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INDUSTRIAL LOCALIZATION. AN EMPIRICAL TEST FOR MARSHALLIAN LOCALIZATION ECONOMIES

Jürgen von Hagen and George Hammond

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Centre for Economic Policy Research
25-28 Old Burlington Street
London W1X 1LB
Tel: (44 71) 734 9110

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ABSTRACT

Industrial Localization. An Empirical Test for Marshallian Localization Economies*

This paper presents empirical tests of the hypothesis that firms cluster geographically due to Marshallian localization economies. The hypothesis implies that changes in employment in localized industries should be more closely related within the regions than across regions. We develop an empirical test of this hypothesis using annual employment data for four US cities and three industries (two-digit SICs) in the durable manufacturing sector. The results suggest that asset sharing is a significant source of localization economies, and that labour pooling effects may play an important role in rapidly growing labour markets.

JEL classification: F15, F20, R12, R23
Keywords: economic geography, regional integration, regional economics

Jürgen von Hagen and George Hammond
Lehrstuhl für VWL VI
Universität Mannheim
Seminargebäude A5
68131 Mannheim
GERMANY
Tel: (49 621) 292 5143

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NON-TECHNICAL SUMMARY

Understanding where economic activities locate and why has long been an issue of importance for economists and policy-makers alike. As European integration becomes deeper and artificial barriers to factor mobility are removed, this question also gains relevance on a European scale and for European policy-makers. European regions will compete more intensively to attract industries. Understanding the determinants of industrial localization, therefore, is important for predicting and dealing with the consequences of European integration.

In some industries, such as extractive industries and many service industries, the location of firms is essentially determined by the nature of their products or their production processes. For others locational choices depend mainly on the availability of large waterways, electrical power stations or other public resources. A large group of industries can locate anywhere, however, because neither their inputs nor their outputs are tied to geographically fixed resources and can be transported at relatively low cost. Among these *footloose industries* are automobile industries, computer industries and tool and machinery industries. This paper deals with the location choices of such industries.

A potentially important class of factors in the location choice of footloose industries are localization economies. Such economies exist when firms of the same industry can reduce average cost by clustering together, or when workers with industry-specific skills benefit from being in a large group of similar workers. In the presence of localization economies, firms and workers will make their choice of location dependent on whether or not similar firms or workers are already located nearby.

The concept of localization economies can be traced back to Marshall. He argued that labour pooling is an important cause of geographical concentration, or localization, of industries. Drawing from a common labour pool allows firms to pay a lower average wage rate over time, and allows firms experiencing positive demand shocks to hire workers with special skills from firms exposed to negative demand shocks. For workers, the attractiveness of being in a labour pool shared among firms results from the implicit insurance against firm-specific shocks.

A second source of localization economies according to Marshall is the sharing of industry-specific assets. Geographical concentration allows firms to take advantage of more highly specialized non-traded assets if they locate near one

another. Furthermore, Marshall argues that knowledge spillovers among firms and workers of the same industry generate localization economies.

The purpose of this paper is to gain further empirical insights into the role and importance of Marshallian localization economies. For this purpose we develop an empirical test based on employment data of a set of US cities and industries.

In the context of Marshallian economics of locational choice, a local industry can be defined as a group of firms sharing a common regional labour pool or a common local asset. Our tests focus on correlations of employment flucutations between firms in the same region and in different regions. Under the labour pooling hypothesis, we should observe that correlation of changes in employment among (groups of) firms of the same local industry is negative and stronger than the correlation of changes in employment among firms belonging to different local industries.

Under the asset sharing hypothesis, in contrast, firms in the same local industry may also be exposed to shocks that are strongly and positively correlated. This will be the case if the dominant shocks hitting these firms are industry-wide demand shocks, or if the main shocks arise from the supply of inputs common to the entire industry. Nevertheless, the hypothesis holds that linkages among firms belonging to the same local industry are stronger than linkages among firms of different local industries. Thus, we expect under this hypothesis that changes in employment are more strongly correlated among firms in the same local industry than among firms in different regions, without, however, discriminating between positive and negative correlations.

Thus, the two empirical hypotheses tested can be summarized as follows:

1. In the presence of Marshallian localization economies the correlation of employment changes should be stronger among firms of the same local industry than among firms pertaining to different local industries.

2. If labour pooling is the dominant source of localization economies, then the correlation of employment changes among firms of the same local industry should be strongly negative.

Our empirical analysis uses two-digit Standard Industrial Classifications (SICs) of firms as published by the US Office of Management and Budget (OMB).

We chose SIC 35, non-electrical machinery including computer manufacture, SIC 36, electrical machinery including television, radio equipment, and semi-conductors, and SIC 37, transportation equipment including automobile and aircraft production. Firms in these three SICs produce durable goods that are readily transportable, and their location decisions are not dictated by the availability of natural resources. To compare employment fluctuations in different

economic areas, we use data for four metropolitan areas, Chicago, Dallas-Fort Worth, Los Angeles and New York.

The empirical evidence supports the notion that localization economies exist and, hence, affect location choices for the cities and industries in our sample. Idiosyncratic shocks to members of the same local industry are more strongly correlated, on average, than they are to the shocks experienced by members of different local industries. This is compatible with the existence of relatively strong intra-regional links among firms of the same industry as predicted by the hypothesis of Marshallian localization economies.

