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ON THE EXTENT OF THE MARKET: WHOLESALE GASOLINE IN THE NORTHEASTERN UNITED STATES*

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ON THE EXTENT OF THE MARKET: WHOLESALE GASOLINE IN THE NORTHEASTERN UNITED STATES

ABSTRACT

This paper develops the classical view of the extent of markets by introducing explicitly in the analysis the concept of arbitrage costs. Arbitrage or transaction costs imply that market boundaries are essentially stochastic. While a set of products (or regions) may have binding arbitrage conditions (i.e. may be in the same "market") at a given point in time, they may not at another. Thus, in defining a "market", the probability that a set of agents (or regions) would have binding arbitrage conditions has to be assessed. This paper develops an econometric methodology to estimate the transaction costs required to arbitrage among a given set of products, as well as the probability that that set of products would be bound by binding arbitrage conditions. Finally, the methodology is applied to wholesale gasoline in the Northeastern part of the United States.

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I. Introduction.

Since Coase's (1937) seminal article on the "Nature of the Firm", transaction costs have been used widely to analyze economic and social institutions. Recently, transaction costs have also been used to explain the development of markets.[1] The purpose of this paper is to expand this line of research by using transaction costs explicitly in defining markets. Our approach develops the classical view of markets.[2] Classical economists saw a market as that set of producers and buyers whose prices tend towards uniformity.[3] That set of agents is a distinct one. The interrelation in their prices is different from that with the rest of the economy. In the classists' framework transaction costs define the boundary of the "market" for each commodity.[4]

Price uniformity has recently received much attention in delineating markets (Stigler and Sherwin (1983), Horowitz(1972)).[5] These papers define

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[1] See Telser and Higinbotham (1977) and Carlton (1983) for an application to the development of futures markets. See Clark (1984) for an analysis of the working of the gold standard with a detailed analysis of transaction costs.

[2] The classicists used transaction costs explicitly in defining and analyzing the developments of markets. See for example Marshall (1936, p.112 and pp.323-330).

[3] Cournot's definition of a market is as that "entire territory of which the parts are so united by the relations of unrestricted commerce that prices there take the same level throughout, with ease and rapidity" (Cournot (1960, pp.51-52, fn.). This view of a market is also shared by Stigler (1966, pp.85-86).

[4] In what follows we will use the terms transaction or arbitrage costs interchangeably.

[5] For a collection of many of the papers addressing the definition of markets (mostly in relation to antitrust) see Elzinga and Rogowsky(1984). Scheffman and Spiller (1984) discuss the difference between 'antitrust' and
(Footnote continued)

markets by including in a market that set of transactions that show a high degree of price correlation.[6]

We argue in this paper that markets' boundaries are essentially stochastic, that the agents (regions, products) that may belong to a "market" at one point in time may not in another, and consequently, that price correlations are not sufficient statistics to characterize which agents (regions, products) may potentially belong to a market. Moreover, we show that in determining the market for a commodity, agents (regions or products) have to be characterized by their arbitrage (transaction) costs and by the probability that their prices will be bound by binding arbitrage conditions (i.e. will show price uniformity). Moreover, we develop a methodology that characterizes agents (regions, products) by those two characteristics. Finally, we implement it to wholesale (terminal) gasoline markets in the northeastern part of the United States.

II. Transaction Costs and Markets.

Assume that the cost of shipping a certain good between two cities is c. It is then clear that the prices in the two cities cannot differ by **more** than c. If they had, traders could, without any risk, have made a profit by buying in one and selling in the other. Those prices could, however, differ by **less** than c. In such a circumstance, no profitable

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[5](continued)
'economic' markets. In this paper we do not claim that our methodology defines antitrust markets. We claim it to be useful, however, in delineating what classical economists called 'economic markets'.

[6]A more stringent criteria requiring the prices of the different commodities to be included in a market to have the same statistical information is presented in Gelfand and Spiller(1984).

arbitrage opportunities arise and price movements in the two cities need not be uniform. That is, at that time the two cities would not be in the same market. A marginal increase in the price in one city would not directly affect the price of the good in the other. Let the price increase, however, be larger, and the two cities could become a single market: their prices would be uniform and differ by c.

