

Asymmetry in Growth and Decline: Multipliers, Housing Prices, Wages and Rustbelt Decline

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Abstract: This paper examines the effect of asymmetric labor demand shocks in a county level spatial equilibrium model that combines housing values (rents), wages and population. Testing the model on a panel of 1,644 U.S. counties, we find significant asymmetry in positive and negative labor demand shocks. This implies an asymmetry between growing and declining regions, which extends to changes in home prices, wages and population. In addition, we find regional differences in willingness to pay for exogenous (natural) amenities in home values. We also report that natural amenities enjoy a causal link to population growth, but that amenities and wages experience very different effects across regions. This may be due to the dual role of urban productivity and compensating differential to low amenity regions played by wages.

Introduction

A number of recent studies conclude that a long period of economic convergence between regions in the United States has ended. In its wake, either divergence in overall levels of economic activity or within regional distribution of incomes is the experience of U.S. metropolitan or county level economies (Young, Higgins and Levy, 2008; Hicks, 2010, Nissan and Payne, 2013; Gerolimetto and Magrini, 2014).¹

This trend appears to begin about three decades ago, appear to be accelerating, and may be a contributing factor to the political polarization which grips the United States (Autor, et. al., 2017; Devaraj, et. al., 2017).

Studies attempting to identify causation of this observed divergence suggest it is likely the result of microeconomic forces best explained in a spatial equilibrium model (Glaeser and Gyourko, 2005; Glaeser and Gottlieb, 2009). These studies expand on Roback's (1982) static model of

¹ These are referred to in the growth literature as β and α convergence respectively, but should not be confused with the use of these greek letters in this paper.

spatial equilibrium with wages, rent and population, but durable housing stock as a factor that limits the speed of factor adjustment.

One result of these models is that the presence of durable housing stock plays a role in asymmetric urban growth. Cities with excess housing stock grow more quickly than they decline, and housing prices are more elastic in the wake of negative population shocks than from positive shocks. These models imply a persistence of city decline, which appears to fit the Rustbelt experience over the past few decades. Additionally, these models report that an excess housing stock and weak labor demand reduces relative human capital in declining cities, as low human capital households seek lower priced housing.

Notowidigdo (2011) constructs a spatial equilibrium model that measures the relative impact of labor demand shocks on workers by type. He finds that low skilled workers experience smaller labor demand shocks, and it is the lower volatility, rather than relocation costs that limits worker mobility. This is the causal effect of increasing shares of low-income workers in declining places.

These concerns are important both in their contribution to an array of spatial modeling considerations, but also because these models convincingly combine with recent evidence of regional divergence. Quite simply, in many parts of the United States regional growth is diverging, with more affluent places growing, and poorer places in persistent decline.

In this paper, we add to the literature in three ways, building upon the evidence of a spatial equilibrium model. First, we attempt to link the causal mechanism of asymmetric shocks to differences in observed experiences in growing and declining places. We do this by introducing evidence from earlier work which tests the symmetry of employment multipliers in a stochastic model (Hicks, 2018). This builds upon Moretti's (2010) empirical examination of multipliers, illustrating some evidence of more recent contributions to divergence. Second, we then extend the asymmetry of labor demand shocks to a spatial equilibrium model, with housing price, wages and population as endogenous components. In this model, we include exogenous (fixed) natural amenities in our simultaneous equation model. Finally, we provide empirical estimates of reduced form effects of asymmetric labor demand shocks and willingness to pay for natural amenities.

To present this research we offer the evidence of asymmetries, outline the theoretical model, identify the data sources and outline econometric considerations and results. This is followed by a summary and conclusions. We begin with a review of the relevant literature.

Studies on Housing in a Spatial Equilibrium Setting

Spatial equilibrium modeling, which included amenities and rents began with Mills (1967), Rosen (1979) and Roback (1982). In these models, households maximize their indirect utility across geographies by choosing combinations of consumption and rents. These are typically proxied by wages and home prices. Varying outcomes by place are dependent upon local

amenities. The result of this early work is a spatial equilibrium model underlying varying levels of amenities, rents and wages.

