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ARE THERE ANY COURNOT INDUSTRIES?

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abstract

For 70 Japanese manufacturing industries, I test the simple Cournot hypothesis of proportionality between industry price-cost margin and Herfindahl index against the non-nested alternative that the industry price-cost margin remains constant in the face of varying Herfindahl index, as it would under a simple product differentiated Bertrand framework. I then test each of these against the alternative hybrid specification that nests both of them, and from the pairwise tests, compute likelihoods of each specification. The simple Cournot specification is the most likely for five of the industries, the simple Bertrand specification for 35, and the hybrid specification for 30.

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ARE THERE ANY COURNOT INDUSTRIES?

1. Introduction

A companion paper to this one (Flath , 2009) estimates Cobb-Douglas production functions for 70 Japanese manufacturing industries, 1961-1990, and from these estimates constructs annual time series for industry price-cost margins. Here, I explore the temporal relation between these price-cost margins and the annual time series of Herfindahl index of concentration in each industry. Under the simple homogenous product Cournot model, industry price-cost margin is proportionate to Herfindahl, and the constant of proportionality is the reciprocal of elasticity of demand facing the industry. If, on the other hand, each industry comprises a collection of price-setting and product differentiated firms –i.e is monopolistically competitive, or equivalently, in a Bertrand pricing equilibrium– then the industry price-cost margin is a weighted average of the reciprocal demand elasticities facing each firm. A non-nested test based on Vuong (1989), comparing these two specifications for each of the 70 industries, at the ten percent significance level, favors the homogeneous product Cournot specification for ten industries and the product differentiated Bertrand specification for 44 of industries. Further comparisons of each of these specifications with the hybrid specification that nests both of them lead to the conclusion that the simple Cournot specification is the most likely for five of the industries, the simple Bertrand specification is the most likely for 35 of them, and the hybrid specification is the most likely for 30.

An earlier study of price-cost margins in Japanese manufacturing industries was performed by Ariga, Ohkusa and Nishimura (1999). Their study focused on manufacturing firms rather than industries and demonstrated a positive but weak association between price cost margins and market shares, which is broadly consistent with my findings.

2. Price-cost margins

The price-cost margins from the companion paper to this one (Flath, 2009) are constructed from estimates of Cobb-Douglas production functions for 70 industries at the four-digit s.i.c. level. For each industry, annual observations of output are constructed by deflating value of shipments by the annual average wholesale price index for the corresponding product. The required matching of industries from the Census of Manufacturers (Ministry of International

Trade and Industry, serial; and METI, url) with the product categories of the Wholesale Price Index (Bank of Japan, serial) limits the sample to a relatively small set of industries, but ones for which the output measure is accurate. The appendix describes the data sources in more detail.

In Flath (2009) I estimated an equation on the pooled annual time-series, cross-section of 70 industries at the four-digit s.i.c. level, 1961-1990. The regression equation is the following:

$$(1) \qquad \ln Q_{it} = A_i + \theta_i \ln L_{it} + (1-\theta_i)\ln e^{At}K_{it} + v_{it}\,, \qquad i=1\ldots, n;\ t= 1,\ldots,T.$$

where the error term follows a first-order autoregressive (AR1) process:

$$(2) \qquad v_{it} = \rho_i\, v_{i,t-1} + u_{it}\,, \qquad \text{and } u_{it} \sim (0, \sigma_i^2).$$

Here Q_{it} represents value of shipments by industry i in year t divided by average monthly wholesale price index for the corresponding product during the same year. The labor input is L_{it}, defined as the number of workers employed in the industry i in year t. And K_{it} is the book value of the fixed tangible assets of the industry i at the beginning of year t. This specification imposes constant returns to scale and allows for implicit deflation of book value of capital stock. Essentially, this means that the deflated capital stock series $e^{At}K_{it}$ is measured in pan-industry efficiency units. Any economy-wide technological advances or improvements in labor quality are reflected in the deflator e^{At}, leaving only industry-specific technological advances to the residual error term v_{it}.

From the estimates of these Cobb-Douglas production functions for each industry I constructed time series for the price-cost margins of each industry. For details, refer to the paper (Flath, 2009). In brief, the method of construction follows the logic of Hall (1988). The labor coefficients from the Cobb-Douglas production functions measure labor's share in total cost for each industry. Price-cost margins are computed as the percentage by which value added minus total cost exceeds value of shipments (where total cost is the wage bill divided by the Cobb-Douglas labor coefficient). After dropping from the sample the four industries for which average price-cost margin was negative, the remaining average price-cost margins range from Glass Bulbs for Use in Cathode Ray Tubes at 1.2 percent to Sheet Glass at 45.4 percent. The average price-cost margin across the 70 industries is 12.56 percent, with standard deviation 8.53%.

The sample industries vary in concentration. The average Herfindahl indices range from Sake at 0.005 to Pianos at 0.460. The average Herfindahl index across the 70 industries is 0.155 with standard deviation 0.124.

The object of the current paper is to consider how the annual time series for industry price-cost margins interact with Herfindahl indices of industrial concentration. The question I address is for which, if any, of the industries do price-cost margin and Herfindahl index move together as the homogenous product Cournot model predicts?

3. Herfindahl indices and price-cost margins

The Cournot model of a homogenous product oligopoly implies a precise relation between industry-level price-cost margin and Herfindahl index of concentration defined on shares of output. Specifically, the industry price-cost margin equals the Herfindahl index divided by elasticity of market demand. This has been well-known for many years. See for example Cowling and Waterson (1976), or Tirole (1988), pp. 222-3. Let us call this relationship between price-cost margin and Herfindal index "Model 1–Cournot". The relationship follows directly from the fact that the price-cost margin of firm f in homogenous-product Cournot industry equilibrium equals its market share divided by the elasticity of market demand:

$$(3) \qquad \frac{(p_f - c_f)}{p_f} = \frac{s_f}{\xi} \; .$$

Here, p_f is the firm's price, c_f its marginal cost and s_f its market share (that is share of industry sales revenue $s_f = p_f q_f / \Sigma p_f q_f$). The industry price-cost margin m is, in general, a weighted average of the firms' price-cost margins, with weights equal to market shares:

$$(4) \qquad m = \sum \frac{(p_f - c_f) q_f}{\Sigma p_f q_f} = \sum \frac{(p_f - c_f)}{p_f} \frac{p_f q_f}{\Sigma p_f q_f} = \sum \frac{(p_f - c_f)}{p_f} s_f \; .$$

So in the homogeneous-product Cournot equilibrium, industry price-cost margin equals the summation of squared market shares, or Herfindahl index, divided by elasticity of market demand:

$$(5) \qquad m = \sum \frac{s_f^2}{\xi} = \frac{H}{\xi} \; .$$

I observe Herfindahl indices H_{it} annually for each of the 70 industries, drawn from the Japan Fair Trade Commission data archives (JFTC ,1974, 1975;JFTC url; Senou ,1983). For each industry i, I regress these on the price-cost margin series m_{it} as described by:

(6) **Model 1–Cournot**: $m_t = \boldsymbol{\beta_1} H_t + e1_t$, $t=1,\dots, T$

where $e1_t$ is a stochastic error term. In accordance with the theory I impose a zero intercept.

An alternative formulation (call it "Model 2–Bertrand") is that each firm is in effect an independent monopoly, and the industry price-cost margin is simply a weighted average of the reciprocal demand elasticities facing each firm, the weights corresponding to market shares. If the demand elasticities facing each firm are similar to one another, then the industry price-cost margin is the reciprocal of that demand elasticity and this remains true even as the market shares of firms vary in response to innovation and changing input prices. Under this framework, for each industry i, we have:

(7) **Model 2–Bertrand**: $m_t = \boldsymbol{\beta_0} + e2_t$, $t=1,\dots, T.$

Yet a third specification nests the two previous ones:

(8) **Model 3–Hybrid**: $m_t = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} H_t + e3_t$, $t=1,\dots, T.$

It is possible to construct an example that supports the Hybrid specification. Suppose that firms in an industry are selling both to loyal customers who either buy from their one favorite firm or not at all, and to less loyal customers who only buy from the firm with the lowest price. Each firm may have its own loyal customers. If the firms are price discriminating, charging higher prices to loyal customers, while acting as Cournot oligopolists in selling to the price conscious customers, it can lead to Model 3. It is a kind of hybrid of Bertrand and Cournot. In particular, if the fraction λ of each firm's own sales that are to loyal customers is the same fraction for all the firms, and the firms are price discriminating as just suggested, then the price-cost margin of firm f is

(9) $$\frac{\lambda}{\xi_\ell} + \frac{(1-\lambda)s_f}{\xi} ,$$

where ξ_ℓ is the demand elasticity of the loyal customers and ξ is the market demand elasticity in the Cournot segment. The industry price-cost margin is

$$(10) \qquad m = \frac{\lambda}{\xi_\ell} + \frac{(1-\lambda)H}{\xi} \; .$$

This is one motivation for the Model 3.

