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# SPATIAL MONOPOLY, NON-ZERO PROFITS AND ENTRY DETERRENCE: THE CASE OF CEMENT

Ronald N. Johnson and Allen Parkman\*

At least since Kaldor (1935), a number of economists have argued that indivisibilities and accompanying economies of scale in spatially extended economies can negate the zero profit result generally associated with free entry.<sup>1</sup> The essential argument is that if there are industries in which transportation costs are non-negligible and size economies call for firms that are large relative to local demand, even the most intense competition need not result in a zero profit equilibrium. Recently, Eaton and Lipsey (1978) have provided the analytical underpinnings for Kaldor's largely intuitive argument and demonstrate that pure profits can remain even with free entry of new firms and price competition. Eaton and Lipsey (1978, p. 467) suggest that their result depends critically on the existence of the following conditions: (1) the average total cost curve is declining over some initial range; (2) customers are geographically spread out and intermingled with firms; (3) transport is costly; and (4) once the firm enters the market it has location-specific sunk costs.<sup>2</sup>

This paper offers an empirical investigation of the non-zero profit argument as applied to the U.S. cement industry. On a priori grounds, the cement industry appears to meet the necessary conditions for existence of positive, site associated profits. The existence, or at least the belief that the a priori conditions are satisfied has provided a basis for using the industry as a representative case. Scherer (1980, pp. 252-258), for instance, offers a textbook example of entry deterrence through plant location strategy that combines elements of space and the standard deterrence argument.<sup>3</sup> Scherer then notes that, "In an interview

study of plant-size and location decisions in 12 industries across six nations, the author observed by far the strongest emphasis on geographic space packing as an entry-detering strategy in the cement industry" (p. 257). Scherer's example of entry deterrence via strategic plant proliferation is an extension of the Kaldor non-zero profit argument. However, the non-zero profit argument has at least one major drawback: profits in the cement industry have not been significantly above normal for any sustained period.

The first section of this paper considers the evidence of the cement industry's approximation to the Eaton and Lipsey conditions and its historical profitability. Given the contradictory results between apparent satisfaction of the a priori conditions and the lack of supernormal profits a reformulation of the basic model is presented.

An explanation offered here for the absence of supernormal profits is derivable from the property rights paradigm. The usual procedure in analyzing the reaction to new entrants in a spatially extended model has been to assign either initial locations to a set of firms or provide for a pre-arranged pattern of sequential entry. Both procedures implicitly assign property rights to locational rents and ignore the vital element that there will be competition to be the first plant in a given location.<sup>4</sup> With demand for the product growing, competition to be first at a given location will insure that the timing of construction of the

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<sup>1</sup>An example of the models wherein zero profits are ruled out is Tullock (1965).

<sup>2</sup>Capozza and Van Order (1980, p. 1049) stress that condition no. 4, the immobility of capital, is the critical ingredient.

<sup>3</sup>Analogues of the Kaldor model referred to above are the entry deterrence models of Bain (1954), Modigliani (1958) and more recently Spence (1977).

<sup>4</sup>As an example of the type of jockeying that can go on as firms attempt to establish rights to a market we note the following sequence of events. In the mid-1950s one of the regions of the country where spatial monopoly possibilities existed was the state of New Mexico. At that time the state had no cement plants. The actively competing parties were four firms: Dewey, Kaiser Permanente, New Mexico Cement and Ideal. Dewey announced plans to build a plant north of Albuquerque. However, it decided not to build when Permanente announced in 1956 that it was going to build a plant south of Albuquerque, and New Mexico Cement, a new firm, announced that it was going to build a plant in Las Vegas, New Mexico. The firm in the strongest position was Ideal, which had the only distribution terminal in the state. When Ideal announced that it was going to build a plant, the other parties dropped their plans. The Ideal plant was built in 1959 and is still the only cement plant in New Mexico. (Pit and Quarry, *Annual Reviews of Cement*, January 1957, pp. 58, 59, and 60.)

plant occurs as soon as the discounted net stream of future earnings is positive. A finding that significant dissipation does occur would lend support to the original Kaldor argument as well as indirectly supporting the contention that conditions in the cement industry are conducive to space packing and entry deterrence. The absence of significant dissipation would, when coupled with the lack of supernormal profits, seriously question whether the conditions outlined by Eaton and Lipsey are likely to have much impact on an industry's performance even where the a priori conditions appear to be met.

