

Matching Economic Development Policy to the Local Context: Must we?

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Abstract:

This paper examines 2013 data on high-tech manufacturing employment across metropolitan statistical areas in the United States. The purpose is to discover how a broad set of social/demographic/economic variables relate to varying densities of high-tech manufacturing employment. Two questions are addressed. (1) Do social and industrial circumstances evolve together as suggested by institutionalist theories, and (2) is there any evidence to suggest that economic development policy is likely to be effective at creating the conditions that might invite local development of high-tech manufacturing.

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Economic developers and those who employ them spend a great deal of time and treasure hoping to create or attract high-tech activities to their regions. High-tech firms are described as being “engaged in the design, development, and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge” (Congressional Budget Office quoted in Hecker 2005, p. 57). High-tech firms are perceived as being young, entrepreneurial, and innovative and as potential sources of high-quality jobs (Hathaway 2013). One result is that pursuit of high-tech employment has become a near universal tenet of regional economic development policy, perhaps with little regard for the social, economic, or demographic fit of the industry. The race to be the next Silicon Valley has attracted entries from across the United States and the globe (Gill and Larson 2014).

While the CBO definition is meaningful at one level it can be difficult or impossible to delineate industries by their “high-techness.” Newer/higher technologies are applied across a wide swath of industries from agriculture to waste management. There have been noble attempts to operationalize the high-tech-industry concept. For example the National Science Foundation (<http://www.nsf.gov/statistics/seind06/c8/c8.cfm?opt=9>) identifies nearly 40 North American Industrial Classification System (NAICS) industries as being high-tech industries. Daniel Hecker (2006) provides a similar list that further identifies three high-tech industry levels. Level I includes computers, aerospace, pharmaceuticals and several other industries that are most commonly thought of as being high-tech. At the three-digit NAICS level, most of the Level I

manufacturing industries fall under the NAICS 334 code (computer and electronic product manufacturing) and all subindustries in NAICS 334 are on the Hecker's high-tech list.

The purpose of this paper is to explore the extent to which social/economic/demographic conditions vary systematically with the prevalence of high-tech manufacturing employment across Metropolitan Statistical Areas (MSAs). High-tech manufacturing employment, a large subset of high-tech employment, is defined as employment in the North American Industrial Classification System's (NAICS) 334 industry. After a brief theoretical discussion and review of related literature a set of MSA level data for 2013 will be examined in search of systematic differences across MSAs related to variations in high-tech manufacturing employment. At this phase of analysis the focus is on correlation rather than causation. This work is a partial response to the following critique.

While economic models can be simpler if the interaction of the economy with non-economic aspects of social life remains inside a black box, this strategy abstracts from many social phenomena that strongly affect costs and available techniques for economic action. (Granovetter 2005, p. 47)

Theoretical Discussion

Institutional economists have long been interested in the impact of technological change on society and social progress. Clarence Ayres (1962), among others, recognized the importance of technology in economic development. Ayres (1962 v-xxv) proposes four basic principles of economic development. These principles reflect the importance Ayres places on technological change as a driver of social progress. The principles are paraphrased below.

1. The process of economic development is indivisible and irresistible.

2. The technological revolution spreads in inverse proportion to institutional resistance.
3. The most important factor in the economic life of any people is the educational level (human capital).
4. The values which are engendered in the technological process are universal values.

Together these principles suggest that technical progress can and will drive social progress, if social conditions allow it. From this perspective, economic development policies aimed at attracting high-tech industries seem warranted.

Richard Nelson (1994) observes that “[t]he economy as a whole comprises many different sectors which, at any time, are developing differently” (p. 49). Different processes demand particular technologies and particular technologies evolve at different rates. Which of the many evolving technologies are adopted and applied in the provisioning process depends in part on their suitability to the task, in part on their trajectory (path dependency), and in part on their social fit (institutional support). From this perspective, technology, industrial structure, and institutions co-evolve (Nelson 1994). Thus, one can expect regional differences in industrial structure and related technologies to be correlated with regional social/institutional characteristics. This idea also fits well with the broad principles of original institutional economics (Adkisson 2009, 2010).

