A RAND NOTE

RATES OF RETURN AND INDUSTRIAL INVESTMENT IN METROPOLITAN AREAS WITH PARTICULAR REFERENCE TO CLEVELAND

Aaron S. Gurwitz, Sheila Nataraj Kirby

October 1982

N-1923-CF

Prepared for

The Cleveland Foundation
The research reported herein was performed pursuant to Grant No. 81-455-42U from the Cleveland Foundation.

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This Note examines the effects of changes in the rate of return to investment, by industries in U.S. regions, on the magnitude of investment over time. The research project reported here is part of The Cleveland Foundation's initiative to establish a permanent institutional arrangement for economic monitoring in the Cleveland area.

The economic monitoring process currently envisioned by The Cleveland Foundation will entail five major functions:

- Maintaining, updating, and extending a large-scale data base on local economic conditions, and tabulating data to meet the needs of various local users.
- Developing improved methods for analyzing the effects of external and internal events and trends on the metropolitan economy.
- Preparing regular regional trends reports that examine recent changes in all economic sectors.
- Conducting studies on topics of special interest or concern to local decisionmakers: for example, the factors affecting change in a particular industry, or the likely effects of a particular federal policy or local development project.
- Maintaining an active dialog with community leaders and with economists and technical specialists in other local organizations to enhance the quality of the analysis and to disseminate its findings more effectively.

At present, The Rand Corporation is helping to start the process, carrying out the functions listed above temporarily until local institutional arrangements have been implemented to assure their continued performance.

The particular research project reported here was begun with two objectives in mind. First, Rand wished to develop information that could inform strategic choices by Cleveland policymakers as to which
mechanisms of assistance to implement. Second, the findings reported here are expected to prove useful to the permanent monitoring group should they decide to build an econometric model of the Cleveland economy.
This Note deals with the question of what makes businesses choose to invest in one place rather than another. Businessmen and economists generally assume that investment is attracted to places that offer the highest rates of return on new plant and equipment. However, just stating this assumption does not tell a complete story. Some industries may be more or less sensitive to rate of return differences than others. For some industries in some places—the steel industry in Pittsburgh, for example—the specific year-by-year local rate of return may matter less than the total supply of investment funds to the industry as a whole in the United States. Because of its dominant role, the Pittsburgh steel industry will prosper whenever the American steel industry prospers.

Information about the responsiveness of regional industrial investments to differences in rates of return is of particular value as an aid in developing strategies for economic development. The assistance directed at local industries should be tailored to the specific characteristics of those industries. For example, programs aimed at raising the local rate of return for a specific industry through productivity improvements or changes in the climate of labor relations should be directed at those industries whose local investment is most sensitive to local rates of return. Local lobbying in Washington for policies favorable to expansion of specific industries should focus on the industries whose local investment is most sensitive to the national supply of investment funds for the industry as a whole.

As valuable as such information might be, very few statistical studies of the relationship between local rates of return and regional investment have been reported in the literature. In order to compute an average rate of return for an industry in a region one must have a figure for the size of the industry's existing capital investment in the region. Such figures are not routinely collected
or published. Consequently, the statistical results presented here are based on an estimate of each industry's existing capital investment in each region in our sample. Developing such estimates requires a number of assumptions, and, while our approach is reasonable and has received some acceptance in the economics profession, there is substantial margin for error. The interpretation applied to the results, therefore, is quite conservative.

Our statistical analysis focused on the determinants of investment in five durable goods manufacturing industries (primary metals, fabricated metal products, nonelectrical machinery, electrical equipment, and transportation equipment) between the years 1964 and 1978 in metropolitan Cleveland and four other metropolitan areas (Atlanta, Houston, Pittsburgh, and San Francisco-Oakland). In general we found a statistically significant rate of return effect of substantial magnitude and of the expected direction for four out of five industries in Cleveland. The exception was the transportation equipment industry. For the four other industries, on average, we found that if value added by Cleveland manufacturers increased by about 0.5 percent (the efficiency of the industry elsewhere in the United States and industry payroll in Cleveland held constant), annual investment in Cleveland industries would increase by about 1 percent. Likewise if industry payrolls in Cleveland decreased by 0.5 percent (everything else held constant), annual investment would, again, increase by 1 percent.