The results further indicate that within-region correlations tend to be positive, particularly in mature labour markets, but negative in rapidly growing labour markets. This suggests that among the sources of localization economies, asset sharing dominates in more mature markets, whereas labour pooling is stronger in expanding markets.

These results have interesting implications for the European Community. Today, European industries are still geographically dispersed due to inherited barriers to factor mobility. If economic and monetary union reduces such barriers, footloose industries are likely to become more geographically concentrated over time. Industry-specific shocks would then be more closely associated with regional shocks. Thus, economic and monetary union might increase the importance of asymmetric shocks to European regions. This would raise the demand for fiscal stabilization of regional shocks at the level of the EC. For this, the EC currently and on the basis of the Maastricht Treaty is ill-equipped.

I. INTRODUCTION

Understanding where economic activities locate and why has long been an issue of importance for economists and policy makers alike. As European integration becomes deeper and artificial barriers to factor mobility are removed, this question also gains relevance on a European scale and for European policy makers: European regions will compete more intensively across international borders to attract industries. Understanding the determinants of industrial localization, therefore, is important to predict and handle the consequences of European integration.

In some industries, the location of firms is essentially determined by the nature of their products or their production processes. For example, the location of extraction industries is dictated by the location of their mineral deposits. Similarly, the location of industries such as food processing may be determined by the production site of their agrarian inputs. Many service activities must be produced close to their customers because their products are not tradeable. Other locational choices may depend on the availability of large waterways or electrical power stations. However, a large group of industries can locate anywhere, because neither their inputs nor their outputs are tied to geographically fixed resources and can be transported at relatively low cost. Among these *footloose industries* are automobile industries, computer industries, tool and machinery industries. This paper deals with location choices of such industries.

Firms and workers in footloose industries can choose their location according to a variety of factors, including the level and structure of local tax rates, incentives offered by local

governments, the quality of the local labor pool, alternative employment opportunities in the region, housing prices, and educational opportunities. An important class of factors in this choice are localization economies. Localization economies exist when firms of the same industry can reduce average cost by clustering together, or when workers with industry-specific skills benefit from being in a large group of similar workers. In the presence of localization economies, firms and workers will make their choice of location dependent on whether or not similar firms or workers are already located nearby.

The concept of localization economies can be traced back to Marshall (1920). He argued that labor pooling is an important cause of geographical concentration, or localization, of industries. Drawing from a common labor pool allows firms to pay a lower average wage rate over time, and allows firms experiencing positive demand shocks to hire workers with special skills from firms exposed to negative demand shocks. For workers, the attractiveness of being in a labor pool shared among firms results from the implicit insurance against firm-specific shocks.

A second source of localization economies according to Marshall is the sharing of industry-specific assets. Geographical concentration allows firms to take advantage of more highly specialized non-traded assets if they locate near one another. Furthermore, Marshall argues that firms and workers may benefit from more intensive exchange of industry-specific knowledge and information if they are geographically concentrated. Thus, as Marshall (1920, p. 271) states: "...if one man starts a new idea, it is taken up by others and combined with suggestions of their

own; and thus it becomes the source of further new ideas." This localization economy is known as knowledge spillovers.

Krugman (1991) and David and Rosenbloom (1990) both address Marshallian localization economies with modern rigor. In addition, Krugman (1991) offers evidence of their relevance for industries in the U.S. He finds a significant degree of geographical concentration in some high-tech sectors such as the automotive and the photographic industries, but also in some decidedly low-tech industries such as textiles. According to his study, about 13% of US employment in the transportation equipment industry is located in the Midwest Census region, compared to only 6% in the South Census region. In contrast, the South has about 12% of employment in textile manufacturing, while the Midwest employs just 0.3% of the industry. Krugman concludes that these two industries are not only geographically concentrated, but they have located in different areas of the country.

The purpose of this paper is to gain further empirical insights into the role and importance of Marshallian localization economies. For this purpose we develop an empirical test based on employment data of a set of US cities and industries. The remainder of this paper proceeds as follows. Section II lays out the hypothesis of interest in more detail. Section III describes the data. Section IV explains the test methodology and presents the results. Section V concludes the study.

II. MARSHALLIAN LOCALIZATION ECONOMIES

According to Marshall (1920), localization economies mainly result from two sources, labor pooling and asset-sharing.

Labor Pooling

Geographical concentration of firms facilitates labor pooling and, thereby, risk-sharing for both firms and workers. Krugman's (1991) version of the economics of labor pooling rests on the following assumptions. Production technologies exhibit increasing returns at the firm level. Internal increasing returns are the reason why production is concentrated geographically in large firms rather than dispersed geographically in small firms. Labor is industry-specific. This gives firms an incentive to locate near other firms in the same industry, and not just near large population centers. The supply of industry-specific labor at any location and point in time is less than perfectly elastic with respect to the industry real wage rate. Thus, there are significant costs attached to moving and acquiring firm-specific skills and local labor pools for individual industries are of limited size in the short run. Finally, firms of the same industry are subject to imperfectly correlated shocks. This means that individual firms are exposed to different risks and there is scope for risk-sharing among workers.

Under these assumptions, a firm has an incentive to locate near a large pool of firm-specific labor rather than a small pool, since the average wage rate is lower and the average profit higher when the number of workers per firm is large. A worker has an incentive to move to locations where a large number of firms demanding his skills exist, since the average wage rate increases with the number of firms in a given labor pool.

