Industrial Diversity and Agglomeration Economies

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Abstract. This paper investigates the importance of industrial diversity in determining the nature of agglomeration economies, using an indirect test which measures the effects of export industry demand shocks on center city and suburban employment growth. Testing for the importance of diversity is accomplished by constructing a measure of export price shocks to central cities and their suburbs, called the Export Price Index. The results reveal that urbanization economies do exist, but that their relative importance varies with the diversity of local industrial structure and hence that it varies across cities. This explains why the current literature contains strong empirical support for the importance of both urbanization and localization economies.

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I. INTRODUCTION

Agglomeration externalities, either in the form of urbanization or localization economies, have long provided an explanation for the productivity advantages that justify the existence of large cities[1]. Knowledge spillovers, input sharing, and labor market pooling, all examples of external economies of scale, encourage firms to locate near one another, some in small, specialized cities and others in large, industrially diverse cities. The agglomeration literature seeks to explain the co-existence of small, specialized cities and large, diverse cities, and determine which type of environment fosters higher worker productivity and city-industry growth. The primary debate in the literature concerns the presence of localization economies, external to the firm but internal to its industry, versus urbanization economies, external to the firm and its industry but internal to the metropolitan area. Much of the evidence, including

Nakamura (1985), Henderson (1986, 1988, 2003), Moomaw (1988), and Henderson, Kuncoro and Turner (1995), has established the importance of localization economies. Findings of substantial localization economies suggest that policies which raise industrial diversity increase congestion costs without increasing productivity, thereby limiting growth.

Although the literature provides strong support for the existence of localization economies, particularly over short distances (Rosenthal and Strange 2003) it fails to explain the existence of the many large, diversified cities throughout the U.S. In the absence of urbanization economies, MSA growth would be limited and cities would specialize in one primary export industry or industrial complex. There are, however, a number of studies supporting the existence of urbanization economies. Glaeser et al. (1992) and Henderson (1997), for example, provide strong evidence indicating that industrial diversity promotes city growth.

This disagreement over the nature of agglomeration externalities also appears in the theoretical literature in the contrasting implications of urban simulation models and urban growth models. Urban simulation models, including O'Sullivan (1983, 1986), generally assume cities form based on localization economies. This produces a metropolitan area either with one dominant export industry in the central city or a second export industry located in a suburban ring that competes with the central export industry. Similarly, Henderson's (1988) system of cities model stresses the existence of localization economies which lead to a network of specialized cities. In contrast, theories linking industrial diversity and urban growth date back to Chinitz (1961) and Jacobs (1969). More formally, urban growth models and models based on the new urban geography of Fujita, Krugman and Venables (2001) emphasize the importance of diversity in large cities, and therefore stress urbanization economies and a complementarity among industries. The predictions of this type of model are supported by empirical studies of aggregate urban growth which find a strong link between industrial diversity and metropolitan growth (Glaeser et al. 1992), new firm births (Rosenthal and Strange 2003), and growth in high-tech firms (Henderson, Kuncoro and Turner 1995).

This paper examines the nature of agglomeration externalities over both industrial and geographic dimensions[2] in a model of central city and suburban employment growth. The effect of geographic proximity is tested using a new indicator of exogenous price shocks, the export price index (EPI), that measures price shocks to the central city and suburbs separately and allows for direct tests of the suburban response to central city shocks and, conversely, central city responses to suburban shocks. Diversity in industrial structure is defined first by the employment share of the three largest export industries in the central city and suburbs, and second with a Herschman-Herfindahl Index (HHI) of industrial concentration.

Based on strong results obtained by Rosenthal and Strange (2003), the geographic extent of localization economies appears to be very limited, and should not extend from central city locations to the suburbs or vice versa. In contrast, urbanization economies may well extend across metropolitan areas, particularly those economies associated with knowledge spillovers or labor market pooling. Therefore, if urbanization economies are unimportant, we expect that demand shocks to the center city economy will have little, if any, positive effect on suburban employment and vice versa. Indeed, the major effect of center city growth will be to raise costs of suburban industries. Conversely, if urbanization economies are important, then cross-area effects of demand shocks will be substantial. Because industrial diversification is a necessary condition for urbanization economies to be realized, measures of the effect of diversification on the size and significance of cross-area demand shocks can be used to test the importance of urbanization economies.

The results clearly indicate the association between urbanization economies and industrial diversity. For industrially diverse cities, demand shocks to the central city increase suburban employment, and vice versa, in a manner that is statistically and economically very significant. In contrast, for very specialized cities, the cross-area effect becomes negative. These results suggest why previous studies that fail to account for industrial diversity have produced such mixed results regarding the importance of urbanization versus localization economies.

II. LITERATURE REVIEW

Rosenthal and Strange (2004) identify three dimensions over which agglomeration externalities exist: industrial, geographic, and temporal. The industrial dimension focuses on whether agglomeration effects extend across all industries or only within an industry, i.e. do localization or urbanization economies dominate? The majority of work in this area generally supports the existence of localization economies, although the testing has concentrated on a limited number of manufacturing industries. For example, Nakamura (1985) examines nineteen two-digit manufacturing industries in Japan and finds that urbanization economies tend to dominate light manufacturing industries whereas localization economies are most important for heavy manufacturing. Henderson (1986) examines two-digit manufacturing industries in Brazil and the U.S., but fails to find a pattern between heavy and light manufacturing. Instead, his results strongly support the existence of localization economies across manufacturing in general. Further, Moomaw (1988) estimates industry labor demand equations for two-digit U.S. manufacturing industries. His results confirm Henderson's finding's that localization economies dominate manufacturing industries.