Our statistical analysis also revealed some interesting differences among industries. The most statistically reliable among these are that

1. Investment in the nonelectrical machinery industry in Cleveland is the most sensitive to rate of return differences and least sensitive to national investment trends in the industry, and

2. Investment in the primary metals industry in Cleveland is least sensitive to rate of return differences and most sensitive to national investment trends in that industry.
These conclusions suggest that a strategy for economic development for metropolitan Cleveland might well include programs aimed at raising the rate of return to local investments in the nonelectrical machinery industry along with concerted lobbying in favor of national policies aimed at helping the primary metals industry.

Analysis of data for other regions suggested that the sensitivity of the nonelectrical machinery industry to rate of return differences is a widespread phenomenon, at least among the metropolitan areas in our sample. The analysis also suggested, however, that the determinants of industry investment differ markedly across regions. In general, each industry in each metropolitan area is a special case.
ACKNOWLEDGMENTS

Valuable contributions to this Note were made by Susan N. Lajoie, The Cleveland Foundation Program Officer responsible for the economic monitoring project, who reviewed earlier drafts and made many helpful suggestions, as did the local "panel of economic advisers" set up by The Cleveland Foundation as part of the project. Panel members were not asked to endorse the analysis or its findings, but the authors nonetheless benefited from their insights and suggestions. Members include: Ronald Adams, Polytech, Inc.; Roger A. Brown, Republic Steel; John F. Burke, Jr., Business Research, Inc.; Wynn Van Bussman, TRW, Inc.; Julian Fore, City of Cleveland Department of Economic Development; Gerhardt Mensch, Weatherhead School of Management, Case Western Reserve University; James S. Moose, The Standard Oil Company (Ohio); Nels E. Nelson, Nance College of Business, Cleveland State University; Daniel A. Pavsek, AmeriTrust Company; Robert H. Schnorbus, Federal Reserve Bank of Cleveland; and James Trutko, Greater Cleveland Growth Association.

Several colleagues at Rand provided valuable assistance in the preparation of this Note. The project was designed and implemented under the guidance of C. Thomas Kingsley, then Director of Rand's research program in housing and urban policy and Principal Investigator for the Cleveland project. David Lyon, Vice President and head of Rand's Domestic Research Division, also provided valuable guidance and support. We received periodic infusions of sound analytical advice from Peter Reuter, highly competent data base management from James Small and Priscilla Schlegel, and a thorough and constructively critical review of an earlier draft from James Dertouzos. Susanne Farmer typed several versions of this complicated manuscript quickly and flawlessly.
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INTRODUCTION

This Note presents initial empirical estimates of the relationship between investment in five durable goods industries in U.S. metropolitan areas and three general determinants of the magnitude of the investment. The particular geographic focus is metropolitan Cleveland. This information is valuable both as a guide to strategic policymaking with respect to metropolitan economic development and because it deepens our understanding of the determinants of regional differences in industrial growth rates.

The three determinants of gross investment in industries in a region are: the total national supply of investment funds to the industry, the rate of return to industrial investment in the region relative to the rate of return available elsewhere, and maintenance and other incremental investments that are tied to existing, lumpy investments.

There are a number of reasons to believe that the relative and absolute magnitudes of the effects of these determinants will vary across industries and across regions. Some industries may be footloose. Investment in these industries will be directed at whatever region offers the highest rate of return. Industries might not be footloose for two reasons. First, the location of supplies of inputs and markets for outputs and the structure of transportation costs may be such that investment will always take place in one of a very few places. For these industries in those places, the total supply of investment funds to the industry nationwide will determine regional investment. Other industries might be able to locate anywhere if they were starting from scratch, but are tied down by existing plants. Up to a point incremental and maintenance investments will be higher than they might otherwise have been in places with existing plants.

Corresponding to each of these determinants of the level of local investment in an industry is a class of actions that might be undertaken by regional leaders to induce growth of the industry in the metropolitan area. Efforts can be aimed, through lobbying efforts in Washington, for example, at increasing the supply of investment funds to an industry as a whole through such mechanisms as industry specific tax breaks, import controls, changes in regulations, and so on. Other
federal policies influence the total supply of investment funds to all
durable goods industries, and these too are at least somewhat sensitive
to concerted lobbying from populous regions.

The short run rate of return on capital invested in an industry
in a region can be influenced by a wide variety of instruments includ-
ing direct subsidies through industrial revenue bonds, indirect subsi-
dies through tax abatements, and more subtle policies such as communi-
wide changes in the climate of labor-management relations.

