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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

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 h3S recently r~ceived much attention in delineating markets (Stigler and Sherwin (1983), Horowitz(1972».5 These papers define

'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.

2The classicists used transaction costs explici tly in defining and analyzing the developments_of markets. See for example Marshall (1936, p.112 and pp.323-330).
3Cournot's definition of a market is as that "entire territory of which the parts are so united by the relations of unrestricted CODnerce that prices there take the same level throughout, wi th ease and rapidi ty" (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.
5For a collection of many of the papers addressing the defini tion of markets (mostly in relation to antitrust) see Elzinga and Rogowsky(1984). Scheffman and Spiller (1984) discuss the difference between 'antitrust' and (Footnote continued)

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 ci ty 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, ho~ often the arbitrage conditions among
them are binding.7 Moreover, it is difficult to envision a set of agents
wi th binding arbi trage condi 316 0 0 119 Tm (t.0528 0 0 1f Tm (th)Tj847 0 0 11.7 6T9177

- 6-

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 Pt and �p�~� the autarky prices.

[Insert Figure 1 approximately here]

If the transportation costs from region 1 to 2 exceed �P�~�-�p�t�,� then no trade will take place and we may say that the two regions are not in the

8

same market. Let, however, the transportation costs be given by �T�o�<�p�~�_�p�t�,� then observed it.7r, may

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 • Tbe Model.

Consider two separate regions: 1 and 2. In the presence of legal trading barriers the autarky equilibrium prices (p£A,PrA) 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,
(, a)

(1 b)

where the random error term E€ represents shocks to the markets in each region. In the absence of legal trading barriers but with finite

transaction costs, the observed prices (P£. Pr) may diverge from the
autarky prices. Denote the transaction costs in each period by
Tt.9Then, if the autarky prices differ by less than Tt, no a:'bitrage opportunities arise and the observed prices are in fact the autarky prices.

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For simplicity of discussion assume that �p�~�A� > �p�~�A�.� Then if

o < P fA - p £ A < T t (2)

o < p2 - pl < T E t t

� T�h�i�~� .mplies that

On the other hand, if the autarky prices differ by no less than Tt,

arbitrage opportunities ariseand the observed prices will On

- 9-

• Prob �{�l�o�g�[�(�~�2� - w1) + (ct - c£)] - Vt < log T} - >.. (6)

The constant>. is of course a function of �~�i�,� T, �o�~� and the distribution

parameters of the random variables ct in (1). The probability of arbitrage and hence the probability of observing (5) is (1->').
Define a positive random variable Ut, 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 (Pt - P£) B + Vt - Ut

with probability>. and

(8)

with probability (1->'). Equation

- 10-

propensity to trade. Given that a particular period t is at the autarky state, the smaller the positive value of Ut, the higher the propensity to trade. In this paper, the positive random error component Ut is assumed to be distributed independently of Vt with a one-sided half-normal distribution, i.e., the distribution is derived from a normal distribution N(O,oa) truncated from below at zero. Denote 6 • (B, �o�~�,� �o�~�.� A) as the parameter vector for the regressions (7) and (8), then the likelihood function for the n observation is given by:

n

L· IT [Afl + (l-A)fr]

t .. l

(9)

where fl and f€ are the density functions of (7) and (8) respectively.

Define Yt = log (Pt

- 11-

Defining

(13)

the solution for A in (12)

- 13-

from the different sources is then sold at wholesale through terminals. Contract jobbers or independent jobbers are the "explici til 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 cities12 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. Tha tis, gasoli ne 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

12The 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 ci ty 1 to city 2. Assume furt her tha t there i 3 one ot her city whos e autarky price could also be such as to create arbitrage opportunities with some of the other two cities. Clark (1934) 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 i3 not to say, however,

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Providence. The price in Providence, moreover, will also be bound by the prices in surrounding cities (Boston and Portland, Maine).

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IV.b. The Estlaatlon.

We estimated for each city pair the model given by (9)-{ll}.14 Since Yt

is not defined for pr-pt<o. 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 ci ties was the higher one. The other group comprised those observations for which the other ci ty' s price was higher. 15 Each set represents all the instances where arbitrage would have been performed from the ci ty wi th the lower price to that wi th the higher (see equations (2)-(5» • Each di rection of ar-bi trage 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

14 Observe that Tt t4 0 9 32ea in (2)

- 16-

different starting values are used to avoid local

- 18-

any market.

[Insert Table 3 Approximately Here]

While the results of the estimation are plausi ble, 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 wi th very low probabilities of being under �b�i�n�d�i�n�~� arbitrage conditions, and another with high probabilities. In (13), Wt is the posterior probability, given the actual price differentials, of observation t being in the autarky state. We can then classify observations by their Wt • 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 �c�a�~�e�s� the model discriminates between regimes quite well: the posterior probabilities are clustered near zero or near one. That is, for most observations the probabil i ty of an observation belonging to the autarky state is ei ther below 20% or above 80S. Rarely it is in the probability interval 40 to 60S.

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 �b�i�n�d�~�n�g� arbitrage condi tions. The methodology implies the estimation of a swi tching regimes model. One

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BOSTON

NHJARK

NEW YORK

PORTLAND

TABLE 1
CORRELATION MATRIX - LEVEL/FIRST DIFFERENCES

BOSTON NEWARK

. 98/.68

NEW YORK

. 98/.57

. 99/.57

PORTLAND

. 99/.68

. 99/.54

. 98/.32

TABLE 3

POSTERIOR PROBABILITY JF AUTARKY STATE �(�~�)�
FREQUENCY DISTRIBUTION

� ~�~�-�-�.�-�-�-�.� �~�-�-�- �-�~�-�-�-�- �-�.�-�-�-�-�-�-�-�-�-�-�-�-�~�-�-�.� �-�-�~�- ... �-�~� �-�-�-�-�-�~�- . ---- --------------

BOSTON
NEWARK

NEW YORK ' NEW YORK i NEW YORK NEW YORK PORTLAtlD PORTLAND PORTLAND PROV r DE:ICE PROV IDENCE PROV I DUlCE

BOSTON : NEWARK i PORTLAND r PROVIDErICE BOSTON NEWARK : PROVIDENCE BOSTON NEWARK PORTLAND
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i �:�:�:�f�~�l�:�~�-�'� �:�:�~�:�:�:�~�:� ,::: 0-10 28.2

11-20 25.8

21-30 8.1 I
- - - - - _· ____ 1

31-40 10.5

41-50 8.9

51-60 0.0
- - - -

61-70 0.8
----_ .. _--
71-80 0.3

81-'10 4.8

- - -. ...-._-...

91-100 12.1

:AEMI .33

N 124

12.5 58.3

28.3 24.7
- - - - - - - - - t---------- -------".-.- - -- ------------------- ---------
10.8

13.3

2.5

2.5

3.3

0.13

7.5

18.3

.41

120

I

7.9 I 8.0 8.5 2'L 9

- .--------------- -----+--

0.0

2.0

4.0

2.0

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I 1.3 I

._ 1 __ _ -_

6.6

.20

151

8.0 11. 0

i 8.8 3.3

! 2.6 5.4

8.0