Thus, the composition of markets changes over time as the underlying supply and demand variables evolve. When saying that a given set of traders are in the same "market", we must also clarify how often they are. That is, how often are their prices uniform. There is, then, no way we can exhaustively define a market. We can only determine, for a given set of agents, the transaction costs that are required to arbitrage among the members of that set, and, also, how often the arbitrage conditions among them are binding.[7] Moreover, it is difficult to envision a set of agents with binding arbitrage conditions at **all** times. Thus, while Cheung (1983,p.3) argues, "we do not exactly know what the firm is - nor is it vital to know," we have to recognize that the same goes for "markets". We can know, however, whether a set of agents are at a given point in time bound by binding arbitrage conditions. We cannot say, however, that they form a market, since they may not be bound by binding arbitrage conditions at some other time. Markets' boundaries are, then, stochastic. Whether a given set of agents will belong to the same market in the future is

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[7]Arbitrage (transaction) costs do not need to be only "direct shipping" costs. They also include information costs, all those "costs" generated by governmental policies (e.g. legal maximum or minimum prices, taxes, quotas) and their enforcement as well as any hedging costs required to make arbitrage a no risk activity. Clark (1984) takes a view somewhat similar to the one just stated.

uncertain. If we have knowledge of the underlying supply and demand factors affecting their trades, we may provide a probability statement about it. No clear definition, however, can be provided.

Let us provide an example from regional trade. Figure 1 depicts the autarky equilibrium for two regions. Call P_1^A and P_2^A the autarky prices. [8]

[Insert Figure 1 approximately here]

If the transportation costs from region 1 to 2 exceed $P_2^A - P_1^A$, then no trade will take place and we may say that the two regions are not in the same market. Let, however, the transportation costs be given by $T_0 < P_2^A - P_1^A$, then observed equilibrium prices in the two regions will be given by $P_2 = P_1 + T_0$, region 1 will export X_1 units of the commodity, and the two regions will be in the same market. Observe that if transportation costs exceed $P_2^A - P_1^A$ then the observed equilibrium prices are the autarky prices, and thus P_1 and P_2 are independent. An increase in the autarky price of one region should not affect the observed equilibrium price in the other (unless the autarky price difference exceeds the transaction cost). However, if $P_2^A - P_1^A$ exceeds the transaction costs then the two equilibrium prices are interrelated. A shock in one region translates into the other (unless the autarky price difference falls below the transaction cost).

If the underlying demand and supply functions are subject to stochastic shocks, some times the observed equilibrium prices will differ by the transportation costs, and some other times by less. Thus the probability

[8] We use the term autarky prices as those prices that would prevail if no trade whatsoever is feasible, either because of a binding legal rule or because of some infinitely high transportation cost.

of two regions belonging to the same market is a function of the transaction costs between the two regions and of the variances of the underlying demand and supply functions. Moreover, this probability is a measure of integration. The higher the probability, the more integrated the regions are.

The next section develops a methodology to estimate the probability of arbitrage for a given pair of regions.

III. **The Model.**

Consider two separate regions: 1 and 2. In the presence of legal trading barriers the autarky equilibrium prices (P_t^{1A}, P_t^{2A}) at time t would be determined by demand and supply factors in each region. For simplicity, the reduced form equations of autarky prices are assumed to have constant means,

$$P_t^{1A} = \pi^1 + \varepsilon_t^1 \tag{1a}$$

$$P_t^{2A} = \pi^2 + \varepsilon_t^2 \tag{1b}$$

where the random error term ε_t^i represents shocks to the markets in each region. In the absence of legal trading barriers but with finite transaction costs, the observed prices (P_t^1, P_t^2) may diverge from the autarky prices. Denote the transaction costs in each period by T_t.[9] Then, if the autarky prices differ by less than T_t, no arbitrage opportunities arise and the observed prices are in fact the autarky prices.

[9] For simplicity, let transaction costs be the same in both directions of trade.

For simplicity of discussion assume that $P_t^{2A} > P_t^{1A}$. Then if

$$0 < P_t^{2A} - P_t^{1A} < T_t \tag{2}$$

we have $P_t^1 = P_t^{1A}$ and $P_t^{2A} = P_t^{2A}$. This .mplies that

$$0 < P_t^2 - P_t^1 < T_t \tag{3}$$

On the other hand, if the autarky prices differ by no less than T_t, arbitrage opportunities arise and the observed prices will diverge from the autarky prices in such a way that the observed equilibrium prices in the two regions differ only by the transaction costs. That is, if

