What Determines Welfare Losses from Oligopoly Power in the Food and Tobacco Industries?

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This paper estimates welfare losses in thirty-eight U.S. food and tobacco industries at the four-digit SIC level, then relates such losses to market structure and conduct variables to identify the welfare loss determinants. Empirical findings indicate that these losses are higher in markets characterized by high export intensity, high advertising expenditures, economies of scale, mergers and acquisitions, and market concentration. In addition, losses are larger in industries that sell finished consumer products and face lower import competition.

There is a considerable volume of empirical research that estimates oligopoly-induced welfare losses in the U.S. food and tobacco manufacturing sectors (e.g., Gisser 1982; Willner 1989; Peterson and Connor 1995; Bhuyan and Lopez 1995). The growing literature shows evidence of continued interest in estimating such losses, partly because of the reliance of antitrust authorities on estimates of actual or potential welfare losses when examining the impact of mergers and anticompetitive behavior (Preston and Connor 1992). Stopping at measuring welfare losses, however, leaves many questions unanswered—in particular, which factors are mainly responsible for determining the magnitude of these losses? Answers to such questions are important because they could guide policymakers in selecting effective policy instruments, or deciding whether or not it is desirable to interfere in the markets at all. Thus, beyond measuring welfare losses, a further relevant question involves identifying the factors that are mainly responsible for determining the magnitude of these losses.

The objective of this article is to identify and assess the importance of underlying market structure factors responsible for oligopoly-induced deadweight losses (welfare losses) in the U.S. food and tobacco manufacturing industries. The losses are computed using econometrically estimated Lerner indices, demand elasticities, and economies of scale estimated at the four-digit SIC level for the U.S. food and tobacco industries. These losses are then regressed on a set of market structure factors that underlie the components of the welfare losses.[1] Empirical results indicate that the allocative efficiency losses are positively and significantly related to export intensity, market concentration, advertising, and economies of scale, as well as to merger activities. In addition, consumer product–oriented industries and those facing lower import competition have higher welfare losses.

Theoretical Model

Following Appelbaum (1982), the Lerner index of oligopoly power ($\mathcal{L}$) is given by

$$(1) \qquad \mathcal{L} = \frac{(P_o - MC_o)}{P_o} = \frac{\theta}{\eta},$$

where P_o, θ, η, and MC_o are oligopoly price, conjectural variation elasticity, the absolute value of the price elasticity of demand, and oligopoly marginal cost, respectively. Note that $\theta = 0$ depicts a perfectly competitive industry, $\theta = 1$ a monopolistic one, and $0 < \theta < 1$ various degrees of oligopoly conduct. Following Dickson and Yu (1989) and Bhuyan and Lopez (1995), let the industry demand curve be given by $Q = 1/P^{\eta}$, where the perfectly competitive output and price are indexed to 1. Let the inverse of the industry marginal cost (MC) be given by $Q = MC^{\epsilon}$, where ϵ is the inverse of marginal cost elasticity. Using equation (1), the oligopoly price (P_o) and output (Q_o) are given by

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$$P_o = \frac{\eta Q_o^{1/\epsilon}}{\eta - \theta}, \quad (2)$$

and

$$Q_o = \frac{1}{P_o^{\eta}} = \left(\frac{\eta - \theta}{\eta}\right)^{\frac{\eta\epsilon}{\eta+\epsilon}}. \quad (3)$$

The deadweight loss (*DWL*) can then be computed as

$$DWL = \int_{Q_o}^{1} \left[\left(\frac{1}{Q}\right)^{\frac{1}{\eta}} - Q^{\frac{1}{\epsilon}} \right] dQ. \quad (4)$$

Note that the actual dollar value of the deadweight losses as a percentage of observed sales (herein referred to as *DWL*) is equivalent to indexed losses as a percentage of indexed sales.[2]

From equation (4), it can be shown that *DWL* increases with θ and ϵ and decreases with η, in agreement with the simulation results of Dickson and Yu (1989). Let $\mathbf{Z}_j$ denote a vector of exogenous variables underlying θ, η, and ϵ. Since some of the same exogenous variables in $\mathbf{Z}_j$ may influence more than one of these elements, our empirical approach consists of estimating the net impact of $\mathbf{Z}_j$ on *DWL* via regression analysis. While econometrically estimated market structure and conduct parameters (θ, η, and ϵ) are used to compute welfare loss, a reduced form equation is used to examine the relationship between welfare loss and the variables these market structure and conduct elements.