In the following sections we consider the above-stated hypothesis and provide an empirical test. Our findings suggest that the dissipation that does occur appears to be small and shows up mainly in the form of "suboptimal" plant sizes. In addition, we find no support for the contention that geographic space packing via multi-plant operations offers an effective means for excluding rivals and generating above normal rates of return.

### I. The A Priori Conditions and Profitability

If one accepts the description of the U.S. cement industry offered by Bain (1954) and Scherer et al. (1975) then the critical conditions suggested by Eaton and Lipsey for a non-zero profit result appear to be met. For example, Scherer et al. (1975, p. 80) estimate that operating a cement plant at one-third of the estimated minimum optimal scale would raise unit costs by 26%. Norman (1979, p. 332), using United Nations data, reaches a similar conclusion but suggests that Scherer et al. appear to have underestimated economies of scale. As regards geographical dispersion, inspection of U.S. cement plant locations reveals that all but 10 states have at least one major cement plant.<sup>5</sup> Calcium silicate, which is the major ingredient in the production of cement is essentially ubiquitous in the United States and is not a major factor in determining plant locations within broad areas.<sup>6</sup> In the areas of transportation costs, Scherer et al. (1975, p. 429) list cement as having the second highest composite freight cost index for shipments

out of 101 U.S. industries. As to the fourth condition listed by Eaton and Lipsey, the production of cement involves the use of large cylindrical steel rotary kilns lined with firebrick that are not readily movable.

While the a priori conditions appear to have been met, the profit figures for the industry do not conform to the hypothesis. As the data in table 1 reveal, rates of return in the cement industry have, during the period 1919–1978, averaged out to be slightly less than the average rate of return in manufacturing. A comparison with overall rates of return in manufacturing was chosen because cement production is classified as a manufacturing process in the *Standard Industrial Classification Manual*.<sup>7</sup> Furthermore, comparisons based on a broader spectrum of activity such as average rates of return for all active corporations also indicate that rates of return in cement manufacturing have not been significantly above normal.<sup>8</sup> Of course, there have been periods where earnings in the cement industry have been high such as the 1950s. During that period the cement industry was the subject of anti-trust litigation concerned with price fixing and later vertical integration.<sup>9</sup> Rates of return, however, fell in the 1960s as firms expanded and capacity utilization fell. But more importantly, collusive arrangements are not germane to the non-zero profit argument of Kaldor nor that of Eaton and Lipsey. Above normal profits are alleged to result when the four conditions listed by Eaton and Lipsey hold. However, a possible reconciliation does exist.

<sup>7</sup> According to the U.S. Office of Management and Budget (1972) cement is classified under major group 32 which includes stone, clay, glass and concrete products, and is under the division heading of manufacturing.

<sup>8</sup> Utilizing data from the U.S. Internal Revenue Service on rates of return on all active corporations and cement we constructed yearly ratios in the manner reported in table 1. Over the only period for which data were available from the same survey (1963–1977) the mean value was  $-0.51$  with a standard deviation of  $0.30$ . For the entire period for which IRS data for all active corporations are available (1926–1977) the ratio value using rates of return in cement from data listed in table 1, was  $0.09$  with a standard deviation of  $1.01$ . The latter result, however, may be biased upward as returns reported to the IRS are more apt to be reduced by accelerated depreciation than those appearing in other sources (see Scherer (1980, p. 272)). We conclude that rates of return in cement have not been significantly above average rates experienced elsewhere in the economy.

<sup>9</sup> See Loescher (1959) and Federal Trade Commission (1966). Allen (1971) offers evidence showing that vertical integration did not affect profitability in the cement industry.

