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# THE ECONOMICS OF PLACE-MAKING POLICIES

by

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## Abstract

Should the national government undertake policies aimed at strengthening the economies of particular localities or regions? Agglomeration economies and human capital spillovers suggest that such policies could enhance welfare. However, the mere existence of agglomeration externalities does not indicate which places should be subsidized. Without a better understanding of nonlinearities in these externalities, any government spatial policy is as likely to reduce as to increase welfare. Transportation spending has historically done much to make or break particular places, but current transportation spending subsidizes low-income, low-density places where agglomeration effects are likely to be weakest. Most large-scale place-oriented policies have had little discernable impact. Some targeted policies such as Empowerment Zones seem to have an effect but are expensive relative to their achievements. The greatest promise for a national place-based policy lies in impeding the tendency of highly productive areas to restrict their own growth through restrictions on land use.

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Three empirical regularities are at the heart of urban economics. First, output appears to be subject to agglomeration economies, whereby people become more productive when they work in densely populated areas surrounded by other people. Second, there appear to be human capital spillovers, whereby concentrations of educated people increase both the level and the growth rate of productivity. Finally, the urban system appears to be roughly described by a spatial equilibrium, where high wages are offset by high prices, and high real wages by negative amenities. Do these three regularities provide insights for policymakers, at either the local or the national level?

The concept of spatial equilibrium, presented in the first section of this paper, generally throws cold water on interventions that direct resources toward particular geographic areas. If high prices and low amenities offset high wages in a spatial equilibrium, there is nothing particularly equitable about taking money from rich places and giving it to poor places. Subsidies to poor places will be offset by higher prices, and the primary real effect will be to move people into economically unproductive areas. The spatial equilibrium concept thus suggests that the case for national policy that favors specific places must depend more on efficiency—internalizing externalities—than on equity.

The second section of the paper formalizes this theory and discusses its implications for optimal spatial policy. The model allows for agglomeration economies, which imply that productivity rises with the population or the population density of an area. Two types of evidence support the existence of those externalities: the concentration of economic activity in dense clusters and the robust connection between density and productivity. In principle, omitted exogenous differences in local productivity could explain both facts, but there is little evidence that any such differences are large.

At the local policy level, agglomeration economies provide a further justification for local leaders to seek to maximize population growth. At the national policy level, the existence of agglomeration economies and congestion disamenities makes it unlikely that a centrally unencumbered spatial equilibrium will be socially optimal. However, the mere existence of agglomeration economies does not tell us which areas should be subsidized. The spatial equilibrium model suggests that resources should be pushed to areas that are more productive and where the elasticity of productivity with respect to agglomeration is higher. Empirically, however, economists have little idea where that is the case. Given the difficulty even of

identifying the magnitude of agglomeration economies, it should not be surprising that we cannot convincingly estimate nonlinearities in those economies.

The spatial equilibrium model suggests that agglomeration economies are best identified through shocks to amenities or housing supply. For that reason, in the paper's third section we use the connection between climate and population growth to estimate the impact of population on productivity. We find little evidence to suggest that agglomeration economies are larger for smaller than for bigger cities, or for more compact than for less compact cities. We also find little evidence that the negative impact of population due to urban disamenities differs across types of cities. If anything, there seems to be a more positive link between population and amenities in more compact urban areas.

The fourth section discusses the historical record of place-making policies in the United States. From the Erie Canal to the Interstate Highway System, government-sponsored transportation infrastructure has long influenced the growth of particular places. We review the evidence showing a strong connection between access to railroads and growth in the nineteenth century, and between highways and urban growth in the twentieth century.<sup>2</sup> We argue that the place-making effects of transportation infrastructure do not imply that one should judge transportation spending on the basis of its ability to change the distribution of population across space. Since we lack confidence about which places should be subsidized, a simple model suggests that social welfare is maximized by choosing transport spending to maximize its direct benefits, not according to its ability to enhance one place or another. Current federal subsidies to transportation favor low-income, low-density states, which are unlikely to have particularly large agglomeration effects.

The Appalachian Regional Commission (ARC), created in the 1960s, is the largest example, in terms of total spending, of unambiguous American regional policy. Using transportation subsidies and other forms of spending, the U.S. government has tried to boost the fortunes of Appalachia. There is little robust evidence suggesting that this spending has been effective. Given that the program involved a modest amount of money spread over a vast geographic area, this is unsurprising. No regional policies that direct relatively small amounts of money at big places can be properly judged, since too many other forces influence these areas' outcomes.

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2. Haines and Margo (2006); Duranton and Turner (2008).

The ability to measure impact is one of the appeals of highly targeted interventions, such as the Empowerment Zones established in the 1990s, that direct significant resources at small areas. Matias Busso and Patrick Kline find that Empowerment Zones did boost local employment, but at a high cost: the program spent more than \$100,000 for each new job that can be attributed to an Empowerment Zone.<sup>3</sup> Moreover, just as the spatial equilibrium model suggests, housing prices rose in these zones, possibly more than offsetting any benefits to renters who were employed there before the policy.

The paper's fifth section turns to the national housing policies, such as urban renewal, that were seen as a tool for urban revitalization in the middle decades of the twentieth century. One rationale for these policies is that dilapidated housing creates negative externalities. The case against them is that declining areas already have an abundance of housing supply relative to demand, so that it makes little sense to build more housing. Empirically, we find little evidence that either urban renewal or the subsequent Model Cities Program had any discernable effects on urban prosperity.

Indeed, it might make more sense to focus on building in areas that are more, rather than less, productive. Given the huge wage gaps that exist across space, it may be better strategy to enable more people to move from Brownsville to Bridgeport than to try to turn Brownsville into a thriving, finance-based community. If the most productive areas of the country have restricted construction through extensive land use controls, and these controls are not justified on the basis of other externalities, then it may be welfare enhancing for the federal government to adopt policies that could reduce the barriers to building in these areas.

The sixth section of the paper turns to human capital spillovers, which occur when area-level productivity is a function of average skills in the area. The existence of human capital spillovers suggests that local leaders trying to improve area incomes or increase area population should focus on policies that attract or train more skilled residents. Like agglomeration economies, human capital spillovers mean that a decentralized equilibrium is unlikely to be optimal. For example, some education subsidies are likely to enhance welfare. Determining the correct national policy toward places, however, requires not only identifying the average effect of human capital externalities or industrial spillovers, but also knowing where these effects are larger.

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3. Busso and Kline (2008).

There is little clear evidence that human capital spillovers or industrial spillovers differ between smaller or larger, or more or less dense, cities. If anything, the impact of skilled workers and industries seems to be convex, suggesting possible returns from pushing skilled workers into already skilled areas. Of course, any tendency to artificially subsidize those areas with high human capital would seem inequitable. The recent tendency of skilled people to move to places where skills are already abundant seems to be progressing without government aid. If anything, these results bolster the case for working against land use restrictions that stymie growth in areas with high human capital.

## I. The Spatial Equilibrium

The economic approach to urban policy begins with a model that has three equilibrium conditions. The urban model makes the standard assumption that firms are maximizing profits and hence hiring workers to the point where wages equal the marginal product of labor. The model also assumes that the construction sector is in equilibrium, which means that housing prices equal the cost of producing a house, including land and legal costs. Finally, and most important, the model assumes that migration is cheap enough to make consumers indifferent between locations. High wages in an area are offset by high prices; low real wages are offset by high amenities. For more than forty years this spatial equilibrium assumption has helped economists make sense of housing prices within cities and the distribution of prices and wages across cities.<sup>4</sup>

The assumption of low-cost migration between places implies only that expected lifetime utility levels should be constant across space. In practice, economists typically assume that enough migration occurs at every point in time to ensure that period-by-period utility flows are also constant across space. This assumption is standard, if extreme, and we will use it here. The indirect utility function for an individual in location  $i$  can be written as  $V[W_i, P_i^j, \theta_i(N_i)]$ , where  $W_i$  refers to labor income in area  $i$ ,  $P_i^j$  is a vector of prices of city-specific nontraded goods (especially housing), and  $\theta_i(N_i)$  describes the quality of life in the area, which may be decreasing in population,  $N_i$ , because of congestion externalities. Traded goods prices and unearned income may also enter into welfare, but since these are constant over space, we suppress them. A

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4. Alonso (1964); Rosen (1979); Roback (1982).

variable  $X_i$  that influences wages must have an offsetting impact on either prices or amenities

that satisfies  $\frac{dW_i}{dX_i} + \sum_j \left( \frac{V_j}{V_w} \frac{dP_i^j}{dX_i} \right) + \frac{V_\theta}{V_w} \frac{d\theta_i}{dX_i} = 0$ . If amenities are fixed, if the only nontraded

good is housing, and if everyone consumes exactly one unit of housing, then  $\frac{dW_i}{dX_i} = -\frac{dP_i^j}{dX_i}$ . Any

wage increase is exactly offset by a price increase.

The spatial equilibrium assumption has significant implications for urban policy. If individuals are more or less indifferent to location, then there is no natural redistributive reason to channel government support to poor places. The logic of the spatial equilibrium insists that the residents of those places are not particularly distressed, at least holding human capital constant, because low housing prices have already compensated them for low incomes. Moreover, the equilibrium's logic also suggests that governmental attempts to improve incomes in poor places will themselves create an equal and offsetting impact on housing prices. If the spatial equilibrium assumption holds, then property owners, not the truly disadvantaged, will be the main beneficiaries of aid to poor places.

How strong is the evidence supporting the spatial equilibrium assumption? The striking disparities in income and productivity across American regions might seem to be prima facie evidence against it. Table 1 presents some figures for the U.S. metropolitan areas with the highest and lowest values of several relevant characteristics. The top panel lists the top and bottom five metropolitan areas ranked by gross metropolitan product (GMP) per capita. These figures are produced by the Bureau of Economic Analysis; they are meant to be comparable to gross national product in that they attempt to measure an area's entire output. (The figures are based on the output of the people who work in the area, not of the people who live there.) By this measure Bridgeport, Connecticut (which includes Greenwich), Charlotte, North Carolina, and San Jose, California, are the most productive places in the United States, with GMP per capita in the range of \$60,000 to \$75,000 in 2005. The five least productive places all have GMP figures less than one-third of the low end of that range: GMP per capita in Brownsville, Texas, America's least productive metropolitan area, was \$16,000 in 2005. The relationship between income per capita and GMP, shown in figure 1, is very tight, with a correlation coefficient of 75

percent.<sup>5</sup>

[table 1 about here]

[figure 1 about here]

The next panel of table 1 shows the disparity in family income between the five richest and the five poorest metropolitan areas. The five poorest areas have median family incomes less than half those in the five richest.

For these remarkable income differences to be compatible with the spatial equilibrium model, high prices or low amenities must offset higher incomes in the richest areas. The strongest piece of evidence supporting this view is that there are no legal or technological barriers preventing any American from moving from one metropolitan area to another, and indeed mobility across areas is enormous. Forty-six percent of Americans changed their place of residence between 1995 and 2000, half of them to a different metropolitan area. Critics of the spatial equilibrium assumption can argue, however, that moving costs—both financial and psychological—are often quite high. The existence of these costs leads us to examine other evidence on the existence of a spatial equilibrium.

One reason spatial income differences may not reflect differences in welfare for similarly skilled people is that people in different places do not have similar human capital endowments. The third panel of table 1 shows the differences across metropolitan areas in the share of the adult population with a college degree. Bethesda, Maryland, is one of the richest urban areas in the country, and more than half of its adults have college degrees. By contrast, fewer than one in ten adults in the least educated metropolitan areas have college degrees. The poorest metropolitan areas also have more non-native English speakers and more residents who speak English poorly or not at all. For example, more than three-quarters of the residents of McAllen, Texas, speak a language other than English at home.

One simple exercise is to compare the standard deviation of wages across metropolitan areas before and after controlling for observable individual-level human capital variables, such as years of schooling. The standard deviation of mean wages across metropolitan areas drops by 26 percent when we control for individual characteristics, suggesting that differences in human

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5. Some places, such as Sioux Falls, South Dakota, and Charlotte, North Carolina, have GMP per capita far above their income per capita, presumably reflecting relatively high levels of physical capital.



capital account for about half of the variance in metropolitan-area wage levels.<sup>6</sup> There are also important differences in unobserved human capital, which may themselves be a product of the differing experiences and role models across particular locales.

Even after accounting for differences in human capital, however, large differences in earnings remain across metropolitan areas. For the spatial equilibrium model to be correct, these differences must be offset by variation in the cost of living and amenities. The bottom panel of table 1 shows the disparities in housing prices across areas using Census data on housing prices. In the five most expensive areas, three of which are in California, the value of the median house was \$309,000 or more in the 2000 census. According to National Association of Realtors (NAR) data on recent housing sales, the average sales prices for San Jose and San Francisco were \$852,000 and \$825,000, respectively, in the third quarter of 2007. Meanwhile prices below \$60,000 are the norm in the five cheapest metropolitan areas. These places are again primarily in Texas, although Danville, Illinois, and Pine Bluff, Arkansas, are also among the least expensive areas.<sup>7</sup>

High incomes and high prices go together across metropolitan areas. Regressing the logarithm of income on the logarithm of housing prices across areas yields a coefficient of 0.33, which is reassuringly close to the share of housing in average expenditure.<sup>8</sup> Figure 2 shows a strong relationship (the correlation is 70 percent) between income per capita and house prices across metropolitan areas. For every extra dollar of income, prices increase by nearly ten dollars. This relationship means that higher housing costs exactly offset higher incomes if each extra dollar of housing cost is associated with 10 cents of annual expenses in interest payments, local taxes, and maintenance, net of any capital gains associated with living in the house. This figure does not seem unreasonable for many areas of the country.

[figure 2 about here]

Even though higher housing costs absorb much of the added income in high-wage places, they are only one of the costs of moving into a high-income area—many other goods are also more expensive. The American Chamber of Commerce Research Association (ACCRA) has

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6. This exercise was done using 2000 Census microdata. Our individual-level controls are age, race, educational attainment, and speaking a language other than English at home.

7. The NAR figures for inexpensive areas are considerably higher, since those data only look at recent home sales, which skew the sample toward newer, higher-quality homes. Using NAR data, it is the Rustbelt, not Texas, that has the cheapest homes: Decatur, Illinois, Saginaw, Michigan, and Youngstown, Ohio, are the three cheapest metropolitan areas according to the NAR, with median sales prices below \$90,000.

8. Glaeser and Gottlieb (2008).

assembled cost indices on a full range of commodities across metropolitan areas. Figure 3 shows the relationship between the logarithm of the ACCRA price index and the logarithm of income per capita, both as of 2000. The correlation between these variables is 54 percent, and as the ACCRA index goes up by 0.1 log point, personal income rises by 0.08 log point. Higher prices are offset by higher incomes, just as the spatial equilibrium model predicts.

[figure 3 about here]

Of course, there is still plenty of heterogeneity in real incomes across space. The spatial equilibrium model implies that lower real incomes must be offset by higher amenities. One of these is a pleasant climate. Figure 4 shows the relationship between average January temperature and real wages in 2000: warmer places pay less, just as the spatial equilibrium model suggests. A large literature shows that real incomes are lower where amenities are high.<sup>9</sup>

[figure 4 about here]

If it is much better to live in a high-income place, then one would expect population to be flowing toward richer areas. However, figure 5 shows a lack of any relationship across metropolitan areas between population growth from 1980 to 2000 and income per capita in 1980. People are not moving disproportionately to higher-income areas. The stability of the spatial equilibrium model is also supported by the relatively weak convergence of incomes across metropolitan areas in recent decades. If higher incomes in some areas represented some disequilibrium phenomenon, one would expect firms to abandon those areas and workers to gravitate toward them. Both forces would tend to make incomes converge.<sup>10</sup> But as we have documented elsewhere, the 1980s saw essentially no convergence, and in the 1990s convergence was much weaker than in the 1970s.<sup>11</sup>

[figure 5 about here]

One final piece of evidence comes from happiness surveys. We reject the view that responses to questions about happiness are a direct reflection of consumer welfare—we see no particular reason why utility maximization should be associated with any particular emotional state, even one as desirable as happiness. Still, a strong tendency of people who live in poor areas to report lower levels of happiness would be seen as a challenge to the spatial equilibrium approach. Using the General Social Survey between 1972 and 2006, we form self-reported happiness

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9. Including Roback (1982), Gyourko and Tracy (1989), and Black (1999),

10. Barro and Sala-i-Martin (1991).

11. Glaeser and Gottlieb (2008).

measures at the metropolitan-area level using the fraction of respondents who report being happy.<sup>12</sup> Figure 6 shows no relationship between self-reported happiness and income per capita—people do not seem any less happy in places that are poorer.

[figure 6 about here]

These facts certainly do not prove that the spatial equilibrium assumption holds. Given that amenities are part of any region's appeal and that it is impossible to know how much people value those amenities, it is effectively impossible to prove that welfare levels are equalized across space. A better way to describe the evidence is to say that many empirical facts are compatible with the spatial equilibrium assumption, and few, if any, would cause us to reject the assumption. Of course, we accept that welfare might not be equalized in the short run. A negative shock to an area's productivity will lead to a reduction in income that is not immediately capitalized into housing costs.<sup>13</sup> Moreover, when such capitalization does occur, homeowners will face a real decline in wealth in response to the area's economic troubles. The spatial equilibrium assumption is best understood as a characterization of the medium and long runs, not year-to-year variation in regional well-being.

## II. Economic Policy and Urban Theory

We will now fully specify a model to guide both our empirical work and our policy discussion. For our empirical work, we will assume that production and utility functions are Cobb-Douglas. But since these forms generate policy prescriptions that do not hold generically, we will have to move to a somewhat more general formulation when we discuss the implications for national policy.

We assume that individuals have Cobb-Douglas utility with a multiplicative amenity factor. We assume that they face a proportional tax rate of  $t_i$ , so that the indirect utility function can be written as  $U_i = \theta_i(N_i)(1 - t_i)W_i\Pi_j(P_i^j)^{-\beta_j}$ . The spatial equilibrium assumption is that utility in each area is equal to a reservation utility  $\underline{U}$ , which implies

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12. All of our metropolitan areas have at least 60 respondents to the happiness question over the period, and 95 percent have at least 100.

13. Blanchard and Katz (1992).

$$(1) \log(W_i) = \log(U) - \sum_j \beta_j \log(P_i^j) - \log(1 - t_i) - \log[\theta_i(N_i)].$$

With a slight abuse of notation, we assume that  $\theta(N_i) = \theta_i N_i^{-\sigma}$ , to capture possible congestion externalities. On the production side, we restrict the model to two goods: one traded good that has a fixed price of one, and one nontraded good with an endogenously determined price of  $P_i$ . The share of spending on the nontraded good is denoted  $\beta$ , so overall utility is  $\theta_i(N_i)^{-\sigma} (1 - t_i) W_i P_i^{-\beta}$ .

The traded sector is characterized by free entry of firms that produce traded goods according to a constant-returns-to-scale production function  $A_i(N_i)F_i(L_i, K_{T,i}, K_{N,i})$ . We let  $A_i(N_i) = a_i N_i^\omega$ , which is meant to capture the level of productivity in the area, which may be increasing in the total number of people working in the area.  $L$  represents labor,  $K_T$  a vector of traded capital inputs, and  $K_N$  a vector of nontraded capital inputs. A fixed supply of nontraded capital implies that a production function that displays constant returns to scale at the firm level will display diminishing returns at the area level—at least if agglomeration economies are not too strong. If the production function is written as  $F_i(L_i, K_{T,i}, K_{N,i}) = a_i N_i^\omega \mathbf{K}_{N,i}^{\alpha\gamma} \mathbf{K}_{T,i}^{\alpha(1-\gamma)} L_i^{1-\alpha}$ , and if nontraded capital in the area is fixed (denoted  $\bar{K}_{N,i}$ ), then labor demand in the area can be written  $Q_W (a_i N_i^\omega \mathbf{K}_{N,i}^{\alpha\gamma} W_i^{\alpha-1-\alpha\gamma})^{1/\alpha\gamma}$ , where  $Q_W$  is constant across areas.

We assume a housing sector characterized by free entry of firms with access to a production technology  $H_i G(L, K_T, K_N)$ .  $H_i$  represents factors that impact the ability to deliver housing cheaply, and  $G(., ., .)$  is a constant-returns-to-scale production function. The housing production function is  $H_i \bar{Z}_{N,i}^{\mu\eta} \mathbf{K}_T^{\mu(1-\eta)} L^{1-\mu}$ , where  $\bar{Z}_{N,i}$  represents the nontraded input into housing (land), which we assume is different from the nontraded input into the traded goods sector. To account for the returns to nontraded capital inputs (land), we assume they go to rentiers who also live in the area. They have the same Cobb-Douglas utility functions as workers but do not work or noticeably affect aggregate population. Instead they are a wealthy but small portion of the population; because of their wealth they contribute to demand for the nontraded good, but because of their negligible number they do not add to area population. Thus,  $N_i$  equals only the sum of labor used in the two sectors. The government also spends a share  $\beta$  of its revenue on the nontraded good.

We now define our equilibrium concept:

*Definition:* In a competitive equilibrium, wages equal the marginal product of labor in both sectors, individuals optimally choose housing consumption, and utility levels are constant across space.

The spatial equilibrium condition, labor demand, and equilibrium in the housing sector produce solutions for population, wages, and prices:

$$(2) \log(N_i) = \kappa_N + \frac{1 - \beta(1 - \mu + \mu\eta)}{\varpi} \log(a_i \bar{K}_{N,i}^{\alpha\gamma}) + \frac{1 - \alpha + \alpha\gamma}{\varpi} \log[(1 - t_i)\theta_i (H_i \bar{Z}_{N,i}^{\mu\eta})^\beta]$$

$$(3) \log(W_i) = \kappa_W + \frac{\sigma + \mu\eta\beta}{\varpi} \log(a_i \bar{K}_{N,i}^{\alpha\gamma}) + \frac{\omega - \alpha\gamma}{\varpi} \log[(1 - t_i)\theta_i (H_i \bar{Z}_{N,i}^{\mu\eta})^\beta]$$

(4)

$$\begin{aligned} \log(P_i) = & \kappa_P + \frac{\mu\eta + \sigma(1 - \mu + \mu\eta)}{\varpi} \log(a_i \bar{K}_{N,i}^{\alpha\gamma}) + \frac{\omega(1 - \mu + \mu\eta) + \mu\eta(1 - \alpha) - \alpha\gamma(1 - \mu)}{\varpi} \log[(1 - t_i)\theta_i] \\ & + \frac{\omega - \alpha\gamma - \sigma(1 - \alpha + \alpha\gamma)}{\varpi} \log(H_i \bar{Z}_{N,i}^{\mu\eta}) \end{aligned}$$

where  $\kappa_N$ ,  $\kappa_W$ , and  $\kappa_P$  depend on the tax rate and constants, and  $\varpi = (\sigma + \beta\mu\eta)(1 - \alpha + \alpha\gamma) + (\alpha\gamma - \omega)[1 - \beta(1 - \mu + \mu\eta)]$ . This system of equations will guide our discussion of the empirical work on agglomeration economies. These equations show that an exogenous increase in area-level productivity or amenities will impact population, wages, and prices. In urban research all three outcomes must be used to understand the impact of an intervention.

The most natural social welfare function is  $\sum_i N_i \theta_i (1 - t_i) W_i P_i^{-\beta}$ , which equals the (fixed) total population times individual utility (which will be constant across people). We also include the welfare received by rentiers; if total rentier income is  $Y_i$ , and the size of this group is fixed exogenously, then the additive utility function that includes rentiers can be written as  $\sum_i \theta_i (1 - t_i) (N_i W_i + Y_i) P_i^{-\beta}$ .

Our first policy question concerns the optimal local tax level to fund local amenities. We assume that local amenities are a function of local spending and population, so that  $\theta_i$

$=g_i(t_i W_i N_i, N_i)$ . These amenities could include public safety, parks, and schools. Following Truman Bewley,<sup>14</sup> two assumptions are typical in the literature. Amenities may be a pure public good, meaning that there is no depreciation with population size and  $\theta_i = g_i(t_i W_i N_i)$ , or a pure public service, which means that output is neutral with respect to population and  $\theta_i = g_i(t_i W_i)$ . We assume the latter so that amenities are a function of individual taxes.<sup>15</sup>

*Proposition 1:* The allocation of people across space in a decentralized equilibrium also maximizes social welfare. If an individual's amenity level  $\theta_i$  is a function of that individual's tax payments, then the area-specific tax that maximizes the sum of utility levels across areas is also the tax that maximizes utility within each area when holding population constant. A local government that seeks to maximize population will choose tax rates that maximize the sum of total utility levels, whereas a local government that seeks to maximize wages per capita will minimize social welfare. Housing prices should be maximized if agglomeration economies are sufficiently large or house production is sufficiently capital intensive, and minimized otherwise.

In this model, agglomeration economies do not change the optimal policies for local governments. Maximizing population was desirable even without agglomeration economies; the existence of such economies only provides another reason for its desirability. The result that population maximization is optimal is not general, however. In some cases local governments must decide between actions that improve the welfare of existing citizens and actions that attract more citizens. Restrictions on land use development are a pertinent example of a policy that reduces area population growth but may increase the quality of life for existing residents. When a conflict arises between attracting more people and caring for current residents, agglomeration economies will tend to strengthen the case for policies that attract new residents.

Despite the existence of externalities, our assumptions about functional forms imply that there are no welfare gains from reallocating people across space.<sup>16</sup> The key to this result is that our functional forms imply that the elasticity of welfare with respect to population is constant. To

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14. Bewley (1981).

15. For simplicity we assume that this is true for the rentier class as well.

16. The decentralized equilibrium is, however, not a Pareto optimum. There would still be gains from redistributing income across space, holding populations constant.

address spatial issues more generally, we will need a more general formulation for agglomeration economies.

This observation notwithstanding, Proposition 1 does not rule out a role for government. Indeed, by assumption the government provides the amenity level, so there is an inherent role for government spending. The proposition does imply, however, that decisionmaking about optimal spending can ignore population responses and simply maximize the welfare of the current population. A decentralized decisionmaking process, where individual areas choose tax and amenity levels to maximize the welfare of their citizens, will yield a Pareto optimum. This result depends on the functional form that guarantees a constant elasticity of well-being with respect to population.

