Local Ties in Spatial Equilibrium

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May 20, 2020

Abstract

Someone who lives in an economically depressed place was probably born there. This paper shows that the presence of workers local ties – preferring to live in one's birthplace – leads to smaller migration responses. Smaller migration responses to productivity declines lower real incomes and make them more sensitive to subsequent shocks, a form of hysteresis. Additionally, local ties can persist for generations. Subsidies to economically depressed places where people have local ties also cause smaller distortions, since few people want to move to depressed places. Subsidies to productive places also increase aggregate productivity, since they lead to more migration.

Keywords: Migration, Local Labor Markets, Demography, Growth, Decline
JEL Numbers: J61, R23, E62, R58, H31, D61, J11

*Board of Governors of the Federal Reserve System; Mail Stop I-303; 20th Street and Constitution Avenue N.W.; Washington, DC 20551; mike.zabek@frb.gov. I owe particular thanks to my advisors, Dominick Bartelme, John Bound, Joshua Hausman, and Matthew Shapiro for patience, perspective, knowledge, and encouragement. Helpful comments from a number of people were also invaluable. These people include, but are not limited to Martha Bailey, C. Hoyt Bleakley, Charles Brown, Varanya Chaubey, Patrick Coate, David Green, John Laitner, Nick Moschovakis, Jessica Ott, Claudia Sahm, Robert Schoeni, Christopher Smith, Bryan Stuart, Erin Troland, Robert Willis, and numerous seminar participants. I also am grateful to David Dorn for sharing data and code both via his website and through personal correspondence. The research was supported in part by a NICHD center grant (R24 HD041028) to the Population Studies Center at the University of Michigan, through a Rackham Graduate School pre-doctoral grant, and through computational resources provided by Advanced Research Computing at the University of Michigan. The opinions, analysis, and conclusions are those of the author and do not indicate concurrence by the Federal Reserve Board, the Federal Reserve System, the US Census Bureau, anyone associated with these organizations, or anyone else. Results using non public data have been reviewed to ensure that no confidential information is disclosed. Previous versions of this research circulated as "Population growth, decline, and shocks to local labor markets" and "Implications of local ties in spatial equilibrium."

I Introduction

Migration should equalize differences across places, but does it? In models of spatial equilibrium (Rosen, 1979; Roback, 1982), people move until they are indifferent across places. Empirical papers, however, have found that migration responds slowly to economic shocks and that migration rates have been falling in the United States. Many people live near their birthplaces, and so people appear to have local ties – a preference to live near their birthplace.

This paper examines local ties through a Rosen and Roback style model. The model matches the fact that places have very different shares of their populations who were born in the same place. In the model, economically depressed places have residents who were born nearby and who chose to stay because of their strong local ties. Real wages are lower because population shrinks by less after a series of negative shocks. People also form local ties in new places over time, but local ties to depressed places can persist for generations.

So the paper brings partial equilibrium insights into a general equilibrium model. Several studies have found that many are reluctant to move (e.g. Kennan and Walker, 2011), but partial equilibrium effects are often undone. It is unclear how low rates of migration among a subset of workers will affect equilibrium outcomes, like population distributions, wages, rents, and welfare. For example, Cadena and Kovak (2016) find that the mobility of immigrants offsets the immobility of natives in equilibrium.[1] In fact, a classic critique of place-based policies designed to stimulate depressed areas (Austin, Glaeser and Summers, 2018) is that they induce place-based subsidies that undo increases in real wages by inducing workers to move into depressed areas (Glaeser and Gottlieb, 2008).[2]

Including local ties also explains why people would continue to live in economically depressed places – because they have meaningful local connections. Other studies have claimed

[1] Similarly, Modestino and Dennett (2012) find evidence that the mobility of renters tends to undo the immobility of home owners with negative equity.

[2] The literature on place-based policies also includes Neumark and Simpson (2015); Bilal and Rossi-Hansberg (2018); Chiara Criscuolo, Martin Ralf, Henry G Overman, and John Van Reenen (2019).

that people live in depressed places because inexpensive housing attracts people with low incomes (Notowidigdo, 2011; Ganong and Shoag, 2017; Bilal and Rossi-Hansberg, 2018). However, local ties can also explain why the people who live in depressed places were often born in those places.[3]

Local ties also induce effects that differ from traditional migration costs, as in Rappaport (2004), Kennan and Walker (2011), or Redding and Rossi-Hansberg (2017). Workers with local ties are concentrated in depressed places because local ties, like connections to family and friends, induce people to accept lower real wages to live in their birthplaces. And the accumulation of people with local ties leads to yet lower equilibrium real wages through higher labor supply and housing demand. Low real wages also make depressed places less appealing to outsiders who lack local ties. And so outsiders are reluctant to move in, even after positive shocks. The opposite dynamic occurs in growing places – migration acts as a shock absorber that lessens the impact of local shocks, as in Blanchard and Katz (1992).

My first step in the paper is to empirically document four stylized facts about local ties and economically depressed places. First, the typical American does not move very far – the median U.S. born adult lives within around 100 miles of where they were born. Second, there is a strong positive correlation between population declines and the share of residents born nearby. On average, a place that has expanded 2.5 percent slower will have 30 percent more of its population born nearby. Third, population losses are rare. Fourth, migration responses are smaller in depressed places where most people were born nearby.[4]

Next, I present a spatial equilibrium model that matches the four facts, formalizes the mechanisms behind them, forecasts long term dynamics, and allows me to study the impacts of place-based subsidies on equilibrium outcomes. I match the stylized facts by including local ties – a parameter describing a worker's preference to live in their birthplace. People

[3] Two appendices include the dynamics of worker skill, durable housing, and a non-homothetic preference for housing in my framework. My main policy conclusions are equally relevant when I extend the model to include both features. And my empirical results survive robustness checks for several alternative hypotheses.

[4] These four facts do not appear to be widely known, but it is unlikely that I am the first to point them out. For example, Glaeser and Gyourko (2005) also document that population losses are rare and several authors have noted that people are quite unlikely to move (Kennan and Walker, 2011; Diamond, 2016).

with strong local ties – high utility payoffs for living in their birthplaces – stay in depressed places that are unattractive to outsiders, leading to lower real wages and smaller migration elasticities. The model shows that smaller migration elasticities reflect the preferences of outsiders as much as the preferences of locals. I also include a law of motion for people's birthplaces that leads the model to converge to a steady state. But convergence takes generations. People's local ties are a function of economic fundamentals like productivity in the steady state.

The model overturns the simple story of equilibrium dynamics undoing the benefits of place-based policies. Place-based subsidies can actually be efficacious, but for different purposes in different places. Subsidies to high ties, depressed places decrease geographic inequality. Subsidizing a depressed place transfers income without changing population by very much, so it leads to only a small decrease in aggregate productivity. Subsidies to low ties, productive places increase aggregate productivity. Subsidizing a low ties place moves more people because of a higher migration elasticity. Migration to a productive, low ties place increases aggregate productivity and leads to higher wages in other places. Population reallocations also lead future generations to form ties to a place that is more productive.

The results build on mostly empirical and partical equilibrium papers that highlight mechanisms leading to local ties, along with other papers that find small migration responses to large shocks. One literature focuses on how social networks influence people's decisions to migrate (Munshi (2003); Yannay Spitzer (2015); Black et al. (2015)). Other papers have documented reasons why people could have local ties that lead them to live near where they were born. Workers receive some labor market benefits when they live close to their parents (Kaplan, 2012; Kramarz and Skans, 2014; Coate, Krolikowski and Zabek, 2019) and workers also appear to move closer to their birth places after job displacements (Huttunen, Møen and Salvanes, 2018). But young people can also earn more when they move away from their birth places (Shoag and Carollo, 2016; Nakamura, Sigurdsson and Steinsson, 2016), implying that many people have a strong preference to remain. Many recent papers have also found that migration is unusually slow given high returns (Bound and Holzer, 2000; Dao, Furceri and Loungani, 2017; Yagan, 2017; Chetty and Hendren, 2018). Finally, several papers also find that frictions in the housing market have increased geographic inequality (Glaeser and Gyourko, 2005; Notowidigdo, 2011; Hsieh and Moretti, 2015; Ganong and Shoag, 2017).[5]

Specifically, the framework shows general equilibrium effects of including workers with differing migration elasticities. Most notably, Cadena and Kovak (2016) and Albert and Monras (2018) show that immigrants are more mobile than natives. And Mangum and Coate (2018) show that changes in people's amount of history in places mirror declines in migration rates.[6] My paper enriches those studies by showing that increases in local productivity lead mobile people to concentrate in places with high real wages.[7]

The paper also relates to others that connect equilibrium models to more realistic microeconomic foundations. Related papers examine the impacts of local labor market boundaries (Manning and Petrongolo, 2017; Green, Morissette and Sand, 2017), introduce frictional unemployment into spatial equilibrium (Kline and Moretti, 2013; Beaudry, Green and Sand, 2014), calculate indirect effects of local shocks on other places (Hornbeck and Moretti, 2018), and add additional micro foundations to spatial equilibrium models (Coen-Pirani, 2010; Kennan and Walker, 2011; Davis, Fisher and Veracierto, 2013; Gregory, 2013; Monras, 2015; Diamond, 2016; Fu and Gregory, 2018).

The paper proceeds as follows. First, I document four empirical facts about economically depressed places. Second, I embed the four facts in an equilibrium model. Third, I show how places with high levels of local ties have lower real wages and I use the model to analyze place-based subsidies. I conclude with recommendations for policy and further research.

[5] Appendices A and B show how literatures on differential migration elasticities by worker skill and frictions in the housing market are consistent with the main results of the paper.

[6] Mangum and Coate (2018) refer to these preferences to live in one's (and one's parents') birthplace as "home attachments," but they appear to be similar in spirit to what I refer to as local ties.

[7] An interesting extension would be to study the effects of having a larger pool of relatively mobile workers, for example through increased immigration.

II Four Empirical Facts

This section describes the data and documents the empirical facts.

Data

The analyses use U.S. Census long form and ACS data provided via IPUMS (Ruggles et al., 2010), unless otherwise noted. The Decennial Census and American Community Survey (ACS) are well suited for this study because they contains data on wages, rents, labor force status, and birth places – the equilibrium outcomes of interest. Additionally, the data is from three percent of the population in the ACS and five percent of the population in the Census. This large size is necessary for examining outcomes in smaller rural areas.

I proxy for local ties by comparing workers' current locations with their birthplaces. Birthplaces perform important administrative functions – determining citizenship and social security numbers – and so administrative and survey data often include them. Birthplaces also predict people's subsequent location quite well, so they have been widely used by researches, particularly to estimate the long run impacts of childhood interventions (e.g. Kearney and Levine (2015); Stuart (2017)). Birthplaces imply local ties since someone's identity and childhood experiences are usually tied to their birthplace.

I define places using Commuting Zones (CZs, Tolbert and Sizer (1996)) that encompass both residences and workplaces. CZs match the intuition that people choose a place to live based both on its employment prospects and its quality as a place to live more generally. CZs also cover the entire continental U.S., which allows me to examine ongoing migration from rural areas. I keep these constructs fixed at their definition in 1990 to avoid spurious changes due to changes in geographic boundaries.

My measure of local ties is the proportion of people living in their state of birth, since this is the finest geography available in IPUMS.[8] The lack of further geographic specificity

[8] U.S. territories and foreign countries are generally the finest geographies for people born outside of US states.

could lead to some imprecision in empirical exercises, but it is unlikely to change the main conclusions. I recover very similar results using more detailed administrative data from the U.S. Social Security Administration and when I use other measures, like the amount of time someone has lived in their house. Appendix C discusses the distinction in more detail and presents additional evidence.

I focus on economic outcomes in roughly ten year increments: in 1980, 1990, 2000, and 2008. The roughly ten year increments are useful for looking at changes because the one time moving or migration costs for transporting personal effects are small relative to the flows of higher real wages and/or amenities over ten years.[9] Indeed, much of the previous literature has focused on ten year increments, using data from the Census (e.g. Bound and Holzer (2000); Notowidigdo (2011); Diamond (2016)). The one exception to the ten year rule is the period from 2000 to 2008, when I exclude the Great Recession by using the ACS three year estimates covering 2006, 2007, and 2008.

A few sample restrictions and data adjustments allow me to focus on changes in the labor market. I include only 22 to 64 year olds who are not living in group quarters like barracks, prisons, and dorms. I compute market wages using private sector workers with weights proportional to each person's total hours worked. In addition, I adjust wages and prices using a PCE deflator so they represent 2007 dollars. Appendix C provides additional details on the data and dataset construction.

Facts

This sub-section documents four empirical facts that guide the analysis. First, most people do not move far from their birth place. Second, migrants concentrate in growing places and depressed places contain people who were born nearby. Third, places infrequently lose population. Fourth, migration responses are smaller in depressed places where most people were born nearby.

[9] I also exclude Alaska, Hawaii, and Puerto Rico from the analysis since moving costs to and from these locations is likely to be more expensive.

Most People Live Close to their Birth Places

The first empirical fact is that half of U.S. born adults live within 50 miles of their birth place. Figure 1 shows this through an adaptive kernel cumulative density function of people's distances from their birth places in the 2000 Census.[10] The relationship is roughly linear with a log scale on the horizontal axis. About a quarter of adults live within ten miles of their birth places, about 60 percent live within 100 miles, and about 20 percent live more than 500 miles away.

More broadly, Figure 1 shows shows that migrants are a small, select group. Most people live close to their birth places.[11] And the fact that the group of migrants is so small will influence the analysis that follows in two ways. First, this relatively small group has become quite concentrated in places with low ties. Second, the tastes of this relatively select group of migrants will determine how many people will move in or out after a shock. Places that were unattractive to previous migrants will draw fewer migrants after a subsequent shocks.

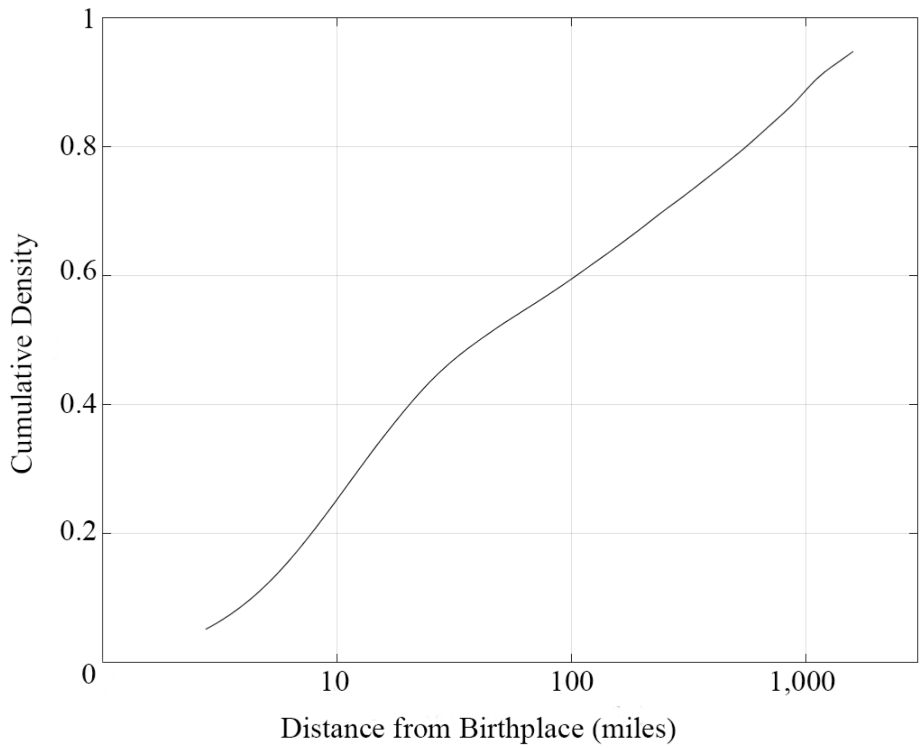
Migrants Concentrate in Growing Places

Inter-state migrants are highly concentrated in particular parts of the U.S., as shown in Figure 2.[12] The differences between the light and dark shades is quite large – the dark shade for Syracuse, New York, implies that 80 percent of residents were born in the same state, while the light shade for Denver, Colorado, implies that around 30 percent of residents were born in the same state. The most obvious pattern is higher shares of migrants in the west, and lower shares of migrants in the east, with the exception of the Atlantic seaboard. The darkest areas are in Appalachia, the Rustbelt, and the Mississippi Delta – areas that many

[10] The comparison is between the census tract that someone lives in in the 2000 census and the population weighted center of their birth county. The data and sample are a match between 2000 census complete count files and the Social Security Administration NUMIDENT. Birth counties are based on text describing someone's place of birth in the NUMIDENT – usually for a birth certificate. Stuart (2017) provides more details about the methodology. The data and links are available after an approval process via U.S. Census Restricted Data Centers.

[11] Some demographic groups, like people with college educations, are more likely to move, but even then they typically find that at least 40 percent of college educated adults live in their state of birth (Bartik, 2009).

Figure 1: Distances Adults Live from their Birthplaces



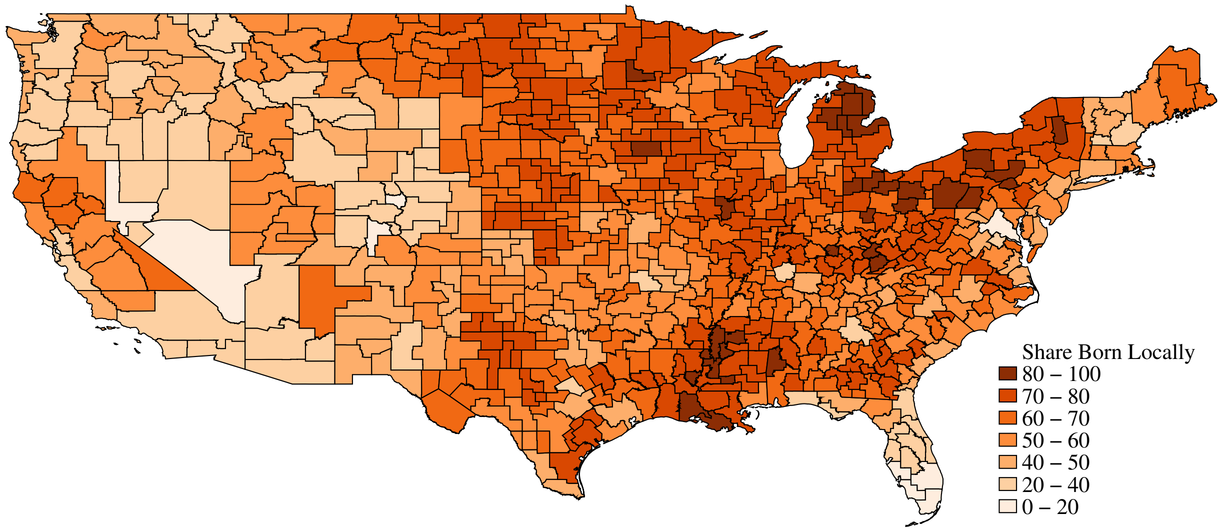
Note: Most U.S. born adults live within around 50 miles of their birthplaces. However, a substantial minority of people also live very far from where they were born. This shows an adaptive kernel density plot of the distances that people live from their birthplaces. The underlying data is the 2000 census complete count data linked to the SSA NUMIDENT. Top and bottom tails are suppressed to ensure respondent confidentiality.

would classify as economically depressed.