The second dimension, geographic, examines the existence of agglomeration externalities over distance. Externalities of this type have only recently begun to receive attention in the literature and are most directly tested by Rosenthal and Strange (2003). Their study examines new firm births for six manufacturing industries at the zip code level and reveals that localization economies attenuate rapidly after just one mile. Henderson (2003) and Rosenthal and Strange (2001) provide further evidence that agglomeration economies attenuate with distance. The finding that the geographic extent of localization economies is limited, is further confirmed in the results of the present study.

Finally, the temporal dimension examines the effect of past conditions and interactions on current industry growth. Glaeser et al. (1992) examine a panel of 170 MSAs, focusing on the effect of industrial structure on industry growth. The results show that cities with higher levels of specialization grow more slowly, providing strong evidence for the existence of urbanization economies over localization externalities. Henderson, Kuncoro and Turner (1995) examine the effect of past concentration and diversity on industry performance for eight manufacturing industries in 224 MSAs. Their results, although based on a much smaller set of industries, provide an interesting contrast to those of Glaeser et al. (1992). They find that higher levels of industry concentration increase industry growth. The results imply that urbanization economies are only important for attracting young, in this case high-tech, industries, but localization economies are important in retaining these industries. Finally, Henderson (1997) tests for dynamic externalities at the county level using a panel of 742 urban counties from 1977 to 1990. Similar to Henderson, Kuncoro and Turner (1995), the results again suggest that localization economies are most important.

III. MODEL OF AGGREGATE LABOR SUPPLY AND DEMAND

A. The Model

The industrial and geographic nature of agglomeration externalities are tested here using a standard model of central city and suburban labor supply and demand. The model below is consistent with the urban models of O'Sullivan (1986) and Ross and Yinger (1995), which are characterized by suburban employment and a fully endogenous labor market. Similar to O'Sullivan (1986), agglomeration economies are explicitly modeled.

Following previous studies, equations 1 and 2 represent the derived demand of labor for the central city and suburbs, respectively. Aggregate demand is a function of export industry output prices (P^Q), the average wage (w), the price of intermediate inputs (P^I), and the cost of capital (r). A_{CC} and A_S represent a productivity effect based on agglomeration economies as a function of own-area industrial diversity (θ) and export price shocks to the neighboring-area (P^Q). This interaction term allows industrial diversity to either strengthen or attenuate the effects of neighboring-area price shocks on own-area labor demand. Thus, if industrial concentration of an export industry promotes neighboring-area growth, a positive shock to the central city will increase growth more in an industrially concentrated suburb relative to an industrially diverse suburb.

$$E_{CC} = A_{CC}(P_S^Q * \theta_{CC}) * D_{CC}(P_{CC}^Q, w_{CC}, P^I, r) \quad (1)$$

$$E_S = A_S(P_{CC}^Q * \theta_S) * D_S \ (P_S^Q, w_S, P^I, r) \quad (2)$$

The subscripts CC and S denote the central city and suburbs, respectively.

The labor supply equations, presented in equations 3 and 4, follow the standard Alonso-Muth-Mills open city model where household labor is determined through utility maximization and is based on an equilibrium of interregional labor markets where the indirect utility of residents is uniform across all metropolitan areas. The compensation workers receive, in the form of wages (w_{CC} and w_S) and local amenities (A_{MSA}), is offset by differences in the cost of housing (P^H) and tradable goods (P^C). National (w_N) and neighboring-area wages (w_S for the central city and w_{CC} for the suburbs) represent alternative opportunities available to workers without changing the cost of housing or amenities.

$$E_{CC} = S_{CC}(w_{CC}, w_N, w_S, P_{MSA}^H(E_{CC,} E_S), P^C, A_{MSA}) \quad (3)$$

$$E_S = S_S \ (w_S, w_N, w_{CC}, P_{MSA}^H(E_{CC,} E_S), P^C, A_{MSA}) \quad (4)$$

Note that the system of central city and suburban labor supply and labor demand is simultaneously determined, as the cost of housing depends on total metropolitan employment.

Reduced form equations are obtained by solving the supply equations for the own-area wage rate, substituting into the demand equations, and solving for employment. Taking first differences, and assuming the relation is linear in the log differences, then yields the following central city and suburban employment growth equations.[3]

$$\Delta E_{CC} = \alpha_0 + \alpha_1 \Delta P_{CC}^Q + \alpha_2 \Delta P_S^Q + \alpha_3 \Delta P_S^Q * \theta_{CC} + \alpha_4 \Delta P^I + \alpha_5 \Delta r + \alpha_6 \Delta w_N + \alpha_7 \Delta P^C + \varepsilon^{CC} \quad (5)$$

$$\Delta E_S = \beta_0 + \beta_1 \Delta P_S^Q + \beta_2 \Delta P_{CC}^Q + \beta_3 \Delta P_{CC}^Q * \theta_S + \beta_4 \Delta P^I + \beta_5 \Delta r + \beta_6 \Delta w_N, + \beta_7 \Delta P^C + \varepsilon^S \quad (6)$$

The coefficients of primary interest are on the export price terms. To begin, own-area export price appreciation should increase employment ($\alpha_1 > 0; \beta_1 > 0$), illustrating the employment response to a positive shock to the area's export industries. More interesting, however, are the effects of the neighboring-area export price (α_2 and β_2) and the interaction terms (α_3 and β_3), which are indeterminate a priori. This indeterminacy is the basis for testing the nature of agglomeration economies.