These incentives are augmented by implicit insurance effects: If a firm experiences a positive, firm-specific demand shock, it

is more likely to be able to hire additional workers without raising its wage rate if there are many other firms using the same kind of workers nearby, because one of these neighboring firms is likely to be experiencing a negative demand shock, and thus is laying off some of its labor force. Similarly, workers laid off from a firm experiencing a negative demand shock are more likely to find new employment at the same wage rate when firms of the same industry are nearby.

Consider now two different locations at which these assumptions hold and assume that, in the absence of any shocks, real wages and profits are the same in both places. If, for some reason, workers expect that firms move from the second to the first location, the expected average wage decreases at the former and increases at the latter location. Thus, workers have an incentive to move to the first place. Similarly, if firms for some reason expect workers to move from the second to the first place, expected profits increase at the latter and decrease at the former location, and firms will want to move, too. Thus, an equilibrium with an even regional distribution of workers and firms is unstable. Over time, it is likely that workers and firms cluster together in one of the two locations.

Asset-sharing

The other main source of localization economies developed by Marshall is the formation of local markets for industry-specific assets. Such assets include, e.g., information networks, shared training facilities for non-traded, industry-specific skills or particular intermediate inputs. Geographical concentration allows

firms to take advantage of a higher degree of specialization of such assets. Furthermore, regional concentration of an industry allows the suppliers of intermediate goods or production-related services to attain a higher degree of specialization due to the increased local demand for such goods or services. For example, highly specialized legal, accounting and consulting services may only be profitable in a region when the industry using them reaches a critical scale. In turn, once that scale has been reached, the availability of such assets and services will attract additional firms of the same industry to the region.

If labor pooling and industry-specific asset sharing are important in practice, firms and workers of the same industry have incentives concentrate geographically. If so, one should be able to observe strong intra-regional links between firms belonging to the same type of footloose industry. The empirical tests presented in this paper start from this key insight.

Empirical Hypotheses

In the context of Marshallian economics of locational choice, a local industry can be defined as a group of firms sharing a common regional labor pool or a common local asset. Our tests focus on correlations of employment flucutations between firms in the same region and in different regions. Under the labor pooling hypothesis, we should observe that correlation of changes in employment among (groups of) firms of the same local industry is negative and stronger than the correlation of changes in employment among firms belonging to different local industries.

Under the asset-sharing hypothesis, in contrast, firms in the same local industry may also be exposed to shocks that are

strongly and positively correlated. This will be the case if the dominant shocks hitting these firms are industry-wide demand shocks, or if the main shocks arise from the supply of inputs common to the entire industry. Nevertheless, the hypothesis holds that linkages among firms belonging to the same local industry are stronger than linkages among firms of different local industries. Thus, we expect under this hypothesis that changes in employment are more strongly correlated among firms in the same local industry than among firms in different regions, without, however, discriminating between positive and negative correlations.

Thus, the two empirical hypotheses tested below can be summarized as follows: 1. In the presence of Marshallian localization economies the correlation of employment changes should be stronger among firms of the same local industry than among firms pertaining to different local industries. 2. If labor pooling if the dominant source of localization economies, then the correlation of employment changes among firms of the same local industry should be strongly negative.

III. DATA DESCRIPTION

Our empirical analysis uses two-digit SIC classifications of firms as published by the Office of Management and Budget (OMB). We chose SIC 35, non-electrical machinery including computer manufacture, SIC 36, electrical machinery including television, radio equipment, and semi-conductors, and SIC 37, transportation equipment including automobile and aircraft production. Firms in these three SICs produce durable goods that are readily transportable, and their location decisions are not dictated by

the availability of natural resources.

SIC classifications are based on the similarity of products rather than economic definitions of firms or local industries. At the regional level of cities, however, two-digit SIC groups often contain only a small number of firms; comparable data series to ours at the three digit level are not available. To map the theory into observable data, we interpret all firms belonging to the three SICs in the same region as members of the same local industry. This is plausible, since firms in these three SICs engage in relatively high-tech manufacturing and so may be considered candidates for sharing common labor pools or common, industry-specific assets. In contrast, in view of the hypothesis of localization economies, we regard firms in different regions as members of different local industries regardless of their SIC classification. On the basis of this interpretation, we can use the SIC data to derive tests of the importance of Marshallian localization economies.

The analysis of localization economies requires to identify regions as economic areas. This makes SIC data at the state level inappropriate, since state borders often cut through economic areas and some states such as California contain several large economic areas. In view of this, we chose metropolitan areas as the relevant geographical unit. Consistent sectoral data for manufacturing SICs exist for some large US cities from about 1974 to 1991. However, there is considerable diversity in the reporting of two-digit detail, so that there is no guarantee that any particular two-digit SIC will be reported for all large cities. Our tests use annual average employment data from the non-farm

establishment survey for the Chicago[1], Los Angeles[2], Dallas-Ft. Worth[3], and New York City[4] metropolitan areas. These four are chosen based on the availability of two-digit detail, and to include one city from each of the four Census regions.