To the extent that an industry is tied to large, lumpy investments
in plant, communities lucky enough to have such plants can feel some-
what secure, at least in the short run. However, as the recent experi-
ence of many northeastern metropolitan areas indicates, conditions can
reach a point where even the largest plant will be abandoned. If incre-
mental expansions and modernizations are closely tied to the location
of existing fixed investments, such large losses are especially damag-
ing to a metropolitan area: not only because the loss itself is large,
but because it will be especially difficult to recoup. Again, communi-
ities have a number of means at their disposal that can help keep a
firm or plant in operation over a difficult period.

The purpose of this Note, then, is to assess the relative impor-
tance of each determinant of regional investment for each of five major
durable goods manufacturing industries: primary metals (SIC 33), fab-
ricated metals (SIC 34), nonelectrical machinery (SIC 35), electrical
equipment (SIC 36), and transportation equipment (SIC 37).

The next section of this Note presents a brief review of the
theoretical and empirical literature on regional industrial invest-
ment. A section on data sources and econometric considerations indi-
cates the assumptions that underlie the statistical results, beyond
the general assumption that there are three broad determinants of re-
gional gross investment. This is followed by a tabulation of econo-
metric results for investment series for the five industries in Cleve-
land and for a pooled set of time series and cross-sectional data for
Cleveland and four other metropolitan areas (Atlanta, Houston, Pittsburgh,
and San Francisco-Oakland. The Note concludes with a discussion of the findings and their application to the strategic issues presented above.

**A BRIEF LITERATURE REVIEW**

Compared with the well-developed literature on aggregate national investment in particular industries or investment by particular firms (Jorgenson, 1971), the literature on industrial investment in regions is fairly rudimentary. The theoretical determinants of firm location decisions have been well understood for a long time (Weber, 1929; Moses, 1958; Kahalili, Mathur, and Bodenhorn, 1974). Firms choose locations for the same reason they choose to use some quantity of any other input: to maximize profits. The source and transportation cost of inputs, the transport costs of outputs, and the location of markets for final products all enter the equation. However, specific analytical conclusions about what types of firms will choose to locate or expand production in what types of locations are difficult to reach, primarily because once the number of inputs purchased from different locations or the number of markets served exceeds one, the mathematical structure of the optimization problem generates few useful general solutions. Most of the theoretical literature on the location of investment, therefore, confines itself to very special cases (e.g., Whitmore, 1981).

Again, compared with the vast amount of literature on the inter-regional migration of labor (Greenwood, 1975), surprisingly little empirical work has been reported on flows of capital across U.S. regions. In fact, the sole journal article that treats this subject explicitly is one by Robert Engle (1974), which deals with the determinants of investment levels for four broadly defined manufacturing industries only in the Commonwealth of Massachusetts.

Engle regressed three-year moving averages of state investment in durable and nondurable goods manufacturing industries on the relative rates of return in Massachusetts and national investment levels in the four broadly defined manufacturing industries. Rates of return were computed by dividing the difference between value added and aggregate payroll (profits) by an estimate of the gross book value of
depreciable assets. Rates of return were computed for Massachusetts and for the United States as a whole. For some industries the relative rate of return was measured as the ratio between the rate of return in Massachusetts and the United States; for other industries the rate of return ratio between Massachusetts and the state in which the rate of return in that industry group was highest in a particular year.

Of course, as Engle pointed out, investment in a region should be driven by the rate of return on marginal investments, not on the average rate of return described above. However, as Engle argued, if one assumes a Cobb-Douglas production function, the ratios of marginal and average rates of return will be identical. We will make that assumption. Any further work on the subject of interregional investment patterns should devote attention to the implications of more general production functions.

Engle's findings fall into three categories. First, he found that the model "worked," in that the relative rate of return carried a significant coefficient of the expected sign for each of the equations. This was considered especially satisfactory given the crudity of the regional variables, especially the capital stock variable (see below). Second, after experimenting with a variety of lag structures, Engle found that no specification generated a statistical improvement on a three-year moving average for each of the variables in the equation. Finally, Engle tested the possibility that a regional accelerator, in addition to the relative rate of return, influenced regional investment. Flexible accelerator models have effectively explained much of the time series variance in national investment, but, as Engle's findings indicate and as our experiments along the same lines confirm, regional accelerators do not appear to explain regional investment, once the rate of return effect is accounted for.

