry, so concentration may not proceed further in this industry. Concentration that has occurred, however, seems to have been motivated by technological and economic factors underlying scale economies. This in turn seems to document the potential in the recent past to take advantage of scale economies and thus increase cost efficiency in this industry, rather than to imply inefficiency.

Thus, overall, little evidence of market power exploitation in the U.S. meat and poultry industries emerges from these numbers, even given the high concentration levels in this sector. Combining the findings about scale economies with those for market power suggests that any evidence of market power abuse is explained by the existence of short- and long-run scale economies or diseconomies. Firms in the meat industries appear to pay more on the margin for materials inputs than justified by their *direct* marginal benefit, due to the importance of maintaining high utilization levels and thus taking advantage of existing capacity. In reverse, firms in the poultry industries pay less on the margin than the direct marginal benefit, but this is due to costs associated with utilization levels which, in terms of cost minimization, are overly high.

Further, cost economies in these industries seem biased with respect to the inputs. The ε_{LY}^{I}, ε_{EY}^{I}, and ε_{MY}^{I} elasticities in table 2 indicate the extent of labor, energy, and materials adjustment in response to output changes at given capacity levels (so this is a utilization or short-run scale measure). The asterisks (*) after the estimated values indicate statistical significance at the 5% level, and the slashes (/) denote insignificance at the 5% level, for 1971, 1981, and 1991 (with respect to the "base" of one for output elasticities, and zero for the other measures).

These numbers indicate labor-saving biases for both the 2013 and 2017 industries ($\varepsilon_{LY}^{I} < \varepsilon_{TCY}^{I}$, so labor increases less than proportionately to overall input costs). Note, however, that the negative (but insignificant) values for ε_{LY}^{I} in the 2017 industry, combined with the very large and positive (but again primarily insignificant) ε_{LK}^{I} elasticity,

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[20] This evidence for the meat industries is consistent with findings in Melton and Huffman, and Ball and Chambers, although the latter was for the entire meat products industry.

Table 2. Labor, Energy, and Materials Input Demand Elasticities, Meat and Poultry Products Industries (mean values for time period 1970–91)

Measures	Elasticities, by Industry			
	No. 2011	No. 2013	No. 2016	No. 2017
LABOR:				
ε^I_{LK}	-0.2477 *, /, *	-1.4440 *, *, *	-1.1886 /, /, /	4.4291 /, *, /
ε^I_{LY}	3.1422 *, *, *	0.6463 *, *, *	3.7823 *, *, *	-0.4556 /, /, *
ε^I_{LpM}	-0.0384 *, *, *	-0.0378 /, *, *	0.0816 /, *, *	-0.7322 /, /, *
ε^I_{LpL}	-0.2769 *, *, *	-1.1024 *, *, *	-1.1188 *, *, *	2.2890 *, *, *
ε^I_{LpE}	-0.2262 *, *, *	-0.4759 *, *, *	-0.8448 *, *, *	1.7706 *, *, *
ε^I_{Lt}	-0.0856 *, *, *	1.4130 *, *, *	-2.0732 /, *, *	-3.9911 *, *, *
ε^I_{LIY}	-0.9205 /, *, *	-0.2154 /, /, /	0.1991 /, /, /	0.3942 /, /, *
ε^I_{LEY}	-0.0289 /, *, /	-0.2088 *, /, *	-0.0733 /, /, *	-0.4800 *, /, /
ENERGY:				
ε^I_{EK}	-3.2872 *, /, *	-9.9233 *, *, *	-11.1892 /, /, /	31.6557 /, *, /
ε^I_{EY}	26.4882 *, *, *	2.1332 /, /, *	20.8393 *, *, *	-10.3509 /, /, /
ε^I_{EpM}	-0.0111 *, *, *	-0.0523 *, *, *	0.1029 /, *, *	-8.1936 /, /, /
ε^I_{EpL}	-2.5546 *, *, *	-5.5283 *, *, *	-8.2649 *, *, *	18.3749 *, *, *
ε^I_{EpE}	-1.8491 *, *, *	-2.8534 *, *, *	-3.6741 *, *, *	16.4067 *, *, *
ε^I_{Et}	4.8951 *, /, *	9.6748 *, *, *	-10.0479 /, *, *	-22.7392 *, *, *
ε^I_{EIY}	-7.1113 *, *, *	-1.5901 *, /, /	1.2223 /, /, /	3.0104 /, /, *
ε^I_{EEY}	-1.8811 /, /, *	-1.2802 /, /, *	-0.9675 /, /, *	-4.7111 *, /, /
MATERIALS:				
ε^I_{MK}	0.0902 *, *, *	0.0997 *, *, *	0.3347 /, /, /	-1.6500 *, *, *
ε^I_{MY}	0.6916 *, *, *	1.1276 *, *, *	0.4947 *, *, *	1.6187 *, *, *
ε^I_{MpM}	-0.0597 *, *, *	-0.3129 *, *, *	-0.5356 *, *, *	0.9985 *, *, *
ε^I_{MpL}	0.0365 *, *, *	0.2268 *, *, *	0.2870 *, *, *	-0.4925 *, *, *
ε^I_{MpE}	0.0282 *, *, *	0.1087 *, *, *	0.1786 *, *, *	-0.4298 *, *, *
ε^I_{Mt}	-0.0814 *, *, *	-0.1926 *, *, *	-0.4578 *, *, *	0.2326 /, /, /
ε^I_{MIY}	0.0265 /, /, /	0.0991 /, *, *	-0.0020 /, /, /	-0.0539 /, /, /
ε^I_{MEY}	0.1143 *, *, *	-0.1685 *, *, *	-0.0138 /, /, /	0.2566 *, *, *