Empirical Procedures

The values for θ, η, and ϵ were obtained for the forty U.S. food and tobacco industries reported in Bhuyan and Lopez (1997). Equation (4) and 1987 sales were then used to compute welfare losses as a percentage of sales for each of these industries at the four-digit SIC level. Two of these industries did not satisfy the welfare loss model (equation [4]) and were dropped from the study.

Next, the elements in $\mathbf{Z}_j$ underlying θ, η, and ϵ were identified. In terms of the conjectural variation elasticity, it can be shown that, by using the Clarke and Davies (1982) parameter α and the Herfindahl-Hirschman Index (*H*), the conjectural variation elasticity can be expressed as $\theta = H + \alpha(1 - H)$. In fact, ever since Cowling and Waterson's seminal work (1976), there has been a well-established theoretical rationale for expecting industry profitability to be positively related to the level of industrial concentration. Thus, we expect θ and *DWL* to be positively correlated with *H*. Moreover, Amos, Perloff, and Perloff (1996) have shown that *H* is a better indicator of industry concentration than are other concentration measures such as the top four-firm concentration (*CR4*). Scherer and Ross (1990) noted that oligopolistic collusion is likely to be higher for consumer products because of a lack of countervailing power. Thus a variable (*CONS*) representing the proportion of shipments made directly to consumers (i.e., sales to wholesalers/retailers rather than to other manufacturing industries) is expected to be positively correlated with *DWL*.

Based on the work of Esposito and Esposito (1971) and Ståhlhammer (1991), the conventional wisdom is that industries facing import competition are more likely to be disciplined toward behaving competitively. Thus, import intensity (*MS*, the ratio of imports to total sales) is expected to be negatively related to *DWL*. Field and Pagoulatos (1996) argued that the effect of export intensity (*XS*, the ratio of exports to total sales) on oligopoly profitability (and consequently on welfare losses) cannot be determined a priori because the relationship may be negative if domestic firms are unable to engage in price discrimination between the domestic and foreign markets, while the opposite may result if exporters, because of tariff protections, can engage in international price discrimination.

The desire to achieve or strengthen market power was a prominent factor in mergers and acquisitions of the past in the United States (Scherer and Ross 1990). Although vigorous antitrust enforcement efforts have reduced competition-inhibiting mergers, the market power motive cannot be ruled out completely. Moreover, the negative implication of mergers, i.e., a reduction in the level of competition in a market (Auerbach and Reishus 1991), is also an important consideration here. The 1980s saw numerous mergers, including the almost \$25 billion leverage buyout of RJR Nabisco by KKR & Co. in 1989. (This merger was announced in 1988 and was so famous that Hollywood made a movie about it!) It is notable that during this period a few firms were responsible for most of the mergers and acquisitions (in terms of value) in the food and tobacco industries. For example, Phillip Morris buying General Foods (valued at \$5.63 billion), RJR buying Nabisco (\$4.9 billion), and Nestle buying Carnation (\$2.9 billion) were responsible for almost 90% of total mergers and acquisitions in 1985 (*Mergers and Acquisitions*, May/June 1986). After running at a feverish rate in the 1980s, mergers and acquisitions in the very late 1980s and the 1990s fell sharply when a few companies involved in highly leveraged transactions defaulted on bond issues and sought bankruptcy protection while at the same time financing costs rose sharply and prices for asset sales weakened (Pickering 1991).

The potential impact of such corporate restructuring activity on industry concentration, as measured by the Herfindahl-Hirschman Index, is closely watched by the federal antitrust authorities as horizontal mergers increase market concentration, thereby raising the possibility of increased price and decreased social welfare (U.S. Department of Justice and Federal Trade Commission 1992). Although the market concentration measure (*H*) is expected to capture the structural and performance impact of mergers and acquisitions in the U.S. food and tobacco industries, a mergers and acquisitions variable (*M&A*) is introduced as an explanatory variable and is expected to be positively related to *DWL*.