The combined signs of $\alpha_2 + \alpha_3$ and $\beta_2 + \beta_3$ not only identifies the relation between the central city and suburbs[4], it also provides an indirect test of the nature of agglomeration externalities. If growth is characterized by localization economies, then positive demand shocks to the central city (suburbs) should result in negative employment effects in the suburbs (center city) because the positive wage and employment gains the center city (suburbs) raise labor costs in suburbs (center city) without a compensating productivity effect. If growth is characterized by urbanization economies, then positive shocks to one part of the city will result in productivity growth and increase employment throughout both the central city and suburbs.

The estimate of $\alpha_2 + \alpha_3$ and $\beta_2 + \beta_3$ allows the own-area effect of a neighboring-area shock to vary with own-area industrial concentration. Thus, while a positive shock to one area may otherwise increase employment in the neighboring-area, this model reveals the conditions under which this effect may strengthen or attenuate. For example, if the estimated coefficient on both the interaction term and the neighboring-area price are positive, then this indicates that not only is central city and suburb growth complementary, but that their interdependence increases with own-area industrial concentration. Alternatively, a negative coefficient on the interaction term would indicate the importance of urbanization economies and industrial diversity.

The expected signs on the remaining coefficients are as follows. Employment is expected to fall in response to increases in intermediate input prices ($\alpha_4 < 0; \beta_4 < 0$) and national average wage appreciation ($\alpha_6 < 0; \beta_6 < 0$). The former is due to its affect on the cost of production and the later due to upward pressure on local wages. The effect of urban consumer prices (α_7; β_7) is indeterminate because they reflect both the relative cost-of-living in other metropolitan areas, which would increase employment, and the relative cost-of-living in urban versus rural areas, which would lower employment.

Similarly, capital costs ($\alpha_5; \beta_5$) have both an output effect that is negative and a substitution effect that is positive. Finally, the error terms, ε^{CC} and ε^{S}, are assumed to have a normal distribution and a mean of zero.

B. *Measures of Industrial Specialization and Diversity*

In order to test for the effect of industrial diversity on agglomeration externalities, interaction terms measuring the effects of cross-area demand shocks were added to the reduced form model. Following Glaeser et al. (1992) and Henderson, Kuncoro and Turner (1995), two measures of industrial concentration were constructed[5]. First, the model was estimated using the export employment share of the three largest export industries. The model was then re-estimated using a Hirschman-Herfandahl index of export employment.

Each measure was calculated separately for the central city and suburbs using the definition of export employment discussed below in Section IIIC. Export industries were identified for the entire metropolitan region followed by the calculation of export employment separately for central cities and suburbs. The employment share measure divides the central city and suburb export employment by total central city and suburb export employment, respectively. The HHI for area j (j=2; central city or suburb) in metropolitan area m is represented as:

$$HHI_{mj} = \sum_i s_{mji}^2 \qquad where \;\; s_{mji} = \frac{export\ emp_{mji}}{export\ emp_{mj}} \tag{7}$$

where s is the export employment share of industry i. As usual, an increase in the HHI reflects an increase in concentration.

C. *Measuring Exogenous Shocks to Export Industries*

The urban growth literature on central city-suburb interactions is hampered by an inability to differentiate exogenous shocks to the central city economy from shocks to the suburban economy. This inability has also prevented the agglomeration literature from examining spillover-effect between the two areas. To overcome this problem, this paper uses an indicator of external demand shocks, developed in Pennington-Cross (1997), called the Export Price Index (EPI). The EPI is a weighted price index of goods exported from an individual metropolitan area.

While Pennington-Cross (1997) constructs this index at the metropolitan level, the EPI for the current study is constructed separately for both central cites and suburbs. Following Pennington-Cross (1997), the MSA export industries are identified using location quotients (LQ). The LQ is a standard tool well established in regional economic analysis as noted in Brown, Coulson, and Engle (1992) and is defined as the share of employment for industry *i* in MSA *m* divided by the same industry employment share for the country.

$$LQ_{im} = (E_{im}/E_m)/(E_{i,US}/E_{US}) \tag{10}$$

In order to ensure that the EPI only captures shocks that are exogenous to the metropolitan area, the location quotients are calculated for the MSA as a whole, rather than for the central city and suburbs separately. Otherwise, local industries, trading between the central city and suburbs, would be identified as an export industry, biasing the index with endogenous shocks between the central city and suburbs and the results toward a positive relationship.

An industry LQ greater than one identifies an export industry for a particular MSA. For each identified export industry, the industry weights, which are represented by equation 8 and equal the share of industry export employment relative to total export employment in the central city or suburbs (j=central city, suburbs), are multiplied times the industry price to create separate central city and suburban EPI series.

