The Economic Consequences of IT: The IT Revolution's Meager Benefits and Major Schisms

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Abstract

The IT revolution, underway since around 1980, has featured mediocre growth and rising geographic, educational, and generational inequality. This stands in stark contrast to the broad prosperity and convergence experienced in the 1950s and 1960s. We attribute this change to a swivel in the leading edge of productivity growth away from manufacturing largely present in towns to information technology mainly housed in "superstar" cities. Using a spatial model, we show how this can explain: rising prosperity and rapid housing inflation in "superstar" cities; falling relative wages in towns and the countryside; mediocre aggregate productivity due to increasing misallocation of labor; the loss of manufacturing jobs, especially in cities; and falling migration.

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I. INTRODUCTION

The COVID-19 recession has underlined issues associated with mediocre growth and rising inequality in the United States and elsewhere. The post-World War Two experience of high growth and convergence of incomes across people and regions went into reverse around 1980 accompanied by four trends.[2] The first is growing prosperity and rapidly rising house prices in successful "superstar" cities. The second is wage stagnation in less fortunate metro areas. The third is mediocre growth in output and productivity. Finally, long-distance internal migration has fallen. This large-city prosperity and small-city decay accompanied by disappointing growth and limited ability to move to prosperity has unleashed social tensions, especially amongst those stranded in decaying areas, that have been linked to the rise in populism.[3]

This paper uses a Rosen-Roback locational model to explain these patterns as the result of a change in the industries experiencing technological progress. Before 1980, the leading edge of productivity came from manufacturing which needed a range of inputs—mainly unskilled labor, land, and machinery, plus some skilled workers to supervise and carry out research—and gravitated toward poorer areas with abundant land and low labor costs, generating income convergence. By contrast, after 1980 productivity growth was increasingly centered on information technology whose primary input was skilled labor, with only limited need for land, machinery, and other workers. Rapid productivity growth swiveled to prosperous and crowded superstar cities where skilled labor was plentiful.[4] House prices and wages in these cities boomed, labor misallocation rose, and national productivity growth stagnated.

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[2] The fall in migration and the rise in geographic inequality in the 1980s marks an end to over a century of income convergence across U.S. regions (Nunn, Parsons, and Shambaugh, 2018). Similar patterns of higher regional inequality and lower (net) migration are also happening within other advanced economies (Gbohoui, Lam, and Lledo, 2019).

[3] The literature on the link between economic developments and the rise in populism is vast. For a comprehensive survey see Guriev and Papaioannou (2020).

[4] This trend was exacerbated by declining manufacturing employment, especially after China joined the World Trade Organization in 2001. The zenith of manufacturing employment was in 1979, when it still represented over 20 percent of employment. Now, its employment share is 8½ percent, smaller than the leisure and hospitality sector.

Symptomatic of this change in the location of productivity growth is that in the 1980s, when auto companies were still at the forefront of technological change, Toyota set up its first US factory in Georgetown Kentucky, population 35,847. By contrast, in 2019 Amazon chose superstar cities of New York and the Washington DC area for its second headquarters. This switch in the location of cutting-edge firms drove the trends discussed above. As new opportunities moved to superstar cities with limited land availability, house prices in these locations soared and wages rose for skilled workers. By contrast, wages stagnated in metro areas with more abundant land and unskilled workers. Migration fell as booming house prices crimped the ability to move to prosperity, leading to labor misallocation that blunted the productivity benefits of the IT revolution. If labor had been efficiently allocated, TFP growth since 1980 could have been almost double its meager 0.9 percent and would have been similar to that seen in the extended boom of the 1950s and 1960s. This spatial misallocation of resources explains why the benefits of the IT revolution have been so narrow, generating rising inequality across a range of dimensions and mediocre growth rather than the broad-based prosperity seen in the decades after World War Two.

Vast numbers of papers have focused on each of these trends. The main contribution of this paper is to provide a unified structure that explains how these trends in wages, jobs, house prices, migration, and economic growth after 1980 fit together. In addition, our structure is relatively straightforward, focusing on differences in the location of productivity shocks in a spatial model using Cobb-Douglas production functions without recourse to concepts such as skill-enhancing technological progress or agglomeration effects.

The rest of the paper is structured as follows. The next section explains how this work fits with the existing literature. The following one presents the model. Section 4 documents developments in labor markets, wages, house prices, productivity, and migration, including regressions relating migration to changes in relative wages and house prices, thereby linking three important trends in a single empirical framework. Section 5 concludes.

II. LITERATURE REVIEW

This paper builds on five existing literatures. The first is the burgeoning literature on widening inequality, including across regions (Autor 2019, Partridge and Tsvetkova 2017, Nunn, Parsons, and Shambough, 2018, Gbohoui, Len, and Lledo 2019), across skilled and unskilled workers (Gordon and Dew-Becker 2008, Autor and Dorn 2013, Autor 2014, Aladbullkareen and others 2018, and Hoxie, Shoag, and Veuger, 2019), the regional impact of the entry of China into the World Trade Organization ("the China shock") (Autor, Dorn, and Hansen 2013, Pierce and Schott 2016, Feenstra, Ma, and Xu 2018, Autor, Dorn, and Hansen, 2019), the plight of those in stuck in decaying areas (Bound and Holzer 2000, Case and Deaton 2015 and 2017, Yagan 2016, and Austin, Glaeser, and Summers 2018), and the links between technology and inequality (Kuznetz 1955, and Milanovic, 2016). The second is the literature on resource misallocation due to frictions, surveyed by Restuccia and Rogerson (2013 and 2017), which includes work on restrictions in land markets (Hsieh and Moretti 2019, Restuccia and Santaeulàlia-Llopis 2015), labor market restrictions (Hsieh and Klenow 2009), financial frictions (Buera, Kaboski, and Shin 2011), and distortions in output markets (Peters 2020). The third is work on the impact of housing constraints on housing supply and housing prices, including the impact of urbanization on housing supply (Glaeser, Gyourko, and Saks 2006, Saks 2008, Saiz 2010, Gyourko, Mayer, and Sinai 2013) and the links between skills, wages, and locational choice (Glaeser and Mare, 2001, Quigley and Raphael, 2004, Moretti, 2016, and Diamond, 2017). The fourth is the literature on US productivity since after 1970 (Gordon 2016, Jorgenson, Ho, and Samuels, 2017, Goldin and Katz, 2008) including the discussion of why growth has slowed even as innovation appears to have accelerated (Gordon, 2018, Bloom, Jones, van Reenen, and Webb, 2020). The fifth is the literature on the drivers of falling internal migration within the United States, including work on the how rising house prices have led the unskilled to leave successful cities (Ganong and Shoag, 2015, Feenstra, Ma, and Xu, 2018, and Bhutta, Laufer, and Ringo, 2017) and how rising wage premiums for skilled workers have reduced their desire to move after completing their education (Wang, 2013).

III. A Spatial Model of the Impact of Technological Change

A. Perfect Labor Mobility

Consider a Rosen-Roback model in which region i produces specific good using a constant returns-to-scale Cobb Douglas production function:

(1) $$Y_i = A_i L_{Ui}^{\alpha_{Ui}} L_{Si}^{\alpha_{Si}} K_i^{\eta_i} T_i^{1-\alpha_i-\beta_i-\eta_i}$$

where Y_i is output is a homogeneous good in the sense that goods in different locations are substitutable for each other, A_i is local productivity, L_{Ui} is unskilled labor, L_{Si} is skilled labor, K_i is capital, and T_i and land available for business use. Capital is fully mobile, and hence its return is equated to R, an exogenous interest rate given in world markets. Land, by contrast, is immobile so output exhibits decreasing returns to scale with respect to labor and capital. We start by assuming labor is fully mobile before discussing the case of imperfect mobility. The model can be generalized in many other dimensions including allowing regions to produce more than one good, as discussed below. Finally, to simplify some of the exposition, we will assume that the share of land is fixed, so $1 - \alpha_{iU} - \alpha_{iS} - \eta_i = \omega$ and that non-wage income accrues to a rentier class. These assumptions can be easily relaxed.

Importantly, the Cobb-Douglas specification excludes the possibility of factor-enhancing technological progress or agglomeration effects, two popular explanations for the rise in the premium for skilled workers.[5] In this model, the impact of technological change comes solely from the location of productivity shocks while higher productivity in cities comes from labor market distortions as a result of high housing costs.

For expositional purposes, it is easiest to solve the model in two stages, first aggregating skilled and unskilled labor into total labor and then describing the demand for different types of labor. Aggregate labor is:

$$(2) \qquad L_i = L_{Ui}^{\frac{\alpha_{Ui}}{\alpha_{Ui}+\alpha_{Si}}} L_{Si}^{\frac{\alpha_{Si}}{\alpha_{Ui}+\alpha_{Si}}} = L_{Ui}^{\rho_i} L_{Si}^{1-\rho_i}$$

which allows equation (1) to be rewritten as:

$$(3) \qquad Y_i = A_i L_i^{\alpha_i} K_i^{\eta_i} T_i^{1-\alpha_i-\eta_i} \text{ where } \alpha_i = \alpha_{Ui} + \alpha_{Si}$$

The demand for aggregate labor is:

$$(4) \qquad L_i = \left(\frac{\alpha_i^{1-\eta_i} \eta_i^{\eta_i}}{R^{\eta_i}} \frac{A_i}{W_i^{1-\eta_i}} \right)^{\frac{1}{\omega}} T_i$$

This is increasing in A_i and T_i and decreasing in W_i. The relative demand for different types of labor is:

$$(5) \qquad \frac{S_i}{U_i} = \frac{\rho_i}{(1-\rho_i)} \frac{W_{Ui}}{W_{Si}}$$

[5] See, for example, Autor (2019) and references therein.

and the aggregate wage level is:

(6) $$W_i = \left(\frac{W_{Ui}}{\rho_i}\right)^{\rho_i} \left(\frac{W_{Si}}{1-\rho_i}\right)^{1-\rho_i}$$

Turning to the supply of labor, workers choose the city that maximizes their utility. The indirect utility function is:

(7) $$V = \frac{W_{ij} Z_i}{P_i^{\beta}}$$

where W_{ij} is the local wage, Z_i are local amenities, P_i is the local housing price, and β is the proportion of income spent on housing. Note that we assume that all workers spend the same proportion of their income on housing. This will be relaxed below.

