For Online Publication: Appendices to Local Ties in Spatial Equilibrium

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Appendix A Data

Data comes primarily from the United States Decennial Census and American Community Survey (ACS). Data on the impact of trade on individual local labor markets comes from Autor, Dorn and Hanson (2013). I generally aggregate these data up to Commuting Zones (CZs Tolbert and Sizer (1996)) and perform analyses at the CZ level.

The data from the United States Census Bureau comes via IPUMS (Ruggles et al., 2010). I use several PUMS samples: For 1970 I use the one percent sample at the metro level. 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 exclude Alaska, Hawaii, and Puerto Rico from the analysis since moving costs to and from these locations is likely to be more expensive.

A few sample restrictions and re weightings allow me to focus on the labor market. I include only 22 to 64 year olds who are not living in group quarters like barracks, prisons, and dorms. 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. In addition, I adjust wages and prices using a PCE deflator so they represent 2007 dollars.

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.[1] 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.

Commuting Zones

I define places using Commuting Zones (CZs, Tolbert and Sizer (1996)) that encompass both residences and workplaces. CZs reflect labor markets where workers live and work, based on commuting data collected in the 1990 Census. CZs also cover the entire continental U.S., which allows me to examine ongoing migration from rural areas. 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. I keep these constructs fixed at their definition in 1990 to avoid spurious changes due to changes in geographic boundaries.

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.[2]

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. Results are similar with more detailed data from the Social Security Administration. However, it is

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

not currently possible to replicate most analyses with these data because the linking cannot be done for all Decennial Census waves. Concerns about confidentiality also limit the use of the data for analyzing specific places, 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 A.1 presents the share of adults in the 2000 Census complete count data 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 Short Form linked to administrative data from the Social Security Administration (SSA) 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 A.1: 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 Short Form. 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 D.[3] 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,

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

even if there is mismeasurement in the proportion of people living in their birth CZ. Fourth, it is unclear what the correct measure of proximity to one's birthplace 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 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 A.2 gives granular view of the relationship, also displayed in Figure 6, 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.

Table A.2: Shares Born Locally in Large Cities

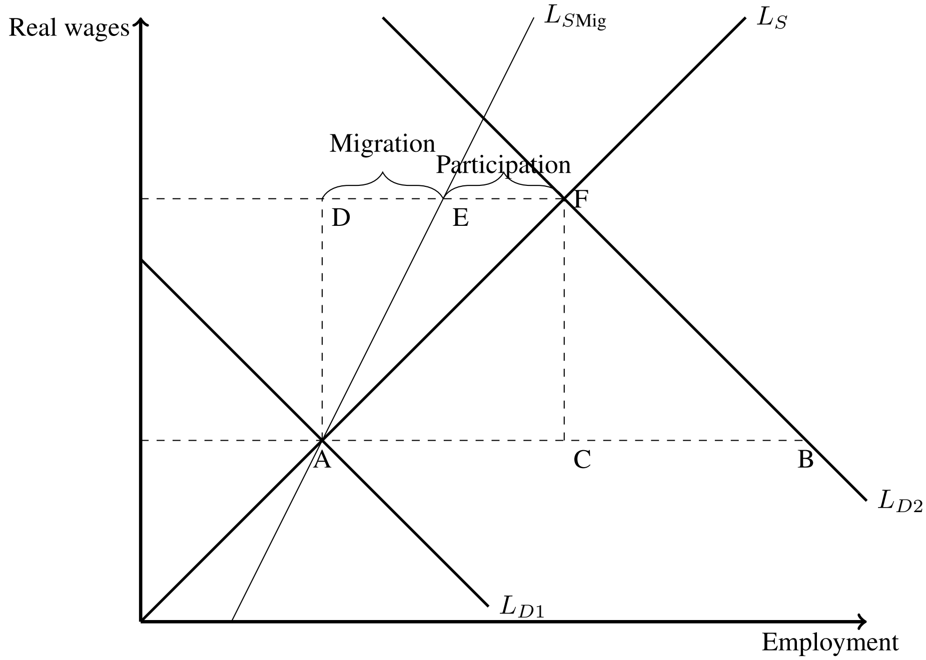
	Share Locals Percent	Population Pct Change	Population Millions in 1980
Miami, FL	18	90	1.24
Washington, DC	18	60	1.90
Phoenix, AZ	21	175	0.85
Tampa, FL	23	88	0.80
Denver, CO	30	78	0.92
Portland, OR	33	76	0.70
Atlanta, GA	33	146	1.13
San Jose, CA	34	43	0.99
San Diego, CA	35	69	0.97
Seattle, WA	37	75	1.40
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.