Later work on spatial equilibrium, by Glaeser and Gyourko (2005) and Glaeser and Gottlieb, (2009) included asymmetric population shocks, in efforts to better model the amenity wage mix across geographies. The first of these generated a clear set of outcomes for urban places. They found that city growth was more rapid than decline, but that decline was more persistent. In the first of these models, the introduction of housing construction costs played a role in limiting housing supply when new construction was no longer profitable. This occurred when the price of housing stock dipped beneath the cost of construction. This condition leads to a persistence of decline in such locations.

One important result of this model is that declining home prices in the wake of population shocks shifts the human capital mix in regions, as lower human capital households are attracted to lower priced housing. This result extends the period of decline in a steady-state model. The later model of Glaeser and Gottlieb introduced agglomeration economies, which offer a more nuanced view of the role of amenities, wages and home prices.

A critical extension of this work by Notowidigdo (2011) examined relative mobility across heterogeneous workers in a spatial equilibrium model with labor demand shocks and transfer payments. He found that lower skilled workers are less responsive to labor demand shocks because their skill set is infrequently affected and social transfers create a place-based stickiness.

An Extension of Spatial Equilibrium

Following Mills (1967), Rosen (1979) and Roback (1982) labor mobility has acted to equilibrate utility across space. These static models have proved enormously successful in their predictive capacity and their adaptability to dynamic spatial modeling. However, decreasing household mobility combined with evidence of economic divergence suggests the speed of adjustment may be lengthier than early studies suggest. Blanchard and Katz (1992) for example, suggest a five-year adjustment period for home prices. Feyrer, et. al. (2007) confirmed this spatial adjustment, but report that migration equilibrated labor markets, resulting in permanently lower population and declining endogenous amenities.

These models also struggle to transition to policy, in part because explanation of steady-state (or equilibrium) conditions are complex. Observable declines in income, rents (or home prices) and population are consistent with these modeling approaches, and general equilibrium results does not necessarily imply an end to observable declines.

In the wake of these observations, Glaeser and Gyourko (2005) introduced durable housing stock into a model of asymmetric population shocks. This study reports much longer adjustment periods for capital stock. This study and report that the utility maximization decisions could extend for decades in declining metropolitan areas.

Building on this robust framework, we wish to evaluate the symmetric effect of labor demand shocks on economic activity. To do this, Hicks (2018) constructed a simple multiplier model which relaxed the assumption of symmetry where tradable (or footloose) labor demand shocks. Using a framework outlined by Jones, Olson and Wohar (2014) for asymmetric tax multipliers, he modeled $N_{i,t} = \alpha N_{i,t}^T | \forall N \geq 0 + \beta N_{i,t}^T | \forall N \leq 0$ where N is employment, and N^T is tradable labor demand shock, either positive (α) or negative (β), with both inclusive of the rare zero value. We begin by reporting the results from Hicks (2018) treatment of asymmetric employment multipliers. See table 1.

Table 1

Imputed Multipliers, with county and mean contiguous county employment shocks

		Full Sample	Early	Mid	Late
		1972 to 2015	1972 to 1985	1985 to 2000	2000 to 2015
Full sample CS=3022, N = 125,160	Increase α	2.51	3.68	1.14	1.28†
	Decrease β	1.23	4.8	2.18	1.21†
	mean effect	1.87	4.24	1.66	1.245
Urban (RUCC 1-3) CS=339, N=14,457	Increase α	2.65	3.92	0.54	0.86
	Decrease β	1.18	4.51	1.57	1.17
Rural (RUCC < 4) CS=1746, N=69,230	Increase α	1.66	2.98	0.36	0.27
	Decrease β	1.16	3.63	1.03	1.12

Note, † denotes these coefficients are not statistically different in a Wald test.

Examined across both the full sample, the labor multipliers demonstrate considerable asymmetry overall, and in the early and mid-periods. The mean effect of the total sample (1.87) is close to a rule of thumb manufacturing employment multiplier (as derived in the RIMS II model).² However, in the sub-sample periods and in the large urban, and rural (and small town) geographies asymmetries emerge. In the early period, positive labor demand shocks enjoyed much larger effects, which dissipated with time, converging by the later period. Notably, the coefficients shrank over time, suggesting far less local employment response to labor demand shocks. This is suggestive of studies that report much smaller employment elasticities to labor demand shocks (e.g. jobs follow people, not people follow jobs) such as Hicks and Faulk, 2015.