Economic distress leads to residents with stronger local ties. To see this, consider the experiences of Dayton, Ohio, and Dallas, Texas.[13] Figure 3 shows the population in each commuting zone, broken out by people who were born in the same state (born locally) and people who were born anywhere else (born outside, which includes the foreign born). In 1970, Dallas and Dayton had a similar populations and two thirds of people were born locally in each area. But Dallas has grown much faster since 1980 because outsiders have moved in. In 2008, less than half of Dallas' population was born in Texas. Dayton still contains mostly people who were born in Ohio.

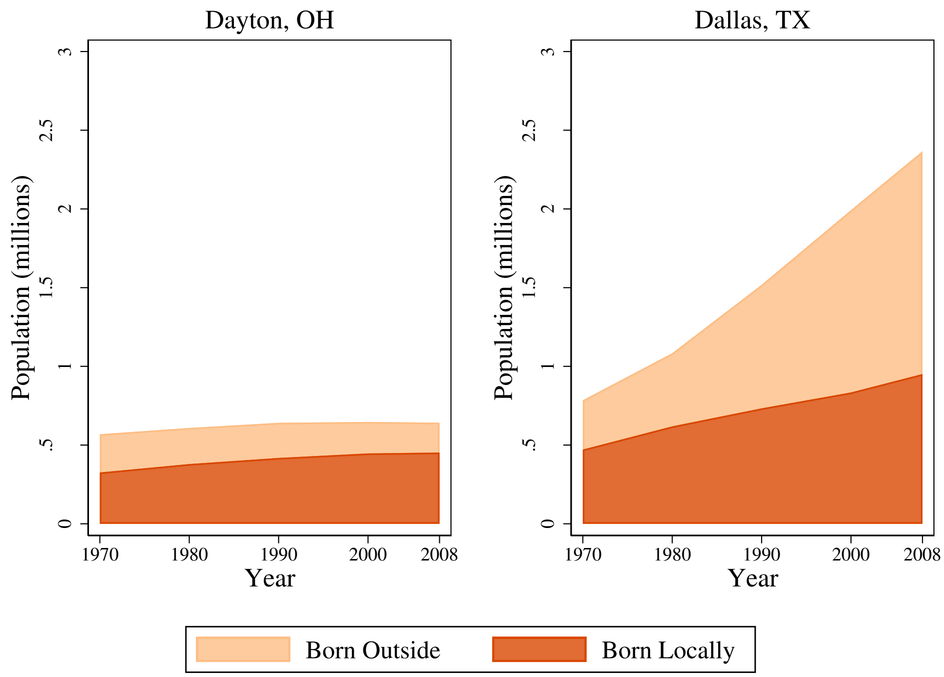
[12]The figure using the amount of time someone has been in their house, which is not affected by a state's size, is in Appendix A.

Figure 2: Shares of Residents Born in the Same State



Note: This maps commuting zones in the continental U.S. with shading proportionate to the share of residents who were born in the same state they live in. Places in the west and cities in the south have much lower shares than places like Appalachia, the Rustbelt, and the Mississippi Delta. Data are from the 2006-2008 ACS three year estimates and use nationally representative weights.

Figure 3: Population Changes in Two Cities

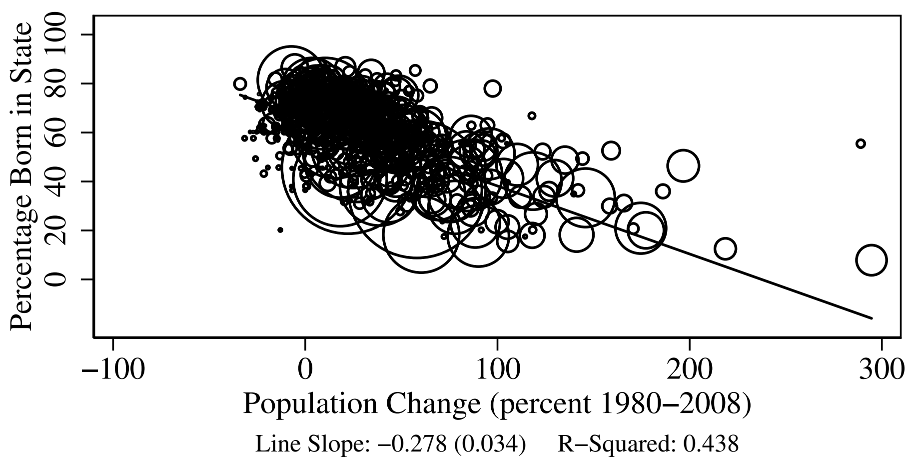


Note: Each figure shows population in each year, broken out by the number of people born in the state and the number born outside of the state. Dallas grew faster than Dayton over the period by attracting people who were born outside of the state. Data are from the long form decennial census and the ACS 3 year estimates (2006-2008) and are weighted to be nationally representative. The two cities are defined as the commuting zones containing them.

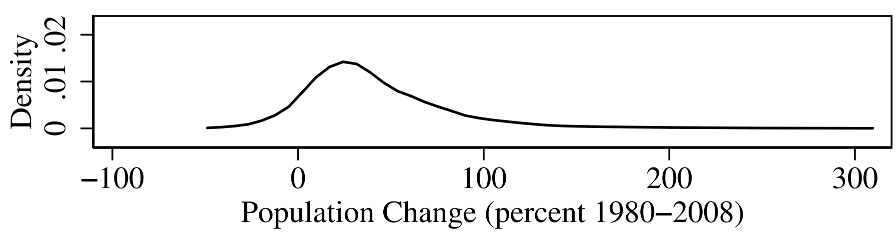
This link between outsiders moving in and increases in population applies more generally. The plot in Panel A of Figure 4 shows the robust negative relationship between population growth from 1980 to 2008 on the horizontal axis and the percentage of residents who were born locally on the vertical axis, measured in 2008. The interpretation of the regression line is that in a CZ whose population increased 100 percent between 1980 to 2008, about 30 percent less of the population will have been born in the same state.

Figure 4: Population Changes and Local Ties

Panel A: Percentage Born in State



Panel B: Density



Note: The figures show a strong and economically significant negative relationship between population changes and the share of population born nearby. They also show that the distribution of population growth is strongly right skewed, and that long term population decline is rare. The top plot is a scatter plot of population changes and the proportion of residents born nearby where each circle is a CZ with a radius proportional to its population in 1980. The regression line is from a weighted least squares regression, using the population weight. The bottom plot is an adaptive kernel density plot of the distribution of population changes from 1980 to 2008 across CZs weighted by initial population. The adaptive kernel density uses an epanechnikov kernel with a bandwidth parameter of 15. Data are from the 1980 census and 2006-2008 ACS. Table C.8 also lists the percentage born in state and population changes for all commuting zones that had at least 500 thousand adult residents in 1980.

Places where people have higher levels of local ties also show signs of economic distress.

Table 1 presents summary statistics broken out for places with high ties – places where more than 60 percent of workers born were locally. Places with high ties have smaller populations, lower wages, lower rents, lower shares of college graduates, slightly older populations, and lower shares of foreign born residents. They also have similar rates of labor force participation and unemployment, despite having lower wages and lower shares of college graduates.[14]

Table 1: Summary Statistics

	Mean	StD	Low Ties	High Ties
Population (thousands)	188	532	326	123
Percent in labor force	74.8	5.4	74.6	74.9
Real wages (hourly $)	15.6	2.2	16.6	15.2
Real rents (monthly $)	524	117	605	487
Percent locals	64.4	15.8	45.0	73.3
Average time in house (yrs)	9.0	1.4	7.7	9.5
Percent unemployed	3.8	1.3	3.9	3.8
Percent foreign born	4.2	5.4	7.8	2.5
Percent migrated	11.3	5.4	16.7	8.8
Percent college educated	42.7	11.3	49.2	39.7
Percent under 35	37.9	5.7	38.5	37.7
Percent over 50	25.9	3.1	24.8	26.4
Bartik shifter (percent)	-9.5	22.5	-11.2	-8.6
Chinese imports in 1990s	-1.2	1.8	-0.7	-1.4
Chinese imports in 2000s	-2.6	3.0	-1.8	-3.1

Note: The tables show unweighted summary statistics for the sample of 722 continental CZs for 1980, 1990, and 2000. The first columns show the mean and standard deviation among all CZs, the next two show means for areas with low and high ties (above or below 60 percent locals). The Bartik and Chinese import variables are measured as changes in the period when they are relevant.

[14] Appendices A and B assess robustness of my empirical results and my modeling framework to other differences between places with high and low ties. Empirically, the results are not sensitive to allowing differing responses by an area's age composition, the share of the population that is college educated, the share of the population working at baseline, two measures of rents in the spirit of Glaeser and Gyourko (2005), and other robustness exercises. The model results are equally meaningful when I extend the model to include a concave housing supply curve, heterogeneous housing expenditure shares, and imperfectly substitutable worker skill levels.

Population Losses are Rare

Several commuting zones have doubled in size or more over roughly thirty years. But it is rare for a commuting zone to shrink, and it is exceptionally rare for a CZ to lose more than a quarter of its population. The adaptive kernel density in Panel B of Figure 4 shows that the distribution of population changes is right skewed and that population declines are rare.

Many researchers have focused on the right tail of this distribution, including many papers focusing on Zipf's law (Gabaix, 1999); fewer researchers have focused on the lack of mass below zero. The lack of mass below zero suggests that some friction prevents populations from shrinking by too much. One possibility is the presence of local ties, or connections that people form to the places where they have lived. Another possibility, explored in Glaeser and Gyourko (2005), is that the durability of the housing stock makes housing so inexpensive that people are still willing to live in depressed places. I explore how local ties and durable housing could interact in Appendix B.

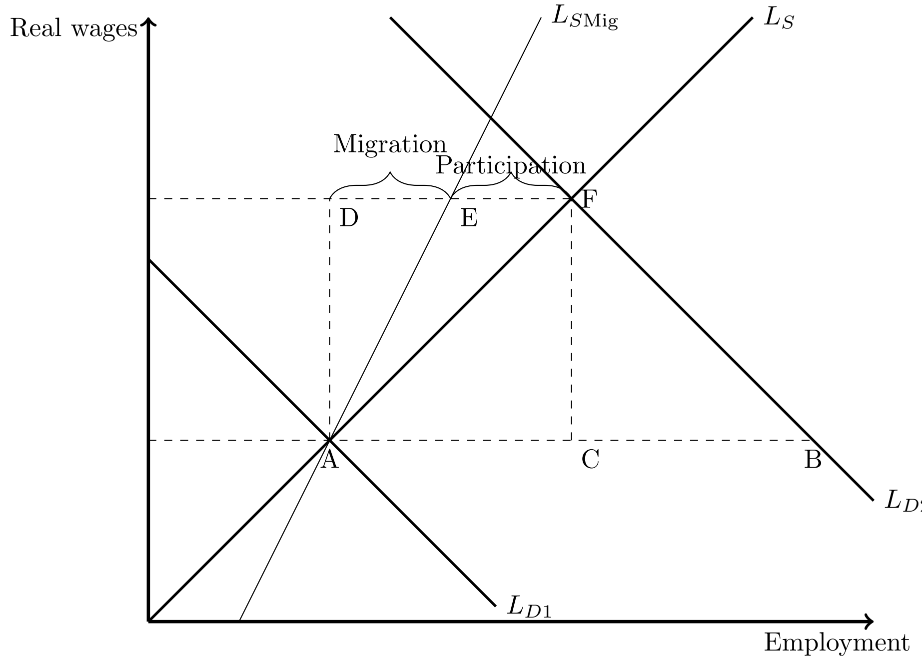
Smaller Migration Responses in Depressed Places

Migration responses are smaller in depressed places where more people were born nearby. This subsection develops and then applies a basic framework to interpret equilibrium effects of a change in labor demand in terms of labor supply elasticities. I analyze several plausibly exogenous changes in labor demand that are commonly used in the literature. The results show that migration responses are smaller in depressed places where more people were born nearby.

Framework

The system of labor demand and supply in Figure 5 illustrates the impact of lower migration on equilibrium outcomes. It plots out total employment against real wages (which include wages and rents) in a local labor market that begins in equilibrium at point A. Labor demand is downward sloping and initially at L_{D1}, and labor supply is upward sloping at L_S. Labor supply incorporates two different margins – migration and participation. To separate out these two effects, $L_{S\text{Mig}}$ shows how labor supply would change if participation was held constant at the same level as point A and only migration were allowed to vary.[15]

Figure 5: Effects of a Labor Demand Shock Along Multiple Margins



A change in labor demand from L_{D1} to L_{D2} shows the relative importance of the two margins of labor supply – migration and participation. The overall effect is to move the equilibrium from point A to point F, with higher levels of both employment and of real wages. To see the impact of the two labor supply margins, consider how each responds to the equilibrium increase in real wages from A to D. The increase in real wages induces a net in migration, increasing employment from D to E, and it also increases participation among people already in the area, from E to F. If one is interested in the migration elasticity, or the slope of $L_{S\text{Mig}}$, then one can use these two responses to see its relative magnitude.[16] Empirically, I can proxy for the distance from D to E by using the change in population after the labor demand shock. Similarly, I can proxy for the distance from E to F by using the change in labor force participation. If the change in population is large relative to either the

[15] Empirically, I do not attempt to compute real wages. Instead I present separate results for nominal wages and rents (for housing). These could be combined to compute a proxy; Albouy (2016) suggests that local rents can proxy for 1/2 of local consumption, while national accounts suggest that about 1/3 of consumption is spent on housing and utilities.

change in participation or to the increase in real wages, or both, then migration is relatively fluid.

Responses along each margin show the equilibrium implications of a lower migration elasticity. As $L_{S\text{Mig}}$ gets more vertical, so does L_S and so the equilibrium real wage response to the change in demand tends to be larger. This larger real wage response will also tend to increase the participation margin response, meaning that more people will be drawn into the labor force after an equivalent change in labor demand. In the case of this increase in labor demand, the implication is that residents of places with lower migration elasticities will have more to gain from an increase in labor demand, since they will earn higher real wages after equivalent demand shocks. The increases in participation may also be advantageous if policymakers have concerns about the long term effects of joblessness (Austin, Glaeser and Summers, 2018). But areas with smaller migration elasticities will have more to lose from decreases in labor demand.[17]

Labor Demand Shocks

I isolate plausibly exogenous shocks to local labor demand using two shift share approaches. The first, developed in Bartik (1991), projects national employment changes. The second, developed in Autor, Dorn and Hanson (2013), projects changes in imports from China. They give reassuringly similar results.

The first approach is a Bartik (1991) shifter, which I construct for the period from 1980 to 1990. For area j, from 1980 to 1990, the Bartik shifter is a weighted average of changes in industry level employment (L) outside the of an area ($-j$), where the weights are the

[16]If I assume a constant elasticity of labor demand (η_D), labor supply due to migration ($\eta_{S\text{Mig}}$), and labor supply due to participation ($\eta_{S\text{Part}}$), then the size of the equilibrium changes will be simple functions of the three elasticities and the size of the labor demand shock, $B - A$. The change due to migration ($E - F$) is $\eta_{S\text{Mig}} \frac{B-A}{\eta_D + \eta_{S\text{Mig}} + \eta_{S\text{Part}}}$ and the total change in employment ($F - D$) is be $(\eta_{S\text{Mig}} + \eta_{S\text{Part}}) \frac{B-A}{\eta_D + \eta_{S\text{Mig}} + \eta_{S\text{Part}}}$. Conveniently, the ratio of these two terms is the ratio of the migration elasticity to the total labor supply elasticity. Also, the change in wages ($F - C$) is $\frac{B-A}{\eta_D + \eta_{S\text{Mig}} + \eta_{S\text{Part}}}$.

[17]I do not distinguish between increases and decreases in any of my outcomes. This is because there are gross flows into and out of areas regardless of whether population is increasing or decreasing. Monras (2015), for example, documents that population changes – including decreases – are often driven by the behavior of people moving in. Responses in the model do not discontiously change at zero, but they exhibit asymmetric responses for population increases and decreases, as in Dao, Furceri and Loungani (2017).

industry's initial share of employment in area j. The last rows of Table 1 shows that these shifters had a wide spread in terms of predicted percentage point changes in employment, but similar average values in places with high and low ties.[18]

$$\Delta \hat{L}_{j,1990} = \sum_{i \in \text{ind}} \left(\frac{\Delta L_{i,-j,1990}}{L_{i,-j,1980}} \right) \frac{L_{i,j,1980}}{L_{j,1980}}$$

The second approach uses increases in Chinese imports in particular industries in the 1990s and early 2000s, owing to Autor, Dorn and Hanson (2013). And the equation is quite similar. For area j from period $t-1$ to t, the trade shifter is a weighted average of changes in Chinese imports to the US, where the weights are the industry's initial share of employment in areas j. In the equation, $\Delta M_{i,t}$ measures changes in imports from China in thousands of dollars. For comparability with the sign of the earlier regressions, I multiply it by negative one and so the instrument is in units of thousands of dollars *fewer* imports per worker. The last rows of Table 1 shows that these shocks had somewhat larger impacts on places with high ties.[19]

$$\Delta \hat{L}_{j,t} = \sum_{i \in \text{ind}} \left(\frac{-\Delta M_{i,t}}{L_{i,t-1}} \right) \frac{L_{i,j,t-1}}{L_{j,t-1}}$$

These two approaches rely on the aggregate changes being large and unrelated to unobservable changes in labor supply in areas that were the most affected (Borusyak, Hull and Jaravel, 2018; Goldsmith-Pinkham, Sorkin and Swift, 2018). In the early 1980s, changes in trade patterns, exchange rates, and capital investment greatly affected particular industries, like auto manufacturing. These changes are unlikely to have been due to changes in labor supply behavior in affected areas. And the emergence of Chinese import competition was

[18] Bartik (1991), Blanchard and Katz (1992), and Bound and Holzer (2000) include changes in employment within the region in question in their calculation of industry wide changes in national employment, which simplifies the construction of the variables. I follow more recent practice, however, and calculate "leave one out" Bartik instruments by excluding each local labor market in question from the nationwide changes used to project employment changes in each industry.

[19] Autor, Dorn and Hanson (2013) present their regressors using different notation and with a different ordering of terms, but I mirror the earlier notation here to keep the exposition as simple as possible. I also use the variables from their published dataset, so I am mechanically using the same variation.

similarly driven by factors unrelated to local labor supply behavior. In fact, the changes were literally outside of the US, since I follow Autor, Dorn and Hanson (2013) in instrumenting using Chinese import penetration in other countries.[20]

I estimate the effects of these changes in labor demand separately for areas with high and low levels of local ties using roughly 10 year changes in the population, in the labor force participation ratio, in residualized wages, and in local rents.[21] The proxy for local ties is having more than 60 percent of workers born locally ($\mathbf{1}_H = 1$) at the beginning of the roughly ten year period.[22] $\Delta\hat{L}_{j,t}$ is the labor demand shifter and so the β coefficients in the equation below show the effect of these shocks for the specified subset of local labor markets.

$$\Delta y_{j,t} = \alpha_t + (\beta_L(1-\mathbf{1}_H) + \beta_H \mathbf{1}_H)\Delta\hat{L}_{j,t} + \gamma_H \mathbf{1}_H + \gamma_X X_{j,t-1} + \epsilon_{j,t} \tag{1}$$

I estimate the equation in first differences, which controls for time invariant effects, and I include other controls to pick up differences in trends. The controls include time dummies (α_t) and several other demographic characteristics of individual local areas (X).[23] Standard errors are clustered by the state that the CZ had the plurality of its population within.