Specifically, national industry output prices are weighted using an industry's share of export employment.

$$w_{ijm} = \frac{export\ emp_{ijm}}{export\ emp_{jm}} = \frac{export\ emp_{ijm}}{\sum_i export\ emp_{ijm}} \tag{8}$$

The weighted average provides an aggregate price for each area.

$$[P_i'][w_{ijm}] = EPI_{ijm} \quad (9)$$

IV. RESULTS

Equations 5 and 6 are estimated using panel data for 77 MSAs from 1982 to 2000. Table 1 lists the sample MSAs while Table 2 contains the variable definitions and sources. Tables 3 and 4 present the reduced form model estimates using the two alternative measures of industrial concentration: employment share of the three largest export industries and a Hirschman-Herfandahl index (HHI) of export employment. The signs of the estimates agree well with prior expectations. Increases in intermediate input price appreciation ($\alpha_4 < 0; \beta_4 < 0$), national wage growth ($\alpha_6 < 0; \beta_6 < 0$) and lagged consumer price appreciation ($\alpha_7 < 0; \beta_7 < 0$) all decrease employment, in both the central city and suburbs. Increases in the rate of change in interest rates ($\alpha_5 > 0; \beta_5 > 0$) result in increased employment. Presumably, this reflects the substitution of labor for capital. The elasticity of employment with respect to consumer prices is negative, reflecting the higher cost-of-living in urban versus rural areas. Finally, the own-area EPI performed as expected, capturing the effect of demand shocks implied by the positive coefficient for both the central city and suburbs ($\alpha_1 > 0; \beta_1 > 0$).

The neighboring-area EPI and the interaction term with industrial concentration identify the nature of both the geographic and industrial dimensions of agglomeration economies. In both specifications (Tables 3 and 4), the coefficient on the neighboring area EPI, representing the geographic dimension, is positive and significant ($\alpha_2 > 0; \beta_2 > 0$), indicating that a positive demand shock in one area results in net gains in employment in the neighboring area if the neighboring area has highly diversified export industries. Given that the positive shock increases employment and wages in the area where it is experienced, the positive inter-area effect implies that productivity increases in the other area are large enough to offset the effects of higher labor costs.

At high levels of industrial concentration, however, the inter-area effect not only diminishes but also becomes negative ($\alpha_3 < 0; \beta_3 < 0$). This indicates that the positive effects found based on the coefficient of neighboring area EPI result from the presence of urbanization economies because they diminish and even become negative as diversity decreases. Of course, this is just the result that was anticipated a priori, but it is gratifying to note that the indirect test performed here appears to demonstrate that the importance of urbanization economies is so sensitive to the degree of diversification of the urban economy.

Table 5 provides an interpretation of the results in Tables 3 and 4 for various levels of industrial concentration. Table 6 provides the results for each MSA. The first box of each panel in Table 5 provides the results using the industry employment share measure, associated with the equations from Table 3, and the second box corresponds to the HHI measure used in Table 4.

The top panel of Table 5 calculates the net effect of a 1% demand shock to the suburbs on central city employment growth. For both concentration measures, the initial positive effect is offset as own-area concentration increases, i.e. urbanization economies dominate and higher levels of specialization limit urban growth. The net effect of the shock, evaluated at the average concentration level of 28.8%, increases central city employment 0.1029%. This positive effect is completely offset when the three largest export industries account for 40.1% of employment, which is less than one standard deviation above the mean. For the maximum concentration level in the sample, 81.9% in Atlantic City, urbanization economies are so small that a positive center city shock of 1% causes a decrease in employment of 0.3812%. The results using the HHI measure of industrial concentration show a similar result.

The effect of exogenous central city demand shocks on suburban employment growth, shown in the lower panel of Table 5, is similar with one notable exception. The level of concentration at which the shock is completely offset is much higher indicating that the suburbs have a larger growth response to changes in central city. Evaluated at the mean concentration level, employment share of 31.0% for the three largest export industries, a 1% central city demand shock increases suburban employment 0.3606%. At one standard deviation above the mean, 45.4%, the effect of the shock remains strong, increasing suburban employment 0.1782%. The shock is not completely offset until the concentration level is

59.6%. For the Santa Fe, NM MSA, the city with the most concentrated suburbs, 74.7% of export employment in the three largest export industries, a 1% shock to the central city decreases suburban employment 0.1913%. In contrast, Chicago has the most diverse suburban industrial structure; the three largest export industries contain Thus, a 1% shock to the central city increases suburban employment 0.6109%.

V. CONCLUSION

This paper has examined the nature of agglomeration externalities at the sub-metropolitan level, using an index of demand shocks exogenous to the metropolitan region. Theories of agglomeration externalities contend that due to the nature of knowledge spillovers, urban growth varies with industrial concentration and geographic proximity. Marshall (1890) posits that knowledge transfers occur primarily between firms within the same industry and therefore growth is higher when an urban area is dominated by one industry. Jacobs (1969) emphasizes that inter-industry interactions foster innovations and therefore higher growth. Thus, diversity is important for the growth of a city.