This study reports significant asymmetry in the magnitude of impacts from positive and negative labor demand shocks from purely exogenous employment. This is useful because it establishes asymmetry in employment shocks that mimics the Glaeser-Gyourko asymmetry in housing price shocks. This study, which is the only asymmetric multiplier test in nearly four decades, also

² See <https://www.bea.gov/regional/rims/rimsii/> for the Regional Input-Output Modeling System prepared by the U.S. Department of Commerce.

provides evidence of asymmetric effects of adverse shocks, which differ significantly across rural and urban places. Positive employment shocks are not driving significant employment into rural places, and labor demand shocks have declined in magnitude in ways that suggest the decline in overall labor mobility. This has many implications, from “welfare magnetism,” optimal policies under broad adverse demand shocks as well as local economic development policy. For our purposes, we are interested in expanding these findings into a more holistic framework of mobility, wages and rent.

A spatial model with asymmetric shocks and exogenous amenities

In this paper, we seek to extend this framework to regional variations, in a spatial equilibrium model that accounts for amenities, consumption and productivity effects and population change. We extend this model to non-urban places, a significant departure from earlier literature. This model seeks to extend the Rosen-Roback framework to labor demand shocks, and a Glaser-Gyourko perspective on housing prices and asymmetry in effects.

We begin with the Rosen-Roback framework, as extended by Glaser and Gottlieb suggests a Cobb-Douglas production function with tradable and non-tradable capital stock such that $Y_{i,t} = Z_{i,t} (K_{i,t}^T)^{\alpha\beta} (K_{i,t}^{NT})^{\alpha(1-\beta)} (N^{NT})_{i,t}^{(1-\beta)(1-\alpha)} (N^T)_{i,t}^{\beta(1-\alpha)}$ where output in region i , in year t , is a function of a technology coefficient Z , tradable and non-tradable capital K and labor N . The share value of each type of capital is β and α is the constant returns to scale parameter.

We assume utility is a function of tradable goods consumption, non-tradable goods consumption and amenities such that $U = U(G_{NT}, G_T, A) = \rho G_{NT}^\pi G_T^{1-\pi}$, which is reduced to an indirect utility function where $V = V(W, H, A)$ composed of personal income (wages), housing and local amenities. Holding amenities constant, this yields $dI_{i,t} = -\frac{V^T}{V^{NT}} dH$, where the ratio of $\frac{V^T}{V^{NT}}$ reflects the slope for demand for the non-traded good. The predictions of this model follow that of Glaeser and Gottlieb (2009) with high income acting as compensating variation for lower amenities, while higher housing costs will be offset by higher incomes.

Translating this into an empirical specification of interest involves some simplification. The non-traded good is dominated by housing, with other non-tradable goods assumed as a covariate. The regional production function must also be simplified. With $Y_{i,t} = Z_{i,t} (K_{i,t}^T)^{\alpha\beta} (K_{i,t}^{NT})^{\alpha(1-\beta)} (N^{NT})_{i,t}^{(1-\beta)(1-\alpha)} (N^T)_{i,t}^{\beta(1-\alpha)}$ as the dual capital production function, we wish to evaluate the role of labor demand shocks associated with traded production, $K_{i,t}^T$. Some share of $N_{i,t}^{1-\alpha}$, will be absorbed by changes to capital used for the production of non-traded goods, which, with constant returns to scale will be equal to $1-\beta$.