Notes: An asterisk (*) denotes significance at the 5% level, and a slash (/) denotes lack of significance at the 5% level; the order of these characters following the estimated values denotes significance (lack of significance) for the years 1971, 1981, and 1991. The four-digit SIC industries are: 2011 = Meat Packing Plants, 2013 = Sausages and Other Prepared Meat Products, 2016 = Poultry Dressing Plants, and 2017 = Poultry and Egg Processing.

suggest labor increases that have occurred in this industry have been connected to capital expansion.[21] These industries also have been materials-using over this time period, which may be associated with the fabricated nature of their output production.

These results are generally consistent with those found by Ball and Chambers, and by Melton and Huffman. Also, results in the current study are less volatile over time than found in those studies. The time dimension, as indicated by the values for subperiods in appendix table A1, does not change the overall picture very much.

However, the results for industries 2013 and 2017 are quite different than those found for the more slaughter-based industries, 2011 and 2016. In these industries, output expansion seems to be labor-using (although reduced labor use occurs at greater capital levels, somewhat counteracting these implications) and materials-saving (although again capital expansion adds to the materials demand responsiveness).

Also note that the energy elasticities are very large, likely due to energy's very small share (averaging 0.5% in industry 2011, 1% in 2013, and 1.3–1.4% in the poultry industries, with a positive time trend in all industries). Energy use seems tied to capital investment in the poultry and egg processing industry (2017—although the connection is marginally insignificant), but increases more than proportionately to output in the other industries when utilization of the existing capital stock changes.

An additional focus of the elasticities in tables 1 and 2 (and in other studies in the existing literature) is how these patterns relate to time trends or "technical change," and also what might be driving these trends. Both technical or time and trade trend impacts on costs and input demands are important to address.

These patterns differ by industry. The direct time impact (or disembodied technical change, reflected in the ε_{TCt}^{I} elasticity) suggests significant cost savings (independent of capital expansion) were occurring in the poultry industries, with some corresponding reduction in the meat packing industry (2011) but a slight increase in industry 2013. This is consistent with the greater impact of technical progress on costs in the poultry industry found by Lambert.

By contrast, cost *increases* seem connected to greater import competitiveness except in the 2011 industry, though these positive effects are all statistically insignificant. Imports appear to have only affected costs in the meat packing industry, which is also consistent with the larger import share in this industry than in the poultry industries (about 5% of output in the meat industries, as compared to 0.2% in the poultry industries). Also, increased exports appear to be associated with higher costs in the 2011 and 2017 industries, but lower costs in the 2013 and 2016 industries, and all are significant.[22]

From table 2, it can be seen that the implications of time and trade trends for labor use are quite consistent across the poultry industries. Increasing import competitiveness augments labor use (but insignificantly), and disembodied technical change (or time) trends and increasing exports stimulate declines in labor demand. Greater

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[21] The capital share is also slightly larger in the 2017 industry than in the 2013 and 2016 industries (approximately 16% in terms of a service flow, as compared to 15% and 13%, respectively), and more than twice as large as for the 2011 industry (7%).

[22] Although the time and trade elasticities are not directly comparable since they are not expressed in percentage form, note that the import elasticities for the poultry industries seem far larger than for the meat industries. This is somewhat misleading, however, since it arises because of the very small amount of imports for these industries. It is also statistically insignificant.

efficiency of labor use also seems evident from the trend factors in the 2016 industry, but in the processing side of poultry production L use increases over time and with exports.