This Note is an extension of Engle's work. Our basic objective was to apply Engle's approach to data on manufacturing industries for Cleveland and a pooled sample of other metropolitan areas. We wished to determine whether Engle's findings extended to a region with a very different economic structure and whether the determinants of industry investment were similar across all metropolitan areas. Consequently,
we have extended Engle's work in three ways. First, we focus on durable goods manufacturing entirely, because this sector tends to be highly concentrated regionally, but, unlike mining, for example, is not bound to a particular place. Durable goods are broken down into five sectors instead of two, and we find substantial variation in the determinants of expenditure among the two digit industries. Incidentally, our breakdown into standard two digit categories makes comparison with national studies of investment behavior easier than Engle's somewhat idiosyncratic aggregation. Second, we have pooled time series and cross-sectional data for several cities. In this Note the pooled data allow us to determine whether the forces that affect regional investment in durable goods industries vary substantially across regions. In one area, however, we have not yet extended our work as far as Engle did. He normalized the Massachusetts rate of return sometimes by the national rate of return and sometimes by the state with the highest rate of return for the industry in a particular year. At this point we have normalized only by the national rate of return.

DATA SOURCES AND TRANSFORMATIONS

The major data sources for the study are the Annual Surveys of Manufactures and the Census of Manufactures conducted by the Bureau of the Census. The annual surveys are undertaken during the intercensal periods; as a result, the two together provide a continuous series of basic statistics for geographic areas and industries. National, state, and standard metropolitan statistical area (SMSA) data for two digit durable goods industry (SIC codes 33, 34, 35, 36, and 37) were collected and value added by manufacture, payroll and new capital expenditures for the period 1964-1978. Five SMSAs were selected as the focus for this study: Atlanta, Cleveland, Houston, Pittsburgh, and San Francisco-Oakland. These metropolitan areas were chosen because they were close together in size and because complete time series data on all five durable goods manufacturing industries were available.

The most critical data problem was the measurement of the regional rate of return, which required the construction of a capital stock series. No data are available at the SMSA level on capital stock;
instead, a number of strong assumptions were made that allowed us to get benchmark estimates of the capital stock for 1964 and 1978. Gross book value of total assets was reported at the state level for two digit industries for only these two years (although it is available for one prior year, 1957). We assumed that the ratio of capital stock in the SMSA to capital stock in the state was the same as the ratio of value added by manufacture for that industry in the SMSA to value added by manufacture in the state as a whole. In other words, for industry i, we assumed that

\[
\frac{K_{1964}^{SMSA}}{K_{1964}^{State}} = \frac{VA_{1964}^{SMSA}}{VA_{1964}^{State}} = \alpha
\]  

(1)

and similarly for 1978. This gave us initial and ending data points for the regional capital stock series.

Next, a simple stock-adjustment model was specified:

\[
K_t = (1 - \delta)K_{t-1} + I_t
\]  

(2)

where

- \(K_t\) = capital stock in time period t
- \(K_{t-1}\) = capital stock in time period t-1
- \(I_t\) = investment during time period t
- \(\delta\) = depreciation factor.

This assumes that all investment is in place and translated into effective capital stock without delay. Summing over the fifteen-year time period:

\[
K_{1978} = (1 - \delta)^{14}K_{1964} + (1 - \delta)^{13}I_{1965} + (1 - \delta)^{12}I_{1966} + \\
\ldots + (1 - \delta)I_{1977} + I_{1978},
\]  

(3)

where \(K_{1964}, K_{1978}\), and \(I_{1965}, \ldots, I_{1978}\) are known and \(\delta\) is unknown.
A numerical grid search with possible values of δ ranging from 0.02 to 0.25 was undertaken to find the δ that came the closest to solving Eq. (3). This value was then used, along with investment (new capital expenditures) data, to generate a capital stock series. Notice that the δ is a peculiar hybrid of physical and economic depreciation factors, since we are working with gross book value figures to begin with.

An average rate of return was then calculated using other fairly standard assumptions. The difference between value added and the total wage bill is an approximate measure of total profits. Dividing total profits by the capital stock provides a measure of the average rate of return to capital. A similar procedure was used to compute the U.S. rate of return, and the ratio of regional to U.S. average (and marginal) rates was entered into the regressions.