<sup>5</sup> Weiss (1972) estimated there are 24 regional cement markets in the United States.

<sup>6</sup> As noted in the U.S. Bureau of Mines (1975, p. 212), "The relative abundance of limestone and other calcareous materials, shales and clays narrows the prospectives and exploration work to delineating the size and chemical uniformity of deposits."

TABLE 1.—COMPARISONS OF RATES OF RETURN IN CEMENT AND MANUFACTURING<sup>a</sup>

Time Period	Cement-Manufacturing (Manufacturing)
1919–1978	–0.14
1919–1940	–0.12
1946–1978	–0.11
1950–1964	0.10

## Sources:

1919–1928	Cement and Manufacturing: R. Epstein, <i>Industrial Profits in the United States</i> (New York: NBER, 1934).
1929–1949	Cement: S. Loeschner (1959). Manufacturing: <i>Statistics of Income, Corporation Income Tax Returns</i> , Internal Revenue Service and Bureau of Internal Revenue, various years.
1950–1964	Cement and Manufacturing: Federal Trade Commission (1966).
1965–1973	Cement: <i>Report of the Federal Trade Commission on Rates of Return in Selected Manufacturing Industries 1964–1973</i> (Washington, D.C.: Federal Trade Commission). Manufacturing: <i>Quarterly Report of Manufacturing Corporations</i> (Washington, D.C.: Federal Trade Commission, various years).
1974–1975	Cement: <i>Corporation Income Tax Returns</i> (Washington, D.C.: Internal Revenue Service, various years). Manufacturing: same as 1965–1973.
1976–1978	Cement: <i>Value Line</i> . Manufacturing: same as 1965–1973.

<sup>a</sup>Average ratios of the differences between the rates of return (after tax) of cement and manufacturing to the absolute value of the rate of return in manufacturing, 1919–1978. A ratio was utilized because accounting procedures and sources vary over the time period 1919–1978. A complete listing is available from the authors upon request.

## II. Competition to be First

The standard versions of the non-zero profit with free entry models contain the first four criteria listed by Eaton and Lipsey.<sup>10</sup> In addition, the market is generally specified as a one dimensional line of unspecified but considerable length over which identical customers are spread at a uniform density. Transport costs are borne by the customer. Within this framework, the analysis typically commences by assuming an initial situation exists wherein firms are evenly spaced along the market line and are charging a common mill price. Given economies of scale and initial spacing, each existing firm is assumed to be earning positive profits.

The existence of positive profits would in the usual neoclassical framework attract new entrants. However, it is expected profits of the potential entrant that are significant, not the profits of the established firms. Even though existing firms have positive profits, with the immobility of plants and all firms having the same cost function, it is both possible and likely that the expected demand curve faced by the new entrant lies everywhere below the average total cost curve. Faced with the constructed “no win” situation entry is deterred and

<sup>10</sup> Tullock's (1965) example is excellent in this regard while also providing a brief discussion of optimum conditions for spatially extended economies.

the existing firms continue to earn above normal rates of return.<sup>11</sup> That, in essence, is the standard non-zero profit argument.

None of the standard versions, however, offer an explanation of how, in a competitive environment, certain firms were able to achieve locations which yield positive economic rents. In the Eaton and Lipsey framework the analysis simply began from an initial equilibrium. No mention is made of how existing firms managed to locate first. Elsewhere, in dealing with related problems of optimal spacing, other writers have assigned patterns of sequential entry.<sup>12</sup> Patterns of sequential entry are property rights assignments and, in the case of cement, have no real world counterpart.

To examine the impact of competition for sites on the non-zero profit argument first consider the optimal timing and size of investment as if exclusive development rights to a particular site existed. Here the site or area can be thought of as a regional market which can be serviced by competitors in adjoining but more distant locations. Assuming that demand for cement over the geographical area is expected to grow over time and given a declining long-run average cost schedule there will exist an optimal time for the construction of the initial plant and a pattern for future expansion. Maximization of net present value would require jointly choosing an initial plant size and timing of its construction as well as future expansion. In a heuristic setting where the market growth rate is expected to be relatively constant and the exit costs of competitors servicing the contested market are assumed to be zero, maximization would call for delaying construction of the initial plant until the rate of return on that investment was equal to the market rate of interest.