$$0 < T_t < P_t^{2A} - P_t^{1A} \tag{4}$$

we have

$$0 < P_t^2 - P_t^1 = T_t \tag{5}$$

Assume that the transaction costs at period t, T_t, is a random variable with a geometric mean T, i.e.,

$$T_t = T\, e^{V_t},$$

where V_t is normally distributed with zero mean and constant variance σ_V^2. The probability of no arbitrage opportunities and hence the probability of observing (3), is a constant λ

$$\text{Prob}\ \{0 < P_t^2 - P_t^1 < T_t\} = \text{Prob}\ \{0 < P_t^{2A} - P_t^{1A} < Te^{Vt}\}$$

$$= \text{Prob}\ \{\log[(\pi^2 - \pi^1) + (\varepsilon_t^2 - \varepsilon_t^1)] - V_t < \log T\} = \lambda. \tag{6}$$

The constant λ is of course a function of π^i, T, σ_V^2 and the distribution parameters of the random variables ε_t^i in (1). The probability of arbitrage and hence the probability of observing (5) is $(1-\lambda)$.

Define a positive random variable U_t, and $B = \log T$. It can be seen that the observed price equations in (3) and (5) are in fact a switching regressions system where,

$$\log (P_t^2 - P_t^1) = B + V_t - U_t \tag{7}$$

with probability λ and

$$\log (P_t^2 - P_t^1) = B + V_t \tag{8}$$

with probability $(1-\lambda)$. Equation (7) corresponds to the regime of no arbitrage opportunities or the autarky state and (8) corresponds to the arbitrage state.

Equation (7) is in fact a composite error regression with a positive component U_t. The regression (7) corresponds to the standard stochastic frontier equation defined and analyzed by Aigner, Lovell and Schmidt [1977]. While the parameter λ measures the probability of being in the autarky (no trade) state, the positive error U_t is a conditional measure of propensity to trade. Given that a particular period t is at the autarky state, the smaller the positive value of U_t, the higher the propensity to trade. In this paper, the positive random error component U_t is assumed to be distributed independently of V_t with a one-sided half-normal distribution, i.e., the distribution is derived from a normal distribution $N(0,\sigma_u^2)$ truncated from below at zero. Denote $\theta = (B, \sigma_u^2, \sigma_v^2, \lambda)$ as the parameter vector for the regressions (7) and (8), then the likelihood function for the n observation is given by:

$$L = \prod_{t=1}^{n} [\lambda f_t^1 + (1-\lambda) f_t^2] \tag{9}$$

where f_t^1 and f_t^2 are the density functions of (7) and (8) respectively.

Define $Y_t = \log(P_t^2 - P_t^1)$, the density functions are

$$f_t^1 = \left(\frac{2}{\sqrt{(\sigma_u^2 + \sigma_v^2)}}\right) \phi \left(\frac{Y_t - B}{\sqrt{(\sigma_u^2 + \sigma_v^2)}}\right)\left[1 - \Phi\left(\frac{(Y_t - B)\sigma_u/\sigma_v}{\sqrt{(\sigma_u^2 + \sigma_v^2)}}\right)\right] \tag{10}$$

$$f_t^2 = \frac{1}{\sigma_v} \phi \left(\frac{Y_t - B}{\sigma_v}\right) \tag{11}$$

where ϕ and Φ are the standard normal density and distribution functions respectively (see Aigner et al [1977] for a derivation of (10)).

The maximum likelihood estimates of the parameters θ can be obtained by maximizing the logarithmic function of (9). However, following Kiefer [1980] it is interesting to observe that the probability parameter λ is obtained by solving

$$\frac{\partial \log L}{\partial \lambda} = \sum_{t=1}^{n} \frac{f_t^1 - f_t^2}{\lambda f_t^1 + (1-\lambda) f_t^2} = 0. \tag{12}$$

Defining

$$W_t = \frac{\lambda f_t^1}{\lambda f_t^1 + (1-\lambda) f_t^2}, \tag{13}$$

the solution for λ in (12) can be shown to be the average of W_t,

$$\lambda = \frac{1}{n} \sum_{t=1}^{n} W_t \tag{14}$$

The variable W_t in (13) is the weight of the likelihood component of being in the autarky state. The weight W_t is then in fact the posterior probability of being in the autarky state conditional on the observation $Y_t = \log (P_t^2 - P_t^1)$. The maximum likelihood estimate of the probability parameter λ is nothing but the sample average of the posterior probabilities of autarky.