For each of the 70 industries in the sample, I next construct specification tests for pairwise comparisons among the models, and from these statistics construct an overall likelihood for each specification for each industry.

4. Specification Tests

4.1. *Nonnested alternatives: 1–Cournot versus 2–Bertrand*

I estimated both the 1–Cournot and 2–Bertrand regressions for each industry using maximum likelihood, here equivalent to OLS, and also computed the value of log likelihood function for each. (Note that log likelihood = -n/2 ln(2πSSE/n) -n/2). These results are represented in Appendix Table A1. The two alternative specifications here are non-nested. Accordingly I draw on the work of Vuong (1989) who proposed a likelihood ratio test statistic for model selection among non-nested alternatives. The Vuong statistic is a normalization of the likelihood ratio that is asymptotically distributed as a standard normal variate under reasonable conditions. Specifically, denote the value of the log likelihood for a single observation by

$$(11) \qquad L_i = -\frac{n}{2} \ln\left(\frac{2\pi SSE}{n}\right) - \frac{n e_i^2}{2SSE} \; .$$

The value of log likelihood function for a regression specification is the sum of L_i over all observations i. The Vuong statistic for comparing two alternative non-nested specifications (1–Cournot and 2–Bertrand) is with obvious notation defined as follows.

$$(12) \qquad \text{Vuong statistic} = \frac{L1 - L2}{\sum(L1_i - L2_i)^2/n} - \sum(L1_i - L2_i)/n\,)^2\,)^{1/2} \; .$$

These Vuong statistics and log likelihoods of the alternate specifications are reported in Appendix Table A2. In only 19 of the industries did the likelihood function favor Cournot over Bertrand. In only ten of these did the data clearly distinguish between the two specifications (i.e. at the ten percent significance level), based on the Vuong statistic. The ten industries are:

BICYCLES
JUTE YARN
MANMADE-GRAPHITE ELECTRODES
ORDINARY STEEL PIPES AND TUBES
RECORDS
STORAGE BATTERIES
SUGAR
SYNTHETIC RUBBER
THERMOS BOTTLES
WHEAT FLOUR

There were far more industries, 44 in all, in which the likelihood ratio strongly favored the Bertrand specification over the Cournot one (again, at the ten percent significance level). That leaves 16 industries for which the Vuong test fails to distinguish between the 1–Cournot and 2–Bertrand specifications, at the ten percent significance level.

4.2. *Nested alternatives: 3–Hybrid versus 1–Cournot, or 2–Bertrand*

The 3–Hybrid specification nests 1–Cournot and 2–Bertrand. Specification tests between Hybrid and Cournot, and between Hybrid and Bertrand, are based on the t-statistics for the intercept and slope coefficients in linear regression of price-cost margin on Herfindahl index (the Hybrid specification). These estimates are reported in Appendix Table A3. The statistical test between the Cournot and Hybrid specification is the p-value for the null hypothesis that the intercept in the Hybrid specification is greater than zero. This p-value is the area under the t-distribution, to the right of the t-statistic, for estimated intercept in the Hybrid specification. It represents the likelihood that the intercept is positive and so the Hybrid specification is superior to the Cournot specification in which the intercept is zero.

Similarly, the statistical test between the Bertrand and Hybrid specification is the p-value for the null hypothesis that the slope in the Hybrid specification is greater than zero. This p-value represents the likelihood that the slope is positive and so the Hybrid specification is superior to the Bertrand specification in which the slope is zero.

The results are these. At the ten percent significance level, the Cournot specification was better than Hybrid for only one of the industries CAST IRON PIPES AND TUBES. One other industry RECORDS just missed at the ten percent significance level. For 38 of the industries, the Hybrid specification was better than Cournot, at the ten percent significance level. For 17 of the industries, the Bertrand specification is better than the Hybrid at the ten percent significance level, and for 15 of the industries the Hybrid specification is better.

4.3 *Likelihoods of each of the three specifications*

From the three pairwise tests among the different specifications, I now construct likelihoods of each specification, using Bayes' rule. Here I make the natural assumption that the likelihood of Cournot versus Hybrid is uninformative regarding the likelihood of Cournot versus Bertrand. And the likelihood of Bertrand versus Hybrid is uninformative regarding the likelihood of Cournot versus Bertrand. Then the likelihood of the Cournot specification is its likelihood versus Bertrand, times its likelihood versus Hybrid. Similarly, the likelihood of the Bertrand specification is its likelihood versus Cournot, times its likelihood versus Hybrid. The likelihood of the Hybrid specification equals one minus the likelihoods of Cournot and Bertrand.

Here is the reasoning. Models "1", "2" and "3" are mutually exclusive. Denote the probability that model 1 is the true one by P(1). Let A=not 1, B=not 2 and C=not 3. Denote by P(C|B)=P(1|B) the conditional probability of C, given B. Thus, P(B|C) is the likelihood of Model 1 versus Model 2 based on the Vuong test, and P(C|B) is the likelihood of Model 1 versus Model 3 based on the t-test that the intercept is positive in the Model 3 specification. P(B|1) = 1, by definition. Bayes' rule is

(13) $P(C|B) = P(B|C)\,P(C) / P(B)$,

or

(14) $P(1|B) = P(B|1)\,P(1) / P(B) = P(1) / P(B)$.

Thus

(15) $P(C|B) = P(1|B) = P(1) / P(B)$.

I assume that P(C|B) is uninformative regarding P(B|C), meaning that

(16) $P(B|C) = P(B)$,

or, in words, the posterior probability of B conditional on C, equals the prior probability of B. But then, from equation (15), we have that

(17) $P(B|C)\,P(C|B) = P(1)$.

By similar logic, I assume that

(18) $P(A|C) = P(A)$

and deduce that

(19) $P(A|C)\,P(C|A) = P(2)$.

The likelihoods of each model, computed in the way just described, are reported in Table 1. 1–Cournot is the most likely for five of the industries, 2–Bertrand is the most likely for 35 of the industries, and the 3–Hybrid specification is the most likely for 30 of the industries. The five for which Cournot is the most likely are:

CAST IRON PIPES AND TUBES

JUTE YARN

RECORDS

SUGAR

THERMOS BOTTLES.

If we consider only the 18 industries for which the likelihood of one specification was at least 90 percent, then there were 11 for which Bertrand was preferred, seven for which Hybrid was preferred, and none for which Cournot was preferred. RECORDS just misses with 89 percent likelihood of Cournot. A summary of the results for all the specification is in Table 2.

Some statistics describing the five industries for which the simple Cournot specification was the most likely are shown in Table 3. And comparable statistics for the eleven industries with likelihood of Bertrand specification greater than 90 percent and the seven with likelihood of Hybrid specification greater than 90 percent are in Table 4 and Table 5. The statistics in these tables include reciprocals of estimated coefficients for preferred specifications, average Herfindahl index, average price-cost margin, and elasticity of output with respect to labor from the estimated Cobb-Douglas production functions. None of the differences in average among the Cournot, Bertrand and Hybrid groups, for Herfindahl, price-cost margin and labor elasticity, are statistically significant, based on a t-test. The reciprocals of estimated coefficients for the Cournot and Bertrand specifications represent implied elasticities of market demand. This elasticity of demand ranges from 0.4 to 3.0 for the five putative Cournot industries and from 2.2 to 50.0 for the eleven Bertrand industries. The Bertrand industries generally face more elastic demand than the Cournot industries. The reciprocals of intercept and slope for the Hybrid industries represent weighted elasticities of demand, the weights being the reciprocals of fraction of sales to loyal customers and others. Because we cannot infer these weights the estimates are not easy to characterize.

5.Conclusion

The homogenous product Cournot model is a good starting point for thinking about many topics in industrial organization. The reasons are many. The model is simple yet elegant, in that it represents the unique Nash solution to a well-defined game. It can be manipulated easily and comports with common sense notions of the way prices, profits and market shares might respond to mergers, technological advance, entry, and exit. But as industrial organization specialists turn toward econometric analysis, the simple Cournot model is a lot less useful. For example, the Berry, Levinson, and Pakes (BLP) approach to intra-industry demand estimation presumes Bertrand pricing. With the wide application of the BLP technique over the last few years, the presumption seems to have settled in that the typical industry actually is best regarded as one in which price-setting firms face differentiated demand. The simple, homogenous product Cournot model, so useful for algebraic explorations, is not in fact empirically apt. Or is it? If the simple Cournot model did represent an actual industry very well, how would we know that? And how rare are such industries? In fact, are there any such industries? This paper has taken a modest step toward answering these questions. And the answer is that homogenous product Cournot industries may exist but are rare.