If we now abandon the notion that development rights exist, competition to develop the area first will result in construction being undertaken as soon as the present value of the site is positive.<sup>13</sup> Any firm delaying construction beyond that point

<sup>11</sup> For a critical evaluation of entry deterrence–limit pricing models see McGee (1980).

<sup>12</sup> See, for example, Prescott and Visscher (1977).

<sup>13</sup> This point is identical to that obtained by Barzel (1968). In his study on the timing of invention, Barzel shows how resource misallocation can result when competition for patent monopolies leads to premature production of inventions. Our concern in this paper is not to argue whether premature construction of cement plants would increase or decrease overall welfare but rather to establish whether or not and in what form dissipation occurs. See also Tullock (1967) and Posner (1975).

in time will find that a rival has constructed a plant in the area. Premature development implies construction of the initial plant prior to the time when the current rate of return on investment is equal to the market rate of interest. We have arrived at our first implication, namely, that competition to be first should result in accounting rates of return being initially depressed while rates of return in later periods are above normal.

Furthermore, as in the case where development rights exist, the timing of construction of the initial plant under site competition depends on the size of the plant to be constructed. Reducing the size of the plant to some minimum feasible but expandable level that would still allow a preemptive claim to the region can allow an even earlier date of construction. The reasoning here is that reducing the initial plant size in the competitive setting can reduce the losses experienced in the earlier periods. But that in turn would imply a positive present value for the site. Once again, competition to be first will advance the date of construction. Accordingly, competition can be expected to reduce present value to zero by lowering the initial date of construction and reducing initial plant size from the maximizing levels. The result is "premature" construction and "suboptimal" plant sizes.

Having made the general point that competition for preferred sites will reduce net present value to zero we stress that the threat of entry at later dates remains. In a world where demand is growing, the niches between the firms will become increasingly attractive to rivals. The niches expose a firm's flanks and market growth will disturb the equilibrium price. As Scherer has noted, "Recognizing this threat, established producers anxious to maintain their dominance must decide how to cope with it. Preempting the niches by locating plants or other outlets in them may be the answer" (1980, p. 253). Even in the absence of growth, Scherer sees plant proliferation or "geographic space packing" as a deliberate strategy aimed at deterring entry.<sup>14</sup> Such a strategy would involve the formation of multi-plant operations where the spacing of adjoining plants would be set to maximize joint profits while entry is foreclosed by constructing plants in the niches prior to rivals' attempts.

<sup>14</sup>Scherer's model does not involve market growth. Rather, he employs a static, spatially extended model similar to that of Eaton and Lipsey.

Scherer's argument would suggest to us that multi-plant operations should be more successful (profitable) in the above described environment than firms operating fewer plants. Furthermore, plant expansion and firm growth over the long run can be considered a form of preempting rivals. If entry deterrence is of any real significance it should contribute positively to profits. In the following section we provide some evidence on both the dissipation argument and on Scherer's plant proliferation hypothesis.

### III. Empirical Methodology and Results

The empirical model proposed here consists of a single equation:

$$\begin{aligned} ROA_{it} = & \alpha + b_1 \cdot \log AC_{it} + b_2 \cdot REGION_{it} \\ & + b_3 \cdot GROWTH_{it} + b_4 \cdot NEW_{it} \\ & + b_5 \cdot NEW_{i(t-1)} + b_6 \cdot NEW_{i(t-2)} \\ & + b_7 \cdot NEW_{i(t-3)} + b_8 \cdot NEW_{i(t-4)} \\ & + b_9 \cdot NEW_{i(t-5)} + b_{10} \cdot NOP_{it} \\ & + \sum_{j=1960}^{1972} b_j \cdot D_j + e_{it}. \end{aligned}$$