It follows that:

(8) $$\frac{W_{Ui}}{W_{Si}} = \frac{V_U}{V_S} = \frac{W_U}{W_S}$$

Relative wages between skilled and unskilled workers are identical in each region because of perfect labor mobility. If one employer was to pay (say) unskilled workers more generously, then other unskilled workers will flock there until balance was restored. Accordingly, relative employment depends only on technology and the aggregate demand for skilled and unskilled workers:

(9) $$L_{Ui} = \frac{L_U}{L_S} \rho_i L_i \text{ and } L_{Si} = \frac{L_U}{L_S}(1-\rho_i) L_i$$

where the overall demand for each type of labor is given by:

(10) $$L_U = \sum_i \rho_i L_i \text{ and } L_S = \sum_i (1-\rho_i) L_i$$

The impact of a productivity shock on the demand for skilled and unskilled labor depends on the local industrial structure. If the local industry favors unskilled workers compared to the typical technology ($\rho_i > \bar{\rho}$ where $\bar{\rho} = \frac{\sum_i \rho_i L_i}{L}$ is the employment weighted average of local employment) then a positive productivity shock will raise the relative demand for skilled workers and hence their relative wages. In the opposite case, the relative wages of unskilled workers will rise.

Next, we solve for the local housing price, which is given by:

(11) $$P_i = \boldsymbol{P}_i L_i^{\gamma_i}$$

where $\gamma_i$is the (inverse) elasticity of housing supply based on the amount of labor in the city and $\mathbf{P}_i$ is the part of the local housing price that does not depend on employment. House prices depend on total employment since skilled and unskilled workers spend the same proportion of their income on housing. Importantly, the sensitivity of housing prices to employment varies by location. There is ample evidence that housing costs are higher and more sensitive in more crowded locations—think of New York City (high housing costs that are sensitivity to changes in employment) versus upstate New York (low housing costs that are insensitive to employment shocks).

From the indirect utility function (7) and equation (13) it follows that:

$$(12) \qquad W_{Ui} = V_U \frac{P_i^\theta}{Z_i} = \frac{\boldsymbol{P}_i^\theta}{Z_i} L_{Ui}^{\beta\gamma_i}$$

with an identical equation for skilled labor, so that the total supply of labor is:

$$(13) \qquad W_i = \tilde{V}_i \frac{P_i^\theta}{Z_i} = \tilde{V}_i \frac{\boldsymbol{P}_i^\theta}{Z_i} L_i^{\beta\gamma_i}$$

where $\tilde{V}_i = \left(\frac{V_U}{\rho_i}\right)^{\rho_i} \left(\frac{V_{Si}}{1-\rho_i}\right)^{1-\rho_i}$.

Equating the demand and supply of unskilled labor produces the following:

$$(14) \qquad L_i = \left(\frac{{\alpha_i}^{1-\eta_i}\, \eta_i^{\eta_i}}{R^{\eta_i}\, \tilde{V}_i^{1-\eta_i}}\; A_i T_i^\omega \left(\frac{Z_i}{\boldsymbol{P}^\beta}\right)^{1-\eta_i}\right)^{\frac{1}{\omega+\beta\gamma_i(1-\eta_i)}}$$

Employment depends on local technology, productivity, amenities, and the elasticity of the local housing supply. The more elastic the local housing supply, the more employment reacts to these other factors.

Aggregate output is given by:

$$(15) \qquad Y = \sum_i A_i^{\frac{1}{1-\eta_i-\alpha_i}} \left(\frac{\eta_i^{\eta_i}}{R^{\eta_i}} \frac{\bar{Q}}{Q_i}\right)^{\frac{1-\eta_i}{1-\eta_i-\alpha_i}} T_i$$

where $Q_i = \frac{P_i^\beta}{Z_i}$ is the "local price", defined as the ratio of house prices to amenities, $\bar{Q} = \sum_i \left(\frac{\alpha_i}{\bar{\alpha}}\right)^{1-\eta_i} L_i Q_i$ is the employment weighted mean of these prices adjusted for local technology, $\bar{\alpha} = \sum_i \frac{Y_i}{Y} \alpha_i$ is the aggregate labor share, and total employment is set at unity.

Aggregate output is a power mean of local total factor productivity weighted by the inverse of the local price of a city compared to the average across all cities. Importantly, since $(1-\eta_i)/(1-\alpha_i-\eta_i)>1$ it follows that an increase in the mean preserving spread of local house prices lowers aggregate output and the share of income accruing to labor. This loss in output comes from the distortion to the allocation of labor coming from differences in house prices. High house prices act as a tax on labor, driving up wages and productivity while reducing employment below the efficient level.

High house prices generate an additional loss in the welfare of workers because they are assumed to pay rent to rentiers. The welfare of workers is $Y/\bar{Q}_j$, where j can represent either unskilled or skilled, or all workers, with appropriate changes to the α_i coefficients in the formula for $\bar{Q}$. This additional loss of welfare over and above the impact of lower output does not occur if workers own their own housing.

B. Imperfect Labor Mobility

We now relax the assumption that labor is perfectly mobile. Following the approach in Hseih and Morretti (2017) we assume that the indirect utility function for worker j in region i is:

$$(16) \qquad V_{ij} = \varepsilon_{ij} \frac{W_i Z_i}{P_i^{\beta}}$$

A larger ε_{ij} implies that worker j prefers city i for idiosyncratic reasons. Assuming that the ε_{ij} are drawn from an extreme value function with joint distribution $F_g(\varepsilon_1, \dots, \epsilon_N) = \exp\left(-\sum_1^N \varepsilon_i^{\theta}\right)$ then the supply of labor in any is given by:

$$(17) \qquad W_i = V \frac{P_i^{\beta} L_i^{1/\theta}}{Z_i}$$

where $1/\theta$ defines the strength of attachment of workers to a particular location which is assumed for the moment ot be the same across different types of workers. When preferences for location are high then $1/\theta$ is large and fewer workers move in response to higher wages. If $\theta = \infty$ the are no locational preferences, which is the perfect mobility case already discussed.

The local demand for labor is now:

$$(18) \qquad L_i = \left(\frac{{\alpha_i}^{1-\eta_i} \eta_i^{\eta_i}}{R^{\eta_i} \tilde{V}_i^{1-\eta_i}} \; A_i T_i^{\omega} \left(\frac{Z_i}{\boldsymbol{P}^{\beta}}\right)^{1-\eta_i} \right)^{\frac{1}{\omega+(\beta\gamma_i+1/\theta)(1-\eta_i)}}$$

Workers still respond to changes in productivity, but the response is more limited because a larger rise in wages is needed to induce marginal workers to move. As a result, post-housing-cost wages across regions are no longer equated. This effect benefits workers in regions with a positive productivity shock since this will raise the demand for local workers, creating a local wage premium that is larger the greater the preference for location. Unlike in the case of perfect labor mobility, workers already working in region i capture more of the benefits of a local productivity shock than those located elsewhere. Their economic surplus rises while the surplus of those remaining in other places falls.

Aggregate output is now given by:

$$(19) \qquad Y = \sum_i A_i^{\frac{1}{\omega}} \left(\frac{\eta_i^{\eta_i}}{R^{\eta_i}} \frac{\bar{Q}}{Q_i} \right)^{\frac{1-\eta_i}{\omega}} T_i$$

and average welfare by $V = Y/\bar{Q}$ where $\bar{Q} = \sum_i \left(\frac{\alpha_i}{\bar{\alpha}}\right)^{1-\eta_i} L_i^{1+1/\theta} Q_i$ and V is now average utility across regions. Limited labor mobility blunts the impact of house prices on output since the labor allocation is also distorted by locational preferences.

C. Further Extensions

Letting regions produce more than one good adds changes in industrial structure to the model.[6] Higher productivity expands output in all regions that produce that good. Since the largest gains accrue to regions most specialized in that industry, they have the largest squeeze on resources available to other industries leading these other industries to migrate to other locations.

Allowing unskilled labor to spend a higher proportion of their income on housing than skilled workers implies that the demand for such workers is more dependent on housing costs, and hence that the distortions coming from housing costs are larger.[7] Finally, as

[6] The solution for this case is discussed in Hsieh and Moretti (2019).

[7] See Gyourko, Mayer and Sanai (2013) and Moretti (2013) for evidence that high housing costs are linked with a rise in the proportion of skilled workers compared to the unskilled.

unskilled labor is also less mobile, wage differentials will be more affected by local conditions.[8] In the discussion below, we include all these extensions.

The impact of a productivity shock in an industry on region i depends on the mix of industries, the sensitivity of local house prices to employment, and the willingness of workers to move location. It can be broken down into five effects. (1) The *national gain* to wages and output as the economy expands. (2) The *technological effect* on relative wages from the factor-bias of the industry; if the industry uses (say) skilled workers relatively intensively then the relative wages of skilled workers will rise nationally. (3) The *distortion effect* on wages and output that comes from changes in housing costs that acts like a tax on local labor, reducing demand, raising local wages, and lowering inward migration; this effect is largest in places where the cost of housing is more sensitive to changes in employment. (4) the *local effect* on wages coming from the need to induce new workers to move to a new location, which again depends on the factor-bias of the industry as well as the propensity to migrate; if the industry uses (say) unskilled workers more intensively then they are in higher relative demand and local wages will rise by more than skilled wages, compounded in this case by the lower willingness of the unskilled to migrate. (5) the *industrial structure effect* on wages and the demand for labor occurs as productivity increases in places specialized in that industry induces other industries to move elsewhere; it reinforces the technological effect as it further reduces local demand for the unprivileged type of labor.