Appendix B A System of Labor Supply and Demand

The system of labor demand and supply in Figure B.1 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.

Figure B.1: 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.[4] 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 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.

Appendix C Estimating Migration Elasticities

It is possible to directly measure the migration elasticities by measuring changes in population after the Bartik and Import shocks. The equation below shows the basic empirical specification that I use to recover the migration elasticity, $\eta_{\text{Mig},j}$. The migration elasticity 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. I do control for decade fixed effects, γ_t, and the standard set of controls from the reduced form regressions in the main text, 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 regressions in the main text, 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.

[4]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 $\frac{B-A}{\eta_D+\eta_{S\text{Mig}}+\eta_{S\text{Part}}}$.

$$\Delta\log \text{pop}_{jt} = \eta_{\text{Mig},j}\Delta\text{income}_{jt} + \gamma_t + \beta X_{jt} + \epsilon_{jt} \quad (1)$$

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.[5] 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. [6]

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.

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 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 C.3 – 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 C.3 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 C.2. To get an idea of the magnitudes, around 15 percent of people who live in Miami were born in Florida. So

[6]Another point about the instruments is that the use of labor incomes abstracts from people's labor leisure choices. In the model in the main text, 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.

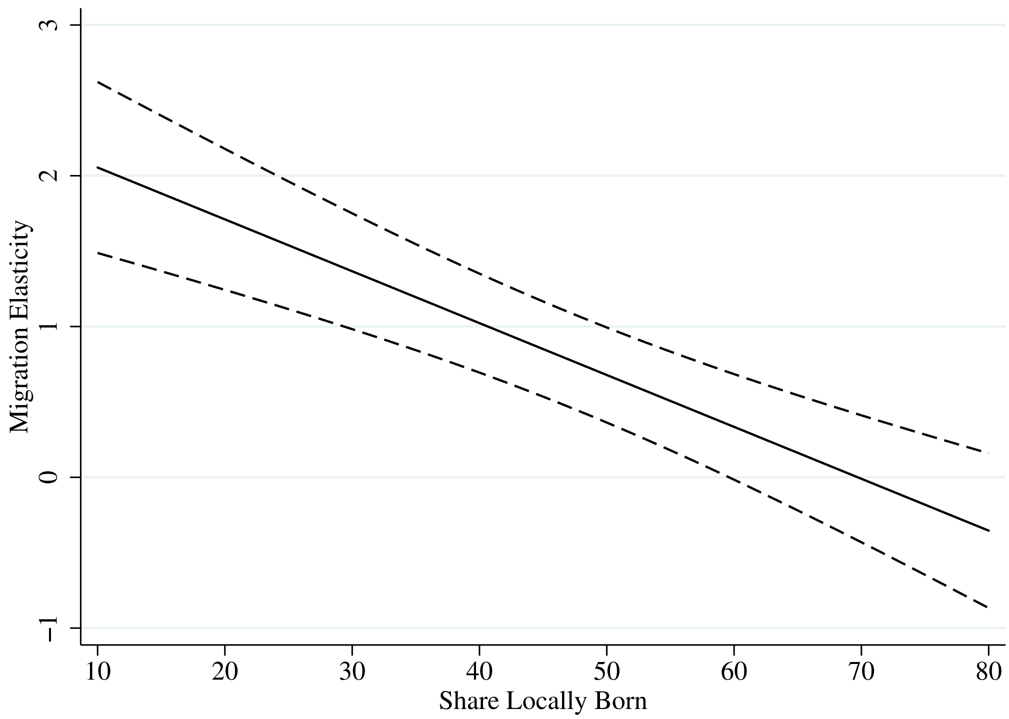
the estimated migration elasticity is around two in Miami. In areas with very high levels of local ties, the estimated migration elasticity reaches zero. The continuous linear interaction term is statistically different from zero at the one percent level, and the regression also passes conventional thresholds for having a sufficiently strong instrument.

Table C.3: 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 C.2: 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 C.3 based on the methodology reported in that table. The dotted lines represent 95 percent confidence intervals of the values.