This procedure is probably the best simple approach available for estimating sub-state regional capital stocks and, therefore, regional rates of return over a period of years. The method does, however, have two serious flaws. First, gross book value itself is not the most appropriate measure of the economic value of a stock of capital. Second, the fact that the regional investment series enters both as the dependent variable and as part of the information used to calculate one of the independent variables could introduce some severe problems. Whenever, for example, there is a positive error in the measurement of investment, there will be an overestimate of the capital stock for that and ensuing years and, therefore, an underestimate of the rate of return. The opposite is also true: any negative error in measuring investment introduces positive errors in the measurement of rate of return. This inverse relationship among errors could obscure the posited positive relationship between relative rate of return and regional investment or even produce a spurious negative estimated effort. The method, therefore, is particularly dependent on the quality of regional investment data from the Survey of Manufactures.
ECONOMETRIC CONSIDERATIONS

The estimating equations for the single city Cleveland data have a simple econometric structure.

\[ I_{it} = \alpha_o + \sum_{n=1}^{3} \alpha_n \frac{r_{it-n}^c}{r_{it-n}^{us}} + \alpha_4 N_{it} + U_{it} \]  \hspace{1cm} (4)

where \( I_{it} \) = three-year moving average of capital expenditures in industry \( i \) in Cleveland in years \( t \), \( t-1 \), and \( t-2 \)

\( r_{it}^c \) = rate of return on gross book value of depreciable assets in Cleveland in industry \( i \) in year \( t \)

\( r_{it}^{us} \) = rate of return on gross book value of depreciable assets in industry \( i \) in the United States in year \( t \)

\( N_{it} \) = three-year moving average of total national investment in industry \( i \) in years \( t \), \( t-1 \), and \( t-2 \)

\( U_{it} \) = a random variable with mean zero.

The choice of the functional form and the specification of three-year moving averages for the dependent variable and for national investment follow Engle's work. We did not believe that our data set was large enough or of sufficient quality to support useful experimentation with alternative specifications.

Initially we estimated such equations with each lagged value of the relative rate of return entered separately and tested the null hypothesis that the lag coefficients were equal. The null hypothesis was rejected in one case: nonelectrical machinery. Also, we initially estimated the Durbin-Watson statistic from an ordinary least squares computation. In cases where this statistic unambiguously indicated serially autocorrelated errors, we reestimated using a first order autoregressive adjustment.

Estimations based on pooled data are econometrically more complex. The estimating equation was as follows:

\[ I_{ijt} = \alpha_o + \sum_{n=1}^{3} \alpha_n \frac{r_{ijt-n}}{r_{it-n}} + \alpha_4 N_{ijt} + \alpha_5 K_{ijt} + V_{ijt} \]  \hspace{1cm} (5)
where \( I_{ijt} \) = three-year moving average of capital expenditures in industry \( i \) in city \( j \) in years \( t, t-1, \) and \( t-2 \)

\( r_{ijt} \) = rate of return on gross book value of depreciable assets in industry \( i \) in city \( j \) in year \( t \)

\( r_{it} \) = rate of return on gross book value of depreciable assets in industry \( i \) in the United States in years \( t, t-1, \) and \( t-2 \)

\( K_{ijt} \) = gross book value of depreciable assets in industry \( i \) in city \( j \) in year \( t \)

\( NI_{ijt} \) = three-year moving average of total national investment in industry \( i \) in years \( t, t-1, \) and \( t-2 \)

\( V_{ijt} \) = a random variable with zero mean and variance discussed below.

Ordinary least squares estimates are unbiased, but, given the possible sources of heteroskedasticity inherent in pooled data, OLS is unlikely to be an efficient estimator. Two sources of autocorrelation among the observations within single city time series should be accounted for: serial autocorrelation and some constant correlation among a single city's observations. In addition it is possible that errors across cities may be correlated at a single point in time. Furthermore, one should, in general, allow for the possibility that coefficients may differ systematically across cities. We have been unable to account for all of these possibilities simultaneously, because computational software for the optimal estimator is unavailable. The estimates reported here assume a constant correlation among the residuals for observations from a single city. This constant correlation is reported as \( \rho \) in the table below. Values of \( \rho \) are used to construct the variance-covariance matrix for a generalized least squares estimator. The estimation technique searches over the values of \( \rho \) and chooses the value that maximizes the log-likelihood ratio. Other sources of non-constant variance and the possibility of variable coefficients across cities should be considered in future work.

In addition, two econometric techniques were applied to deal with the general problems of errors in variables and the small sample sizes we had to work with. We had no reliable way of dealing with the potential bias introduced by possible mismeasurement
in the investment series, but we did apply a technique suggested by Leamer (1978) to assess the effects of errors in measurement of the rate of return variable. Leamer's technique involved running a "reverse regression": in this case regressing rate of return on investment. By comparing the inverse of the coefficient on investment in the reverse regression with the coefficient on rate of return in the original equation we get some indication of the effect of measurement error on the estimate. Application of this technique suggested, not surprisingly, the presence of substantial errors in the measurement of this variable. With two exceptions the differences between the two estimates equalled about two standard errors. The exceptions were primary metals, where the difference was much larger, and nonelectrical machinery, where the difference between the two coefficients was negligible.