D. The Impact of Manufacturing and IT Productivity Shocks

This model can be used to analyze the impact of productivity shocks in a stylized version of the economy comprising two relatively similarly sized regions, a group of towns and a single city. The towns mainly produce manufacturing goods that require large amounts of unskilled labor and land, in which they are abundant, as well as capital. The city specializes in producing intellectual goods, that require large amounts of skilled labor, in which it is abundant, and relatively little unskilled labor, land, or capital. Reflecting differences in land availability, housing is cheap in towns and its cost is little affect by

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[8]See Current Population Survey Migration/Geographic Mobility Tables, 1991-2016 for data showing the less skilled move less frequently than the skilled.

changes in employment, while the opposite is true of the city. Finally, the rentier class that collects the income from housing is assumed to be older and mainly live in the city, attracted by its cultural depth.

In the initial equilibrium the towns are poorer than the city but have lower inequality. The towns are poorer because they have fewer residents with high incomes (skilled workers and rentiers). Wages adjusted for housing costs are also lower in the towns than the city because higher housing costs reduces the demand for city workers, which boosts their productivity and real wages. In short, cities will exhibit higher wages and a greater concentration of skilled workers and rentiers, implying they are more prosperous but also have higher inequality.

Now consider the impact of rise in productivity in an industry. Since the two regions are similarly sized, the *national gain* is similar. However, the other effects are quite different depending on whether the shock is to manufacturing or intellectual goods. First, consider a rise in manufacturing productivity, which can be thought of as the typical pre-1980 shock as manufacturing was the leading edge of the economy. The *technological effect* drives up the relative demand for unskilled labor, leading to a lower skill premium nationally. The *distortion effect* increases aggregate output. Housing costs in the towns are little changed as land is relatively abundant, but housing costs fall in the city due to the outflow of workers to the newly prosperous towns. The fall in house prices in the city reduces labor market distortions which boosts the growth in aggregate output as well as crimping the incomes of rentiers. The *local effect* raises relative wages in the towns because of the need to induce workers to leave the city, eroding the wage gap caused by higher housing costs. The impact is largest for unskilled workers since they are in high demand and are less willing to move. Finally, the *industrial structure* effect moves information-based jobs away from the towns towards the city, increasing the geographic concentration of both industries. In sum, high growth is combined with a reduction in inequality across different types of workers (as the national wage premium falls), between the city and the towns (as the wage premium of cities falls), and between workers and rentiers (as income from housing is undercut).

Next consider the impact of a rise in productivity in intellectual goods, which we will characterize as a post-1980 “IT shock” (see also Table 1). The mechanisms discussed earlier go into reverse. The rise in demand for skilled workers raises the national skill premium.[9] The increase in demand for workers in cities raises housing costs, increasing labor market distortions through a higher wage premium in the city which blunts the increase in aggregate output. The need to induce skilled workers to move to the city further raises their local wages. The change in industrial structure drives manufacturing out of the city, further lowering the local demand for unskilled labor. The net impact on the demand for unskilled workers in the city depends on three factors. The technology effect increases the demand for unskilled workers while industrial migration and the higher proportion of income spent on housing reduces demand for them. We assume that the overall effect is to lower the demand for unskilled workers, leading to outward migration from the city which lowers unskilled wages in the city compared to the towns (the outward migration of unskilled workers is discussed in Ganong and Shoag, 2015). Finally, rentiers income increases.

The counterpart to rise in the city's skilled wage premium is a fall in internal migration. The rising cost of housing chokes off much of the increase in demand for skilled workers, allowing those already with such jobs to capture more of the benefits of the increase in IT productivity. Meanwhile, as discussed above, unskilled workers tend to leave the city. This contrasts with the manufacturing productivity shock discussed earlier, where abundant availability of cheap housing meant that more of the benefits of the productivity shock accrue to the entire economy as migration to prosperity is not impeded by high house prices.

IV. Empirical Evidence

This section compares the predictions of the model with economic outcomes since 1980, as seen through developments in labor markets, productivity, housing prices, and migration.

A. Labor Market Developments

A detailed discussion of the economic geography of labor market developments since 1970 is contained in Autor (2019). The analysis examines changes in the wages of workers of

[9] Moving beyond the model, this effect is magnified by fall in demand for unskilled work coming from the offshoring, itself driven by the breakup of the value chain as IT lowered the cost of coordination across locations (Baldwin 2016 and 2019)

different levels of education and how these vary with the density of the population.[10] Figure 1 summarizes these results by reporting the logarithm of the average hourly wage by density of population for workers with different levels of education in 1980 and 2015 using Autor's data. The vertical axis represents the (logarithm of the) wage and the horizontal axis the density of population by quartile, so that the left-most data represent wage for the quarter of workers in the least densely populated locations in 1970 and the right-most the wage of those in the densest quartile. The two panels are on the same scale to ease comparison. The thin colored lines show average wages across 5 levels of education (less than high school, high school, some college, a college degree, and a graduate degree), which can be thought of as proxies for skill, while the thick black lines show wages across all types of workers.

In 1980 wages of different types of workers slope upwards and are parallel to each other. Wage differentials were relatively stable across skills and compensation rose with population density. Average wages are close to those for workers with some college education (about 55 percent of workers had only high school experience) and the slope of the line is slightly steeper as highly educated workers were more prevalent in cities. The picture in 2015 is different in several respects. First, the wage advantage of more education has expanded across the board, implying a rise in inequality within metro areas. Second, the upward tilt of wages has steepened for skilled workers (those with a college degree or more) while flattening for unskilled workers (high school diploma or less) implying inequality has risen more in cities than towns. Finally, the slope of average wages has steepened compared to 1980 as the wage premium on skilled workers has risen, implying a rise in inequality between towns and cities. These patterns correspond with the predictions of the model. Higher demand for skilled workers led to wider wage premiums, especially in cities with a major IT base. By contrast, the movement of unskilled jobs out of these cities led to a compression in their wages in cities compared to towns.

The rest of this paper analyzes differences in behavior across metro area. Accordingly, we focus on the behavior of average wages, although where appropriate we will discuss the implications of the changes in the skill premium across education levels. Our data is different from Autor's in two respects. First, we use Census Based Statistical Areas

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[10] Baum-Snow, Freedman, and Pavan (2018) also discuss the geographic dispersion of unskilled wages.

(CBSAs) rather than commuting zones. While commuting zones include many more rural areas, CBSAs are a more logical unit for our analysis as they focus on the locales dependent on a central town or city. In addition, our house prices data are reported by CBSA (as discussed below) and Saiz (2010) has calculated another key component of our analysis, the elasticity of land supply, in a manner that is easily linked to CBSAs.[11] Second, we use median wages rather than average wages. Median wages have the advantage that they are not as affected by a few very high-income workers. In our case another reason for using the median wage is that our house price data are also medians.

Given the change in skill premia shown in Figure 1, there is a question of whether median wages accurately represent the complex dynamics in mean wages in labor markets analyzed by Autor. To investigate this, we compared four measures of relative wages across employment-weighted quartiles of population density, two using Autor's mean wages across commuting zones for 1980 and 2015 and two using our median wages across CBSAs for 1980 and 2016. In both datasets we calculate both the mean wage in each quartile and the wage in the median location in the same quartile. As can be seen in Figure 2, the results are similar across the four methods—the maximum deviation is 2% in 1980 and. 6% in 2015/6—suggesting that our use of median wages across CBSAs creates no systemic distortions.[12]

B. Industrial Structure and Wages

This section examines how industrial structure depends on and availability and then how wages depend on house prices and industrial structure. Table 2 reports regressions looking at how the (inverse) of the elasticity of land depends on the logarithm of the proportion of employment in manufacturing and technology. The coefficient on manufacturing employment is negative and highly significant in both 1980 and 2016, while the coefficient on IT jobs is positive in both periods, confirming that manufacturing jobs are generally located in small towns and IT jobs in large cities. Table 3 reports employment-

[11] The Saiz data include adjustments for uninhabitable land and the stringency land use regulations (originally land use regulations in 2005, but recently updated recently to 2018).

[12] We also analyzed data on the 10% most densely populated cities. Reflecting the size of these cities, the samples are small (4-5 commuting zones out of 722 and 3 CBSAs out of a total of 916) making the calculations less reliable, but the results remain reasonably similar across calculation methods with a maximum difference of 8%.

weighted regressions of wages on house prices as well as the employment proportions in manufacturing and in IT on wages across CBSAs in 1980 and 2016. As anticipated given the wage patterns in Figure 1, median house prices matter significantly for wages; in 1980 a 1% increase in house prices raises wages by 0.16% and in 2016 by a somewhat larger 0.2%, although the difference is not statistically significant. Industrial structure also matters and vividly illustrates the decline in manufacturing and rise in IT as determinants of wage across locations. In 1980, the coefficient on the logarithm of the proportion of manufacturing was 0.117 and highly significant; in 2016 it had fallen by two-thirds to 0.0339 and was insignificant. By contrast, the coefficient on technology workers almost doubled from 0.058 to 0.098 and is highly significant in both years.

C. Dispersion of House Prices and Wages

We next examine the impact of the IT revolution on the dispersion of median house prices and wages across CBSAs. The dispersion of house prices is important since, as discussed in the theoretical section, it is a measure of the degree of labor misallocation. Our main source of house price data is the Zillow Home Value Database, which provides median nominal estimated house prices for 571 census-based statistical areas (CBSAs) across the United States going back annually to 1996.[13] We extend these data back to 1980 using the Federal Housing Finance Agency's (FHFA) House Price Index for different cities.

As can be seen in Figure 3, the standard deviation of the logarithm of median home values rose by well over 50 percent between 1980 and 2016. There has been a parallel increase in divergences of wages across cities although, as the model predicts, it has been smaller. The standard deviation of median incomes in logs of 381 CBSAs grew by 20 percent, with the main growth after 1996. These trends were accompanied by a fall in internal migration, analyzed further in a later section.