IV. An Application to Wholesale Gasoline Markets.

IV.a. The Data.

In this section we apply the methodology developed in the previous section to analyze the extent of integration of the gasoline (terminal) markets in the northeastern part of the United States. We gathered, from the Oil Price Information Service's weekly reports, weekly price quotations at terminals for five northeastern cities (Boston, Newark, New York, Providence and Portland, Maine). For each period we chose as the relevant price the lowest price quotation for regular gasoline.[10] We collected weekly price quotations from March 5, 1981 to January 19, 1984. Thus the data set includes 151 price quotations for each city. During this period prices declined, going from more than $1 per gallon at the beginning of the period to around $.80 at its end. Wholesale prices were relatively stable, increasing only by 6.5% during the same period.

Gasoline flows to the northeast mainly through two ways. One is through pipelines that bring gasoline from the Gulf Coast area and whose northernmost point is Newark, New Jersey.[11] Another is through waterborne cargoes. Gasoline imports as well as Gulf Coast gasoline are delivered to each of the seaport cities through barges or tanker shipments. Gasoline

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[10] The common wisdom among industry analysts is that the prices quoted by the majors at terminal locations are not necessarily those actually charged. Thus by choosing the lowest price available we may eliminate the difference between posted and transaction prices.

[11] The main pipeline reaching the northeast is the Colonial Pipeline. It transported more than 693 billion barrel-miles in 1982, thus being the largest pipeline company in the country. The Plantation pipeline follows a very similar route as Colonial, but it only goes as far as Washington, D.C. It transported 93 billion barrel-miles in 1982. See Colonial Pipeline Company (1983, p.8).

from the different sources is then sold at wholesale through terminals. Contract jobbers or independent jobbers are the "explicit" purchasers of the terminaling product. Shipments to own retailers, on the other hand, are "implicit" wholesale sales. These should, therefore, compete with those "explicit" transactions.

Arbitrage among the different cities[12] is performed in two different ways. First, water cargoes that were directed originally to one city can be diverted, at a cost, to some other city whose expected price (in the absence of arbitrage) may have increased. Alternatively, actual intercity barge shipments may take place. Since Newark, New Jersey, is the place where the Colonial Pipeline ends, it would naturally become a central distribution place for the northeast. That is, gasoline to, say Providence, may be delivered from the Gulf in two ways: it may be sent directly by tanker, or, alternatively, through the Pipeline to Newark and from it, by barges, to its final destination. Thus Newark will usually have the lowest price, and its price should be expected to limit the other cities' prices.[13] That is, the price, say, in Providence cannot exceed the price in Newark by more than the cost of shipping gasoline from Newark to

[12]The discussion until now was based on the existence of only two cities (or regions). The question that can arise is whether the existence of, say, a third city could not change the direction of arbitrage. Assume the autarky prices of cities 1 and 2 differ by more than the transaction cost between the two cities so as that arbitrage should be performed from city 1 to city 2. Assume further that there is one other city whose autarky price could also be such as to create arbitrage opportunities with some of the other two cities. Clark (1984) has shown that if direct arbitrage between two cities is cheaper than indirect one, then city 1 should be "exporting" while city 2 should be "importing" the good. That is not to say, however, that city 2's imports will come from city 1's exports.

[13]During the whole period of analysis Newark's price was the lowest quoted price among the five cities we consider here.

Providence. The price in Providence, moreover, will also be bound by the prices in surrounding cities (Boston and Portland, Maine). Thus, arbitrage can occur between any pair of cities. We would expect, however, that arbitrage occurs more often among cities that are geographically closer. That is, because of their proximity, we would expect New York and Newark, on the one hand, and Boston, Portland (Maine) and Providence, on the other, to be highly integrated.

Table 1 presents the correlation matrix for the five cities' prices, both in levels and first differences. In levels, all prices are highly correlated (as we would expect). In first differences, however, price correlations are relatively low. The lowest correlations are between Providence and Portland, New York and Portland and Newark and Providence. Our previous discussion suggests, however, that price correlations are not the proper statistic to infer whether two regions are usually in the same market: first, transaction costs may differ depending on the direction of arbitrage; second, the correlation of prices when not subject to binding arbitrage conditions is spurious (i.e. the result of common movements in the determinants of **local** supply and demand conditions), thus polluting the statistic. In what follows we find that our results provide substantially different implications than those of simple correlation coefficients.

[Insert Table 1 Approximately here]

IV.b. The Estimation.