Appendix D Robustness Checks

This section shows robustness of the regression results that depressed places have lower migration responses to labor demand shocks. 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,[7] 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 a single linear interaction term – 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.

$$\Delta y_{j,t} = \alpha_t + \beta_1 \text{Ties}_{j,t-1} \Delta \hat{L}_{j,t} + \beta_2 \text{Ties}_{j,t-1} + \beta_3 \Delta \hat{L}_{j,t} + \gamma_X X_{j,t-1} + \epsilon_{j,t} \quad (2)$$

The linear interaction term has a different interpretation than the coefficients in the specification in the main text, equation 1. In equation 2 the effect of a labor demand shock linearly scales 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

[7] 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.

local ties. So a more reasonable number is to divide each linear interaction term by three, since Table 1 in the main text 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 2 for outcomes where I observe meaningful effects in Table 2. The simplest of these are the first and the last three columns of each robustness table. 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 2. Column six shows the effects are not driven by control variables by omitting them. Column seven shows the effects are not driven by weighting by presenting unweighted results. Finally, column eight shows that the results are not driven by my measure of local ties by using the total number of years someone has been living in their house as an alternative.[8]

I address the possibility that other variables are driving the different effects by including their interaction with local ties and showing that the effect of local ties is largely unchanged, and sometimes strengthened. Column two of each robustness table 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.

I replicate the main results for the Bartik labor demand shifters in terms of population and rent in Table D.4. The linear interaction term in the triple difference specification for population, shown in column one of Panel A in Table D.4 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.

[8]Note that the coefficient has a different interpretation, so it is meaning full only in terms of its sign.

Table D.4: 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. The first column shows a triple difference specification interacting the labor demand shock with the share of locals. The second through fifth include other variables that could lead to different responses. Column two includes the share of people under 35 and over 50. Column three includes the share college educated. Column four includes the share 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. Column seven omits weights. Finally, column eight measures ties by the average amount of time people have been in their house. Share coefficients are multiplied by 100, as is the lagged log change in rents. Additional details follow Table 2.

The the results for the trade shocks are similarly robust. The only major departure in Tables D.5 and D.6 is that the interaction term in column one of Panel A of Table D.5 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 D.5 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 D.5: 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 D.6: 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 E Model Equilibrium

The model's equilibrium is a set of prices and quantities (p_j, w_j, r_j, N_j) conditional on the distribution of workers' local ties (all μ_i and N_{ik} terms) where agents behave optimally and markets clear.

$$N_j = \sum_{k' \in K} \sum_{i'} \psi_{i'jk'} N_{i'k'} \tag{3}$$

$$w_j = (1 - \alpha^Y)(p_j \theta_j)^{1/(1-\alpha^Y)} \left(\frac{\alpha^Y}{\rho} \right)^{\alpha^Y/(1-\alpha^Y)} \tag{4}$$

$$r_j = \left[\alpha^H w_j N_j \right]^{\frac{1}{1+\eta^H}} \tag{5}$$

$$\theta_j N_j \left(\frac{p_j \theta_j \alpha^Y}{\rho} \right)^{1/(1-\alpha^Y)} = Y \frac{\phi_j}{p_j^{\eta^Y}} \tag{6}$$

Appendix F Expanded Model with Skill Levels and Durable Housing

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 dynamics observed in the literature on regional migration, including a growing concentration of skilled workers in highly productive, rich cities. The basic model is flexible enough to accommodate additional features that have been emphasized in the literature on domestic migration.[9]

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

[9] 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.

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).[10] Low skilled workers earn less in depressed 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.[11] 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 rel-

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

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

ative to low skilled labor and η_N is the elasticity of substitution between the two types.

$$N_j = \left[(1 - A_H) N_{Lj}^{\frac{\eta_N - 1}{\eta_N}} + A_H N_{Hj}^{\frac{\eta_N - 1}{\eta_N}}\right]^{\frac{\eta_N}{\eta_N - 1}} \tag{7}$$

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.[12]

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

Concave Housing Supply

To keep the housing market relatively tractable and to match the intuition of Glaeser and Gyourko (2005), I include a piecewise linear housing supply function. The function exhibits a kink at the supply of housing in the previous period multiplied by a depreciation rate. Intuitively, this would cover a case where a fixed, random percentage of the housing stock is destroyed each period, matching Glaeser and Gyourko (2005). The function is concave so long as the housing supply elasticity below the kink is lower than the one above it, $\eta_E > \eta_C > 0$.[13]

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

[12] 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.