This paper explored a panel data set matching establishment-based production statistics from Japan's *Census of Manufacturers* with wholesale price indices from the Bank of Japan, and Herfindahl indices from the Japan Fair Trade Commission. The data include annual observations over the period 1961-1978 for 70 industries at the four-digit s.i.c. level. I estimated Cobb-Douglas production functions and used these to construct annual time series for price-cost margins in each industry.

Industry price-cost margins in only 7 percent of the industries varied with temporal changes in Herfindahl index as the simple Cournot model would predict. Far more of the industries, 50 percent of them, exhibited stable price-cost margins as industrial concentration fluctuated, as the product differentiated Bertrand model might predict. The remaining industries were a hybrid of Cournot and Bertrand. From this sample, the modal Japanese manufacturing industry is a product differentiated Bertrand industry in which the seven or so major firms each face a demand with elasticity of ten or greater.

Appendix. Data Sources

I have constructed a panel data set by merging 1961-1990 calender year observations from three different sources for the intersecting subset of four-digit s.i.c. industries, of which there were 70.

From Japan's *Census of Manufacturers – Report by Industries*, listed in the references under the author MITI, we draw value-added, value of shipments, employment, wages, and book value of fixed tangible assets. The book value of tangible assets is observed for establishments employing ten or more. All other items are for establishments employing four or more. The book value of tangible assets is observed at the beginning of the calender year. These data and continuation of like data through 2002, are available for downloading from the website of the Ministry of Economy, Trade and Industry (METI) here:
http://www.meti.go.jp/statistics/kougyou/arc/index.html

From two published sources and a website we compile observations of Herfindahl index of industrial concentration of production. The two published sources are JFTC (1975) and Senou (1983). These data are collected by the Japan Fair Trade Commission in fulfillment of its charge under the antimonopoly law . The two sources comprise overlapping time-series, respectively: (1960-1972) and (1971-1980). The series are continued (1975-2002) in data posted on the website of the Japan Fair Trade Commission from which I was able to extend my data through 1990:
http://www.jftc.go.jp/ruiseki/ruisekidate.htm,
The FTC observations on Herfindahl indices, both from the published sources and the web site, represent the summation of squared shares of industry production for nearly 500 industries. These data are, in principle, shares of physical units produced, not shares of revenues. But apparently for many of the industries a production index is used in lieu of physical units.

Finally I collect the monthly observations of wholesale price index series for each commodity, from the Bank of Japan for 1962-1990. Monthly data from 1985 on are available in electronic format from the website of the BOJ here:
http://www.boj.or.jp/en/type/stat/dlong/index.htm
Earlier data were drawn from the BOJ serial *Price Indices Annual*. From these sources I converted linked series to common 1980 base year units and calculated calender year averages for each.

The three sets of data correspond to imperfectly matched industries. I was able to identify an overlapping subset of 74 industries with observations from all three sources (corresponding to the four-digit s.i.c. level in the *Census of Manufacturers*). In the current study I dropped the four of these for which average price-cost margin was negative, leaving 70 industries in all. This is a relatively small subset of any of the three sources. For example there are about 450 industries for which the JFTC reports Herfindahl indices and more than a thousand commodities for which the BOJ tracks wholesale price indices. And Japan's *Census of Manufacturers* identifies around 700 four-digit s.i.c. industries.

Appendix Table A1. Regression analysis of average industry price-cost margin: Cournot versus Bertrand

Model 1–Cournot: $m_t = \boldsymbol{\beta_1} H_t + e1_t$, $t=1,\ldots, T$

Model 2–Bertrand: $m_t = \boldsymbol{\beta_0} + e2_t$, $t=1,\ldots, T$.

	Model 1–Cournot						Model 2–Bertrand				
INDUSTRY	error DF	β_1	S.E.	t value	prob >|t|	R^2	β_0	S.E.	t value	prob >|t|	R^2
ALUMINUM WINDOW SASHES	23	0.40	0.05	7.9	0.00	0.73	0.07	0.01	10.5	0.00	0.83
BEARINGS	29	0.10	0.08	1.3	0.21	0.05	0.02	0.02	1.5	0.14	0.07
BEER	29	0.15	0.02	9.3	0.00	0.75	0.06	0.01	9.6	0.00	0.76
BICYCLES	23	1.75	0.11	15.5	0.00	0.91	0.11	0.01	14.9	0.00	0.91
BOILERS	23	0.16	0.07	2.2	0.04	0.18	0.04	0.02	2.2	0.04	0.18
BRIQUETTES	13	1.81	0.13	13.8	0.00	0.94	0.15	0.01	20.6	0.00	0.97
CALCIUM CARBIDE	19	0.30	0.06	5.1	0.00	0.58	0.10	0.01	7.4	0.00	0.74
CANNED SEAFOOD	23	1.26	0.12	10.8	0.00	0.84	0.09	0.00	21.8	0.00	0.95
CAST IRON PIPES AND TUBES	13	0.70	0.03	23.0	0.00	0.98	0.27	0.01	18.5	0.00	0.96
CAUSTIC SODA	29	3.75	0.25	14.8	0.00	0.88	0.18	0.01	15.4	0.00	0.89
CELLOPHANE	13	0.28	0.05	5.3	0.00	0.68	0.06	0.01	5.1	0.00	0.67
CEMENT	29	3.19	0.15	21.6	0.00	0.94	0.28	0.01	23.4	0.00	0.95
CHARGING GENERATORS	19	0.09	0.02	3.7	0.00	0.42	0.03	0.01	3.9	0.00	0.44
CHEMICAL SEASONING	13	0.26	0.08	3.0	0.01	0.42	0.09	0.03	3.2	0.01	0.44
COKE	23	0.23	0.05	4.9	0.00	0.51	0.04	0.01	5.5	0.00	0.57
COLD-ROLLED STEEL PLATE	29	0.29	0.04	7.8	0.00	0.68	0.06	0.01	9.9	0.00	0.77
COMBED FABRICS	19	10.05	0.85	11.9	0.00	0.88	0.13	0.00	27.3	0.00	0.98
COTTON FABRICS	29	12.06	0.79	15.2	0.00	0.89	0.08	0.00	16.5	0.00	0.90
COTTON YARN	29	0.93	0.27	3.4	0.00	0.28	0.03	0.01	3.3	0.00	0.28
DISSOLVING PULP	19	0.25	0.08	3.2	0.00	0.36	0.09	0.02	3.9	0.00	0.45
EIGHTEEN LITER CANS	23	3.82	0.15	25.3	0.00	0.97	0.16	0.01	29.7	0.00	0.97
ELECTRICAL COPPER	29	0.49	0.06	8.0	0.00	0.69	0.09	0.01	8.0	0.00	0.69
ELECTRICAL WIRES AND CABLES	19	0.81	0.09	8.8	0.00	0.80	0.06	0.01	8.9	0.00	0.80
FIREPROOF BROOKS	19	1.85	0.19	9.8	0.00	0.84	0.09	0.01	10.1	0.00	0.84
FISHING NETS	23	1.81	0.21	8.5	0.00	0.76	0.10	0.01	13.4	0.00	0.89
FISHMEAT SAUSAGE	13	0.40	0.08	5.1	0.00	0.67	0.06	0.01	6.4	0.00	0.76