Selected Related Literature

Researchers have worked to understand the variables/conditions that are necessary to encourage high-tech or innovative activities. As a result of this research, reinforced by substantial practitioner/policymaker-driven conventional wisdom, high-tech activities are thought to be associated with particular regional characteristics.

Belal Fallah, et al (2014) identify three factors thought to be associated with regional variation in high-tech growth, size of the high-tech industry, urban agglomeration, and human capital and the presence of research universities. Additionally they account for variations in natural amenities and, because their analysis is at the county level distances to the nearest urban center. They acknowledge that different types of human capital may be more or less important depending on the specifics of the local industry. For example development of high-tech products likely requires a different type of human capital than production of the same products requires. Therefore, they operationalize human capital using various levels of educational attainment. Fallah, et al (2014) develop a basic model and then use the model to explain five categories of high-tech employment. Results vary across categories. The manufacturing model for metropolitan areas explains about 17 percent of county-by-county variation in high tech manufacturing employment growth. Urban agglomeration and education to at least the bachelor's level are influential. Relatedly, De Silva and McComb (2012) find that, at least in Texas, geographical concentration tends to enhance high-tech firm survival.

Iryna Lendel (2010) asks how research universities impact regional (MSA) economies. She finds the specific knowledge spillover effects difficult to assess. Industrial, geographic and data availability issues intervene in the process although, generally, she finds that universities have a positive role in regional economic performance. The bundled nature of university products makes it difficult to assess the impact of specific university products on regional economies. Some evidence suggests that prominent universities (high research and development expenditures) have strong positive regional impacts.

David Hart and Zoltan Acs (2011) report that 16 percent of high impact, high-tech firms have at least one (not necessarily recent) immigrant among their founders. These firms tend to be

located in states with large immigrant populations and are more likely than other firms to have strategic relationships with foreign firms (Hart and Acs 2011, p. 126). Foreign-born founders tend to have higher levels of formal education than native founders.

Jeffrey Dorfman, et al (2009) find that attempts to form high-tech clusters around major research or land-grant universities are unlikely to be successful and that the presence of natural amenities is not clearly a high-tech attractor. Richard Adkisson (2015) finds mixed results regarding the relations between regional characteristics and high-tech employment. In particular he finds economic development spending to be negatively related or unrelated to high-tech employment at the state level and that high-tech manufacturing and high-tech services relate to regional characteristics differently.

The brief literature review suggests several variables thought to influence high tech employment. This provides guidance for the analysis discussed below. Simultaneously the review suggests that the influence of the suggested variables may vary depending on the particulars of the specific high-tech industry examined.

Method and Data

The observed data come from 191 MSAs (of 381 possible) that report all needed data. The dominance of high-tech manufacturing employment is measured by the MSA's NAICS 334 employment location quotient, using a national base. Location quotient (LQ) values of 1 indicate that an MSA has a ratio of NAICS 334 to total employment equal to the nation's ratio. LQs less than one indicate relatively less and LQs greater than one indicate relatively more local NAICS 334 employment. The observational units fall into two different groups. The basic group (177 MSAs) has LQ values over a relatively continuous range of .02 (Billings, MT MSA) to 2.75

(Sherman-Denison, TX MSA). The high LQ group (14 MSAs) has higher and discontinuous LQ values ranging from 3.37 (Fort Collins, CO MSA) to 14.6 (San Jose-Sunnyvale-Santa Clara, CA MSA). The data are analyzed as follows.