[13] Zillow created its Home Value Index by estimating prices of both houses that were sold and ones that did not sell on a monthly basis, covering over 100 million homes nationwide. Zillow constructs its estimates based on an array of "automated valuation models", which are retrained three times a week based on a latest data. The estimates are subject to minimal systematic error, meaning that estimation errors are as likely to overprice as underprice the value of a particular home. The Zillow series are highly correlated with other series that measure house prices at the city level, such as the Case-Shiller index (which covers only twenty CBSAs) and the FHFA series (which use a much more limited and less representative sample).

The increase in house prices have been largest in crowded, superstar cities. The top panel of Figure 4 shows the cross-section of the deviation of employment-weighted house prices from the median for 1980 and for 2016.[14] Deviations from the median value have increased over this period and the tails have become more marked, indicating a major increase in labor misallocation. The rise in the right-hand tail is particularly striking and features a small second mode in the right-hand tail reflecting surging house prices in successful supercities. As shown in the middle panel, wages have had an extremely similar transformation, with thicker tails and a bimodal distribution.

The bottom panel shows the distribution of wages adjusted for housing costs, calculated under the admittedly crude assumptions that housing costs are proportional to house prices and that the typical household spends 30 percent of their income on housing. The surge in house prices and wages in successful cities largely cancel each other out, and the resulting distribution is unimodal. Indeed, in contrast to the other two panels, the mode has shifted to the right and hence that while many metro areas have seen robust wage growth there is a thick tail of decaying low-wage locales.

A more detailed examination of the metro areas with high housing-adjusted-wages charts the decline in manufacturing towns and rise in IT-based super cities. In 1980 almost all the CBSAs in the top 10% of post-housing wages were in small manufacturing towns in the heartland, such as Flint Michigan or Youngstown Ohio. They represent just 8% of employment, with about half of the jobs located in the Detroit and Pittsburg areas. None of the six future supercities we discuss in more detail below (San Francisco, San Jose, New York, Boston, Seattle, and Washington DC) are included. By contrast, in 2016 proportion of jobs in places in the top 10% of post-tax wages had leapt to 34%, and 40% of these high-waging jobs were in our six supercities. The bottom 10% of CBSAs by housing-adjusted-wages are concentrated in small towns that represent less than 2% of employment in both 1980 and 2016, although over time they have become even more concentrated in the heartland and the southwest.

[14] The geographical distribution that underlies the Zillow house price data looks as one would expect. Analyzing the ten metropolitan areas with fastest growing house prices, eight of them are in California, plus one in Florida (Key West) and one in Massachusetts (Vineyard Haven). Large metro areas like New York, Washington, DC, Boston, Denver, and Seattle are ranked in the top 50. Meanwhile, the ten metropolitan areas with the lowest house price growth are all in Indiana, Ohio, and Georgia.

D. Productivity

In a simplified version of the theoretical model in which labor is homogeneous and technology is the same across locations, productivity can be measured as $\ln(A_i) = (1 - \alpha - \eta)\ln(L_i) + (1 - \eta)\ln(W_i)$, where we assume that alpha is 0.65 and eta is 0.25 (as in Hsieh and Moretti, 2018). The very different coefficients on employment and wages reflects the distortion caused by house prices.[15] Note that this formula will tend to underestimate the rise in productivity in successful cities compared to towns as employment is not adjusted for the influx of skilled workers. Despite this bias, Table 4 shows that productivity growth has been much stronger in cities with limited land availability. In cities in the lowest quartile of land availability, relative productivity rose by 7.5 percent between 1980 and 2016 while falling by 5.4 percent in the quartile with the most land availability, implying a difference in annual productivity growth of one-third of a percent.

As discussed in the theoretical section, rapid productivity growth in crowded cities will be associated with low national productivity growth due to rising distortions in labor allocation. Indeed, total factor productivity growth since 1980 has been disappointing despite the prosperity in superstar cities. From 1980 to 2016 TFP growth has averaged 0.9% a year, under half the rate of increase in the 1950s and 1960s (1.9%) and is slightly below the 1% achieved in the 1970s, a decade generally viewed as having had mediocre economic performance. Part of the reason for this is that people did not move to prosperity. The proportion of employment accounted for in our sample by the six supercities fell marginally from 16.1% in 1980 to 15.6% in 2016.

We next use our estimates of productivity growth by CBSA to examine how far this disappointing outcome reflects labor misallocation. We first calculate the average rise in productivity across our sample of 917 CBSAs (which represent around 80% of total US employment). This yields a rise in total factor productivity between 1980 and 2016 of 0.89%, extremely close to the Bureau of Labor Statistic's estimate of 0.87% for the aggregate economy. Next, we can recalculate the allocation of labor assuming that the rise in

[15] Since the underlying model is Cobb-Douglas, the elasticity of substitution of labor is one.

productivity yields sufficient in-migration to leave relative wages unchanged.[16] Under this scenario, total factor productivity growth between 1980 and 2016 would have been 1.66%, almost double the actual rate and close to the rate seen in the "golden period" of the 1950s and 1960s when the leading edge of productivity was in manufacturing. The catch is that employment in our supercities would have expanded four-fold. This is where the location of IT matters. Such an increase is implausible in these crowded supercities. But such an increase would have been much easier if IT was in small towns with abundant land.[17]

These results underline how the concentration of the IT sector in "superstar cities" limited the transmission of benefits to the rest of the economy. In 2016 IT employment in comprised just 2.3% of all employment in our sample, a fraction of the imprint of the manufacturing sector whose expansion drove the golden period of the 1950s and 1960s—in 1980 manufacturing made up 27% of jobs in our sample and was still almost 10% of employment in 2016. Its small size reflects, at least in part, the limited increase in the demand for skilled workers due to the rising "tax" coming from higher housing costs.

In this context, it is also notable that successful cities can become more congested over time. A good example is the evolution of total factor productivity, employment, and wages in the Washington DC CBSA. As can be seen in Figure 5, while relative productivity growth rose rapidly from 1980 to 1998 and from 1998 to 2016, the first period was characterized by large increase in relative employment and little increase in relative house prices, while in the second period relative employment growth flattened out and relative house prices boomed, consistent with a fall in land supply. Even when the IT boom widens to encompass new urban areas, these can transform into expensive superstar cities.

[16] Note that this thought experiment leaves unchanged initial differences in productivity across cities. In the calculations the estimated impact of the rise in productivity on employment was reduced for the San Jose area for the implausible 50-fold rise in employment to a still-striking 10-fold rise.

[17] To take an extreme example from the nineteenth century, Chicago's population rose 50-fold from 1950 to 1900 as it went from being an unknown outpost to the nation's second city.

E. Internal Migration

Another measure of the distortions caused by the IT revolution is the fall in long-distance internal migration and hence labor market churning.[18] The longest-running migration database available, the Current Population Survey (CPS) Annual Geographical Mobility Rates, reports an approximate halving in inter-state migration rates from 3.0 percent in 1981 to 1.7 percent in 2016 (Figure 1—by contrast, intra-state migration has only fallen by about a quarter).[19] Long-distance migration is also closely linked to education. In 2016, those with an education beyond high school were almost twice as likely to move to another state than those with only high school education (in contrast, there is almost no difference in the likelihood of the two groups moving within a county).[20]

While the model presented earlier only envisages migration in one direction, actual migration involves a lot of churning, as workers move to and fro between locations. Fortunately, it is easy to adapt the model to create churning by simply assuming that the locational preferences of workers can change over time, as a result (for example) of changes in personal circumstances, such as jobs, births, deaths, and marriages. If a certain percentage of workers change their locational preferences every period, then there will be churning in addition to net migration. Rising dispersion of house prices will continue to deter migration to successful cities. However, if "uphill" migration into successful cities with rising housing costs falls, there must also be a fall in "downhill" migration out of such cities. In the model, the reason that "downhill" migration falls is low wages in cities that have been left behind. The model thus produces a clear prediction. Uphill migration should fall because of higher housing costs and downhill migration should fall because of relative wages. This asymmetry in behavior explains why a widening in house price and wage differentials lowers migration. By contrast, if there is no difference in the response of uphill and downhill migration to

[18] Job-related motives explain 34.3 percent of moves across counties in 2016 while jobs were linked with only 20.2 percent of moves within a county (the CPS survey has incorporated questions regarding motivations to move since 1998, although the results are only distinguished between intra- and intercounty migration). U.S. Census Bureau, Current Population Survey, March 1999; U.S. Census Bureau, Current Population Survey, November 2016.

[19] Current Population Survey Annual Social and Economic Supplement, 1997-2016.

[20] Current Population Survey Migration/Geographic Mobility Tables, 1991-2016.

differences in house prices and wages then gross migration will be unaffected by such a widening.

We now bring various elements in the model together empirically by examining the links between falling migration, rising house prices, and wage differentials. This is of particular interest as it connects falling migration with two other indicators of rising labor market distortions, the rising dispersion of house prices and wages. We use the Internal Revenue Service's statistics on migration to test the model because it contains data on flows of migrants between individual cities while the longer-running CPS survey data looks only at overall in- and out-migration.[21] To focus on labor market churning we examine moves between CBSAs that are over 200 miles apart.[22] The loss of opportunity to move to successful cities is evident in the raw data, where the decline in migration is largest for metro areas with lower median incomes (Figure 6). While migration out of metro areas in the lowest quartile of median income fell by 35 percent, the reductions get progressively smaller as median income rises, culminating in a fall in migration of only 2 percent for metro areas in the top quartile. Reflecting these trends, the "smile" that characterized labor mobility in the early 1990s, with higher migration out of metro areas in the highest and lowest quartiles of median incomes, has turned into a smirk, in which migration is elevated only for the highest quartile.[23]

Our data on migration flows between 270 CBSAs whose centers are at least 200 miles from each other amounts to roughly 400,000 observations over 25 years.[24] To make the

[21] The IRS Migration data reports county-to-county migration across the United States from 1990-2016 by tallying the number of tax returns and exemptions, proxies for households and individuals respectively, that have filed taxes for a given year from a different mailing address than the previous year, an indication the household in question has moved. Since the IRS database only covers households whose level of income requires them to file taxes it excludes some low-income families, as well as students and retirees. However, this may be less of an issue given our focus on migration related to jobs since most of the employed file taxes, especially as the earned income tax credit (a form of negative income tax) brings many of the working poor into the tax system.