The proposition also hints at some of the key results from urban public finance. When localities maximize population or property values, they will also be maximizing utility and choosing an optimal tax level. If they try to maximize income per capita, however, they will actually be minimizing social welfare. In other settings, of course, maximizing population does not yield socially beneficial results. For example, if one area suffers a negative externality from congestion and another area has no such congestion, it will not maximize social welfare for the congestion-prone area to try to maximize population. A distinguished literature, following Henry George,<sup>17</sup> shows that choosing policy to maximize local land values is usually the most reliable way to achieve a Pareto optimum.<sup>18</sup>

To derive more general results about the location of people across space, we move to a more general model and ignore the role of government in creating local public goods. We will also suppress the terms for capital and write output of nontraded goods in an area as  $A_i(N_i)F_i(N_i - L_i)$ , which represents total output of nontraded goods minus the costs of traded capital, assuming that traded capital is chosen optimally. Likewise, we write production of housing as  $G_i(L_i)$ , which again is meant to be net of traded capital. Utility is  $U[Y_i, H_i, \theta_i(N_i)]$ , where  $Y_i$  is net income, which may include rental income, minus housing costs. The next proposition then follows:

*Proposition 2: (a) A competitive equilibrium where net unearned income is constant*

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17. George (1879).

18. See, for example, Brueckner (1983).

across space is a social optimum if and only if  $U[Y_i, \theta_i(N_i)]$  and  $N_i \theta'_i(N_i)U_{\theta,i} + U_Y A_i(N_i)F(N_i - L_i)$  are constant across space, where  $U_{\theta,i}$  is the marginal utility of amenities in location  $i$ .

(b) If either all unearned income from an area goes to the residents of that area, or the marginal utility of income is constant across space, then moving individuals from area  $j$  to area  $i$  will increase total welfare relative to the competitive equilibrium if and only if

$$\theta_i(N_i)U_{\theta,i} \frac{N_i \theta'_i(N_i)}{\theta_i(N_i)} + U_{Y,i} \frac{N_i A'_i(N_i)}{A_i(N_i)} \frac{A_i(N_i)F_i(N_i - L_i)}{N_i}$$

is greater than

$$\theta_j(N_j)U_{\theta,j} \frac{N_j \theta'_j(N_j)}{\theta_j(N_j)} + U_{Y,j} \frac{N_j A'_j(N_j)}{A_j(N_j)} \frac{A_j(N_j)F_j(N_j - L_j)}{N_j}.$$

Part (a) of Proposition 2 reveals two reasons why a spatial equilibrium may not be a social optimum. First, a spatial equilibrium equates total utility levels across space, not marginal utilities of income.<sup>19</sup> Thus a planner could increase welfare by transferring utility to areas where the marginal utility from traded-goods consumption is high, and holding population levels constant.<sup>20</sup> Since everyone is identical ex ante, there is no natural means of placing different social welfare weights on different individuals to eliminate the gains from redistribution that come from different marginal utilities of income.

The Cobb-Douglas utility functions discussed above imply that the marginal utility of income equals total utility (which is constant across space) divided by income. In this case redistributing income to poor places is attractive—if population can be held fixed—not because poorer places have lower welfare but because they have a higher marginal utility from spending. This result would disappear if poor places had amenities that were substitutes for rather than complements to cash.<sup>21</sup>

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19. This is a spatial version of the Bergstrom (1986) problem, where wages for the volunteer army equate total utility levels but not marginal utility levels. Glaeser (1998) examines this issue in the context of indexing transfers for local price levels.

20. This failure of the decentralized equilibrium is not an artifact of assuming a utilitarian social welfare planner. The decentralized equilibrium will not generally maximize any weighted average of individual utility levels. If the planner puts a larger weight on people in areas where the marginal utility of income is high, then the spatial equilibrium will generically be suboptimal, because the utility of those people is the same as the utility of people in areas where the marginal utility of income is low.

21. This argument for redistribution appears in many situations where the market equilibrium equates total utilities, rather than the marginal utility of income; the same argument can be used to justify transfers to high-amenity



The second reason for government intervention arises if  $N_i \theta'_i(N_i)U_{0,i} + U_Y A'_i(N_i)F(N_i - L_i)$  is not constant across space. In the absence of congestion and agglomeration economies, the competitive equilibrium is a social optimum. Alternatively, if the sum of agglomeration plus congestion effects were (somewhat magically) the same everywhere, the decentralized equilibrium would be a social optimum. These unusual circumstances were satisfied under the functional forms described above, which reflect a constant elasticity of amenities and agglomeration with respect to population. Those conditions, and the assumption about the functional form of the utility function, ensured that welfare could not be improved by moving population around.

Another way to understand the benefits from subsidizing places is to consider moving people from one region to another, as discussed in part (b) of Proposition 2. Gains can accrue from reallocating people to an area if either the amenity elasticity is lower there or the agglomeration economies are higher. The condition on agglomeration economies multiplies the agglomeration elasticity  $\frac{N_i A'_i(N_i)}{A_i(N_i)}$  by  $U_{Y,i} \frac{A_i(N_i)F_i(N_i - L_i)}{N_i}$ ; in words, it is the product of the marginal utility of income and output per capita in the nontraded sector. This second term implies that it is desirable to move people to richer areas if the marginal utility of income is constant across space. We will focus on the differences in agglomeration elasticities in the next section.

### III. Agglomeration Economies

Two important facts support the existence of agglomeration economies: the spatial concentration of economic activity, and the tendency of densely populated areas to be richer and more productive. The majority of the world now lives in cities, and hundreds of millions of people crowd into a small set of particularly large megacities. Industries are also often spatially concentrated.<sup>22</sup> In principle, the concentration of people in cities and of industries in clusters could simply reflect exogenous differences in productivity. This view may well be accurate for the nineteenth century, when, for example, hundreds of thousands came to New York to enjoy the

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occupations that pay lower wages, at least if those amenities are not a complement to earnings. However, as Oliver Hart emphasized in his comment on Bergstrom (1986), this problem can be solved privately with cash lotteries that occur before choosing occupations or locations.

22. Ellison and Glaeser (1999).

productive advantages created by its natural harbor. In the twenty-first century, however, it is hard to think of any comparable exogenous advantages that could explain massive urban agglomerations. Glenn Ellison and Glaeser find that a large battery of local characteristics can explain less than one-fifth of the concentration of manufacturing industries across space.<sup>23</sup> Since so much clustering occurs without an obvious exogenous cause, urban economists have tended to interpret it as the result of endogenous gains from co-location, which are referred to as agglomeration economies.

The belief in agglomeration economies is also bolstered by the robust correlations between income or productivity and urban density. Figure 7 shows the relationship between the logarithm of GMP per capita and the logarithm of metropolitan-area population. City size explains one-quarter of the variation in GMP per capita (that is, the correlation is 0.50), and the elasticity of productivity with respect to city size is 0.13.

[figure 7 about here]

Because GMP data have been available for only a few years, earlier researchers looked at either metropolitan-area income or state-level productivity measures. Antonio Ciccone and Robert Hall show the remarkably strong correlation between state productivity and the degree to which the population within a state is concentrated in a small number of dense counties.<sup>24</sup> Glaeser and D. Mare show that the urban wage premium does not seem to reflect differential selection of more-skilled people into big cities.<sup>25</sup> They do find, however, that recent migrants to cities experience only a small portion of the urban wage premium immediately, instead reaping most of the gains through faster wage growth. The steep age-earnings profile in cities suggests that cities may speed the pace of human capital accumulation.

The great challenge facing research on the connection between city size and income is that this connection may reflect the tendency of people to move to already-productive areas, rather than any sort of agglomeration economy. Ciccone and Hall address this reverse causality issue by turning to historical variables, such as nineteenth-century population and railroad density. P. Combes and coauthors pursue a similar exercise using French data.<sup>26</sup> Using these variables as instruments for density, these authors continue to find a strong connection between density and

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23. Ellison and Glaeser (1999).

24. Ciccone and Hall (1996).

25. Glaeser and Mare (2001).

26. Combes and others (2008).

economic productivity. However, as we will discuss later, historical instruments of this kind do not naturally solve the identification problem in a spatial model such as the one described above.

Since the public policy implications of agglomeration economies depend on the size and nature of those economies, table 2 reproduces these standard approaches to measuring agglomeration using individual-level data from the 2000 Census. We run the regressions using only prime-working-age men (those between the ages of 25 and 55) to avoid capturing variation from differences in labor force participation, but similar results obtain when we include all employed adults. Regression 2-1 in table 2 shows the basic correlation between the logarithm of population in a metropolitan area and the logarithm of wages, holding individual-level controls constant. The measured elasticity is 0.041, meaning that as population doubles, income increases by a little more than 2.8 percent. If population is exogenously distributed, then the Cobb-Douglas functional forms above imply that the measured elasticity of wages with respect to area population equals  $\frac{\omega - \alpha\gamma}{1 - \alpha + \alpha\gamma}$ ; thus if labor's share in output is two-thirds, then the agglomeration parameter  $\omega$  equals  $\alpha\gamma$ , the share of nontraded capital in production, plus 0.027.

[table 2 about here]

Regression 2-2 in table 2 examines whether the elasticity of wages with respect to population differs between big and small cities. It is specified as a piecewise linear regression with a break at the median population across our sample of metropolitan areas, thus allowing the impact of area population to be bigger or smaller for larger areas. The estimated elasticity is higher for smaller cities (0.076 versus 0.038), but the difference is not statistically significant.

Some agglomeration theories focus on area size, others on population density. Regression 2-3 includes both population and density as independent variables. The coefficients on the two variables are similar, at 0.023 and 0.029, respectively. Regression 2-4 is a piecewise linear regression for both density and population. Again the estimated coefficient on population is stronger for smaller cities. However, the estimated coefficient on density is stronger for areas with more people per acre, but the difference in the density coefficients is not statistically significant.

Regression 2-5 follows Ciccone and Hall and uses historical data—population of the metropolitan area in 1850—to instrument for current population.<sup>27</sup> We have data for only 210

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27. Ciccone and Hall (1996).

metropolitan areas from this period, so our sample size shrinks. The estimated coefficient on population in this regression is actually higher than that in regression 2-1, which suggests that the population-income relationship does not reflect the impact of recent population movement to more productive areas.

The model clarifies what we need to assume for instrumental variables regressions such as this one to be interpreted as estimates of agglomeration economies. If historical population affects wages by raising productivity, perhaps because it is associated with investment in nontraded infrastructure, then the estimated coefficient will equal  $\frac{\sigma + \mu\eta\beta}{1 - \beta(1 - \mu + \mu\eta)}$ , which is also what ordinary least squares would estimate if cross-city variation came from heterogeneity in productivity. These parameters do not tell us anything about agglomeration economies, but instead provide us with information about decreasing returns in the housing sector. If, however, historical population acts through housing supply or amenities, then the estimated instrumental variables coefficient will equal  $\frac{\omega - \alpha\gamma}{1 - \alpha + \alpha\gamma}$ , which can be transformed to get an estimate of agglomeration economies. This would also be the ordinary least squares coefficient if the exogenous spatial variation came entirely from amenities or housing supply.

Table 2 raises two challenges for economic policy. First, these simple correlations between income and area population may not be instructive about agglomeration economies, since they could result from omitted productivity. Second, even the ordinary least squares relationships fail to find a clear difference in agglomeration economies between bigger and smaller areas or between more and less dense areas. Since the rationale for agglomeration-based spatial interventions requires agglomeration elasticities to be different in different types of areas, we next look for this effect using more complex estimation techniques. But uncovering differences in elasticities that are not visible using ordinary least squares is a tall order.

### *Estimating Agglomeration*

The urban model presented in equations 2 through 4 implies that agglomeration economies can be estimated if we have exogenous sources of variation that impact amenities or housing supply, but not productivity. If agglomeration economies exist, then the extra population brought in by

amenities should raise productivity. The mean temperature of an area is certainly an amenity: people prefer milder climates. We therefore use climate data to see whether places that attract more people because of their climate also see an increase in wages.

January temperature and precipitation are both relatively reliable predictors of urban growth in postwar America. Regressing the change in population between 1970 and 2000 on these two variables yields the following equation:

$$(5) \quad \log(\text{population}_{2000}/\text{population}_{1970}) = 0.0603 + 0.0166 \text{ temperature} - 0.0068 \text{ precipitation.}$$

(0.0549) (0.0012) (0.0011)

The adjusted  $R^2$  is 0.39 and there are 316 observations; standard errors are in parentheses. One interpretation of these correlations is that they reflect the interaction between climate and new technologies, such as air conditioning, that make warm places relatively more appealing. Glaeser and Kristina Tobio argue that warm areas tend also to have had more-permissive land use regulations.<sup>28</sup> An alternative approach might therefore be to use the Wharton Land Use Index, which measures the restrictiveness of the building environment, to capture variation related to housing supply.<sup>29</sup> In both cases identification hinges critically on these variables being orthogonal to changes in productivity at the local level, except insofar as the productivity changes are due to agglomeration economies. We cannot be sure that this is the case, but given the absence of other alternatives we will use variation in climate as our instrument.

Using the model above, we assume that our climate-based instruments predict changes in the housing supply and amenity variables,  $\log(H_i Z_{N,i}^{\mu\eta})^\beta + \log(\theta_i)$ , but not changes in the productivity variable  $\log(a_i K_{N,i}^{\alpha\gamma})$ . In this case the univariate regression of wage growth on population growth will estimate  $\frac{\omega - \alpha\gamma}{1 - \alpha + \alpha\gamma}$ . By examining the interaction of this treatment effect with other area-level characteristics, we can determine whether  $\omega$  appears to be higher in some places than in others. This procedure also requires  $\alpha$  and  $\gamma$  to be constant across space.

Taking the logarithm of our baseline wage equation (equation A1 in appendix A) yields the following relationship between the wage of person  $j$  and the size of metropolitan area  $i$ ,

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28. Glaeser and Tobio (2008).

29. The index was developed by Gyourko, Saiz, and Summers (2007) based on a survey of local zoning authorities nationwide.

where the person lives:

$$(6) \quad \log(W_j) = (b_0 + b_1 X_i) \log(N_{i,t}) + \sigma_t Z_j + \zeta_i + \varepsilon_j.$$

The vector  $Z_{j,t}$  represents individual characteristics, such as age and education, and  $\sigma$  the vector of coefficients on  $Z$  at time  $t$ . Each metropolitan area has a fixed effect,  $\zeta_i$ , due to nontraded capital and MSA-specific noise, and the error term  $\varepsilon_j$  represents the effect of any unobservable individual characteristics as well as noise in setting the wage. Population size  $N_{i,t}$  impacts the wage through the coefficient  $b_0 + b_1 X_i$ , which equals  $\frac{\omega - \alpha\gamma}{1 - \alpha + \alpha\gamma}$ . The possibility that these coefficients might be different for different types of cities is captured by the term  $b_1 X_i$  which allows city-level characteristics,  $X_i$ , to impact the agglomeration economy. This procedure requires  $b_0$  and  $b_1$ , to be constant across space. If we also assume them to be constant over time, then we can write

$$(7) \quad \log(W_j) = (b_0 + b_1 X_i) \log(N_{i,t+1}) + (\sigma + \tau) Z_j + \zeta_i + \varepsilon_j,$$

where  $\tau$  augments  $\sigma$  because we allow the effect of individual characteristics to change over time. We can rewrite equation 7 to show an explicit dependence on population growth:

$$(7') \quad \log(W_{j,t+1}) = (b_0 + b_1 X_i) \log(N_{i,t+1}/N_{i,t}) + (\sigma + \tau) Z_j + \mu_i + \varepsilon_j.$$

In equation 7' the MSA-level fixed effect is  $\mu_i = (b_0 + b_1 X_i) \log(N_{i,t}) + \zeta_i$ , which will be the estimated MSA-level fixed effect in equation 6, so we can write

$$(6') \quad \log(W_j) = \sigma_t Z_j + \mu_i + \varepsilon_j.$$

We will estimate  $b_0$  and  $b_1$  by pooling equations 6' and 7' together for Census years 1990 and 2000. We can thus run

$$(8) \quad \log(W_j) = (b_0 + b_1 X_i) \log(N_{i,2000}/N_{i,1990}) I_{2000} + \sigma Z_j + \tau Z_j I_{2000} + \mu_i + \varepsilon_j,$$

where  $I_{2000}$  is a dummy variable equal to one for observations in 2000.

We first estimate equation 8 as an ordinary least squares regression, omitting any interaction with population growth. Results are presented as regression 3-1 in table 3, and the sample again includes only prime-working-age men. The coefficient on population growth is strongly positive, indicating that expanding cities are also getting more productive. In regression 3-2 we attempt to identify the effect by using January temperature, July temperature, and precipitation as instruments for population growth between 1990 and 2000. If  $b_1 = 0$ , this should yield an unbiased estimate of  $b_0 = \frac{\omega - \alpha\gamma}{1 - \alpha + \alpha\gamma}$ . The coefficient drops to 0.004, implying that a doubling in population is associated with a 0.3 percent increase in wages. But this coefficient does not mean that agglomeration economies are absent. The theory predicts that wages will only increase with population ( $b_0 > 0$ ) if population is a larger input into production than fixed capital. If  $b_0 = 0$ , then  $\omega = \alpha\gamma$ ; that is, extra population is just as valuable as extra fixed capital, and increasing prices absorb all of the gains from agglomeration.

[table 3 about here]

We have little empirical guidance on the amount of non-traded capital in the production function. Eventually, all capital may be endogenous, but over the course of a decade or two, much capital is relatively fixed. The user cost of commercial real estate provides one possible source of information on the fraction of fixed capital in the economy's aggregate production function. If this real estate is worth the \$5.3 trillion claimed by Standard and Poor's (2007), then assuming the same 10 percent user cost as for residential real estate gives a contribution of \$530 billion to U.S. GDP, or about 4 percent. Assuming  $\alpha$  to be one-third, fixed capital would thus represent  $\gamma = 0.12$ , or 12 percent of all capital.

The coefficient of 0.004 estimated in regression 3-2 gives a point estimate indicating that agglomeration is only slightly more important than fixed capital, although the large standard errors make the true agglomeration effect hard to estimate. The 95 percent confidence interval on our estimate ranges from -0.19 to 0.2; with  $\alpha\gamma = 0.04$  (12 percent of one-third), the former implies that  $\omega = -0.09$  and the latter yields  $\omega = 0.18$ . A higher value of  $\gamma$  would push both of these estimates upward, and a lower value would reduce them.

The main implication of the model was that policy should subsidize places where the

elasticity of productivity with respect to population is higher than elsewhere. One significant question is whether agglomeration economies are greater for larger or smaller cities, and table 2 suggested the latter. To test this hypothesis, regressions 3-3 through 3-5 interact the log of population in 2000 with various variables  $X_i$  intended to capture larger, denser, and declining cities, respectively. We now instrument for the population growth with the weather variables as well as the weather variables interacted with  $X_i$ .

We first explore whether adding people has more of an effect on the productivity of larger places. Regression 3-3 thus uses a dummy variable indicating whether an MSA's population was above the sample median in 1990 for  $X_i$ . A positive coefficient  $\delta$  on the interaction between this dummy and population growth would imply that adding population is in fact more valuable for the productivity of larger places, but we find no significant evidence for any such interaction. The impact of population on productivity seems to be the same for both smaller and larger metropolitan areas.

Another possibility is that growing population has more of a positive effect in areas that are more geographically compact, with a dense urban core. To test this hypothesis, regression 3-4 uses a measure of centralization—the share of employment in the area that lies within five miles of the central business district—as the interaction variable. These data are based on zip code employment data described by Glaeser and M. Kahn.<sup>30</sup> The data would ideally come from before 1990 but are available only from 1998. In this regression the coefficient  $\delta$  is small and statistically insignificant. We cannot conclude that density increases productivity in faster-growing cities more than in others.

Regression 3-5 examines whether agglomeration economies seem to be greater in places that were previously in relative decline. We include an indicator variable that takes a value of one if the area was in the bottom quartile of population growth (that is, had population growth of 7.08 percent or less) between 1970 and 1990 for  $X_i$ . This regression shows that having been in relative decline reduces productivity, but this effect is dampened slightly for larger cities. This result suggests that population increases may be most advantageous in areas that have already been in decline.

This analysis does not offer a compelling answer as to where agglomeration economies are strongest. We look for differences based on size, compactness, and past decline, and are

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30. Glaeser and Kahn (2004).



unable to uncover convincing differences. If anything, the table suggests that agglomeration effects are stronger in smaller metropolitan areas, more centralized metropolitan areas and metropolitan areas that have been in decline. However, all of these measured effects are statistically insignificant and not robust. Until further research yields more precise estimates, these results suggest the difficulty of establishing any clear gains to subsidizing one region or another.

### *Congestion Externalities*

We now turn to the impact that metropolitan-area size has on amenities. We will first look at the connection between area population and three direct measures of urban disamenities: commute times, pollution, and crime. We will then consider real wages. In all of these cases we remain concerned that the disamenity is itself influencing urban population. However, since the costs of these disamenities are arguably minor relative to overall income, we are more comfortable looking at the ordinary least squares coefficients. Since the case for national spatial policies depends on different effects of population on amenities across different cities, our focus will be on whether the slope of population is different for cities that are larger or more centralized.

Regression 4-1 in table 4 examines the connection between average commute time and population. The basic elasticity is 0.12, meaning that as city size doubles, the average commute increases by 8.7 percent, or about two minutes. We also investigate whether this coefficient is larger for cities above the median population in our sample. The interaction is tiny in both economic and statistical terms. In fact, the interaction is sufficiently precisely estimated that we can reject the hypothesis that the elasticity of commute times with respect to population increases or decreases by any significant amount for larger cities.

[table 4 about here]

Regression 4-2 in table 4 considers the interaction between area population and centralization, again using Glaeser and Kahn's data on the share of employment within five miles of the city center.<sup>31</sup> In this case we find a marginally significant interaction. Increasing population has a bigger effect on commute times in denser cities than in cities where the population is more dispersed.

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31. Glaeser and Kahn (2004).

Regression 4-3 looks at the atmospheric concentration of TSP-10 particulates, one of the key measures of air quality at the metropolitan-area level.<sup>32</sup> The elasticity of this variable with respect to city size is 0.142, which is statistically significant: bigger cities have slightly worse air. However, we do not find a larger slope for bigger cities. Regression 4-4 adds a variable interacting city size with centralization. We find that city population has a weaker effect on pollution in more centralized places, perhaps because people there are more likely to use public transportation.

Regression 4-5 focuses on crime, another disamenity generally associated with urban size. Glaeser and Bruce Sacerdote provide evidence that although some of this connection reflects the sorting of crime-prone individuals into urban areas, it partly also reflects the tendency of big cities to increase the supply of potential victims and make arrest and conviction more difficult.<sup>33</sup> This regression finds only a weak connection between murder and city size, although this has declined substantially over time.<sup>34</sup> Regression 4-6 finds no significant association between murder rate and centralization.

Regression 4-2 suggested that increasing population in centralized places has a more unfavorable impact on commute times, and the regression in column 4-4 that increasing population in centralized places has a small negative impact on pollution. The overall lesson for spatial policy is therefore unclear. We attempt to get around this by looking at real wages, which provide a measure of overall amenities. Since population is more likely to respond to the entire basket of amenities than to these individual disamenities, we are more concerned with problems of reverse causality in this regression.

Regression 4-7 investigates the elasticity of real wages with respect to area population. Neither the raw effect nor the interaction with population above the median is statistically significant. The failure to find a robust relationship confirms the spatial equilibrium assumption that agglomeration economies offer no free lunch: high nominal wages are offset by higher prices. The absence of a clear interaction means that there does not appear to be an amenity-based rationale for pushing population toward bigger or smaller cities.

Regression 4-8 finds a statistically significant negative interaction between area population and area centralization. Interpreted literally, this result implies that any negative

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32. Kahn (2003).

33. Glaeser and Sacerdote (1999).

34. Glaeser and Gottlieb (2006).

effects of population on amenities are minimized in more centralized locales. In principle, this finding seems to suggest that pushing population toward more compact and less sprawling places might be welfare-enhancing.

Despite this finding, we have little confidence that either agglomeration or congestion externalities differ significantly across smaller or larger, or denser or less dense, cities. This does not reassure us that the current situation is a Pareto optimum, but it does suggest that it is not obvious which way government policy should deviate from the status quo. For us, this degree of ignorance suggests that explicit spatial policies are as likely to do harm as good.

#### **IV. U.S. Policies toward Places**

In this section we turn to a brief empirical evaluation of three major types of policies related to urban growth. The first is transportation policy. America's most significant place-making policies have been improvements in transportation. Railroads in the nineteenth century and highways in the twentieth both had major impacts on the growth of different areas. Nonetheless, there is little evidence to suggest that the place-making capacities of transportation are actually working in a desirable way. As a result, transportation should be judged on its ability to reduce transport costs and not on its ability to remake the urban landscape. The second type of policy consists of large-scale interventions that had the direct goal of strengthening particular places. In the twentieth century, such interventions included urban renewal and the Appalachian Regional Commission. We find no clear effects of these policies, but this is unsurprising, because they involved small amounts of money relative to the sizes of the areas involved. The third type of policy is typified by the enterprise zones of the 1980s and 1990s, which provided much greater resources to much smaller areas. These policies do seem to have had an impact, but the costs per new job are extremely high.

##### *Transportation and Place Making*

American governments have been in the business of subsidizing transportation since the dawn of the Republic. Even before the Revolution, George Washington had contemplated a canal that

would connect the Potomac River to the Ohio River valley and the western states.<sup>35</sup> After the Revolution, Washington's enormous prestige enabled him to get the support of the Maryland and Virginia legislatures to charter the Potomac Company. Washington served as its president. The states invested in the company, granted it a perpetual monopoly on water traffic along the Potomac, and gave it considerable powers to acquire land. Even with this support, the Potomac Canal was unable to fulfill its mission, and it collapsed in the mid-1820s. Construction along the route turned out to be enormously difficult, and the limited willingness of credit markets in 1800 to trust private companies with vast sums made it hard for any firm to raise sufficient finances to pay for such an expensive undertaking. The Potomac Company was not a complete failure, but it did not produce America's great waterway to the west.