1. A basic regression model incorporating independent variables suggested by the literature review is developed and estimated. The basic model includes a dummy variable and interaction terms to identify systematic differences between the basic and high-LQ groups. The high-LQ dummy variable reveals whether the regression intercept differs between the basic and high-LQ MSA groups. The interaction terms reveal differences in regression line slopes (marginal effects) between the two groups. The variables included are identified in the upper part of Table 1. The dependent variable is the NAICS 334 location quotient.
2. Having identified which variables are statistically related to the NAICS 334 LQ in the basic regression model, step-wise regressions are conducted to see if including any of a broad set of social/demographic/economic variables improves the model. These variables come primarily from the American Community Survey-5 year estimates for 2013 and cover various measures of poverty, income distribution, household size and composition, age structure, labor force participation, religion, dependency ratios, and regional origin of immigrants. Those that are shown to be related to high-tech manufacturing employment with a significance level of at least .10 are included in the second model and are identified in the lower part of Table 1.
3. A discussion of the results and their implications is provided.

INSERT TABLE 1 ABOUT HERE

The results of the basic and expanded model estimations are reported in Table 2. The models were first estimated using ordinary least squares. Heteroscedasticity tests indicated heteroscedastic errors, especially in the expanded model, so the models were re-estimated using White's heteroscedastic-consistent covariance matrix method (White 1980). The independent variables included in the basic model were selected based on the literature review and remain in the model whether they demonstrate a statistically detectable relationship with the dependent variable or not. Interaction terms are retained only when they improve the fit of the model.

The expanded model includes the stepped-in independent variables that improved the statistical fit and explanatory power of the model. With two exceptions the base-model variables yield the same results in both models. The interpretation of the results is based only on the expanded model with comments on the two changed results. Because several of the estimated coefficients are very small in magnitude, the reader is reminded that the range of the dependent variable is only .02 to 14.6 with most values at the lower end of the range. While recognizing the importance of discussing economic as well as statistical significance (McCloskey and Ziliak 1996) the discussion here will focus only on qualitative findings (signs and significance).

INSERT TABLE 2 ABOUT HERE

Discussion - Base Model Variables

AWAGE334 was included to account for labor cost variation across MSAs. It is related to the size of LQ334EMP but no claims as to the direction of causation is claimed. The positive sign on AWAGE334 indicates a positive relationship between wages and employment for the basic-group MSAs. The coefficient on the AWAGEHIGH interaction variable has a negative

sign and an absolute magnitude greater than the coefficient on AWAGE334 indicating a negative relationship between wages and employment among the high-LQ MSAs.

Industry size, operationalized as AVEEMP334, indicates a positive relationship between the absolute employment in high-tech manufacturing and its relative presence, other things (including population) equal though endogeneity is a possible problem since the value of the LQ includes local employment as a component. This is partially consistent with Fallah, et al (2014). The negative coefficient on TOTPOP indicates that relative high-tech manufacturing employment tends to decrease with population. The industry size and population relationships hold across both MSA groups. The presence of research universities (UNIVDUM) shows a positive influence on LQ334EMP for the basic-group MSAs although the impact is weaker in the high-LQ MSAs (UNIVHIGH). This fits with the findings of Dorfman, et al (2009) and Lendel (2010). Universities vary in their quality and research foci so universal impacts would not be expected.

Three of the variables suggested by the literature have weaker, or at least less consistent, relationships to high-tech employment than suggested by the literature and conventional wisdom. For the basic-group MSAs education (PCTBAPL), immigrants (PCTFORB), and natural amenities (AMENITY) show no significant statistical relationship with LQ334EMP. However the interaction term (FORBORNHIGH and AMENITYHIGH) results show positive relationships between high-tech manufacturing employment and both immigrants and natural amenities. Finally, the independent variables in the basic model explain 88 percent of the variation in the dependent variable indicating a good statistical fit.