[22] In their "Reasons for Moving" issue, the Census reports that 31 percent of moves of up to 200 miles are motivated by job-related reasons, compared to 48 percent for migration of 200-499 miles; separate analysis finds that 47.5 percent of moves of over 500 miles are related to following or attempting to find a job (Ihrke, 2014).

[23] See also Nunn, Parsons, and Shambaugh (2018).

[24] The Zillow house price database has data for 571 CBSAs, while the income database provides data for 381 CBSAs. The overlap between those and other control variables comprises 270 CBSAs (30 percent of total number of CBSAs in the United States, but 70 percent by population). Finally, we calculated our bilateral

migration flows comparable across metro areas with different numbers of people, we take a "gravity" approach and divide bilateral migration by the square root of the product of their respective populations (the regression results accept the implied coefficient restrictions on the logarithm of population).[25] Given the key prediction that falling migration to more prosperous cities is driven by rising house prices and falling migration to poorer cities by wages we run a model that allows the coefficients to differ depending on the type of migration. Accordingly, we calculate a dummy D_{UH} for observations where the house price in the destination CBSA is higher than the house price for the source CBSA (*HP* is positive, and the migration is uphill) and use (1-D_{UH}) to identify downhill migration.[26] We then multiply the house price dummies with the house price and income variables.

The model is:

$$M_{ij,t} = \propto + \beta_1 D_{UH} + \beta_2 (D_{UH} \cdot HP_{ij,t}) + \beta_3 ((1 - D_{UH}) \cdot HP_{ij,t}) + \beta_4 (D_{UH} \cdot I_{ij,t}) + \beta_5 ((1 - D_{UH}) \cdot I_{ij,t}) + \beta_6 X_{ij,t} + \beta_7 \delta_i + \beta_8 \theta_j + \beta_9 \tau_t + u_{ij,t} \quad (12)$$

where HPij,t is the log median house prices in the destination CBSA minus the log median house price in the source CBSA and the income variable, Iij,t, is the difference between log median income in the destination and source CBSA. Other control variables, Xij,t, include the log of the distance between the centers of the two CBSAs to account for gravity effects; the proportion of the population over 54 in the source and in the destination CBSA to account for lower mobility of the old; relative regional unemployment to account for the business cycle; and relative population growth to account for economic vitality. The sample is 1990-2016.

distance variable using a trigonometric equation using county-level longitude and latitude coordinates taken from the US Census.

[25] The gravity model is a flexible specification for examining geographic relationships which, in the context of trade, is compatible with a wide range of theoretical models (Costinot and Rodriguez-Clare, 2014).

[26] Results using income to calculate the uphill and downhill dummies are reported as a robustness check. That model finds similar results, but fits less well, suggesting that house prices are a more fundamental driver of our findings.

Since migration may affect relative incomes and house prices as well as respond to them, we use instrumental variables.[27] We use the averages of incomes and house prices of other CBSAs within a 200-mile radius of the CBSA in question (recall that our migration data exclude trips within 200 miles) and well as house price and income differentials from 10 years earlier. While income and house prices shocks can last for some time, it seems highly unlikely that current migration is significantly affected by conditions a decade earlier.[28]

The anticipated asymmetry in the impact of relative house prices and incomes on those moving uphill and downhill is strongly confirmed by the data (Table 5). The coefficient on *HP* for those moving uphill (to a more expensive housing market) is -0.0081 and highly significant. By contrast, the coefficient on house prices associated with downhill migration is 0.0015 and insignificant, implying that lower house prices elsewhere provide no incentive to move. The opposite asymmetry is seen in incomes, with an uphill coefficient (0.0105) that is only about half of the downhill one (0.0199). In both cases, the differences between the uphill and downhill coefficients are economically large and highly statistically significant. Also, note that the changes in the labor market shown in Figure 1 would, if anything, increase this asymmetry as high skill workers with relatively larger wage differentials across locations are more likely to move uphill implying an upward bias to the associated coefficient, while poorer workers with lower wage differences tend to move downhill, implying the opposite bias. Exactly as predicted by our model, high house prices discourage migration into supercities while stagnant wages discourage migration to places with low house prices (the correlation between relative house prices and wage rates is around 0.8).

A potential concern with the baseline specification is that it only measures migration between metro areas that are *relatively* poor or rich. However, there may also be a role for *absolute* poverty. Migration from poor areas such as Dayton, Ohio to rich superstar metro areas such as San Francisco might respond differently to house price and income differences

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[27] Higher migration will increase house price differentials by bidding up house prices in the destination region and lowering them in the source and reduce income differentials by increasing labor supply in the destination while lowering it in the source.

[28] The first stage regressions are well specified. The F-statistic for all first-stage regressions is well over the cut-off of 30. In addition, the Kleibergen-Paap rk LM and Wald F-statistics, which can be seen as generalizations of the Anderson LM and Cragg-Donald Wald statistics respectively to the case of non-i.i.d. errors, firmly reject the null hypotheses of under and weak identification.

than flows within poor areas, such as from Dayton to Lafayette, or within rich ones, such as from Washington, DC to San Francisco. To incorporate absolute measures of economic standing, we include dummies that differentiate poor CBSAs, with house prices below the median in that year, and rich CBSAs with above-median values. We thus identify the coefficients on house price and income differences across six possible ‘economic directions’ for migration: from poor CBSAs to rich ones, from rich to poor, from poor to less poor, from poor to poorer, from rich to less rich, and from rich to richer.

Table 6 shows that the marked asymmetry in response to house prices and incomes between those moving between rich and poor metro areas continues to hold. These asymmetries also hold for migration within poor locales and rich ones, but the relative importance differs. Across poor metro areas the impediment created by high house prices diminishes while the incentives created by wages is larger. Rich cities have the opposite pattern. High house prices matter more for migration while the impact of wage differences is basically identical regardless of the direction of movement. Churning within poorer cities is largely driven by the desire for higher wages, while migration across rich cities depends much more on relative house prices, consistent with our model.

Our finding of major asymmetries in responses to house price and income differences is also robust to a range of other specifications (Table 7). This includes: switching to defining uphill and downhill migration using relative incomes rather than relative house prices; defining migration by households rather than individuals; weighting the regression by population to check the results are not dominated by smaller metro areas; excluding the twenty largest metropolitan areas to check the results are not due to the behavior of a few large cities; and cutting off the sample before 2007 to ensure our results were not driven by the housing bust and its aftermath.

V. CONCLUSIONS

This paper has presented a spatial model in which changes in the location of productivity gains from manufacturing mainly located in towns to information technology concentrated in crowded cities, can explain five trends that have been documented in the literature: rising skilled wages and (especially) house prices in prosperous “superstar” cities; stagnating wages and house prices in less prosperous locales; mediocre productivity growth;

falling internal migration; and the movement of manufacturing and the unskilled out of prosperous cities. Consistent with the model, we find that productivity has been rising fastest in cities with the largest housing constraints, that house prices have boomed in these cities, and that productivity, wages, and house prices have been stagnating in poor areas. A detailed examination of the behavior of migration confirms that the fall has been driven by rising house prices in successful cities and stagnant wages in less successful places.

The inability to move more workers into productive supercities has created a major misallocation of labor that explains mediocre total factor productivity growth. Our calculations suggest that these growing distortions may almost halved the rate of expansion of national productivity, implying that without these growing distortions productivity would have expanded at a similar rate to the 1950s and 1960s. In addition, the concentration of productivity gains in crowded cities has spawning growing inequality across three dimensions. Between skilled and unskilled workers, between large cities and other locations, and between (generally older and better-off) owners of property and (generally younger and poorer) renters. The contrast with the broad-based economic convergence experiences in the 1950s and 1960s is again stark.

How can policies mitigate these widening inequalities? As discussed in many papers, improving land use regulations that often constrain the availability of land for businesses and housing (Saiz, 2010) would reduce the economic distortions from the housing market. However, the fact that the major labor market trends are largely unchanged if population density in 1970 is used (as in Autor, 2019) suggests that the impact of better regulations will be limited. The alternative is to provide a palliative in the form of larger fiscal transfers to the poor, and possibly also to poorer regions (see Auston, Glaeser, and Summers, 2018), paid for by higher taxes on the groups who have benefited most from the IT, which is skilled workers and landowners. This would reverse the thrust of policies since 1980, which have sought to increase growth by improving incentives through lower taxes (especially on the wealthy) and making support for the poor more targeted.

REFERENCES

Alabdulkareem, Ahmad, M. R. Frank, L. Sun, B. AlShebli, C. Hidalgo, and I. Rahwan (2018), "Unpacking the polarization of workplace Skills", *Science Advances* 4:7.

Austin, B., E. Glaeser, and L. Summers (2018), "Saving the Heartland: Place-Based Policies in 21st Century America," Spring 2018 *Brookings Paper on Economic Activity*, pp. 151-232.

Autor D. H. (2019) "Work of the Past, Work of the Future," Richard T. Ely Lecture, AEA Annual Meeting.

Autor, D. H. (2014) "Skills, Education, and the Rise of Earnings Inequality Among the 'Other 99 Percent'", *Science* 344, No 6186 (May) pp. 843-51.

Autor, D. H, and D. Dorn (2013) "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market." *American Economic Review* 103(5): 2013).1553–1597.

Autor, D. H., D. Dorn, and G. H. Hansen (2018), "When Work Disappears: Manufacturing Decline and the Falling Marriage Market Value of Young Men," NBER Working Paper No. 23173.

Autor, D. H., D. Dorn, and G. H. Hansen (2013), "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, pp. 2121-68.

Baldwin, Richard (2016) *The Great Convergence: Information Technology and the New Globalization*, Harvard University Press, Cambridge and London.

Baldwin, Richard (2019) *The Globotics Upheaval: Globalization, Robots, and the Future of Work*, Harvard University Press, Cambridge and London.