We estimated for each city pair the model given by (9)-(11).[14] Since Y_t is not defined for $P_t^2-P_t^1<0$, the estimation had to be performed in two directions. That is, for each city pair we divided the sample in two. One group was comprised of all the observations for which the price in one of the two cities was the higher one. The other group comprised those observations for which the other city's price was higher.[15] Each set represents all the instances where arbitrage would have been performed from the city with the lower price to that with the higher (see equations (2)-(5)). Each direction of arbitrage may involve different transaction costs. Particularly in gasoline markets, where there is a usual flow from Newark northbound. Thus, temporarily increasing the flow in that direction may be less costly than increasing it from a northern to a southern city. Thus, estimating the model in each direction of arbitrage would allow us to estimate the transaction costs involved in each one.[16] The estimation is carried out by maximizing the likelihood function (8).[17] In each instance

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[14]Observe that T_t in (2) reflects <u>real</u> transaction costs. Thus to estimate the model we first have to deflate all our price series by a price index. We chose to deflate the series by the Wholesale Price index. Since it is reported monthly, we gave the same index number to each week of a month. Since during the period wholesale prices were relatively stable, we estimated the model also without deflating the price series. The results were essentially unchanged and thus are not reported. They are available upon request.

[15]Seldom were the prices in two cities the same. These observations had to be discarded.

[16]In the estimation it will be assumed that arbitrage costs in each direction are different. That is, the stochastic processes generating them are not assumed to be the same. Consequently, we estimate the model in two parts, one for each direction.

different starting values are used to avoid local maxima. The results appear in table 2.

[Insert Table 2 approximately here]

Table 2 presents the maximum likelihood estimates (and their asymptotic t-statistics) of the four parameters of the model (i.e. the logarithm of the transaction costs, the variances of U and V, and the probability of not being bound by binding arbitrage conditions). This Table provides some interesting results. First, city-pairs with high probability of being in the same market (low λ's) seem to be those that are close-by: New York-Newark ($1-\lambda=.80$), Portland-Boston ($1-\lambda=.78$), Portland-Providence ($1-\lambda=.85$), Providence-Boston ($1-\lambda=.85$), and Providence-Newark ($1-\lambda=.82$).[18] On the other hand, distant city-pairs seem to be less likely to be in the same market (high λ's): Boston-Newark ($1-\lambda=.68$), New York-Boston ($1-\lambda=.59$), New York-Portland ($1-\lambda=.34$), and Portland-Newark ($1-\lambda=.70$). Also, city pairs requiring arbitrage in a north-south direction seem to have lower probabilities of being in the same market than city pairs requiring arbitrage in the opposite direction.[19] The average probability of being in

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[17] We estimated the model only for those cases in which the price in one city exceeded the other city's price in at least 50 weeks.

[18] The order of the cities is important. The second city is the one from which arbitrage would have taken place (i.e. the one with the lower autarky price). Thus New York-Newark refers to those observations for which the price in New York was higher than that in Newark. For those cases, 80% of the times we would expect Newark to limit New York's price by binding arbitrage.

[19] In circumstances where there are only two locations and where shipments are evenly distributed in each direction, this feature of the market would not develop. In our case, however, shipments are multilateral
(Footnote continued)

the same market for the former type of city pairs is .45, compared with .81 for the latter. (Observe, however, that Boston-Providence has a high probability of being in the same market (.85) even when it is a North to South city pair.) Moreover, except for New York-Newark,[20] city-pairs with low transaction costs have also relatively high probabilities of being in the same market.[21] Furthermore, and perhaps not surprisingly, indirect arbitrage is more expensive than direct one.[22] That is, if arbitrage from Newark to Portland is worth undertaking, it will be cheaper to ship the product directly rather than first shipping it, say, to Boston and from it to Portland.

Finally, Newark's price is found to bound all other cities' prices by binding arbitrage conditions most of the times. Thus Newark is almost always a relevant player in gasoline markets in the other cities. Boston is also an active player in Providence and Portland, while Providence is active only in Portland's market. Portland, however, is not very active in

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[19](continued)
and there is a normal south-north flow pattern. Thus, its appearance is understandable. A similar conclusion, albeit with a very different methodology and data set, was obtained by Slade(1983).