To summarize, the size of the industry (AVEEMP334) appears to be important showing a positive relationship with LQ334EMP across all MSAs included in the data. Alternatively, urban agglomeration, at least as measured by TOTPOP, shows a negative relationship with LQ334EMP across all MSAs included in the data. The presence of human capital (PCTBAPL) has no obvious impact in this work while the relationship with research universities (UNIVDUM and UNIVHIGH) and high-tech employment differs across MSA groups. Finally, the presence of a foreign-born population (PCTFORB and FORBORNHIGH) and natural amenities (AMENITY and AMENITYHIGH) seem to have positive relationships with high-tech manufacturing employment only in the high-LQ MSAs. Given that this paper only considers high-tech manufacturing employment these findings seem reasonable, particularly given the R-squared value, but one might find different results upon examination of some other portion of high-tech employment.

Discussion – Stepped in Variables

The independent variables in the basic model explain 88 percent of the variation in the dependent variable indicating a good statistical fit. Thus it is not surprising that few of the many social/demographic/economic subjected to the step-in process are found to be significant. Even so, five additional variables are found to have statistically significant relationships with LQ334EMP. Jointly these variables add about four percentage points more explanatory power to the model and, importantly, seem to explain variation in high-tech manufacturing employment that is not previously explained by the basic model. Adding the new variables does not cause notable changes in the slope parameters of the basic model or their statistical detectability. Their addition does have some impact on the regression intercept. HIGHLQDUM becomes

insignificant and UNIVDUM becomes significant (compared to the base model) when the five new variables are stepped in.

Religion shows no relation to LQ334EMP for the basic-group MSAs but a negative relationship for the high-LQ MSAs (RELIGIONHIGH) is evident. The number of religious congregations of any faith is inversely related to LQ334EMP for high-LQ MSAs. Though some suggest that high-tech is a young person's game, the share of the MSA population in the 20-44 years of age range is negatively related to LQ334EMP. Conversely, the Gini coefficient is positively related to LQ334EMP for the high-LQ group. Beyond some point, income distribution appears to become less equal as high-tech manufacturing becomes ever denser in an MSA. Finally, the positive coefficient on EUROPE and the negative coefficient on ASIA indicates that as high-tech manufacturing becomes denser, the composition of the foreign born population in MSAs tends to be more European and less Asian.

Conclusion

With regard to theory, the analysis conducted here provides some evidence for Ayres (1962) and Nelson's (1994) notion of industrial/technical/social coevolution. Over 90 percent of the variation in LQ334EMP is explained with a very simple and parsimonious regression model that includes sociodemographic as well as purely economic variables. The stepped in variables, which would typically be hidden in Granovetter's (2005) black box did add some explanatory power to the model. The evidence is not overwhelming but at least provides some initial empirical support of this institutionalist proposition. Similar studies of a wider variety of industries could build on this foundation.

As for policy, there is little here to suggest that local/regional economic development policies will result in a massive change in the national structure of high-tech manufacturing.

Most MSAs in the data set have LQ values well below one while a few, only 14, MSAs seem dominant in the industry. Of the variables that are statistically related to high-tech manufacturing employment, none are likely to be influenced by regional policy. The fact that over 90 percent of the variation in LQ334EMP can be explained independent of variables subject to policy controls lends some credence to Adkisson's (2015) findings that economic development policy is largely ineffective in promoting high-tech employment. Thus, while the match between industries and social conditions appears important there is little to suggest that economic development policy will create a match where none really exists.