That waterway would be created by an even more extensive governmental investment in transportation infrastructure. It seemed obvious to DeWitt Clinton, New York City's mayor during most of 1803-15, that connecting the country's greatest seaport with the Great Lakes would yield enormous returns.<sup>36</sup> Clinton became one of the canal's greatest proponents, and when he was elected governor of New York State in 1817, he quickly began construction. To many contemporary observers, a New York canal looked no wiser than one in Virginia, and the idea was dubbed "Clinton's Folly." Yet with massive government spending and prodigious feats of engineering, Clinton managed to construct a canal that connected the Hudson River to Lake Erie.

The Erie Canal was an enormous success by any measure. Its toll revenues readily covered its costs, and, like the earlier success of the Bridgewater Canal in Manchester, England, it set off a national craze for canal building that changed the face of America. In 1816 it cost 30 cents to move a ton of goods a mile by wagon overland. At that price, moving goods fifteen miles overland cost the same as moving them across the Atlantic. The canal reduced the cost of transport by more than two-thirds, to less than 10 cents per ton-mile.

Urban economics certainly suggests that transportation infrastructure could have a major impact on urban growth. Some forms of transportation, like a port or a rail yard, significantly increase the productivity of adjacent land and therefore attract new businesses. Others, however, like the highway system, reduce the gains from clustering and hence disperse population. It is

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35. Achenbach (2004).

36. Bernstein (2005).



both in the 1850s and for the rest of the century. Regression 5-1 looks at population growth in the 1850s and access to rail in 1850. We control for the logarithm of initial population, proximity to the ocean, and, as a proxy for human capital, the presence of Congregationalists in 1850.<sup>40</sup> There is a strong positive relationship between access to rail in 1850 and population growth in the ensuing decade: on average, those counties with access grew by more than 14 percent more than those without. Regression 5-2 looks at population growth over the entire 1850-1900 period and again finds a strong positive effect of rail access in 1850 on subsequent growth.

[table 5 about here]

The Craig, Palmquist, and Weiss data also provide information on access to waterways in 1850, but for a smaller set of counties. We also find a significant effect for this variable for the 1850s: counties with access to water grew by 0.12 log point more, on average, than counties without access (results not reported).

It is easy to argue with these regressions. After all, rail yards were not randomly strewn throughout the United States, but rather were located in places considered to have the brightest economic future. Still, plenty of supporting evidence suggests that railroads were important for urban success. After all, civic boosters worked extremely hard to get rail lines to come through their towns. This would hardly have made sense if rail were not expected to have an impact. Moreover, case studies of most large American cities that grew rapidly in the nineteenth century, from Boston to Los Angeles, argue that rail played an important role in that growth.

In the nineteenth century, population growth accompanied rail access, and railroads seem to have particularly encouraged the growth of big cities. Initially, people and firms clustered around rail yards, as exemplified by Chicago's stockyards, to save transport costs. Later, intraurban railroads enabled cities to expand by facilitating commuting from "streetcar suburbs."<sup>41</sup> In the twentieth century, further declines in transportation costs accelerated the process of urban decentralization. Nathaniel Baum-Snow compellingly shows that suburbanization proceeded more rapidly in those cities that had more highway development.<sup>42</sup> He addresses the problems of reverse causality using an early highway plan developed for national security purposes.

Highway development also seems to have been strongly associated with the growth of

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40. Glaeser and Saks (2006).

41. Warner (1978).

42. Baum-Snow (2007).

metropolitan areas as a whole. G. Duranton and M. Turner show a striking connection between highways and urban growth in the United States over the last thirty years.<sup>43</sup> They use a number of different instruments, including the security-based highway plan used by Baum-Snow, to handle the issue of reverse causality. The raw correlations are impressive.

Regressions 5-3 and 5-4 in table 5 follow Duranton and Turner in reporting correlations between population and income growth, respectively, from 1960 to 1990 and highway mileage built during the same era. The first of these regressions shows the relationship between population growth and highway construction, controlling for initial population, proximity to the coast, and initial share of the population with a college degree. The elasticity of population growth with respect to new highway mileage is 0.11, and the coefficient has a *t* statistic of 4.3. Regression 5-4 reports the elasticity of growth in income per capita with respect to the same variables from 1960 to 1990. In this case the elasticity is 0.039 and the *t* statistic is again over 4. The extent to which we can be sure that highways were causing growth, rather than vice versa, depends on the validity of the instruments of Baum-Snow and Duranton and Turner, such as the initial highway plan based on national security needs. Yet it is certainly true that highways and growth move together quite closely.

More generally, the decline in transportation costs has been associated with a host of changes in urban form. Figure 8 documents the 90 percent reduction in the cost of moving a ton of goods one mile by rail, and figure 9 the parallel explosion of highway transport. These two developments mean that whereas it was enormously costly to move goods over space in 1900, transporting goods had become almost free 100 years later. Glaeser and J. Kohlhase argue that this change has led to the rise of consumer cities, which are located in places where people want to live, rather than producer cities, which are located in places where firms have innate productive advantages due to waterways or coal mines.<sup>44</sup> That paper also argues that the decline of transportation costs helps explain the exodus of manufacturing from urban areas and the decline of manufacturing cities. Glaeser and Giacomo Ponzetto go a step further and argue that declining transport costs may have contributed to the decline of goods-producing cities like Detroit but boosted the growth of idea-producing cities like Boston and New York.<sup>45</sup> Their argument is that globalization has increased the returns to skill and that workers become skilled

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43. Duranton and Turner (2008).

44. Glaeser and Kohlhase (2004).

45. Glaeser and Ponzetto (2007).

by locating around skilled people in cities that are rich in human capital.

[figure 8 about here]

[figure 9 about here]

R. Green argues that airports have played the same role in promoting urban growth in the last fifteen years that railroads and highways did in the past.<sup>46</sup> His principal piece of evidence is that places that have more airline boardings per capita have grown faster. Although this fact could represent the positive impact of access to airports, it could also reflect consumer amenities: places that are attractive for people to visit should also be attractive places for people to live.<sup>47</sup> One way to check whether the connection between airplane boardings and growth reflects access or consumer amenities is to replace the number of boardings per capita with an indicator variable for whether a metropolitan area has a major airport. We constructed a dummy variable for having a major airport, with “major” defined as one of the fifty airports in the country with the most flights per day. Regressions 5-5 and 5-6 in table 5 show that having a major airport did have a positive but modest effect on population and income growth in the 1990s.

Although new transport technologies such as airports still seem to matter for urban growth, there is little evidence to suggest that investments in older technologies such as rail have any impact on urban success today. For example, Glaeser and J. Shapiro find that places with more public transit usage grew less in the 1990s than those with less usage.<sup>48</sup> This certainly casts some doubt on the view of public transportation advocates that new rail systems have the same potential to foster growth in the twenty-first century that they had in the nineteenth.

There is no question that new transportation infrastructure has been able to reduce the cost of moving people across space. This suggests that local leaders who lobby for new forms of transportation spending are not being foolish. However, it is less clear how transportation’s ability to make places should influence the evaluation of national transportation projects. We turn to that issue next.

### *Place and the Evaluation of Transportation Investment*

When discussing the benefits of transportation investments, it is typical for public officials to

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46. Green (2007).

47. Glaeser, Kolko, and Saiz (2001).

48. Glaeser and Shapiro (2003).



emphasize the ways in which a new highway or rail line could turn their area around economically. The previous discussion has suggested that these advocates have been right in some cases. Yet the ability of transportation to make or break cities does not necessarily change the rules by which transportation investment should be evaluated.

Transportation infrastructure can be seen both as nontraded productive capital and as a consumer amenity that enters directly into the utility function. In that case:

*Proposition 3:* In a social optimum, the social benefits of transportation spending within an

area,  $N_i \frac{U_t [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + A_i(N_i) K_N'(t_i) \frac{\partial F_i [K_N(t_i), N_i - L_i]}{\partial K_N(t_i)}$ , are set equal to the

marginal cost of that spending. In a competitive equilibrium, where marginal utility of income is constant across space, the social benefit of transport spending in area  $i$  exceeds

$N_i \frac{U_t [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + A_i(N_i) K_N'(t_i) \frac{\partial F_i [K_N(t_i), N_i - L_i]}{\partial K_N(t_i)}$  if and only

if

$$N_i \theta_i'(N_i) \frac{U_\theta [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + \frac{A_i'(N_i)}{N_i A_i(N_i)} \frac{A_i(N_i) F_i [K_N(t_i), N_i - L_i]}{N_i} > \sum_{j \neq i} \frac{-\partial N_j / \partial t_i}{\partial N_i / \partial t_i} \left( N_j \theta_j'(N_j) \frac{U_\theta [Y_j, H_j, \theta_j(N_j), t_j]}{U_Y [Y_j, H_j, \theta_j(N_j), t_j]} + \frac{A_j'(N_j)}{N_j A_j(N_j)} \frac{A_j(N_j) F_j [K_N(t_j), N_j - L_j]}{N_j} \right)$$

This proposition implies that at the social optimum, transportation spending should be evaluated according to its direct effect on consumer welfare and firm productivity, not according to its place-making potential. This result reflects the fact that in a social optimum, population is directly optimized across space. In a competitive equilibrium there can be place-making benefits from transportation, but these benefits result only if the externalities are higher in particular locales. Unsurprisingly, the ability of transportation to move people across space has value only if moving people across space is desirable.

The previous section gave only a little guidance about where those externalities might be higher. There may be productivity gains from moving people to richer areas and the negative externalities of population growth might be lower in places that are already denser, but these

effects are weak. They do, however, provide a benchmark for thinking about current transportation spending. Should transportation be subsidized disproportionately in rich, dense areas?

Table 6 reports, for several different modes of transport, the correlations between transport spending per capita and measures of agglomeration—population size and population density—and income. Highways are the dominant recipient of federal aid to transportation. The table shows federal transfers for highways both with and without the gasoline tax payments that the states make to the national transportation trust fund. The results suggest that the United States subsidizes long-distance transportation in lower-density and lower-income places, which is exactly the opposite of the model's predictions. Transportation policy seems to be working against, rather than toward, taking advantage of agglomeration economies. Environmental externalities probably also push toward higher-density development that involves driving over shorter distances.<sup>49</sup>

[table 6 about here]

Of course, if the direct benefits from transportation spending are greater in poorer, low-density areas, then current spending patterns make sense. Indeed, the major point of this section is that transportation needs to be evaluated according to its impact on travel costs, and nothing we have said suggests that the current distribution of highway spending fails to meet this criterion. However, if one includes the place-making effects of transportation when evaluating its benefits, then current spending does not appear to be targeting the high-income, high-density areas where the agglomeration effects are likely to be strongest.

### *Urban Renewal, the Appalachian Regional Commission, and Empowerment Zones*

Americans have rarely embraced a wholesale regional policy dedicated toward reinvigorating declining regions. Despite regular calls from mayors and even promises from presidential candidates, only in a few instances has the U.S. government explicitly embraced policies meant to turn around declining areas. In this the United States stands in stark contrast to many European countries, which have regularly invested heavily in their poorer regions since before

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49. The full environmental calculus is quite complex and involves the trade-off between more air pollution in densely settled areas and less pollution per square mile over a larger area.

the formation of the European Union. For example, Italy has a long-standing policy of using tax incentives to encourage investment in its south. Such policies have been a particularly important activity for the European Union, which has regularly redistributed funds from wealthy areas to poor ones.

The supporters of place-based policies have generally argued for such policies on the basis of two related arguments. The first is purely egalitarian: place-based support for poor places may create more economic opportunity for poorer people. The second invokes some market failure that is causing a particular place to underperform. For example, it is sometimes alleged that the need for coordinated investments makes it impossible for private firms on their own to turn a declining area around. In the framework of the model, this can be understood as claiming that agglomeration economies are particularly strong for such places. Yet our empirical work in the previous section found little evidence to support that claim.

Against these arguments, economists argue that place-based policies are unlikely to be of material help to poor people. Place-based policies that aim to turn a declining region around are often thought to be futile, since the forces of urban change are quite powerful. Place-based policies that throw enough resources at a small enough community may indeed be able to improve the quality of that place, but it is not obvious that the poorer residents of that community will benefit. Some community-based policies may just lead employers to come to the area and hire new migrants. Others may make the community a more attractive place for outsiders to live and thus increase rental costs for longer-term residents. In general, the spatial equilibrium model leads economists to think that place-based improvements increase the value of property, which may be a good thing for local homeowners and landlords, but may not be so desirable for renters.

Finally, economists have voiced a basic skepticism about the desire to induce poor people to stay in poor areas. Place-based policies may boost a poor area, but they may also discourage poor people from leaving that area for areas where opportunities may be greater. The rationale for spending federal dollars to try to encourage less advantaged people to stay in economically weak places is itself extremely weak. For example, it is not clear why the federal government spent over \$100 billion after Hurricane Katrina to bring people back to New Orleans, a city that was hardly a beacon of economic opportunity before the storm.

In U.S. history the major instances of regional policy have been the Appalachian Regional Commission (ARC), which targeted development of a large area in the eastern United

States; the enterprise zones and Empowerment Zones of the 1980s and 1990s, which offered tax breaks to firms locating in poorer communities; and policies aimed at urban renewal. The last class of policies was primarily oriented toward housing and construction, and so we will consider them in the next section. We turn first to the ARC.

### *The Appalachian Experience*

In 1962 Harry Caudill published *Night Comes to the Cumberlands*, which described the rural poverty of the Cumberland Plateau of eastern Kentucky.<sup>50</sup> Caudill's book brought national attention to Appalachia and suggested that the region's problems were the fault of northern coal investors who had taken the wealth out of the ground and then invested their returns elsewhere. Needless to say, this argument works better as rhetoric than as sound economic analysis—the policy implications of the spatial equilibrium model are not changed if rentiers live outside the regions where they receive their rents.

Even before Caudill's book, the governors of several Appalachian states had started a coordinated effort to obtain federal assistance, and President John Kennedy responded in 1963 by forming the Appalachian Regional Commission. The ARC was originally founded to seek legislation to provide assistance for the region. In 1965 Congress turned the ARC into a federal agency that would distribute funds among the Appalachian counties, to be used for a variety of local projects intended to enhance economic vitality. Transportation accounted for a particularly large share of this funding, so the ARC should be seen as a hybrid between a pure transportation program and a local economic development program.

The political definition of Appalachia was county-based, and the area covered by the ARC stretched from Mississippi to New York. The inclusion of so many states helped to create a legislative coalition for the policy, but it inevitably meant that funding per acre was modest. In the first thirty years after it was founded, the ARC disbursed \$13 billion.<sup>51</sup> Today the ARC receives much less funding, about \$90 million a year.

Did the billions spent on the ARC have a demonstrable effect on Appalachian success? A. Isserman and T. Rephann address this question by comparing income and population growth for

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50. Caudill (1962).

51. Isserman and Rephann (1995).

a matched sample of Appalachian and non-Appalachian counties.<sup>52</sup> They use a matching algorithm to connect counties that were in the Appalachian region with other areas. The study specifically excluded counties that were close to Appalachia as possible matches because of fears of contamination from the ARC. As a result, Allegheny County, Pennsylvania, was matched with Erie County, New York, which contains Buffalo, and Catoosa County, Georgia, was matched with Warren County, in southwestern Ohio. Comparing the growth experiences of the two samples, the authors find that income in the Appalachian counties grew by 5 percent more than in their comparison counties between 1969 and 1991, and income per capita 17 percent more. Their bottom line is quite remarkable: they find that \$13 billion in Appalachian expenditure yielded \$8.4 billion of income in one year alone. This appears to be a quite positive demonstration of the efficacy of regional policy.

Since Isserman and Rephann's methods are sufficiently different from those used in most economic analyses, we repeat their exercise using a more standard regression methodology. Our approach is to include all counties in any state that was partly included in the ARC, except those counties within 90 kilometers (56 miles) of the coast. We then use a dummy variable to identify those counties covered by the ARC. We are thus comparing Appalachian counties with reasonably comparable counties in the same region. We examine both income growth and population growth. We include only the initial values as controls, but the results are not sensitive to including other controls.

Table 7 presents our results. The first regression finds that between 1970 and 1980, being part of the ARC coverage area was associated with 0.037 log point faster population growth—evidence of a treatment effect on population during this first decade. Between 1970 and 2000, however (the second regression), the dummy variable for location in the ARC area has a coefficient of -0.002, which is small and statistically insignificant. The remaining two regressions report the relationship between inclusion in the ARC and growth in income per capita. We find an insignificant positive effect in the 1970s, which turns negative over the longer period. One possible interpretation of these results is that although the ARC was able to boost population growth slightly during the period in which it was best funded, the effect soon disappeared.

[table 7 about here]

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52. Isserman and Rephann (1995).

Given that Issermann and Rephann found quite different results, we do not claim to have proved that the ARC had no effect. Indeed, the standard errors on our coefficients are sufficiently large that we cannot rule out large positive effects of the program, at least relative to its modest cost. A more supportable conclusion is that it is unlikely that the effects of a \$13 billion program spread over a giant swath of America over three decades can be accurately evaluated. Far too many things were affecting regional growth at the same time for a relatively modest government program to have had clear positive effects. Powerful economic forces are driving people to the Sunbelt and to coastal cities. Current spending on the ARC is no more than the cost of a few large Manhattan buildings. Could such a program really have changed the course of a region considerably larger than California? The ARC may or may not be cost effective, but there is little chance that its effectiveness will ever be evident in the data.

### *Enterprise and Empowerment Zones*

We now turn to a much more targeted approach: enterprise zones. As L. Papke summarizes, enterprise zones were pioneered in the United Kingdom by Margaret Thatcher's government in 1981.<sup>53</sup> There were originally eleven such zones, but the number later increased to twenty-five. The British zones were particularly oriented toward industrial development. Firms that located in the zones were exempted from local property taxes and could deduct all spending on industrial buildings from corporate income tax. This tax relief was accompanied by significant public sector investment in the area.

Although plenty of economic activity occurred in the enterprise zones, evaluations of the zones were largely negative. R. Tym suggests that most of the jobs in these zones did not represent new activity but simply a reallocation within the metropolitan area.<sup>54</sup> J. Schwarz and T. Volgy estimate a cost per job created of \$67,000 during the 1980s, which would be more than \$125,000 in 2007 dollars.<sup>55</sup> R. Erickson and P. Syms find a moderate increase in land prices within the enterprise zones.<sup>56</sup>

In the United States the enterprise zone experience begins with state enterprise zones in

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53. Papke (1994)

54. Tym (1984).

55. Schwarz and Volgy (1988)

56. Erickson and Syms (1986).

the 1980s. Papke reports that thirty-seven states had created such zones by the early 1990s.<sup>57</sup> Unlike the British zones, the American enterprise zones were particularly oriented toward revitalization of urban neighborhoods and were, in some sense, the descendants of the urban renewal projects described below. The zones were often quite small—the median zone had 4,500 residents—and they were quite poor.

Papke's own evaluation focused on the Indiana enterprise zone system, which exempted businesses in the zones from property taxes and taxes on income from inside the zone. There was also a tax credit for hiring workers who lived within the zone and an income tax credit for zone residents. Despite these considerable tax incentives, and despite an increase in business inventories within the zones, Papke finds that the zones actually lost population and income relative to nonzone areas. Certainly, this should not be interpreted as a true negative treatment effect of zones, but rather as evidence that the Indiana zones were relatively ineffective.

In the 1990s the federal government began its own system of areas called Empowerment Zones, administered by the Department of Housing and Urban Development (HUD). There were six original Empowerment Zones; two more were added later. Firms in the zones received employment tax credits and regulatory waivers. There were also block grants and spending on infrastructure. The overall cost of the program was slightly more than \$3 billion.<sup>58</sup>

Busso and Kline undertake a particularly careful analysis of the federal zones' impact. They compare the zones with similar areas chosen from among communities that also applied to HUD to receive Empowerment Zone support. Busso and Kline use a propensity score method to match these communities appropriately and find strong positive results. Although the populations of the zones did not increase, the poverty rate fell by an average of 5 percentage points and the unemployment rate by an average of 4 percentage points in these communities relative to comparable outside areas. Housing prices increased by 0.22 log point and rents by 0.077 log point. There was no appreciable increase in earnings.

On one level these results seem much more promising than Papke's findings, but there are still reasons to be skeptical. First, the authors estimate that a program costing more than \$3 billion created 27,000 jobs between 1995 and 2000. This comes to more than \$100,000 per job in current dollars, which seems an expensive way to boost employment. The figure of 27,000 jobs

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57. Papke (1994).

58. Busso and Kline (2008).

refers to the employment increase in 2007. If 27,000 extra jobs were created in every year, then each job-year would have cost \$20,000. The \$3 billion figure includes substantial private money, however, so it is not clear whether this should be counted as an actual cost. The answer depends on whether this money reaped private returns and whether it was induced by other federal programs, such as the Community Reinvestment Act. It does seem clear, however, that the true cost per year is below the \$100,000 number.

For already-employed workers in Empowerment Zones who were renters, earnings did not increase, but rents did. Perhaps other amenities rose in the Empowerment Zones, but for this group the zones represent a pure financial loss.

Busso and Kline themselves suggest that the program generated a \$1.1 billion increase in output and a \$1.2 billion increase in the value of homes and rental properties. These two estimates should not be added, since the housing values are presumably capturing the value of having access to a more successful labor market. Indeed, one view is that the closeness of these figures reflects the fact that both are capturing the same gains. However, in the case of housing values these gains would omit benefits to previous residents who are not changing their behavior due to the program. Nevertheless, these gains do seem to be substantially less than the cost of the program.

Overall, the evidence on enterprise zones is hardly overwhelming. The British evidence shows positive effects, but the price per job created is extremely high. The Indiana evidence shows essentially no effects on key social outcomes. The evidence on federal Empowerment Zones shows significant employment gains from the programs, but the price per job is again extremely high. It is hard to see an empirical case for zone-based policy.

It is harder still to evaluate more amorphous government policies such as those embodied in the Community Reinvestment Act of 1977 (CRA). This act required financial institutions to invest in businesses in poor areas as well as rich areas and to make credit available to poorer people. It can be argued that economic efficiency would be better served by allowing banks to focus on lending to firms that are most likely to be most productive rather than firms that have a particular geographic locale. However, one could also argue that the CRA served equity purposes and had only a small negative effect on overall financial efficiency. Without more thorough evaluation—and it would be hard to imagine how to produce such an evaluation—it is difficult to come to any strong conclusions about the CRA.



An alternative way of understanding enterprise zones and certain other place-based policies is as a means of reducing taxes on nontraded business inputs such as real estate. Optimal taxation theory suggests that it makes sense to have lower tax rates in areas where these inputs are more elastic. Enterprise zones can be justified if the supply of the nontraded output is more elastic in depressed areas. However, we know of no evidence that this is the case.

Another interpretation of enterprise zones is as an indirect means of freeing local businesses from paying for social services for poor residents of their community. If one thinks of those social services as a national responsibility whose costs must be borne by someone, then making the residents of one community pay disproportionately for those services will be distortionary. These taxes will induce lower input demand in that area, which will lead to too little production there relative to the first-best outcome. A similar conclusion results if one taxes the rich in a community to pay for services to the poor in that community. Such a policy will lead the rich to live elsewhere, which is also a distortion relative to the first-best. Reducing the added governmental costs of locating near poor people may reduce the tax-created distortions that induce firms and people to leave poor places.

To sum up, the combination of theory and evidence leads us to be suspicious of local economic policies that are meant to increase production in a particular area, whether that area is depressed or booming. Empirically, these policies seem to be either extremely expensive or ineffective. Theoretically, the case for these policies depends either on extra agglomeration economies in depressed areas or on a particularly high elasticity of demand for inputs in those areas. These conditions may exist, or they may not. There is, however, a case for reconsidering policies that require local businesses and workers to pay for social services for the local poor in a way that essentially amounts to redistribution.

## **V. U.S. Housing Policies as Place-Making Policies**

As in the case of transportation policy, one could have a housing policy without any particular spatial objective. It is not necessary for the cabinet secretary who oversees housing to also supervise urban development. Indeed, the earliest federal forays into the housing market during the Great Depression, the Reconstruction Finance Corporation and the Federal Home Loan Bank Board, were not intended to reinvigorate any particular locale. More modern interventions, such

as Section 8 vouchers and the low-income housing tax credit, are similarly aimed mainly at making housing cheaper, not at making places more economically vibrant.

### *Urban Renewal*

Starting in the 1940s, there has been an increasing tendency to link housing policy and urban revitalization. In 1941 the National Association of Real Estate Brokers advanced a scheme whereby the government would use its powers of eminent domain to assemble urban parcels and then subsidize private development of that land.<sup>59</sup> The Harvard economist Alvin Hansen endorsed a similar scheme, and individual cities, such as New York, increasingly subsidized urban renewal efforts. After a great deal of legislative wrangling, in which “Mr. Republican,” Senator Robert Taft of Ohio, strongly supported public housing against the opposition of his fellow Republican, Wisconsin Senator Joseph McCarthy, Congress passed the Housing Act of 1949. Title I of that act brought the federal government into the business of urban renewal.

The 1949 housing act authorized \$1 billion in loans to cities for them to acquire blighted land and \$100 million a year in outright grants for such purchases. In principle, the cities were to pay one-third of the purchase price, but the contribution could be made in the form of new public facilities.<sup>60</sup> The sites would then be given to private developers to build new housing or commercial buildings. The Housing Act of 1954 broadened the program to allow funds to be used for renovation and for Federal Housing Administration mortgages for renewal projects.

Several rationales have been given for urban renewal. The intellectual roots of the slum clearance movement go back to the Progressive Era, when reformers believed that the poor conditions and high densities of poor neighborhoods spread disease and fomented crime. A related, externality-based argument is that blighted areas create aesthetic externalities for neighbors. A. Schwartz and coauthors find some evidence for this view:<sup>61</sup> neighboring housing prices seem to go up when dilapidated housing is replaced with a new housing project.

Another argument for urban renewal is that private developers may be unable to assemble sufficiently large land parcels for major projects because of the hold-up problem: any individual landowner’s part of the area is indispensable to the project, so all of the former landowners will

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59. Von Hoffman (2000).