INDUSTRY	error DF	Model 1–Cournot β_1	S.E.	t value	prob >|t|	R^2	Model 2–Bertrand β_0	S.E.	t value	prob >|t|	R^2
GALVANIZED	29	0.34	0.09	4.0	0.00	0.35	0.06	0.01	4.5	0.00	0.41
GLASS BULBS FOR USE IN CATHODE RAY TUBES	13	0.01	0.08	0.1	0.92	0.00	0.01	0.04	0.3	0.74	0.01
GLASS CONTAINERS FOR BEVERAGES	23	1.11	0.08	14.8	0.00	0.90	0.19	0.01	15.4	0.00	0.91
GRINDING STONES	27	1.99	0.16	12.6	0.00	0.85	0.14	0.01	15.5	0.00	0.90
HAM SAUSAGE	19	1.18	0.08	15.7	0.00	0.93	0.09	0.00	28.4	0.00	0.98
JUTE YARN	9	0.33	0.05	6.3	0.00	0.81	0.13	0.03	4.9	0.00	0.73
MANMADE-GRAPHITE ELECTRODES	23	1.20	0.08	14.9	0.00	0.91	0.22	0.02	14.2	0.00	0.90
MEDICINES	27	10.85	0.80	13.6	0.00	0.87	0.30	0.01	38.5	0.00	0.98
MEN'S SHOES	9	3.45	0.29	12.0	0.00	0.94	0.13	0.01	19.0	0.00	0.98
MISO	23	14.89	0.57	26.1	0.00	0.97	0.27	0.01	48.3	0.00	0.99
MIXED FEED	19	0.50	0.08	6.6	0.00	0.69	0.08	0.00	28.9	0.00	0.98
ORDINARY STEEL PIPES AND TUBES	29	0.83	0.08	11.1	0.00	0.81	0.11	0.01	10.8	0.00	0.80
PAINTS	23	3.56	0.18	19.5	0.00	0.94	0.21	0.01	24.7	0.00	0.96
PAPER PULP	29	1.57	0.16	10.1	0.00	0.78	0.11	0.01	9.9	0.00	0.77
PETROLEUM PRODUCTS	29	1.29	0.07	18.2	0.00	0.92	0.09	0.00	19.5	0.00	0.93
PIANOS	27	0.15	0.04	3.6	0.00	0.33	0.07	0.02	3.8	0.00	0.35
POWER TILLERS	19	1.01	0.05	19.9	0.00	0.95	0.15	0.01	22.1	0.00	0.96
PRINTING INK	29	0.53	0.04	12.8	0.00	0.85	0.08	0.00	16.3	0.00	0.90
PRINTING MACHINES	13	1.07	0.11	9.3	0.00	0.87	0.13	0.01	12.4	0.00	0.92
PUMPS	23	0.15	0.14	1.0	0.31	0.04	0.02	0.01	1.4	0.16	0.08
RAW SILK	19	1.73	0.17	10.0	0.00	0.84	0.05	0.01	10.0	0.00	0.84
RECORDS	9	2.57	0.23	11.0	0.00	0.93	0.26	0.03	8.3	0.00	0.88
RECTIFIERS	13	0.29	0.15	1.9	0.07	0.22	0.04	0.02	2.3	0.04	0.29
ROLLED AND WIRE-DRAWN COPPER PRODUCTS	19	0.88	0.22	3.9	0.00	0.45	0.04	0.01	4.0	0.00	0.46
SAKE	29	34.90	1.92	18.2	0.00	0.92	0.20	0.00	52.5	0.00	0.99
SANITARY WARE	23	0.14	0.06	2.3	0.03	0.19	0.08	0.02	3.3	0.00	0.32
SHEET GLASS	29	1.16	0.04	28.6	0.00	0.97	0.45	0.01	38.4	0.00	0.98
SOY	29	2.99	0.13	23.0	0.00	0.95	0.23	0.00	48.8	0.00	0.99

INDUSTRY	error DF	Model 1–Cournot β_1	S.E.	t value	prob >|t|	R^2	Model 2–Bertrand β_0	S.E.	t value	prob >|t|	R^2
SPINNING MACHINES	13	0.01	0.07	0.1	0.92	0.00	0.02	0.02	0.8	0.42	0.05
STORAGE BATTERIES	29	0.73	0.03	22.1	0.00	0.94	0.16	0.01	20.4	0.00	0.93
SUGAR	19	1.23	0.13	9.3	0.00	0.82	0.08	0.01	8.8	0.00	0.80
SYNTHETIC FIBERS	12	1.85	0.18	10.4	0.00	0.90	0.26	0.02	10.8	0.00	0.91
SYNTHETIC RUBBER	13	1.43	0.08	19.1	0.00	0.97	0.34	0.02	18.2	0.00	0.96
THERMOS BOTTLES	19	0.61	0.09	6.9	0.00	0.72	0.15	0.02	6.6	0.00	0.69
TILE	23	1.58	0.13	11.9	0.00	0.86	0.17	0.01	14.0	0.00	0.89
TIRES AND TUBES FOR MOTOR VEHICLES	29	0.50	0.04	11.6	0.00	0.82	0.15	0.01	12.5	0.00	0.84
TRACTORS	19	0.46	0.05	9.5	0.00	0.83	0.14	0.01	10.8	0.00	0.86
VALVE COCKS	9	4.24	0.29	14.6	0.00	0.96	0.16	0.01	19.3	0.00	0.98
VEGETABLE OIL	13	1.49	0.27	5.5	0.00	0.70	0.15	0.02	6.4	0.00	0.76
VINYL CHLORIDE RESIN	13	1.28	0.15	8.4	0.00	0.85	0.08	0.01	10.2	0.00	0.89
WEAVING MACHINES	19	1.31	0.27	4.9	0.00	0.56	0.20	0.03	6.2	0.00	0.67
WHEAT FLOUR	29	0.99	0.03	29.8	0.00	0.97	0.15	0.00	29.2	0.00	0.97
WORSTED YARN	29	2.16	0.19	11.5	0.00	0.82	0.08	0.01	13.2	0.00	0.86
ZINC	23	0.30	0.07	4.2	0.00	0.43	0.05	0.01	4.1	0.00	0.42
mean		2.26	0.18	10.86		0.71	0.13	0.01	14.27		0.75
s.d.		4.82	0.27	7.13		0.27	0.09	0.01	11.65		0.27

Appendix Table A2. Vuong Statistic for Test between Model 1–Cournot and Model 2–Bertrand

Model 1–Cournot: $m_t = \boldsymbol{\beta_1} H_t + e1_t$, t=1,..., T

Model 2–Bertrand: $m_t = \boldsymbol{\beta_0} + e2_t$, t=1,..., T.

INDUSTRY	log Likelihood Model 1–Cournot	log Likelihood-Model 2–Bertrand	Likelihood ratio:Cour vs Bert	s.d.likeli-hood ratio for indvidual obs.	Vuong	Norm dist	n	favored model	implied elasticity-Cournot	implied elasticity-Bertrand
WHEAT FLOUR	66.6	66.1	0.6	0.0	7003.0	1.00	30	Cournot	1.0	6.9
STORAGE BATTERIES	54.3	52.0	2.3	0.0	1555.0	1.00	30	Cournot	1.4	6.2
JUTE YARN	13.2	11.3	1.9	0.0	1297.0	1.00	10	Cournot	3.0	7.8
RECORDS	12.2	9.6	2.5	0.0	956.8	1.00	10	Cournot	0.4	3.9
ORDINARY STEEL PIPES AND TUBES	46.0	45.3	0.7	0.0	469.7	1.00	30	Cournot	1.2	9.4
SYNTHETIC RUBBER	18.5	17.9	0.6	0.0	174.8	1.00	14	Cournot	0.7	2.9
MANMADE-GRAPHITE ELECTRODES	29.5	28.5	1.0	0.0	162.2	1.00	24	Cournot	0.8	4.6
THERMOS BOTTLES	18.5	17.7	0.8	0.0	116.3	1.00	20	Cournot	1.6	6.6
SUGAR	37.3	36.4	0.9	0.3	2.9	1.00	20	Cournot	0.8	12.7
BICYCLES	47.3	46.4	0.8	0.3	2.5	0.99	24	Cournot	0.6	9.2
CELLOPHANE	24.4	24.2	0.2	0.3	0.7	0.76	14	Cournot?	3.5	16.3
CAST IRON PIPES AND TUBES	24.4	21.5	3.0	4.7	0.6	0.74	14	Cournot?	1.4	3.7
SPEED CHANGERS	37.2	35.1	2.1	4.8	0.4	0.67	24	Cournot?	-2.0	-32.6
ELECTRICAL COPPER	42.3	42.0	0.2	0.7	0.3	0.63	30	Cournot?	2.1	11.4
COTTON YARN	46.9	46.7	0.1	0.4	0.3	0.63	30	Cournot?	1.1	31.7
PAPER PULP	42.9	42.6	0.3	1.0	0.3	0.63	30	Cournot?	0.6	9.3
RAW SILK	47.2	47.2	0.0	0.1	0.2	0.59	20	Cournot?	0.6	19.1