The left-hand variable is the rate of return on total assets earned by firm  $i$  in time period  $t$ .<sup>15</sup> Data on the rates of return on assets were taken from *Moody's Industrial Manual*. The time period covered in our analysis is 1960–1973. We hesitated to go beyond 1973 as merger activities reduced the size of our sample, inflation may have biased the real rates of return downwards after that period, and the increase in the relative price of energy had varying effects on firms depending on their production techniques. Our sample of cement firms was chosen in a manner designed to reduce biases in conglomerate reporting. Firms were included

<sup>15</sup>An alternative measure of the rate of return in our model would be the rate of return on stockholders' equity. Both measures tend to be highly correlated but for our purposes the rate of return on assets is more consistent with our model. During a period when a cement firm is building a new plant, its total assets will be increasing, while stockholders' equity may be decreasing if the increase in liabilities through debt financing exceeds the increase in total assets. This is especially true since firms often have incentives to expense costs rather than capitalize them for tax purposes. When the project eventually generates profits, the rate of return on equity can be substantial because of the relatively small size of equity to total assets. For additional commentary see Van Horne (1971). Nevertheless, we ran our equation with the dependent variable being the rate of return on stockholders' equity. Qualitatively, the results are similar to those reported here.

only if their major line of business was cement, they were publicly held and they had at least one plant in operation throughout the period 1960–1973. Twenty such firms were identified and are listed along with summary descriptive data in the appendix. A brief description of each of the explanatory variables is given below.

Log  $AC$  is the natural log of the  $i^{\text{th}}$  firm's total capacity in year  $t$  divided by the number of plants the firm operated. A complete series on firm capacities for the years 1955–1973 was obtained by utilizing three sources; *Pit and Quarry's Portland Cement Plant Maps*, *Pit and Quarry Publications* and the 1973 *Portland Cement Association, Plant Information Summary*. Capacity is stated in millions of barrels.

Following our argument about the dissipation of rents via the construction of suboptimal plants we anticipate the sign on the coefficient of log  $AC$  to be positive and the size of new plants brought on line to be relatively small. Accordingly, the construction of smaller plants will reduce the firm's rate of return if the coefficient on log  $AC$  is positive.

$REGION$  is a measure of the percentage of each firm's total capacity located in the North Central and Eastern parts of the United States. The variable  $REGION$  was included because the rate of growth in cement sales in those areas was below that of the other major regions in the country.<sup>16</sup> Furthermore, the market density is higher in the East and North Central regions. Holding transportation costs and economies of scale constant, a higher market density would tend to reduce the effect of spatially separated markets. We anticipate the coefficient on  $REGION$  to be negative.

$GROWTH$  is a measure of the percentage change in each firm's total capacity over the preceding five years at pre-existing locations. It is a relative measure of plant expansion activity. With the existence of scale economies, growth in response to increased demand will increase profits. However, if growth is used as a device to preempt rivals, excess capacity could reduce the rate of return in the short run. It is not unambiguously clear what the sign of the coefficient will be.

<sup>16</sup> Regional rates of growth were calculated using value of shipment data for hydraulic cement as reported in the 1963 and 1972 U.S. Census of Manufactures. The states included were New York, Ohio, Pennsylvania, Wisconsin, Michigan, Illinois, Indiana, Maryland and Virginia.

The variables  $NEW_t$  to  $NEW_{t-5}$  measure the percentage addition to existing capacity via the construction of *new plants at new locations*. The lag structure which goes back five periods is meant to capture the hypothesized negative impact of premature construction. The negative effects are expected to diminish as the lag increases. Various forms of the lag structure were utilized including the Almon lag technique.<sup>17</sup> The results obtained using different lag structures were qualitatively the same as the result reported here.

$NOP$  is the number of plants operated by firm  $i$  in time period  $t$ . If multi-plant operations are more successful, we anticipate the sign on  $NOP$  to be positive.