Results

Migration responses are smaller in places with higher levels of local ties. The results in Panel A of Table 2 show smaller population changes in areas with high local ties after changes

[20] Note that this argument does not rely on industry employment shares being exogenous. Also note that the critiques in Borusyak, Hull and Jaravel (2018) of Autor, Dorn and Hanson (2013) style instruments are focused on attributing changes in industry demand to changes in international trade. They do not appear to apply to my use case, where the interpretation of the instrument is only as a plausibly exogenous labor demand shifter.

[21] Residualized wages are residuals from a regression of log wages on four categories of education, gender, whether the worker was black, and whether the worker was foreign born. I do this separately in each year using the labor supply weights.

[22] I chose 60 percent because it creates roughly two equal sized groups in most years. Triple differences specifications that do not rely on a specific cutoff in Appendix A give similar results.

[23] In addition to dummy variables for each bin of local labor markets, I control for the share of working age adults outside the labor force, unemployed, foreign born, having entered the state in the past five years, and the share of adults who are under 35 and 50 to 64. Appendix A shows that the specifications are not sensitive to the choice of controls. I also include interactions of some of these controls with the labor demand shifters in Appendix A. I find no evidence that this is the case.

in the Bartik shifters. A one percentage point predicted increase in employment in an area with high local ties increases the population by a statistically insignificant 0.4 percent. And the population increase of almost 1.5 percent in a low ties area is large relative to a one percent predicted increase in employment. The one percentage point difference between population responses in high and low ties places is also statistically significant. There are no statistically significant differences in any of the other outcomes. In high ties places the lack of other responses supports the finding by Blanchard and Katz (1992) that places can respond to shocks through changes in populations as opposed to wages or other labor supply margins. The results are especially noisy in terms of wages, however, so I am unable to rule out large responses. I also find no evidence that differences in housing affordability drive the different population responses since rents do not appear to respond deferentially across high and low ties places.

Places with high local ties adjust in terms of wages and labor force participation, as opposed to population. Panel B of Table 2 shows that a $1,000 per worker decrease in import competition from Chinese firms in a low ties area leads to a 0.8 percent increase in population in a low ties area and a statistically insignificant change in a high ties area. Instead, high ties areas see labor force participation increase by 0.8 percentage points and wages increase by around 0.6 percent. High and low ties areas also experience similar increases in rents.[24]

The results in Table 2 also persist after a number of robustness checks that report in Appendix A. The robustness checks focus on other differences between high and low ties places – in terms of educational attainment, the local age structure, and local housing markets. An area's level of local ties continues to predict the different response that I report here after I include interactions of these variables with the labor demand shifters. So my measure of

[24]Panel B also keeps with the finding of very large non-participation responses in Autor, Dorn and Hanson (2013). The larger non-particpation responses support a literature on both declining recent migration as well as a more vibrant non-participation margin since the 1980's because of the entry of women and the growing importance of male labor force non-participation. Finally, one additional explanation for their finding of large non-participation responses after Chinese trade shocks is to combine the finding of small population and robust non-participation responses in high ties places with the fact that Chinese import shocks affected high ties areas more than low ties areas (Table 1).

Table 2: Labor Demand Shocks by Share Born Locally

Panel A: Bartik Shifter in the 1980s

	Population	Participation	Wages	Rents
Bartik: High ties	0.37	0.08	0.29	0.29
	(0.22)	(0.03)	(0.21)	(0.25)
Bartik: Low ties	1.46	0.05	0.26	0.25
	(0.39)	(0.03)	(0.24)	(0.33)
High ties	15.40	-0.42	-0.35	-1.22
	(5.32)	(0.45)	(4.40)	(5.52)
P-val: No diff	0.01	0.29	0.92	0.93
R^2	0.58	0.36	0.35	0.54
Observations		722		

Panel B: Chinese Import Shifter in the 1990s and Early 2000s

	Population	Participation	Wages	Rents
Imports: High ties	-0.10	0.78	0.64	1.19
	(0.30)	(0.17)	(0.18)	(0.57)
Imports: Low ties	0.78	-0.01	0.09	1.37
	(0.38)	(0.10)	(0.25)	(0.28)
High ties	-5.42	2.17	0.36	-2.76
	(1.58)	(0.41)	(0.89)	(1.81)
P-val: No diff	0.02	0.00	0.08	0.78
R^2	0.47	0.54	0.12	0.18
Observations		1444		

Note: Panel A reports OLS regression coefficients from regressing each outcome on a predicted percentage change in employment (Bartik, 1991) and Panel B reports two stage least squares estimates using Chinese trade with other countries to instrument for Chinese imports to the U.S. in thousands of dollars per worker (Autor, Dorn and Hanson, 2013). The estimates are allowed to vary by whether a place has a population with high ties, which is defined as having 60 percent of residents born in the state they currently live in. The p-values are from Wald tests for the hypothesis that the effect is constant for high and low ties areas. Population stands for changes in log population 22 to 64, participation stands for the labor force participation rate (in percent), wages are residualized log wages, and rents are log gross rents. Units of observation are 1990 Commuting Zones, which are are weighted by initial population, and the controls are: the birth share variable used in the interaction term, the share of working age adults outside the labor force, unemployed, with a college education, foreign born, having entered the state in the past five years, and the share of adults who are under 35 and 50 to 64. Standard errors in parentheses are clustered by state, which is determined by the plurality of residents. Data are from the decennial census and ACS including all CZs in the continental US.

local ties predicts differences in responses independently of differences in population age, education, and the housing market. The tables also show a triple difference specification, so the 60 percent cutoff does not drive the results.

Overall, migration elasticities are smaller in places where people have stronger local ties. Appendix D shows this by using the labor demand shocks as instruments for changes in local incomes in a regression on log local population. Migration elasticities are an order of magnitude lower in places with high levels of local ties – 0.1 versus around 1.

III Model

This section presents a Rosen and Roback style model of spatial equilibrium model that incorporates local ties – a preference for living in one's birth place. Incorporating local ties allows me to match all of the facts that I laid out above – that people do not move very far, that residents of depressed places have strong local ties, that population declines are rare, and that migration responses are smaller in depressed places – in a relatively parsimonious model of spatial equilibrium.

The model also allows me to analyze how local ties affect the equilibrium. An increase in a place's local ties leads real incomes to fall by more since people with strong local ties will accept low real incomes. The drop in real incomes makes depressed places even more unattractive to outsiders, and this lowers migration responses by even more.

In the long run, the model enters a steady state where local ties have no influence. Steady state occurs because people with local ties to depressed places die. Children are born with more ties to productive places, since I assume that births are proportionate to population. Permanent subsidies to depressed places are undesirable, since they keep populations, and new births, in depressed places permanently. But a subsidy that slowly declines will have a only small effect since convergence is so slow.

Setting and agents The model is in Rosen and Roback type spatial equilibrium across a large number of places, indexed by j. Workers can move in each period without any mobility cost, but they have ties to their birthplace, indexed by k. I use i to index the size of these local ties, which are utility benefits that workers enjoy when they live in their birthplaces. In addition, each place has an amenity value (A_j) and a wage (w_j) that apply to both locals and outsiders. Local firms set local wages based on market conditions, which includes the level of local productivity (θ_j). Landlords set rents (r_j) based on an imperfectly elastic supply of potential housing. I also allow the government to levy net subsidies to particular places (g_j) so long as they balance the budget.

Workers

Workers choose where to live based on their consumption in the place as well as the amenity value that they attach to living in the place, which varies based on the worker's birth place. Specifically, a worker of type i, living in place j, and with birth place k, has Cobb-Douglas utility in a consumption good (c_j) and local housing (h_j) with a housing share parameter of α^H. The worker also values a local amenity (A_j) and a type I extreme value distributed error term (ξ_{ij}).

$$u_{ijk} = (1 - \alpha^H)\ln(c_j) + \alpha^H \ln(h_j) + A_j + \mathbb{1}(k = j)\mu_i + \xi_{ij}$$

A worker's local tie to k is the μ_i term that gives them additional utility when they live in k. For tractability, I assume that the distribution μ_i is normal and that it has the same shape in all places. So people are no more attached to depressed places at birth. Instead, these aggregate differences in local ties emerge as a result of people selecting to live in depressed places.

The budget constraint in place j balances local wages w_j, local rents r_j, and the possibility of a net subsidy from the government g_j that varies based on where someone lives.[25] I

[25] I normalize the price of the consumption good to one, so it is the numerare.

include only one skill level here, but Appendix B shows that the main points also apply to an extension with different worker skill levels. I also assume that workers inelastically supply labor, following the literature on spatial equilibrium.[26]

$$c_j + r_j h_j = w_j + g_j$$

The setup yields a log linear indirect utility function that is a function of the prices, subsidies, amenities, local ties, and other idiosyncratic factors (ξ_{ij}). I separate common from idiosyncratic factors by denote the prices, subsidies, and amenities that apply to all residents' utilities with real incomes, ω_j.

$$\begin{aligned} u_{ijk} &= \ln(w_j + g_j) - \alpha^H \ln(r_j) + A_j + \mu_i \mathbb{1}(k = j) + \xi_{ij} \\ u_{ijk} &= \omega_j + \mu_i \mathbb{1}(k = j) + \xi_{ij} \end{aligned}$$

The payoff is a formula for the likelihood that an individual worker lives in place j (ψ_{ijk}), which is an important part of the analytic migration elasticity in the model. The parameter ψ_{ijk} increases in both ω_j and μ_i. It also varies with the spread of the type I extreme value term (σ_ξ).

$$\psi_{ijk} = \frac{\exp\left(\frac{\omega_j + \mu_i \mathbb{1}(k=j)}{\sigma_\xi}\right)}{\sum_{j' \in J} \exp\left(\frac{\omega_{j'} + \mu_i \mathbb{1}(k=j')}{\sigma_\xi}\right)}$$

Production

Local good varieties are produced by a representative, perfectly competitive local firm. The local firm uses a Cobb-Douglas production function to combine capital (K_j), supplied at interest rate ρ with local labor (N_j) to produce Y_j of the local good. The place has a

[26] Appendix D provides a simple way to connect a wide class of models, including this one, to the empirical results that include employment to population ratios.

specific productivity θ_j that is effectively a proxy for the place's economic prospects. The α_Y parameter is the same everywhere.

$$Y_j = \theta_j K_j^{\alpha^Y} N_j^{1-\alpha^Y}$$

A perfectly competitive national firm produces consumption goods out of local goods using a CES aggregator. It buys each local good at a price of p_j, to combine them into the numeraire consumption good Y. The Armington elasticity (of substitution) between local goods is η^Y and ϕ_j is a demand shifter for each local good.

$$Y = \left(\sum_{j' \in J} \phi_{j'}^{\frac{1}{\eta^Y}} (Y_{j'})^{\frac{\eta^Y - 1}{\eta^Y}} \right)^{\frac{\eta^Y}{\eta^Y - 1}}$$

Housing

As places grow, housing becomes more expensive. Local rents, r_j depend on demand from workers and an upward sloping housing supply curve, with elasticity η^H.[27]

$$H_j^S = r_j^{\eta^H}$$

Equilibrium

The model's equilibrium is a set of prices and quantities (p_j, w_j, r_j, N_j) where agents behave optimally and markets clear.

$$N_j = \sum_{j' \in J} \sum_{k' \in K} \psi_{i'jk'} N_{i'k'} \tag{2}$$

[27] The common interpretation of this setup is that absentee landlords provide housing by developing land, which abstracts from the investment motive for owning a home. A concern could be that people are locked into houses due to housing price declines, but the literature on the size of the housing lock in effect is mixed (e.g. Ferreira, Gyourko and Tracy (2010); Bricker and Bucks (2013); Valletta (2013)). So abstracting from these effects is reasonable, particularly since they would not apply to the 40 percent of the population that are renters.

$$w_j = (1-\alpha^Y)(p_j\theta_j)^{1/(1-\alpha^Y)}\left(\frac{\alpha^Y}{\rho}\right)^{\alpha^Y/(1-\alpha^Y)} \tag{3}$$

$$r_j = \left[\alpha^H w_j N_j\right]^{\frac{1}{1+\eta^H}} \tag{4}$$

$$\theta_j N_j \left(\frac{p_j\theta_j\alpha^Y}{\rho}\right)^{1/(1-\alpha^Y)} = Y\frac{\phi_j}{p_j^{\eta^Y}} \tag{5}$$

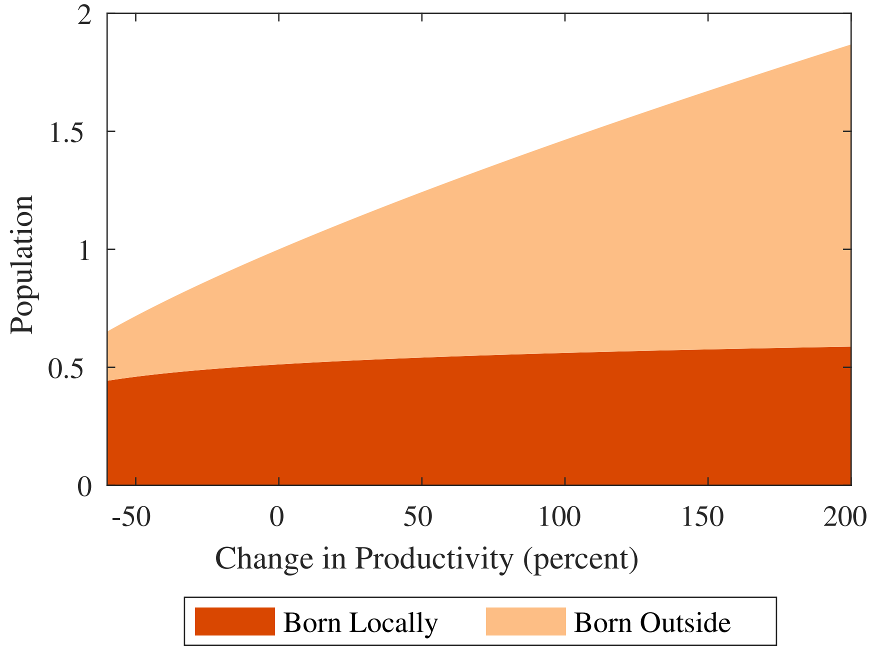
The Distribution of Local Ties Across Places

Historical changes in productivity determine the model's distribution of local ties. Mechanically, I start the model at a steady state where equal fractions of workers in all places were born nearby. I then change the local productivity terms (θ_j) to create a distribution of places where different fractions of workers were born nearby.

Figure 6 shows model simulations of how large, one time productivity changes lead to changes in both total population and the share of people born locally.[28] The x axis shows productivity shocks, while the y axis shows population broken out by where workers were born and normalized to one in a place with no change in productivity. Positive productivity shocks lead to increases in population through increases in the number of outsiders, while negative productivity shocks lead to a concentration of locals and smaller decreases in population, since the place becomes unappealing to outsiders.

[28]The simulations use the model's baseline calibration, which I explain below.

Figure 6: Population after Productivity Changes in the Model



Note: Positive productivity shocks lead to increases in population through increases in the number of outsiders, while negative productivity shocks lead to a concentration of people in the place and smaller decreases in population. The y axis shows total population broken out by people who were and were not born in the place, normalized to 100 for no change in productivity. The x axis shows percentage changes in productivity times. The results are for the baseline calibration after the specified change in the model's productivity parameter, θ_j.

Figure 6 also shows that the model is able to match the empirical facts that I outlined above. Places that had negative productivity shocks have a similar number of people who were born locally, but a much smaller number of outsiders. This lack of outsiders matches with the finding that economically depressed places tend to house mostly people who were born locally.

I use one time changes in productivity to mimic economic decline over a decade or two. Since population changes are quite persistent (Blanchard and Katz, 1992), cumulative changes can be quite large over ten to twenty years.

It should be possible for local ties to evolve over long time frames, and so I include a law of motion for local ties to model how these evolve over longer periods of time while keeping total population stable. The essential assumptions are that new ties are formed proportionate to population and that new people receive a local tie to their birthplace that comes from the same distribution for all birth places.

The number of people born in place k in the next period is equal to the number of people with ties last period who survive from last period plus the number who are born this period. I assume that people have a fixed and unchanging likelihood of dying each period (s_D) so $N_k(1-s_D)$ people will survive with a local tie to place k. New people – children – are born according to the current distribution of population. So $\sum_{k'} N_{kk'} \frac{s_D}{1+s_F}$ people will be born – the first term is the current population and the second term is a scaling parameter to keep both a constant population and a constant share of the population being foreign born.[29]

$$N'_k = N_k(1-s_D) + \sum_{k'} N_{kk'} \frac{s_D}{1+s_F}$$

In the long run, the law of motion implies a steady state where the number of people who were born in the place is equal to the population over one plus the share of foreign born people in the country.[30]

$$N_k = \frac{\sum_{k'} N_{kk'}}{1+s_F}$$

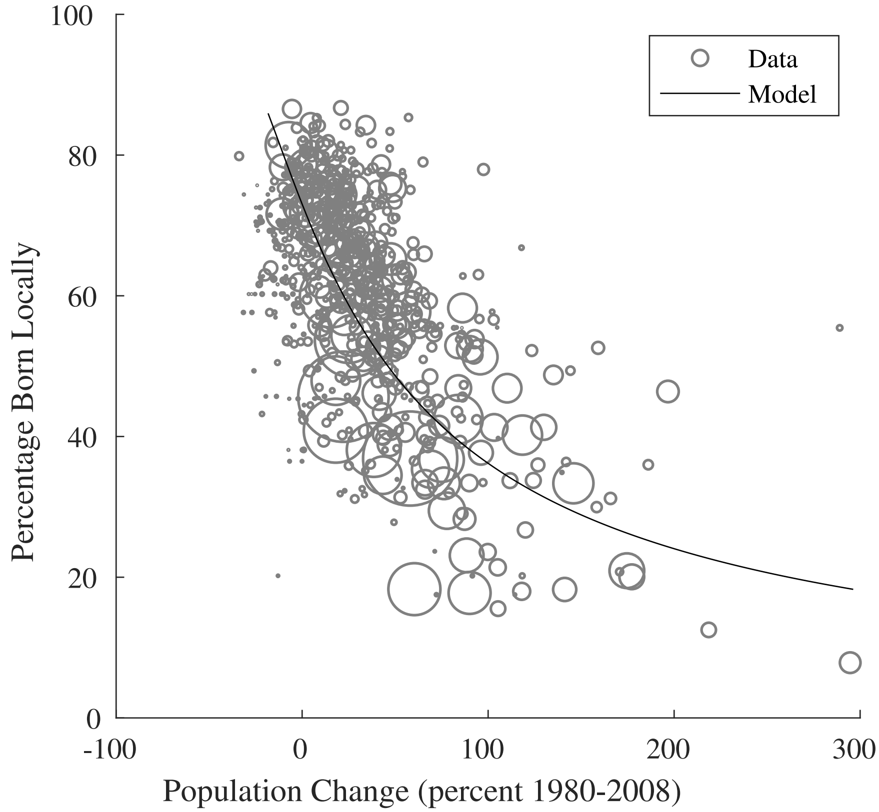
Calibration

The objective of the calibration is to find realistic parameter values to illustrate the impact of adding local ties into an otherwise standard model of spatial equilibrium. So I mostly use parameters from the literature. But an obvious exception is the distribution of local ties, since I cannot rely on previous literature. To overcome this I use the method of simulated moments to match an important empirical fact that I outlined above.