Including the Rosen-Roback amenity consideration into this relationship provides a full spatial equilibrium model:

$$\log(Y_{i,t}) = \begin{bmatrix} \log H_{i,t} \\ \log W_{i,t} \\ \log P_{i,t} \end{bmatrix} = \alpha(1 - \beta)\log(K_{i,t}^{NT}) + (1 - \beta)(1 - \alpha)\log N_{i,t}^{NT} + \alpha(\beta)\log(K_{i,t}^T) + (\beta)(1 - \alpha)\log N_{i,t}^T + \theta\log A_i \quad (1)$$

From this we can reconstruct a difference equation for the production function holding fixed capital constant as $d\log Y_{i,t} = \alpha(\beta)\log(K_{i,t}^{NT}) + (\beta)(1 - \alpha)\log N_{i,t}^{NT}$. Where non-traded goods (home prices, or H), wages and population are a function of regional production and amenities. This moves us closer to a direct empirical specification, but with several remaining challenges. We are interested in the effect of asymmetric labor demand shocks to N^T , as well as evidence of spatial equilibrium, which informs our choice of model and allows us to confirm some of the observations from the indirect utility function.

Our empirical challenge is similar to that of Glaeser and Gottlieb in that the interpretation of a parameter is clouded by containing both a share weight and coefficient of interest. Theoretically, the adjustment of productivity to population change is endogenous, not static and households respond to nominal wages and home prices.

Glaeser and Gottlieb also focused on urban places, and we seek a broader view, extending some of these dynamics to non-urban locations. This imposes data limitations, which necessitate some further assumptions. Since we are interested in the asymmetry of the shock, we separate dN^T into non-negative and non-positive series, which separates the element $(\beta)(1 - \alpha)\log N_{i,t}^T$ into two series, where $dN^T \geq 0$ and $dN^T \leq 0$.

Assuming constant shares of $K_{i,t}^T$ would create two covariates we collect these values into a single common error term. This prevents direct interpretation of the estimated $\alpha(\beta)$ coefficient values for capital. Future availability of capital values at the county level would provide interesting insight into the role of capital stock of tradable goods as a source of spatial growth.

Data and Estimation

Our model will be tested on U.S. county level data from 1996 through 2016. Data on population, employment, average wage per job were all obtained from the Bureau of Economic Analysis, Regional Economic Information Systems. Data on the positive and negative labor demand shocks include overall manufacturing employment adjusted to provide non-negative and non-positive series in a method used by Jones, Olson and Wohar (2014) for asymmetric tax multipliers. This is the dual series for element $(\beta)(1 - \alpha)\log N_{i,t}^T$, where $dN^T \geq 0$ and $dN^T \leq 0$.

The Zillow home price data were obtained directly from Zillow in 2018, and include data through our period of specification for roughly 1,644 counties. The natural amenities data is the current (2017) version of the USDA natural amenities index as described by McGranahan, 1999. Summary statistics appear in Table 2.

Table 2

Summary Statistics (full sample, n = 1,644)

	Mean	Median	Maximum	Minimum	Std. Dev.	Source
Population	175,993.6	59,967	10,170,292	1,843	425,482.5	BEA
Total employment	103,623.7	28,950	6,207,536	1,143	265,549.8	BEA
Average wage (nominal)	\$37,638.77	36,147	130,399	1,2417	10,563.46	BEA
Zillow Home Price (nominal)	\$135,975.1	116,308.3	1,073,633	20,722.22	81,319.97	Zillow
Positive Labor Demand Shock	111.1287	0	15401	0	418.4995	BEA
Negative Labor Demand Shock	793.7662	11	659089	0	70,89.782	BEA
Natural Amenities	0.334993	-0.04	11.17	-5.4	2.553531	USDA
n= 27,801 with 1,647 cross sections						

The empirical specification is a reduced form, simultaneous estimate of:

$$\log(Y_{i,t}) = \begin{bmatrix} \log H_{i,t} \\ \log W_{i,t} \\ \log P_{i,t} \end{bmatrix} = \omega + (\beta)(1 - \alpha) \log N_{i,t}^T | \forall dN \geq 0 + (\beta)(1 - \alpha) \log N_{i,t}^T | \forall dN \leq 0 + \theta A_i + e_{i,t} \quad (2)$$

The cross sectional, time series model is estimated in a generalized linear model, with diagonal White's [1980] heteroscedastic invariant variance-covariance matrix. Our interest is in the marginal effects of positive and negative labor demand shocks in the tradable sector and the incremental effect of exogenous (natural) amenities. We test this model on a full sample, and on the Midwest, and Southeast states. See accompanying map, with results appearing in Table 3.