Bhutta, N, S, Laufer, and D. Ringo (2017) "Residential Mortgage Lending in 2016: Evidence from the Home Mortgage Disclosure Act Data," *Federal Reserve Bulletin*, Vol. 103, No. 6.

Bloom, Nicholas, Charles I. Jones, John Van Reenen, and Michael Webb. 2020. "Are Ideas Getting Harder to Find?" *American Economic Review*, 110 (4): 1104-44.

Bound, J. and H. J. Holzer (2000), "Demand Shifts, Population Adjustments, and Labor Market Outcomes during the 1980s," *Journal of Labor Economics*, 18(1), pp. 20-54.

Buera, F. J., J. P. Kaboski, and Y. Shin (2011) "Finance and Development: A Tale of Two Sectors," *American Economic Review*, 101 (5), pp. 1964-2002.

Case, A. and A. Deaton (2017), "Mortality and Morbidity in the 21st Century," *Brookings Papers on Economic Activity*, Spring 2017, pp. 397-443.

Case, A. and A. Deaton (2015), "Rising Morbidity in Mid-Life among White non-Hispanic Americans in the 21st Century," *Proceedings of the National Academy of Sciences*, 112, No. 49, pp. 15078-83.

Chetty, R. and N. Hendren (2018) "The Impacts of Neighborhoods on Intergenerational Mobility I: Childhood Exposure Effects," *The Quarterly Journal of Economics*, Vol 133(3), pages 1107-1162.

Costinot, A. and A. Rodríguez-Clare (2014) "Trade Theory with Numbers: Quantifying the Consequences of Globalization," in *Handbook of International Economics, Volume 4*, edited by G. Gopinath, E. Helpman, and K. Rogoff (North-Holland).

Diamond, R. (2016) "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000," *American Economic Review,* 106 (3): 479-524.

Donovan C., C. Schnure, 2011, "Locked in the House: Do Underwater Mortgages Reduce Labor Market Mobility?" Social Science Research Network.

Feenstra, R., H. Ma, and Y. Xu (2018) "Magnification of the 'China Shock' Through the US Housing Market," paper given at the 2018 AEA meetings.

Frey, W., 2009, "The Great American Migration Slowdown: Regional and Metropolitan Dimensions," Metropolitan Policy Program, the Brookings Institute.

Ganong, P., D. Shoag, 2017, "Why Has Regional Income Convergence in the US Declined?" *Journal of Urban Economics.*

Gbohoui, W., W R. Lam, and V. Lledo (2019) "The Great Divide: Regional Inequality and Fiscal Policy" IMF Working Paper 19/88.

Glaesser, E. L. and D. C. Mare (2001) "Cities and Skills," *Journal of Labor Economics*, 19:2, pp. 316-42.

Glaeser, E. L., J. Gyourko, and R. E. Saks (2006) "Urban Growth and Housing Supply," *Journal of Economic Geography*, vol. 6, issue 1, 71-89.

Gordon, R. J. and I. Dew-Becker (2008) "Controversies about the Rise of American Inequality: A Survey," NBER Working Paper No. 13982.

Goldin, Claudia, and Lawrence Katz, (2008) *The Race Between Education and Technology*, Harvard University Press, Cambridge.

Goldin, Claudia, and Robert Margo, (1992) "The Great Compression: The Wage Structure in the United States at Mid-Century," *Quarterly Journal of Economics,* CVII, 1–34.

Gordon, Robert J. (2016). *The Rise and Fall of American Growth: The U.S. Standard of Living Since the Civil War.* Princeton and Oxford: Princeton University Press.

Gordon, Robert J. (2018) "Why has Economic Growth Slowed when Innovation Appears to be Accelerating?" NBER Working Paper 24554.

Greenwood, M. J. (1975) "Research of Internal Migration in the United States A Survey," *Journal of Economic Literature*, 13:2 (June) pp. 397-433.

Guriev, S. and E. Papaioannou (2020) "The Political Economy of Populism" available at SSRN: https://ssrn.com/abstract=3542052.

Gyourko J., C. Mayer, T. Sinai, 2013, "Superstar Cities," *American Economic Journal: Economic Policy.*

Gyourko J., R. Molloy, 2014, "Regulation and Housing Supply," Working Paper 20536, National Bureau of Economic Research.

Hacker, J.S. (2012) "Sharing Risk and Responsibility in a New Economic Era," in *Shared Responsibility, Shared Risk: Government, markets and Social Policy in the Twenty-First Century* (ed. J. Hacker and A. O'Leary Oxford University Press.

Howard, G., 2016, "The Migration Accelerator: Labor Mobility, Housing, and Aggregate Demand," Massachusetts Institute of Technology.

Hoxie, P., D. Shoag, and S. Veuger, 2019, "Moving to density: Half a century of housing costs and wage premia from Queens to King Salmon," AEI Economics Working Paper 2019-24, December 2019

Hsieh, C., E. Moretti, 2019, "Housing Constraints and Spatial Misallocation," *American Economic Journal: Macroeconomics* Vol 11:2 pp. 1-39.

Hsieh, C., P. J. Klenow (2009) "Misallocation and Manufacturing TFP in China and India," *The Quarterly Journal of Economics*, Volume 124, Issue 4, November 2009, Pages 1403–1448.

Ihrke, D., 2014, "Reason for Moving: 2012 -2013," Population Characteristics, US Department of Commerce.

Jorgenson, Dale W., Ho, Mun S., and Samuels, Jon D. (2017). "Educational Attainment and the Revival of U.S. Growth," in Charles Hulten and Valerie Ramey, eds., *Education, Skills, and Technical Change: Implications for Future U.S. GDP.* Studies in Income and Wealth. Chicago and London: University of Chicago Press for NBER

Kaplan, G., S. Schulhofer-Wohl, 2015, "Understanding the Long-Run Decline in Interstate Migration," Working Paper 697, Federal Reserve Bank of Minneapolis.

Katz, Lawrence F. and Robert A. Margo (2014) "Technical Change and the Relative Demand for Skilled Labor: The United States in Historical Perspective," in *Human Capital in History: The American Record*, editors Leah Platt Boustan, Carola Frydman, and Robert A. Margo (University of Chicago Press).

Kuznets, Simon. 1955. "Economic Growth and Income Inequality." *American Economic Review*, 45(1): 1–28.

Milanovic, Branco 2016 *Global Inequality: A New Approach for the Age of Globalization*, Harvard University Press.

Molloy, R., C. Smith, A. Wozniak, 2011, "Internal Migration in the United States," *Journal of Economic Perspectives*.

Molloy, R., C. Smith, A. Wozniak, 2013, "Declining Migration Within the US: The Role of the Labor Market," 2013-27, Finance and Economics Discussion Series, Divisions of Research and Statistics and Monetary Affairs Federal Reserve Board, Washington, DC.

Moretti, Enrico, 2013, "Real Wage Inequality." *American Economic Journal: Applied Economics*, 5 (1): 65-103.

Nunn, R., J. Parsons, and J. Shambaugh (2018) "The Geography of Prosperity," in *Place-Based Policies for Shared Economic Growth*, ed. J. Shambaugh and R. Nunn, The Hamilton Project, Brookings Institution, Washington, DC.

Partridge, M. and A. Tsvetkova (2017) "The Road to Despair and the Geography of the America Left Behind," paper presented at the 2017 American Economic Association Conference.

Peters, M. (2020) "Hetrogeneous Markups, Growth, and Endogenous Misallocation" *Econometrica*, Econometric Society, vol. 88(5), pp. 2037-2073, September.

Pierce, J. R. and P. K. Schott (2016) "Trade Liberalization and Mortality: Evidence Across US Counties," NBER Working Paper 22849.

Quigley, J. and S. Rachael (2004) "Is Housing Unaffordable? Why Isn't It More Affordable? *Journal of Economic Perspectives*, 18 (1): 191-214.

Restuccia D., R. Santaeulalia-Llopis (2015) "Land Misallocation and Productivity" Working Papers tecipa-541, University of Toronto, Department of Economics.

Restuccia, D., and R. Rogerson (2013) "Misallocation and Productivity" *Review of Economic Dynamics*, 16 (1): 1-10.

Restuccia, D., and R. Rogerson. 2017. "The Causes and Costs of Misallocation" *Journal of Economic Perspectives*, 31 (3): 151-74.

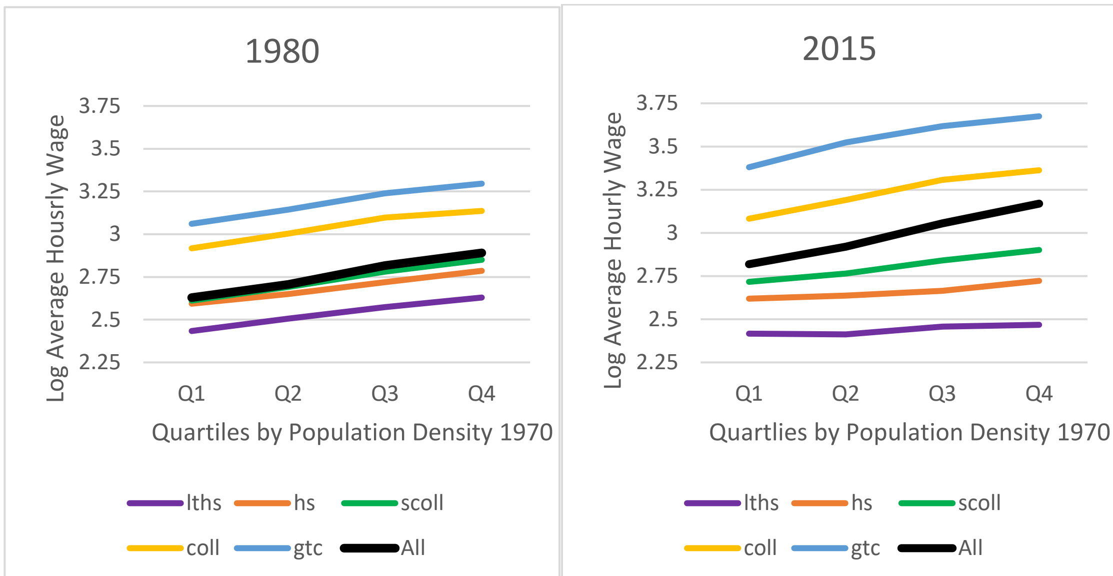
Saiz, A. (2010) "The Geographic Determinants of Housing Supply," *Quarterly Journal of Economics*, August, pp. 1253-96.