60. Von Hoffman (2000).

61. Schwartz and others (2005).

try to extract the project's entire surplus. Of course, this argument is really a justification for the use of eminent domain and provides no rationale for subsidizing private developers. A policy intended to solve hold-up problems would presumably have developers pay market rates for land assembled through the use of eminent domain.

In the 1950s and 1960s, urban renewal was increasingly also seen as a tool for revitalizing cities. There are two ways of understanding how subsidizing housing might, in principle, help declining cities. The number of people in an area is generally proportional to the number of homes there.<sup>62</sup> Subsidizing new housing is one way of increasing the population of an area to take advantage of agglomeration economies. A slightly different view is that better housing might attract residents with more human capital, who will then generate positive externalities in the workforce. In this case housing policy becomes a human capital policy, as discussed in the next section. However, there are also good reasons for skepticism about these arguments. A key distinguishing characteristic of declining cities is that they have an abundance of housing relative to demand.<sup>63</sup> Many of these cities have large numbers of vacant homes, making it hard to see how building more housing is likely to improve the situation. Moreover, in many cases subsidized housing destroyed large numbers of units, so the overall population of the area did not increase.

We are not aware of any comprehensive data that measure total federal spending on urban renewal in the 1950s and 1960s. Since aid to cities often came from many different sources, there is no unified data source for such funding. Using the limited data that J. Staples assembled on urban renewal for twenty-one cities,<sup>64</sup> table 8 examines whether any correlation exists between that spending and urban success. The regression reported in the first column examines the correlation between urban renewal spending per capita and population growth across these twenty-one cities during the 1960s. The point estimate is positive but statistically insignificant and small. The second regression investigates the correlation between this spending and growth in income per capita. Again the coefficient is tiny and not statistically distinguishable from zero.

These results cannot say whether the benefits of urban renewal outweighed its costs, only that there was no statistically significant surge in those cities that received more urban renewal funding. As with the ARC, however, these interventions were modest relative to the population

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62. Glaeser, Gyourko, and Saks (2005).

63. Glaeser and Gyourko (2005).

64. Staples (1970).

covered; they were also modest relative to the other forces driving urban change. Such small-scale interventions are unlikely to ever yield statistically robust results, making proper cost-benefit evaluation essentially impossible. At best, one can say only that urban renewal does not seem to have turned places around, but that is perhaps sufficient to reject the strongest claims of the early urban renewal advocates.

### *The Model Cities Program*

During the twenty years that followed the 1949 housing act, the primary opposition to urban renewal did not come from economists questioning the value of spending to build new houses in places with low demand. The loudest cries came from community activists who protested the destruction of older neighborhoods. The writer and civil rights activist James Baldwin famously referred to urban renewal as “negro removal.” By the mid-1960s there was a growing consensus that urban renewal created social, or at least political, costs that outweighed its benefits.

In response to these outcries, Congress in 1966 passed the Demonstration Cities and Metropolitan Development Act, which established the Model Cities Program as part of the War on Poverty. This program still aimed to improve urban areas through new housing and commercial development, but it embraced community participation and the rehabilitation of existing neighborhoods. In the first round of the program, 193 cities applied to HUD to be included. There was no uniform model city plan; rather, the cities themselves offered detailed plans for using Model Cities funds. HUD then selected seventy-five model cities using an “intricate selection process.”<sup>65</sup> Political pressure led eventually to an expansion to include 150 cities, which meant a reduction in the funding available per city.

At its height, the program was supposed to spend more than \$500 million a year. Administrative difficulties, however, often meant that actual funding was significantly less. The more holistic nature of the plans developed under Model Cities made them a bridge between the housing-based urban renewal projects of the 1950s and the Empowerment Zones of the 1990s, discussed above.

The Model Cities Program was thus another place-based program that offered aid to particular cities in the hopes of reviving their fortunes. It was essentially a transfer from

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65. Gilbert and Specht (1974b, p. 565).

taxpayers nationwide to the governments of particular places. The individual projects are so varied that it is impossible to say anything categorical about them. We will only attempt to see whether cities that were included in the program achieved greater economic success than cities that were left out. We consider only those cities that won funding in the more selective and potentially more generous first round. Since HUD did not engage in random assignment, this is not a natural experiment.

The third regression reported in table 8 shows the correlation between Model Cities status and population growth between 1970 and 2000. The coefficient is negative and insignificant. The fourth regression considers the relationship between Model Cities status and growth of income per capita, and again the coefficient is insignificant. In results not reported here, we also found an insignificant relationship with housing prices, and we found similar results when we focused only on the 1970s, when the program was active.

[table 8 about here]

Urban renewal and Model Cities thus do not seem to be significantly related to urban success, but this finding can lead to two very different conclusions. One view is that these programs could have had important results if they had been better funded. A second view is that these programs were never going to achieve meaningful results. Many commentators, such as the political scientist Edward Banfield, have embraced the latter view, but our statistical results certainly cannot distinguish between the two interpretations. Perhaps the only thing we can say is that our statistics do not yield any positive evidence supporting the benefits of these federal attempts at place making.

### *Housing Supply and Urban Growth*

Past place-making forays into the housing market have focused primarily on generating new building in places where private demand is low. The theoretical grounds for such policies seem weak, and empirically there is little evidence that they were successful. However, this does not imply that there is no role for the federal government in housing and urban development. Over the past forty years, many localities have become much more stringent in their restrictions on land use.<sup>66</sup> These restrictions may be having a major impact on where and how America grows.

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66. Glaeser and Ward (2006a); Glaeser, Gyourko, and Saks (2005).

If localities determine local supply conditions in ways that may benefit their own voters, but that do not maximize national welfare, then there may be a role for national policy toward land use.

The first analytical step in making the case for national involvement in land use planning is to show that land use restrictions do impact urban growth. It is clear that housing supply is not constant across the United States. Figure 10 plots relative growth in the housing stock between 2000 and 2005, as measured by permits issued, against housing prices in 2005. If housing supply were equally elastic in all areas, then this graph should show an upward-sloping relationship: places with stronger housing demand should have higher prices and more building. However, the figure reveals that the most expensive places have little building, while the places with the most building are not particularly expensive. This pattern cannot be explained by heterogeneity in demand alone. It must be that housing supply is quite inelastic in some areas and elastic in others.

[figure 10 about here]

One possible explanation for this heterogeneity is the natural availability of land. Perhaps land is simply abundant in the area around Las Vegas, for example, and not on the San Francisco peninsula. But land availability does not seem to be driving the heterogeneity in new construction. Figure 11 shows the relationship between permits per square mile between 2000 and 2006 and existing houses per square mile in 2000: the places with the least available land built the most. This fact persists when one controls for demand by controlling for prices, or when one considers only those areas where prices are high enough to motivate new supply. The negative correlation between land availability and new construction can also be seen within some metropolitan areas, such as Boston.<sup>67</sup>

[figure 11 about here]

An alternative explanation for the heterogeneity in housing supply is land use regulations. Local communities have significant ability to impact the ease of new development through regulations ranging from minimum lot sizes to rules concerning subdivisions. These supply restrictions would naturally be expected to reduce construction from its equilibrium level without the restrictions, and consequently to increase prices. After all, what does a minimum lot size do if not limit the number of homes that can be constructed on a fixed amount of land? Is a local growth control that explicitly limits the number of new homes anything but a limit on the size of

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67. Glaeser and Ward (2006a).

the community? Glaeser and B. Ward compare 187 towns in Greater Boston and show a strong connection between the amount of housing in a town and its rules restricting new development.<sup>68</sup> L. Katz and J. Rosen compare communities with and without growth controls in California and find higher prices in those areas with controls.<sup>69</sup>

Figure 12 shows that the Wharton Land Use Index, described earlier as a measure of the difficulty of new construction, is positively correlated with housing prices. The overall correlation between this index and new construction activity is slightly negative but statistically insignificant. In a regression of permits issued on the Wharton index and climate and education variables, we find that the Wharton index is negatively associated with new permitting (results not reported).

[figure 12 about here]

Land use restrictions may reduce development and increase prices, but this does not necessarily mean they are bad policy. Perhaps there are externalities, such as congestion, that justify price-increasing restrictions. One way of testing whether land use restrictions are welfare maximizing is to see whether they appear to maximize land values. A standard result in urban economics is that land value maximization leads to efficient outcomes.<sup>70</sup> Local communities that succeed in maximizing land values by restricting development are in effect shifting the costs to outsiders, at least if the community does not have monopoly power over some particular amenity or natural resource.

To see whether communities are maximizing land values, we need to examine the elasticity of prices with respect to density. If the cost of building a house is denoted  $C$ , and a community has a total land area of one, and a total of  $D$  homes are built, then the value of land in the community is  $D[P(D) - C]$ , that is, the number of homes times the price of homes, less construction costs. This quantity will be maximized with respect to  $D$  when  $DP'(D) + P(D) - C = 0$ , or  $[P(D) - C]/P(D) = -DP'(D)/P(D)$ .

According to this calculation, efficient land use restrictions should imply that the elasticity of housing prices with respect to density equals that share of housing prices that is not related to construction costs. Glaeser and Ward found elasticities of price with respect to density that were less than -0.15 across areas in Greater Boston. These estimates were made using both

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68. Glaeser and Ward (2006a).

69. Katz and Rosen (1987).

70. Brueckner (1983).

ordinary least squares and a variety of instruments, including zoning laws and forest acreage in 1885. On average, construction costs are less than 50 percent of home value in their sample, so building more housing would substantially increase land values. Although Greater Boston is hardly typical of the United States as a whole, these results do suggest that some areas experience far less development than they would if communities were actually maximizing land value.<sup>71</sup>

The spatial equilibrium model presented above suggests that land use restrictions could be desirable if they move people from areas with low to areas with high agglomeration economies, or if they move people away from areas with large negative externalities. There is scant evidence that this is happening.

There are certainly environmental and other externalities associated with new construction, but it is far from obvious that existing land use restrictions handle these externalities appropriately or even work in the right direction. If one regards carbon emissions as creating an externality that is currently underpriced, then building on the urban fringe in Texas, where land use restrictions are few, is not environmentally friendly. Yet this is exactly the outcome if coastal California and the East Coast suburbs restrict new building. Communities do not have the ability to stop development in the United States as a whole; they can only push it elsewhere. So if denser communities restrict development, they will push it to areas where there are fewer people. Glaeser and Kahn show that land use restrictions are most stringent in places with the lowest carbon emissions, suggesting that the impact of land use restrictions is to move development to areas that have higher environmental costs.<sup>72</sup>

Land use restrictions also seem to push people away from high-income areas, which have stronger agglomeration effects, at least if the marginal utility of income is constant across space. Figure 13 shows that human capital, as measured by college completion rates, has a weak positive association with the Wharton Land Use Index. As we will discuss later, skilled areas are much more productive than unskilled areas. By restricting development in the nation's most

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71. Why do communities fail to maximize land value? The Coase theorem, after all, suggests that side deals between property owners should lead to maximizing joint wealth. One answer is that property rights are murky and that the democratic process is not geared toward such side payments. In many cases the right of an owner to build is the outcome of a complicated regulatory process that cannot be predicted in advance. In other cases explicit legal impediments prevent such side deals. Since each new development creates a windfall for one owner and a host of inconveniences for everyone else, one can understand why democratic decisionmaking would lead to many restrictions on building.

72. Glaeser and Kahn (2008).



productive places, land use restrictions are pushing people toward less economically vibrant areas.

[figure 13 about here]

If local governments are undertaking land use policies that are undesirable from a national point of view, then federal policies that worked against such policies could be welfare enhancing. What would a federal policy that tried to encourage development in high-cost, high-wage areas look like? It seems implausible that the federal government could directly oversee land use controls in tiny local areas. An alternative approach would be to reward high-cost states for undertaking policies that encourage building in restrictive areas. Another approach would be to directly offer incentives to those communities in high-cost areas that build.<sup>73</sup>

Any attempt to handle local land use restrictions runs into the same problems faced by the Model Cities Program: the federal government is not well positioned to interact directly with small communities. Yet moving people into high-wage areas seems to be an easier spatial policy that would increase GDP. More people will not be able to move into those areas unless there is more building, and this cannot happen unless localities change their land use rules.

Some transportation policies can also be seen as a means of dealing with local land use policies.<sup>74</sup> Building more highways allows more housing to be built on the urban fringe, where restrictions are less binding. But although this may allow some metropolitan areas to grow, it does so in a more expensive and inefficient manner than if more construction were allowed in areas closer to core employment centers. Whatever may be the best way to move people around, a fundamental reason that it matters where they end up is what comes of their interactions. Since ideas are nonrival, it is natural to examine their spillovers, and more generally all the externalities that flow from human capital. We now turn to human capital spillovers.

## **VI. Human Capital and Industrial Spillovers**

Human capital spillovers result whenever people learn from other people around them. As our neighbors acquire more knowledge, a little bit of that wisdom rubs off on us. The existence of such spillovers is beyond debate; we are an enormously social species who spend much of our

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73. Glaeser (2008) provides a more detailed plan of this kind.

74. Lawrence Summers emphasized this point to us.

lives listening to and watching people around us, beginning with our parents. The relevant empirical question is not whether such spillovers exist, but rather how important they are and where they are most prevalent.

For more than a century, economists and other urbanists have suggested that these idea flows will be more prevalent in dense environments flush with face-to-face interactions. If people learn by communicating ideas to each other, urban proximity helps them transmit those ideas. Alfred Marshall wrote that in industrial clusters, “the mysteries of the trade are no mystery, but are as it were, in the air.”<sup>75</sup> The urbanist Jane Jacobs was particularly associated with the hypothesis that urban areas foster creativity by speeding the flow of knowledge. Robert Lucas connected the flow of urban ideas with his new growth theory, which emphasizes the production and sharing of knowledge.<sup>76</sup> Just as urban density two centuries ago facilitated the flow of cargo onto clipper ships, so that same density today serves to facilitate the flow of ideas among people.

Faster idea flows in cities are one of the many types of agglomeration economies, and they suggest that cities where large numbers of skilled workers live are likely to be particularly successful. Any urban edge in facilitating communication should be more important for more skilled people, who have more to communicate and can benefit more from others’ knowledge. This type of reasoning has led to a significant literature documenting that skilled places are more successful than unskilled ones.

Over the past fifteen years, a series of papers has established several propositions about the relationship of skills to urban success. First, holding individual skills constant, incomes are higher in cities with more skilled workers.<sup>77</sup> Second, skilled cities have faster population and income growth than less skilled places.<sup>78</sup> Third, skilled places seem to be growing because productivity is rising faster there.<sup>79</sup> Fourth, skilled people tend increasingly to move near other skilled people.<sup>80</sup> Finally, skilled industries are more likely to locate near the urban core, and less skilled industries on the urban periphery.<sup>81</sup>

The existence of human capital spillovers justifies subsidizing education and provides some guidance for local leaders trying to boost either incomes or population growth. Indeed, the

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75. Marshall (1890, Book 2, ch. 10).

76. Lucas (1988); Romer (1986).

77. Rauch (1993).

78. Glaeser and others (1992).

79. Shapiro (2006).

80. Berry and Glaeser (2005).

81. Glaeser and Kahn (2004).

remarkably strong (50 percent) correlation between urban growth and initial skill levels among cities in the Northeast and Midwest suggests that skills are by far the best antidote for Rustbelt decline. Local policies that either attract or produce skilled people seem likely to offer the best chance of improving the fortunes of a troubled urban area. Good public education, which both produces skilled students and attracts skilled parents, is surely the primary example of such a policy.

However, the existence of human capital spillovers does not provide any clear guidance for national place-making policies. A policy that moves a skilled person from one area to another helps the area that receives the skilled worker and hurts the area that loses her. A framework like the spatial equilibrium framework presented in this paper can help sort through the welfare implications of human capital spillovers. The framework allows for individual heterogeneity, but to keep things simple we now omit the nontraded goods sector. If there are  $K$  types of people, we assume that total urban output in the traded goods sector is  $A_i F(N_i^k)$ , where  $N_i^k$  is the vector of labor in each of the different subsectors.

The wage spillover literature essentially postulates that the productivity parameter,  $A_i$ , is a function of the average skill level in the area,  $S_i$ .<sup>82</sup> This literature emphasizes that working around skilled people makes people more productive at a single point in time. The urban growth literature that shows a connection between initial skills and subsequent population and income growth postulates that the average skill level in the area also increases the growth rate of  $A_i$ . This literature suggests that the growth rate of local productivity is higher when there are more skilled people, perhaps because skilled people come up with more new ideas.

Since the urban growth literature considers both population and income, it has generally specified a spatial equilibrium, although usually the equilibrium does not fully explain why some places have more skilled people than others. The wage literature often fails to specify the spatial equilibrium at all. To specify a complete model that will help us interpret the results and discuss appropriate public policy, we assume that the utility of people of each group in city  $i$  can be denoted  $\theta_i \mathfrak{G}_i^k (N_i^k)^{-\sigma} W_i^k$ , where  $\theta_i$  is a city-level amenity variable,  $\mathfrak{G}_i^k$  is the exogenous endowment of amenities in city  $i$  that appeal to people of type  $k$ ,  $N_i^k$  is the endogenous number of people of type  $k$  in city  $i$ , and  $W_i^k$  is the endogenous wage of type  $k$  people in city  $i$ . Each type of worker has a reservation utility denoted  $\underline{U}_k$ . Amenities will essentially drive the distribution of labor, and

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82. Following Rauch (1993).

this is the best case for empirical work.

Firms' production functions are typically characterized by a constant elasticity of substitution across different groups, or  $N_i^k = [\sum_k E_k (N_i^k)^\rho]^{1/\rho}$ , so that wages for individuals of type  $k$  in city  $i$

equal  $A_i \varphi E_k (N_i^k)^{\rho-1} \left[ \sum_k E_k (N_i^k)^\rho \right]^{\frac{\varphi-1}{\rho}}$ . The skill distribution in an area satisfies

$N_i^k = N_i^1 \left( \frac{\mathfrak{S}_i^k E_k \underline{U}_1}{\mathfrak{S}_i^1 E_1 \underline{U}_k} \right)^{\frac{1}{1+\sigma-\rho}}$ ; hence the distribution of skills across cities is determined only by

amenity differences. We let  $n_i^k$  denote the ratio of type  $k$  individuals to type 1 individuals in area

$i$ . For any type  $m$ , population will equal  $N_i^m = \left\{ \frac{A_i \varphi \theta_i \mathfrak{S}_i^m E_m}{\underline{U}_m} \left[ \sum_k E_k \left( \frac{\mathfrak{S}_i^k E_k \underline{U}_m}{\mathfrak{S}_i^m E_m \underline{U}_k} \right)^{\frac{\rho}{1+\sigma-\rho}} \right]^{\frac{\varphi-1}{\rho}} \right\}^{\frac{1}{1+\sigma-\rho}}$ , so

total population in the area equals

$$(14) \quad N_i = (A_i \varphi \theta_i)^{\frac{1}{1+\sigma-\varphi}} \sum_k \left( \frac{\mathfrak{S}_i^k E_k}{\underline{U}_k} \right)^{\frac{1}{1+\sigma-\rho}} \left[ \sum_k E_k \left( \frac{\mathfrak{S}_i^k E_k}{\underline{U}_k} \right)^{\frac{\rho}{1+\sigma-\rho}} \right]^{\frac{\varphi-\rho}{(1+\sigma-\varphi)\rho}},$$

and wages for type  $m$  individuals equal

$$(15) \quad W_i^m = (A_i \varphi E_m)^{\frac{\sigma}{1+\sigma-\varphi}} \left( \frac{\underline{U}_m}{\theta_i \mathfrak{S}_i^m} \right)^{\frac{1-\varphi}{1+\sigma-\varphi}} \left[ \sum_k E_k \left( \frac{\mathfrak{S}_i^k E_k \underline{U}_m}{\mathfrak{S}_i^m E_m \underline{U}_k} \right)^{\frac{\rho}{1+\sigma-\rho}} \right]^{\frac{\sigma(\varphi-\rho)}{(1+\sigma-\varphi)\rho}},$$

which is a function of amenities and productivity as in equations 2 and 3. This type of spatial equilibrium model provides an interpretation for the city-level growth regressions, because if

only amenities and productivity change, then  $\log \left( \frac{N_{i,t+1}}{N_{i,t}} \right) = \frac{1}{1+\sigma-\varphi} \log \left( \frac{A_{i,t+1} \theta_{i,t+1}}{A_{i,t} \theta_{i,t}} \right)$  and

$$\log\left(\frac{W_{i,t+1}^m}{W_{i,t}^m}\right) = \frac{\sigma}{1+\sigma-\varphi} \log\left(\frac{A_{i,t+1}}{A_{i,t}}\right) - \frac{1-\varphi}{1+\sigma-\varphi} \log\left(\frac{\theta_{i,t+1}}{\theta_{i,t}}\right).$$

If human capital changes the rate of productivity or amenity growth, it will impact the growth of population and wages.

Figure 14 shows the relationship between population growth from 1940 to 2000 and the percent of the city's over-25 population with a college degree in 1940 for those metropolitan areas that had more than 100,000 people in 1940. This type of result holds when we instrument for population growth using the presence of land grant colleges before 1940,<sup>83</sup> or using the skills implied by a city's occupation distribution in 1880.<sup>84</sup> If the skill level in 1940 caused either productivity or amenities to grow more quickly, then the model predicts that more-skilled places will see more population growth, assuming the other parameters are constant over time.

[figure 14 about here]

Two recent papers have used this type of framework to test whether the rise of the skilled city reflects rising amenities or rising productivity,<sup>85</sup> both papers conclude that it is the latter. The premium associated with working around skilled people has risen steadily over time. The connection between initial skills and productivity growth can be understood as a reflection of the greater tendency of skilled people to innovate, or of the growing importance of working around skilled people. If people become skilled by being around skilled people, then the rising wage premium associated with working in skilled cities is yet another example of the rising returns to skill in the economy as a whole.

The assumption that skills are unrelated to changes in other parameters seems belied by the fact that skilled places are becoming more skilled. Figure 15 shows the relationship between the percent of the over-25 population with college degrees in 1980 and the growth in that share between 1980 and 2000. The correlation between these two variables is 58 percent. As the share of the population with college degrees in 1980 increases by 10 percent, the growth in the same variable over the next twenty years increases by 3 percentage points. This fact, documented by C. Berry and Glaeser,<sup>86</sup> might also reflect an increasing tendency of skilled entrepreneurs to innovate in ways that employ other skilled people.

[figure 15 about here]

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83. As in Moretti (2004).

84. Simon and Nardinelli (1996).

85. Glaeser and Saiz (2004); Shapiro (2006).

86. Berry and Glaeser (2005).

To address contemporaneous human capital spillovers, we assume that productivity is a

$$\text{function of the current spillover level, } S_i^{\wedge}, \text{ where } \hat{S}_i = \frac{\sum_k S_k N_i^k}{\sum_k N_i^k} = \frac{\sum_k S_k \left( \frac{\mathfrak{S}_i^k E_k}{U_k} \right)^{\frac{1}{1+\sigma-\rho}}}{\sum_k \left( \frac{\mathfrak{S}_i^k E_k}{U_k} \right)^{\frac{1}{1+\sigma-\rho}}}, \text{ where } S_k$$

might or might not equal  $E_k$ . If  $A(S_i^{\wedge}) = a_i S_i^{\wedge \varepsilon}$ , then the equation becomes

$$(15') \quad W_i^m = Q_W^m \left( \frac{a_i^{\sigma} (\mathfrak{S}_i^1)^{\frac{\sigma(\varphi-\rho)}{1+\sigma-\rho}}}{(\theta_i)^{1-\varphi} (\mathfrak{S}_i^m)^{\frac{1+\sigma-\varphi-\rho}{1+\sigma-\rho}}} \right)^{\frac{1}{1+\sigma-\varphi}} \left( \frac{\sum_k S_k n_i^k}{\sum_k n_i^k} \right)^{\frac{\sigma\varepsilon}{1+\sigma-\varphi}} \left[ \sum_k E_k (n_i^k)^{\rho} \right]^{\frac{\sigma(\varphi-\rho)}{(1+\sigma-\varphi)\rho}},$$

where  $Q_W^m$  is constant across areas. The  $n_i^k$  term denotes the ratio of type  $k$  individuals to type 1 individuals in area  $i$ , which captures the skill distribution within the city. Typically, some form of nonlinear least squares procedure would be needed to estimate this equation. If  $\varphi = \rho$ , then ordinary least squares can be used. In that case wages equal

$$Q_W^m \left( \frac{a_i^{\sigma}}{(\theta_i)^{1-\varphi} (\mathfrak{S}_i^m)^{\frac{1+\sigma-2\varphi}{1+\sigma-\rho}}} \right)^{\frac{1}{1+\sigma-\varphi}} \left( \frac{\sum_k S_k n_i^k}{\sum_k n_i^k} \right)^{\frac{\sigma\varepsilon}{1+\sigma-\varphi}}. \text{ To use least squares we would need to assume that}$$

$\mathfrak{S}_i^m$  is constant for some group or set of groups across space, and that all of the variation in the skill distribution is coming from amenities that impact the location of the omitted groups. In that case we would need to run the regression only for the groups whose amenity levels do not change.

This formulation suggests the difficulty of using wage regressions to estimate spillovers. Even when we assume that there is no heterogeneity in the relative productivity levels of different skill groups across space, herculean assumptions are needed to justify least squares estimation. When different groups have different productivity levels, estimation becomes even more difficult.

J. Rauch's 1993 paper was the first to set out to estimate human capital externalities using within-country data. He documented that, holding individual skills constant, wages were higher in cities that had a higher concentration of skilled people. He showed that rents were also higher

in those areas, which presumably maintains the spatial equilibrium. Although it is possible that high wages in high-skilled areas reflect unobserved individual skill characteristics, Rauch's finding remains an important part of understanding wage patterns across urban areas.

Regression 9-1 in table 9 reproduces a version of the Rauch result using area-level human capital and wages from the 2000 Census. Individual skills and industries are held constant. As before, we look only at fully employed men between 25 and 55 years old. As the share of the adult population with college degrees increases by 10 percent, wages increase by 7.8 percent. Figure 16 shows the relationship across metropolitan areas between the average wage residual from this equation and the share of the population with a college degree.