Figure 1, Counties with Zillow Data (1,644)

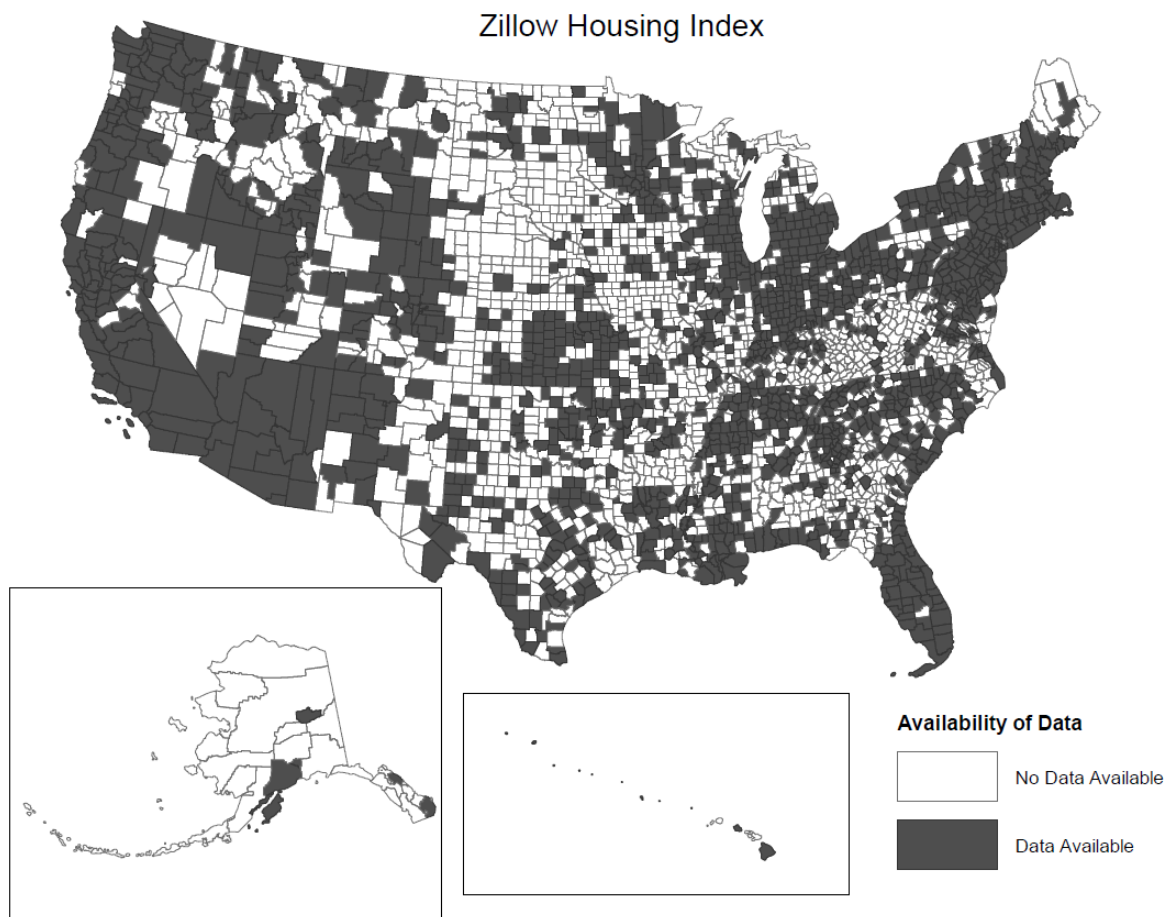


Table 3**Results of labor demand shocks over three geographies**

full sample n=25,337	Positive labor demand shock	Negative labor demand shock	Wald-test (absolute value of t-statistic)
Housing price	1.05E-04 (0.30)	0.00114 (3.56)	5.23
Average wages	0.152605 (24.43)	0.10564 (2.61)	7.92
Population	1.665078 (44.21)	0.77928 (53.25)	24.07
Midwest n=5,442	Positive labor demand shock	Negative labor demand shock	Wald-test (absolute value of t-statistic)
Housing price	3.76E-05 (0.05)	0.00126 (-1.81)	2.88
Average wages	0.131 (12.91)	0.06209 (9.50)	6.20
Population	1.559 (17.75)	0.83958 (23.03)	9.63
Southeast n=6,071	Positive labor demand shock	Negative labor demand shock	Wald-test (absolute value of t-statistic)
Housing price	0.000445 (1.31)	0.00228 (4.43)	4.70
Average wages	0.171963 (13.50)	0.11807 (15.9)	5.14
Population	1.491804 (22.50)	0.75992 (23.79)	13.62