Pagoulatos and Sorensen (1986) found that the price elasticity of industrial demand depends negatively on advertising (*ADV*) and research and development (*R&D*), possibly denoting product differentiation and product development, respectively. These variables are measured as the percentage of sales and are expected to be positively related to *DWL*. Pagoulatos and Sorenson also argued that demand elasticity is lower in consumer products, which should reinforce the negative relation between *CONS* and *DWL* expected above.

Where the previous literature offers little guidance is on the determinants of ϵ, which is the inverse of the marginal cost elasticity with respect to output and is thus negatively related to the degree of economies of scale (Ferguson 1979). The closest empirical work on the determinants of ϵ is the study by Caves et al. (1980) on the determinants of minimum efficient scale, which yielded mixed results. Harris (1988) shows that economies of scale affect oligopoly power as a barrier to entry of potential competitors. To control for the importance of scale economies, an economies of scale dummy variable (*SCALDUM*) representing those food and tobacco industries with economies of scale is included as an explanatory variable. This control variable was constructed using the reported estimates of scale economies by Bhuyan and Lopez (1997). Those food and tobacco industries (e.g., meat packing) that had economies of scale were assigned the value 1. The economies of scale variable, *SCALDUM*, is expected to be positively related to *DWL* since the larger the degree of economies of scale, the larger the potential impact of economies of scale on oligopoly power as a barrier to entry.

In sum, $\mathbf{Z}_j = (ADV, R\&D, CONS, SCALDUM, MS, XS, H, M\&A)$ is the vector of exogenous variables underlying θ, η, and ϵ, to be used in assessing the determinants of welfare losses. Thus, using equation (4), $DWL = f(\mathbf{Z}_j)$. Consider a log-linear version of this function to obtain the following relationship:

$$(5)\quad \ln DWL = \gamma_0 + \gamma_1 \ln ADV + \gamma_2 \ln R\&D + \gamma_3\, SCALDUM + \gamma_4 \ln CONS + \gamma_5 \ln H + \gamma_6 \ln XS + \gamma_7 \ln MS + \gamma_8 \ln M\&A + U,$$

where ln is the natural log operator, the γs are parameters to be estimated, and U is a random disturbance. From the discussion above, all the γs except γ_7 are expected to be positive.

The observations for the dependent variable are from table 1. Other data sources included Pagoulatos and Sorenson (1986) for *R&D* and Connor et al. (1985) for *ADV*; both of these variables are expressed as a percentage of industry sales. *CONS* is constructed from input-output tables (U.S. Department of Commerce 1992). The Herfindahl-Hirschman Index and industry sales were obtained from the *1987 Census of Manufacturers* (U.S. Department of Commerce). Export and import data were obtained from a computer tape supplied by the U.S. International Trade Commission (1990). The economies of scale data were from Bhuyan and Lopez (1997).

Obtaining mergers and acquisitions data at the four-digit SIC level was the most difficult task in terms of data collection because of the paucity of *publicly available* merger data at that level of aggregation. The publication *Mergers and Acquisition* was the principal source of mergers and acquisitions data used in this study.[3] The *M&A* variable is constructed as the ratio of mergers and acquisitions values to industry sales. The parameters were estimated correcting for dependent-variable heteroskedasticity (multiplicative model) using the SHAZAM computer program.

Empirical Results

The deadweight loss estimates for each of the thirty-eight industries are presented in table 1, both in dollar terms and as percentages of 1987 sales. Oligopoly-induced allocative efficiency losses in the U.S. food and tobacco manufacturing industries were 5.03% of sales in 1987, which amounted to over $15 billion. The average welfare losses in the food industries (SIC 20) were 5.19% of sales or