[table 9 about here]

[figure 16 about here]

The same two major problems that trouble the interpretation of the correlation between income and city size also bedevil interpretation of the correlation between area-level human capital and productivity. First, omitted area-level productivity variables may be positively correlated with area-level human capital, if skilled people move to areas that are more productive. Second, omitted individual-level human capital may be positively correlated with area-level human capital. The fact that real wages increase with human capital much less than nominal wages do should make one slightly less concerned about the second problem.

Two recent papers have tried to address the problem that unobserved ability may be correlated with area-level human capital. Daron Acemoglu and Joshua Angrist use changes in laws that mandate a minimum age of leaving school to estimate the social returns to schooling.<sup>87</sup> They find little evidence for human capital externalities using this method, but it seems unlikely that raising the skills of the people at the bottom of the skill distribution would generate the human capital externalities that lie at the heart of new growth theory. Enrico Moretti uses land grant colleges as an instrument for area education and looks at longitudinal data to correct for individual fixed effects.<sup>88</sup> He finds much stronger evidence supporting human capital externalities.

However, the model makes it difficult to interpret either approach unless these instruments are understood to be changes in the skill-specific amenities. Historical human capital

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87. Acemoglu and Angrist (2001).

88. Moretti (2004).

levels will be valid instruments only when they have no direct effect on any of the productivity parameters. In the context of the model, this means that they must work through amenities.

Moreover, just as in the case of agglomeration economies, the case for spatial policies that change the distribution of population depends on nonlinearities in human capital spillovers. Using the above framework, where we assume that utility is  $U(Y_i^k, \theta_i^k)$  and the production function is  $A(\hat{S}_i)F(\tilde{N}_i^k)$ :

*Proposition 4:* (a) A competitive equilibrium, where net unearned income is constant across space, can be a social optimum if and only if  $U_Y(Y_i^k, \theta_i^k)$  and

$$(S_k - \hat{S}_i) \frac{A'_i(\hat{S}_i) A_i(\hat{S}_i) F(\tilde{N}_i^k)}{A_i(\hat{S}_i) N_i} \text{ are both constant across space for every group } k.$$

(b) Relative to a competitive equilibrium where  $U(Y_i^k, \theta_i^k)$  is constant across space, welfare can be improved by moving type  $k$  people from area  $j$  to area  $i$  if and only

$$\text{if } (S_k - \hat{S}_i) \frac{A'_i(\hat{S}_i) A_i(\hat{S}_i) F(\tilde{N}_i^k)}{A_i(\hat{S}_i) N_i} > (S_k - \hat{S}_j) \frac{A'_j(\hat{S}_j) A_j(\hat{S}_j) F(\tilde{N}_j^k)}{A_j(\hat{S}_j) N_j}.$$

This proposition parallels Proposition 2. Just as in that case, the marginal utility of income, in this case within groups, must be constant across space in a social optimum. Moreover, the spillover effect from the group also needs to be constant across space. If this condition does not hold, then welfare can be improved by moving type  $k$  individuals to an area where

$$(S_k - \hat{S}_i) \frac{A'_i(\hat{S}_i) A_i(\hat{S}_i) F(\tilde{N}_i^k)}{A_i(\hat{S}_i) N_i} \text{ is higher. Our assumption that productivity depends on average}$$

skill levels yields the unambiguous result that if type  $k$  individuals are present in numbers below the average in area  $j$  and above the average in area  $i$ , they should be moved from  $j$  to  $i$ , raising the average ability of both places. This implication would not survive a more general skill spillover function that does not depend solely on average skills.

Just as in the case of Proposition 2, this proposition suggests that a federal spatial policy would only be beneficial if there are nonlinear effects. Moving skilled people from one area to another is advantageous only if the impact of skills differs across areas. We do not know of an instrumental variables strategy that can effectively estimate the degree of nonlinearity in the



relationship between area-level human capital and wages. The imprecise relationship between instruments, such as historical levels of human capital, and human capital today makes it enormously difficult to reliably estimate the degree of nonlinearity. As a result, we restrict ourselves here to ordinary least squares estimates. We recognize that these estimates are plagued with the two problems facing most attempts to estimate human capital spillovers: the potential correlation between area-level human capital and unobserved individual-level skills, and the endogeneity of area-level human capital.

To illustrate the ordinary least squares relationships, regression 9-2 in table 9 finds that the impact of area skills on wages is slightly higher for more skilled than for less skilled places. The difference between the effects is only weakly significant, and there are many issues with interpreting this coefficient. However, it does cast doubt on the view that policy should be trying to move more skilled people into less skilled areas.

In principle, spillovers might come from different industries rather than different levels of human capital. This would justify government policies that create clusters of either industry or human capital. The U.S. government has never actively embraced such efforts, although certainly many states and localities, such as North Carolina's Research Triangle, have tried to build areas around particular activities. Many state economic development policies have sought to target particular industries in particular locales in the hope that the magic of agglomeration economies would make those places thrive. Outside the United States, countries have explicitly tried to build industrial areas or to induce human capital to migrate to particular regions.

Regressions 9-3 and 9-4 in table 9 address the skill level of industries rather than workers. The idea behind these regressions is that spillovers are created by working in cities surrounded by skilled, successful industries rather than working in less skilled industrial clusters. We use the national Census microdata to estimate average skills at the industry level and then use metropolitan area-level data to calculate the average skill level of the industries in the area. We continue to control for industry fixed effects in these regressions. We find that as the average educational mix of an area's industries rises, average earnings in that area also rise. A 10 percent increase in the predicted share of the industry's employment with a college degree raises wages by 5.9 percent.

Regression 9-4 finds significant nonlinearities in this effect. Increasing the skill mix of the industry grouping is quite unimportant for areas with a low average industry-based skill mix.

The effect gets much stronger for areas with a high predicted skill level. The variable's impact is extremely convex, which suggests that it might be beneficial to push skilled industries to locate with other skilled industries.

Since the existence of general human capital externalities is also suggested by the link between human capital and area population growth, we performed similar regressions for the average skill level of an area's industries. In table A1 in appendix A, we show that this average industrial skill level increases area population, as it should if it increases productivity, and population growth. Just as in the wage-level regressions, the impact of this variable is convex in both the population and the population growth regressions (table A2 in appendix A).

There are reasons to be skeptical about the skill clustering policies suggested by regressions 9-2 and 9-4. First, these regressions represent correlations, not identified causal estimates. Second, policies that induce skilled groups to cluster together would tend to increase segregation by skill, which would probably end up increasing inequality as well.<sup>89</sup>

Finally, in regressions 9-5 and 9-6 in table 9 we turn to the question of industrial concentration. Does it make sense for cities to try to specialize in a small number of industries? Are workers more productive in places that have concentrated in a few core areas of excellence? Regression 9-5 controls for individual characteristics, again including industry fixed effects, and looks at the impact of overall industrial concentration at the metropolitan-area level. We use a Herfindahl index based on three-digit industries to measure the degree of concentration. In this case we find that more-concentrated places have lower productivity. This result is in line with the finding by Glaeser and others that industrially concentrated areas grow more slowly.<sup>90</sup>

Regression 9-6 looks within broad sectors. We measure the degree of concentration based on three-digit industries for each sector within each metropolitan area. This allows us to control for both metropolitan-area and industry fixed effects. In this case the workers in less concentrated one-industry groups earn more, but this is comparing them with other workers in the same metropolitan area. One concern with this type of regression is that if workers can readily move across industries within a metropolitan area, then productivity differences should

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89. We also examined the share of the industry's goods that are exported and the average wage residual in the industry. Both of these variables were suggested by Lawrence Summers. We do not find a significant tendency of wages to be higher in areas surrounded by such industries, nor do we find any significant nonlinearities in the impact of these variables on wages or population growth.

90. Glaeser and others (1992).

be eliminated within that area.

Regression 9-6 confirms within broad sectors the result from regression 9-5. Having a wide range of industries helps the entire metropolitan area, and more diversity within a given sector in a given metropolitan area increases wages in that sector. Although neither regression is based on anything like a natural experiment, the consistency of the results supports the value of industrial diversity for an area's aggregate welfare.

These results suggest that concentrations of skilled workers and skilled industries may increase local productivity. Yet we worry about the equity consequences of a policy that would encourage such concentrations, especially since skilled people already tend to move disproportionately into skilled areas. The results on industrial concentration are certainly only suggestive, but they cast doubt on the view that cities are best off creating specialized industrial clusters.

The strongest results in this section support the view that skilled workers and skilled industries generate positive effects. At the national level, however, there is little evidence to support the view that any gains would be realized by moving these industries into less developed areas. If anything, the results point in the opposite direction. On the other hand, for local leaders the existence of human capital externalities suggests that attracting skilled workers and skilled industries may be the most promising avenue for improving the success of their region.

## **VII. Conclusion**

Urban economists generally believe that the world exhibits spatial equilibrium, agglomeration economies, and human capital spillovers. The concept of spatial equilibrium suggests that policies that aid poor places are not necessarily redistributive and will have indirect consequences, for example pushing up housing costs and inducing poor people to move to poor areas. Agglomeration economies and human capital spillovers are both positive externalities, whose existence raises the possibility that national spatial policies could increase welfare. However, for these externalities to create a justification for any particular spatial policy, these externalities must be stronger in some places than in others. Even if we accept the existence of agglomeration economies, those economies make the case for subsidizing particular places only if they are nonlinear. Empirically, we cannot be confident that these effects are either convex or

concave. Economics is still battling over whether such spillovers exist at all, and we are certainly not able to document compelling nonlinear effects.

This does not mean that urban economics yields no implications for public policy. At the local level, human capital spillovers suggest policies for leaders who are trying to maximize either income or wages. If such spillovers are important, then increasing the skill level of a city, by either attracting or training more skilled people, will raise wages and population. At the national level, investment in infrastructure should be based on the tangible benefits of that infrastructure for consumers, not on the ability of that infrastructure to change location patterns. Indeed, the current tendency to subsidize transportation disproportionately in low-income, low-density states seems to run counter to what little is known about where agglomeration effects are more important.

Urban economics also yields suggestions for housing policy. Support for building new structures in declining areas merely subsidizes construction where it is least desired. After all, places that are in decline are defined in part by already having an excess of buildings relative to demand. A federal policy that enabled more building in those high-income areas that currently restrict new construction through land use controls seems more likely to increase welfare.

## Appendix A Proofs of Propositions

The core equations are that demand equals supply for the nontraded good (housing), which means that  $P_i H_i \bar{Z}_{N_i}^{\mu\eta} K_T^{\mu(1-\eta)} L_H^{1-\mu} = \frac{\beta(1-\alpha+\alpha\gamma)}{1-\beta(1-\mu+\mu\eta)} a_i N_i^\omega K_N^{\alpha\gamma} K_T^{\alpha(1-\gamma)} L_p^{1-\alpha}$ , where  $L_H$  is labor in the housing sector and  $L_p$  is labor in the traded sector. The two wage equations imply that

$$(1-\mu)P_i H_i \bar{Z}_{N_i}^{\mu\eta} K_T^{\mu(1-\eta)} L_H^{1-\mu} = W_i = (1-\alpha)a_i N_i^\omega K_N^{\alpha\gamma} K_T^{\alpha(1-\gamma)} L_p^{1-\alpha}.$$

Together these equations imply that  $L_p = \frac{(1-\alpha)[1-\beta(1-\mu+\mu\eta)]}{1-\alpha+\beta[\alpha\gamma(1-\mu)-\mu\eta(1-\alpha)]} N_i$  and

$$L_H = \frac{\beta(1-\mu)(1-\alpha+\alpha\gamma)}{1-\alpha+\beta[\alpha\gamma(1-\mu)-\mu\eta(1-\alpha)]} N_i.$$

Solving for traded capital gives us that  $W_i = Q_{W,1} \left( a_i N_i^\omega K_N^{\alpha\gamma} L_p^{-\alpha\gamma} \right)^{\frac{1}{1-\alpha+\alpha\gamma}}$ , or

$$(A1) \quad W_i = Q_W \left( a_i K_N^{\alpha\gamma} N_i^{\omega-\alpha\gamma} \right)^{\frac{1}{1-\alpha+\alpha\gamma}}.$$

The price solves  $P_i = \frac{Q_{P,1}}{H_i \bar{Z}_{N,i}^{\mu\eta} L_H^{1-\mu}} \left( a_i N_i^\omega K_N^{\alpha\gamma} L_p^{1-\alpha} \right)^{\frac{1-\mu+\mu\eta}{1-\alpha+\alpha\gamma}}$  or

$$P_i = \frac{Q_P}{H_i \bar{Z}_{N,i}^{\mu\eta}} \left( a_i K_N^{\alpha\gamma} \right)^{\frac{1-\mu+\mu\eta}{1-\alpha+\alpha\gamma}} N_i^{\frac{\omega(1-\mu+\mu\eta)+\mu\eta(1-\alpha)-\alpha\gamma(1-\mu)}{1-\alpha+\alpha\gamma}}, \text{ where } Q_{W,1}, Q_W, Q_{P,1}, \text{ and } Q_P \text{ are constants.}$$

Finally, to solve for overall population, we use  $\underline{U} = \theta_i N_i^{-\sigma} (1-t_i) W_i P_i^{-\beta}$ , which delivers the result that

$$N_i^{\frac{(\alpha\gamma-\omega)[1-\beta(1-\mu+\mu\eta)]+(\sigma+\beta\mu\eta)(1-\alpha+\alpha\gamma)}{1-\alpha+\alpha\gamma}} = Q_N \theta_i (1-t_i) (a_i K_N^{\alpha\gamma})^{\frac{1-\beta(1-\mu+\mu\eta)}{1-\alpha+\alpha\gamma}} \left( H_i \bar{Z}_{N,i}^{\mu\eta} \right)^\beta.$$

Equations 2 through 4 in the text then follow.

*Proof of Proposition 1:* We are trying to solve for  $\sum_i \theta_i N_i^{-\sigma} (1-t_i) (N_i W_i + Y_i) P_i^{-\beta}$ . Total earnings of  $N_i W_i + Y_i$  are  $(1-\alpha+\alpha\gamma) a_i N_i^\omega K_N^{\alpha\gamma} K_T^{\alpha(1-\gamma)} L^{1-\alpha} + (1-\mu+\mu\eta) P_i H_i \bar{Z}_{N,i}^{\mu\eta} K_T^{\mu(1-\eta)} L^{1-\mu}$ , which, using the demand for housing equation and the wage equation, equals

$$\frac{1-\alpha+\alpha\gamma}{1-\alpha+\beta[\alpha\gamma(1-\mu)-\mu\eta(1-\alpha)]} N_i W_i. \text{ Thus total utility is a constant times } \sum_i \theta_i (1-t_i) N_i^{1-\sigma} W_i P_i^{-\beta}.$$

Thus the total maximization problem can be written as

$$(A2) \sum_i \theta_i (1-t_i) N_i^{1-\sigma} W_i P_i^{-\beta} + \lambda_N \left( N_T - \sum_i N_i \right),$$

where  $N_T$  is aggregate population in all regions.

We use the formulation above where both wages and prices can be thought of as a function of population, and exogenous parameters, but not the tax rate or the amenity level. The derivative with respect to  $N_i$  is  $\theta_i (1-t_i) \frac{d}{dN_i} N_i^{1-\sigma} W_i P_i^{-\beta} = \lambda_N$ , which can also be written as  $k U_i -$

$\lambda_N$ , where  $k$  is a constant and  $U_i$  is total utility, which will be equal everywhere in a spatial equilibrium. As such, the decentralized equilibrium is location equilibrium, despite the existence of agglomeration economies and congestion effects in amenities.

As shown in equation 2, population is an increasing function of  $\theta_i (1-t_i)$ , so any choice of  $t_i$  that maximizes  $\theta_i (1-t_i)$  will also maximize population. Wages (equation 3) are a monotonically decreasing function of  $\theta_i (1-t_i)$ , so maximizing wages per capita will end up minimizing utility. Equation 4 reveals that house prices are increasing in  $\theta_i (1-t_i)$  as long as  $\omega(1-\mu+\mu\eta)+\mu\eta(1-\alpha)-\alpha\gamma(1-\mu) > 0$  and decreasing in  $\theta_i (1-t_i)$  if the reverse inequality holds.

*Proof of Proposition 2:* (a) Social welfare maximization can be written as maximizing the Lagrangian, where  $H_i$  now stands for housing consumption per capita and  $T$  is total taxes:

$$\sum_i N_i U[Y_i, H_i, \theta_i(N_i)] + \lambda_N \left( N_T - \sum_i N_i \right) + \lambda_Y \left[ \sum_i A_i(N_i) F(N_i - L_i) - T - N_i Y_i \right] + \sum_i \lambda_H^i [G_i(L_i) - N_i H_i]$$

which yields four first-order conditions:  $U_H[Y_i, H_i, \theta_i(N_i)] = \lambda_H^i$ ,  $\lambda_Y A_i(N_i) F'_i(N_i - L_i) = \lambda_H^i G'(L_i)$ ,  $U_Y[Y_i, H_i, \theta_i(N_i)] = \lambda_Y$ , and  $U[Y_i, H_i, \theta_i(N_i)] + N_i \theta'_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)] + \lambda_Y [A_i(N_i) F'_i(N_i - L_i) + A'_i(N_i) F'_i(N_i - L_i) - Y_i] - \lambda_H^i H_i = \lambda_N$ . In the competitive equilibrium the marginal product of labor equals the wage, so  $A_i(N_i) F'_i(N_i - L_i) = P_i G'(L_i) = W_i$ , and consumer optimization yields  $P_i \{U_Y[Y_i, H_i, \theta_i(N_i)]\} = U_H[Y_i, H_i, \theta_i(N_i)]$ . If  $U_Y[Y_i, H_i, \theta_i(N_i)]$  is constant over space in the competitive equilibrium, then the competitive equilibrium is equivalent to the first three first-order conditions. If  $U_Y[Y_i, H_i, \theta_i(N_i)]$  is not constant over space, then the competitive equilibrium cannot be a social optimum.

The fourth condition can be rewritten as

$$U[Y_i, H_i, \theta_i(N_i)] + N_i \theta'_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)] + U_Y[Y_i, H_i, \theta_i(N_i)] \left[ A_i(N_i) F'_i(N_i - L_i) + A'_i(N_i) F'_i(N_i - L_i) - Y_i - \frac{U_H}{U_Y} H_i \right] = \lambda_N$$

If  $N_i \theta'_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)] + U_Y[Y_i, H_i, \theta_i(N_i)] A'_i(N_i) F'_i(N_i - L_i)$  is constant across space, then this condition will also be implied by the competitive equilibrium, since  $U[Y_i, H_i, \theta_i(N_i)]$  is constant across space and so is unearned income, which equals  $A_i(N_i) F'_i(N_i - L_i) - Y_i - \frac{U_H}{U_Y} H_i$ .

If  $N_i \theta'_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)] + U_Y[Y_i, H_i, \theta_i(N_i)] A'_i(N_i) F'_i(N_i - L_i)$  is not constant, then the competitive equilibrium cannot satisfy this condition when  $U[Y_i, H_i, \theta_i(N_i)]$  is constant across space.

(b) Moving someone from area  $j$  to area  $i$  represents setting  $N_i = N_{i,C} + \varepsilon$  and  $N_j = N_{j,C} - \varepsilon$ , where  $N_{i,C}$  and  $N_{j,C}$  are the competitive population allocations. To determine the value of this change, we take the derivative of social welfare with respect to  $\varepsilon$  and evaluate it at  $\varepsilon = 0$ . Total social welfare can be written as

$$\sum_i N_i U \left[ W_i + Z_i - P_i \frac{G_i(L_i)}{N_i}, \frac{G_i(L_i)}{N_i}, \theta_i(N_i) \right],$$

where total unearned income is  $\sum_i N_i Z_i = \sum [A_i(N_i) F_i(N_i - L_i) + P_i G_i(L_i) - N_i W_i] - T$ , or total revenue minus labor costs minus taxes.

If the marginal utility of income is constant across space, then this derivative equals  $N_i \theta'_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)] - N_j \theta'_j(N_j) U_\theta[Y_j, H_j, \theta_j(N_j)] + U_Y [A'_i(N_i) F'_i(N_i - L_i) - A'_j(N_j) F'_j(N_j - L_j)]$ . This term is positive if and only if

$$\frac{N_i \theta'_i(N_i) \theta_i(N_i) U_\theta[Y_i, H_i, \theta_i(N_i)]}{\theta_i(N_i) U_Y[Y_i, H_i, \theta_i(N_i)]} + \frac{N_i A'_i(N_i) A_i(N_i) F'_i(N_i - L_i)}{A_i(N_i) N_i} > \frac{N_j \theta'_j(N_j) \theta_j(N_j) U_\theta[Y_j, H_j, \theta_j(N_j)]}{\theta_j(N_j) U_Y[Y_j, H_j, \theta_j(N_j)]} + \frac{N_j A'_j(N_j) A_j(N_j) F'_j(N_j - L_j)}{A_j(N_j) N_j}$$

If the marginal utility of income is not constant across space, but if unearned income from an area goes entirely to the residents of that area, then the condition becomes

$$\frac{N_i \theta'_i(N_i)}{\theta_i(N_i)} \theta_i(N_i) U_0 [Y_i, H_i, \theta_i(N_i)] + U_Y [Y_i, H_i, \theta_i(N_i)] \frac{N_i A'_i(N_i)}{A_i(N_i)} \frac{A_i(N_i) F_i(N_i - L_i)}{N_i} >$$

$$\frac{N_j \theta'_j(N_j)}{\theta_j(N_j)} \theta_j(N_j) U_0 [Y_j, H_j, \theta_j(N_j)] + U_Y [Y_j, H_j, \theta_j(N_j)] \frac{N_j A'_j(N_j)}{A_j(N_j)} \frac{A_j(N_j) F_j(N_j - L_j)}{N_j} .$$

Both of these are equivalent to the expression given in the text.

*Proof of Proposition 3:* We can write social welfare maximization as the maximization of a social planner's Lagrangian:

$$\sum_i N_i U [Y_i, H_i, \theta_i(N_i), t_i] + \lambda_N \left( N_T - \sum_i N_i \right) + \lambda_Y \left\{ \sum_i A_i(N_i) F_i [K_N(t_i), N_i - L_i] - t_i - N_i Y_i \right\} + \sum_i \lambda_H^i [G_i(L_i) - N_i H_i]$$

This yields a first-order condition for transportation spending of

$$N_i \frac{U_t [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + A_i(N_i) K'_N(t_i) \frac{\partial F_i [K_N(t_i), N_i - L_i]}{\partial K_N(t_i)} = 1 .$$

In a competitive equilibrium, total social welfare can be written as

$$\sum_i N_i U \left[ W_i + Z_i - P_i \frac{G_i(L_i)}{N_i} - N_i - t_i, \frac{G_i(L_i)}{N_i}, \theta_i(N_i), t_i \right],$$

where  $\sum_i N_i Z_i = \sum \{ A_i(N_i) F_i [K_N(t_i), N_i - L_i] + P_i G_i(L_i) - N_i W_i \} - T$  again. The derivative of this with respect to transport spending is

$$N_i \frac{U_t [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + \sum_j N_j \theta'_j(N_j) \frac{U_0 [Y_j, H_j, \theta_j(N_j), t_j]}{U_Y [Y_j, H_j, \theta_j(N_j), t_j]} \frac{\partial N_j}{\partial t_i} + A_i(N_i) K'_N(t_i) \frac{\partial F_i [K_N(t_i), N_i - L_i]}{\partial K_N(t_i)}$$

$$+ \sum_j \frac{A'_j(N_j)}{N_j A_j(N_j)} \frac{A_j(N_j) F_j [K_N(t_j), N_j - L_j]}{N_j} \frac{\partial N_j}{\partial t_i} = 1$$

The added benefit of transport spending is positive if and only if

$$N_i \theta'_i(N_i) \frac{U_0 [Y_i, H_i, \theta_i(N_i), t_i]}{U_Y [Y_i, H_i, \theta_i(N_i), t_i]} + \frac{A'_i(N_i)}{N_i A_i(N_i)} \frac{A_i(N_i) F_i [K_N(t_i), N_i - L_i]}{\partial N_i} >$$

$$\sum_{j \neq i} \frac{\partial N_j / \partial t_i}{\partial N_i / \partial t_i} \left\{ N_j \theta'_j(N_j) \frac{U_0 [Y_j, H_j, \theta_j(N_j), t_j]}{U_Y [Y_j, H_j, \theta_j(N_j), t_j]} + \frac{A'_j(N_j)}{N_j A_j(N_j)} \frac{A_j(N_j) F_j [K_N(t_j), N_j - L_j]}{\partial N_j} \right\} .$$

*Proof of Proposition 4:* Social welfare can be written as

$$\sum_k \lambda_k \sum_i N_i^k U(Y_i^k, \theta_i^k) + \sum_k \lambda_{Nk} (N_T^k - \sum_i N_i^k) + \lambda_Y \left[ \sum_i A_i(\hat{S}_i) F(\tilde{N}_i^k) - \sum_i \sum_k N_i^k Y_i^k \right].$$

First-order conditions are  $\lambda_k U_Y(Y_i^k, \theta_i^k) = \lambda_Y$ , and

$$\lambda_k U(Y_i^k, \theta_i^k) + \lambda_Y \left[ (S_k - \hat{S}_i) \frac{A_i'(\hat{S}_i)}{A_i(\hat{S}_i)} \frac{A_i(\hat{S}_i) F(\tilde{N}_i^k)}{N_i} + A_i(\hat{S}_i) \frac{\partial F(\tilde{N}_i^k)}{\partial N_i^k} - Y_i^k \right] = \lambda_{Nk}. \text{ For these}$$

conditions to be satisfied in a competitive equilibrium, where net unearned income is constant across space,  $U_Y(Y_i^k, \theta_i^k)$  and  $(S_k - \hat{S}_i) \frac{A_i'(\hat{S}_i)}{A_i(\hat{S}_i)} \frac{A_i(\hat{S}_i) F(\tilde{N}_i^k)}{N_i}$  must be constant across space.