Included in the equation are 13 time dummies ( $D_j$ ). The year 1973 was excluded. Environmental controls were increased towards the end of the 1960s, and while capacity utilization increased in the early 1970s, wages and fuel costs also rose.<sup>18</sup>

As proposed, the data for our testing equation consist of 20 firms taken over 14 years. One estimating procedure for cases of time-series, cross-section pooling is the use of both time and firm dummies. An argument against the use of firm dummies in our case is that it would preempt a major portion of independent sample variation in the primary explanatory variables while also resulting in a loss of degrees of freedom.<sup>19</sup> Instead, we utilize a variance components scheme and obtain maximum likelihood estimates of the coefficients.

In the dummy variable technique, firm effects are treated as fixed while in a variance-components model firm effects are considered random. Hence, with random effects, the error term in our testing equation is

$$e_{it} = u_i + v_{it}$$

where  $u_i$  are the firm effects which are assumed  $IN(0, \sigma_u^2)$  and the  $v_{it}$  are  $IN(0, \sigma_v^2)$ . We further

<sup>17</sup> See Johnston (1972, ch. 10) for a discussion of lagged variables including the Almon lag technique.

<sup>18</sup> For a discussion of factors affecting profitability in the cement industry in the 1960s and 1970s see Portland Cement Association (1978).

<sup>19</sup> This is especially true when the between firm effects are relatively large. In our model, we have the problem that variables such as  $NOP$  vary between firms but there is only slight variation within a firm. The use of firm dummies could in that case capture the effects of the explanatory variable.

assume

$$\begin{aligned} \text{cov}(u_i, u_j) &= \sigma_u^2 && \text{for } i = j \\ &= 0 && \text{otherwise} \\ \text{cov}(v_{it}, v_{jt}) &= \sigma_v^2 && \text{if } i = j, t = s \\ &= 0 && \text{otherwise} \\ \text{cov}(u_i, v_{jt}) &= 0 && \text{for all } i, j, t \end{aligned}$$

and finally

$$\begin{aligned} \text{cov}(e_{it}, e_{is}) &= \sigma_u^2 + \sigma_v^2 && \text{for } t = s \\ &= \sigma_u^2 && \text{for } t \neq s \\ \text{cov}(e_{it}, e_{js}) &= 0 && \text{for all } t, s \text{ if } i \neq j. \end{aligned}$$

Given the above error term specification ordinary least squares (OLS) does not provide efficient estimators. Accordingly, we follow the procedure suggested by Maddala (1971) and Maddala and Mount (1973) and obtain maximum likelihood estimates of the coefficients.<sup>20</sup>

Turning to the results shown in table 2, we first note that the evidence does not strongly confirm the existence of dissipation via premature construction of cement plants. The variables  $NEW_t$  to  $NEW_{t-5}$  carry signs that suggest a time profile that is consistent with our argument; however, the coefficients are not individually significantly different than zero at the 5% level.<sup>21</sup> The coefficient of  $\log AC$  is significantly positive confirming the existence of scale economies among cement plants. Therefore, possibilities for spatial monopoly rents exist. Since significant premature entry was not revealed by the coefficients of the variables  $NEW_t$  to  $NEW_{t-5}$ , we would expect to find that firms established their property rights to a given location by initially building suboptimal plants.

The results indicate that new plants were brought on line at suboptimal sizes. The average cement

<sup>20</sup> We also obtained ordinary least squares (OLS) estimates for the equation. The estimated coefficients obtained are similar to the results from the variance components model. However, a likelihood ratio test definitely indicated that OLS was an inappropriate technique.

<sup>21</sup> Furthermore when we combined the effects of new capacity construction into a single variable covering the entire six-year period the coefficient on that variable was positive but not significantly different from zero at the 5% level. Hence, while one can argue that some dissipation through premature construction is occurring the magnitude appears small with rates of returns depressed as a result of new construction only over a period of one or two years.