INDUSTRY	log Likelihood Model 1– Cournot	log Likelihood- Model 2– Bertrand	Likelihood ratio:Cour vs Bert	s.d.likeli-hood ratio for indvidual obs.	Vuong	Norm dist	n	favored model	implied elasticity- Cournot	implied elasticity- Bertrand
BOILERS	22.4	22.4	0.0	0.2	0.2	0.59	24	Cournot?	6.4	22.7
ZINC	32.7	32.5	0.2	1.2	0.2	0.56	24	Cournot?	3.3	18.7
GLASS BULBS FOR USE IN CATHODE RAY TUBES	8.4	8.5	-0.1	0.3	-0.2	0.43	14	Bertrand?	119.5	81.3
SANITARY WARE	15.6	17.6	-2.0	5.7	-0.4	0.36	24	Bertrand?	7.3	12.6
ELECTRICAL WIRES AND CABLES	41.0	41.0	0.0	0.1	-0.4	0.36	20	Bertrand?	1.2	15.8
BEARINGS	30.5	30.8	-0.3	0.9	-0.4	0.36	30	Bertrand?	10.0	40.7
SPINNING MACHINES	17.8	18.1	-0.4	0.6	-0.6	0.28	14	Bertrand?	127.1	65.1
MEN'S SHOES	19.9	24.3	-4.4	7.0	-0.6	0.26	10	Bertrand?	0.3	7.4
CHARGING GENERATORS	40.2	40.5	-0.3	0.5	-0.7	0.25	20	Bertrand?	11.6	35.2
FISHMEAT SAUSAGE	24.7	26.9	-2.2	1.8	-1.2	0.11	14	Bertrand?	2.5	16.0
PIANOS	24.5	24.9	-0.4	0.3	-1.3	0.10	28	Bertrand	6.6	13.8
BRIQUETTES	25.8	31.1	-5.3	1.4	-3.9	0.00	14	Bertrand	0.6	6.7
TILE	30.8	34.1	-3.4	0.8	-4.0	0.00	24	Bertrand	0.6	5.9
DISSOLVING PULP	17.0	18.5	-1.5	0.4	-4.2	0.00	20	Bertrand	3.9	11.6
POWER TILLERS	39.8	41.8	-2.0	0.5	-4.3	0.00	20	Bertrand	1.0	6.6
PAINTS	37.9	43.4	-5.4	1.2	-4.4	0.00	24	Bertrand	0.3	4.9
PETROLEUM PRODUCTS	67.8	69.6	-1.9	0.4	-4.7	0.00	30	Bertrand	0.8	11.6
WORSTED YARN	55.2	58.7	-3.5	0.7	-4.8	0.00	30	Bertrand	0.5	12.0
PRINTING MACHINES	22.6	26.2	-3.7	0.7	-4.9	0.00	14	Bertrand	0.9	7.8
MEDICINES	22.5	50.0	-27.4	5.3	-5.2	0.00	28	Bertrand	0.1	3.3
GRINDING STONES	40.5	45.6	-5.1	0.8	-6.5	0.00	28	Bertrand	0.5	7.1
COMBED FABRICS	33.9	49.6	-15.7	2.3	-6.8	0.00	20	Bertrand	0.1	7.9
TIRES AND TUBES FOR MOTOR VEHICLES	38.4	40.3	-1.9	0.3	-6.9	0.00	30	Bertrand	2.0	6.8
SHEET GLASS	31.4	40.1	-8.6	1.2	-7.2	0.00	30	Bertrand	0.9	2.2
ALUMINUM WINDOW SASHES	43.2	48.6	-5.4	0.7	-7.4	0.00	24	Bertrand	2.5	14.3

INDUSTRY	**log Likelihood Model 1– Cournot**	**log Likelihood- Model 2– Bertrand**	**Likelihood ratio:Cour vs Bert**	**s.d.likeli-hood ratio for indvidual obs.**	**Vuong**	**Norm dist**	**n**	**favored model**	**implied elasticity- Cournot**	**implied elasticity- Bertrand**
COLD-ROLLED STEEL PLATE	56.5	61.6	-5.1	0.6	-7.9	0.00	30	Bertrand	3.4	17.5
HAM SAUSAGE	46.7	58.1	-11.4	1.4	-8.3	0.00	20	Bertrand	0.8	11.6
SOY	45.4	67.4	-22.0	2.4	-9.2	0.00	30	Bertrand	0.3	4.3
BEER	57.7	58.5	-0.8	0.1	-9.4	0.00	30	Bertrand	6.5	16.3
MIXED FEED	33.6	59.8	-26.2	2.6	-10.2	0.00	20	Bertrand	2.0	12.4
WEAVING MACHINES	8.4	11.3	-2.8	0.1	-19.6	0	20	Bertrand	0.8	5.1
CHEMICAL SEASONING	11.3	11.6	-0.3	0.0	-23.8	0.00	14	Bertrand	3.9	10.7
TRACTORS	26.8	28.9	-2.1	0.0	-43.7	0.00	20	Bertrand	2.2	7.1
SYNTHETIC FIBERS	13.3	13.7	-0.4	0.0	-67.8	0.00	13	Bertrand	0.5	3.8
VEGETABLE OIL	13.0	14.5	-1.5	0.0	-164.1	0.00	14	Bertrand	0.7	6.6
CEMENT	37.8	40.2	-2.4	0.0	-280.6	0.00	30	Bertrand	0.3	3.6
GALVANIZED	37.0	38.3	-1.3	0.0	-323.4	0.00	30	Bertrand	2.9	17.9
CAUSTIC SODA	40.1	41.1	-1.0	0.0	-354.7	0.00	30	Bertrand	0.3	5.7
GLASS CONTAINERS FOR BEVERAGES	32.4	33.4	-0.9	0.0	-560.1	0.00	24	Bertrand	0.9	5.2
CALCIUM CARBIDE	23.3	28.2	-4.9	0.0	-926.8	0.00	20	Bertrand	3.3	10.0
PUMPS	36.7	37.2	-0.5	0.0	-1244.9	0.00	24	Bertrand	6.9	65.0
ROLLED AND WIRE-DRAWN COPPER PRODUCTS	36.8	36.9	-0.2	0.0	-1431.9	0.00	20	Bertrand	1.1	28.5
RECTIFIERS	19.5	20.1	-0.6	0.0	-2265.3	0.00	14	Bertrand	3.5	27.4
FISHING NETS	37.0	45.9	-9.0	0.0	-4154.4	0.00	24	Bertrand	0.6	10.0
FIREPROOF BRICKS	35.7	36.1	-0.5	0.0	-4398.6	0.00	20	Bertrand	0.5	10.9
SAKE	43.3	74.0	-30.7	0.0	-5724.5	0.00	30	Bertrand	0.0	5.0
COKE	46.1	47.7	-1.5	0.0	-7726.4	0.00	24	Bertrand	4.3	26.4
MISO	38.4	52.8	-14.4	0.0	-8843.3	0.00	24	Bertrand	0.1	3.7
EIGHTEEN LITER CANS	50.0	53.7	-3.7	0.0	-15174.3	0.00	24	Bertrand	0.3	6.3
COTTON FABRICS	64.2	66.3	-2.1	0.0	-17755.8	0.00	30	Bertrand	0.1	12.3
PRINTING INK	61.6	68.1	-6.5	0.0	-18806.5	0.00	30	Bertrand	1.9	13.2

INDUSTRY	log Likelihood Model 1– Cournot	log Likelihood- Model 2– Bertrand	Likelihood ratio:Cour vs Bert	s.d.likeli-hood ratio for indvidual obs.	Vuong	Norm dist	n	favored model	implied elasticity- Cournot	implied elasticity- Bertrand
CANNED SEAFOOD	44.7	60.0	-15.3	0.0	-23406.9	0.00	24	Bertrand	0.8	11.1
VINYL CHLORIDE RESIN	27.8	30.1	-2.3	0.0	-28406.3	0.00	14	Bertrand	0.8	12.6
VALVE COCKS	20.0	22.7	-2.7	0.0	-40565.7	0.00	10	Bertrand	0.2	6.2
mean			-3.68	0.72	-2443.61	0.25			5.45	13.94
s.d.			6.87	1.38	7375.52	0.37			20.50	14.44

Appendix Table A3. Regression analysis of average industry price-cost margin:

Model 3–Hybrid: $m_t = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} H_t + e3_t$, t=1,..., T.