Starting with a competitive equilibrium where the marginal utility of income is constant across space, welfare can be improved by moving type  $k$  individuals from city  $j$  to city  $i$  if and only if  $(S_k - \hat{S}_i) \frac{A_i'(\hat{S}_i)}{A_i(\hat{S}_i)} \frac{A_i(\hat{S}_i) F(\tilde{N}_i^k)}{N_i} > (S_k - \hat{S}_j) \frac{A_j'(\hat{S}_j)}{A_j(\hat{S}_j)} \frac{A_j(\hat{S}_j) F(\tilde{N}_j^k)}{N_j}$ .

## Appendix B Data Description

Census aggregated data are taken from the compilation provided by the Inter-University Consortium for Political and Social Research, under record number 2896. This compilation includes Census county data from 1790 to 2000, including data from various issues of the Census's *City and County Data Book*.

To analyze the metropolitan-area level data, we aggregate the county data according to metropolitan statistical area (MSA) definitions released by the Office of Management and Budget. Each figure or table specifies the definition used for that particular application. We use different definitions for different purposes in order to be consistent with data from other sources used in a particular figure or table.

A word of caution is in order regarding some aggregate numbers computed from these data. In order to use a consistent set of MSA definitions for each purpose, we need median family income and median house value data at various MSA definitions; these medians are only presented under certain definitions. We therefore estimate the median by averaging the component counties' median values, weighting by families in the case of family income and by housing units in the case of house values. The resulting numbers are not equal to the true median for the metropolitan area, but they should be a close enough approximation for our purposes.

We obtained the Census Bureau's 5 percent Public Use Microdata Sample (PUMS) of the 2000 Census from the Integrated Public Use Microdata Series (IPUMS) service of the Minnesota Population Center. The sole geographical identifier included in the PUMS is a Public Use Microdata Area (PUMA), which IPUMS links to an MSA where appropriate. (In particular, IPUMS uses the 1999 MSA definitions, using primary rather than consolidated MSAs where applicable.) This identification is imperfect because the Census does not ensure that each PUMA is contained within a county, so PUMAs do not necessarily map onto MSAs. Nonetheless it is the best that can be done to link the Census microdata to other geographical data.

When running wage regressions on the individual-level data, we include only prime-age men (defined as those 25 to 55 years old) in order to avoid picking up differing labor force



participation rates. We exclude anyone who reports not having a full-time job or whose annual earnings are below half of the annual minimum wage. We include dummy controls for each individual's age (grouped by decade: 20s, 30s, 40s, or 50s) and educational attainment (high school dropout, high school graduate, or college graduate), and in the repeated panel regressions (table 3) we allow the coefficient on each dummy variable to change across Census years.

When we use industry-level data in conjunction with Census industry categorization, it is necessary to match the different industry classification systems used in the different datasets. Census industry codes for manufacturing industries, on the 1990 basis, are matched to Standard Industrial Classification (SIC) codes using appendix A to Census Technical Paper No. 65, which is available online at [www.census.gov/hhes/www/ioindex/tp65\\_report.html](http://www.census.gov/hhes/www/ioindex/tp65_report.html). Since there is not an exact one-to-one relationship between Census industry codes and SIC codes, the concordance is necessarily imperfect; we select one SIC code if multiple ones are given, and we use data from the SIC code given even when informed that the Census industry code matches only part of the SIC category. A given Census industry code can be matched with a two-digit, three-digit, or four-digit SIC code, so our resulting dataset uses a mixture of levels of detail. These SIC data are in turn matched to exporting data from the International Trade Administration, available online at [ita.doc.gov/td/industry/otea/industry\\_sector/tables.htm](http://ita.doc.gov/td/industry/otea/industry_sector/tables.htm).

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**Table 1. U.S. Metropolitan Statistical Areas Ranked on Selected Indicators<sup>a</sup>**

Indicator	Top five MSAs	Average value	Bottom five MSAs	Average value
Gross metropolitan product per capita, 2004	Bridgeport, CT	\$74,285	Brownsville, TX	\$16,025
	Charlotte, NC	\$68,406	McAllen, TX	\$16,149
	San Jose, CA	\$68,311	Lake Havasu City, AZ	\$17,126
	Washington, DC	\$62,251	Cumberland, MD	\$18,302
	Sioux Falls, SD	\$59,003	Prescott, AZ	\$18,482
Median family income, 2000	San Jose, CA	\$81,053	McAllen, TX	\$26,009
	Bethesda, MD	\$81,000	Brownsville, TX	\$27,853
	Bridgeport, CT	\$77,690	Laredo, TX	\$29,394
	Nassau-Suffolk, NY	\$76,595	El Paso, TX	\$33,410
	San Francisco, CA	\$75,416	Las Cruces, NM	\$33,576
Share of adult population with a college degree, 2000 <sup>b</sup>	Boulder, CO	52.4%	Dalton, GA	9.0%
	Bethesda, MD	50.2%	Lake Havasu City, AZ	9.9%
	Ann Arbor, MI	48.1%	El Centro, CA	10.3%
	San Francisco, CA	43.6%	Hanford, CA	10.4%
	Cambridge, MA	43.6%	Merced, CA	11.0%
Median house price, 2000	San Jose, CA	\$441,900	Odessa, TX	\$47,700
	San Francisco, CA	\$440,500	McAllen, TX	\$52,400
	Santa Cruz, CA	\$377,500	Brownsville, TX	\$53,000
	New York, NY	\$362,500	Danville, IL	\$56,000
	Honolulu, HI	\$309,000	Pine Bluff, AR	\$56,200

Sources: Bureau of Economic Analysis; U.S. Census Bureau.

a. Units of observation are metropolitan statistical areas (MSAs) under the 2006 definitions, using metropolitan divisions where applicable. All dollars are current (2000 or 2004) dollars.

b. Among MSAs with at least 100,000 population.

**Table 2. Regressions of Wages on Metropolitan-Area Population and Density<sup>a</sup>**

Independent variable	Regression				
	2-1	2-2	2-3	2-4	2-5 <sup>b</sup>
Log of population in 2000	0.041 (0.009)		0.023 (0.010)		0.089 (0.037)
Log of population in 2000, below-median subsample		0.076 (0.029)		0.057 (0.029)	
Log of population in 2000, above-median subsample		0.038 (0.012)		0.020 (0.013)	
Log of population density, 2000			0.029 (0.015)		
Log of density in 2000, below-median subsample				0.041 (0.017)	
Log of density in 2000, above-median subsample				0.027 (0.020)	
No. of observations	1,591,140	1,591,140	1,591,140	1,591,140	1,282,116
No. of MSAs	283	283	283	283	210
$R^2$	0.22	0.22	0.22	0.22	

Source: Authors' regressions.

a. The dependent variable is the logarithm of the individual wage. The regression method is ordinary least squares except where noted otherwise. Only fully employed men aged 25 to 55 are included in the sample. All regressions include individual controls for age and education. Individual-level wage data are from the U.S. Census Public Use Microdata Sample, as described in appendix A. Metropolitan-area covariates are from the U.S. Census Bureau as described in appendix A. Units of observation are metropolitan statistical areas (MSAs) presented under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable. Standard errors (in parentheses) are clustered by MSA.

b. Instrumental variables regression using the logarithm of population in 1850 in place of log of population in 2000.

**Table 3. Instrumental Variables Regressions Testing for Agglomeration Effects<sup>a</sup>**

Independent variable	Regression				
	3-1 <sup>b</sup>	3-2	3-3	3-4	3-5
Population growth in 1990s × year 2000 dummy	0.200 (0.044)	0.004 (0.098)	0.166 (0.088)	-0.020 (0.121)	-0.099 (0.141)
Above-median population dummy × year 2000 dummy			0.006 (0.017)		
Population growth in 1990s × above-median population dummy × year 2000 dummy			-0.165 (0.133)		
Above-median centralization <sup>c</sup> dummy × year 2000 dummy				-0.038 (0.022)	
Population growth in 1990s × above-median centralization dummy × year 2000 dummy				0.216 (0.163)	
Dummy for bottom quartile of MSA population growth, 1970-90 × year 2000 dummy					-0.057 (0.026)
Log of population in 2000 × dummy for bottom quartile of MSA population growth, 1970-90 × year 2000 dummy					0.398 (0.252)
No. of observations	2,950,850	2,950,850	2,950,850	2,490,733	2,950,850
No. of MSAs	287	287	287	229	287

Source: Authors' regressions.

a. The dependent variable is the logarithm of the individual wage for employed men aged 25 to 55. Regressions are instrumental variables regressions except where noted otherwise. Instruments are mean January temperature, mean July temperature, and precipitation, from the 1994 City and County Data Book. Individual data are from the 1990 and 2000 Census Public Use Microdata Sample, as described in appendix A. Population data are from the Census. Units of observation are metropolitan statistical areas (MSAs) under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable. All regressions include individual controls for sex, age, and education and MSA and year fixed effects. Standard errors (in parentheses) are clustered by MSA.

b. Regression is by the ordinary least squares method.

c. Centralization is defined as the fraction of MSA employment located within five miles of the central business district, from Glaeser and Kahn (2004).



**Table 4. Regressions of Urban Disamenity Measures on Metropolitan-Area Population and Centralization Measures<sup>a</sup>**

Independent variable	Dependent variable							
	Log of average commute (minutes)		Log of concentration of TSP-10 particulates <sup>b</sup>		Log of murder rate		Log of real wage <sup>c</sup>	
	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8
Log of population in 2000	0.12 (0.012)	0.057 (0.016)	0.142 (0.056)	0.145 (0.079)	0.222 (0.146)	0.485 (0.234)	0.03 (0.015)	0.04 (0.024)
Log of population × population above median in 2000	-0.003 (0.002)		0.001 (0.012)		0.004 (0.018)		0 (0.003)	
Centralization <sup>d</sup>		-0.874 (0.420)		2.065 (2.134)		4.305 (5.476)		1.03 (0.611)
Log of population in 2000 × centralization		0.052 (0.033)		-0.222 (0.156)		-0.309 (0.442)		-0.093 (0.048)
Constant	1.65 (0.137)	2.531 (0.210)	1.945 (0.657)	2.284 (1.134)	-1.371 (1.733)	-4.947 (3.025)	8.345 (0.184)	8.301 (0.330)
No. of observations	318	248	40	37	153	126	219	185
Adjusted $R^2$	0.48	0.56	0.36	0.52	0.07	0.09	0.05	0.07

Source: Authors' regressions.

a. Population, income, and commute time data are from the U.S. Census Bureau, as described in appendix A. Murder rate is from the Federal Bureau of Investigation Uniform Crime Reports, and TSP-10 data are from the Environmental Protection Agency. Units of observation are metropolitan statistical areas (MSAs) under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable. Numbers in parentheses are standard errors.

b. Total suspended particulates of less than 10 microns diameter, a standard measure of atmospheric pollution.

c. Computed by adjusting the average nominal wage for the cost of living index from the American Chamber of Commerce Research Association.

d. Percent of employment within 5 miles of the central business district, from Glaeser and Kahn (2004).

**Table 5. Historical Regressions of Population and Income Growth on Metropolitan-Area Transportation Measures and Controls<sup>a</sup>**

Independent variable	Dependent variable					
	Population growth, 1850-60	Population growth, 1850-1900	Population growth, 1960-90	Income per capita growth, 1960-90	Population growth, 1990-2000	Income per capita growth, 1990-2000
	5-1	5-2	5-3	5-4	5-5	5-6
Log of initial population	-0.335 (0.011)	-0.629 (0.017)	-0.101 (0.023)	-0.038 (0.010)	-0.007 (0.007)	-0.02 (0.004)
Distance in miles to ocean or Gulf of Mexico	0.04 (0.003)	0.037 (0.005)	-0.021 (0.004)	-0.013 (0.002)		
Dummy for county accessible by rail in 1850	0.144 (0.023)	0.203 (0.036)				
Congregationalists per capita in 1850	0.925 (0.181)	0.96 (0.286)				
Log of new miles of highway, 1960-90			0.111 (0.026)	0.039 (0.009)		
Dummy for top-50 airport					0.046 (0.021)	0.027 (0.011)
Percent of population with college degree in 1990					0.337 (0.088)	0.093 (0.047)
Constant	3.154 (0.100)	6.431 (0.158)	1.309 (0.245)	2.412 (0.109)	0.136 (0.086)	0.65 (0.045)
Unit of observation	Counties	Counties	MSAs	MSAs	MSAs	MSAs
No. of observations	1,517	1,517	205	205	318	317
Adjusted $R^2$	0.53	0.57	0.15	0.22	0.07	0.1

Source: Authors' regressions.

a. Metropolitan statistical areas (MSAs) are under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable. Population, income, and Congregationalists data are from the U.S. Census Bureau, as described in appendix A. Data on proximity to rail transportation are from Craig, Palmquist, and Weiss (1998). Distance to ocean or Gulf is from Rappaport and Sachs (2003) and is the distance from the closest county in the MSA. Highway data are from Baum-Snow (2007). Airport data are from Bureau of Transportation Statistics (1996). Standard errors are in parentheses.

**Table 6. Correlations of Federal Transportation Spending with State Size<sup>a</sup>**

Spending measure	Correlation with log of population	Correlation with log of population density	Correlation with log of income per capita
Log of highway spending per capita, including trust fund <sup>b</sup>	-0.53	-0.32	-0.18
Log of highway spending per capita, excluding trust fund	-0.48	-0.49	-0.39
Log of air travel spending per capita	-0.34	-0.79	-0.45
Log of railroad spending per capita	-0.50	-0.18	-0.14
Log of public transit spending per capita	0.11	0.46	0.53

Source: Authors' calculations.

a. Each cell reports the correlation coefficient between the indicated transportation spending measure and the indicated state characteristic. Transportation spending data are from U.S. Census Bureau (2004). Population data are from the U.S. Census Bureau as described in appendix A. Land area is from Rappaport and Sachs (2003).

b. Includes contributions by the states to the national transportation trust fund.

**Table 7. Regressions Estimating Impact of the Appalachian Regional Commission<sup>a</sup>**

Independent variable	Dependent variable			
	Population growth		Growth in income per capita	
	1970-80	1970-2000	1970-80	1970-2000
Dummy for county in ARC coverage area	0.037 (0.008)	-0.002 (0.020)	0.004 (0.005)	-0.029 (0.008)
Log of initial population	-0.018 (0.004)	-0.036 (0.010)		
Log of initial income per capita			-0.323 (0.011)	-0.406 (0.016)
Constant	0.299 (0.038)	0.637 (0.099)	3.418 (0.082)	5.172 (0.123)
Adjusted $R^2$	0.051	0.015	0.512	0.420

Source: Authors' regressions.

a. Units of observation ( $N = 898$ ) are counties. Income and population data are from the U.S. Census Bureau, as described in appendix A. Standard errors are in parentheses.

**Table 8. Regressions Estimating Impact of Urban Renewal<sup>a</sup>**

Independent variable	Dependent variable			
	Growth from 1960 to 1970		Growth from 1970 to 2000	
	In population	In income per capita	In population	In income per capita
Urban renewal spending per capita (dollars)	0.0022 (0.0014)	0.0004 (0.0006)		
Dummy for Model Cities participant			-0.051 (0.063)	0.023 (0.016)
Log of initial population	-0.027 (0.051)		-0.053 (0.021)	
Log of initial income per capita		-0.459 (0.152)		-0.177 (0.035)
Constant	0.054 (0.768)	5.92 (1.17)	1.06 (0.26)	3.34 (0.28)
No. of observations	21	21	318	318
Adjusted $R^2$	0.20	0.45	0.04	0.07

Source: Authors' regressions.

a. Units of observation are metropolitan statistical areas under the 1999 definitions (primary rather than consolidated MSAs where applicable, New England county metropolitan areas where applicable). Income and population data are from the U.S. Census Bureau, as described in appendix A. Urban renewal spending per capita is from Staples (1970).

**Table 9. Regressions of Wages on Metropolitan-Area Human Capital and Industrial Structure<sup>a</sup>**

Independent variable	Regression					
	9-1	9-2	9-3	9-4	9-5	9-6 <sup>b</sup>
Percent of population with college degree	0.814 (0.024)				0.792 (0.024)	
Percent with college degree, below-median subsample		0.638 (0.072)				
Percent with college degree, above-median subsample		0.862 (0.031)				
Percent employment in top quartile of human capital			0.671 (0.027)			
Percent employment in top quartile, below-median subsample				0.035 (0.070)		
Percent employment in top quartile, above-median subsample				0.946 (0.034)		
Herfindahl index for MSA					-1.011 (0.243)	
Herfindahl index for MSA and sector						-0.087 (0.001)
No. of observations	3,789,707	3,789,707	3,789,707	3,789,707	3,789,707	3,789,707
No. of MSAs	285	285	285	285	285	285
Adjusted $R^2$	0.31	0.31	0.31	0.31	0.31	0.32

Source: Authors' regressions.

a. The dependent variable is the logarithm of the individual wage; the sample includes fully employed men aged 25 to 55 only. Individual-level data are from the 1990 and 2000 Census Public Use Microdata Sample, as described in appendix A. All regressions include individual controls for sex, age, and education and industry fixed effects (but not MSA fixed effects except where noted otherwise). Data on industry concentration and human capital by industry are calculated from the microdata. Metropolitan-area education data are from the U.S. Census Bureau as described in appendix A. City characteristics are at the level of MSAs under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable. Standard errors (in parentheses) are clustered by MSA and industry.

b. Regression includes MSA fixed effects.

**Table B1. Additional Regressions<sup>a</sup>**

Independent variable	Dependent variable				
	Log wage	Log wage residual	Log population	Population growth, 1990s	Income growth, 1990s
Human capital predicted by industrial distribution <sup>b</sup>	2.32 (0.33)	0.28 (0.21)	9.36 (2.06)	0.23 (0.20)	0.02 (0.11)
Constant	9.20 (0.10)	-0.17 (0.07)	10.0 (0.6)	0.06 (0.06)	0.41 (0.03)
No. of observations	285	285	285	285	285
Adjusted $R^2$	0.15	0.01	0.07	0.005	0.0001
Human capital predicted by industrial distribution <sup>b</sup>	2.39 (0.59)	-0.45 (0.37)	-0.55 (3.62)	-0.12 (0.35)	0.29 (0.20)
Predicted human capital × above median subsample	-0.01 (0.10)	0.15 (0.06)	2.06 (0.62)	0.07 (0.06)	-0.056 (0.034)
Constant	9.18 (0.16)	-0.03 (0.10)	11.5 (0.4)	0.16 (0.10)	0.34 (0.06)
No. of observations	285	285	290	285	285
Adjusted $R^2$	0.15	0.02	0.10	0.01	0.01
Exporting predicted by industrial distribution <sup>c</sup>	0.35 (0.24)	0.16 (0.14)	1.48 (1.43)	-0.31 (0.13)	0.03 (0.08)
Constant	9.85 (0.05)	-0.11 (0.03)	12.7 (0.3)	0.19 (0.03)	0.41 (0.01)
No. of observations	285	285	285	285	285
Adjusted $R^2$	0.01	0.005	0.004	0.02	0.0004
Exporting predicted by industrial distribution <sup>c</sup>	0.27 (0.47)	-0.06 (0.28)	-5.18 (2.74)	-0.38 (0.26)	0.18 (0.15)
Predicted exporting × above-median subsample	0.03 (0.18)	0.10 (0.11)	2.99 (1.05)	0.03 (0.10)	-0.07 (0.05)
Constant	9.86 (0.07)	-0.08 (0.04)	13.6 (0.4)	0.20 (0.04)	0.39 (0.02)
No. of observations	285	285	285	285	285
Adjusted $R^2$	0.01	0.01	0.03	0.02	0.01
Wage premium predicted by industrial distribution <sup>d</sup>	1.71 (3.76)	-0.44 (2.23)	-31.3 (22.3)	0.50 (2.11)	-1.21 (1.18)
Constant	9.92 (0.01)	-0.08 (0.01)	12.9 (0.06)	0.13 (0.01)	0.417 (0.003)
No. of observations	285	285	285	285	285
Adjusted $R^2$	0.0007	0.0001	0.007	0.0002	0.004
Wage premium predicted by industrial distribution <sup>d</sup>	-2.1 (13.2)	-3.16 (7.83)	-60.3 (78.2)	2.91 (7.41)	3.37 (4.12)
Predicted wage premium × above-median subsample	4.3 (14.0)	3.03 (8.35)	32.3 (83.4)	-2.68 (7.89)	-5.09 (4.39)
Constant	9.92 (0.01)	-0.082 (0.007)	12.9 (0.1)	0.13 (0.01)	0.418 (0.003)
No. of observations	285	285	285	285	285
Adjusted $R^2$	0.001	0.0006	0.007	0.0006	0.008

Source: Authors' regressions.

a. Units of observation are MSAs according to the 1999 definitions, using primary rather than consolidated MSAs where applicable. Data for the dependent variables are from the U.S. Census Bureau as described in appendix A.

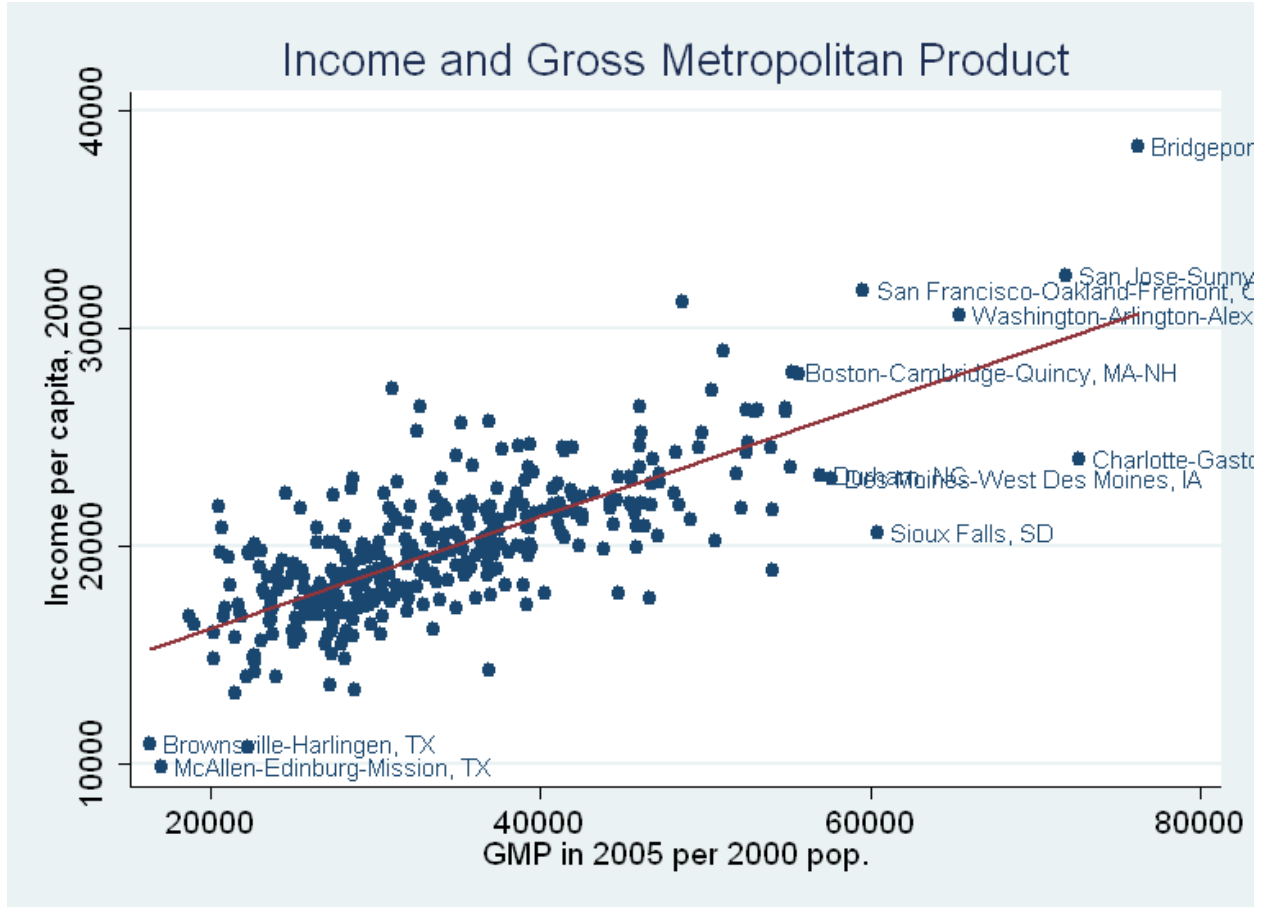
b. Calculated from the Census Public Use Microdata Sample (PUMS) as described in appendix A. The percent of workers with a college degree is first calculated for each industry code as defined by the Census Bureau. These numbers are then averaged for each metropolitan area, weighting by the distribution of industry employment in the metropolitan area from the 1980 PUMS.

c. Calculated using data from the International Trade Administration as described in appendix A as the value of an industry's exports divided by the total value of its shipments. The industry-level export fraction is averaged for each metropolitan area, weighting by the distribution of industry employment in the metropolitan area from the 1980 PUMS.

d. Calculated from the PUMS as described in appendix A. A wage premium is first calculated for each industry code, as defined by the Census, as the industry fixed effect in a wage regression containing controls for individual age, sex, and education. These industry wage premiums are then averaged for each metropolitan area, weighting by the distribution of industry employment in the metropolitan area from the 1980 PUMS.