[13] 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 Each worker is still paid their marginal product but now their marginal product depends on an additional term proportional to the relative supply of their skill level. Less skilled workers receive higher wages when there are relatively more high skilled workers, since high skilled workers make them more productive.

$$\frac{\partial Y_j}{\partial N_{Lj}} = \underbrace{(1-\alpha^Y)(p_j\theta_j)^{\frac{1}{1-\alpha^Y}}\left(\frac{\alpha^Y}{\rho}\right)^{\frac{\alpha^Y}{1-\alpha^Y}}}_{\text{Unchanged}}\underbrace{(1-A_{Hj})\left(\frac{N_j}{N_{Lj}}\right)^{1/\eta_N}}_{\text{New}} \tag{8}$$

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.

$$\frac{w_{Hj}}{w_{Lj}} = \frac{A_{Hj}}{1-A_{Hj}}\left(\frac{N_{Lj}}{N_{Hj}}\right)^{1/\eta_N} \tag{9}$$

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. And the additions increase the number of parameters to calibrate and estimate. 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 F.7. 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 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 F.7: 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 they 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.

The model matches the three distributions, as shown in Figure F.3. The relatively good match is despite taking the spread of the logit distribution from the literature and 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 F.4 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).

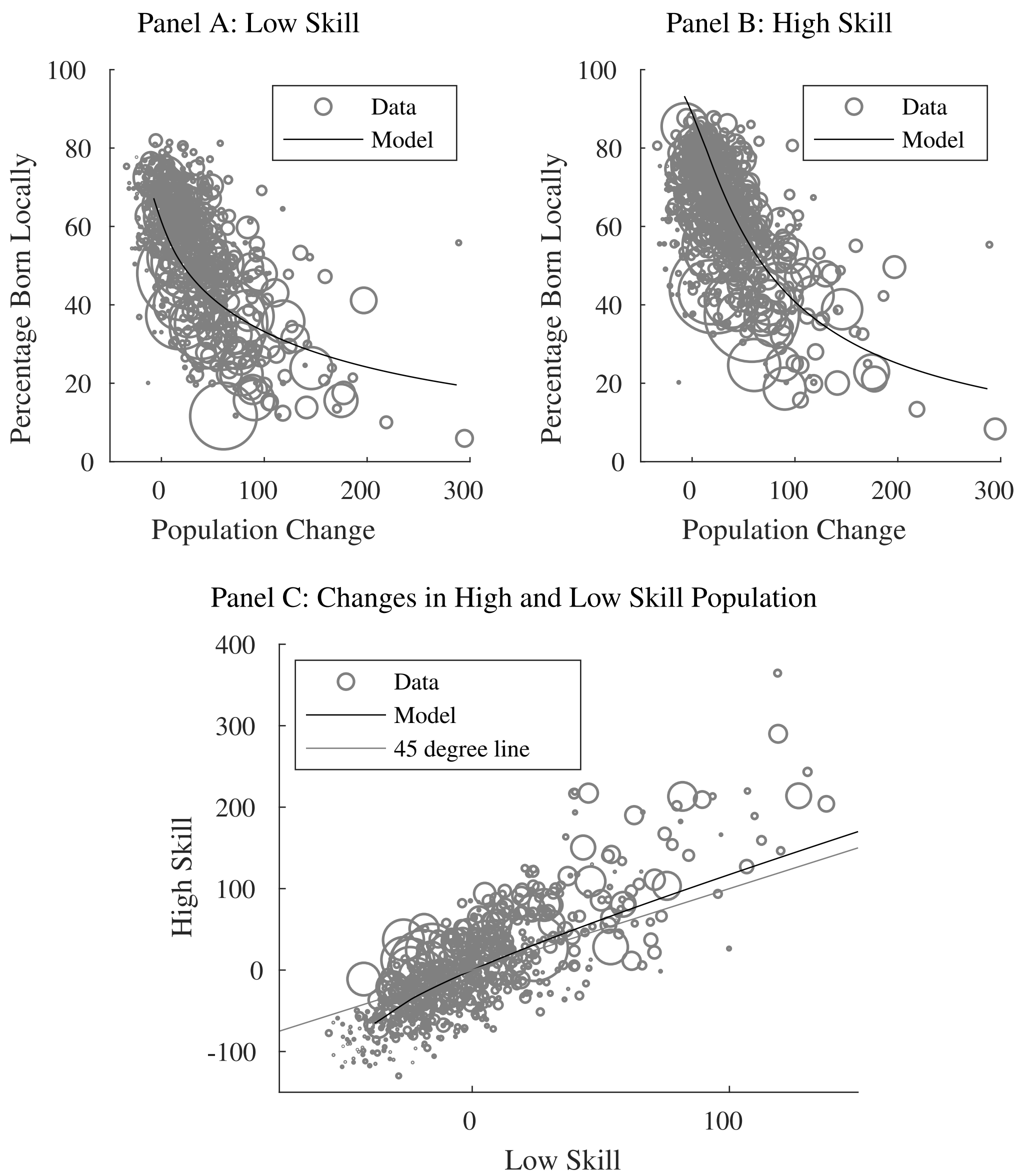
The lower supply of higher skilled workers in depressed places increases the nominal wages of high skilled workers and decreases the nominal wages of low skilled workers. Panel A of Figure F.5 shows that the share of high skilled workers is lower in places that saw declines in productivity, as explained in Figure F.4. 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 9 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 F.5 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. 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.