[20]New York had the highest average terminal gasoline price of the five cities. Since the Oil Price Information Service assured us in private communication that their reported prices do not include taxes in any of the cities we are considering here, the reason is unclear. Our estimates of transaction costs for arbitrage going to New York are the highest among all city-pairs. Nevertheless, Newark and New York are almost always bound by binding arbitrage conditions.

[21]From the definition of λ in equation (5), it can be seen that, ceteris paribus, the higher T the higher λ. In our calculations, however, a high λ may occur because of relatively low variances in the local (autarkic) demand and supply shocks, and therefore may not imply a high T.

[22]This is the assumption required to be able to perform city-pair wise comparisons. See Clark(1984) and footnote 14 above.

any market.

[Insert Table 3 Approximately Here]

While the results of the estimation are plausible, it is proper to inquire about the ability of the model to discriminate between regimes. That is, given the ex-ante probability of two cities belonging to the same market, we would like the model to be able to separate, for a given city pair, the observations in two distinct groups: one with very low probabilities of being under binding arbitrage conditions, and another with high probabilities. In (13), W_t is the posterior probability, given the actual price differentials, of observation t being in the autarky state. We can then classify observations by their W_t. This is done in Table 3.

Table 3 shows the frequency distribution -over the sample- of the posterior probability, given the actual prices, of two cities not belonging to the same market. We observe from Table 3 that for most cases the model discriminates between regimes quite well: the posterior probabilities are clustered near zero or near one. That is, for most observations the probability of an observation belonging to the autarky state is either below 20% or above 80%. Rarely it is in the probability interval 40 to 60%.

V. Final Comments.

We developed in this paper a methodology to estimate the transaction costs required to arbitrage among a given set of products, as well as the frequency of their being bound by binding arbitrage conditions. The methodology implies the estimation of a switching regimes model. One regime is characterized by the prices between the two products differing by the arbitrage (or transaction) costs. In other, when there is no (explicit or implicit) arbitrage between the two products, their prices differ by less than the transaction costs. This regime is statistically identified by a truncation in its error structure, similarl to the stochastic frontier models estimated elsewhere in the literature. We applied the methodology to wholesale (terminal) gasoline in the Northeastern part of the United States. Our main findings are as follows: First, the model was able to discriminate quite well between regimes, thus suggesting that our methodology could be useful in other applications. Second, the results are quite intuitive: close-by cities are more integrated than further-away cities; city-pairs with higher transaction costs are less integrated than those with smaller transaction costs; arbitrage costs increase with the distance between the cities. Also, arbitrage costs, and thus the extent of integration, depend on the direction of arbitrage.

REFERENCES

Aigner, Dennis, Lovell, C.A. Knox and Schmidt, Peter. "Formulation and Estimation of Stochastic Frontier Production Function Models, Vol 6,No.1, Journal of Econometrics (July 1977):21-37.

Carlton, Dennis W. "Futures Trading, Market Interrelationships, and Industry Structure," Vol 65, No.2 American Journal of Agricultural Economics (May 1983):380-87.

Cheung, Steven N. S. "The Contractual Nature of the Firm," 26 Journal of Law and Economics, (April 1983):1-22.

Clark, Truman A. "Violations of the Gold Points, 1980-1908," Vol. 92, No.5 Journal of Political Economy, (October 1984):791-823.

Coase, Ronald H. "The Nature of The Firm," 4 Economica (November 1937):386-405.

Colonial Pipeline Company (1983)

Cournot, Augustin. Mathematical Principles of the Theory of Wealth. Translated by Nathaniel T. Bacon, Augustus M. Kelley, New York (1960).

Kenneth G. Elzinga and Robert A. Rogowsky, eds. Relevant Markets in Antitrust, Vol 14, No.2, Journal of Reprints for Antitrust Law and Economics (1984).

Gelfand, Matthew D. and Pablo T. Spiller, "Price Based Tests of Market Integration: An Application to the Uruguayan Banking Sector", Discussion Paper, Hoover Institution, Stanford University (September 1984).

Horowitz, Ira. "Market Definition in Antitrust Analysis: A Regression Based Approach," 48 Southern Economic Journal (July 1972):1-16.

Marshall, Alfred. Principles of Economics.Eight Edition, MacMillan and Co.

Limited, London (1936).

Scheffman David and Pablo T. Spiller, "Geographic Market Definition Under The DOJ Guidelines: An Economic Approach," (1984) forthcoming.

Slade, M.E. "Causality Tests for Market Extent Applied to Petroleum Products," Working Paper #83, Bureau of Economics, Federal Trade Commission, Washington D.C. (1983).