Table 1. Welfare Loss Estimates for the U.S. Food and Tobacco Industries, 1987

SIC	Industry	Rank	Welfare (Deadweight) Loss (% of 1987 sales)	Welfare (Deadweight) Loss (mil. $)	1987 Sales (mil. $)
2011	Meat Packing	12	4.96	2232.95	44,991
2013	Saus. & Prep. Meats	23	1.70	282.47	16,623
2016	Poultry & Egg Proc.	6	7.94	1183.39	14,912
2022	Cheese	21	1.79	231.28	12,948
2023	Cond. & Evap. Milk	13	4.45	260.46	5,857
2024	Ice Cream	20	1.80	70.55	3,915
2026	Fluid Milk	16	2.51	517.29	20,591
2032	Canned Specialties	34	0.23	12.46	5,350
2033	Canned Fruit & Veg.	24	1.52	180.85	11,890
2034	Dried Fruit & Veg.	37	0.12	2.22	1,820
2035	Pickled, Sauces, etc.	4	10.36	523.27	5,050
2041	Flour & Grain Mill	3	26.17	540.90	2,067
2043	Cereal Breakfast Prep.	1	33.43	2191.84	6,557
2044	Rice Milling	35	0.16	2.00	1,235
2047	Pet Food	38	0.07	4.02	5,639
2048	Prepared Feeds	14	3.60	392.01	10,899
2051	Bread & Bakery	25	1.12	251.63	22,511
2061	Refined Sugar	17	2.45	135.72	5,531
2065	Candy & Confectionary	30	0.46	42.14	9,158
2066	Chocolate & Cocoa Pr.	27	0.96	28.53	2,960
2067	Chewing Gum	36	0.14	1.53	1,090
2074	Cottonseed Oil Mills	32	0.46	2.14	471
2075	Soybean Oil Mills	2	31.79	2884.58	9,074
2076	Vegetable Oil Mills	22	1.77	7.62	432
2077	Anim. & Marine Fats & Oils	19	2.12	37.31	1,763
2079	Edible Fats & Oils	15	3.20	132.80	4,151
2082	Malt Beverages	7	7.22	1021.64	14,150
2084	Wine & Brandy Sp.	28	0.66	21.09	3,179
2085	Distilled Liquor	11	5.19	176.95	3,411
2086	Soft Drinks	5	10.18	2240.49	22,006
2087	Flavor Extr. & Syrups	29	0.56	25.99	4,646
2092	Fresh or Frozen Prep. Fish	33	0.23	13.42	5,752
2095	Roasted Coffee	8	6.87	439.81	6,401
2098	Macaroni & Spaghetti	31	0.46	5.99	1,315
2111	Cigarettes	9	5.94	1032.06	17,372
2121	Cigars	10	5.51	10.56	192
2131	Chew. & Smok. Tobacco	18	2.23	24.83	1,114
2141	Tobacco Stemm. & Redry.	26	0.96	20.05	2,079
20	All Food Products	——	5.19	14,946.87	288,341
21	Tobacco Manufactrs.	——	3.66	759.71	20,752
20–21	All Food & Tobacco	——	5.03	15,1706.60	309,099

Notes: Rank = rank of *DWL*, where *DWL* = estimates of percentage welfare losses. Data at the two-digit level are simple averages of the respective sample industries.

almost $14.95 billion, while similar losses in the tobacco industries (SIC 21) amounted to over 3.6% of sales or over $759 million. In terms of their rankings, the prepared breakfast cereal industry (SIC 2043) had the highest percentage of allocative efficiency losses, while the pet food industry (SIC 2047) showed the smallest percentage loss. Previous studies with similar objectives (e.g., Willner 1989; Bhuyan and Lopez 1995) have found evidence of the same higher than average welfare losses. It is noteworthy that some of these industries (e.g., SIC 2043, SIC 2082, SIC 2095, and SIC 2111) have been the focus of antitrust investigations in the past.

The regression results for equation (5) are presented in table 2. All the coefficients of the explanatory variables were statistically significant at the 99% level. The beta coefficients[4] suggest that import penetration was the most important factor in determining allocative efficiency losses in the U.S. food and tobacco industries, followed by export intensity, advertising intensity, economies of scale, mergers and acquisitions, market concentration, R&D intensity, and finally the least important

Table 2. Determinants of Welfare Losses in the U.S. Food and Tobacco Industries (N = 38)

Dependent variable: ln *DWL*[a]