[29] I assume is that people change the distribution of people's future local ties by moving without considering how this will affect future periods. So I rule out either a parent deciding to live in their birth place because it will lead their children to have a connection to the place, or a parent deciding to live somewhere else to cultivate an attachment to that place by their child.

[30] It is straightforward to show that this steady state is stable and unique. Also, note that not all of these people will live in their birth place.

Figure 7: Estimation: Predicted and Observed Percentages Born Locally



Note: I set the distribution of local ties (μ_i) to minimize the squared deviation with the joint distribution of population changes from 1980 to 2008 and the percent of residents born locally in the data. The line in this figure shows the relationship in the model while the circles show the observations in the data with their radius representing each CZ's initial population.

The target for the estimated distribution of local ties (μ) is the joint distribution of commuting zone level population changes from 1980 to 2008 and the share of people who were born locally in 2008.[31] The inverse relationship of these two variables, shown in Figure 4, is what connects local ties to depressed areas. So it is important that the model be able to match it. Figure 7 shows both a scatter plot of the data and the relationship between these two variables in the model after a series of productivity draws that change the population of the affected area.[32] The model matches the distribution.

[31] I compute μ_i using Gaussian quadrature with 100 nodes per area.

[32] This is without loss of generality. Changes in amenities would also lead to the same relationship between population changes and the share of the population that were born locally. The relationship also does not vary with any of the other parameters, except for σ_ξ.

I set the other parameters according to the literature. All of the relevant parameters are in Table 3. The spread of worker's idiosyncratic preferences for living in different places, σ_ξ, at 0.6 matches estimates in Suarez Serrato and Zidar (2016). The share of workers without any local ties matches the share of the US population that was born outside the US. The share dying each year gives workers a 60 year lifespan, on average. The Armington elasticity (η^Y) follows Feenstra et al. (2018), and the share of non-tradeable goods in consumption (α^H) matches Albouy (2009).

Table 3: Parameter Values

Parameter	Description	Value	Reasoning
μ_{μ_i}	Mean local tie	4.46	Estimated
σ_{μ_i}	Variance of local ties	5.52	Estimated
σ_ξ	Preference spread	0.6	Suarez Serrato and Zidar (2016)
s_F	Share without ties	0.13	Share foreign born in US
s_D	Share dying each year	0.017	60 year average lifespan
η^Y	Armington elasticity	4	Feenstra et al. (2018)
α^H	Non-tradeable share of cons	0.33	Albouy (2009)
η^H	Housing supply elasticity	2	Saiz (2010)
α^Y	Capital share	0.33	Standard
ρ	Real interest rate	0.05	Standard
J	Number of areas	722	Number of Commuting Zones

Note: This shows relevant parameter values. The distribution of local ties was estimated based on the relationship between the share of locals in a commuting zone and changes in population from 1980 to 2008 – displayed in Figure 7. Otherwise I set parameters set according to population moments and prior literature.

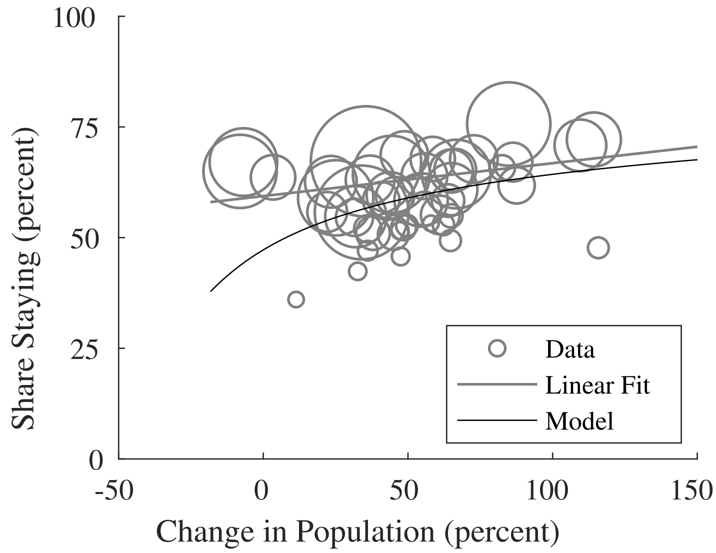
I assume a single, baseline set of local parameters governing productivity, amenities, and housing supply since my goal is distinct from understanding different levels of productivity, quality of life, geographic accessibility, and zoning.[33] In practice, this means that I set the housing supply elasticity term (η^H) to roughly the middle of the estimates in Saiz (2010) for all cities. I set all of the other local place specific terms to be identically equal to one, with the exception of productivity, which is the variable that I shock in my quantitative exercises.

The model's estimated parameters allow it to approximate an un-targeted moment – the

[33]Substantial literatures examine variations in all of these terms. For example, Rosen (1979), Roback (1982), Albouy (2016), and Diamond (2016) study variation in productivity and amenities.

relationship between population changes and share of people born in a place who stay in it as adults. Figure 8 shows that the share of people who stay in a growing state is similar to the share who stay in a declining one and that the model predicts a slightly less modest relationship.

Figure 8: Share of People Staying in Places: Model and Data



Note: The model's estimated parameters allow it to approximate the share of people who stay in their state of birth when states experience various population changes. The line in this figure shows this relationship in the model, for CZs, and the circles show this relationship in the data, among states in the continental United States. The radius of the circles is proportionate to the state's initial population and the grey line is the line of best fit, incorporating the weights.

Why There is Less Migration in Depressed Places

The model both matches the fact that there are smaller migration responses in areas with high local ties, and its structure gives an idea of why this should be the case. To see why there is less migration in places with higher local ties, consider the analytic formula for the percentage increase in population after an increase in real incomes (ω_j).

$$\frac{\partial \ln(N_j)}{\partial \omega_j} = \frac{(1-\bar{\psi}_j)}{\sigma_\xi} \tag{6}$$

The impact of this change in real incomes, holding all else constant, depends on a $\bar{\psi}_j$. Since $\bar{\psi}_j$ is the average level of attractiveness of the place relative to all other places for residents, it increases higher when people have higher levels of μ_i. So higher local ties imply lower migration elasticities.[34]

Intuition

The migration decisions of outsiders create low migration elasticities in depressed places. To show how outsiders can actually determine migration elasticities in high ties places I present a simplified version of the model with two areas and two types. The logit distribution allows me to show the exact relationship above. But the features of the logit distribution that lead to the result are common across many discrete choice probability distributions and the basic intuition extends to much more complex modeling strategies.

Consider a simplified world there are stayers who were born in a place and who always want to stay there, so $\psi_S = 1$, and outsiders who were born elsewhere and who have no special affection for it, so $\psi_O < 1$. For simplicity, assume that the probability has a logit distribution. The place that we are considering is small relative to the all of the places people could live, so there are ten times as many outsiders as stayers.[35]

The partial equilibrium effect of a change in real incomes on the likelihood that someone lives in a place ($\frac{\delta \psi_i}{\delta \omega}$) is a function of their baseline likelihood of living there (ψ_i) in the model.[36] And the function peaks when the worker has an even likelihood of being there, as shown in Figure 9. So people are the most responsive to changes in places that they are actively considering against attractive alternatives.

Why does partial equilibrium effect of a change in real incomes vary with the baseline likelihood that someone lives in a place? The relationship is an important ingredient for taking a model of discrete choice to the data. Specifically, discrete choice probability distributions

[34] Formally, $\bar{\psi}_j = \sum_{k'} \sum_{i'} \psi_{i'jk'} \frac{N_{i'jk'}}{N_j}$ where ψ_{ijk} is defined in equation III.

[35] Note that I drop the j and k subscripts since they are implied in this exercise.

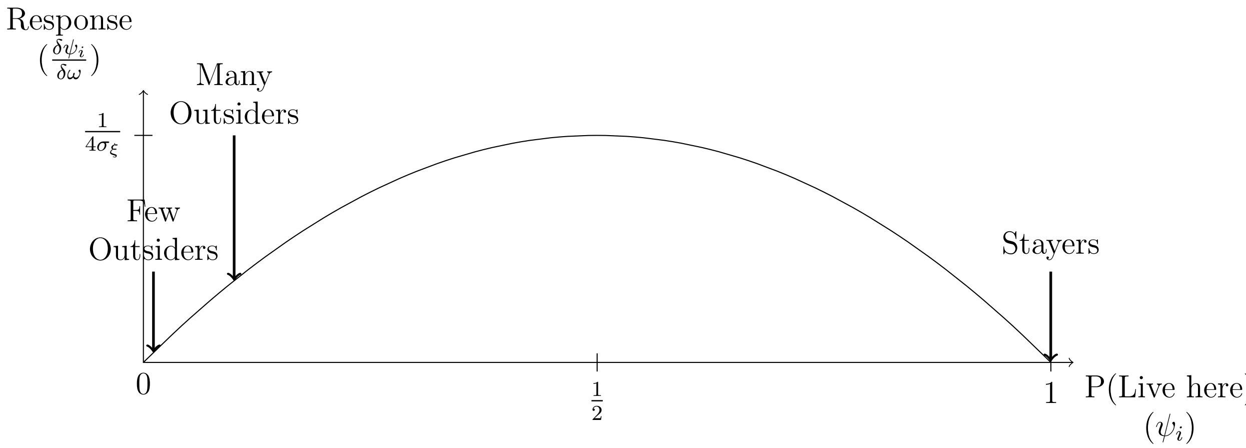
[36] The function is $\frac{1}{\sigma_\xi}(1 - \psi_i)\psi_i$ and so the maximum at $\psi_i = 1/2$ gives a value of $\frac{1}{4\sigma_\xi}$ (Train, 2009).

are S curves that has a linear portion in the middle and a lower slopes at extreme values – at least in two dimensions. The lower slope at extreme values allows the model to have a zero to one range also allows the model to include a minority of agents who make choices that seem to contradict the model's predictions (Train, 2009). Each feature is important for taking the model to the data and so each feature is used across many types of discreet choice probability distributions – logit, probit, generalized extreme value, mixed logit, etc.

So there are very low levels of migration by outsiders in places with high ties – places with many stayers and few outsiders. Take a place where 3/4 of residents are stayers in Figure 9. In the simplified model $\psi_O = 1/90$ and so outsiders will be at the point labeled "Few Outsiders" and relatively unresponsive to increases in real incomes. Contrast this with a situation where 1/4 of residents are stayers. Here, $\psi_O = 1/10$ and outsiders are at the point labeled "Many Outsiders." Since ψ_O is higher, outsiders are more responsive to changes in real incomes. The aggregate equation that I presented above emerges from aggregating the responses among both groups into a percentage change in population after a shock. Since the number of people in the place is equal to the number of each type times their probability of being in the place, the value is equal to an average of $\frac{1-\bar{\psi}_{i_i}}{\sigma_\xi}$ where the weights are each type's share of the current population.

$$\begin{aligned}\frac{\delta \ln(N_j)}{\delta \omega_j} &= \frac{N_O\psi_O(1-\psi_O)\frac{1}{\sigma_\xi} + N_S\psi_S(1-\psi_S)\frac{1}{\sigma_\xi}}{N_O\psi_O + N_S\psi_S} \\ &= \frac{1-\bar{\psi}}{\sigma_\xi}\end{aligned}$$

Figure 9: Migration Responses in the Simplified Model



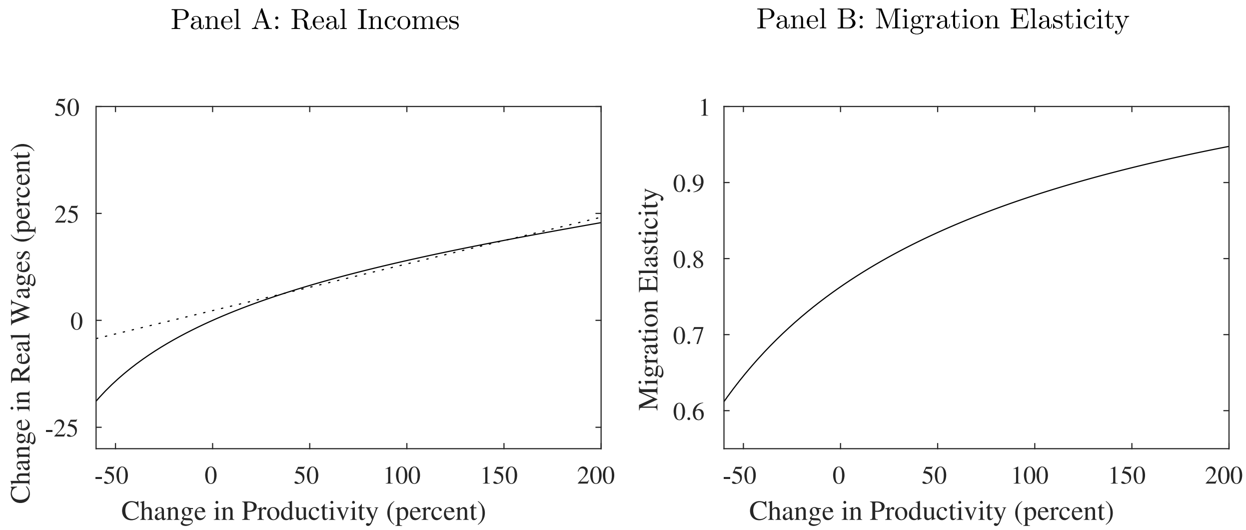
Note: When there are few outsiders, an increase in a place's desirability has a small impact on their likelihood of living in the place ($\frac{d\psi_i}{d\omega}$). The figure plots the function $\frac{d\psi_i}{d\omega} = \frac{1}{\sigma_\xi}(1-\psi_i)\psi_i$, which is the change in the likelihood of residing somewhere after an increase in real incomes for an individual worker in the model. The arrows give the positions of stayers, who will always remain in the place, and outsiders in two cases. The arrow few outsiders gives outsiders' position in the graph when they make up 1/4 of the population, and the arrow labeled many outsiders gives their position when they are 3/4 of the population, according to the exercise presented in the text.

Equilibrium Migration Responses

The equilibrium elasticity of population with respect to nominal wages is the elasticity with respect to real incomes times a factor that depends on the housing market. The second factor represents how increases in housing costs impact Rosen and Roback style equilibrium. A less elastic housing supply will increase η^H and α^H will be higher if people spend more on housing. Each will cause rent increases to be larger and each tends to lower the migration elasticity.

$$\frac{d\ln(N_j)}{d\ln(w_j)} = \frac{(1-\bar{\psi}_j)}{\sigma_\xi} \times \frac{1+\eta^H-\alpha^H}{1+\eta^H+\alpha^H(1-\bar{\psi}_j)/\sigma_\xi} \tag{7}$$

Figure 10: Real Incomes and Migration Elasticities after Productivity Changes



Note: Positive productivity shocks lead to smaller changes in real incomes because migration elasticities increase when areas are positively shocked. The x axis of each panel shows log changes in productivity times 100. The y-axis shows the impacts on real incomes and migration elasticities. The results are for the baseline calibration after the specified change in the model's productivity parameter, θ_j.

IV Dynamics of Decline

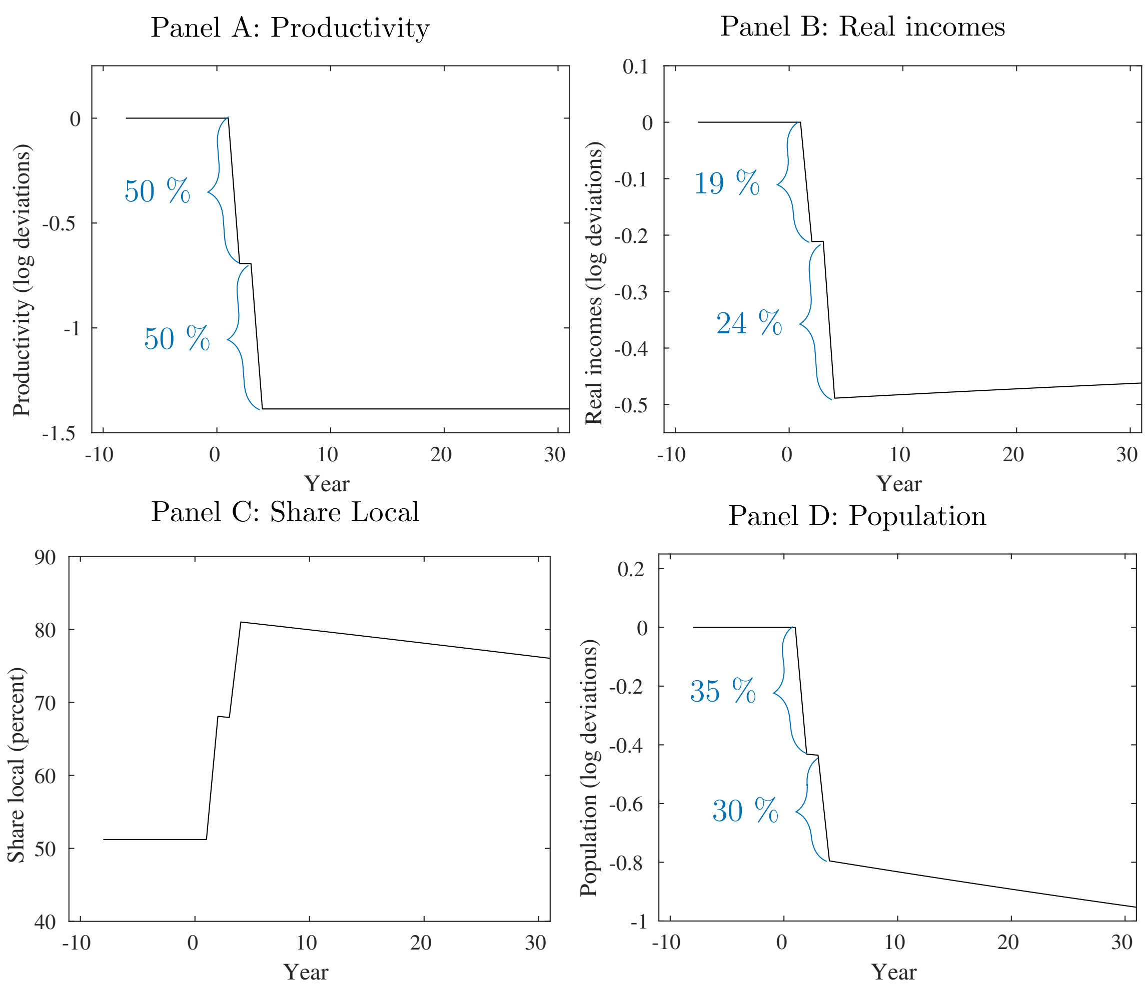
The section shows the equilibrium dynamics of local ties using the model developed in the last section. I show that local ties lead to hysteresis, that local ties change the cost and the benefits of place-based subsidies in subtle ways, and that local ties persist for generations.