	Intercept β_0						Slope β_1					
INDUSTRY	**error DF**	**β_0**	**S.E.**	**t value**	**prob >|t|**	**prob >t**	**β_1**	**S.E.**	**t value**	**prob >|t|**	**prob >t**	**R2**
ALUMINUM WINDOW SASHES	22	0.1	0.03	3.84	0	0	-0.19	0.16	-1.20	0.24	0.88	0.06
BEARINGS	28	1.08	0.19	5.52	0.00	0.00	-5.02	0.93	-5.41	0.00	1.00	0.51
BEER	28	0.08	0.06	1.28	0.21	0.11	-0.04	0.15	-0.26	0.79	0.60	0.00
BICYCLES	22	0.04	0.05	0.69	0.50	0.25	1.19	0.82	1.45	0.16	0.08	0.09
BOILERS	22	0.02	0.08	0.21	0.83	0.42	0.10	0.29	0.34	0.74	0.37	0.01
BRIQUETTES	12	0.18	0.05	3.82	0.00	0.00	-0.37	0.58	-0.65	0.53	0.73	0.03
CALCIUM CARBIDE	18	0.09	0.03	3.41	0.00	0.00	0.03	0.09	0.32	0.75	0.38	0.01
CANNED SEAFOOD	22	0.07	0.01	8.43	0.00	0.00	0.27	0.13	2.02	0.06	0.03	0.16
CAST IRON PIPES AND TUBES	12	-0.33	0.17	-1.90	0.08	0.96	1.56	0.45	3.45	0.00	0.00	0.50
CAUSTIC SODA	28	0.21	0.15	1.42	0.17	0.08	-0.67	3.13	-0.21	0.83	0.58	0.00
CELLOPHANE	12	0.03	0.04	0.62	0.55	0.27	0.17	0.19	0.88	0.39	0.20	0.06
CEMENT	28	0.32	0.15	2.23	0.03	0.02	-0.55	1.69	-0.33	0.75	0.63	0.00
CHARGING GENERATORS	18	0.24	0.14	1.68	0.11	0.06	-0.67	0.45	-1.48	0.16	0.92	0.11
CHEMICAL SEASONING	12	0.99	0.56	1.75	0.11	0.05	-2.54	1.60	-1.59	0.14	0.93	0.17

INDUSTRY	**error DF**	**β_0**	**S.E.**	**t value**	**prob $>\vert t\vert$**	**prob >t**	**β_1**	**S.E.**	**t value**	**prob $>\vert t\vert$**	**prob >t**	**R2**
COKE	22	0.04	0.03	1.76	0.09	0.05	-0.05	0.16	-0.28	0.79	0.61	0.00
COLD-ROLLED STEEL PLATE	28	0.07	0.02	3.49	0.00	0.00	-0.08	0.11	-0.72	0.48	0.76	0.02
COMBED FABRICS	18	0.15	0.02	8.62	0.00	0.00	-1.56	1.40	-1.11	0.28	0.86	0.06
COTTON FABRICS	28	0.16	0.07	2.44	0.02	0.01	-12.27	10.02	-1.23	0.23	0.88	0.05
COTTON YARN	28	-0.04	0.11	-0.32	0.75	0.62	1.97	3.28	0.60	0.55	0.28	0.01
DISSOLVING PULP	18	0.35	0.11	3.08	0.01	0.00	-0.89	0.38	-2.36	0.03	0.99	0.24
EIGHTEEN LITER CANS	22	0.16	0.06	2.82	0.01	0.01	0.02	1.35	0.02	0.99	0.49	0.00
ELECTRICAL COPPER	28	-0.08	0.22	-0.38	0.71	0.65	0.95	1.22	0.78	0.44	0.22	0.02
ELECTRICAL WIRES AND CABLES	18	0.04	0.13	0.28	0.78	0.39	0.34	1.68	0.20	0.84	0.42	0.00
FIREPROOF BRICKS	18	0.21	0.18	1.17	0.26	0.13	-2.42	3.66	-0.66	0.52	0.74	0.02
FISHING NETS	22	0.22	0.03	8.57	0.00	0.00	-2.44	0.51	-4.82	0.00	1.00	0.51
FISHMEAT SAUSAGE	12	0.14	0.05	2.78	0.02	0.01	-0.54	0.34	-1.57	0.14	0.93	0.17
GALVANIZED	28	0.08	0.05	1.67	0.11	0.05	-0.15	0.31	-0.49	0.63	0.69	0.01
GLASS BULBS FOR USE IN CATHODE RAY TUBES	12	0.77	0.29	2.64	0.02	0.01	-1.64	0.63	-2.61	0.02	0.99	0.36
GLASS CONTAINERS FOR BEVERAGES	22	0.39	0.25	1.55	0.14	0.07	-1.16	1.46	-0.79	0.44	0.78	0.03
GRINDING STONES	26	0.24	0.06	3.90	0.00	0.00	-1.42	0.88	-1.61	0.12	0.94	0.09
HAM SAUSAGE	18	0.09	0.01	6.17	0.00	0.00	0.01	0.19	0.04	0.97	0.48	0.00
JUTE YARN	8	-0.05	0.09	-0.54	0.60	0.70	0.44	0.22	2.04	0.08	0.04	0.34
MANMADE-GRAPHITE	22	0.06	0.11	0.51	0.62	0.31	0.90	0.60	1.49	0.15	0.07	0.09

INDUSTRY	error DF	β_0	S.E.	t value	prob $>\lvert t\rvert$	prob >t	β_1	S.E.	t value	prob $>\lvert t\rvert$	prob >t	R2
ELECTRODES												
MEDICINES	26	0.35	0.03	13.67	0.00	0.00	-1.95	0.98	-1.99	0.06	0.97	0.13
MEN'S SHOES	8	0.12	0.03	3.47	0.01	0.00	0.47	0.88	0.53	0.61	0.30	0.03
MISO	22	0.19	0.02	11.34	0.00	0.00	4.53	0.94	4.82	0.00	0.00	0.51
MIXED FEED	18	0.07	0.00	18.24	0.00	0.00	0.08	0.03	2.75	0.01	0.01	0.30
ORDINARY STEEL	28	0.00	0.09	0.01	0.99	0.49	0.82	0.72	1.14	0.26	0.13	0.04
PIPES AND TUBES												
PAINTS	22	0.24	0.07	3.60	0.00	0.00	-0.55	1.15	-0.48	0.64	0.68	0.01
PAPER PULP	28	0.04	0.07	0.51	0.61	0.31	1.02	1.08	0.95	0.35	0.18	0.03
PETROLEUM	28	0.06	0.03	2.11	0.04	0.02	0.35	0.45	0.79	0.44	0.22	0.02
PRODUCTS												
PIANOS	26	0.25	0.21	1.20	0.24	0.12	-0.38	0.44	-0.85	0.40	0.80	0.03
POWER TILLERS	18	0.11	0.05	2.16	0.04	0.02	0.25	0.35	0.72	0.48	0.24	0.03
PRINTING INK	28	0.17	0.03	5.54	0.00	0.00	-0.72	0.23	-3.16	0.00	1.00	0.26
PRINTING MACHINES	12	0.17	0.06	3.01	0.01	0.01	-0.33	0.47	-0.70	0.50	0.75	0.04
PUMPS	22	0.12	0.05	2.20	0.04	0.02	-1.33	0.68	-1.95	0.06	0.97	0.15
RAW SILK	18	0.02	0.05	0.47	0.65	0.32	0.91	1.76	0.52	0.61	0.31	0.01
RECORDS	8	-0.23	0.17	-1.35	0.21	0.89	4.82	1.68	2.87	0.02	0.01	0.51
RECTIFIERS	12	0.17	0.09	1.85	0.09	0.04	-1.22	0.83	-1.48	0.17	0.92	0.15
ROLLED AND WIRE-	18	0.03	0.06	0.54	0.59	0.30	0.08	1.49	0.05	0.96	0.48	0.00
DRAWN COPPER												
PRODUCTS												
SAKE	28	0.17	0.01	15.73	0.00	0.00	5.47	1.97	2.77	0.01	0.00	0.22
SANITARY WARE	22	0.53	0.09	5.90	0.00	0.00	-1.01	0.20	-5.10	0.00	1.00	0.54
SHEET GLASS	28	0.88	0.14	6.12	0.00	0.00	-1.10	0.37	-2.97	0.01	1.00	0.24
SOY	28	0.20	0.02	10.21	0.00	0.00	0.41	0.26	1.59	0.12	0.06	0.08
SPINNING MACHINES	12	0.15	0.05	3.03	0.01	0.01	-0.55	0.19	-2.85	0.01	0.99	0.4
STORAGE	28	0.03	0.06	0.53	0.60	0.30	0.59	0.27	2.23	0.03	0.02	0.15