Variable	Notation	Coefficient	Expected Sign	t-Ratio	Beta Coefficient (Absolute)
Constant	1	−3.560	±	−14.81	———
Advertising intensity	ln *ADV*	0.776	+	21.56	0.338
R&D intensity	ln *R&D*	−0.051	+	−6.637	0.099
Share of consumer product	ln *CONS*	0.275	+	5.875	0.090
Economies of scale (dummy)[b]	*SCALDUM*	0.880	+	6.204	0.285
Market concentration[c]	ln $\hat{H}$	0.377	+	5.085	0.101
Import penetration	ln *MS*	−0.468	−	−21.860	0.672
Export intensity	ln *XS*	0.306	+	17.800	0.339
Mergers & acquisitions	ln *M&A*	1.067	+	5.085	0.257

NOTE: (a) The regression was corrected for multiplicative heteroskedasticity; (b) Economies of scale dummy = 1 implies an industry with scale economies according to Bhuyan and Lopez (1997); (c) the market concentration variable ($\hat{H}$) is the predicted Herfindahl-Hirschman Index as described in note 5.

factor among all—share of sales to final consumers.[5]

The empirical finding (table 2) that higher advertising intensity causes higher welfare loss is consistent with the findings of Connor and Peterson (1992) that food industry price cost margins are positively and significantly influenced by advertising. Pagoulatos and Sorenson (1986) argue that advertising facilitates oligopolistic pricing by lowering elasticity of demand and contend that advertising may lead to greater collusion. In the present context, however, welfare losses from advertising do not necessarily imply that advertising leads to collusion. An extensive literature exists on this debate, the resolution of which is beyond the scope of this paper (see Schmalensee 1986 for a discussion of this issue).

Contrary to expectations, empirical results show that research and development (R&D) has a salutary impact on welfare loss, potentially reducing welfare loss due to market power. Past studies (Imel, Behr, and Helmberger 1972; Scahill 1985) have recognized the potential dual (and conflicting) impact of R&D on competition and consequently on welfare loss. The impact of R&D on market behavior also depends on whether the research activity is devoted to product development or process innovation (Scahill 1985; Lunn 1986). Although the food and tobacco industries have very low R&D intensities relative to other industries (NSF 1989), there is ample evidence that much of the R&D expenditure is targeted at new product development (Connor et al. 1985).

Results also show that the share of sales made directly to consumer outlets (*CONS*) is positively and significantly correlated with the allocative efficiency losses. Consumers' (or wholesalers'/retailers') countervailing power is often absent because of the more frequent and lower average sales value to final household consumers, leading to potentially higher welfare losses (Gabel 1983). This study provides support for that argument.

As hypothesized, the results in table 2 show that the potential for increased welfare loss is higher in industries with economies of scale because they can create barriers to entry, hence increasing oligopoly power and consequently allocative efficiency losses. Table 2 also confirms the positive and significant impact of market concentration on allocative efficiency, consistent with the hypothesis that industrial concentration leads to oligopolistic conduct (Caves et al. 1980; Eckard 1994).

The results also confirm the disciplinary effect of imports, which has a countervailing effect on oligopoly-induced welfare losses. The export share variable shows positive and significant impact on welfare loss in the food and tobacco industries, an effect which, as Field and Pagoulatos (1996) have hypothesized, may be due to the ability of U.S. food and tobacco manufacturers to engage in international price discrimination, partly aided by tariff protections. Regarding the impact of mergers and acquisitions, empirical results suggest that food and tobacco industries with higher mergers and acquisitions intensity incur greater welfare losses. Although there is a lack of relevant studies in the literature for comparison and substantiation of this finding, the negative implications of mergers, namely, a reduction in the level of competition in a market, are pointed out by Auerbach and Reishus (1991). This finding lends support to the hypothesis that mergers and acquisitions potentially reduce competition in a market and thereby reduce social welfare.

Conclusions

This study examined the determinants of allocative efficiency losses in thirty-eight food and tobacco industries in the United States. First, oligopoly welfare losses were computed using econometrically estimated conjectural variation, product demand, and marginal cost elasticities. Second, the determinants of these losses were identified via a regression model using the computed welfare losses as a dependent variable and market structure characteristics as explanatory variables.