**Figure 1. Income per Capita and Gross Metropolitan Product per Capita<sup>a</sup>**

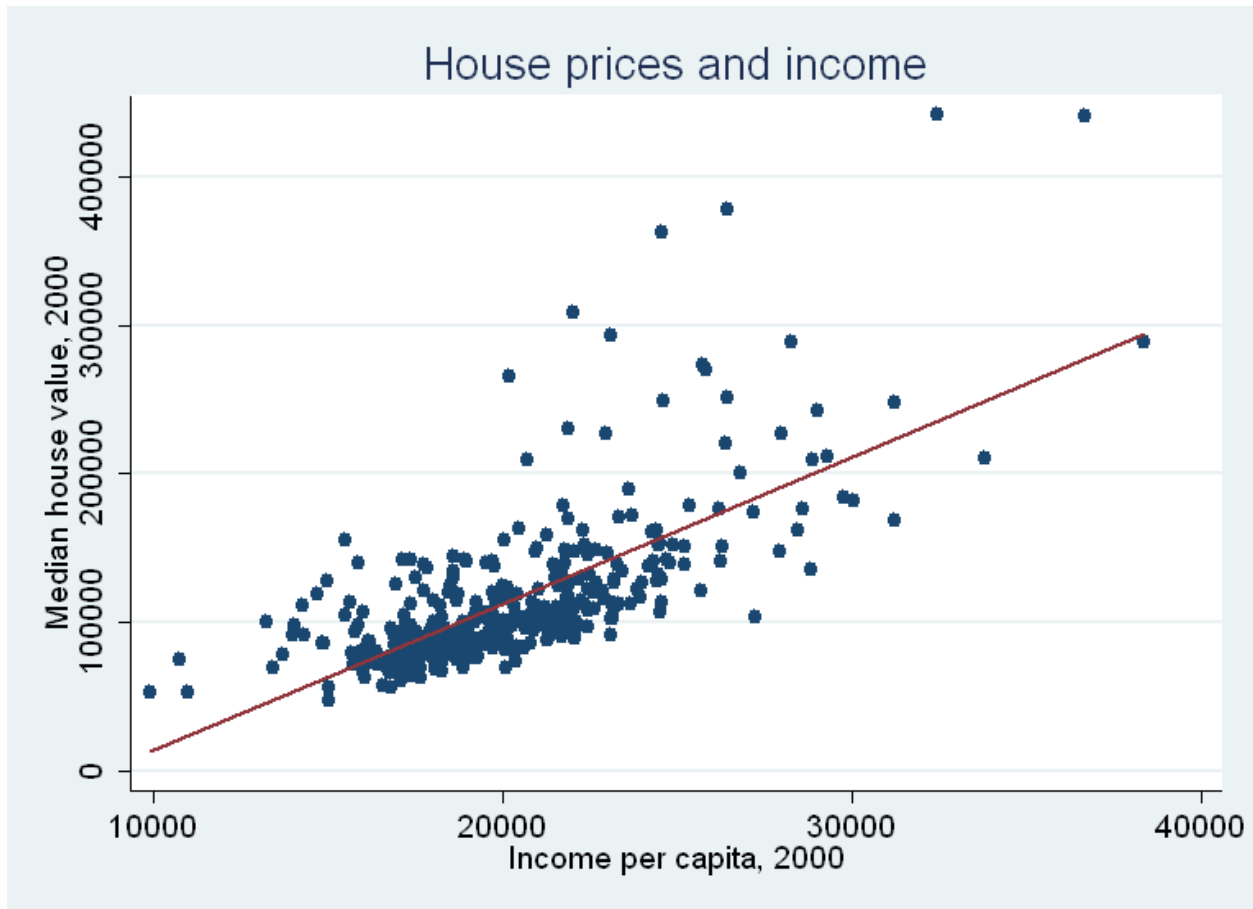


Sources: U.S. Census Bureau; Bureau of Economic Analysis. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 2006 definitions.

b. Gross metropolitan product in 2005 divided by 2000 population.

Figure 2. House Prices and Income per Capita<sup>a</sup>



Source: U.S. Census Bureau. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 2006 definitions, using metropolitan divisions where applicable.

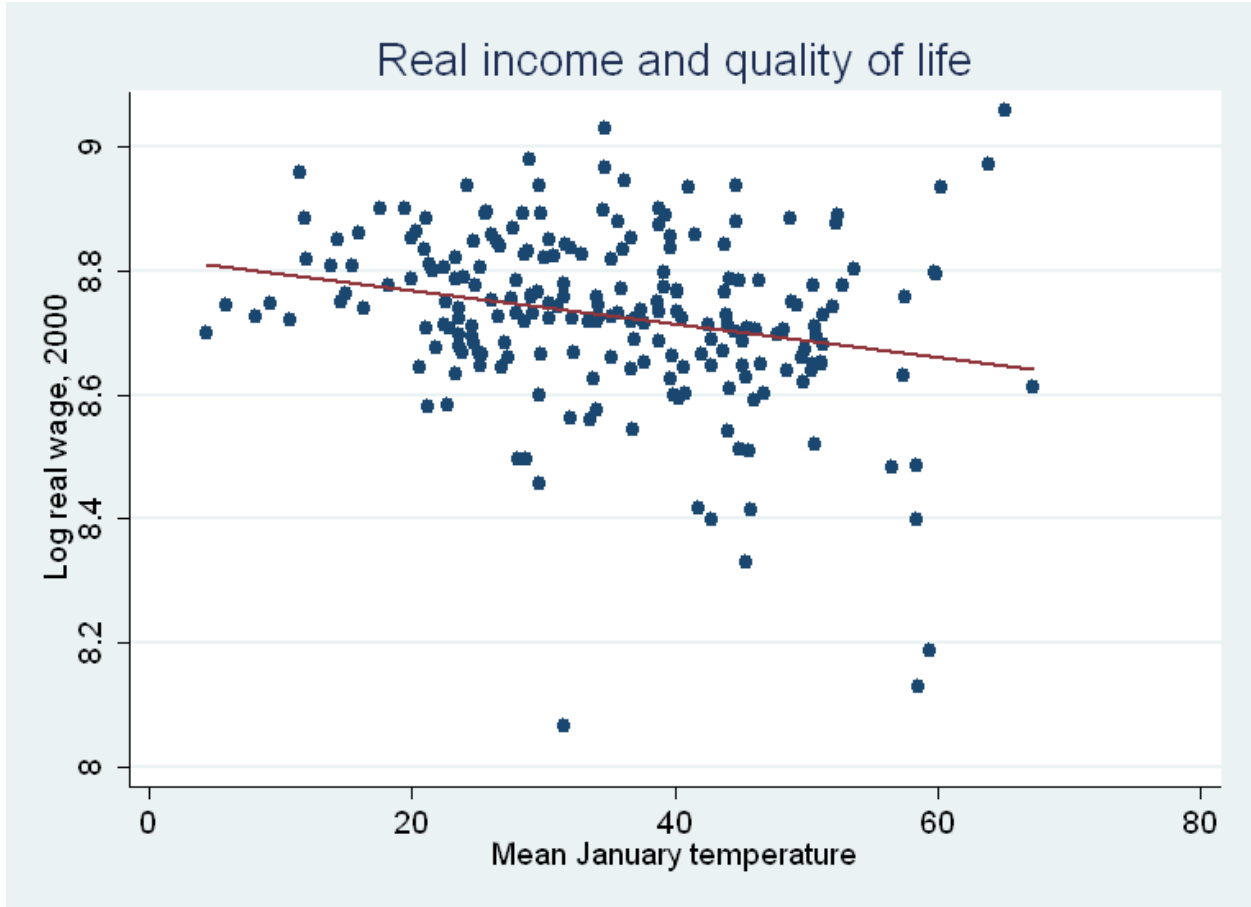
Figure 3. Income per Capita and Cost of Living<sup>a</sup>



Sources: U.S. Census Bureau; American Chamber of Commerce Research Association. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 1999 definitions, using metropolitan divisions where applicable and New England county metropolitan areas where applicable.

**Figure 4. Real Wages and Mean January Temperature<sup>a</sup>**

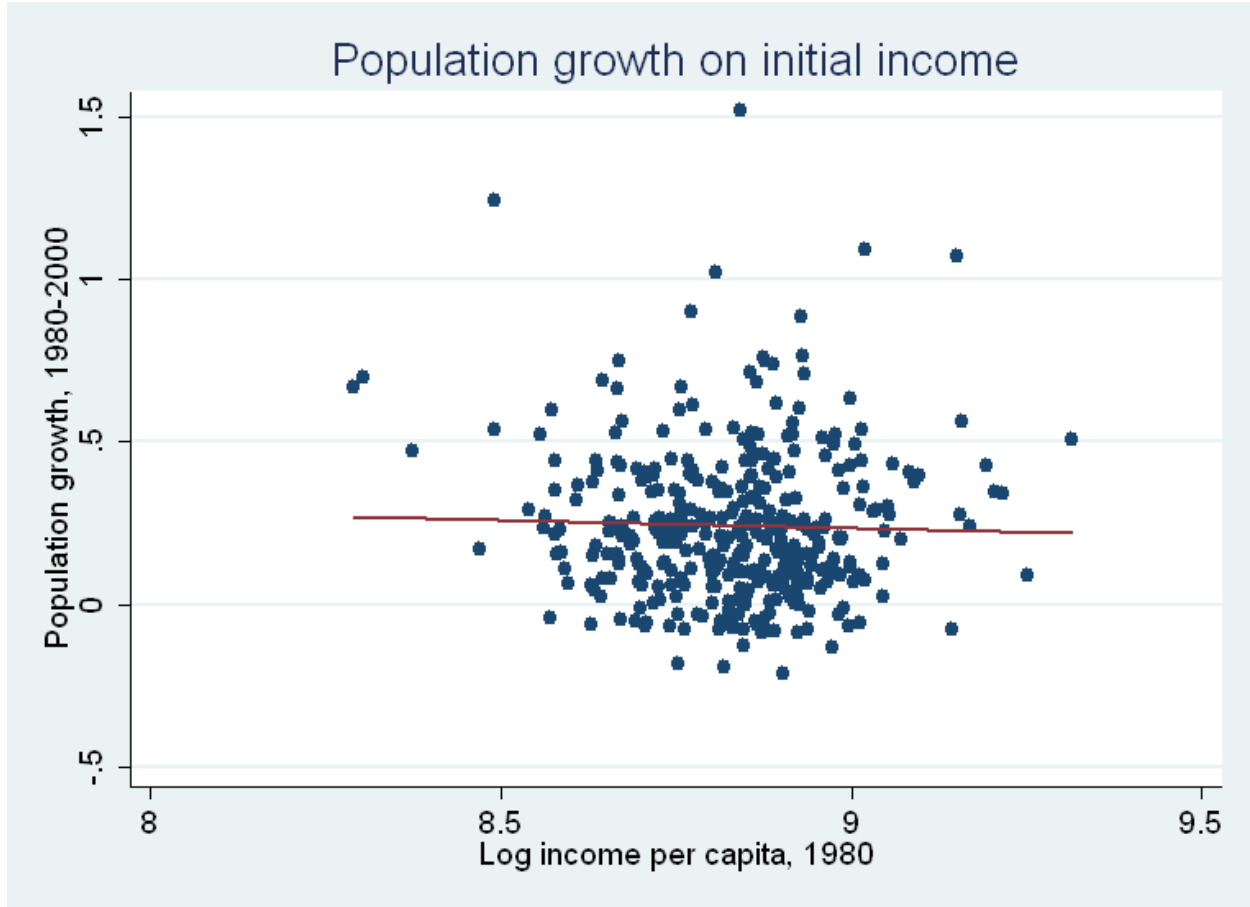


Sources: U.S. Census Bureau; American Chamber of Commerce Research Association; *City and County Data Book*, 1994. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable.

b. Real wages are defined as the ratio of income per capita to the ACCRA cost of living index.

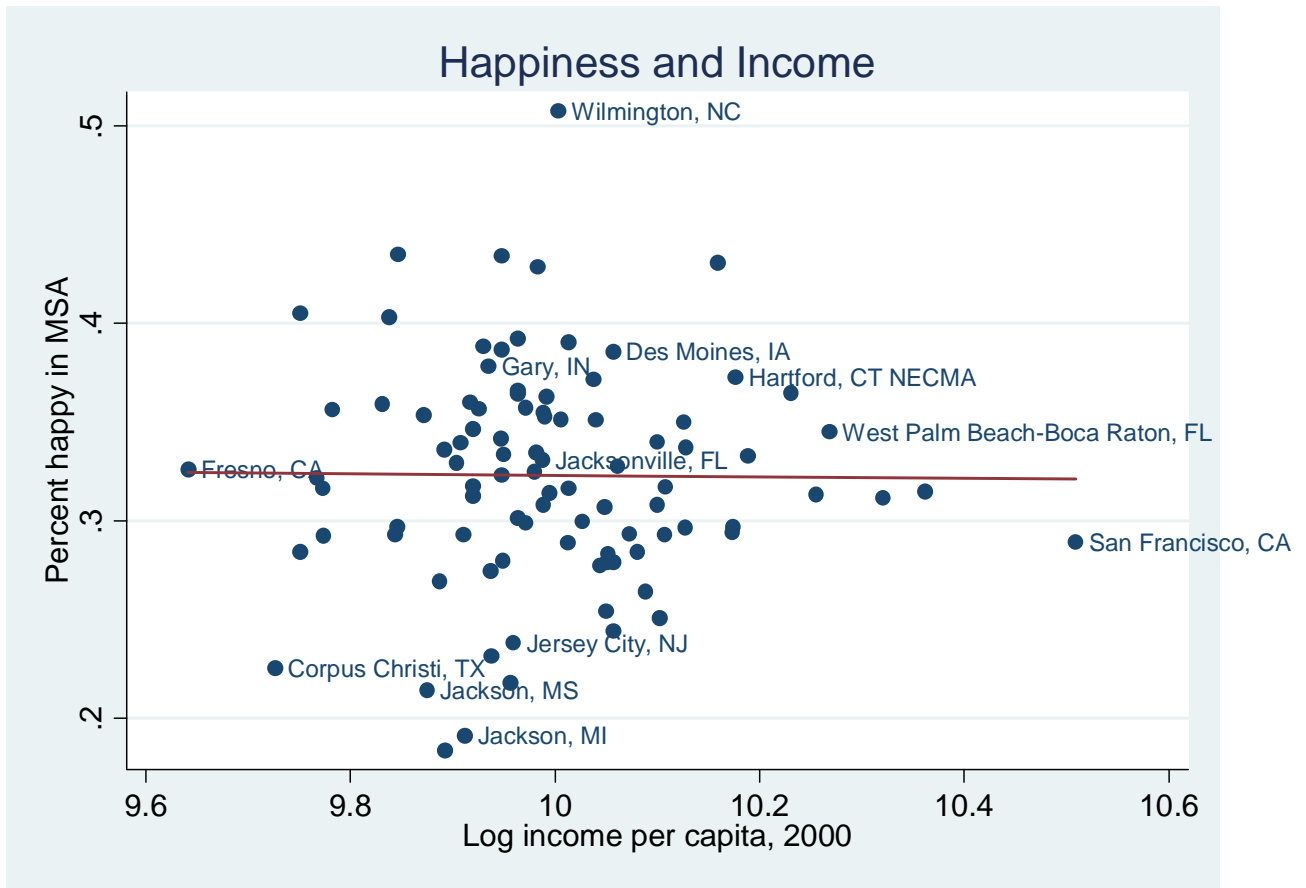
**Figure 5. Population Growth and Income per Capita<sup>a</sup>**



Source: U.S. Census Bureau. See appendix B for details.

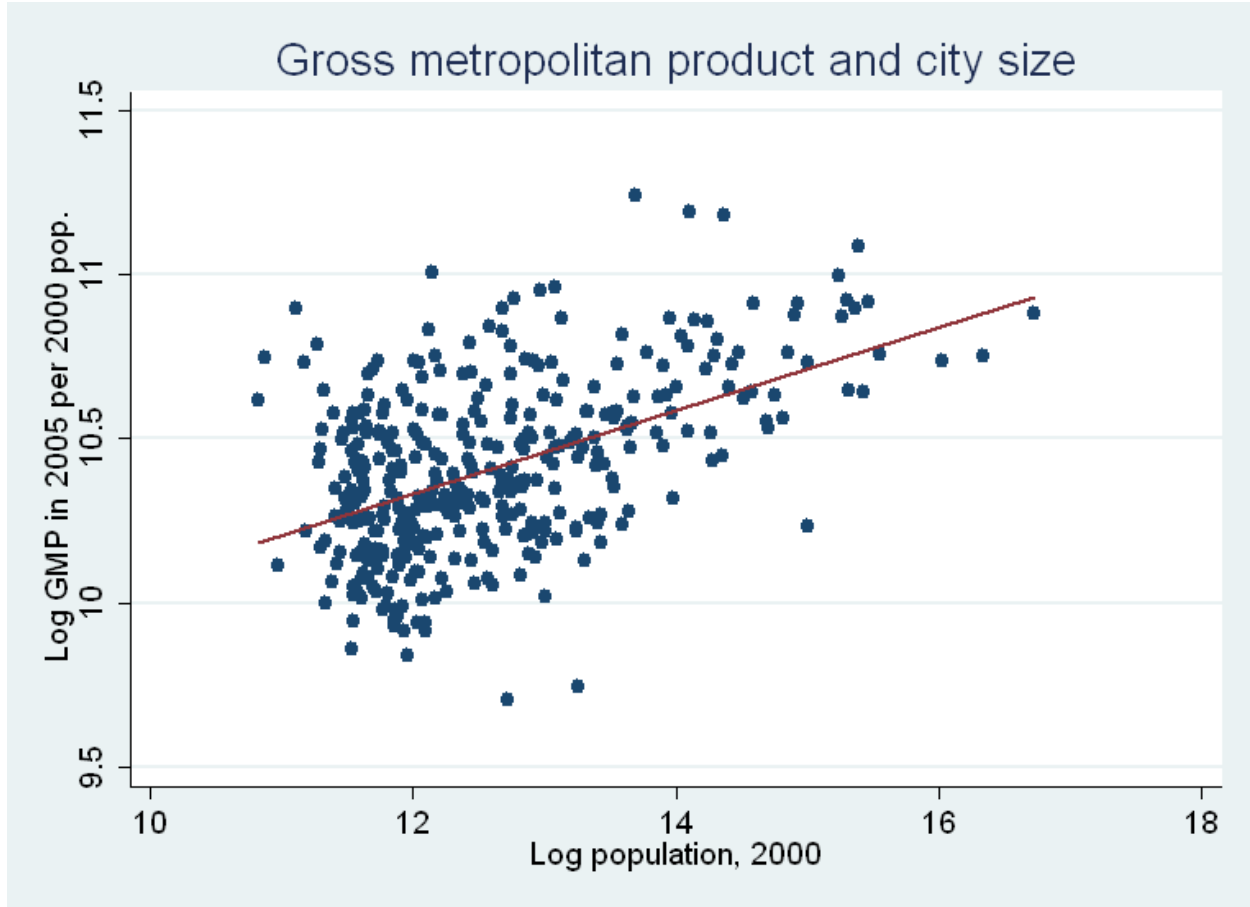
a. Each observation represents a single metropolitan statistical area under the 2006 definitions.

Figure 6. Reported Happiness and Income per Capita<sup>a</sup>



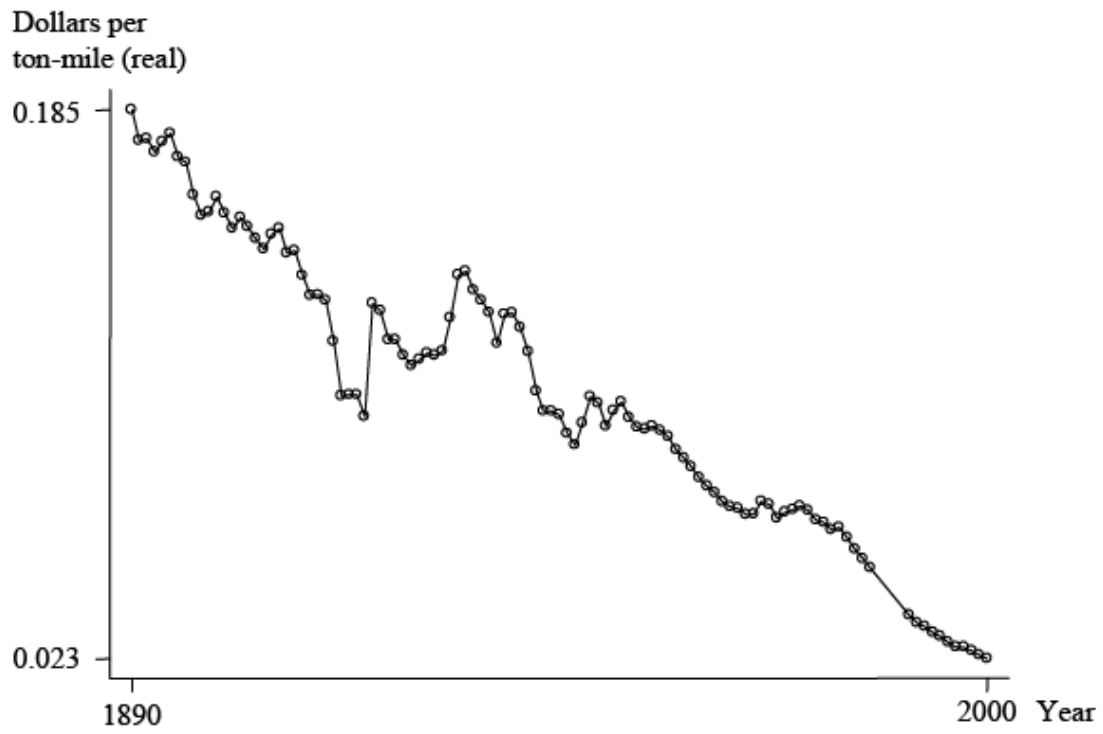
Sources: General Social Survey, 1972-2006; U.S. Census Bureau. See appendix B for details.  
a. Each observation represents a single metropolitan statistical area under the 1999 definitions.  
b. Respondents are considered happy if they chose the happiest of three possible responses.

**Figure 7. Gross Metropolitan Product per Capita and Population<sup>a</sup>**



Sources: U.S. Census Bureau; Bureau of Economic Analysis. See appendix B for details.  
a. Each observation represents a single metropolitan statistical area under the 2006 definitions.  
b. Gross metropolitan product in 2005 divided by 2000 population.

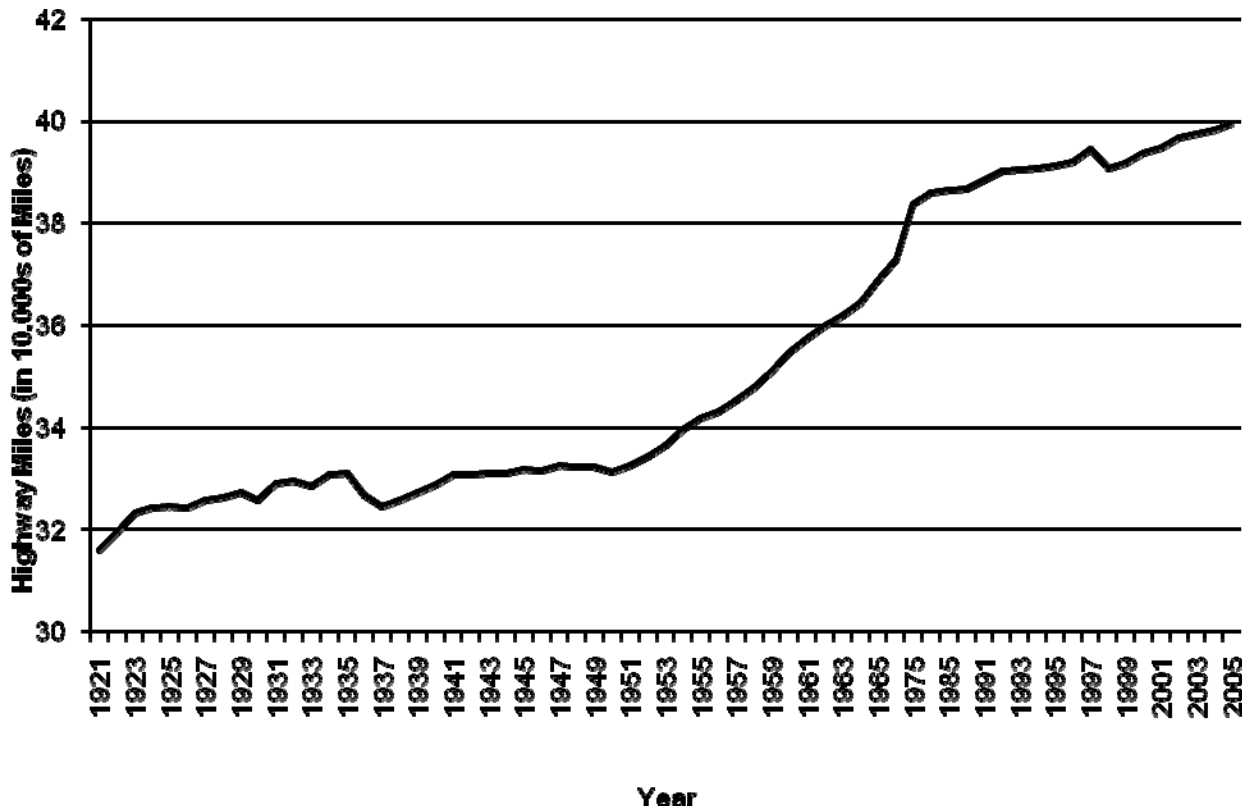
Figure 8. Rail Shipping Costs, 1890-2000



Source: Glaeser and Kohlhase (2004).