Results of reduced form employment growth equations for central cities and suburbs reveal that agglomeration externalities, in the form of urbanization economies, do exist, but that their relative importance varies with the diversity of local industrial structure and hence that it varies across cities.. For cities where the industrial structure is moderately diverse, the positive demand shocks to the center city result in substantial growth in the suburbs, and vice versa. This indicates that the positive effects of urbanization economies across sectors outweigh any tendency for growth of the "rival" area to raise wages, congestion, and other production costs. Conversely, for cities with a specialized or concentrated industrial structure, the effects of cross-area demand shocks are reversed. Thus, the importance of urbanization economies appears to depend on local industrial structure. For example, in Salt Lake City's central city, the three largest export industries account for 15.5% of its export employment, placing it at the top of the first decile. A positive 1% shock to the suburb economy would increase central city employment 0.22%. At the top of the ninth decile, the three largest export industries in Memphis's central city comprise 43.3% of total central city export employment. Due to the higher concentration, or lack of diversity, a 1.0% shock to the Memphis suburbs would decrease central city employment by 0.03%. These results explain why the current literature contains strong empirical support for the importance of both urbanization and localization economies. Put another way, the results confirm the findings of Glaeser et al. (1992) that industrial diversity promotes overall city employment growth but also explain why Henderson (2001), Moomaw (1988), and Rosentahl and Strange (2003) find that localization economies can be very important in manufacturing.

It should be emphasized that these results are based on a sample of the largest metropolitan areas in the U.S. The smallest urban area in the sample is Sante Fe, New Mexico with 1999 population of 142,500 and 1999 employment of 65,200. All other metropolitan areas in the sample have over 200,000 residents and 100,000 jobs. Theories of agglomeration externalities, such as Henderson's (1988) system of cities model, generally posit that localization economies lead to small and medium-sized cities dominated by a single export industry whereas urbanization economies are associated with larger cities. Results presented here are in general agreement with this reasoning.

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Notes

[1] Carlino, Chatterjee and Hunt (2001), for example, find that the rate of innovation is substantially higher in the densest urban areas.

[2] Rosenthal and Strange (2004) identify three dimensions over which agglomeration externalities occur: industrial, geographic and temporal. These are discussed further in the literature review.

[3] The results presented here also include MSA fixed effects. Results excluding fixed effects dummies yield similar results and are available from the author upon request.

[4] See Ihanfeldt (1995) for a review of the central city/suburb literature.

[5] Unlike Glaeser et al. (1992) and Henderson, Kuncoro and Turner (1995), the measures are included in alternate specifications, rather than including both measures in the same equation.

TABLE 1.- MSAS IN SAMPLE

Akron, OH PMSA	Lexington, KY MSA
Albuquerque, NM MSA	Little Rock-North Little Rock, AR MSA
Ann Arbor, MI PMSA	Louisville, KY-IN MSA
Atlanta, GA MSA	Macon, GA MSA
Atlantic-Cape May, NJ PMSA	Memphis, TN-AR-MS MSA
Austin-San Marcos, TX MSA	Milwaukee-Waukesha, WI PMSA
Baltimore, MD PMSA	Minneapolis-St. Paul, MN-WI MSA
Baton Rouge, LA MSA	Nashville, TN MSA
Birmingham, AL MSA	New Orleans, LA MSA
Boise City, ID MSA	New York, NY PMSA
Buffalo-Niagara Falls, NY MSA	Newark, NJ PMSA
Canton-Massillon, OH MSA	Norfolk-Virginia Beach-Newport News, VA-NC MSA
Charleston-North Charleston, SC MSA	Oakland, CA PMSA
Charlotte-Gastonia-Rock Hill, NC-SC MSA	Oklahoma City, OK MSA
Chattanooga, TN-GA MSA	Omaha, NE-IA MSA
Chicago, IL PMSA	Orlando, FL MSA
Cincinnati, OH-KY-IN PMSA	Philadelphia, PA-NJ PMSA
Cleveland-Lorain-Elyria, OH PMSA	Phoenix-Mesa, AZ MSA
Columbia, SC MSA	Pittsburgh, PA MSA
Columbus, OH MSA	Portland-Vancouver, OR-WA PMSA
Dallas, TX PMSA	Roanoke, VA MSA
Daytona Beach, FL MSA	Rochester, NY MSA
Denver, CO PMSA	Rockford, IL MSA
Des Moines, IA MSA	Sacramento, CA PMSA
Detroit, MI PMSA	Salem, OR PMSA
Fort Wayne, IN MSA	Salt Lake City-Ogden, UT MSA
Fort Worth-Arlington, TX PMSA	San Antonio, TX MSA
Fresno, CA MSA	San Francisco, CA PMSA
Gary, IN PMSA	Santa Fe, NM MSA
Harrisburg-Lebanon-Carlisle, PA MSA	Seattle-Bellevue-Everett, WA PMSA
Houston, TX PMSA	Springfield, IL MSA
Huntsville, AL MSA	St. Louis, MO-IL MSA
Indianapolis, IN MSA	Syracuse, NY MSA
Jackson, MS MSA	Toledo, OH MSA
Jacksonville, FL MSA	Tulsa, OK MSA
Kansas City, MO-KS MSA	Washington, DC-MD-VA-WV PMSA
Knoxville, TN MSA	Wichita, KS MSA
Lansing-East Lansing, MI MSA	Wilmington-Newark, DE-MD PMSA
Las Vegas, NV-AZ MSA	

TABLE 2.- DATA DEFINITIONS AND SOURCES

Variable	**Description**
E_j	Central City, Suburb Employment (Bureau of Labor Statistics)
EPI	Export Price Index (EPI) (constructed as discussed in Section IIIC)
θ_j	1. Export employment share of the three largest export industries in area j
	2. Herschman-Herfindal Index of Export Employment (calculated as discussed in Section IIIC)
P_I	Producer Price Index (Bureau of Labor Statistics)
r	One-Year Treasury Rate (Federal Reserve Board)
w_N	National Average Wage (Bureau of Labor Statistics)
P^C	Consumer Price Index (Bureau of Labor Statistics)

Note: Employment data in BLS' Quarterly Census of Employment and Wages (QCEW) is reported on a county basis. Thus, in this study, the county in which the central city is located represents the central city while the remaining counties form the suburbs.