Dynamic impacts of durable housing

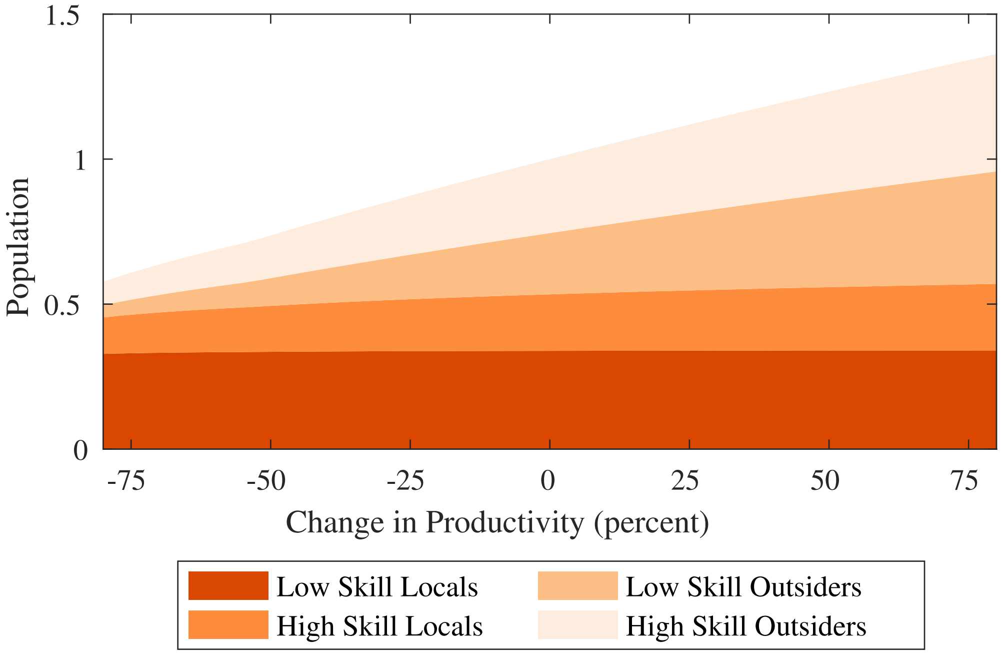
Durable housing can have a large impact initially, but including durable housing does not have the same generational impacts that including local ties has on equilibrium outcomes. To show how the effects of durable housing are large at first but then wane, Table F.8 reports changes in the population 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 F.8 reports population immediately and 50 years after the specified change in productivity as well as the time