However, because the presence of errors in variables tends to bias estimated effects toward zero, and because our discussion turns on whether the estimated effects are different from zero, we can still use the estimates to generate a conservative interpretation of the data.

In order to test the robustness and stability of the regression estimates, we used Cook's distance to identify influential extreme points. These are points that unduly affect estimates because they are outliers either with respect to the dependent variable or the independent variable. When only one of these conditions occurs, the regression coefficients may be unaffected but when both occur simultaneously, the observation will have considerable influence on the estimates, as measured by Cook's distance. The likelihood of unduly influential observations is especially severe when, as in this case, we have very few observations.

Application of Cook's distance measure indicated, however, that the estimated coefficients for both the Cleveland and pooled regressions in our study were quite stable and did not appear to be sensitive to any particular observation.

Note also that a capital stock term is not included in the single city specification, but is in the pooled specification. Experiments
with a capital stock term in the Cleveland regression did not generate interesting results, largely, we suspect, because the total magnitude of the capital stock in a single city did not change markedly from year to year. The capital stock variable in the Cleveland equation was, therefore, either carrying the effect of a constant term or of a time term, and, in either case, was not helping to explain time series variance in the level of investment.

Finally, note that only results for a three-year moving average of relative rate of return are reported for the pooled sample. Experimental tests indicated that a more complex lag pattern did not improve on this specification.

REGRESSION RESULTS

The results of the estimates described above are presented in the following table. Overall the reported results seem satisfactory, especially given the relatively poor quality of regional data and the strong assumptions that underlie the estimation of the capital stock. The results for Cleveland mirror Engle's findings for Boston with two exceptions. First, while Engle found that a three-year moving average of the relative rate of return was the best specification of the lag structure of that variable's effects, we found in one case, primary metals, that we rejected the null hypothesis of equal coefficients on the lagged rate of return variables. Second, none of Engle's coefficients had a counterintuitive sign, but one of ours did. We estimated a small but significant negative coefficient on the rate of return variable for the transportation equipment industry. The explanation for this finding may relate to the systematic relationship between measurement errors in investment and rate of return discussed above, and the difference between our estimates and Engle's may be in the different degrees of industrial disaggregation in the two analyses.

In general, however, we find a significant rate of return effect on regional investment of the expected sign for four out of five industries. Furthermore, the estimated effects appear to be of substantial magnitude. This result is especially strong given the likely bias toward zero. The effects of a 1 percent increase in Cleveland's
## Regression Results: Determinants of Regional Investment

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Primary Metals(\text{a}) (SIC 33)</th>
<th>Fabricated Metals(\text{a}) (SIC 34)</th>
<th>Non-Elec. Machinery (SIC 35)</th>
<th>Electrical Machinery (SIC 36)</th>
<th>Transp. Equipment (SIC 37)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cleveland Results</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-3.43**</td>
<td>-0.20</td>
<td>-0.70**</td>
<td>0.12</td>
<td>-0.33*</td>
</tr>
<tr>
<td></td>
<td>(-2.49)</td>
<td>(-1.41)</td>
<td>(-6.14)</td>
<td>(-0.88)</td>
<td>(-3.21)</td>
</tr>
<tr>
<td>Relative Rate of Return (Moving Average)</td>
<td>--</td>
<td>0.27**</td>
<td>0.36**</td>
<td>0.086*</td>
<td>-0.10*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.46)</td>
<td>(11.19)</td>
<td>(2.17)</td>
<td>(-3.09)</td>
</tr>
<tr>
<td>Relative Rate of Return (1 Year Lag)</td>
<td>-0.78</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(-2.83)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Rate of Return (2 Year Lag)</td>
<td>1.66</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(1.70)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Rate of Return (3 Year Lag)</td>
<td>2.24**</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>(2.64)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Investment</td>
<td>0.05**</td>
<td>0.03**</td>
<td>0.0092**</td>
<td>0.0050</td>
<td>0.05**</td>
</tr>
<tr>
<td>(Moving Average)</td>
<td>(3.72)</td>
<td>(3.96)</td>
<td>(4.37)</td>
<td>(0.54)</td>
<td>(8.08)</td>
</tr>
<tr>
<td>R²</td>
<td>0.89</td>
<td>0.72</td>
<td>0.95</td>
<td>0.72</td>
<td>0.94</td>
</tr>
<tr>
<td>F-Statistic (Equality of Lag Coefficient)</td>
<td>7.28</td>
<td>0.26</td>
<td>1.34</td>
<td>0.72</td>
<td>0.08</td>
</tr>
<tr>
<td>Elasticity of Investment with Respect to Rate of Return</td>
<td>1.29</td>
<td>0.50</td>
<td>1.91</td>
<td>1.32</td>
<td>-0.28</td>
</tr>
</tbody>
</table>