To set up our tests, we need measures of shocks which are specific to the region and SIC under consideration. Let $L^k_{i,t}$ be employment in SIC i in region k at time t and $L_{i,t}$ be national employment in SIC i at time t. Then relative employment in SIC k in region i at time t is

$$l^k_{i,t} = \frac{L^k_{i,t}}{L_{i,t}} \quad . \tag{1}$$

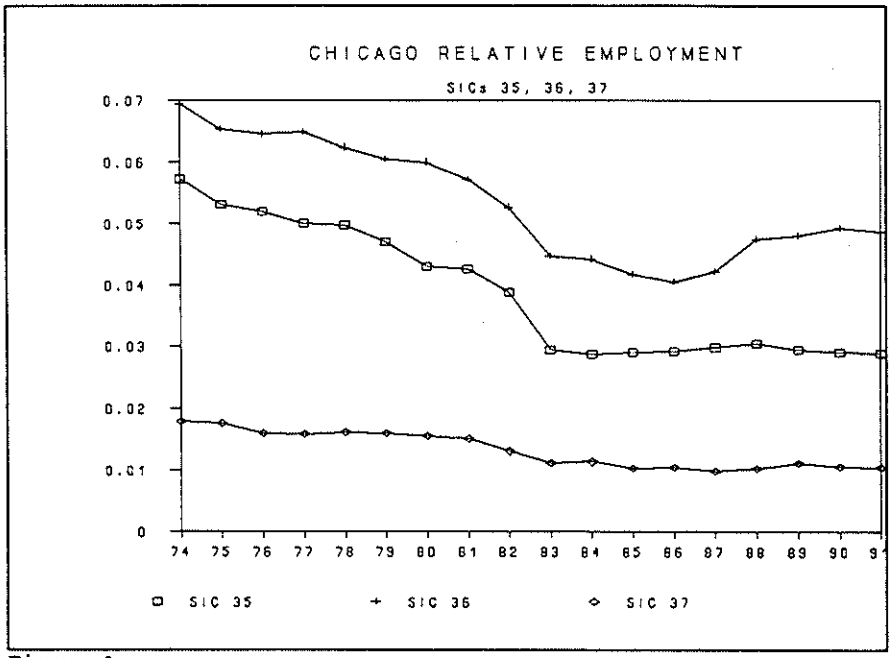

Figure 1

These relative employment series are plotted in Figures 1 to 4.[5]

To filter out the expected component from these series, we regress $l^k_{i,t}$ on a constant, its own first lag, a linear and a squared trend[6] and define the local SIC employment shocks, $y^k_{i,t}$, as the residuals of that regression, i.e.,

$$y^k_{it} = l^k_{i,t} - (\hat{a}_{ik,0} + \hat{a}_{ik,1} l^k_{i,t-1} + \hat{a}_{ik,2} T + \hat{a}_{ik,3} T^2) \ . \qquad (2)$$

Standard tests show that these residuals are not serially correlated.

Our hypotheses above then say that the correlation of idiosyncratic shocks, $y^k_{i,t}$, across SICs within a region should be

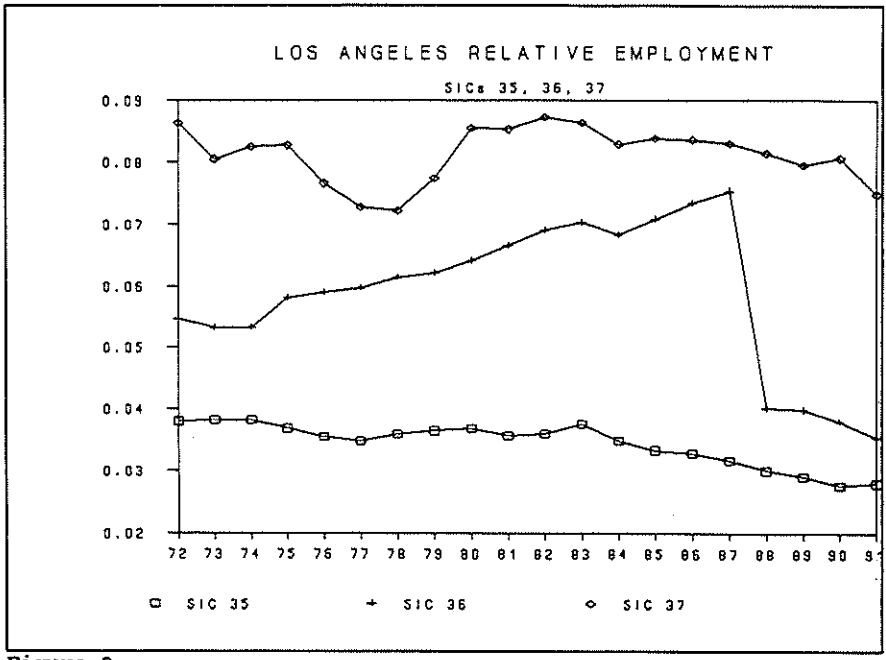

Figure 2

stronger than the correlation of such shocks across regions. In terms of our notation, the correlation between $y^k_{i,t}$ and $y^k_{j,t}$ should be stronger than the correlation between $y^k_{i,t}$ and $y^l_{i,t}$.