Figure F.3: Two Skill Estimation Moments and Targets



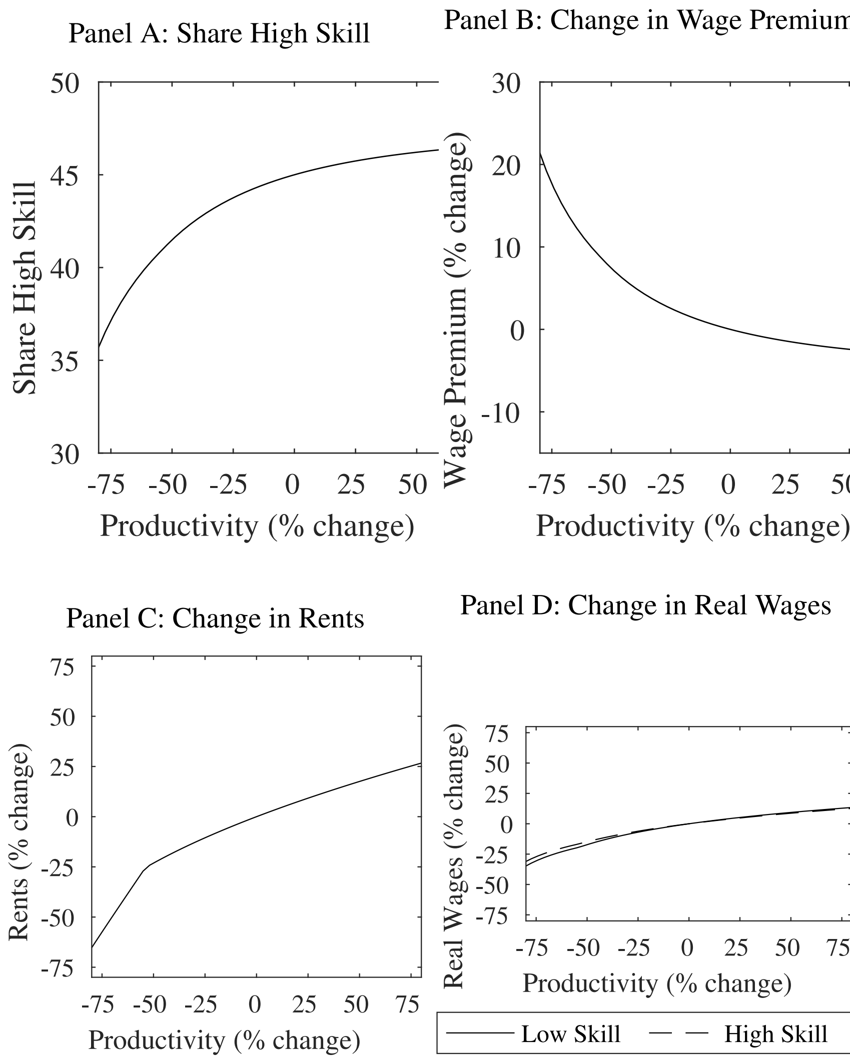
Note: The model matches the distribution of low and high skill people born locally across places as well as population changes for each group. This figure plots each distribution in the data as well as the model analogue I use to approximate it in my estimation procedure.

Figure F.4: 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.

Figure F.5: 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.

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 F.6 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 F.8). 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.

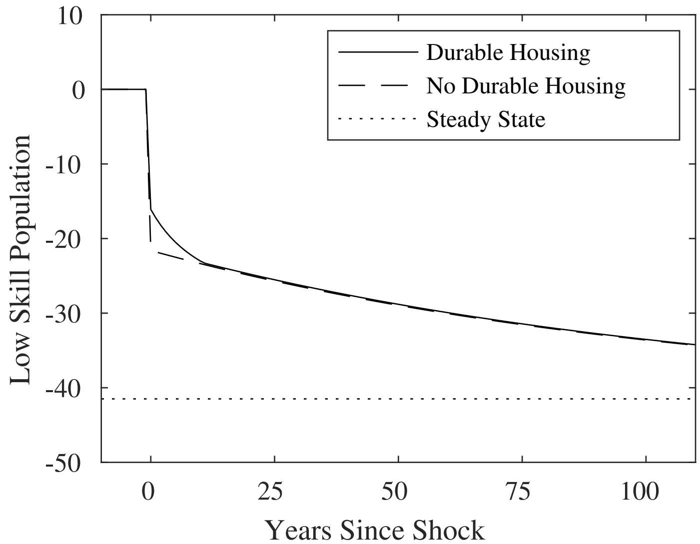
Table F.8: Population Changes after Productivity Changes with and without Durable Housing

Productivity change	Initial		50 years		Half-life	
	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 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.

Figure F.6: 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.