INDUSTRY	error DF	β_0	S.E.	t value	prob >|t|	prob >t	β_1	S.E.	t value	prob >|t|	prob >t	R2
BATTERIES												
SUGAR	18	-0.04	0.09	-0.44	0.66	0.67	1.81	1.32	1.37	0.19	0.09	0.09
SYNTHETIC FIBERS	11	0.15	0.10	1.54	0.15	0.08	0.83	0.68	1.22	0.25	0.12	0.12
SYNTHETIC RUBBER	12	0.17	0.04	4.66	0.00	0.00	0.76	0.15	4.98	0.00	0.00	0.67
THERMOS BOTTLES	18	-0.17	0.22	-0.76	0.46	0.77	1.27	0.88	1.45	0.17	0.08	0.10
TILE	22	0.10	0.02	6.22	0.00	0.00	0.76	0.15	4.89	0.00	0.00	0.52
TIRES AND TUBES	28	0.79	0.20	3.85	0.00	0.00	-2.23	0.71	-3.14	0.00	1.00	0.26
FOR MOTOR												
VEHICLES												
TRACTORS	18	0.11	0.05	2.20	0.04	0.02	0.12	0.16	0.75	0.46	0.23	0.03
VALVE COCKS	8	0.12	0.04	2.75	0.02	0.01	1.19	1.13	1.06	0.32	0.16	0.12
VEGETABLE OIL	12	0.23	0.12	1.81	0.09	0.05	-0.77	1.27	-0.61	0.55	0.72	0.03
VINYL CHLORIDE	12	0.09	0.04	2.22	0.05	0.02	-0.25	0.70	-0.35	0.73	0.63	0.01
RESIN												
WEAVING	18	0.37	0.13	2.96	0.01	0.00	-1.34	0.93	-1.45	0.16	0.92	0.11
MACHINES												
WHEAT FLOUR	28	0.01	0.13	0.05	0.96	0.48	0.94	0.91	1.04	0.31	0.15	0.04
WORSTED YARN	28	0.10	0.04	2.78	0.01	0.00	-0.46	0.96	-0.48	0.63	0.68	0.01
ZINC	22	-0.1	0.22	-0.63	0.54	0.73	1.05	1.20	0.87	0.39	0.20	0.03

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Table 1. Specification Tests

INDUSTRY	prob 1-Cournot vs 2-Bertrand	prob 2-Bertrand vs 3-Hybrid	prob 1-Cournot vs 3-Hybrid	Likelihood Model 1-Cournot	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Preferred Specification	Likelihood of preferred specification
	Vuong-Norm dist from Table A2	prob >t (prob β1>0) from Table A3	prob >t (prob β0>0) from Table A3					
ALUMINUM WINDOW SASHES	0.00	0.88	0.00	0.00	0.88	0.12	2-Bertrand	0.88
BEARINGS	0.36	1.00	0.00	0.00	0.64	0.36	2-Bertrand	0.64
BEER	0.00	0.60	0.11	0.00	0.60	0.40	2-Bertrand	0.6
BICYCLES	0.99	0.08	0.25	0.25	0.00	0.75	3-Hybrid	0.75
BOILERS	0.59	0.37	0.42	0.25	0.15	0.60	3-Hybrid	0.6
BRIQUETTES	0.00	0.73	0.00	0.00	0.73	0.27	2-Bertrand	0.73
CALCIUM CARBIDE	0.00	0.38	0.00	0.00	0.38	0.62	3-Hybrid	0.62
CANNED SEAFOOD	0.00	0.03	0.00	0.00	0.03	0.97	3-Hybrid	0.97
CAST IRON PIPES AND TUBES	0.74	0.00	0.96	0.71	0.00	0.29	1-Cournot	0.71
CAUSTIC SODA	0.00	0.58	0.08	0.00	0.58	0.42	2-Bertrand	0.58
CELLOPHANE	0.76	0.20	0.27	0.21	0.05	0.75	3-Hybrid	0.75
CEMENT	0.00	0.63	0.02	0.00	0.63	0.37	2-Bertrand	0.63
CHARGING GENERATORS	0.25	0.92	0.06	0.02	0.69	0.30	2-Bertrand	0.69
CHEMICAL SEASONING	0.00	0.93	0.05	0.00	0.93	0.07	2-Bertrand	0.93
COKE	0.00	0.61	0.05	0.00	0.61	0.39	2-Bertrand	0.61
COLD-ROLLED STEEL PLATE	0.00	0.76	0.00	0.00	0.76	0.24	2-Bertrand	0.76

INDUSTRY	prob 1-Cournot vs 2-Bertrand	prob 2-Bertrand vs 3-Hybrid	prob 1-Cournot vs 3-Hybrid	Likelihood Model 1-Cournot	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Preferred Specification	Likelihood of preferred specification
	Vuong-Norm dist from Table A2	prob >t (prob β1>0) from Table A3	prob >t (prob β0>0) from Table A3					
COMBED FABRICS	0.00	0.86	0.00	0.00	0.86	0.14	2-Bertrand	0.86
COTTON FABRICS	0.00	0.88	0.01	0.00	0.88	0.12	2-Bertrand	0.88
COTTON YARN	0.63	0.28	0.62	0.39	0.10	0.51	3-Hybrid	0.51
DISSOLVING PULP	0.00	0.99	0.00	0.00	0.99	0.01	2-Bertrand	0.99
EIGHTEEN LITER CANS	0.00	0.49	0.01	0.00	0.49	0.51	3-Hybrid	0.51
ELECTRICAL COPPER	0.63	0.22	0.65	0.41	0.08	0.51	3-Hybrid	0.51
ELECTRICAL WIRES AND CABLES	0.36	0.42	0.39	0.14	0.27	0.59	3-Hybrid	0.59
FIREPROOF BRICKS	0.00	0.74	0.13	0.00	0.74	0.26	2-Bertrand	0.74
FISHING NETS	0.00	1.00	0.00	0.00	1.00	0.00	2-Bertrand	1
FISHMEAT SAUSAGE	0.11	0.93	0.01	0.00	0.83	0.17	2-Bertrand	0.83
GALVANIZED	0.00	0.69	0.05	0.00	0.69	0.31	2-Bertrand	0.69
GLASS BULBS FOR USE IN CATHODE RAY TUBES	0.43	0.99	0.01	0.00	0.56	0.43	2-Bertrand	0.56
GLASS CONTAINERS FOR BEVERAGES	0.00	0.78	0.07	0.00	0.78	0.22	2-Bertrand	0.78
GRINDING STONES	0.00	0.94	0.00	0.00	0.94	0.06	2-Bertrand	0.94
HAM SAUSAGE	0.00	0.48	0.00	0.00	0.48	0.52	3-Hybrid	0.52
JUTE YARN	1.00	0.04	0.70	0.70	0.00	0.30	1-Cournot	0.7

INDUSTRY	prob 1-Cournot vs 2-Bertrand	prob 2-Bertrand vs 3-Hybrid	prob 1-Cournot vs 3-Hybrid	Likelihood Model 1-Cournot	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Preferred Specification	Likelihood of preferred specification
	Vuong-Norm dist from Table A2	prob >t (prob β1>0) from Table A3	prob >t (prob β0>0) from Table A3					
MANMADE-GRAPHITE ELECTRODES	1.00	0.07	0.31	0.31	0.00	0.69	3-Hybrid	0.69
MEDICINES	0.00	0.97	0.00	0.00	0.97	0.03	2-Bertrand	0.97
MEN'S SHOES	0.26	0.30	0.00	0.00	0.22	0.78	3-Hybrid	0.78
MISO	0.00	0.00	0.00	0.00	0.00	1.00	3-Hybrid	1
MIXED FEED	0.00	0.01	0.00	0.00	0.01	0.99	3-Hybrid	0.99
ORDINARY STEEL PIPES AND TUBES	1.00	0.13	0.49	0.49	0.00	0.51	3-Hybrid	0.51
PAINTS	0.00	0.68	0.00	0.00	0.68	0.32	2-Bertrand	0.68
PAPER PULP	0.63	0.18	0.31	0.20	0.07	0.74	3-Hybrid	0.74
PETROLEUM PRODUCTS	0.00	0.22	0.02	0.00	0.22	0.78	3-Hybrid	0.78
PIANOS	0.10	0.80	0.12	0.01	0.72	0.27	2-Bertrand	0.72
POWER TILLERS	0.00	0.24	0.02	0.00	0.24	0.76	3-Hybrid	0.76
PRINTING INK	0.00	1.00	0.00	0.00	1.00	0.00	2-Bertrand	1
PRINTING MACHINES	0.00	0.75	0.01	0.00	0.75	0.25	2-Bertrand	0.75
PUMPS	0.00	0.97	0.02	0.00	0.97	0.03	2-Bertrand	0.97
RAW SILK	0.59	0.31	0.32	0.19	0.13	0.68	3-Hybrid	0.68
RECORDS	1.00	0.01	0.89	0.89	0.00	0.11	1-Cournot	0.89
RECTIFIERS	0.00	0.92	0.04	0.00	0.92	0.08	2-Bertrand	0.92