The empirical approach to testing for localization economies used in this paper is thus different from Krugman's (1991) approach. There, the analysis focuses on relative amounts of employment in certain industries across regions and on average over long periods of time. With the focus here on the correlation between employment shocks, our analysis is more closely related the regional economics literature concerned with industrial diversification.[7]

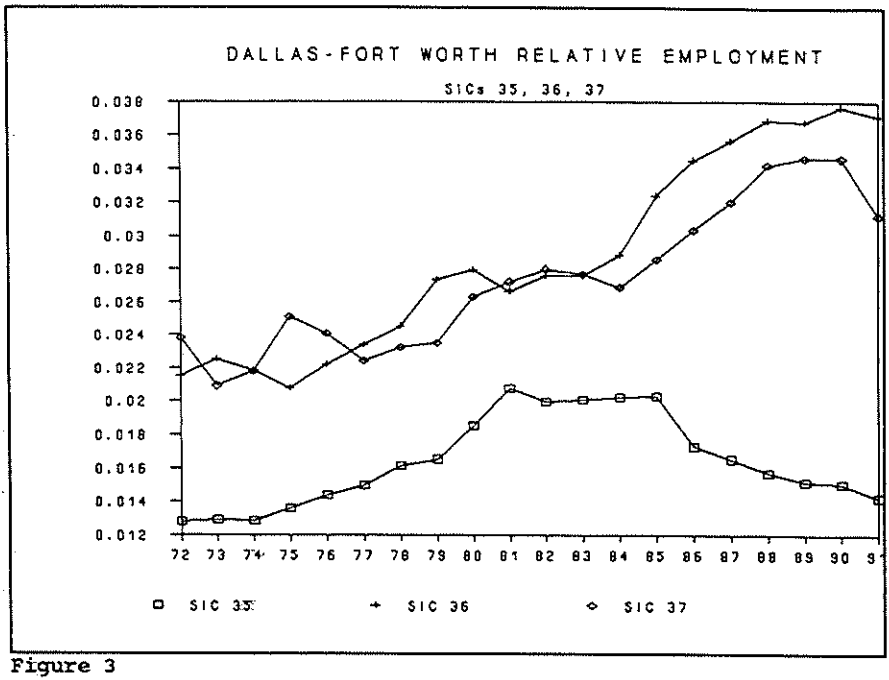

Figure 3

IV. EMPIRICAL TESTS

To test our hypotheses, we wish to compare the correlation of SIC employment shocks within and across regions. Given our set of three SICs and four cities, the correlation matrix of our shock series is the 12 by 12 matrix

$$R = \begin{bmatrix} P^{11} & . & . & . \\ P^{21} & P^{22} & . & . \\ P^{31} & P^{32} & P^{33} & . \\ P^{41} & P^{42} & P^{43} & P^{44} \end{bmatrix} \qquad (3)$$

where each P^{kl} is a three by three matrix of partial correlations of shocks to the three SICs in city k and city l,

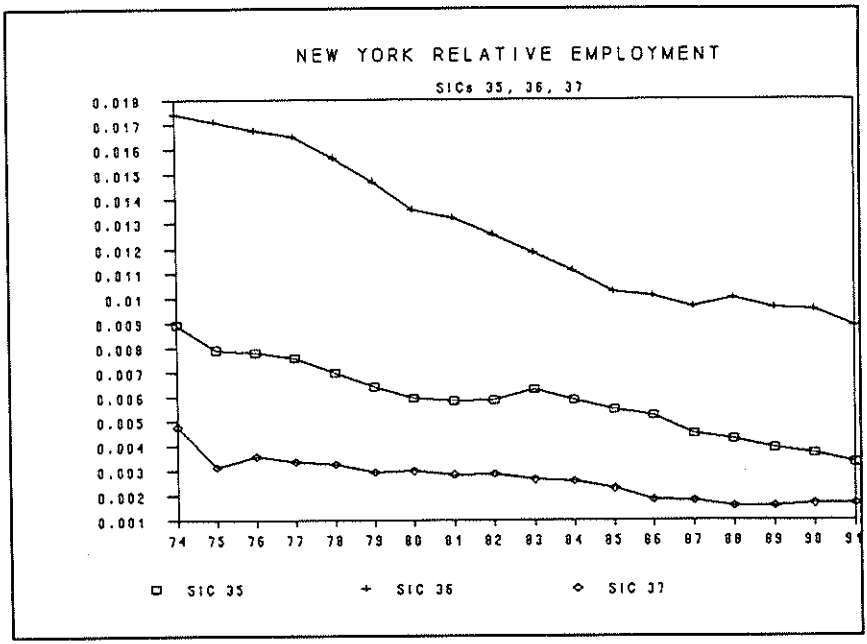

Figure 4

$$P^{kl} = \begin{bmatrix} \rho_{11}^{kl} & \cdot & \cdot \\ \rho_{21}^{kl} & \rho_{22}^{kl} & \cdot \\ \rho_{31}^{kl} & \rho_{32}^{kl} & \rho_{33}^{kl} \end{bmatrix} . \qquad (4)$$

To save degrees of freedom in the subsequent analysis, we restrict these matrices such that only cross-SIC-within-city correlations, ρ^{kk}_{ij}, and within-SIC--cross-city correlations, ρ^{kl}_{ii}, are non-zero, so that all P^{kl} are diagonal matrices for $k \neq l$ and there are 30 coefficients to estimate.

One way to estimate these correlations is to use a regression approach. Ordinary least squares regression coefficients can be interpreted as partial correlation coefficients when the data are standardized by dividing each series by its standard deviation.

This has the advantage that the estimated partial correlation coefficients can be compared to others using standard regression hypothesis testing.