Hysteresis

Declines in local productivity lead to hysteresis. Depressed places have residents with strong local ties, which keeps keeps population up and real incomes down in spatial equilibrium. And migration elasticities are lower in depressed places. So repeated negative shocks lead to successively larger real income declines.

Real incomes respond asymmetrically to changes in productivity. Panel A of Figure 10 shows real incomes on the y-axis and changes in productivity on the x axis, along with a dotted line of best fit based on positive productivity shocks. The convexity of the solid line shows that negative productivity shocks lead to larger declines in real incomes than positive ones. And the larger changes in real incomes after negative productivity shocks is due to the changing share of locals, which produces the migration elasticities shown in Panel B.[37]

Figure 11: Responses after Two Negative Productivity Shocks



Note: Real incomes decline by more and population declines by less and after a second 50 percent decline in local productivity. Shown is the equilibrium response of the specified variables after the noted change in productivity in an area. The blue labels give the percent changes each time.

A history of negative shocks leads to smaller population responses and larger real income responses after new shocks. Figure 11 plots the impact of two successive fifty percent declines in productivity – Panel A. Each shock changes the share of locals in the area – Panel C – and the changing levels of residents' local ties changes equilibrium responses.

[37]Dao, Furceri and Loungani (2017) find similar asymmetric responses.

Real incomes decline by more and population by less after the second shock. Panels B and D of Figure 11 show population and real income responses. The initial shock involves a real income decline of about 18 percentage points and a population decline of around 40 percentage points. The second shock changes productivity by the same percentage, but leads to a 27 percent larger decline in real incomes and a ten percent smaller decline in population.

Place-Based Subsidies

Many governmental programs subsidize some places at the expense of others, either explicitly or implicitly. Place-based policies, for example, induce place-based subsidies in so far as they improve outcomes in one place based on revenues raised from other places.[38]Indeed, concerns about inequality across places have led to renewed interest in place-based policies (Neumark and Simpson, 2015; Austin, Glaeser and Summers, 2018). A common criticism, however, is that subsidizing one area at the expense of another leads to population distortions. But the dynamics of residents' high levels of local ties in depressed areas, and of smaller movements to productive areas because of people's local ties, make these criticisms less empirically relevant.

The dynamics of local ties imply that subsidies to depressed places, where most residents have local ties, will lead to smaller distortions, decreasing their cost. Instead, subsidies to depressed places transfer money to people who would have lived in the same place without the subsidy. Only a small amount goes to paying for people to move in, since people who lack local ties are reluctant to live in depressed places.

Local ties also imply that subsidies to growing, newly productive places will lead more people to move to productive areas, increasing their benefits for aggregate productivity. The

[38] Place-based policies have taken many different forms. Some have included grants and tax benefits targeted at particular communities (empowerment and opportunity zones, Busso, Gregory and Kline (2013)). Others have increased funding for local schools or paid residents' college tuition (promise programs, Bartik, Hershbein and Lachowska (2019)). Others have included state and local tax incentives designed to attract particular companies (e.g. packages from many cities designed to attract Amazon's second headquarters). Some policies have led to place-based subsidies more indirectly, like the use of nominal prices in the federal tax and transfer system (Albouy, 2009)).

larger migration elasticities in growing, low ties places lead to larger population responses. And population reallocations to productive places increases wages in other places, particularly in the medium run.

To show how local ties affect the benefits and costs of place-based subsidies, I show the impacts of subsidies to places with varying levels of local ties. I model a per worker subsidy equal to ten percent of initial wages, paid by taxes in other areas. I assume that the subsidy declines by four percent per year (as in Kline and Moretti, 2014*a*). So the subsidy is a 1.3 percentage points of initial wages after 50 years and a 0.2 after 100.

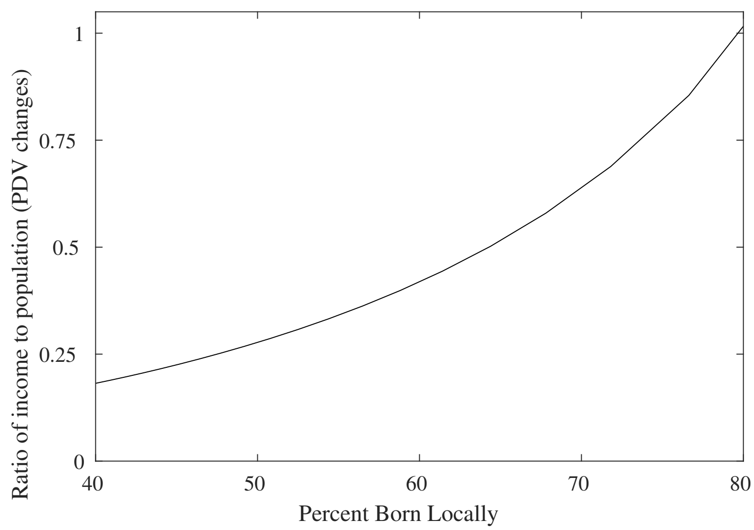
I provide two metrics based on changes in real incomes net of taxes (ω). The first is the ratio of percent changes in real incomes per capita to percent changes in population in the subsidized area. The ratio of changes in incomes and populations highlights the trade off between increasing the utility of residents and increasing local population, which Kline and Moretti (2014*b*) and Zabek (2018) show is a sufficient statistic for decreases in aggregate utility in standard models of spatial equilibrium. The second metric is the change in per capita real incomes, net of taxes. Plotting changes in per capital real incomes is theoretically less elegant, but it shows the trade off between the incomes of people in different places more directly.[39]

Subsidies to depressed places where residents have stronger local ties can lower geographic inequality at a lower cost to aggregate productivity because they increase real incomes without much population distortion. Panel A of Figure 12 shows that the impact on real incomes relative to population increases (at an increasing rate) with higher levels of local ties. Subsidizing a place with 60 percent of its population born locally, like Minneapolis, leads to a slightly less than one-half percentage point increase in real incomes for every percentage point increase in population. And subsidizing a place where around 80 percent of the population was born locally, like Dayton, Buffalo, or Pittsburgh, leads to a one percentage point increase in population for each percent point increase in real wages.[40]Panel B shows a sim-

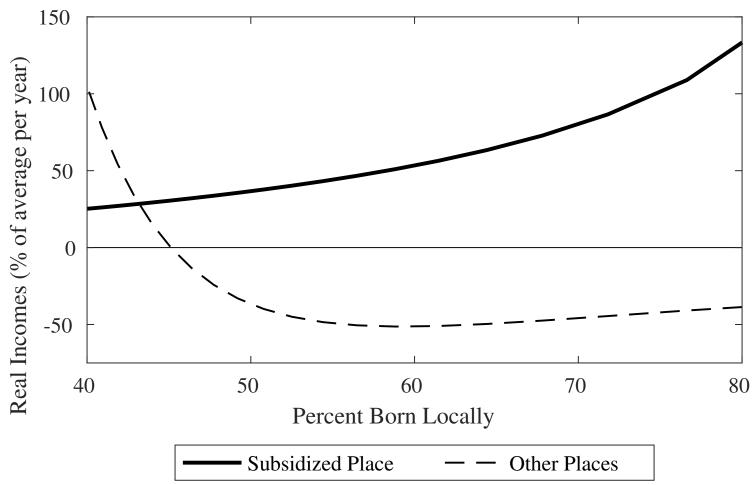
[39]Note that I scale the effect on real incomes in other places by multiplying by their number (721 in this calibration).

Figure 12: Real Income Changes after Place-Based Subsidies

Panel A: Ratio of Income to Population Changes



Panel B: Real Income Changes



Note: Subsidies to places with high shares born locally, or high ties, increase real incomes by more relative to population. And subsidies to newly productive places with low levels of local ties increase wages in other places. The top panel plots the ratio of the present discounted value of percentage changes in local real incomes relative to percentage changes in population due to a subsidy. The bottom panel plots the present discounted value of changes in real incomes per worker (ω) after the subsidy. The subsidy is equal to 10 percent of initial wages in an area with no productivity shock, and it decays at four percent per years. Real incomes include wages net of taxes as well as rents. The line for other areas is multiplied by the number of other areas, which is 721 in this calibration.

ilar story. Real wages in subsidized places with high levels of local ties increase with local ties. The real wage impacts on other areas are mostly flat with respect to local ties in the subsidized area. So subsidies to depressed places where residents have strong local ties lead to higher local incomes with low costs in aggregate productivity and real incomes in other places.

Subsidies to productive places where residents lack local ties move more people to productive places, which increases aggregate productivity and real wages in other places. Since subsidies to places with low ties increase population by more than incomes, as shown in Panel A, they have larger impacts on aggregate productivity through labor reallocation. So much so that subsidies to productive places can increase real incomes in laces that pay for them, as shown in Panel B. Subsidies to places where less than around 45 percent of residents were born locally lead to increases in real incomes in other places. So, subsidizing cities where low shares of the population were born locally – like Dallas, Los Angeles, Atlanta, and Houston – can benefit workers in other areas that pay for the subsidies through higher taxes.[41]

Real incomes increase other places because of real wages increases that result from reductions in local labor supply and increases in aggregate productivity from people moving to a more productive place. Labor supply decreases in other places push up wages (Hornbeck and Moretti, 2018). And movement into a productive place increases aggregate productivity. Since modest subsidies to productive places lead many people to move, the wage benefits to other places can outweigh the cost of the subsidy in terms of increased taxes, as shown in Panel B of Figure 12.

Subsidies to productive places also counteract an externality, since parents make migration decisions based on their own local ties and not their children's. Children benefit when their parents move to places that are more productive, since children develop ties to places with higher real wages. So subsidies counteract the externality by paying parents to move to productive places.

[40] Examples are based on Table C.8, which represent values in the relevant Commuting Zones in 2008.

[41] Subsidies do not generally lead to pareto improvements, however.

Subsidies to productive places also speed convergence and lead to larger long run population increases, because more children stay in productive areas. Table 4 shows the impacts of subsidies on populations and on real incomes initially, after 50 years, and after 100 years. On impact, the subsidy increases population by around 6.5 percentage points in most places. After 50 and 100 years the impacts on population are smaller in all areas, but in relative terms they are more dramatic in low ties places. The persistent effects on population also mean that subsidies to productive places have more persistent impacts on real incomes in other places.

Table 4: Effects of Subsidies to Depressed and to Growing Places

	Subsidized Place						Other Places		
Share	Population			Real Incomes			Real Incomes		
Locals	0	50	100	0	50	100	0	50	100
40	6.6	1.6	0.7	1.6	0.2	-0.0	4.1	1.6	0.8
50	6.4	1.5	0.6	2.3	0.2	-0.0	-2.5	-0.2	0.0
60	6.3	1.4	0.6	3.3	0.3	-0.0	-3.1	-0.4	-0.1
70	6.4	1.3	0.5	4.9	0.5	-0.0	-2.8	-0.4	-0.1
80	6.9	1.3	0.4	7.9	0.9	0.0	-2.5	-0.3	-0.1

Note: This table shows that a subsidy to a place with a high share locals and fewer local ties speeds convergence. A subsidy to a place with few local ties also leads to a bigger long run increase on population. The table also shows details of present discounted value of impacts to real incomes per worker (ω) presented in Figure 12. The subsidy is equal to 10 percent of average wages and that declines at four percent per year. The share of the population that is locally born (share locals) is due to contemporaneous permanent shocks to productivity. The numbers refer to the years after the shock and subsidy. Population numbers are percentage point changes, as are real incomes in the subsidized place. Real incomes elsewhere are multiplied by the number of other areas.

The Persistence of Local Ties

Local ties are persistent. Table 5 shows that population and real incomes are still evolving nearly fifty years after a change in productivity. The first column of the table shows the size of the initial shock the productivity – positive or negative. The second through sixth columns show the initial percentage change in population, the change in population after fifty years, the change after 100 years, and the half life of population in terms of its deviation from steady state. The following columns show the same process for real incomes in the model

(ω).

Convergence is quite slow regardless of the size of the productivity shock. The 50 percent decline in productivity in the first row of Table 5 leads to a 28 percentage point initial decline in population. The initial decline is only about 63 percent of the total decline of 45 percent, however. After 50 years – almost a generation in this calibration – population has declined by an additional seven percentage points, but it still has to fall by another ten to reach its steady state. Slow convergence is apparent in all rows, though it scaled by magnitude of the productivity changes.

Table 5: Convergence After Productivity Changes

Productivity	Population					Real Wages				
change	Initial	50	100	SS	HL	Initial	50	100	SS	HL
-50	-28.3	-35.2	-39.2	-45.0	65	-14.2	-13.2	-12.5	-11.5	65
-25	-13.4	-16.8	-18.9	-22.0	67	-5.8	-5.4	-5.2	-4.8	67
-10	-5.2	-6.6	-7.4	-8.7	67	-2.1	-2.0	-1.9	-1.8	67
-5	-2.6	-3.3	-3.7	-4.3	67	-1.0	-1.0	-0.9	-0.9	67
50	24.3	31.0	35.2	41.9	72	8.2	7.6	7.3	6.8	72

Note: This table shows slow convergence after changes in productivity and that real incomes overshoot their steady state values. It plots responses to a permanent change in local productivity. The first column shows the change in productivity. The next five columns show the population response with the second showing the initial percentage change, the third the percentage change after fifty years, the fourth after 100 years, and the fifth showing the time it takes for the gap between the initial and the steady state value to halve. The next five columns show the same values for real incomes, ω.

Real incomes overshoot their steady state values and recover slowly. Table 5 shows that real incomes initially drop by 14 percentage points after the same 50 percent decline in productivity – about one quarter more than their steady state value. Even after fifty years, real incomes are about two percentage points lower than their eventual steady state.

The convergence process is slow because it takes generations for local ties to be reallocated. After a decrease in productivity, population falls due to the fall in real incomes. Since people still have local ties, however, the change in population is smaller than the change in steady state. The smaller population response leads to the overshooting in real incomes. Low real incomes keep people moving out of the area each generation, however, so local ties decline with each generation. The very gradual downward slope of the line at the end of Panel C in Figure 11 highlights how slowly these local ties change, however.[42]

V Conclusion

Local ties keep people in depressed places. Places with high levels of local ties have lower real wages that change by more in response to local shocks. And local ties persist for generations.

Several phenomena could lead to local ties. Local ties could be due to interconnections with family members (Kaplan, 2012; Kramarz and Skans, 2014; Coate, Krolikowski and Zabek, 2019) and job referral networks (Topa, 2011). It would be useful to quantify how much of people's local ties can be related to these phenomena and how unchanging local ties are in the face of various interventions.

Place-based policies can be efficacious in places that are economically depressed and in places that have recently become productive. In depressed places, residents' local ties imply that place-based policies will lead to small population changes. So place-based policies transfer income without distorting where people live. In newly productive places, place-based policies increase aggregate productivity and increase wages outside of the area by changing where people live. Place-based policies in growing areas also increase the number of people born with ties to newly productive areas.

More knowledge of local ties could inform policy responses that shape how people form local ties. Social networks could be transportable if local conditions become particularly unfavorable (Yannay Spitzer, 2015), governments could provide loans to encourage mobility, and certain interventions could address information frictions (Wilson, 2016). Recognizing heterogeneity in residents' local ties could also inform policies so that they balance the benefits of population reallocation with the reality that most people live close to their birthplaces.

[42]For the changes in productivity that I show here, real incomes never fully recover. This is because the area has a high level of amenities relative to its now lower level of productivity and because the dynamics of the ξ term imply that workers will have idiosyncratic attachments to the place that will lead them to forego higher wages.

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Appendix A Robustness Checks

This section shows that the regression results showing that depressed places have lower migration responses to labor demand shocks are robust. Specifically, the regression results are not driven by other observable differences across areas, by mis-measurement of local ties, or by other specification choices, like my cutoff for a having high ties. The lower migration responses are not due to observable differences in education, due to asymmetries in the housing market caused by durable housing, due to differences in the average age of residents, or due to differences in labor force participation. When I include each variable as an additional interaction with the labor demand shock, the effects of local ties are quite similar to those in Table 2. Similarly, the results in Table 2 are not due to the inaccuracy of using state of birth because I find similar results when I use an alternative measure of local ties – the average amount of time a residents have spent living in their houses. Finally, results in Table 2 are not due to my choice of 60 % as the cutoff for having a high level of local ties because I obtain similar results without a fixed cutoff.

I show the robustness of the results in Table 2 by presenting results using single linear interaction term, or a triple difference. The triple difference shows differences in the responses of places with different levels of local ties using one as opposed to two statistics. Presenting a single statistic is important for controlling the size of these tables because I use many alternative specifications and dependent variables. Using a linear interaction term also shows that the specifications in Table 2 are not sensitive to the 60 % cutoff because they do not use it.

$$\Delta y_{j,t} = \alpha_t + \beta_1 \text{Ties}_{j,t-1} \Delta \hat{L}_{j,t} + \beta_2 \text{Ties}_{j,t-1} + \beta_3 \Delta \hat{L}_{j,t} + \gamma_2 \text{Ties}_{j,t-1} + \gamma_X X_{j,t-1} + \epsilon_{j,t} \quad (8)$$

The linear interaction term has a different interpretation than the coefficients in the main specification, equation 1. Equation 8 shows the triple difference specification, which allows the effect of a labor demand shock to linearly scale with the share of residents who are living in their state of birth. A positive main effect (β_3) and a negative linear interaction term (β_1) mean that a labor demand shock increases the dependent variable by more in places with low levels of local ties than high levels of local ties. The unmodified linear interaction term, which I multiply by 100 for readability, gives the difference between a place where no residents live where they were born and a place where everyone lives where they were born. However, no places have either full or zero local ties. So a more reasonable number is to divide each linear interaction term by three, since Table 1 shows that two standard deviation of the share of locals across areas is around 30 percent.