Saks, R. E. (2008) "Job creation and housing construction: Constraints on metropolitan area employment growth," *Journal of Urban Economics*, 64:1, pp. 178-195.

Yagan, D. (2016), "Is the Great Recession Really Over? Longitudinal Evidence of Enduring Labor Market Impacts," mimeo UC Berkeley.

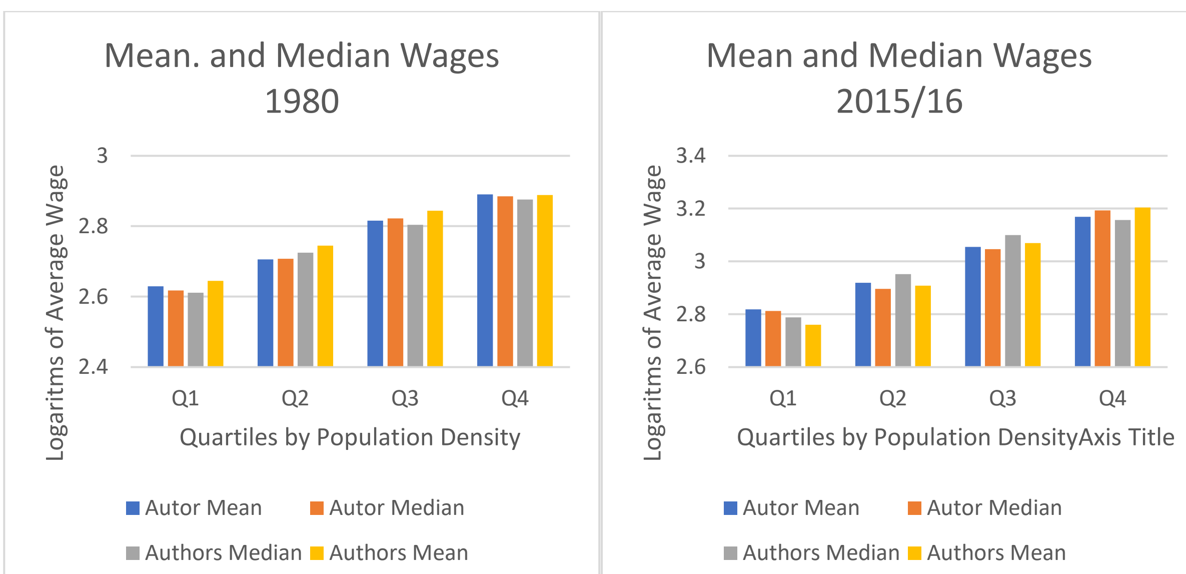
Wang, Z., 2013, "Smart City, Life-cycle Migration and Falling Mobility since the 1980s," Brown University.

Figure 1. Wages by Population Density



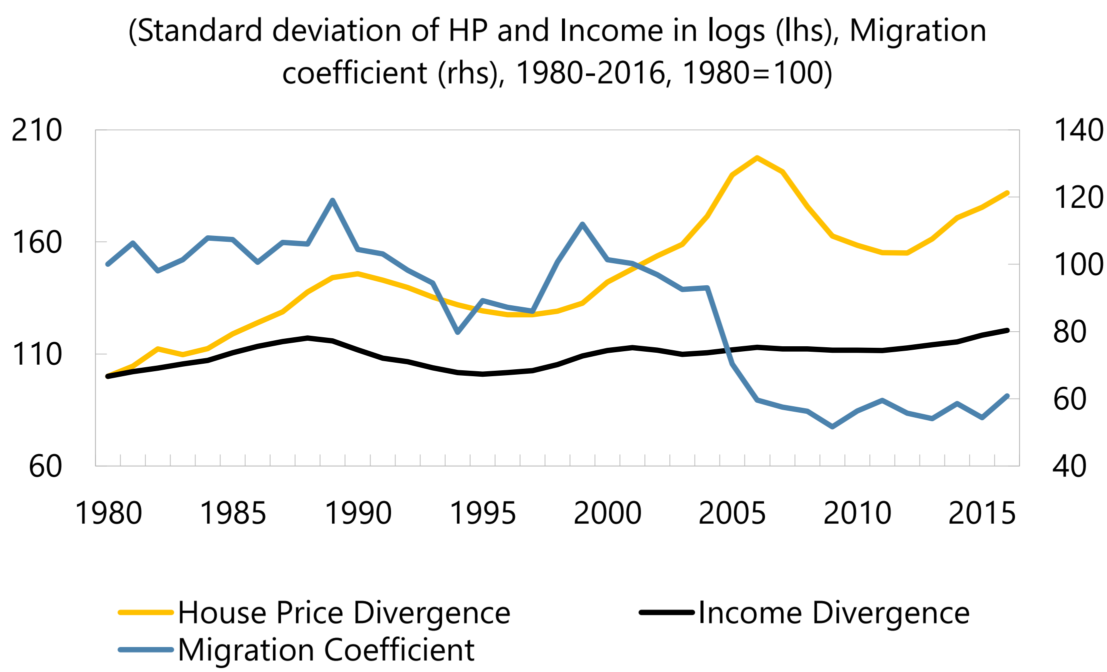
Source: Autor's calculations using data from Autor (2019)

Figure 2. Different Methods of Calculating Average Wages By Population Density



Source: Authors calculations

Figure 3. House Price and Income Divergence Has Increased As Migration Has Slowed



Source: Zillow House Price Index, Census, and Current Population Statistics Population Migration Data

Figure 4. Distribution of House Prices, Wages, and Housng-Adjusted Wages Over Time

(Employment-weighted across CBSAs compared to median value)