To obtain these coefficients, we estimate the following system of regression equations

$$x^k_{i,t} = \sum_{j \neq i} \rho^{kk}_{ij}\, x^k_{j,t} + \sum_{j \neq k} \rho^{k}_{ii}\, x^j_{i,t} + e^k_{i,t} \,, \qquad (5)$$

for each region k = 1, 2, 3, 4, and each SIC i = 1, 2, 3, where $e^k_{i,t}$ is the regression disturbance, and $x^k_{i,t} = y^k_{i,t}/\sigma_{ik}$ is the standardized SIC employment shock, and σ_{ik} is the standard deviation of $y^k_{i,t}$. The estimated coefficients ρ^{kk}_{ij} are the estimated elements of the correlation matrix (3). In the first version of our estimation procedure, we allow all coefficients of interest to be different for each city-SIC combination. Meanwhile, the covariance matrix of the regression residuals, e^k_{it}, is restricted to be diagonal.

Having obtained the estimates, we are now in position to test the hypothesis of interest, namely if the average of the within-region-across-SIC correlations is larger than the average of the within-SIC-across-region correlations in each equation. We do this in four steps with increasing degrees of aggregation. At the lowest level of aggregation, the Null hypothesis of equal average correlations is tested for pairs of SICs within a city and across cities. We call this the set of hypotheses H1:

$$\frac{1}{2}\left[\sum_{j \neq i} \rho^{kk}_{ij}\right] = \frac{1}{3}\left[\sum_{j \neq k} \rho^{kj}_{ii}\right] \,. \qquad (6)$$

$$\textit{for } i = 1, 2, 3 \;\; \textit{and} \;\; k = 1, 2, 3, 4 \,.$$

If the null hypothesis is rejected, and the sum of the within-

region-across-SIC correlation coefficients is greater than the sum of the within-SIC-across-region correlation coefficients, then the idiosyncratic shocks are more correlated across SICs within the region than they are across regions within the SIC. This would support the hypothesis of Marshallian localization economies.

Next, we aggregate correlations across cities, i.e., we test cross-equation restrictions for each group of four cities per SIC. We call this set of hypotheses H2:

$$\frac{1}{8}\left[\sum_{k=1}^{4}\sum_{n=1}\rho_{in}^{kk}\right] = \frac{1}{12}\left[\sum_{k=1}^{4}\sum_{j\neq k}\rho_{ij}^{kj}\right] \qquad (7)$$

$$for\ i = 1, 2, 3\ .$$

Similarly, tests can be defined for each city, comparing the average of the within-region-across-SIC correlation coefficients to the average of the within-SIC-across-region correlations. The relevant null hypothesis for this test is called H3,

$$\frac{1}{6}\left[\sum_{i=1}^{3}\sum_{j=1}\rho_{ij}^{kk}\right] = \frac{1}{9}\left[\sum_{i=1}^{3}\sum_{l\neq k}\rho_{il}^{kl}\right] \qquad (8)$$

$$for\ k = 1, 2, 3, 4.$$

Finally, an overall test can be done by comparing the average of the within-region-across-SIC correlation coefficients for all cities to the average of the within-SIC-across-region correlation coefficients for all SICs and all regions. The Null hypothesis for this overall test is shown in equation (11). The left side of this equation shows the average of the within-region-across-SIC partial correlations and the right hand side shows the average value of the within-SIC-across-regions correlations.

Table 1 reports the results of the first set of tests. All table entries are marginal significance levels (p-values) for

$$H4: \quad \frac{1}{24}\left[\sum_{k=1}^{4}\sum_{i=1}^{3}\sum_{j\neq i}\rho_{ij}^{kk}\right] = \frac{1}{36}\left[\sum_{k=1}^{4}\sum_{i=1}^{3}\sum_{j\neq k}\rho_{ii}^{kj}\right] . \qquad (9)$$

rejecting the relevant Null-hypotheses. Looking first at the overall test H4, the cell in the lower right-hand corner shows that the null is decisively rejected. Thus within-region correlations are significantly stronger across-region correlations of changes in employment. This suggests that localization economies are important empirically.

The last column of Table 1 shows the final significance values for the set of hypotheses H2. They are below ten percent for the two industries of SIC 35 and SIC 37, but not for SIC 36. The null is rejected at the 0.1% and 9% levels for SICs 35 and 37, respectively. The last row of Table 1 contains the results for the set of hypotheses H3. The null of equal correlations on average is rejected at the 0.01% level for Chicago and at the 0.1% level for New York. For Los Angeles, the null is rejected at the 40% level, while for Dallas-Fort Worth, the null is rejected at the 84% level. Thus, there are considerable differences in the relative strength of within and across region correlations across both cities and SICs.

Table 1
Results of F-tests, Null Hypotheses H1 - H4
Probabilities of F value

SIC/City	Chicago	Los Angeles	Dallas-FW	New York	H2: All 4 Cities
SIC 35	0.001	0.089	0.478	0.002	**0.001**
SIC 36	0.101	0.270	0.430	0.951	**0.398**
SIC 37	0.037	0.399	0.290	0.121	**0.088**
H3: All 3 SICs	**0.000**	**0.399**	**0.838**	**0.001**	**H4: 0.000**

The tests conducted so far ignore the possibility of correlation between the same SIC in two different locations. This poses the risk that cross-regional correlation coefficients are affected by sector-specific shocks. To explore the importance of this danger, we re-estimate our test equations and set up the following Null-hypothesis

$$H5: \quad \frac{1}{2}\left[\sum_{i \neq j} \rho_{ij}^{kk}\right] = \frac{1}{6}\left[\sum_{i \neq j}\sum_{k \neq m} \rho_{ij}^{km}\right] , \qquad (10)$$
$$for \quad i = 1, 2, 3, \; and \; k = 1, 2, 3, 4 .$$

This amounts to restricting each partial correlation matrix P^{kl}, for $k \neq l$, to have zeroes on the diagonals but be unrestricted otherwise, resulting in a total of 48 estimated coefficients. The same aggregation procedure as above is used again to define tests aggregating across cities (H6), across SICs (H7), and to set up an overall test (H8). Each of these tests uses up more degrees of freedom than the corresponding one defined earlier. With the limited sample size available, these tests are, therefore, somewhat less powerful.