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Table 1		
Variables Used in the Regression Models		
Variable Name (concept operationalized)	Variable Description	Source
LQ334EMP (Dependent Variable)	Annual Average Employment Location Quotient, NAICS 334, 2013	1
BASIC MODEL INDEPENDENT VARIABLES		
AVEWAGE334 (Labor Cost)	Annual average wages per employee in MSA for 2013, NAICS334	1
AVEEMP334 (Industry Size)	Average annual employment in MSA for 2013, NAICS 334	1
TOTALPOP (Agglomeration)	Estimated total population for 2013	2
PCTBAPLUS (Human Capital)	Percentage of the population 25 and over with at least a high school diploma in MSA, 2013	3
UNIVDUM (Research University)	Dummy variable with a value of 1 if there is at least one Carnegie High or Very High Research institutions in MSA, otherwise 0.	4
PCTFORBORN (Immigrant Presence)	Percentage of MSA population that is foreign born	3
AMENITY (Natural Amenities)	Natural Amenities Scale, MSA values are average index values for all counties included in the MSA. Values are not provided for Alaska or Hawaii. Higher values indicate greater natural amenities (range 1-7).	5
HIGHLQDUM (Identify High LQ MSAs)	Dummy variable with value of 0 for MSAs with LQ334EMP values ≤ 2.75 and a value of 1 for MSAs with LQ334EMP values > 2.75 .	6
AWAGEHIGH	Interaction term, HIGHLQDUM* AVEWAGE334	6
HIGHUNIV	Interaction term, HIGHLQDUM*UNIVDUM	6
HIGHFORBORN	Interaction term, HIGHLQDUM*PCTFORBOR	6
HIGHAMENITY	Interaction term, HIGHLQDUM*AMENITY	6
STEPPED IN INDEPENDENT VARIABLES		
HIGHRELIGION	Interaction term, HIGHLQDUM*RELIGION (Number of congregations, any faith)	6, 7
HIGHAGE2044	Interaction term, HIGHLQDUM*POP2044 (Estimated percentage of total pop 20-44 years of age in 2013)	2, 6
HIGHGINI	Interaction term, HIGHLQDUM*GINI (GINI index of income inequality, Households)	6, 8
EUROPE	Percentage of foreign born population born in Europe	3
ASIA	Percentage of foreign born population born in Asia	3
DATA SOURCES		
1	United States Department of Labor, Bureau of Labor Statistics, Quarterly Census of Employment and Wages	
2	Age and Sex, 2009-2013 American Community Survey, 5-Year estimates.	
3	Selected Economic Characteristics, 2009-2013 American Community Survey 5-Year Estimates, DP02	
4	The Carnegie Classification of Institutions of Higher Education, Interim Site	
5	U.S. Department of Agriculture, Economic Research Service,	
6	Created by authors	
7	Association of Statisticians of American Religious Bodies, U.S. Religion Census, 2010,	
8	U.S. Bureau of the Census, 2009-2013 American Community Survey, 5-Year Estimates (B19083).	

Table 2		
Regression Results		
Dependent Variable = LQ334EMP, n=191		
Variable	Base Model Coefficient (t-ratio)	Expanded Model Coefficient (t-ratio)
AWAGE334	0.994E-05 (4.159)*	0.956E-05 (3.988)*
AVEEMP334	0.487E-04 (4.614)*	0.578E-04 (7.574)*
TOTPOP	-0.163E-06 (-3.547)*	-0.194E-06 (-4.984)*
PCTBAPL	0.002 (0.317)	-0.002 (-0.358)
UNIVDUM	0.114 (1.363)	0.179 (2.174)**
PCTFORB	-0.002 (-0.332)	0.005 (0.686)
AMENITY	0.003 (0.101)	-0.018 (-0.524)
HIGHLQDUM	3.360 (3.382)*	2.676 (0.518)
AWAGEHIGH	-0.421E-04 (-3.320)*	-0.184E-04 (-2.826)*
UNIVHIGH	-1.473 (-2.437)**	-1.126 (-2.155)**
FORBORNHIGH	0.392 (3.569)*	0.374 (7.676)*
AMENITYHIGH	0.514 (2.427)**	0.492 (3.498)*
RELIGIONHIGH		-0.058 (-8.178)*
AGE2044HIGH		-0.256 (-8.424)*
EUROPE		0.014 (3.413)*
GINIHIGH		24.821 (2.300)**
ASIA		-0.005 (-1.657)***
CONSTANT	-0.116 (-0.516)	0.056 (-0.211)
Adj. R Square	0.8845	0.9255
* Statistically detectable relationship at 0.01 level of confidence		
** Statistically detectable relationship 0.05 level of confidence		
*** Statistically detectable relationship 0.10 level of confidence		