Stigler, George J. The Theory of Price, MacMillan Publishing Co., New York (1966).

Stigler, George J. and R.A. Sherwin. "The Geographic Extent of the Market", Working Paper, University of Chicago, (1983).

Telser Lester G. and Higinbotham, Harlow. "Organized Futures Markets: Costs and Benefits," 85 Journal of Political Economy (1977):969-1000.

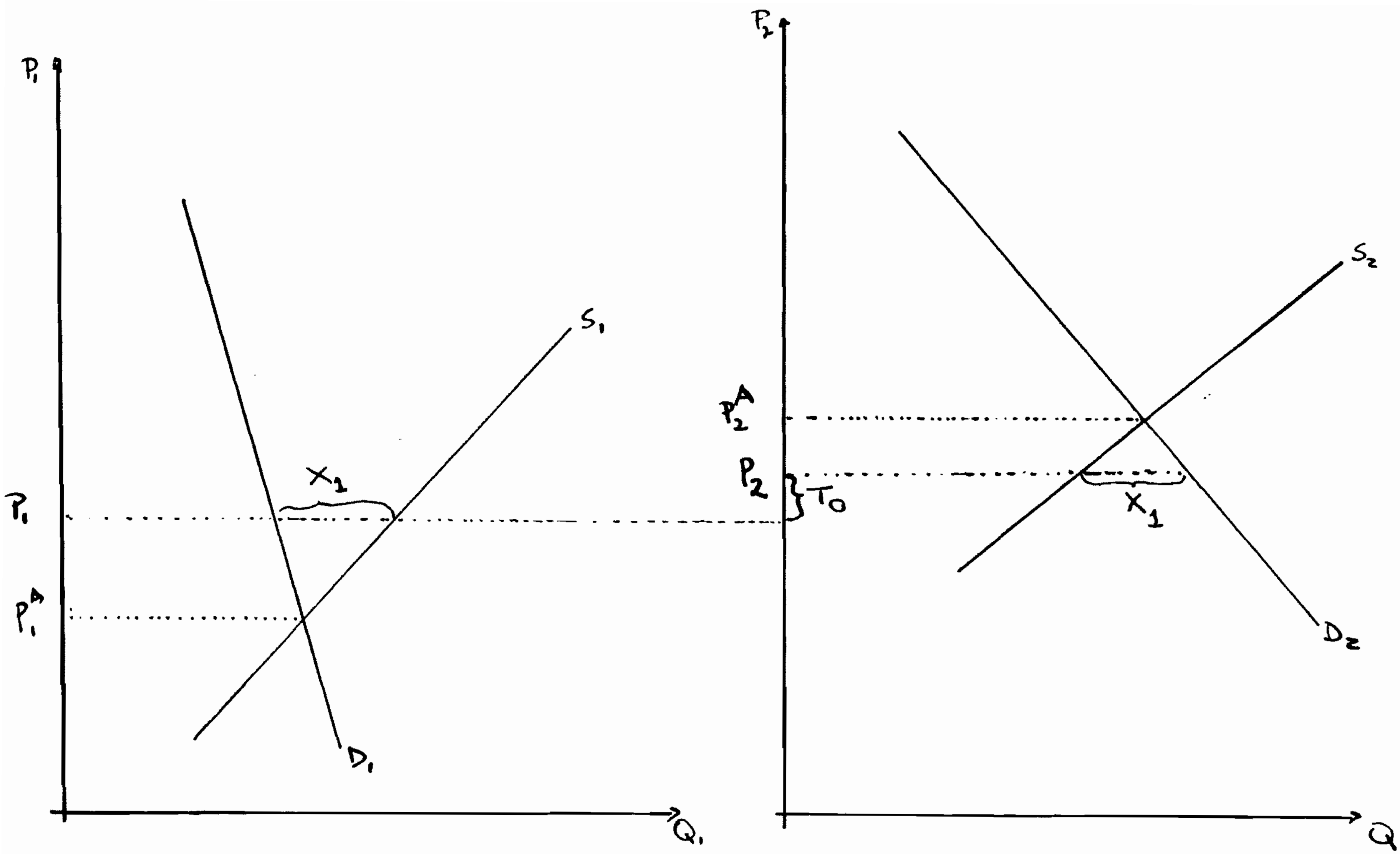

FIGURE 1

TABLE 1

CORRELATION MATRIX - LEVEL/FIRST DIFFERENCES

	BOSTON	NEWARK	NEW YORK	PORTLAND	PROVIDENCE
BOSTON	-	.98/.68	.98/.57	.99/.68	.98/.52
NEWARK	-	-	.99/.57	.99/.54	.98/.34
NEW YORK	-	-	-	.98/.32	.98/.49
PORTLAND	-	-	-	-	.98/.28