TABLE 3.- CENTRAL CITY AND SUBURB EMPLOYMENT GROWTH WITH INDUSTRY SHARE EFFECTS

	Central City		Suburb	
variable	coefficient	stnd error	coefficient	stnd error
Δ EPI_{CC}	0.3018 *	0.0504	0.7511 *	0.1132
Δ $EPI_{CC} * \theta_S^{Ind}$			-1.2612 *	0.2997
Δ EPI_S	0.3654 *	0.0906	0.2934 *	0.0522
Δ $EPI_S * \theta_{CC}^{Ind}$	-0.9114 *	0.2561		
Δ P_I	-0.0320	0.0231	-0.1193 *	0.0277
Δ r	0.0017 *	0.0003	0.0019 *	0.0004
Δ w_N	-0.1259 *	0.0361	-0.1749 *	0.0431
Δ P^C	-0.7499 *	0.0287	-0.9586 *	0.0349
Fixed Effects	MSA Dummies		MSA Dummies	
# MSAs	77		77	
Observations	1463		1463	

* = significant at 1% Confidence Level

Note: Industry concentration, θ_j^{Ind} (j= CC, S), is measured using the export employment share of the three largest export industries.

TABLE 4.- CENTRAL CITY AND SUBURB EMPLOYMENT GROWTH WITH HHI EFFECTS

	Central City		Suburb	
variable	coefficient	stnd error	coefficient	stnd error
Δ EPI_{CC}	0.3038 *	0.0509	0.5376 *	0.0774
Δ $EPI_{CC} * \theta_S^{HHI}$			-2.7265 *	0.6554
Δ EPI_S	0.1635 *	0.0489	0.3038 *	0.0525
Δ $EPI_S * \theta_{CC}^{HHI}$	-1.4835 *	0.5433		
Δ P_I	-0.0269	0.0229	-0.1173 *	0.0277
Δ r	0.0017 *	0.0003	0.0019 *	0.0004
Δ w_N	-0.1285 *	0.0361	-0.1718 *	0.0431
Δ p^C	-0.7425 *	0.0286	-0.9560 *	0.0348
Fixed Effects	MSA Dummies		MSA Dummies	
# MSAs	77		77	
Observations	1463		1463	

* = significant at 1% Confidence Level

Note: Industry concentration, θ_j^{HHI} (j= CC, S), is measured using a Herschman-Herfindal Index of Export Employment (see Section IIIB).

TABLE 5.- NET EFFECT OF EXOGENOUS DEMAND SHOCKS

Effect of 1% Shock to Suburb on Central City Employment

	coefficient	
Δ EPI_S	0.3654	
Δ $EPI_S * \theta_{CC}^{Ind}$	-0.9114	
θ_{CC}^{Ind} evaluated at:		Net Effect of 1% Shock
minimum	11.7%	0.2590
mean	28.8%	0.1029
shock completely offset	40.1%	0.0000
1 s.d above mean	42.4%	-0.0208
maximum	81.9%	-0.3812

	coefficient	
Δ EPI_S	0.1635	
Δ $EPI_S * \theta_{CC}^{HHI}$	-1.4835	
θ_{CC}^{HHI} evaluated at:		Net Effect of 1% Shock
minimum	0.013	0.1447
mean	0.061	0.0727
shock completely offset	0.110	0.0000
1 s.d above mean	0.155	-0.0667
maximum	0.622	-0.7599

Effect of 1% Shock to Central City on Suburb Employment

	coefficient	
Δ EPI_{CC}	0.7511	
Δ $EPI_{CC} * \theta_S^{Ind}$	-1.2612	
θ_S^{Ind} evaluated at:		Net Effect of 1% Shock
minimum	11.1%	0.6108
mean	31.0%	0.3606
1 s.d above mean	45.4%	0.1782
shock completely offset	59.6%	0.0000
maximum	74.7%	-0.1913

	coefficient	
Δ EPI_{CC}	0.5376	
Δ $EPI_{CC} * \theta_S^{HHI}$	-2.7265	
θ_S^{HHI} evaluated at:		Net Effect of 1% Shock
minimum	0.011	0.5070
mean	0.068	0.3516
1 s.d above mean	0.139	0.1591
shock completely offset	0.197	0.0000
maximum	0.364	-0.4541