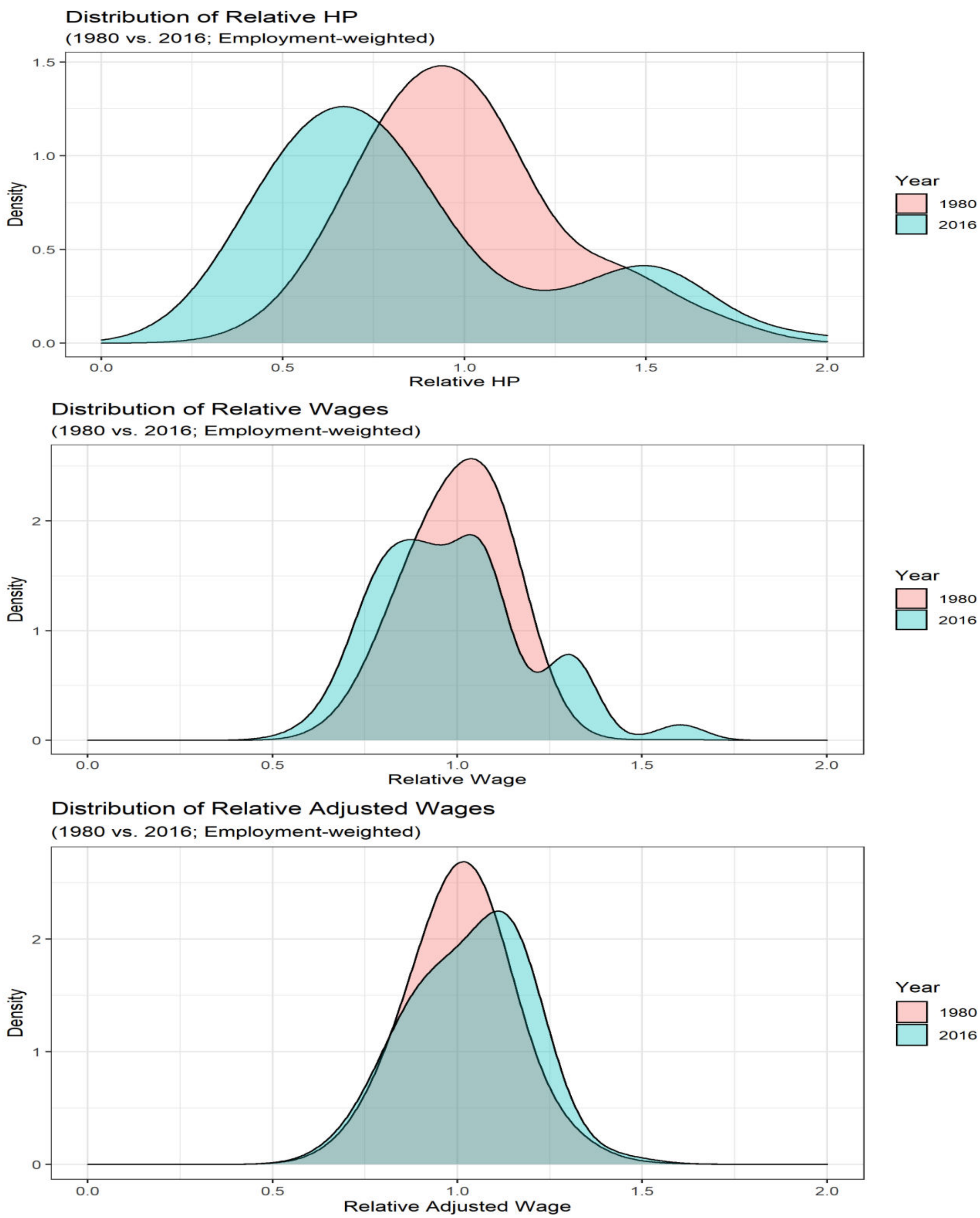
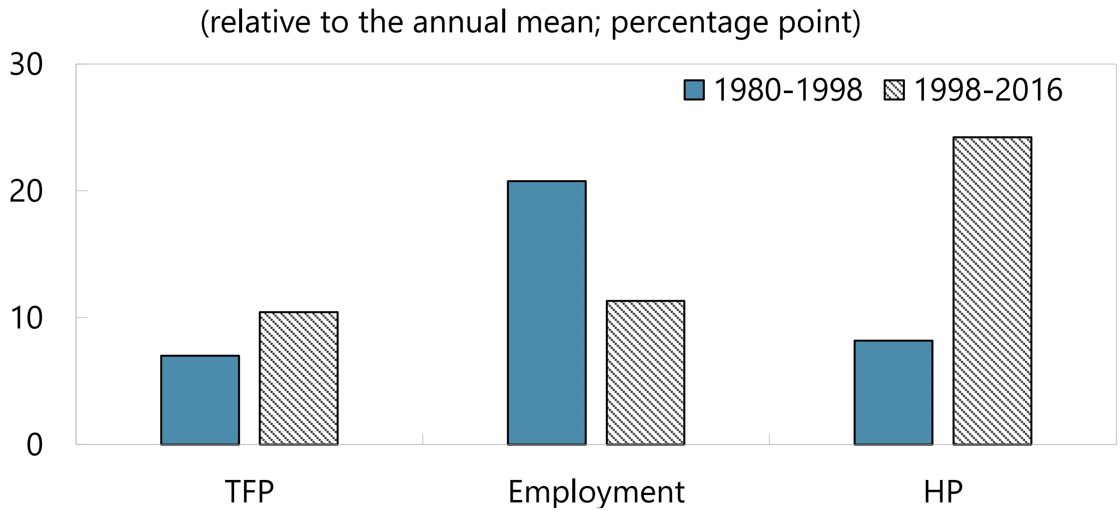
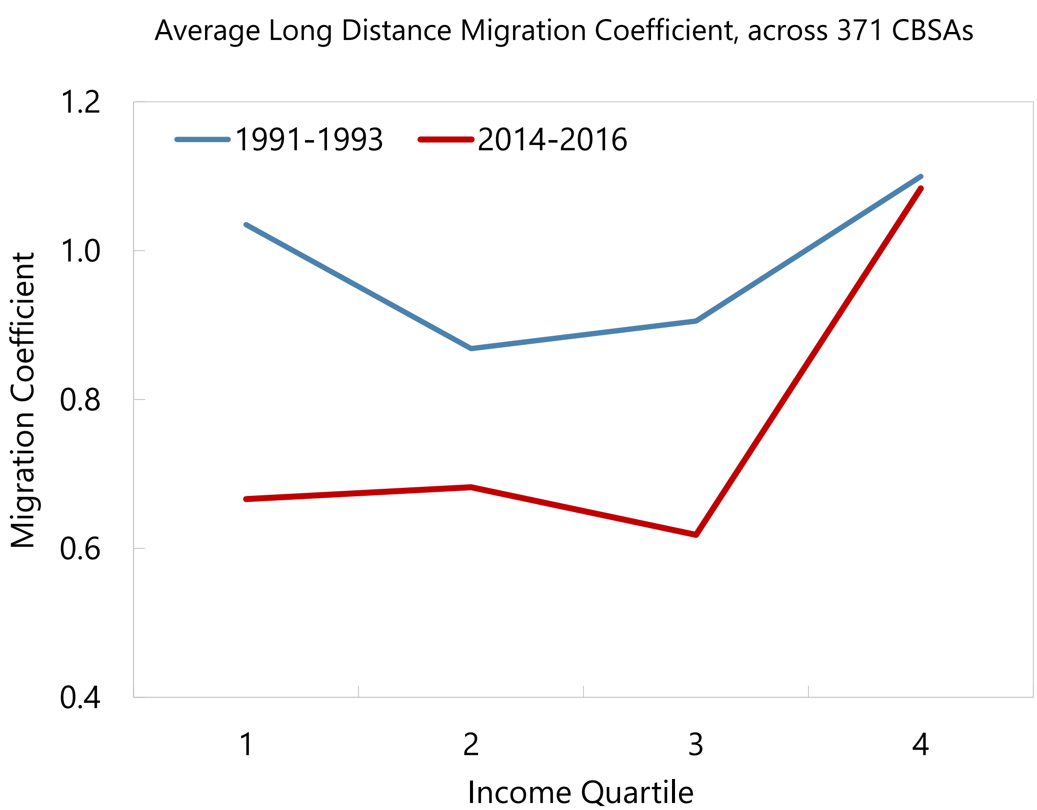


Figure 5. Washington DC Area: Change in Employment/House Price Tradeoff



Source: Zillow House Price Index; County Business Patterns

Figure 6. Migration Rates By City Wage



Source: International Revenue Service Population Migration Data

Table 1. Impact of an IT Productivity Shock						
		Shock				
		Texhnology	Distortion	Local	Ind Structure	Sum
		Versus Manufacturing Productivity Shock				
National	Productivity/Wages	--	⇩	--	--	⇩
	Skill Premium	⇧	⇧	--	--	⇧
	Migration	--	⇩	--	--	⇩
City	Productivity/Wages	--	⇧	⇧	--	⇧
	Skill Premium	⇧	--	⇧	⇧	⇧
	Migration	--	⇩	⇩	--	⇩
Towns	Productivity/Wages	--	⇩	⇩	--	⇩
	Skill Premium	⇧	--	⇩	⇩	⇧
	Migration	--	⇩	⇩	⇩	⇩
		City Compared to Town				
Wage	Skilled	--	⇧	⇧	⇧	⇧
	Unskilled	--	⇧	⇩	⇩	⇩
Migration	Skilled to City	⇧	⇩	⇧	⇧	⇧
	Unskilled to City	⇧	⇩	⇩	⇩	⇩

Table 2. Land Availability and Industrial Structure

	1980	2016
Log Manufacturing Employment	-0.049**	-0.043**
	(-2.67)	(-2.68)
Log Tech Employment	0.0192*	0.0113
	(1.99)	(1.43)
Constant	0.387***	0.289***
	(5.04)	(4.35)
Observations	500	525
R-squared	0.082	0.112

Table 3. Wages, House prices, and Manufacturing and Technology Employment

Dept Var: Land Availability	1980	2016
Log Manufacturing Employment	0.117***	0.0339
	(5.96)	(1.31)
Log Tech Employment	0.0583***	0.0975***
	(5.50)	(8.88)
Log House Prices	0.163***	0.211***
	(4.18)	(4.81)
Constant	0.666***	0.657***
	(8.32)	(6.89)
Observations	422	836
R-squared	0.358	0.653

Table 4. Relative Productivity Growth by Land Availability

Percent, 1980 to 2016

Years	Weighted Gamma Quartile	Relative Productivity Growth, Emp-weighted Mean
1980-2016	Quartile 1	-5.4%
	Quartile 2	-2.3%
	Quartile 3	0.8%
	Quartile 4	7.5%

Table 5. Basic Specification: Regressing Migration on House Price and Income Divergence, Accounting for Relative HP in Source CBSA

Dept Var: Bilateral Migration Coefficient	Coefficient
HP - Uphill	-0.00814***
	(-10.92)
HP - Downhill	0.00151
	(1.94)
Income - Uphill	0.0105***
	(5.68)
Income - Downhill	0.0199***
	(10.40)
Population over 54 in Destination CBSA	-0.0444***
	(-10.27)
Population over 54 in Source CBSA	-0.00951*
	(-2.29)
Relative Unemployment	-0.0218***
	(-8.77)
Relative Population Growth	0.00288**
	(2.66)
Log of Distance between Source and Destination	-0.0112***
	(-32.35)
Observations	393195
R-squared	0.135
t statistics in parentheses	
*** p<0.1 ** p<0.05 *** p<0.01**	

Table 6. Extended Specification Accounting for Absolute Differences in House Prices

Dept Var: Bilateral Migration	Coefficient
HP - Poor to Rich	-0.00746***
	(-9.09)
HP - Rich to Poor	0.000250
	(0.30)
HP - Poor to Less Poor	-0.00484**
	(-2.73)
HP - Poor to Poorer	-0.00317
	(-1.69)
HP- Rich to Richer	-0.0103***
	(-7.37)
HP - Rich to Less Rich	0.00152
	(0.97)
Income - Poor to Rich	0.00861***
	(4.16)
Income - Rich to Poor	0.0224***
	(10.98)
Income - Poor to Less Poor	0.00996***
	(4.23)
Income - Poor to Poorer	0.0242***
	(10.21)
Income- Rich to Richer	0.0134***
	(5.46)
Observations	**393195**
R-squared	0.136
t statistics in parentheses	
*** p<0.05 ** p<0.01 *** p<0.001**	

Table 7. Other Robustness Checks

	Using Inc Dummies instead of HP dummies	Using Households instead of Individuals	Only looking at observations prior to 2007	Running a population-weighted regression	Excluding superstar cities
HP - Uphill	-0.00665***	-0.00433***	-0.0106***	-0.0126***	-0.00309***
		(-10.78)	(-13.09)	(-9.06)	(-3.39)
HP - Downhill	-0.000392	0.00137***	-0.000771	0.00350*	-0.000942
		(3.34)	(-0.91)	(2.26)	(-0.99)
Income - Uphill	0.00920***	0.00471***	0.0281***	0.0151***	0.00785**
		(5.45)	(11.63)	(4.67)	(2.99)
Income - Downhill	0.0225***	0.00951***	0.0379***	0.0240***	0.0111***
	(9.78)	(10.80)	(15.45)	(7.37)	(4.04)
Distance in logs	-0.0113***	-0.00607***	-0.0117***	-0.0156***	-0.00751***
	(-32.20)	(-33.90)	(-33.03)	(-22.27)	(-20.88)
Observations	393194	393195	273382	455169078645	219349
R-squared	0.134	0.172	0.143	0.238	0.057
t statistics in parentheses					
*** p<0.05 ** p<0.01. *** p<0.001**					