The empirical findings show that welfare losses are higher in industries that also have higher advertising intensities, confirming the role of differentiated products in enhancing oligopolistic pricing conduct. The impact of research and development on welfare losses was negative or salutary, perhaps showing the potential impact on cost reduction and thereby outweighing the potential deleterious barrier to entry effects. This study also confirms the negative effect of import penetration on domestic aggregate welfare, while raising the question of the impact of increased exports on domestic welfare. Welfare losses were higher in markets with economies of scale and high market concentration, possibly showing the direct and indirect effects of scale economies on market power. Welfare losses were also higher in markets dealing with finished consumer products, a reflection of the lack of countervailing power of buyers, such as supermarkets. Finally, findings indicate that welfare losses are strongly and positively determined by mergers and acquisitions intensities, confirming the undesirable impact of mergers on competition.

Several outcomes of this study may have useful policy implications. For instance, the finding on the impact of mergers and acquisitions on competition and welfare raises the issue of the need to examine merger petitions more closely from an allocative (not technical) efficiency viewpoint. Similarly, the findings on advertising further contribute to the much-debated issue of the role and impact of advertising and its relationship to market structure measurements such as concentration. Extending the current analysis to include technical efficiency considerations or formally modeling the relationships among some of the independent variables may prove a fruitful avenue for further research.

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Notes

1. There is a small but growing literature quantifying the impact of various forms of oligopoly conduct and demand/cost assumptions on the estimated welfare losses via simulation analysis (Dickson and Yu 1989; Willner 1989; Willner and Ståhl 1992; Peterson and Connor 1995; Bhuyan and Lopez 1995). These studies are different from the current study in two ways. First, those studies assess the importance of model assumptions, i.e., how would the welfare loss change if a different demand elasticity were assumed or if firms are in a Cournot or price leadership regime? In contrast, in the present analysis, the underlying model is a maintained hypothesis; therefore, the estimated welfare losses are treated as data. Second, results of previous studies should be regarded as counterfactual experiments and, thus, are not focused on explaining the "observed" welfare losses. The present study goes further than past studies by considering the determinants of observed welfare losses.

2. Express the allocative loss as a percentage of sales (DWL) as

$$DWL = \left(\frac{DWL}{P_0Q_0}\right) * 100 = [\beta + \lambda(1 - \mathcal{L}) - (1 - \mathcal{L})^{\omega} (\beta + \lambda)] * 100,$$

where $\mathcal{L}$ is the Lerner index defined in equation (1), $\beta = \eta/(1 - \eta)$, $\lambda = \epsilon/(\epsilon + 1)$, and $\omega = [\epsilon(1 - \eta)]/(\eta + \epsilon)$. Note that β, λ, and ω are introduced for simplicity of expression.

3. *Mergers and Acquisitions* is the principal source of publicly available merger information. It records merger, acquisition, and divestiture transactions involving a U.S. company valued at $1 million or more in cash, market value of capital stock, or debt securities issued. Although it reports the frequency of completed merges in a particular year, say 1985, at the two-digit SIC level (e.g., SIC 20 and 21), complete information on the value of mergers for *each transaction* is not available, nor is the aggregate value of mergers and acquisitions at the four-digit level. However, this publication provides a merger summary for high-value mergers for each year, which comprise the bulk of merger values in a particular industry. To remedy any missing data problem and to take into account the lag effect of mergers, we used aggregate merger values for the years 1985, 1986, and 1987 to construct the *M&A* variable.

Another public domain source of merger data is *Megerstat,* published by Houlihan Lokey Howard

& Zukin (www.hlhz.com). Among commercial sources, the Securities Data Company (SDC) is a well-known source (www.securitiesdata.com).

4. In order to determine which variables contribute the most to the regression, the beta coefficient takes into account the effect of a typical or "equally likely" change in the variable, using sample standard deviations as a measure of typical change. The absolute values of the beta coefficients were calculated by multiplying the estimated coefficients by the standard deviation of each regressor and dividing by the standard deviation of the dependent variable.

5. Although the dependent variable was generated via a NEIO approach, equation (5) is in the spirit of the more traditional structure-conduct paradigm. Therefore, the endogeneity of some of the variables (industrial concentration in particular) is potentially troublesome. To partially address this problem, a generalized instrumental variable approach (Harvey 1983) was used for industrial concentration. Based on the work of Martin (1979) and Mueller and Rogers (1980), the Herfindahl-Hirschman Index was predicted ($\hat{H}$) for the sample industries based on four-firm concentration, advertising intensity, minimum efficiency scale, etc. Then the predicted variable was used as an instrumental variable.