The results of this step are reported in Table 2. The overall test still supports the existence of localization economies. At the disaggregated level, however, the results are mixed. Aggregating over cities, the p-value for SIC 37 drops to 2.9 percent, while the others rise. Aggregating over industries, the p-value for Los Angeles drops below the 10 percent mark, but the p-value for New York rises to 27 percent.

So far, firm-specific shocks to employment were estimated by measuring deviations from trend and national average in changes in firm (i.e., SIC) employment. Traditional regional economic

Table 2
Results of F-tests, Null Hypotheses H5 - H8
Probabilities of F value

SIC/City	Chicago	Los Angeles	Dallas-FW	New York	H6: All 4 Cities
SIC 35	0.129	0.145	0.401	0.084	**0.046**
SIC 36	0.094	0.838	0.429	0.899	**0.981**
SIC 37	0.176	0.068	0.425	0.505	**0.029**
H7: All 3 SICs	**0.011**	**0.078**	**0.689**	**0.269**	H8: **0.023**

analysis emphasizes the importance of region-specific shocks. In our tests, strong region-specific shocks might affect the results by increasing the correlation of within-region-across-SIC changes in employment. To account for such effects, we change the definition of firm-specific shocks in equation (2) by expanding equation (1) by a variable measuring region-specific shocks. This yields

$$\tilde{y}^k_{it} = l^k_{i,t} - (a_{ik0} + a_{ik1} l^k_{i,t-1} + a_{ik2} T + a_{ik3} T^2 + a_{ik4} l^k_t) \ , \qquad (11)$$

where $l^k_t = L^k_t / L_t$ is the ratio of total regional employment to total national employment.

Using the new definition of firm-specific employment shocks from (11), we redo the tests defined before. Corresponding to the Null hypotheses H1 - H4, we now have the Null hypotheses H1A - H4A. Table 3 shows the results of these tests. After the adjustment for region-specific shocks the results become generally sharper. The p-value for the overall test is 0.1 percent, strongly supporting the prevalence of localization economies. Aggregating over cities, H2B, the Null-hypotheses are strongly rejected for SIC 35 and SIC 37, but not for SIC 36. Aggregating over industries, H3B, we reject the Null hypotheses except for all

cities except for Dallas-Fort Worth.

Table 3
Results of F-tests, Null Hypotheses: H1A - H4A
Probabilities of F value

SIC/City	Chicago	Los Angeles	Dallas-FW	New York	H2A: All 4 Cities
SIC 35	0.019	0.244	0.208	0.015	**0.007**
SIC 36	0.100	0.028	0.187	0.981	**0.909**
SIC 37	0.045	0.357	0.130	0.033	**0.003**
H3A: All 3 SICs	**0.000**	**0.040**	**0.581**	**0.014**	H4A: **0.001**

The tests so far do not account for the fact that the two sources of Marshallian localization economies discussed above have different implications for the signs of the correlations. If both sources of localization economies are important, some correlation coefficients might be positive (*asset-sharing*) and others negative (*labor pooling*) and cancel each other out in the test. This might explain why we do not reject the Null for Dallas-Fort Worth and SIC 36. In order to address this problem, we test, for these two cases, the Null that the sum of the squared cross-SIC-within-city correlations is larger, on average, than the sum of the squared within-SIC-cross-city correlations.[8] The p-values of these tests are 0.72 for SIC 36 and 0.55 for Dallas-Fort Worth.

It is interesting to note at this point that the estimated partial correlation coefficients are uniformly positive for all industries in Chicago and New York. In contrast, several significant, negative values were estimated for Dallas-Fort Worth, while the estimates for Los Angeles contain several non-significant but negative values. This suggests that labor market

pooling and asset sharing are of different importance for the four metropolitan areas.

To get a sharper picture, we now re-estimate our system of equations (5), restricting the cross-SIC-within-city correlations to be equal for each city, $\rho^{kk}_{ij} = \rho^{kk}_{ii}$, and let the covariance matrix of the regression residuals be unrestricted. Intuitively, we estimate an average correlation for each city, putting within-city differences into the residual covariance, rather than looking at averages of within-city correlations as before. This reduces the number of coefficients to estimate and increases efficiency under the null of equal correlations for each city. We use the shocks defined by equation (11) for this step.

The estimated average within-city correlations are positive and similar for Chicago, New York and Los Angeles, but strongly negative for Dallas-Fort Worth. Pairwise testing the equality of these correlations p-values of p=0.31 comparing Chcago and New York, p=0.33 comparing Chicago and Los Angeles, and p=0.001 comparing Chicago and Dallas-Fort Worth. Thus, we restrict the system further to force the within-city correlations to be the same for the first three cities. The estimated within-city correlations are then ρ=0.25 for the first three cities and ρ=-0.49 for Dallas-Fort Worth, with t-values of t=9.26 and t=8.12, respectively.