| **Pooled Results**   |                                      |                                       |                               |                               |                           |
| Intercept            | -0.28                                | 0.17*                                 | -0.21*                        | -0.049                        | 0.0070                    |
|                      | (-0.57)                              | (2.06)                                | (-2.67)                       | (-0.67)                       | (0.12)                    |
| Relative Rate of Return | 0.083                                | 0.031**                               | 0.14*                         | -0.0063                       | -0.0083                   |
|                      | (0.92)                               | (2.21)                                | (4.62)                        | (0.82)                        | (-1.17)                   |
| National Investment  | 0.059*                               | -0.011*                               | -0.00093*                     | 0.0030                        | 0.0015                    |
|                      | (5.20)                               | (-2.43)                               | (-6.21)                       | (0.82)                        | (0.51)                    |
| Capital Stock        | -0.00012                             | 0.00069*                              | 0.00068*                      | 0.00075*                      | 0.0013*                   |
|                      | (-0.94)                              | (6.12)                                | (4.10)                        | (7.15)                        | (9.99)                    |
| ρ                    | 0.90                                 | 0.39                                  | 0.56                          | 0.55                          | 0.33                      |
| R²                   | 0.46                                 | 0.55                                  | 0.61                          | 0.64                          | 0.69                      |
| Elasticity of Investment with Respect to Rate of Return | 0.08                                 | 0.14                                  | 0.60                          | --                           | --                        |

**NOTE:** t-statistics in parentheses.

*Significant at .01 level.
**Significant at .05 level.
\(\text{a}\)Estimated using a first-order autoregressive adjustment.
relative rate of return would result in more than 1 percent increase in a three-year moving average of investment in three industries, by these estimates.* Nor would a 1 percent increase in relative rates of return be an especially wrenching change in a local industry. If value added for a Cleveland industry increased by about 0.5 percent, Cleveland payroll and national returns being held constant, the relative rate of return in Cleveland would increase by 1 percent. Likewise, if Cleveland payroll decreased by about 1 percent, Cleveland value added and national rate of return being held constant, the relative rate of return would increase by 1 percent. These 0.5 percent and 1 percent estimates are fairly constant across industries. These figures, along with the substantial elasticities derived from the estimates in the table, suggest that relatively small subsidies or relatively small localized improvements in production efficiency could have substantial effects on regional investment trends.

Furthermore, the Cleveland results suggest that subsidization of the regional rate of return is likely to have different effects for different industries. First, the results do not support any particular strategy with respect to the transportation equipment industry. The anomalous finding with respect to the behavior of this industry should be investigated further. It is possible that the automobile industry is so highly concentrated that regional investments do not follow relative rates of return in the "typical" way. For example, GM's decision to build the Hamtramick plant on expensive land in the high wage Detroit area might be difficult to explain in simple economic terms.

It is easy to rank the other four industries according to the sensitivity of their Cleveland investments to rate of return

*The elasticity figures were computed in a straightforward manner for those industries for which the lagged coefficients were taken to be equal (fabricated metals, nonelectrical machinery, and transportation equipment). For the other two industries we assumed that a 1 percent increase in the relative rate of return was experienced in equal increments over a three-year period, and the elasticity was computed on that assumption.
differences. Nonelectrical machinery appears to be most sensitive and fabricated metals least sensitive with the other two industries in between. This suggests that efforts to raise the rate of return on capital invested in Cleveland should focus first on the nonelectrical machinery industry and last on the fabricated metals industry. These rankings are, however, much less certain than the fact of a rate of return effect. Different effects of the errors in variables problem along with the fairly wide confidence intervals around the point estimates might mean that the differences across sectors are statistical artifacts.

The results also suggest that, given the magnitude of the coefficients on the national investment terms, Cleveland's lobbying efforts in Washington should focus on increasing investments in the primary and fabricated metals industries and that regional level efforts should be aimed at the nonelectrical and electrical equipment.