I show robustness by presenting several variations on equation 8 for outcomes where I observe meaningful effects in Table 2. The first column of each robustness table shows the effect of the arbitrary cutoff for having high ties by using the basic triple difference specification in equation 8. Column two shows that the effects of local ties are not driven by the age composition of the population by including additional interactions of the labor demand shock with the share of adults under 35 in interaction 2 and over 50 in interaction 3. Column three shows that the effects are not due to differences in resident's educational attainment by including the share of people who are college educated as interaction 2. Column four shows that the results are not driven by differences in labor force participation by including the share of adults who are outside the labor force as interaction 2. Column five addresses concerns about the durability of housing by including several variables similar to those in Glaeser and Gyourko (2005) – the level of local log rents as interaction 2 and the lagged ten year change in log rents as interactions 3. Column six omits controls and column seven omits weights. Finally, column eight measures ties by the average amount of time people have been living in their current house.[43]

I replicate the main results for the Bartik labor demand shifters in terms of population and rent in Table A.1. The linear interaction term in the triple difference specification for

[43]Note that the coefficient has a different interpretation.

population, shown in column one of Panel A in Table A.1 has a statistically and economically significantly negative coefficient. The coefficient shows that a two standard deviation increase in the share born locally is associated with a 1 percentage point smaller population response to the Bartik shifter, which lines up well with estimates in Table 2. The coefficient is consistently negative across the bulk of specifications, though the magnitude does vary around that baseline number. I also find a significantly negative coefficient when I use the average number of years that adults have lived in their houses as the measure of local ties in the last column. Finally, Panel B shows that rents do not appear to increase by more in places with higher levels of local ties.

The the results for the trade shocks are similarly robust. The only major departure in Tables A.2 and A.3 is that the interaction term in column one of Panel A of Table A.2 is insignificantly different from zero and its magnitude is somewhat modest. Column one is the smallest in magnitude of any of the columns on the table, but the term is only significantly negative in some of these columns. The insignificance across columns appears to mostly be due to imprecision.

The results for labor force participation, wage responses, and rent responses to a trade shock all reinforce the results in Table 2. For example, the labor force participation rate results in Panel B of Table A.2 show that an increase of two standard deviations in the share of local residents is associated with around a 0.8 percentage point larger increase in the labor force participation rate per every thousand dollars of import competition per worker. And the difference in the effect of the trade shock between low and high ties areas in Table 2 is also around 0.8. A similar story applies for wages, and the differences in rents are similarly insignificant.

Table A.1: Population and Rent Responses to Labor Demand Shocks in the 1980's

Panel A: Population

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	-2.93	-3.33	-4.77	-3.70	-3.65	-1.65	-5.19	-0.38
	(0.92)	(0.76)	(0.78)	(0.75)	(1.26)	(0.84)	(1.11)	(0.08)
Bartik Shock	2.56	-12.41	5.86	-0.45	9.18	1.58	4.01	3.94
	(0.61)	(7.01)	(0.90)	(0.92)	(9.58)	(0.54)	(0.82)	(0.70)
Local Ties	0.22	0.31	0.42	0.33	0.36	-0.07	0.65	1.86
	(0.18)	(0.17)	(0.14)	(0.14)	(0.16)	(0.13)	(0.18)	(1.17)
Interaction 2		18.75	-6.23	12.15	-1.05			
		(10.67)	(1.77)	(2.64)	(1.43)			
Interaction 3		26.33			3.50			
		(9.15)			(1.21)			
Observations	722	722	722	722	722	722	722	722
R^2	0.604	0.629	0.626	0.641	0.620	0.474	0.297	0.645

Panel B: Percent in the Labor Force

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	0.48	0.59	0.42	0.15	1.90	1.80	-1.73	-0.06
	(0.98)	(0.91)	(1.09)	(0.96)	(1.22)	(1.22)	(0.84)	(0.14)
Bartik Shock	-0.08	-15.26	0.03	-1.38	-18.58	-0.73	1.43	1.02
	(0.67)	(9.70)	(1.13)	(1.19)	(9.28)	(0.92)	(0.58)	(1.21)
Local Ties	-0.23	-0.21	-0.22	-0.18	-0.36	-0.52	0.08	2.85
	(0.17)	(0.16)	(0.20)	(0.17)	(0.20)	(0.25)	(0.17)	(1.70)
Interaction 2		23.78	-0.21	5.26	2.75			
		(14.25)	(1.94)	(2.92)	(1.42)			
Interaction 3		18.24			2.50			
		(12.70)			(1.61)			
Observations	722	722	722	722	722	722	722	722
R^2	0.548	0.555	0.548	0.553	0.559	0.199	0.186	0.555

Note: This table shows robustness of the population and rent responses reported in Table 2 to different specifications. The first column shows a triple difference specification where I interact the labor demand shock with the share of locals in the place. The second through fifth show the effects of including various other possible reasons for the heterogeneous responses. Column two includes interactions with the share of people under 35 and over 50. Column three includes the share of people college educated. Column four includes the share who are outside the labor force. Column five includes the level of local log rents and the lagged ten year change in log rents. Column six omits controls and column seven omits weights. Finally, column eight measures ties by the average amount of time people have been in their house. For readability, all of the share coefficients are multiplied by 100, as is the lagged log change in rents. The specifications follow the notes in Table 2 and include standard errors that are clustered by state.

Table A.2: Population and LFP Responses to Trade Shocks

Panel A: Population

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	-1.47	-2.60	-3.55	-1.73	-4.16	-4.26	-1.83	-0.18
	(1.77)	(1.77)	(1.97)	(1.64)	(2.45)	(1.93)	(1.65)	(0.12)
Bartik Shock	1.09	-1.94	4.83	-0.16	11.35	2.55	0.55	1.68
	(1.14)	(7.59)	(2.19)	(1.85)	(8.15)	(1.37)	(1.11)	(1.08)
Local Ties	-0.29	-0.32	-0.34	-0.30	-0.34	-0.29	-0.22	-3.61
	(0.07)	(0.08)	(0.08)	(0.07)	(0.08)	(0.05)	(0.09)	(0.51)
Interaction 2		2.11	-4.84	5.99	-1.36			
		(12.30)	(2.69)	(4.69)	(1.13)			
Interaction 3		11.96			-0.05			
		(14.81)			(1.81)			
Observations	1444	1444	1444	1444	1444	1444	1444	1444
R^2	0.485	0.491	0.490	0.487	0.521	0.298	0.290	0.580

Panel B: Percent in the Labor Force

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	2.50	2.19	2.83	2.56	2.67	2.60	0.84	0.22
	(0.55)	(0.59)	(0.87)	(0.55)	(0.73)	(0.54)	(0.46)	(0.07)
Bartik Shock	-0.99	-3.57	-1.60	-0.69	-5.29	-1.05	-0.27	-1.54
	(0.27)	(1.87)	(0.97)	(0.49)	(2.20)	(0.27)	(0.29)	(0.62)
Local Ties	0.08	0.08	0.09	0.09	0.10	0.06	0.04	0.66
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.19)
Interaction 2		3.55	0.79	-1.42	0.65			
		(3.04)	(1.09)	(2.13)	(0.28)			
Interaction 3		6.16			-1.02			
		(3.33)			(0.81)			
Observations	1444	1444	1444	1444	1444	1444	1444	1444
R^2	0.545	0.543	0.547	0.541	0.648	0.488	0.223	0.547

Note: This table shows robustness of the population and labor force participation responses to trade shocks presented in Table 2. The first column shows a triple difference specification where I interact the labor demand shock with the share of locals in the place. The second through fifth show the effects of including various other possible reasons for the heterogeneous responses. Column two includes interactions with the share of people under 35 and over 50. Column three includes the share of people college educated. Column four includes the share who are outside the labor force. Column five includes the level of local log rents and the lagged ten year change in log rents. Column six omits controls and column seven omits weights. Finally, column eight measures ties by the average amount of time people have been in their house. For readability, all of the share coefficients are multiplied by 100, as is the lagged log change in rents. For readability, all of the share coefficients are multiplied by 100, as is the lagged log change in rents. The specifications follow the notes in Table 2 and include standard errors that are clustered by state.

Table A.3: Wage and Rent Responses to Trade Shocks

Panel A: Wage

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	2.05	2.19	2.56	2.23	1.15	1.06	1.10	0.01
	(1.07)	(1.08)	(1.44)	(1.07)	(0.91)	(0.90)	(0.91)	(0.16)
Bartik Shock	-0.79	2.21	-1.69	0.07	-0.39	-0.17	-0.23	0.30
	(0.64)	(3.29)	(1.47)	(0.60)	(3.11)	(0.52)	(0.57)	(1.47)
Local Ties	-0.04	-0.03	-0.02	-0.03	-0.04	-0.01	0.05	-0.65
	(0.04)	(0.04)	(0.05)	(0.04)	(0.03)	(0.03)	(0.04)	(0.38)
Interaction 2		-4.69	1.17	-4.10	-0.01			
		(6.46)	(1.40)	(2.45)	(0.43)			
Interaction 3		-5.79			-0.14			
		(5.22)			(1.60)			
Observations	1444	1444	1444	1444	1444	1444	1444	1444
R^2	0.135	0.142	0.138	0.126	0.320	0.031	0.107	0.152

Panel B: Rent

	Base	Age	College	NILF	Rents	Direct	Un-Wt	Alt Tie
Bartik and Local Ties	-0.83	0.29	1.85	-0.31	0.80	-0.04	-2.28	-0.23
	(2.16)	(2.05)	(3.76)	(2.25)	(2.81)	(2.04)	(1.57)	(0.31)
Bartik Shock	1.73	9.33	-3.08	4.25	-15.80	1.28	1.83	3.32
	(1.01)	(6.86)	(4.02)	(1.54)	(9.09)	(0.92)	(0.99)	(2.48)
Local Ties	-0.10	-0.08	-0.04	-0.08	-0.01	-0.02	-0.20	-0.92
	(0.09)	(0.09)	(0.12)	(0.10)	(0.11)	(0.05)	(0.07)	(0.83)
Interaction 2		-9.85	6.24	-12.02	2.42			
		(13.32)	(4.18)	(8.03)	(1.19)			
Interaction 3		-19.40			2.49			
		(9.91)			(2.35)			
Observations	1444	1444	1444	1444	1444	1444	1444	1444
R^2	0.177	0.176	0.186	0.172	0.444	0.091	0.043	0.175

Note: This table shows robustness of the residualized wage and unresidualized gross rent responses to trade shocks presented in Table 2. The first column shows a triple difference specification where I interact the labor demand shock with the share of locals in the place. The second through fifth show the effects of including various other possible reasons for the heterogeneous responses. Column two includes interactions with the share of people under 35 and over 50. Column three includes the share of people college educated. Column four includes the share who are outside the labor force. Column five includes the level of local log rents and the lagged ten year change in log rents. Column six omits controls and column seven omits weights. Finally, column eight measures ties by the average amount of time people have been in their house. For readability, all of the share coefficients are multiplied by 100, as is the lagged log change in rents. For readability, all of the share coefficients are multiplied by 100, as is the lagged log change in rents. The specifications follow the notes in Table 2 and include standard errors that are clustered by state.

Appendix B Expanded Model with Skill Levels

This section extends the baseline model to include heterogeneity in workers' skills and a concave housing supply curve due to a durable housing stock. Including heterogeneous skills and concave housing supply connects to literatures and policy discussion about workers' differing location choices by skill. Adding worker skill also allows the model to match several major dynamics observed in the literature on regional migration, including a growing concentration of skilled workers in highly productive, rich cities. Adding worker skills also shows that the basic model is flexible enough to accommodate additional features that have been emphasized in the literature on domestic migration.[44]

The main policy takeaways of the main text – that place based subsidies can be efficacious in economically depressed as well as fast growing places – are equally apparent in the expanded model. The effects of skill heterogeneity, imperfect skill substitutability, durable housing, and differences in housing expenditures tend to balance each other out in terms of the effects of productivity shocks and of place based subsidies on real wages. There are differences in how the mechanisms play out that match other literatures, but these are less of a concern than the first order impacts of workers with high levels of local ties making up most of the population of depressed areas, regardless of their level of skills.

Including skill heterogeneity, however, does allow me to match the finding that high skilled workers are more mobile (Malamud and Wozniak, 2012) and explore dynamics in workhorse models of worker productivity (Katz and Murphy, 1992) that lead to larger nominal wage losses among low skilled workers in economically depressed places. The clustering of low skilled workers in depressed places with few high skilled workers leads to larger declines in low skill wages, as in Giannone (2017).[45] Low skilled workers earn less in depressed places

[44] I do not include these dynamics in the main text because the emphasis on multiple types of workers distracts from the main mechanisms of workers with higher levels of local ties accumulating in economically depressed places. This section shows that the mechanisms I describe in the main text indeed survive the inclusion of these additional features.

[45] Bound and Holzer (2000); Notowidigdo (2011) verify empirically that less skilled workers concentrate in economically depressed places despite earning less in these places.

because of the limited substitutability of high and low skilled labor (Moretti, 2013; Diamond, 2016) and the limited supply of high skilled labor in depressed places.

Including a concave housing supply and heterogeneous expenditure shares on housing across skill groups also reinforces the dynamic of immobile, low skilled workers accumulating in economically depressed places. More low skilled workers choose to live in economically depressed places because they benefit more from inexpensive rents (Notowidigdo, 2011; Ganong and Shoag, 2017; Bilal and Rossi-Hansberg, 2018). And inexpensive rents arise because of the inelastic supply of already built housing in an area with weak demand for housing from high skilled workers. In my calibration, the differential impact of cheap housing leads to similar declines in the real wages of high and low skilled workers because it roughly balances the negative effect of the lack of high skilled workers on low skilled worker wages.

The effects of durable housing persist over the medium run, or a period of under 20 years, which is significantly shorter than the period that I find that ties matter over.[46] Intuitively, the durability of housing has fewer long run impacts because landlords make directed and forward looking decisions based on economic conditions. Workers form local ties in a less directed way.

Additions to the Baseline Model

Skill Levels

I include worker skills using the workhorse nested Constant Elasticity of Substitution (CES) production function that includes labor with two skill levels ($l \in H, L$) in each place. The parameter A_H defines the productivity of high skilled labor relative to low skilled labor and η_N is the elasticity of substitution between the two types.

$$N_j = \left[(1 - A_H) N_{Lj}^{\frac{\eta_N - 1}{\eta_N}} + A_H N_{Hj}^{\frac{\eta_N - 1}{\eta_N}}\right]^{\frac{\eta_N}{\eta_N - 1}} \tag{9}$$

[46]Consistent with the focus of Glaeser and Gyourko (2005).

Heterogeneous Housing Expenditures

To allow workers to have heterogeneous expenditures on housing, and to allow heterogeneous wage rates, the specification of utility is different between high and low skilled workers. The result is an indirect utility function that includes heterogeneous wages, governmental subsidies, a distribution of locational preferences that can vary by skill group, and the possibility of a different housing share by group α_l^H.[47]

$$
\begin{aligned}
u_{ijkl} &= \ln(w_{jl} + g_{jl}) - \alpha_l^H \ln(r_j) + A_j + \mu_{il}\mathbb{1}(k = j) + \xi_{ijl} \\
u_{ijkl} &= \omega_{jl} + \mu_{il}\mathbb{1}(k = j) + \xi_{ijl}
\end{aligned}
$$

Concave Housing Supply

To keep the housing market relatively tractable and to match the intuition of Glaeser and Gyourko (2005), I include a piece wise linear housing supply function. At the supply of housing in the previous period multiplied by a depreciation rate, the function exhibits a kink. Intuitively, this would cover a case where a fixed, random percentage of the housing stock is destroyed each period, as in their model. The function is concave so long as the housing supply elasticity below the kink is lower than the one above it, $\eta_E > \eta_C > 0$.[48]

$$
H_s = \begin{cases} \theta_E^H r_j^{\eta_E^H} & \text{if } H_s > \gamma_\delta H_s' \\ \theta_C^H r_j^{\eta_C^H} & \text{if } H_s \leq \gamma_\delta H_s' \end{cases}
$$

[47] This has the advantage of being extremely tractable and keeping the problem mostly unchanged. Another likely more realistic but less tractable way to induce differing housing expenditure shares is by allowing them to vary with income through non-homothetic preferences.

[48] The two lines intersect at $r^* = \left(\frac{\gamma_\delta H_s'}{\theta_E^H}\right)^{1/\eta_C^H}$ and $\theta_C^H = \frac{\gamma_\delta H_s'}{r^{*\eta_C^H}}$.

Results

The model implies a few analytical results as well as a larger number of computational results. The analytic results reinforce many of the intuitions from literature in labor economics. The computational results echo the main themes of the paper.

Analytic Results

Wages Based on this setup, each worker is still paid their marginal product, but their marginal product now decreases with the relative supply of their skill level. Less skilled workers receive higher wages when there are relatively more high skilled workers.

$$\frac{\partial Y_j}{\partial N_{Lj}} = \underbrace{(1-\alpha^Y)(p_j\theta_j)^{\frac{1}{1-\alpha^Y}}\left(\frac{\alpha^Y}{\rho}\right)^{\frac{\alpha^Y}{1-\alpha^Y}}}_{\text{Unchanged}}\underbrace{(1-A_{Hj})\left(\frac{N_j}{N_{Lj}}\right)^{1/\eta_N}}_{\text{New}} \tag{10}$$

The skill premium, or the ratio of high to low skilled wages, depends both on the relative productivity of high skilled labor, A_H, and the relative supply of high skilled workers. And the extent that the ratio of the two types of workers is relevant is governed by the elasticity of substitution.

$$\frac{w_{Hj}}{w_{Lj}} = \frac{A_{Hj}}{1-A_{Hj}}\left(\frac{N_{Lj}}{N_{Hj}}\right)^{1/\eta_N} \tag{11}$$

Partial equilibrium changes in absolute wages Another way of seeing how the movements of high skilled workers affect low skilled workers is to look at the *cetrus paribus* effect of an increase in the number of high skilled workers on low skilled workers' wages. Having more high skilled workers increases low skilled workers' wages, and it does so by more when the elasticity of substitution between the two types is lower. Increasing the number of high skilled workers also tends to increase low skilled workers' wages by more when high skilled workers are more productive.

$$\frac{\partial \ln(w_{Lj})}{\partial \ln(N_{Hj})} = \frac{1}{\eta_N} \times \frac{A_{Hj}\left(\frac{N_{Hj}}{N_{Lj}}\right)^{\frac{\eta_N - 1}{\eta_N}}}{1 - A_{Hj} + A_{Hj}\left(\frac{N_{Hj}}{N_{Lj}}\right)^{\frac{\eta_N - 1}{\eta_N}}}$$

Calibration

Adding skill groups, heterogeneous housing expenditures, and a concave supply of housing not only complicates the dynamics of the model, it also increases the number of parameters that I have to calibrate and estimate. To provide the best estimates possible, I continue estimating the distribution of local ties using a simulated method of moments procedure conditional on other parameters calibrated based on relevant literatures.

The calibrated parameters, which build off my earlier calibration, are presented in Table B.4. I allow the spread of the logit distribution for each type to vary based on a 30 percent higher migration elasticity among college educated workers in Malamud and Wozniak (2012). I also assume that housing expenditures are 40 percent among low skill workers and 25 percent among high skill workers – estimates that are in keeping with an elasticity of housing demand with respect to income that is below one, fitting the literature. Finally, I assume that housing depreciates at a rate of around two percent and that the housing supply elasticity is 0.1 in places where demand is too low for landlords to build new housing (Glaeser and Gyourko, 2005). The housing supply elasticity in expanding places matches the calibration of the model in the main text.