INDUSTRY	prob 1-Cournot vs 2-Bertrand	prob 2-Bertrand vs 3-Hybrid	prob 1-Cournot vs 3-Hybrid	Likelihood Model 1-Cournot	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Preferred Specification	Likelihood of preferred specification
	Vuong-Norm dist from Table A2	prob >t (prob β1>0) from Table A3	prob >t (prob β0>0) from Table A3					
ROLLED AND WIRE-DRAWN COPPER PRODUCTS	0.00	0.48	0.30	0.00	0.48	0.52	3-Hybrid	0.52
SAKE	0.00	0.00	0.00	0.00	0.00	1.00	3-Hybrid	1
SANITARY WARE	0.36	1.00	0.00	0.00	0.64	0.36	2-Bertrand	0.64
SHEET GLASS	0.00	1.00	0.00	0.00	1.00	0.00	2-Bertrand	1
SOY	0.00	0.06	0.00	0.00	0.06	0.94	3-Hybrid	0.94
SPINNING MACHINES	0.28	0.99	0.01	0.00	0.71	0.28	2-Bertrand	0.71
STORAGE BATTERIES	1.00	0.02	0.30	0.30	0.00	0.70	3-Hybrid	0.7
SUGAR	1.00	0.09	0.67	0.67	0.00	0.33	1-Cournot	0.67
SYNTHETIC FIBERS	0.00	0.12	0.08	0.00	0.12	0.88	3-Hybrid	0.88
SYNTHETIC RUBBER	1.00	0.00	0.00	0.00	0.00	1.00	3-Hybrid	1
THERMOS BOTTLES	1.00	0.08	0.77	0.77	0.00	0.23	1-Cournot	0.77
TILE	0.00	0.00	0.00	0.00	0.00	1.00	3-Hybrid	1
TIRES AND TUBES FOR MOTOR VEHICLES	0.00	1.00	0.00	0.00	1.00	0.00	2-Bertrand	1
TRACTORS	0.00	0.23	0.02	0.00	0.23	0.77	3-Hybrid	0.77
VALVE COCKS	0.00	0.16	0.01	0.00	0.16	0.84	3-Hybrid	0.84
VEGETABLE OIL	0.00	0.72	0.05	0.00	0.72	0.28	2-Bertrand	0.72
VINYL CHLORIDE RESIN	0.00	0.63	0.02	0.00	0.63	0.37	2-Bertrand	0.63

INDUSTRY	prob 1-Cournot vs 2-Bertrand Vuong-Norm dist from Table A2	prob 2-Bertrand vs 3-Hybrid prob >t (prob $\beta 1>0$) from Table A3	prob 1-Cournot vs 3-Hybrid prob >t (prob $\beta 0>0$) from Table A3	Likelihood Model 1-Cournot	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Preferred Specification	Likelihood of preferred specification
WEAVING MACHINES	0.00	0.92	0.00	0.00	0.92	0.08	2-Bertrand	0.92
WHEAT FLOUR	1.00	0.15	0.48	0.48	0.00	0.52	3-Hybrid	0.52
WORSTED YARN	0.00	0.68	0.00	0.00	0.68	0.32	2-Bertrand	0.68
ZINC	0.56	0.20	0.73	0.41	0.09	0.50	3-Hybrid	0.50
mean	0.25	0.51	0.16	0.11	0.45	0.44		0.76
s.d.	0.37	0.37	0.25	0.22	0.37	0.30		0.16

Table 2. Results of Specification Tests.

Numbers of industries in each category at ten-percent statistical significance.

	1-Cournot vs. 2-Bertrand	1-Cournot vs. 3-Hybrid	2-Bertrand vs. 3-Hybrid	
test statistic:	Vuong	p-value for Hybrid intercept > 0	p-value for Hybrid slope > 0	Likelihoods
preferred specification:				
1-Cournot	10	1		0
2-Bertand	44		17	11
3-Hybrid		38	15	7
inderminate	16	31	38	52

Numbers of industries in each category; most likely specification, regardless of statistical signifcance.

	1-Cournot vs. 2-Bertrand	1-Cournot vs. 3-Hybrid	2-Bertrand vs. 3-Hybrid	
test statistic:	Vuong	p-value for Hybrid intercept > 0	p-value for Hybrid slope > 0	Likelihoods
preferred specification:				
1-Cournot	19	8		5
2-Bertand	51		35	35
3-Hybrid		62	15	30

Table 3. Five industries for which Cournot specification was the most likely.

INDUSTRY	**Likelihood Model 1-Cournot**	Likelihood Model 2-Bertrand	Likelihood Model 3-Hybrid	Implied Elasticity of Demand $1/\beta_1$	Avg. Herfindahl H	Avg. Price-Cost Margin m	Estimated Labor Elasticity θ
RECORDS	**0.89**	0.00	0.11	0.4	0.101	25.6%	0.53
THERMOS BOTTLES	**0.77**	0.00	0.23	1.6	0.250	15.0%	0.51
CAST IRON PIPES AND TUBES	**0.71**	0.00	0.29	1.4	0.383	26.8%	0.59
JUTE YARN	**0.70**	0.00	0.30	3.0	0.396	12.7%	0.77
SUGAR	**0.67**	0.00	0.33	0.8	0.065	7.9%	0.66
mean				1.7	0.274	15.6%	0.63
s.d.				0.9	0.154	8.0%	0.11

Table 4. Eleven industries for which likelihood of Bertrand specification was at least 90 percent.

INDUSTRY	Likelihood Model 1- Cournot	**Likelihood Model 2- Bertrand**	Likelihood Model 3- Hybrid	Implied Elasticity of Demand $1/\beta_0$	Avg. Herfindahl H	Avg. Price-Cost Margin m	Estimated Labor Elasticity θ
FISHING NETS	0.00	**1.00**	0.00	10.0	0.050	10.0%	0.66
PRINTING INK	0.00	**1.00**	0.00	12.5	0.137	7.6%	0.65
SHEET GLASS	0.00	**1.00**	0.00	2.2	0.388	45.4%	0.49
TIRES AND TUBES FOR MOTOR VEHICLES	0.00	**1.00**	0.00	6.7	0.288	14.7%	0.53
DISSOLVING PULP	0.00	**0.99**	0.01	11.1	0.299	8.6%	0.67
PUMPS	0.00	**0.97**	0.03	50.0	0.077	1.5%	0.42
MEDICINES	0.00	**0.97**	0.03	3.3	0.025	30.1%	0.33
GRINDING STONES	0.00	**0.94**	0.06	7.1	0.069	14.2%	0.59
CHEMICAL SEASONING	0.00	**0.93**	0.07	11.1	0.352	9.3%	0.49
RECTIFIERS	0.00	**0.92**	0.08	25.0	0.111	3.7%	0.51
WEAVING MACHINES	0.00	**0.92**	0.08	5.0	0.133	19.6%	0.78
mean				13.1	0.175	15.0%	0.56
s.d.				13.7	0.131	12.8%	0.13

Table 5. Seven industries for which likelihood of Hybrid specification was at least 90 percent.

INDUSTRY	Likelihood Model 1- Cournot	Likelihood Model 2- Bertrand	**Likelihood Model 3- Hybrid**	implied ξ_ℓ/λ $(=1/\beta_0)$	implied $\xi/(1-\lambda)$ $(=1/\beta_1)$	Avg. Herfindahl H	Avg. Price-cost Margin m	Estimated Labor Elasticity θ
SYNTHETIC RUBBER	0.00	0.00	**1.00**	5.9	1.3	0.322	34.0%	0.5
MISO	0.00	0.00	**1.00**	5.3	0.2	0.017	26.9%	0.74
SAKE	0.00	0.00	**1.00**	5.9	0.2	0.005	20.0%	0.69
TILE	0.00	0.00	**1.00**	10.0	1.3	0.090	17.0%	0.65
MIXED FEED	0.00	0.01	**0.99**	14.3	12.5	0.107	8.1%	0.53
CANNED SEAFOOD	0.00	0.03	**0.97**	14.3	3.7	0.060	9.0%	0.66
SOY	0.00	0.06	**0.94**	5.0	2.4	0.074	23.2%	0.71
mean				8.7	3.1	0.096	19.7%	0.64
s.d.				4.2	4.3	0.106	9.4%	0.09