Finally, we test our hypotheses H3A and H4A on the basis of these new estimates. This yields the p-values reported in Table 4. Thus, looking at average correlations within cities, our data supports the hypothesis of Marshallian localization economies in all four cities.

Table 4: Tests for Average Correlations Hypotheses H3A and H4A					
Test	Chicago	Los Angeles	New York	Dallas-Fort Worth	Overall
p-value	.0001	.0271	.004	.0001	.044

With our limited data set, it is impossible explore to where the differences between Dallas-Fort Worth and the other three cities come from. A suggestive answer is, however, possible. Over the sample period considered in our analysis, Dallas-Fort Worth is by far the most rapidly growing metropolitan area of the four. In view of this, one may speculate that labor pooling is a more important source of localization economies in rapidly growing labor markets than in more established markets, where asset-scharing is the more important source. This is plausible if one assumes that building up industry-specific assets takes some time.

V. CONCLUSION

This paper presents an empirical investigation into Marshallian localization economies among US industries and cities. Given the data limitations and the simplicity of our tests from these, any conclusions must, of course, remain tentative.

Nevertheless, the empirical evidence supports the notion that localization economies exist and, hence, affect location choices for the cities and industries in our sample. Idiosyncratic shocks to members of the same local industry are more strongly correlated than they are to the shocks experienced by members of different

local industries. In this sense, the data provides some empirical evidence for the Marshallian localization economies.

The results further indicate that within-region correlations tend to be positive particularly in mature labor markets. This suggests that asset sharing dominates labor pooling as a source of localization economies in such markets. In contrast, labor pooling seems equally prevalent in rapidly growing labor markets.

These results have interesting implications for the European Community. Today, European industries are still geographically dispersed due to inherited barriers to factor mobility. If economic and monetary union reduces such barriers, footloose industries are likely to become more geographically concentrated over time. Industry-specific shocks would then be more closely associated with regional shocks. Thus, economic and monetary union might increase the importance of asymmetric shocks to European regions. This would raise the demand for fiscal stabilization of regional shocks at the level of the EC. For this, the EC currently and on the basis of the Maastricht Treaty is ill-equipped.

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Endnotes

1. The Chicago, Illinois PMSA includes Cook, Du Page, and McHenry Counties.

2. The LA-Long Beach, California PMSA consists of Los Angeles County.

3. The Dallas, Texas PMSA consists of Collin, Dallas, Denton, Ellis, Kaufman and Rockwall Counties. The Fort Worth, Texas PMSA consists of Johnson, Parker and Tarrant Counties.

4. New York City, NY consists of Bronx, Kings, New York, Queens, and Richmond Counties. This differs from the New York City PMSA in that the PMSA equals the City plus Putnam, Rockland and Westchester Counties.

5. The large drop in SIC 36 in Los Angeles is caused by a reallocation of employment from SIC 36 to SIC 38 due to definition changes by OMB.

6. Data limitations do not allow us to test formally for unit roots in our series. However, the specification defined by equation (2) assures that the estimated shocks are stationary whether or not the relative employment series have unit roots.

7. Regional industrial diversification is an old topic in regional economics, and, as pointed out by Jackson (1984), the diversification of a region's economy has been measured in several different ways. One way is to assume that a region is most diversified if it has equal proportions of all industries. Another measure of economic diversification is the "national average" measure. This measure is similar to a location quotient and assumes that the nearer the region's industrial mix is to the nation's mix, the more diversified is the region. The third main measure of regional diversification is based on portfolio theory. This type of analysis borrows the concepts of expected return and risk from theories of the optimal diversification of financial portfolios developed by Markowitz (1959) and Sharpe (1963). Conroy (1974, 1975) introduced this technique into regional economics by conceptualizing the regional mix of industries as a portfolio which provides returns to the region in the form of employment, income and tax revenues. The regional portfolio is composed of a set of industries which yield expected returns, but these returns are associated with risk, as represented by the variance and covariance in the returns. It is this measure of risk, the portfolio variance, which measures the degree of diversification of the region. The riskier the region, the larger is its portfolio variance, and the less diversified it is. This method of measuring regional diversification is interesting because it accounts for the variability in returns from an industry in such a way that not only the industry's own variability is accounted for but its covariation with other industries is accounted for as well. Recent contributions to the portfolio approach to regional industrial diversification include Conroy 1974, 1975; Barth, Kraft, and Wiest 1975; Kurre and Weller 1989; Brewer 1984; Parr 1989 and Gruben and Phillips 1989; Diamond and Simon 1990; Brown and Pheasant 1985; and St. Louis 1980.

8. Since this test involves non-linear restrictions on the coefficients, a Wald test must be used which is of the following, general form:

$$W = h(\hat{\rho})'[\frac{\partial h(\hat{\rho})}{\partial \rho'}\Omega_{\hat{\rho}}^{-1}\frac{\partial h(\hat{\rho})}{\partial \rho}]^{-1}h(\hat{\rho})$$

where h(.) is the nonlinear restriction evaluated at the coefficient estimates and Ω is the covariance matrix of the estimates. Under the Null, W is chi-square distributed with one degree of freedom.