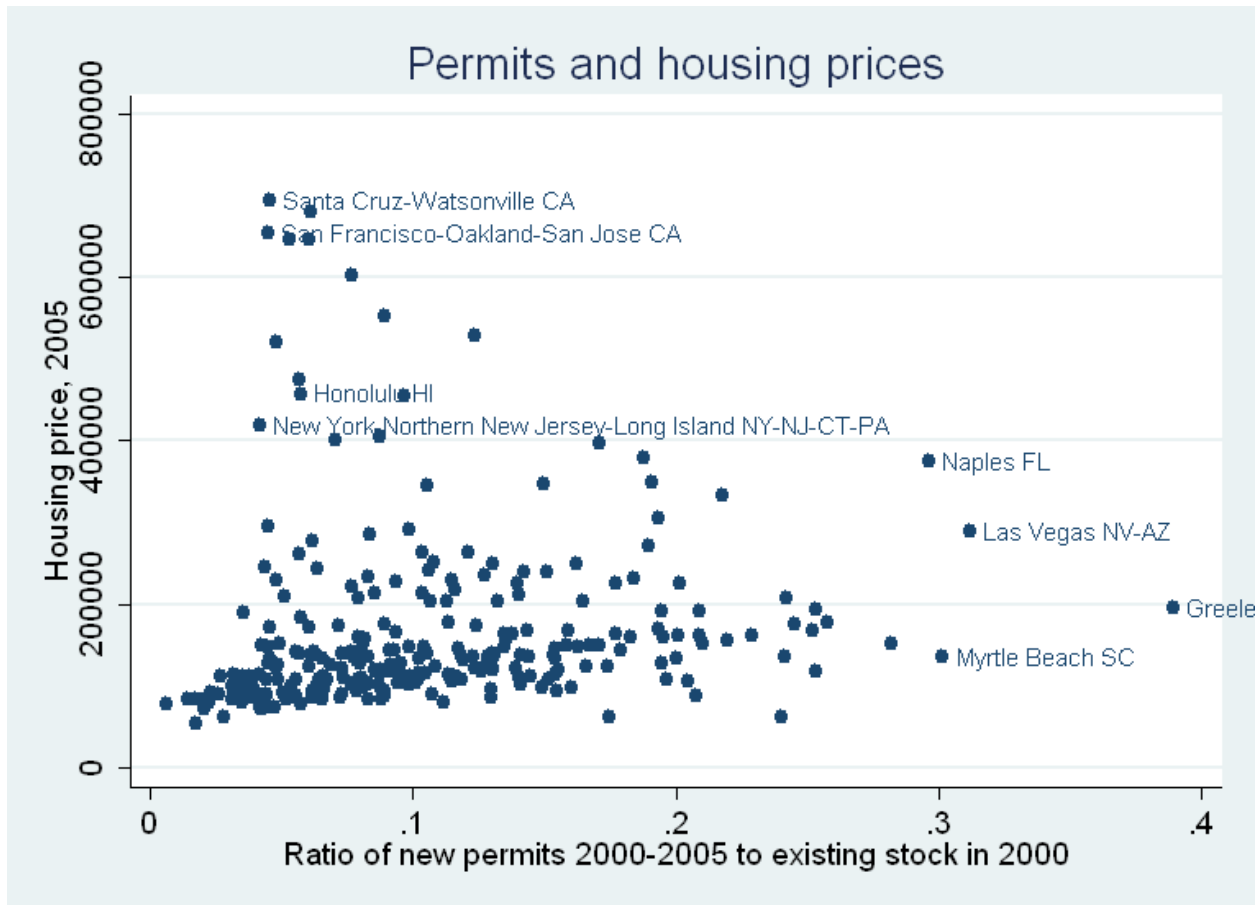


Figure 9. Highway Miles, 1921-2005



Sources: U.S. Census Bureau, Historical Statistics of the United States, Series Q-50; U.S. Department of Transportation, Federal Highway Administration, *Highway Statistics Summary to 1995*, FHWA-PL-97-009, various issues, table HM-212, and *Highway Statistics*, table HM-20, various issues ([www.fhwa.dot.gov/policy/ohpi/hss/index.htm](http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm)), as of January 4, 2007

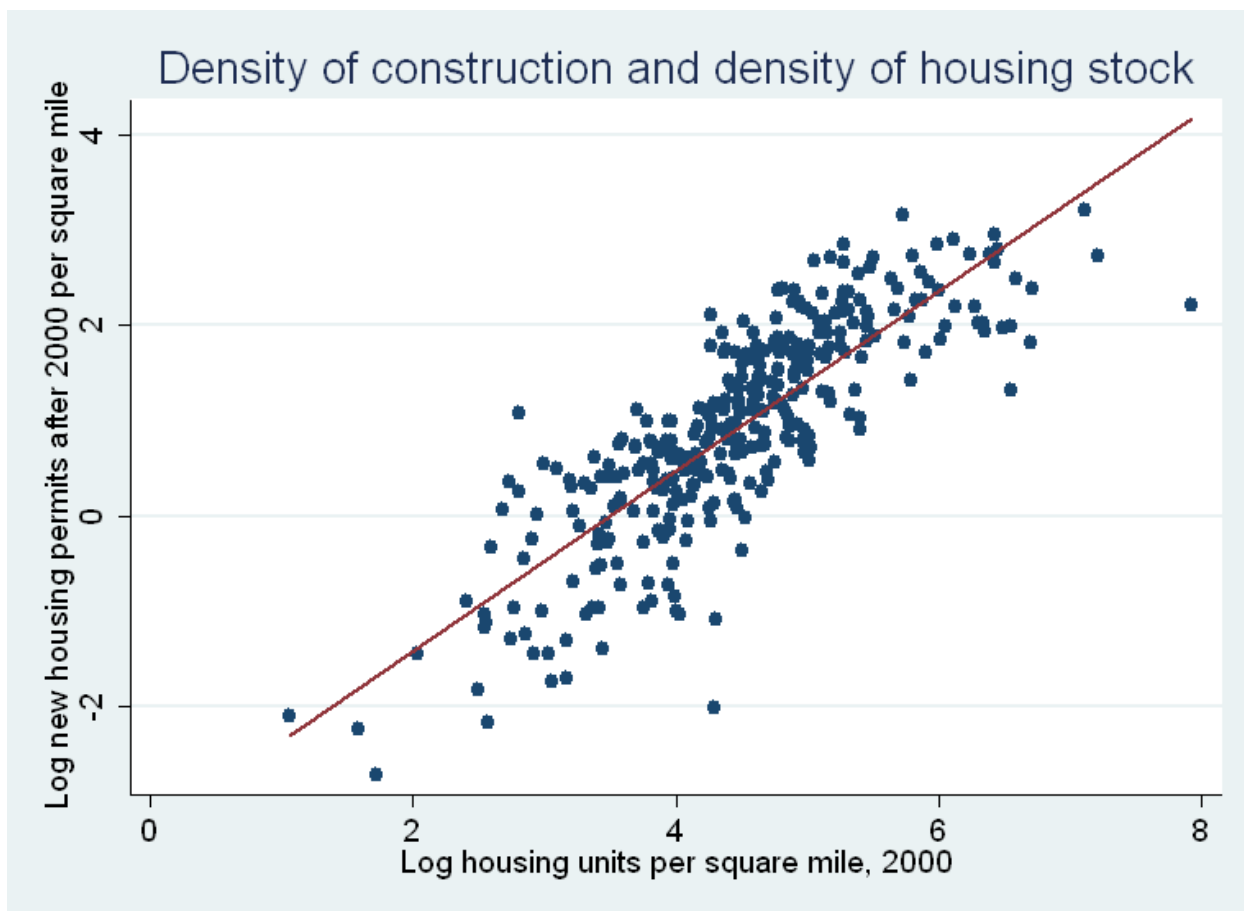
**Figure 10. Housing Prices and Housing Permits Issued<sup>a</sup>**



Source: National Association of Realtors; Census of Construction, as described in Glaeser and Gyourko (2007).

a. Each observation represents a single metropolitan statistical area under the 2003 definitions.

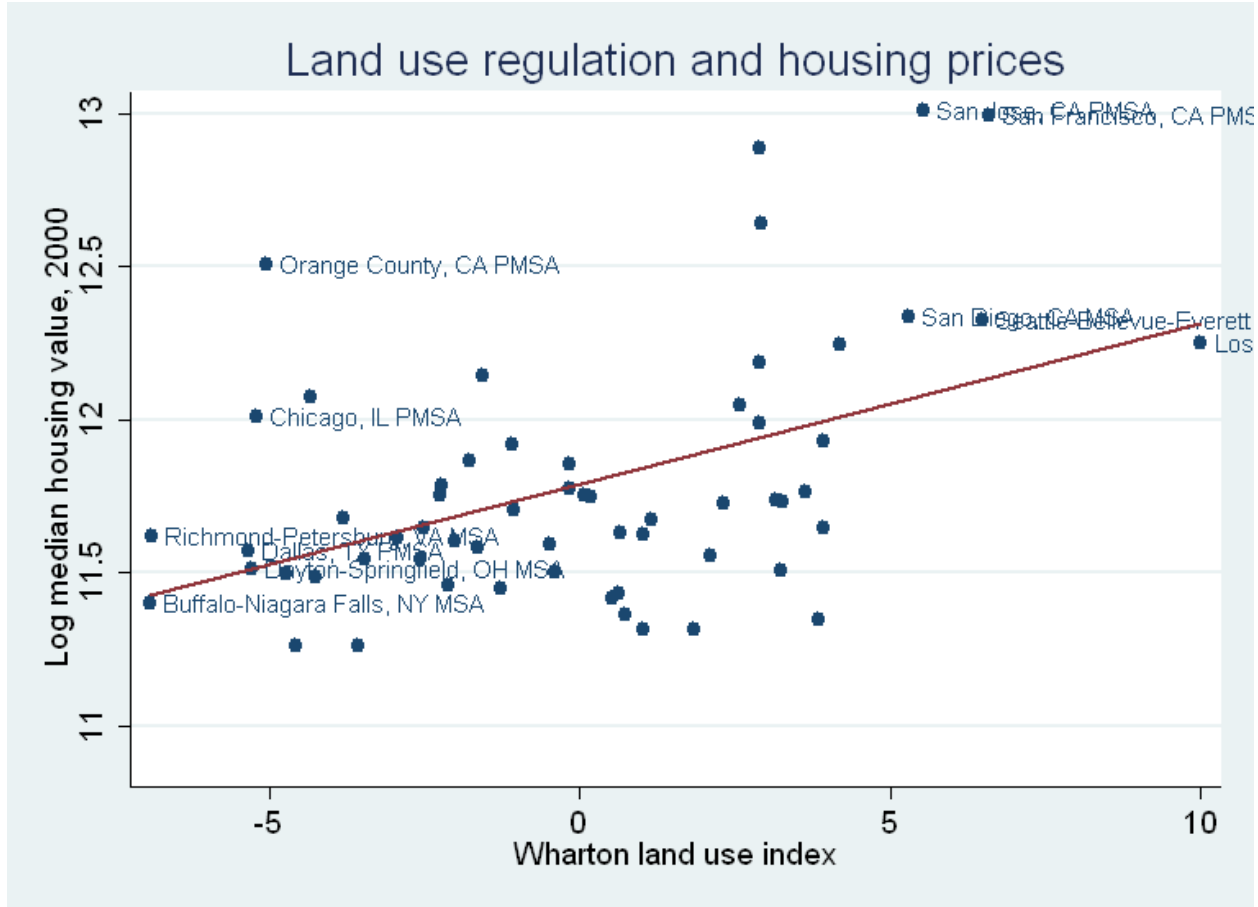
Figure 11. Density of Housing Construction and of Existing Housing<sup>a</sup>



Sources: Census of Construction, as described in Glaeser and Gyourko (2007); U.S. Census Bureau. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 2003 definitions.

**Figure 12. Land Use Regulation and Housing Prices<sup>a</sup>**

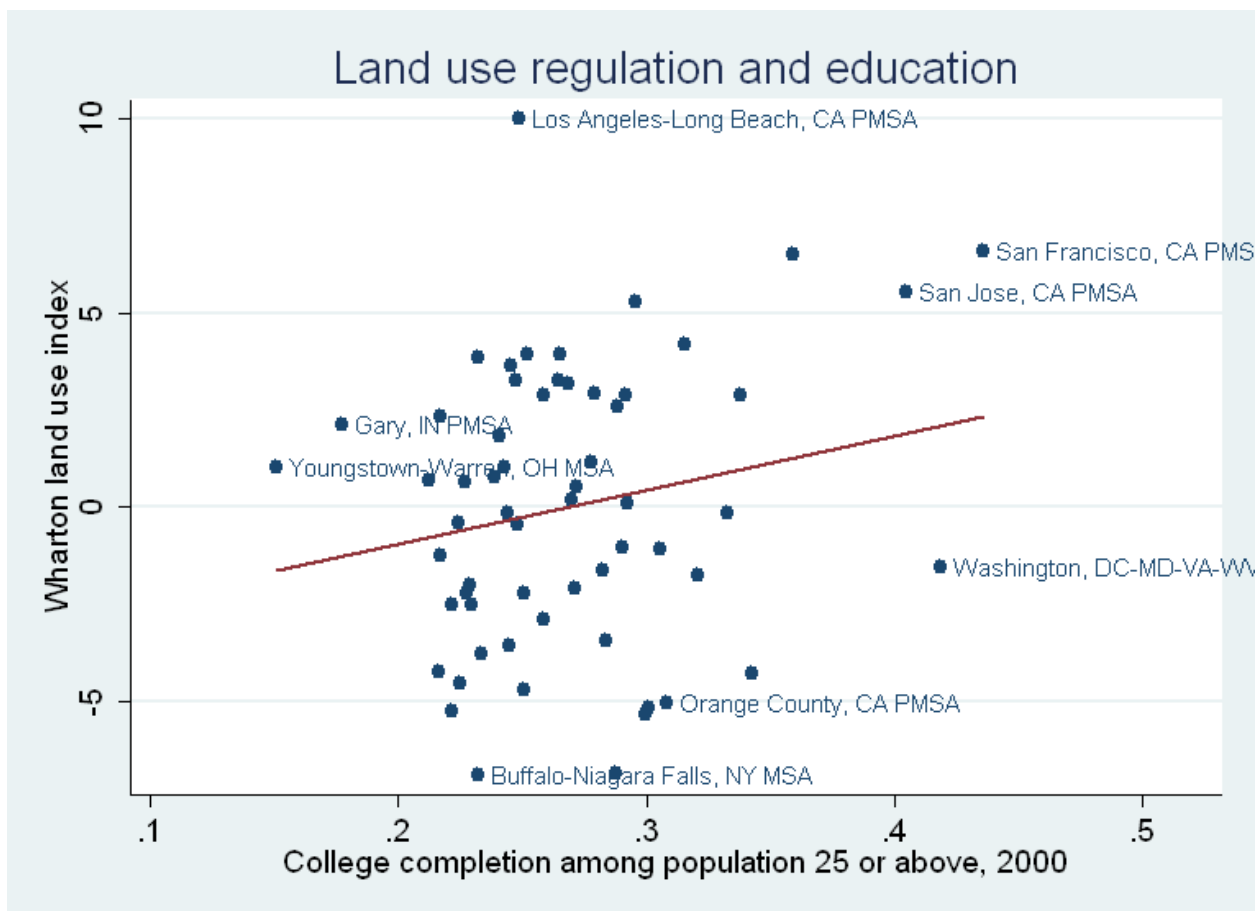


Sources: U.S. Census Bureau; Gyourko, Saiz, and Summers (2007). See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable.

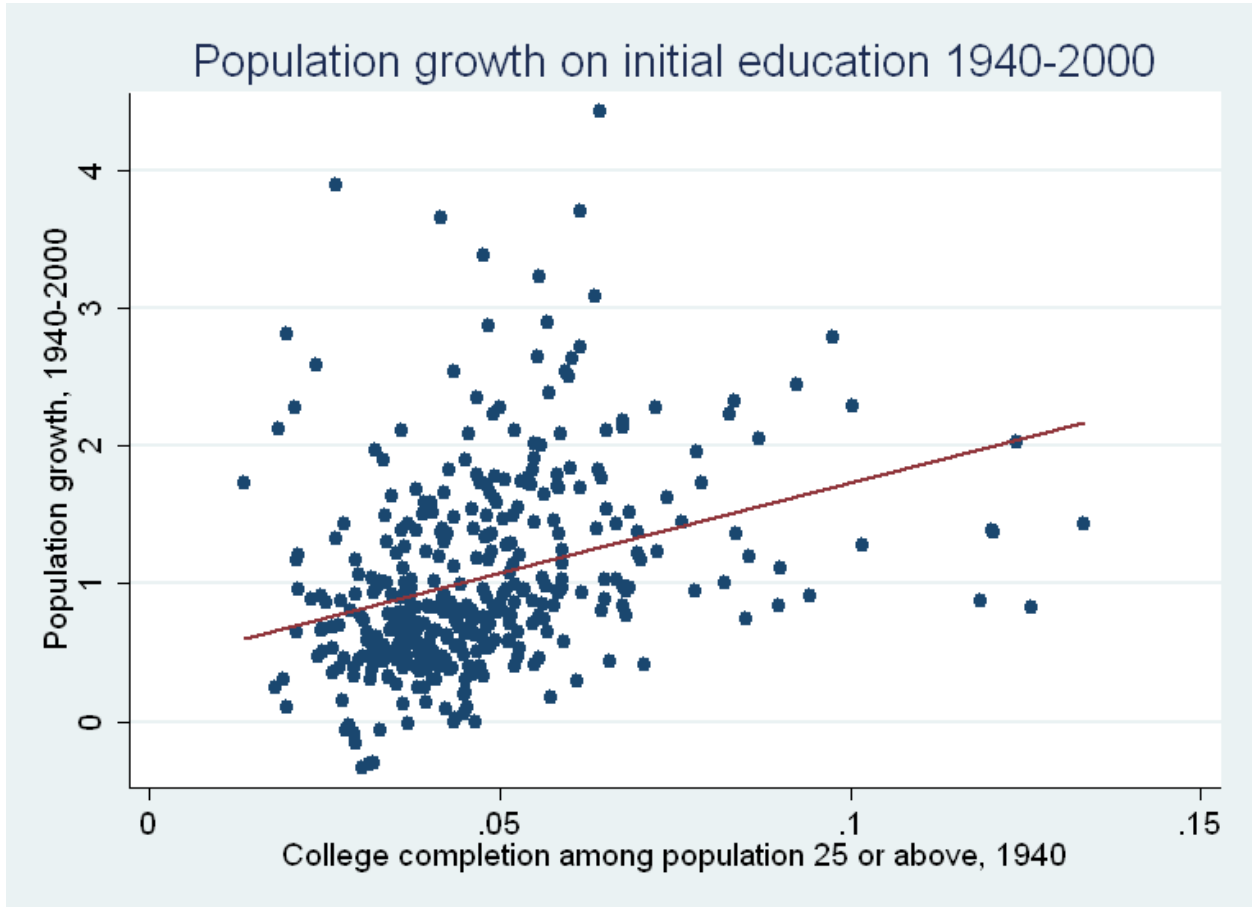
b. The index is a measure of the restrictiveness of local building environments.

**Figure 13. Land Use Regulation and College Completion Rate<sup>a</sup>**



Sources: U.S. Census Bureau; Gyourko, Saiz and Summers (2007). See appendix B for details.  
 a. Each observation represents a single metropolitan statistical area under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable.  
 b. See figure 12.

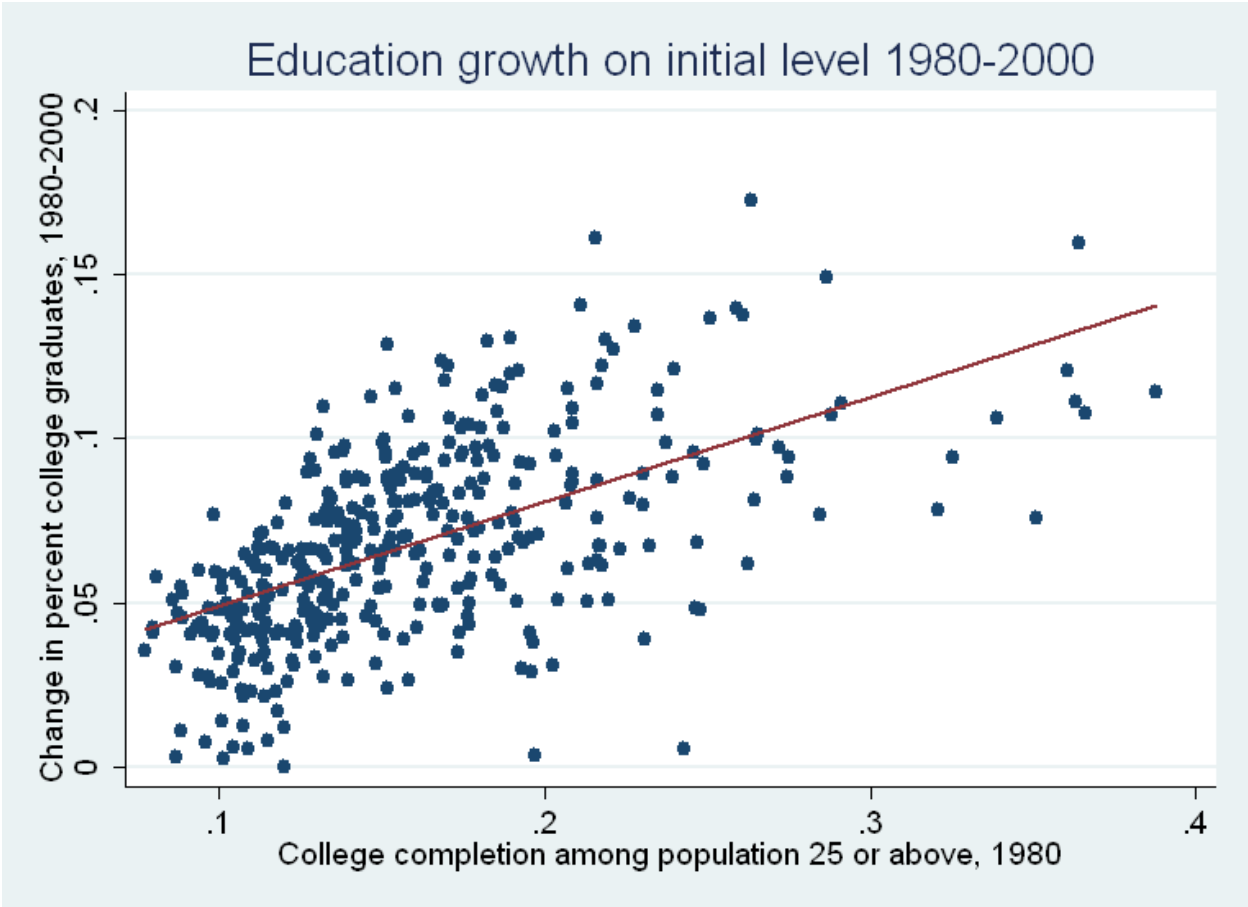
**Figure 14. Population Growth and College Completion Rate<sup>a</sup>**



Source: U.S. Census Bureau. See appendix B for details.

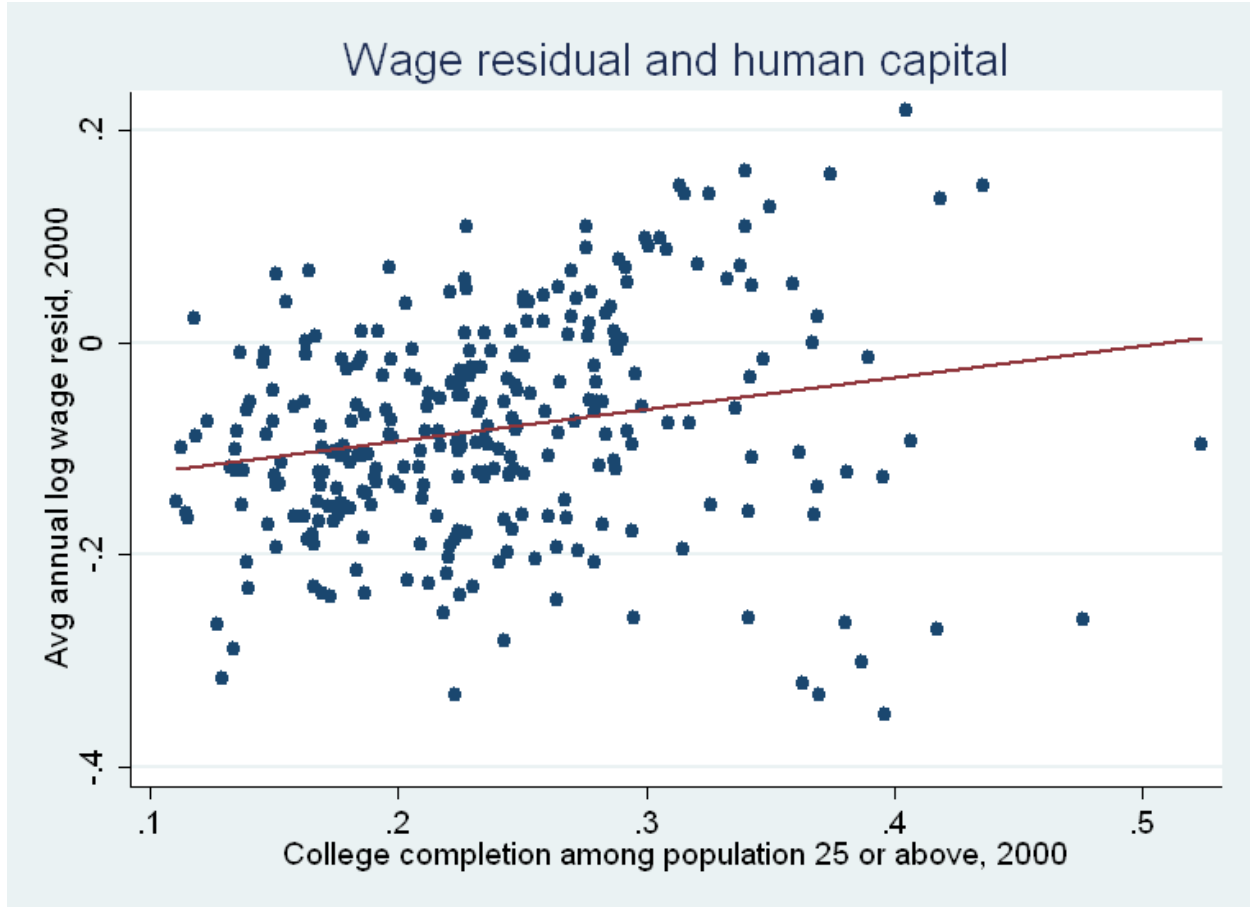
a. Each observation represents a single metropolitan statistical area under the 2006 definitions, using metropolitan divisions where applicable.

Figure 15. Change in College Completion Rate, 1980-2000, and Completion Rate in 1980<sup>a</sup>



Source: U.S. Census Bureau. See appendix B for details.  
a. Each observation represents a single metropolitan statistical area (MSA) under the 2006 definitions, using metropolitan divisions where applicable.

Figure 16. Wage Residuals and College Completion Rates, 2000<sup>a</sup>



Sources: Authors' regressions; U.S. Census Bureau. See appendix B for details.

a. Each observation represents a single metropolitan statistical area under the 1999 definitions, using primary rather than consolidated MSAs where applicable and New England county metropolitan areas where applicable.

b. Residuals from a regression of wages on individual age and education; sample consists of all working males aged 25 to 55, from the U.S. Census Bureau Public Use Microdata Sample, as described in appendix A.