TABLE 6.- NET EFFECT OF EXOGENOUS DEMAND SHOCKS BY MSA

MSA Name	θ_{CC}^{Ind}	Net Effect of 1% Shock to Suburbs	θ_{CC}^{HHI}	Net Effect of 1% Shock to Suburbs	θ_{S}^{Ind}	Net Effect of 1% Shock to CC	θ_{S}^{HHI}	Net Effect of 1% Shock to CC
Akron, OH	19.1%	0.1910	0.0255	0.1257	21.1%	0.4848	0.0326	0.4487
Albuquerque, NM	25.2%	0.1355	0.0371	0.1085	62.3%	-0.0345	0.2798	-0.2252
Ann Arbor, MI	37.9%	0.0197	0.0797	0.0453	32.6%	0.3399	0.0619	0.3688
Atlanta, GA	25.2%	0.1356	0.0309	0.1176	21.1%	0.4847	0.0247	0.4702
Atlantic-Cape May, NJ	81.9%	-0.3812	0.6225	-0.7599	40.7%	0.2374	0.0827	0.3122
Austin-San Marcos, TX	35.6%	0.0406	0.0577	0.0779	46.6%	0.1635	0.1280	0.1886
Baltimore, MD	32.2%	0.0720	0.0506	0.0884	13.6%	0.5790	0.0165	0.4927
Baton Rouge, LA	17.4%	0.2067	0.0234	0.1287	26.9%	0.4113	0.0422	0.4225
Birmingham, AL	15.9%	0.2208	0.0195	0.1345	12.9%	0.5887	0.0190	0.4858
Boise City, ID	44.6%	-0.0412	0.0989	0.0167	32.8%	0.3375	0.0515	0.3973
Buffalo-Niagara Falls, NY	14.9%	0.2300	0.0176	0.1374	32.5%	0.3409	0.0649	0.3608
Canton-Massillon, OH	22.5%	0.1608	0.0291	0.1203	60.2%	-0.0078	0.2320	-0.0950
Charleston-North Charleston, SC	28.6%	0.1051	0.0418	0.1015	28.0%	0.3979	0.0440	0.4177
Charlotte-Gastonia-Rock Hill, NC-SC	22.8%	0.1575	0.0318	0.1163	23.2%	0.4586	0.0320	0.4503
Chattanooga, TN-GA	33.9%	0.0568	0.0654	0.0664	46.0%	0.1706	0.0944	0.2803
Chicago, IL	11.7%	0.2590	0.0127	0.1447	11.1%	0.6108	0.0112	0.5070
Cincinnati, OH-KY-IN	23.9%	0.1473	0.0305	0.1182	19.0%	0.5118	0.0240	0.4723
Cleveland-Lorain-Elyria, OH	16.7%	0.2129	0.0196	0.1344	12.6%	0.5920	0.0170	0.4913
Columbia, SC	19.1%	0.1915	0.0278	0.1222	18.1%	0.5226	0.0264	0.4656
Columbus, OH	18.3%	0.1987	0.0228	0.1297	27.9%	0.3995	0.0404	0.4274
Dallas, TX	14.3%	0.2353	0.0173	0.1378	23.4%	0.4565	0.0310	0.4532
Daytona Beach, FL	25.3%	0.1347	0.0355	0.1108	31.9%	0.3494	0.0562	0.3844
Denver, CO	27.5%	0.1145	0.0389	0.1058	20.7%	0.4904	0.0252	0.4690
Des Moines, IA	27.6%	0.1142	0.0436	0.0988	39.6%	0.2522	0.0751	0.3329
Detroit, MI	48.0%	-0.0717	0.1074	0.0041	35.1%	0.3085	0.0624	0.3674
Fort Wayne, IN	21.7%	0.1673	0.0299	0.1192	19.6%	0.5034	0.0295	0.4573
Fort Worth-Arlington, TX	39.6%	0.0042	0.0711	0.0580	23.2%	0.4579	0.0336	0.4461
Fresno, CA	42.7%	-0.0235	0.1006	0.0142	62.9%	-0.0420	0.1875	0.0265
Gary, IN	49.6%	-0.0862	0.1331	-0.0340	61.7%	-0.0270	0.2896	-0.2520
Harrisburg-Lebanon-Carlisle, PA	31.2%	0.0811	0.0471	0.0936	29.6%	0.3773	0.0439	0.4180
Houston, TX	20.3%	0.1800	0.0259	0.1251	18.8%	0.5142	0.0248	0.4700
Huntsville, AL	33.2%	0.0630	0.0546	0.0824	58.9%	0.0078	0.2065	-0.0254
Indianapolis, IN	17.2%	0.2089	0.0219	0.1309	19.4%	0.5067	0.0279	0.4616
Jackson, MS	20.4%	0.1799	0.0322	0.1156	22.8%	0.4641	0.0372	0.4363
Jacksonville, FL	20.7%	0.1764	0.0317	0.1164	30.6%	0.3646	0.0467	0.4104
Kansas City, MO-KS	28.0%	0.1102	0.0383	0.1066	23.7%	0.4518	0.0304	0.4546
Knoxville, TN	19.5%	0.1876	0.0257	0.1253	21.3%	0.4822	0.0332	0.4470
Lansing-East Lansing, MI	42.5%	-0.0223	0.1017	0.0127	25.9%	0.4246	0.0393	0.4305
Las Vegas, NV-AZ	80.4%	-0.3669	0.5720	-0.6851	51.7%	0.0988	0.1119	0.2325
Lexington, KY	29.2%	0.0989	0.0485	0.0915	34.9%	0.3110	0.0771	0.3274
Little Rock-North Little Rock, AR	20.6%	0.1779	0.0260	0.1249	27.2%	0.4083	0.0425	0.4219
Louisville, KY-IN	27.3%	0.1170	0.0409	0.1028	23.0%	0.4612	0.0333	0.4469
Macon, GA	32.5%	0.0688	0.0506	0.0884	26.1%	0.4219	0.0431	0.4200
Memphis, TN-AR-MS	43.3%	-0.0296	0.0947	0.0229	25.0%	0.4352	0.0367	0.4377
Milwaukee-Waukesha, WI	13.4%	0.2429	0.0160	0.1398	16.0%	0.5487	0.0203	0.4824
Minneapolis-St. Paul, MN-WI	16.3%	0.2173	0.0193	0.1348	17.0%	0.5366	0.0206	0.4816
Nashville, TN	20.9%	0.1751	0.0271	0.1232	18.8%	0.5141	0.0233	0.4740
New Orleans, LA	27.4%	0.1160	0.0386	0.1062	24.9%	0.4374	0.0343	0.4442
New York, NY	22.6%	0.1591	0.0301	0.1189	15.4%	0.5563	0.0212	0.4799
Newark, NJ	25.1%	0.1365	0.0347	0.1120	20.2%	0.4964	0.0242	0.4716
Norfolk-Virginia Beach-Newport News, VA-NC	26.0%	0.1285	0.0368	0.1089	31.4%	0.3552	0.0515	0.3972
Oakland, CA	12.2%	0.2545	0.0139	0.1429	24.9%	0.4375	0.0321	0.4500
Oklahoma City, OK	18.8%	0.1941	0.0256	0.1255	22.1%	0.4719	0.0317	0.4513
Omaha, NE-IA	31.5%	0.0781	0.0454	0.0961	51.8%	0.0980	0.1531	0.1201
Orlando, FL	54.3%	-0.1293	0.1369	-0.0396	29.5%	0.3793	0.0511	0.3983
Philadelphia, PA-NJ	37.3%	0.0251	0.0671	0.0639	17.2%	0.5346	0.0189	0.4860
Phoenix-Mesa, AZ	33.7%	0.0587	0.0549	0.0820	59.1%	0.0057	0.1972	0.0000
Pittsburgh, PA	27.4%	0.1153	0.0400	0.1042	20.2%	0.4959	0.0248	0.4699
Portland-Vancouver, OR-WA	13.0%	0.2472	0.0142	0.1424	25.1%	0.4352	0.0401	0.4283
Roanoke, VA	26.8%	0.1211	0.0357	0.1105	27.0%	0.4108	0.0419	0.4234
Rochester, NY	47.5%	-0.0677	0.1424	-0.0478	19.1%	0.5102	0.0273	0.4631
Rockford, IL	23.9%	0.1474	0.0326	0.1151	41.7%	0.2257	0.0998	0.2656