TABLE 2

PARAMETER ESTIMATES

METHOD: MAXIMUM LIKELIHOOD ESTIMATION

ASYMPTOTIC t-STATISTICS IN PARENTHESIS

FIRST CITY: CITY WITH THE HIGHEST PRICE

	BOSTON NEWARK	NEW YORK BOSTON	NEW YORK NEWARK	NEW YORK PORTLAND	NEW YORK PROVIDENCE	PORTLAND BOSTON	PORTLAND NEWARK	PORTLAND PROVIDENCE	PROVIDENCE BOSTON	PROVIDENCE NEWARK	PROVIDENCE PORTLAND
T	.57 (4.31)	.88 (5.85)	1.03 (28.81)	1.01 (9.91)	.76 (19.7)	-.25 (-2.41)	.72 (6.19)	-.25 (-1.51)	-.12 (-.74)	.60 (7.19)	.76 (2.67)
σ_u^2	1.85 (1.96)	2.34 (2.39)	.73 (2.46)	2.81 (3.30)	1.47 (28.9)	1.79 (1.85)	2.66 (2.12)	6.77 (1.48)	1.69 (.89)	3.06 (1.87)	2.81 (2.45)
σ_v^2	0.19 (2.51)	.17 (2.30)	.09 (5.16)	.06 (2.02)	.09 (3.68)	.34 (3.63)	.14 (2.19)	.40 (2.68)	.52 (3.12)	.23 (4.21)	.11 (.99)
λ	.33 (1.96)	.41 (2.42)	.20 (2.73)	.65 (5.60)	.72 (209.3)	.22 (3.80)	.30 (2.08)	.15 (1.60)	.15 (.72)	.18 (2.23)	.81 (3.81)
N	124	120	151	113	118	105	136	75	97	144	74
TRANS-ACTION COSTS (in 1980 cents)	1.77	2.40	2.81	2.76	2.13	.78	2.05	.78	.89	1.82	2.14
Log L	-131.6	-.140.4	-.81.8	-142.6	-130.2	-121.6	-135.9	-98.6	-120.9	-150.8	-103.8

TABLE 3

POSTERIOR PROBABILITY OF AUTARKY STATE (%)
FREQUENCY DISTRIBUTION

	BOSTON NEWARK	NEW YORK BOSTON	NEW YORK NEWARK	NEW YORK PORTLAND	NEW YORK PROVIDENCE	PORTLAND BOSTON	PORTLAND NEWARK	PORTLAND PROVIDENCE	PROVIDENCE BOSTON	PROVIDENCE NEWARK	PROVIDENCE PORTLAND
0-10	28.2	12.5	53.6	2.6	0.0	41.9	46.3	72.0	58.3	68.7	0.0
11-20	25.8	28.3	22.5	14.2	1.7	20.0	16.2	14.7	24.7	10.4	0.0
21-30	8.1	10.8	7.9	8.0	8.5	20.9	8.1	0.0	3.1	4.9	6.7
31-40	10.5	13.3	0.0	8.0	11.0	1.9	1.5	4.0	4.1	4.9	1.3
41-50	8.9	2.5	2.0	8.8	9.3	1.9	3.7	0.0	5.1	0.7	10.8
51-60	0.0	2.5	4.0	2.6	5.4	4.8	0.0	0.0	0.0	1.4	5.4
61-70	0.8	3.3	2.0	3.5	10.2	1.9	9.5	0.0	1.0	0.0	6.7
71-80	0.8	0.8	0.0	1.8	4.2	0.0	0.0	1.3	1.0	0.0	6.7
81-90	4.8	7.5	1.3	1.8	5.1	0.0	0.0	0.0	0.0	0.7	0.0
91-100	12.1	18.3	6.6	38.0	41.5	6.7	13.2	8.0	2.1	8.3	52.7
MEAN	.33	.41	.20	.65	.72	.22	.30	.15	.15	.13	.81
N	124	120	151	113	118	105	136	75	97	144	74