The attenuation of human capital spillovers

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Abstract

This paper uses 2000 Census data to estimate the relationship of agglomeration and proximity to human capital to wages. The paper takes a geographic approach, and focuses on the attenuation of agglomeration and human capital effects. Differencing and instrumental variable methods are employed to address endogeneity in the wage–agglomeration relationship and also to deal with measurement error in our agglomeration and human capital variables. Three key results are obtained. First, the spatial concentration of employment within five miles is positively related to wage. Second, the benefits of spatial concentration are driven by proximity to college educated workers, an instance of human capital spillovers. Third, these effects attenuate sharply with distance.
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1. Introduction

Understanding the economy is not possible without understanding cities. One fact that illustrates the importance of cities particularly clearly is the urban wage premium. Glaeser and Mare (2001) show that there is a wage premium of 33% between the largest metropolitan areas (with population 500,000 or more) and non-urban locations. Not all agglomerations are equal, however. Rauch (1993) and others have established the existence of human capital externalities, where the proximity to educated workers is associated with a higher wage. Both of these effects are instances of agglomeration economies. Other evidence of agglomeration economies has come from estimates of production functions (Ciccone and Hall, 1996;

Henderson, 2003) and growth (Glaeser et al., 1992 and Henderson et al., 1995).[1]

The heart of the agglomeration literature is the idea that spatial concentration—either of population or human capital—enhances productivity. In all of the above papers and in most of the rest of the literature, workers are treated as being agglomerated if they share the same city or county. This approach leaves some fundamental questions unanswered. What is the spatial extent of externalities associated with the agglomeration of population or human capital? How quickly do these external economies attenuate with distance? These questions are important for both business location decisions and for local economic development policy. Businesses must choose locations, for instance in a downtown or an edge city, and this choice will depend on the how the benefits of agglomeration attenuate. Planners seek to create environments that are "competitive" in the sense that they can attract firms. They are also interested in the multiplier effects of local development policies such as building stadiums or attracting key firms. In both cases, the

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[1] See Rosenthal and Strange (2004) for a survey of the agglomeration literature.

rate at which agglomeration economies attenuate impacts the cost-benefit calculus. Attenuation is also important for understanding urban sprawl, with its many social and environmental consequences.

This paper estimates a series of wage equations to assess the impact of agglomeration on wage rates. We devote special attention to human capital externalities and the rate at which the wage–agglomeration relationship attenuates with distance. Our approach makes use of geographic information software and 2000 Census data to characterize the spatial distribution of economic activity. Specifically, we create concentric ring variables that measure the employment of both educated and less educated workers at various distances from a given worker's place of employment (i.e., within 5 miles, between 5 and 25 miles, etc.). We then estimate the relationship between these concentric ring measures of agglomeration and local human capital and the log of individual worker wages.

In taking this geographic approach, we will focus on several key aspects of the agglomeration–wage relationship. The first is the urban wage premium, where workers are paid more in large cities, controlling for their characteristics.[2] The second is human capital externalities, where the proximity to more educated workers raises a worker's wage. Human capital externalities have been reported in wage studies by Rauch (1993) and, more recently, by Moretti (2004a), who instruments for the presence of college educated workers with the lagged presence of universities. Our third area of focus is whether agglomeration is of greater benefit to more educated workers. Considering a range of occupations, Wheeler (2001) finds that more educated workers enjoy a larger premium, while Adamson et al. (2004) find the opposite.[3]

None of these papers consider attenuation. The list of papers that do consider attenuation is short. Rosenthal and Strange (2003, 2005) consider births. The key result is that the effects of the local environment on births and on new firm employment both attenuate by roughly half after five miles. Anderson et al. (2004, 2005) consider the local impacts of a shift in the organization of higher education in Sweden. The policy change—a significant decentralization—is a kind of natural experiment. They find that the effects on productivity and patenting are highly localized. Arzaghi and Henderson (2006) show that external economies in advertising are also highly localized.

We face two econometric challenges when regressing wage on agglomeration, measurement error and endogenous regressors. The measurement error arises from the construction of our agglomeration variables. They are based on data at the level of the individual worker's Work Public Use Micro Area (PW-PUMA). In characterizing the local economic environment of an individual worker, we treat the worker as being situated at the geographic centroid of the PWPUMA, with employment for each individual PWPUMA uniformly distributed throughout the given PWPUMA. We then draw concentric rings around the geographic centroid of each PWPUMA and measure the amount of employment within each distance band extending out from the PWPUMA centroid. While it is not obvious that a better procedure is feasible given our data, this nonetheless gives rise to an errors-in-variables problem: our agglomeration variables are measured with error, biasing our estimates of the influence of agglomeration towards zero. To deal with this, we restrict the estimating sample to individuals who live in MSAs and who work in PWPUMAs where the first concentric ring (five-mile) at least touches on two PWPUMAs. Restricting the sample to these small PWPUMAs reduces measurement error that would otherwise arise from larger PWPUMAs in sparsely populated areas.[4]

Our agglomeration measures may also be endogenous to an individual's wage. Concerns about endogenous measures of agglomeration dominate much of the empirical literature in this area (i.e., Combes et al., 2008). The issue of greatest concern has been that unusually skilled individuals are drawn to agglomerated areas. Selection of this sort would cause the error in a worker's wage equation to be correlated with the agglomeration variables, biasing the estimated effect of agglomeration on wage rates.[5] Balanced against the downward bias arising from measurement error, the net effect of the two biases is ambiguous.

To address endogeneity, we begin by including a rich set of observable worker-specific attributes in the regressions.[6] In addition, we difference our estimates in several ways. This has the effect of further stripping away the influence of unobserved worker-specific skill. As our first layer of differencing, all of our models include thousands of MSA/occupation fixed effects.[7] This ensures that the only endogenous sorting that might bias our estimates is within MSAs and occupations, a much narrower selection problem than is typical in agglomeration research. A second level of differencing occurs when we compare estimates of the effects of agglomeration in various concentric rings. Differencing in this fashion removes any unobserved effects that are common across rings. A third level of differencing is obtained when we estimate the influence of human capital spillovers: we difference the effect of proximity to college-educated workers relative to workers without college degrees. This removes unobserved effects associated with the total number of workers in a given ring. When estimating the attenuation of human capital externalities—by comparing human capital

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[2] In addition to the previously mentioned paper by Glaeser and Mare (2001), several papers find evidence of an urban wage premium. See, for instance, Combes et al. (2003, 2008), Tabuchi and Yoshida (2000), Di Addario and Patacchini (in press), and Wheeler (2006). See also Diamond and Simon (1990) and Wheaton and Lewis (2002), who find that wages are higher in more specialized locations.

[3] Lee (2005), considering health care workers, also finds that workers with less skill benefit more from agglomeration.

[4] In earlier versions of the paper, we report results of models restricting the sample to just the New York MSA. The PWPUMAs in New York are smaller in geographic size relative to most parts of the US Results were similar.

[5] It is worth pointing out that Bacolod et al. (2007) document a pattern where skills increase only modestly with city size (as measured by Dictionary of Occupational Titles job characteristics).

[6] Our control variables include the worker's age, age squared, education, race, marital status, presence of children, and years in the United States.

[7] With 331 MSAs and many different occupations, over 24,000 fixed effects are included in some models.