TABLE 2.—RATE OF RETURN ON ASSETS: 1960–1973

Constant	3.88 (2.37)	$D_{61}$	2.60 (3.94)
$\log AC$	2.92 (2.94)	$D_{62}$	2.14 (3.31)
<i>REGION</i>	-1.56 (-1.29)	$D_{63}$	1.30 (2.02)
<i>GROWTH</i>	-0.24 (-0.21)	$D_{64}$	0.86 (1.35)
$NEW_t$	-1.63 (-0.92)	$D_{65}$	0.19 (0.30)
$NEW_{t-1}$	-2.01 (-1.16)	$D_{66}$	-0.60 (-0.94)
$NEW_{t-2}$	1.09 (0.64)	$D_{67}$	-1.78 (-2.83)
$NEW_{t-3}$	1.83 (1.08)	$D_{68}$	-1.16 (-1.87)
$NEW_{t-4}$	3.60 (1.77)	$D_{69}$	-1.65 (-2.60)
$NEW_{t-5}$	3.63 (1.61)	$D_{70}$	-2.49 (-3.98)
<i>NOP</i>	-1.09 (-1.19)	$D_{71}$	-0.85 (-1.38)
$D_{60}$	3.62 (5.33)	$D_{72}$	0.04 (0.07)

Note:  $t$ -statistics are in parentheses.  $R^2 = .35$ .

plant in our sample had an annual capacity of around 2.8 million barrels. That figure is considerably less than Scherer et al.'s (1975, p. 80) minimum optimal scale estimate of around 7.5 million barrels. But as Scherer et al. (p. 138) have pointed out, transport costs and other market fragmenting influences offer an explanation as to why existing plants are typically much smaller. In contrast to Scherer's estimate obtained through engineering studies and interview data, Allen (1971) applied a "survivor test" to cement industry data. He concluded that, "Generally the size classes lower than 3.25 accounted for lower proportions in 1963 than in 1957" (p. 261). Over time cement plant capacities have increased.<sup>22</sup> Our data reveal that the average size of new plants brought on line was only 2.2 million barrels. That figure is less than the average of existing plants and well below the estimates of efficient size plants by either Scherer or Allen.

If we accept Allen's figure of 3.25 million barrels as a measure of the minimum efficient operating

<sup>22</sup> Council on Wage and Price Stability (1977, p. 26–30).

scale and compare that to the average size of new plants the coefficient of  $\log AC$  indicates a decline in the rate of return of approximately 1%. Although not trivial, the 1% figure does not constitute a massive amount.<sup>23</sup> This is especially true when it is recognized that in subsequent years most of the new plants will be expanded either by building new additional kilns or expanding existing kilns.<sup>24</sup> Plant expansion then contributes to a higher rate of return via increased economies of scale effects. Generally speaking, the dissipation argument cannot be denied but it certainly does not appear pervasive. Furthermore, our results lend no support to the notion of geographic space packing via multi-plant operations. The coefficient on  $NOP$  has the wrong sign and is not significantly different from zero.

### Implications and Conclusions

In the introduction to this paper we referred to the works of Kaldor, Eaton and Lipsey, and Scherer as showing that a non-zero profit outcome is likely when certain conditions are met. Those conditions were economies of scale, spatially distributed customers and firms, plant immobility and high transportation costs. Based on the findings of Bain, Scherer and others those conditions appear to be met in the cement industry. Yet, long-run rates of return in that industry are not above those of manufacturing as a whole. Given that there are no significant barriers to entry in cement, we postulated that competition for preferred sites could explain the absence of supernormal rates of return over the long run.