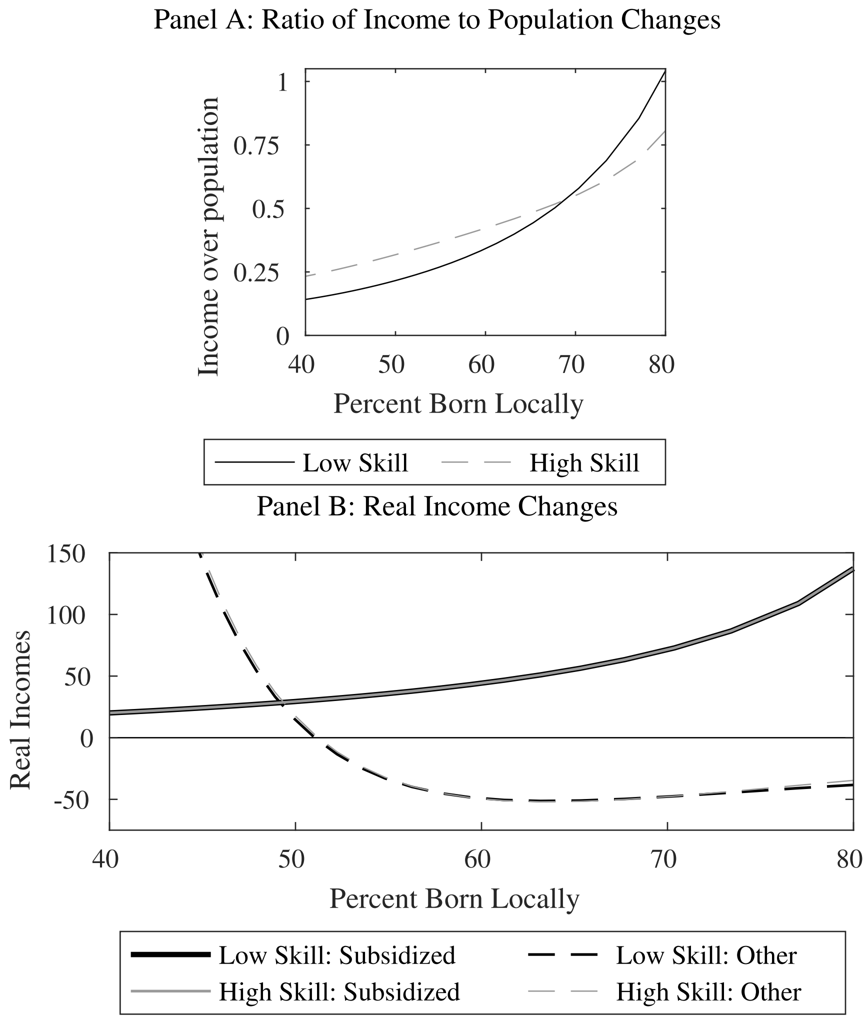
Place-Based Subsidies

The policy conclusions in the main text – that subsidies to economically depressed and to growing places are efficacious for different reasons – also apply to the extended model. Subsidies to depressed places increase incomes among both skill groups at a modest cost because they lead to relatively small changes in population. Subsidies to productive places move workers and produce wage gains for both groups of workers in other areas.

Figure F.7 presents the same metrics as Figure 11 in the main text. Each metric behaves similarly for the two skill groups and each metric also has similar patterns to Figure 11. Subsidies to economically depresses places do not distort population by much. In places with higher shares born locally, income responses for both groups are larger both absolutely and relative to population responses. In growing places, with lower shares born locally, population responses are larger and incomes in other areas rise among both groups. Besides the larger differences in population responses shown by the steeper line in Panel A of Figure F.7, there 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 F.7 does reflect some underlying differences in how subsidies affect the two groups in high and low ties places. Table F.9 shows that rents rise quite

Figure F.7: Real Income Changes after Place-Based Subsidies



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 includes both groups. The subsidy is the same as in the main text – 10 percent of initial wages decaying at four percent per year. Real incomes include wages net of taxes and rents. The line for other areas is multiplied by the number of other areas – 721.

Table F.9: 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. This table shows responses of variables for each worker skill level across each row. Initial, 50, and 100 refer to the number of years after both the subsidy begins and the productivity shock hits. Columns labeled "Extended" represent the model with two skill levels and durable housing, columns labeled "No Durable Housing" apply to the model with two skill levels but no durable housing, and columns labeled "One Skill Level" signify the baseline model. I omit the no durable housing columns in the growing panel because they are identical to the extended model.

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.

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