NET EFFECT OF EXOGENOUS DEMAND SHOCKS BY MSA (CONTINUED)

MSA Name	θ_{CC}^{Ind}	**Net Effect of 1% Shock to Suburbs**	θ_{CC}^{HHI}	**Net Effect of 1% Shock to Suburbs**	θ_{S}^{Ind}	**Net Effect of 1% Shock to CC**	θ_{S}^{HHI}	**Net Effect of 1% Shock to CC**
Sacramento, CA	14.7%	0.2318	0.0219	0.1310	30.6%	0.3650	0.0480	0.4067
St. Louis, MO-IL	25.9%	0.1291	0.0386	0.1062	22.2%	0.4705	0.0287	0.4593
Salem, OR	19.2%	0.1904	0.0271	0.1232	33.9%	0.3235	0.0651	0.3603
Salt Lake City-Ogden, UT	15.5%	0.2245	0.0189	0.1354	16.3%	0.5449	0.0206	0.4814
San Antonio, TX	26.1%	0.1277	0.0345	0.1123	31.2%	0.3579	0.0546	0.3889
San Francisco, CA	19.7%	0.1861	0.0250	0.1263	30.0%	0.3725	0.0440	0.4177
Santa Fe, NM	33.9%	0.0560	0.0502	0.0889	74.7%	-0.1913	0.2478	-0.1380
Seattle-Bellevue-Everett, WA	38.4%	0.0159	0.0760	0.0507	67.9%	-0.1057	0.3637	-0.4541
Springfield, IL	32.8%	0.0661	0.0575	0.0782	43.2%	0.2067	0.0936	0.2824
Syracuse, NY	19.8%	0.1851	0.0258	0.1253	19.2%	0.5094	0.0281	0.4610
Toledo, OH	28.3%	0.1077	0.0373	0.1081	35.1%	0.3080	0.0532	0.3927
Tulsa, OK	21.5%	0.1699	0.0295	0.1197	35.5%	0.3029	0.0628	0.3663
Washington, DC-MD-VA-WV	29.0%	0.1014	0.0475	0.0930	23.3%	0.4573	0.0333	0.4468
Wichita, KS	66.1%	-0.2374	0.2075	-0.1444	41.9%	0.2220	0.1029	0.2570
Wilmington-Newark, DE-MD	38.7%	0.0130	0.0679	0.0627	51.5%	0.1015	0.1447	0.1432