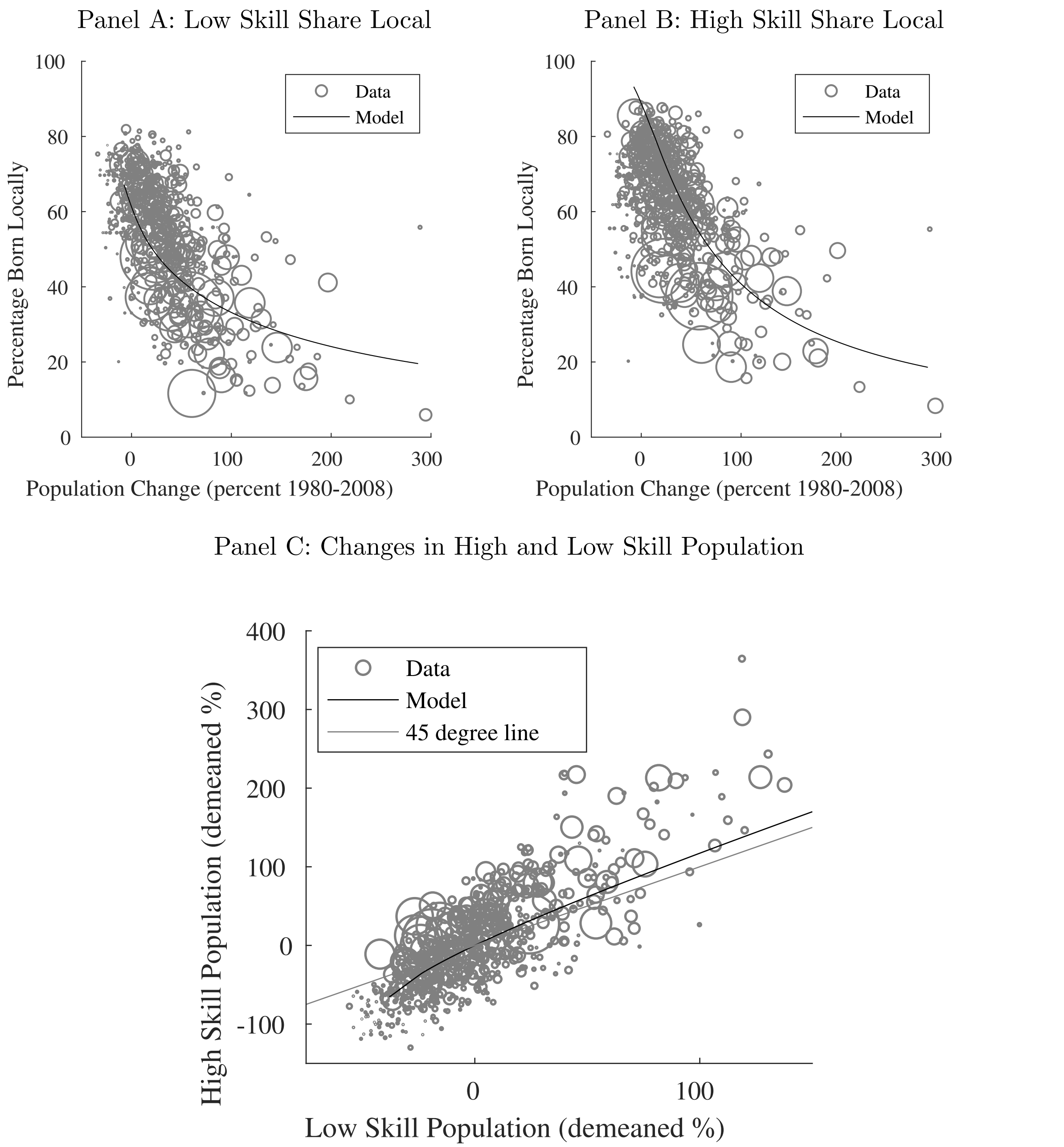
Table B.4: Parameter Values for the Expanded Model

Parameter	Description	Value	Reasoning
μ_{Li}	Local ties values for low skill workers	$[0.00, 5.96]$	Estimated
$\frac{N_{Li}}{N_L}$	Share low skill with each local tie	$[0.30, 0.70]$	Estimated
$\sigma_{\xi L}$	Idiosyncratic preference spread, low	0.522	Suarez Serrato and Zidar (2016)
$\frac{N_H}{N}$	Share high skill workers	0.45	Table 1
μ_{Hi}	Local ties values for high skill workers	$[4.09, 6.51]$	Estimated
$\frac{N_{Li}}{N_H}$	Share high skill with each local tie	$[0.74, 0.26]$	Estimated
$\sigma_{\xi H}$	Idiosyncratic preference spread, high	0.695	Malamud and Wozniak (2012)
η_N	Elasticity of substitution for workers	2	Autor, Katz and Kearney (2008)
A_H	Productivity of high skilled workers	0.659	75 % avg skill premium
η_E^H	Housing supply elasticity, expanding	2	Saiz (2010)
η_C^H	Housing supply elasticity, contracting	0.1	Glaeser and Gyourko (2005)
γ_δ	Depreciation rate of housing per yr.	0.98	Glaeser and Gyourko (2005)

Note: These are the additional calibrated parameters for the extended model. Other parameters follow from the main calibration in Table 3.

My target moments for the estimation are the distribution of changes in the number of high and low skilled workers living across places and the the share of each population living in their birth place. I chose changes in the population of high and low skilled workers across places because these changes have been the focus of a robust literature in labor economics. I chose the proportion of people in each skill group living in their birth place across places because it is the analogue to the approach that I used in the main text.

Figure B.1: Two Skill Estimation Moments and Targets



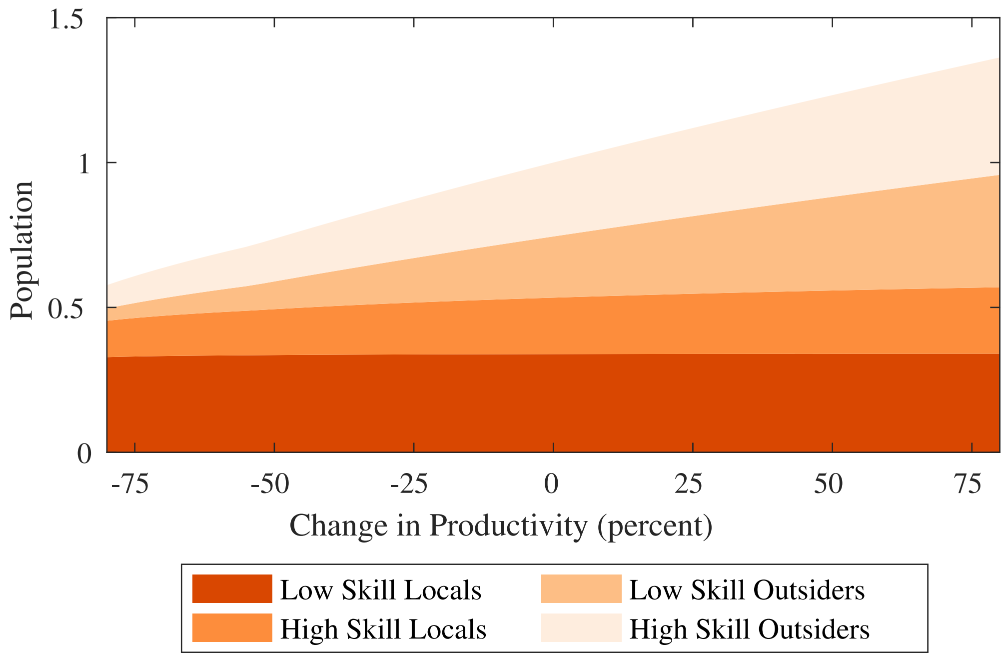
Note: The model matches the distribution of low skill people staying, high skill people staying, and each population growing in places where populations are growing at different rates. This figure plots each distribution in the data as well as the model analogue I use to approximate it in my estimation procedure.

The model matches the three distributions, as shown in Figure B.1. The relatively good match is despite taking the spread of the logit distribution from the literature and despite including only two possible levels of local ties in the name of computational tractability.

Computational Results

Places grow by attracting outsiders, who tend to be high skilled. Figure B.2 shows how the population of a place adjusts in terms of low and high skilled locals and outsiders. The population of locals is relatively stable, as before, but the population of outsiders fluctuates. And the group that fluctuates the most is the population of high skill outsiders, who tend to drive population increases in place where productivity has increased. High skill outsiders drive population increases because they are more mobile and also because they are more willing to pay high rents, as in Notowidigdo (2011); Ganong and Shoag (2017); Bilal and Rossi-Hansberg (2018).

Figure B.2: Populations of Outsiders and Local of Two Skill Levels

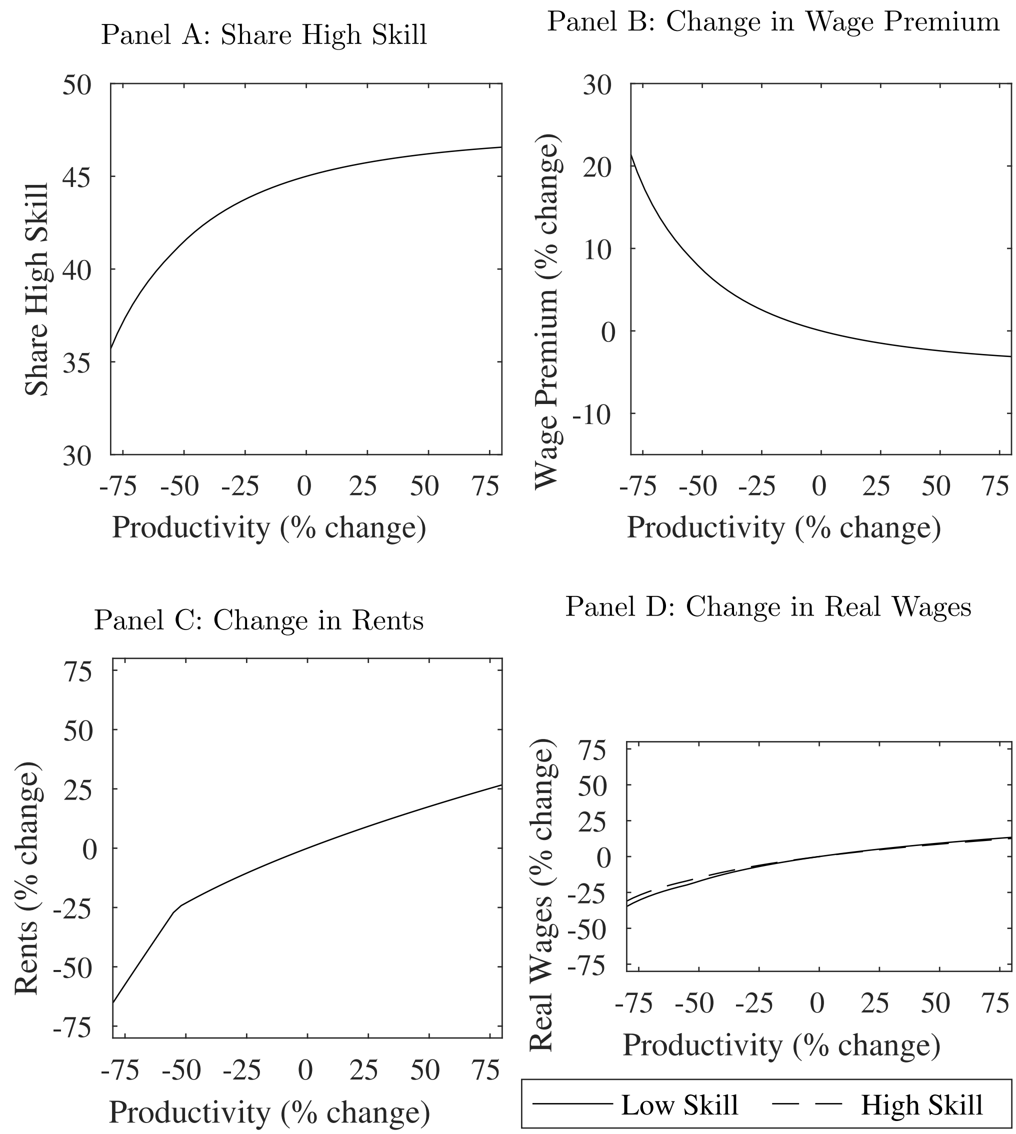


Note: Places that grow in population do so by attracting outsiders, particularly high skill outsiders. This figure plots how the population of locals and outsiders who have high and low skilled changes with productivity shocks. Each height represents the population at that productivity level. They are normalized so the total population is one in an place that has no shocks.

The lower supply of higher skilled workers in depressed places increases the nominal wages of high skilled workers and decreases the nominal wages of low skilled workers. Panel A of Figure B.3 shows that the share of high skilled workers is lower in places that saw declines in productivity, as explained in Figure B.2. Panel B shows that the smaller supply of high skilled worker leads to a larger high skill wage premium, as in Katz and Murphy (1992) and many other studies of relative wages. Intuitively, high skilled workers earn more relative to low skilled workers because the two types of workers are imperfectly substitutable. Analytically, equation 11 gives the skill premium and describes its dependence on the elasticity of substitution parameter, η_N.

Rents also fall by more in depressed places, however, so real wages fall by only slightly more for low skilled workers. Panel C of Figure B.3 shows that rents decline by more in places that received strongly negative productivity shocks. Panel C has a kink because rents fall by more in places where the housing stock has not yet had a chance to depreciate, so housing is steadily depreciating in the left section (as in Glaeser and Gyourko, 2005). And the effects on real wages in Panel D balance the larger declines in nominal wages for low skilled workers with the fact that low skill workers spend larger fractions of their incomes on housing, which becomes much cheaper in depressed places. So real wages in Panel D fall only by slightly more for low skilled workers.

Figure B.3: Effects of Productivity Changes in the Expanded Model



Note: There are fewer high skilled workers in economically depressed places, despite high skilled workers earning higher relative wages. Including a convex housing supply and a higher demand for housing among low skill workers mutes the effects of nominal wage decreases in terms of the real wages of low skilled workers, however. The figures plot the levels of the variables immediately after the specified change in productivity in the expanded model.

Dynamic impacts of durable housing

Durable housing can have a large impact initially, but including durable housing does not have the same generational impacts that including local ties has on equilibrium outcomes. To show how the effects of durable housing are large at first but then wane, Table B.5 reports changes in the population of low skilled workers in both the expanded model with durable housing (Exp) as well as the expanded model when I allow housing to immediately depreciate (NDH). Table B.5 reports population immediately and 50 years after the specified change in productivity as well as the time it takes the difference between the immediate decline and the model's steady state value to halve (the Half Life). Initial population responses are around one third smaller when I include durable housing after a negative productivity shock. However, the effects are very similar after 50 years because housing rapidly deteriorates after the shock. So there is a much faster half life of population changes in the expanded model with durable housing.

Figure B.4 shows how durable housing impacts the low skilled population over a period of around 20 years or less. It plots the change in the low skilled population after a 50 percent decline in productivity (as in the first row of Table B.5). Comparing the response with and without durable housing shows that durable housing leads to a smaller initial drop in population, but a quicker decline after the initial drop. The quicker decline in population in the model with durable housing leads to similar declines in population after around 20 years.

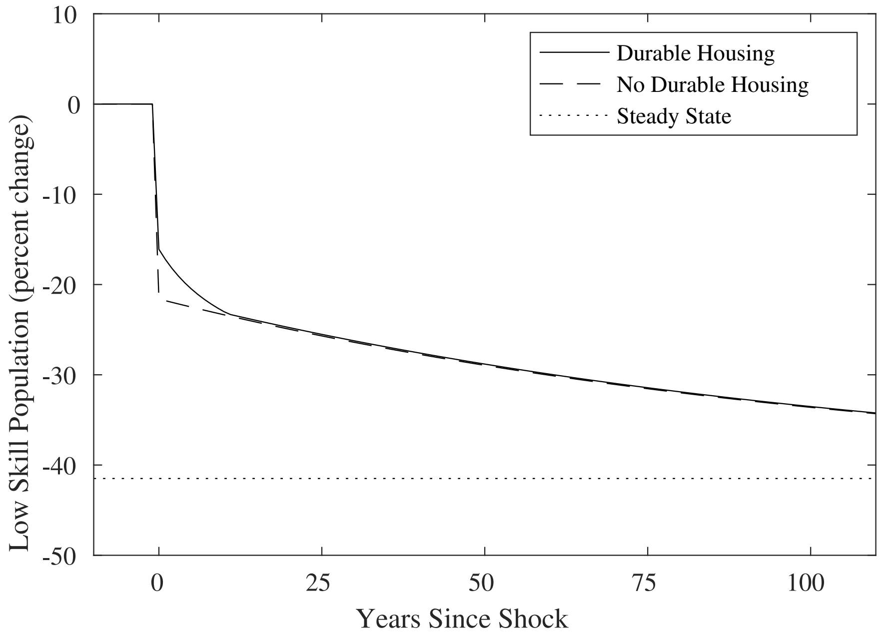
Table B.5: Population Changes after Productivity Changes with and without Durable Housing

Productivity	Initial		50 years		Half-life	
change	Exp	NDH	Exp	NDH	Exp	NDH
-50	-16.1	-21.6	-28.8	-28.9	50	75
-25	-7.7	-10.7	-14.0	-14.1	45	75
-10	-3.2	-4.2	-5.5	-5.6	46	73
-5	-1.8	-2.1	-2.8	-2.8	52	70
50	20.5	20.5	26.5	26.5	76	76

Note: Durable housing leads to smaller immediate declines in the low skill population productivity declines, but faster declines afterwards make its impact negligible within 50 years. Shown are changes in the population after the specified changes in productivity initially, after 50 years, and the half life of population's difference from its eventual steady state. Exp stands for effects in the expanded model including durable housing and NDH stands for the expanded model without durable housing.

Why do local ties have longer term impacts than durable housing? Local ties are formed

Figure B.4: Population Responses with and without Durable Housing



Note: Durable housing limits immediate population responses to a negative productivity shock, but the effect of durable housing declines with time. Plotted are percent changes in the population of low skilled workers in a place that experiences a 50 percent persistent decline in productivity in year zero.

incidentally based on experience in a place, while housing is formed based on workers' willingness to pay for new construction. Intuitively, local ties continue to be formed in economically depressed places because parents still live there. Construction of durable housing, on the other hand, only occurs when rents cover the cost of new construction. So new construction does not occur when rents fall below a certain level.

Place-Based Subsidies

The policy conclusions in the main text – that subsidies to high and low ties areas are efficacious for different reasons – also apply to the extended model. Subsidies to depressed places increase incomes in depressed places at a modest cost to aggregate productivity because they lead to relatively small changes in local population. Subsidies to productive places move workers and produce wage gains in other areas.

Measures of the costs and benefits of place-based subsidies are similar in a model with two skill levels. Figure B.5 presents the same metrics as Figure 12 in the main text, and each metric is quite similar. In places with higher shares born locally, income responses are larger both absolutely and also relative to population responses. So subsidies to places where residents have strong local ties do not distort population by much. In places with lower shares born locally, population responses are larger and wages in other areas rise by more. Besides the larger differences in population responses shown by the steeper line in Panel A of Figure B.5, there also are few differences in metrics for high and low skilled workers.