The impacts of time and trade trend factors on labor use are consistent with the conclusion of Lambert that there is a trend (or technical change) bias toward using labor in the poultry industries. This stems from both disembodied technical change and export increases. This is also true for the meat industries, but to a somewhat lesser extent (and technical change seems L-using for industry 2013). The counteracting impact of imports is both small (the IY ratio is only about 0.002) and insignificant (the trend in this measure is negligible for these industries, and the IY parameters are insignificant).

In addition, energy savings appear to have been associated with increased export levels in all industries, and with disembodied technical change trends in the poultry (but not the meat) industries. M-saving is evident in industries 2013 and 2016 from export expansion, but exports are materials-using in 2011 and 2017. And, although the time trend has been toward M-saving in industry 2011, it is M-using in industry 2017, as are increases in EY (which may stem from the processed nature of output in this industry).

Finally, the input demand elasticities in table 2 can be used to assess input substitutability. Although it is often asserted that little substitution may take place in these industries—especially industry 2011 which is a slaughter-based industry with a materials share of nearly 90%—the demand elasticities indicate significant substitution effects. The own-price elasticities are the right sign, with the exception of the 2017 industry.[23] Other indications of substitution are provided by the cross-elasticities. For example, increases in materials prices reduce demand for other inputs in all but the 2016 industry, where increases in demand for the product may counteract the price effects.

Summary and Concluding Remarks

In this study, a cost-oriented model of production processes and output and input pricing behavior is used to evaluate patterns of costs, market power, and input use in the four-digit SIC U.S. meat products industries. The model is based on a flexible cost function that allows adjustment processes, scale economies, and time (technical change) and trade trend factors to be modeled, measured, and evaluated.

The measures suggest some evidence of market power, yet it was difficult to identify as stemming from the output or input side. The limited indications of market power are closely related to associated scale economies. Disembodied technical change (or time) and trade trend factors seem to have stimulated cost efficiency through both materials saving and labor saving in these industries (although less so for more processed products). Also, the primary trade impact can be attributed to export expansion rather than import competitiveness.

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[23] This industry, which includes more food processing than the others, may have had a somewhat different structure due to the great increases in demand for processed foods during this time period, which require increased labor, energy, and capital independent of price changes.

Monopsony models seem best to represent production (cost and market) structure patterns in these industries, although limited evidence of output price markups appears in the meat industries.[24] For these industries, once utilization adjustment is taken into account, higher prices appear optimal to pay in order to increase throughput and thus utilization (to take advantage of "short-run scale economies"), since the cost economies deriving from utilization changes exceed the diseconomies from increased price levels. Both intermediate- (utilization) and long-run scale economies are apparent, but they decreased over time as the market became more consolidated. These results are reversed for the poultry industries, which exhibit diseconomies. Increased costs of output expansion cause the true marginal benefit of the materials input (M) to fall short of its direct value, resulting in little motivation to pay high marginal prices for M.

Some evidence of trade and time effects was also found. A combination of trend (technical and trade) impacts has stimulated cost efficiency in all these industries over time. There is little evidence of import impacts, especially in the poultry industries where imports are negligible. Exports have differing patterns across industries, with the overall impact being cost-saving in industries 2013 and 2016, and cost-enhancing in industries 2011 and 2017. Labor savings are associated with export expansion and time trends (except for industry 2013). M-using trend impacts were found in industry 2017, and M-saving in industries 2013 and 2016. Finally, export enhancement seems to be M-using in industry 2011, although the trend over time is toward M-saving.

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[24] This lack of apparent market power in the output market is intuitively appealing for at least two reasons. First, as noted by a helpful referee, it seems consistent with the nature of the products since outputs of all four of these industries are "food" and therefore compete with each other as well as with other food products, at least to some degree. Also, as noted by Connor, producers in meat products industries (in his context, meat packers) may be highly and increasingly concentrated, but face similarly concentrated output markets, so significant markups from packers to wholesalers or retailers are doubtful. By contrast, few marketing alternatives exist for material input suppliers to these industries, especially given the scale economies inherent in slaughter and processing (as also stated by the anonymous referee).