**POOLED RESULTS**

The Cleveland findings were robust with respect to the several specifications of the model we ran. The nonelectrical machinery industry was consistently most sensitive to rate of return differences, the transportation equipment industry consistently generated "strange" results. The next step is to determine whether the effects estimated for Cleveland are generalizable to other metropolitan areas. The results of the pooled estimation indicates that only some of the Cleveland findings are immediately generalizable. As with the Cleveland estimates, the pooled results are generally satisfactory. Again, there is only one counterintuitive, significant coefficient, the negative effect of national investment in the fabricated metals equation. Where in the Cleveland case, we found a significant rate of return effect of the expected sign in four out of five cases, here only two out of five cases generate a significant expected result. Furthermore, while the nonelectrical machinery industry remains the most sensitive to rate of return effects, now the second most sensitive industry is fabricated metals. Also, we find that a great deal of gross investment is explained by the size of the capital stock,
supporting the general finding (Jorgenson, 1971) that most of gross investment is replacement investment, or is otherwise tied closely to existing capital assets in place. It is also possible, however, that the capital stock term is capturing some unmodeled difference across cities.

Because the econometric specification of the pooled equation was no more than an initial exploratory run, we should probably place some faith in the Cleveland specific results. Nevertheless, the pooled findings, as far as they go, do suggest three general things about regional investment patterns. First, the sensitivity of the nonelectrical machinery industry to relative rates of return and its insensitivity to national investment levels is confirmed. This conclusion has an ambiguous policy implication. It strengthens our conclusion that investment in this industry is sensitive to rate of return differences, but this does not necessarily mean that it should be assigned the highest priority for regional subsidization. To the extent that all regions' investment in this industry is sensitive to rates of return, all regions have an incentive to subsidize returns to the industry. If all regions subsidize, then the industry as a whole will simply enjoy the subsidy and the regional distribution of nonelectrical machinery manufacturing will be unchanged.

Second, the conclusion that regional investment in the primary metals industry is most sensitive to the total national supply of investment funds to that industry and less sensitive to differences in regional rates of return is strengthened. This suggests that Cleveland area lobbyists may be able to make common cause with representatives of other primary metals producing regions in efforts to stimulate or protect the growth of this industry in the United States.

Finally, we note substantial differences in the estimated magnitudes of effects across all industries between the Cleveland specific and the pooled estimates. This suggests that the magnitude of the sensitivity of regional investment to, say, rate of return differences differs markedly across regions. It is not enough to say that, for most industries, investment flows in the direction of the highest rates of return. Investigation of regional investment patterns should now
focus on why industries in different regions exhibit different sensitivities to relative rates of return.

CONCLUSIONS

The statistical results presented here allow us to state tentatively two general policy conclusions. Efforts to stimulate growth of the nonelectrical machinery industry in Cleveland should concentrate on policies that will increase the rate of return on investments in that industry in the region with the caveat that Cleveland should avoid joining a zero-sum game of regional subsidization of this industry. Efforts to help the primary metals industry should concentrate on improving the national climate for investment in that industry.

Several other conclusions can be stated with less confidence. Efforts to increase the local rates of return in the primary metals, fabricated metals, and electrical machinery industries may have substantial effect on regional investment rates in those industries. Efforts aimed at increasing national investment in the fabricated metals industry could have a substantial effect on the local performance of that industry.

All of these conclusions are presented with the strong caveat that while we have dealt with the problem of an unmeasured capital stock in a reasonable way, our method is subject to considerable potential error. Consequently, our point estimates of effects are likely to be somewhat wrong. In all cases, however, we have subjected our findings to very conservative interpretations.

These prescriptions should conclude with two important notes of caution. First, the subject of this Note is investment, not necessarily job creation. Under certain circumstances of industry technology and certain conditions of market demand for an industry's products, the result of increased investment could be decreases in local employment in those industries. The next steps in determining which policies with respect to which industries are likely to have the greatest effect on regional employment will involve estimates of
the price elasticity of demand facing Cleveland metropolitan producers (Engle, 1979).

Second, the unavailability of highly detailed annual data on capital flows or of any detailed data on regional capital stocks has forced us to confine our analysis to the two digit level. Assistance to real-world firms will, of course, be on the four or five digit level. The conclusions presented here should, therefore, not simply be mechanically applied to specific instances, but, instead should constitute just one of many considerations that enter into a decision to adopt a policy.
BIBLIOGRAPHY