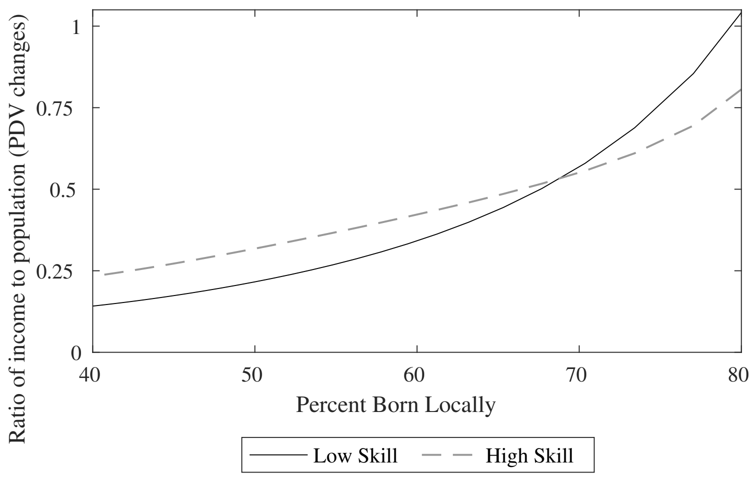
The steeper slope in the ratio of incomes to populations among low skill workers in Figure B.5 does reflect some underlying differences in how subsidies affect the two types in high and low ties places, however. Table B.6 shows that rents rise quite substantially after a subsidy to a high ties place that has recently experienced a 50 percent decline in productivity. Rents rise because durable housing leads to a very inelastic housing supply in a declining area. And the increase in rents undoes part of both the direct impact of the subsidy on low skilled workers' incomes and the increases in low skilled workers' nominal wages because of the influx of high skilled workers. So the two elements of the model tend to undo each other, at least in terms of workers' real wages in the subsidized place.

Appendix C Data

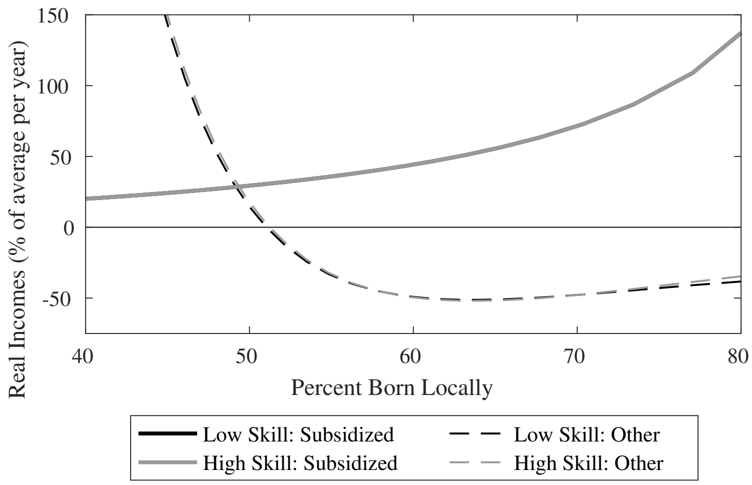
The data comes primarily from the decennial census and ACS as collected by IPUMS at the University of Minnesota (Ruggles et al. (2010)). Data on the impact of trade on individual local labor markets comes from Autor, Dorn and Hanson (2013), and the vital statistics data comes from the NBER. I generally aggregate these data up to Commuting Zones (Tolbert and Sizer (1996)) and perform most analyses at this level.

Figure B.5: Real Income Changes after Place-Based Subsidies

Panel A: Ratio of Income to Population Changes



Panel B: Real Income Changes



Note: The main findings for place based policies apply to both skill groups in the extended model. Subsidies to places with high shares born locally, or high ties, increase real incomes by more relative to population. And subsidies to newly productive places with low levels of local ties increase wages in other places. The top panel plots the ratio of the present discounted value of percentage changes in local real incomes relative to percentage changes in population due to a subsidy. The bottom panel plots the present discounted value of changes in real incomes per worker (ω) after the subsidy. the percent born locally in each figure is for the total population – including both groups. The subsidy is equal to 10 percent of initial wages in an area with no productivity shock, and it decays at four percent per years. Real incomes include wages net of taxes as well as rents. The line for other areas is multiplied by the number of other areas, which is 721 in this calibration.

Table B.6: Impact of Subsidies to Growing and Depressed Places in the Extended Model

Panel A: High Ties, Economically Depressed Place (50 Percent Productivity Decline)

	Extended			No Durable Housing			One Skill Level		
	Initial	50	100	Initial	50	100	Initial	50	100
Low - Real Wages	3.3	0.5	-0.1	4.9	0.5	-0.1	3.9	0.4	-0.0
Low - Population	3.8	1.2	0.5	4.7	1.2	0.6	6.3	1.4	0.5
Low - RW Outside	-3.9	-0.4	-0.0	-3.8	-0.4	-0.0	-3.0	-0.4	-0.1
Rents	35.3	2.1	0.4	13.5	2.1	0.4	8.7	1.2	0.2
High - Real Wages	3.1	0.5	0.1	3.9	0.5	0.1	3.9	0.4	-0.0
High - Population	6.2	0.9	0.1	7.2	0.9	0.1	6.3	1.4	0.5
High - RW Outside	-3.1	-0.4	-0.1	-3.0	-0.4	-0.1	-3.0	-0.4	-0.1

Panel B: Low Ties, Productive Place (50 Percent Productivity Increase)

	Extended			One Skill Level		
	Initial	50	100	Initial	50	100
Low - Real Wages	2.0	0.2	-0.0	1.8	0.2	-0.0
Low - Population	5.6	1.4	0.6	6.5	1.6	0.7
Low - RW Outside	0.4	0.3	0.2	0.3	0.5	0.4
Rents	7.1	1.1	0.2	4.2	0.6	0.1
High - Real Wages	1.9	0.3	0.0	1.8	0.2	-0.0
High - Population	7.1	0.9	0.1	6.5	1.6	0.7
High - RW Outside	0.2	0.2	0.1	0.3	0.5	0.4

Note: Subsidies to economically depressed places lead to similar increases in real wages for low and high skilled workers. Larger inflows of high skilled workers increase low skilled workers' wages by enough to counteract the large increases in rent due to durable housing. Subsidies to growing places have similar impacts for both groups. Plotted are the responses of the specified variables across each row that apply to the relevant worker skill level. Initial, 50, and 100 refer to the number of years after both the subsidy begins and the productivity shock hits. Columns that apply to the extended model are labeled "Extended," columns that apply to the extended model without durable housing are labeled "No Durable Housing," and columns that apply to the base model are labeled "One Skill Level." I omit the no durable housing columns in the growing panel because the presence of new construction makes them identical to the extended model.

IPUMS

The data from the U.S. Census comes via the IPUMS sample detailed in Ruggles et al. (2010). I use several PUMS samples: For 1970 I use the from 1 one percent sample at either the state or metro level, depending on whether the analysis uses states or commuting zones. For 1980, 1990, and 2000 I use the five percent samples. For 2008 I use the ACS 3 year estimates from 2006 to 2008. I exclude people residing in group quarters, such as military barracks or dormitories. For worker wages I exclude unpaid family workers and only include people who worked last year.

I also compute "labor supply weights" following Autor and Dorn (2013) that weight each worker by their total hours worked last year, and I exclude the top and bottom 1 percent of wages from the computation. All wages are deflated using the personal consumption expenditure chained price index with a reference year of 2007.

Birth Locations

I use the proportion of residents of a local labor market who are living in the state of their birth as my primarily measure of local ties. Since the Decennial Censuses and the ACS only ask for state of birth, it is impossible to determine precisely what local labor market a respondent was born in without using another data source. So the choice is largely driven by convenience.

This section briefly discusses results that are possible with a linked data source and provides several reasons why using state of birth, as opposed to another measure, is unlikely to be driving the main conclusions in the paper. The primary result is that results are similar with more detailed data based on linking Census data to data from the Social Security Administration. However, it is not currently possible to replicate most analyses with these data because the linking cannot be done for all census waves. Concerns about confidentiality also limit the use of the data for analyzing specific areas, which would restrict me replicating several analyses that I present with public data. So this section compares the two measures and provides several reasons why differences between them are unlikely to drive the main results presented in the paper.

Linked data shows that two measures of local ties are quite similar. Table C.7 presents the share of adults in the 2000 census who are living in their state of birth and who are also living in their CZ of birth, as well as within 50 miles of their birth county. It uses data from the 2000 Census linked to administrative data from the Social Security Administration on adults' places of birth (developed in Stuart, 2018). Seventy-four percent of adults living in their birth state are also living within their birth commuting zone, compared with three percent of adults who are living outside their birth state. An even higher proportion of people living in their birth state live within 50 miles of their birthplace.

Table C.7: Comparison with More Detailed Places of Birth

	In CZ	Within 50 Miles
In Birth State	73.8	80.3
Outside Birth State	3.3	7.2

Note: Most people who live in their birth state also live in the same CZ they were born in and within 50 miles of where they were born. This table shows the share of people who live in their CZ of birth and within 50 miles of their birth place, split by whether they already live in their birth state or not. Data come from a link between the SSA NUMIDENT and the 2000 census. Methodological details are contained in Stuart (2018).

There are also several other reasons why mismeasurement is unlikely to be driving the paper's findings. First, using other measures of time spent in an area yields similar empirical results, as shown in Section A.[49] Second, the lack of more detailed information should lead to higher shares of locally born residents in large western states like California and Texas, which is the opposite of what I find. Third, the measure's relationship with historical population is strong and likely to still hold, even if there is mismeasurement in the proportion of people living in the commuting zone of their birth. Fourth, it is unclear what the correct measure of proximity to one's birth place is. Workers who live in their state of birth could still be more likely to have local ties than workers who were born many states away, even if they

[49] In earlier versions of the paper I also excluded states where measurement error was more likely to be a problem and obtained similar results.

live in a city on the other side of the state.

Finally, mismeasurement is unlikely to be a problem because my measure of local ties has strong structural relationship with population changes – a relationship also detailed by Mangum and Coate (2018). Table C.8 gives granular view of the relationship, also displayed in Figure 7, by presenting the share of locally born adults as well as population changes for all commuting zones where the population age 22 to 64 was at least 500,000 in 1980.

Commuting Zones

I define places using Commuting Zones (CZ) defined by Tolbert and Sizer (1996). Commuting Zones are designed to reflect local labor markets where workers live and work, based on commuting data collected in the 1990 Census. A given CZ can contain multiple states and states can contain multiple CZs. When I cluster by state, it is the state that contains the plurality of the CZ's population. CZ are, of course, a useful simplification of a more complex reality (Manning and Petrongolo, 2017; Foote, Kutzbach and Vilhuber, 2017).

Appendix D Estimating Migration Elasticities

It is possible to directly measure the migration elasticities by measuring changes in population after the Bartik and China demand shocks. The equation below shows the basic empirical specification that I use to recover the migration elasticity, $\eta_{\text{Mig},j}$. The migration elasticity, $\eta_{\text{Mig},j}$, measures the effect of an increase in log incomes on log population, including the endogenous responses of other local prices. Since I intend to include the effects of these other local prices, like housing prices, I do not attempt to control for them. Following the reduced form results, I do control for decade fixed effects, γ_t, and the standard set of controls from the reduced form regressions, βX_{jt}. These ensure that the regressions are not being driven by different trends for areas where people are of different ages, different education levels, or places where more people are foreign born, for example. Following my earlier

Table C.8: The Share Born Locally in Large Cities

	Share Locals Percent	Population Pct Change	Population Millions in 1980
Miami, FL	18	90	1.24
Washington, DC	18	60	1.90
Phoenix, AZ	21	175	0.85
Tampa, FL	23	88	0.80
Denver, CO	30	78	0.92
Portland, OR	33	76	0.70
Atlanta, GA	33	146	1.13
San Jose, CA	34	43	0.99
San Diego, CA	35	69	0.97
Seattle, WA	37	75	1.40
Los Angeles, CA	37	58	6.24
San Francisco, CA	38	38	2.04
Dallas, TX	40	118	1.08
Newark, NJ	41	18	2.88
Houston, TX	42	84	1.67
New York, NY	46	22	5.75
Kansas City, MO	46	42	0.77
Fort Worth, TX	47	110	0.57
Bridgeport, CT	48	18	1.66
Sacramento, CA	51	96	0.85
Chicago, IL	54	27	3.84
Baltimore, MD	54	27	1.17
Boston, MA	55	25	2.34
Providence, RI	57	23	0.74
Minneapolis, MN	58	58	1.16
San Antonio, TX	58	86	0.58
Philadelphia, PA	60	16	2.73
Indianapolis, IN	62	51	0.64
Louisville, KY	64	27	0.53
Columbus, OH	65	48	0.70
St. Louis, MO	65	22	1.12
Cincinnati, OH	67	32	0.89
Milwaukee, WI	67	20	0.80
Dayton, OH	70	5	0.61
New Orleans, LA	72	-11	0.70
Detroit, MI	72	10	2.76
Cleveland, OH	73	2	1.43
Albany, NY	74	22	0.51
Grand Rapids, MI	75	49	0.50
Buffalo, NY	78	4	1.24
Syracuse, NY	79	6	0.55
Pittsburgh, PA	81	-7	1.49

Note: This table shows inverse relationship between the share locally born in 2008 and population changes from 1980 to 2008 by showing values of each for all commuting zones with prime aged adult populations of 500,000 or more in 1980. All statistics reflect the paper's sample or prime aged adults.

regressions, I allow heterogeneity across areas, j, by splitting areas into bins based on their levels of local ties, and also by including a continuous interaction with the level of local ties in each area.

$$\Delta \log \text{pop}_{jt} = \eta_{\text{Mig},j} \Delta \text{income}_{jt} + \gamma_t + \beta X_{jt} + \epsilon_{jt} \tag{12}$$

To isolate plausibly exogenous changes in local incomes, I use both the Bartik shifters in the 1980s and the Chinese import measures in the 1990s and early 2000s.[50] To maximize power, I stack the data for each of the three decades and estimate one set of parameters in the second stage. I allow the Bartik instruments to have different first stage effects from the trade instruments, but I assume the impact of the trade instruments is the same in each decade. [51]

I measure changes in incomes by combining information about changes in wages with information about the availability of jobs, as measured by the employment to population ratio. Wages are an imperfect measure of labor incomes because there appear to be significant frictions to their adjustments, particularly in periods when labor demand is falling. Workers and employees may be reluctant to accept declines in nominal wages, for example, and search frictions could also play a role.

In my empirical setup, labor incomes are the product of wages once one is employed times one's probability of being employed, as in Harris and Todaro (1970). Potential migrants consider not only wages, but also the difficulty of finding and keeping a job. I use the employment to population ratio as a measure of this probability. Changes in log labor income, then, are changes in log wages, Δwage_{jt}, plus changes in the local employment to

[51] Another point about the instruments is that the use of labor incomes abstracts from people's labor leisure choices. In my model, and in much of the literature on spatial equilibrium, an increase in labor incomes has an identical effect as an equivalent increase in local subsidies, because people work for a fixed number of hours in the place where they live. By the logic of the sufficient statistics derivation, however, the impacts on people's labor leisure choice should fall out from the first order welfare impacts of a local subsidy. Intuitively, people are roughly indifferent about working more or searching harder for a job. The most serious limitation for my empirical work appears to in terms of attracting population; local subsidies may be more or less appealing to migrants than increases in wages.

population ratio, $\Delta\text{emp ratio}_{jt}$.

$$\Delta\text{income}_{jt} = \Delta\text{wage}_{jt} + \Delta\text{emp ratio}_{jt}$$

The estimated migration elasticities – reported in Table D.9 – are an order of magnitude lower in areas with higher levels of local ties. The migration elasticities in column one are 0.08 in high ties areas and 0.99 in low ties areas. These are statistically significantly different from one another at the ten percent level. The instrument also appears to be strong enough to support this inference, since the first stage since traditional Wald and Kleibergen-Paap corrected Wald F statistics are above traditional thresholds.

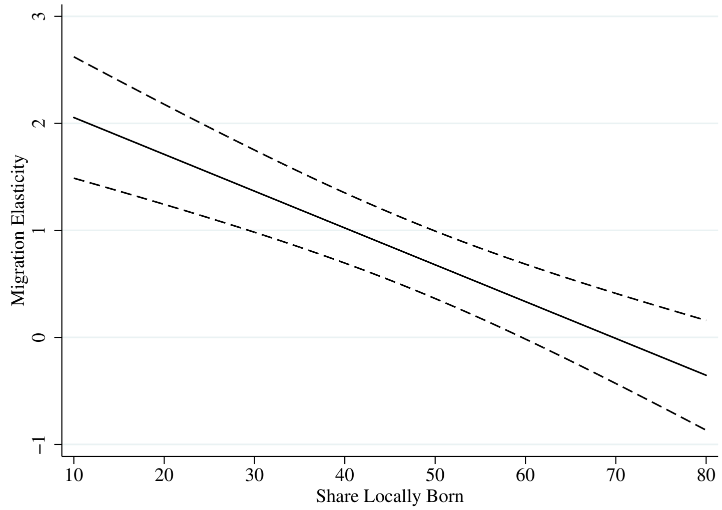
The slope of the continuous linear interaction in column two of Table D.9 implies that migration elasticities decline by around 0.35 for every 10 percent increase in the share of locals. I also plot the estimate in Figure D.6. To get an idea of the magnitudes, around 15 percent of people who live in Miami were born in Florida. So the estimated migration elasticity is around two in Miami. In areas with very high levels of local ties, the estimated migration elasticity reaches zero. The continuous linear interaction term is statistically different from zero at the one percent level, and the regression also passes conventional thresholds for having a sufficiently strong instrument.

Table D.9: Estimated Migration Elasticities from Demand Shocks

	(1)	(2)	(3)
High Ties: Incomes	0.08		
	(0.24)		
Low Ties: Incomes	0.99		
	(0.39)		
High Ties Indicator	-0.95		
	(1.14)		
Main Effect of Incomes		2.40	1.35
		(0.34)	(0.58)
Interaction (x100)		-3.44	
		(0.64)	
Main Effect of ties		-0.14	
		(0.07)	
Year Fixed Effects	Y	Y	Y
Controls	Y	Y	Y
P-val: No diff	0.03	0.00	
First stage F: Wald	35	37	46
First stage F: K-P	12	11	14
Observations	2166	2166	2166

Note: Estimated migration elasticities are much lower in areas with high shares of locally born residents, or high local ties. This table displays the estimated coefficients from a regression using the two labor demand shocks – due to trade and national industry level changes – to instrument for log incomes in a regression predicting log population. So, the estimated relationship is an estimated migration elasticity. The regressions use the standard set of controls and standard errors clustered at the state level, as in Table 2 of the main text. The statistics at the bottom report a Wald test for no difference in the elasticities between low and high ties areas, the first stage partial Wald F statistic and Kleibergen-Paap corrected Wald F statistic.

Figure D.6: Estimated Migration Elasticities



Note: Estimated migration elasticities are much lower in areas with high shares of locally born residents, or high local ties. This figure displays the migration elasticities implied by column two of Table D.9 based on the methodology reported in that table. The dotted lines represent 95 percent confidence intervals of the values.