Our empirical results, however, indicate little evidence of significant dissipation and that result leads us to question the non-zero profit contention or at least the significance of it in the case of cement. As a consequence, we would also have to question the relevancy of deterring entry via preemptive plant proliferation. Our results indicate that such practices, to the extent they are actually carried out, do not contribute to higher rates of returns. Furthermore, it is difficult to view maps of the cement plant locations and arrive at the con-

clusion that exclusionary tactics employing multi-plant operations or preemptive expansion have been successful. Numerous examples exist where firms have successfully entered what appeared to have been an exclusive territory.<sup>25</sup>

In reviewing the empirical results we are drawn back to the initial conditions specified by Eaton and Lipsey. While we argue that the cement industry meets the four basic conditions outlined in the introduction there are factors that can mitigate the significance of the model's non-zero profit implication. For example, the Eaton-Lipsey (1978, p. 456) model assumes that all firms operate with a similar and indivisible unit of capital. Divisible capital, on the other hand, would make protecting an area from intrusion more difficult. Our results indicate that entry often comes in the form of smaller plants than established units. Furthermore, spatial models either implicitly or explicitly assume a particular form of conjectural variations on the part of competitors. Eaton and Lipsey (1978, p. 457) assume that all firms hold the same set of conjectural variations and expectations about future profits. While convenient, these assumptions may obscure the real underlying process by ignoring costly information and heterogeneous entrepreneurs. Frequent ventures into competitors' territories are not a part of the Eaton and Lipsey static equilibrium analysis. Yet, in 1964, over 20% of all cement shipments were directed through 230 distribution terminals located across the United States.<sup>26</sup> The existence of terminals serviced by rail or barge and often located in the heart of competitor's territories suggests that firms do invade one another's market areas. It appears then, that in actual practice, protecting large monopoly rents is difficult. Accordingly, firms are unlikely to expend large resources (e.g., suboptimal plants and premature construction) obtaining territories that cannot be protected against future entry.

<sup>25</sup> In the 1950s there were two cement plants operating in the state of Colorado. Both were owned by Ideal. By 1959 Monolith had a distribution terminal in Denver served by its Laramie, Wyoming plant. In 1969 Martin Marietta constructed a plant at Lyons, Colorado, approximately equal distance from the two Ideal plants (Pit and Quarry Maps, various years).

<sup>26</sup> Federal Trade Commission (1966, p. 27). Distributional terminals present an opportunity for entrants to use low capital and relatively lower cost transportation. Shipping by rail versus truck can cut shipping costs in half. See Scherer et al. (1975, p. 431). Nevertheless, even with shipping by rail, cement remains one of the more costly products per unit value to ship.

<sup>23</sup> Eaton and Lipsey (1978, p. 462-463) argue by use of simulation that the divergence from the competitive rate of return can be large. They suggest that the returns in spatially extended environments with free entry can be "as much as twice the normal rate of return on capital."

<sup>24</sup> Council on Wage and Price Stability (1977).



Certainly firms are conscious of rivals and are likely to express such concerns along with schemes aimed at deterring entry. But the desire to deter entry is universal. It is the ability to actually do it that counts. The evidence we have presented suggests that entry has not been significantly deterred in the cement industry. Yet, the industry did appear to have met a universal and general set of criteria that suggests supernormal profits and ideal conditions for the successful deterrence of rivals. This study indicates that competition within spatially extended environments is more complicated than the Eaton and Lipsey model would imply and denies that supernormal profits are a likely outcome in such an environment.

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## APPENDIX

TABLE A - 1.—SUMMARY DATA ON CEMENT FIRMS

Firm	Average Plant Capacity 1960–1973 (in millions of barrels)	Average Number of Plants 1960–1973
1. Alpha	1.79	7.86
2. Amcord	3.39	6.71
3. California	4.49	3.00
4. Coplay	3.03	1.50
5. General Portland	3.29	8.71
6. Giant	3.22	1.77
7. Ideal Basic Ind.	2.33	16.57
8. Kaiser Cement & Gypsum	3.88	4.78
9. Keystone	3.30	1.00
10. Lehigh	2.44	10.71
11. Lone Star	2.56	13.64
12. Louisville	3.68	2.21
13. Marquette	1.77	12.93
14. Medusa	2.49	5.64
15. Missouri Portland	3.74	2.78
16. Monolith	2.50	2.00
17. Oregon Portland	1.53	2.36
18. Penn-Dixie	2.02	8.28
19. Texas Industries	3.14	1.00
20. Whitehall	3.00	1.00