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Appendix

Table A1. Labor, Energy, and Materials Input Demand Elasticities, Meat and Poultry Products Industries (mean values for subperiods 1970–80 and 1981–91)

	SUBPERIOD 1970–80					SUBPERIOD 1981–91			
	Elasticities, by Industry					Elasticities, by Industry			
Measures	No. 2011	No. 2013	No. 2016	No. 2017	Measures	No. 2011	No. 2013	No. 2016	No. 2017
LABOR:					**LABOR:**				
ε_{LK}^I	0.3324	−1.4209	−1.3815	5.2684	ε_{LK}^I	−0.8278	−1.4671	−0.9957	3.5897
ε_{LY}^I	2.8228	0.9165	3.9044	−1.2366	ε_{LY}^I	3.4617	0.3760	3.6602	0.3253
ε_{LpM}^I	−0.0505	−0.0284	0.0241	−1.0531	ε_{LpM}^I	−0.0262	−0.0471	0.1392	−0.4114
ε_{LpL}^I	−0.3405	−1.2544	−1.4521	3.3209	ε_{LpL}^I	−0.2134	−0.9504	−0.7855	1.2571
ε_{LpE}^I	−0.2145	−0.4606	−1.0064	2.4353	ε_{LpE}^I	−0.2379	−0.4912	−0.6832	1.1058
ε_{Lt}^I	−0.7912	1.0115	−1.3449	−2.9204	ε_{Lt}^I	0.6200	1.8144	−2.8015	−5.0618
ε_{LIY}^I	−0.4307	−0.2260	0.1112	0.5639	ε_{LIY}^I	−1.4104	−0.2048	0.2870	0.2244
ε_{LEY}^I	−0.0257	−0.0186	0.1003	−0.6714	ε_{LEY}^I	−0.0321	−0.3990	−0.2469	−0.2886
ENERGY:					**ENERGY:**				
ε_{EK}^I	1.4846	−10.8953	−14.7379	42.0806	ε_{EK}^I	−8.0590	−8.9513	−7.6405	21.2307
ε_{EY}^I	24.9607	4.3676	25.0198	−17.4445	ε_{EY}^I	28.0157	−0.1013	16.6588	−3.2572
ε_{EpM}^I	−0.0170	−0.0525	0.0450	−11.8152	ε_{EpM}^I	−0.0052	−0.0521	0.1608	−4.5720
ε_{EpL}^I	−3.1861	−6.9111	−11.8464	28.7406	ε_{EpL}^I	−1.9231	−4.1455	−4.6835	8.0092
ε_{EpE}^I	−1.8312	−3.1502	−5.0105	23.8775	ε_{EpE}^I	−1.8671	−2.5566	−2.3376	8.9359
ε_{Et}^I	−2.7041	7.7631	−6.6201	−18.8728	ε_{Et}^I	12.4942	11.5865	−13.4757	−26.6057
ε_{EIY}^I	−3.4008	−1.8540	0.8385	4.6857	ε_{EIY}^I	−10.8219	−1.3261	1.6060	1.3350
ε_{EEY}^I	−1.2451	0.1189	0.1099	−6.7135	ε_{EEY}^I	−2.5172	−2.6792	−2.0448	−2.7086
MATERIALS:					**MATERIALS:**				
ε_{MK}^I	0.0886	0.0952	0.3169	−1.9596	ε_{MK}^I	0.0918	0.1042	0.3525	−1.3404
ε_{MY}^I	0.6885	1.0652	0.4314	1.7046	ε_{MY}^I	0.6948	1.1899	0.5581	1.5327
ε_{MpM}^I	−0.0659	−0.3299	−0.5828	1.3226	ε_{MpM}^I	−0.0535	−0.2959	−0.4884	0.6744
ε_{MpL}^I	0.0452	0.2477	0.3454	−0.6819	ε_{MpL}^I	0.0278	0.2060	0.2286	−0.3032
ε_{MpE}^I	0.0274	0.0993	0.2023	−0.5512	ε_{MpE}^I	0.0289	0.1181	0.1548	−0.3084
ε_{Mt}^I	−0.0620	−0.1545	−0.3660	0.2399	ε_{Mt}^I	−0.1008	−0.2307	−0.5496	0.2254
ε_{MIY}^I	0.0272	0.1060	−0.0019	−0.0666	ε_{MIY}^I	0.0258	0.0922	−0.0020	−0.0412
ε_{MEY}^I	0.0796	−0.1243	−0.0122	0.2793	ε_{MEY}^I	0.1489	−0.2128	−0.0153	0.2340

Note: The four-digit SIC industries are: 2011 = Meat Packing Plants, 2013 = Sausages and Other Prepared Meat Products, 2016 = Poultry Dressing Plants, and 2017 = Poultry and Egg Processing.