Note: t-statistics in parentheses

Labor Demand Shocks and Home Prices

Focusing first on housing prices we observe asymmetry in labor demand shocks, which mimics the asymmetric effects of population shocks estimated by Glaeser and Gyourko (2005) though their shocks are population, and these are labor demand in tradable goods. In general, demand shocks that are positive play a smaller role in home price changes than do adverse demand shocks. Notably, the population coefficients in Glaeser and Gyourko are an order of magnitude larger and are statistically significant only over the three-decade model. Using different home price data, and differential shocks, the results are markedly.

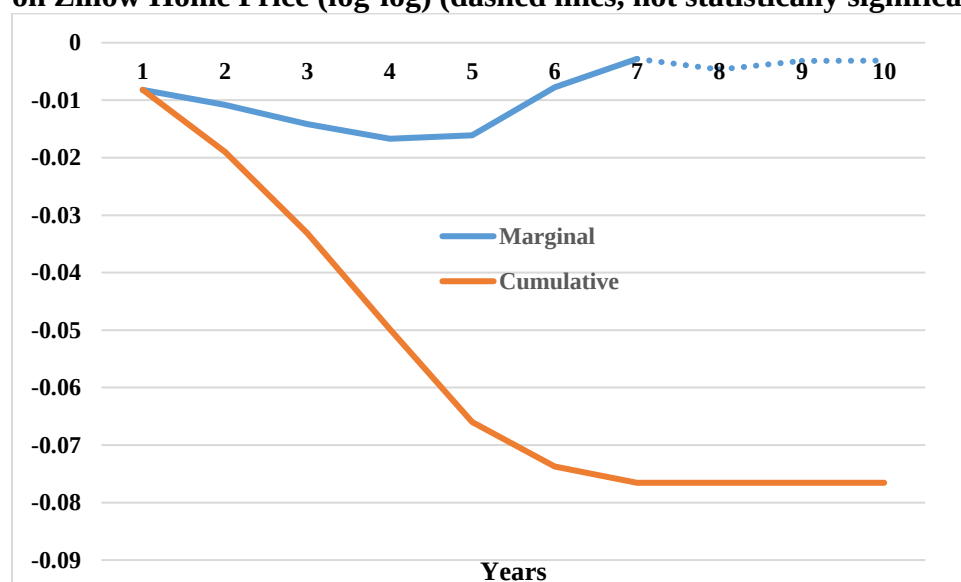
In our entire sample, within the Midwest and southeast, positive labor demand shocks have no effect on housing prices. These coefficients were both smaller than the negative shocks, and not statistically different from zero at any acceptable level. These are non-zero normalized log-log specifications so may be usefully interpreted as elasticities.

Negative labor demand shocks reduced housing prices, with elasticities ranging from a 0.1 to a 0.2. This would appear a small coefficient, though it is an order of magnitude larger than any of

the positive demand shocks. However, the labor demand shocks reflect our measure of tradable production, which is in this case limited to manufacturing employment. The mean positive demand shock is just over 111 workers, while the mean negative demand shock is 793 workers. So, a relatively small number of job changes in a county generate large change in home prices.

Also, though we lack the time series to conduct a full series of dynamic tests, the results of a distributed lag model indicate some persistence (we included 10 lags of negative labor demand shocks). Figure 2 reports the effects of a negative demand shock on home prices over a 10-year lag. As is apparent, the effect of the demand shock continues to grow through seven periods, and thereafter loses both magnitude and statistical significance. However, the cumulative effect is quite large, with elasticities approaching 0.1, for labor demand on home prices.

Figure 2, Results of Distributed lag of Negative Employment Shocks on Zillow Home Price (log-log) (dashed lines, not statistically significant)



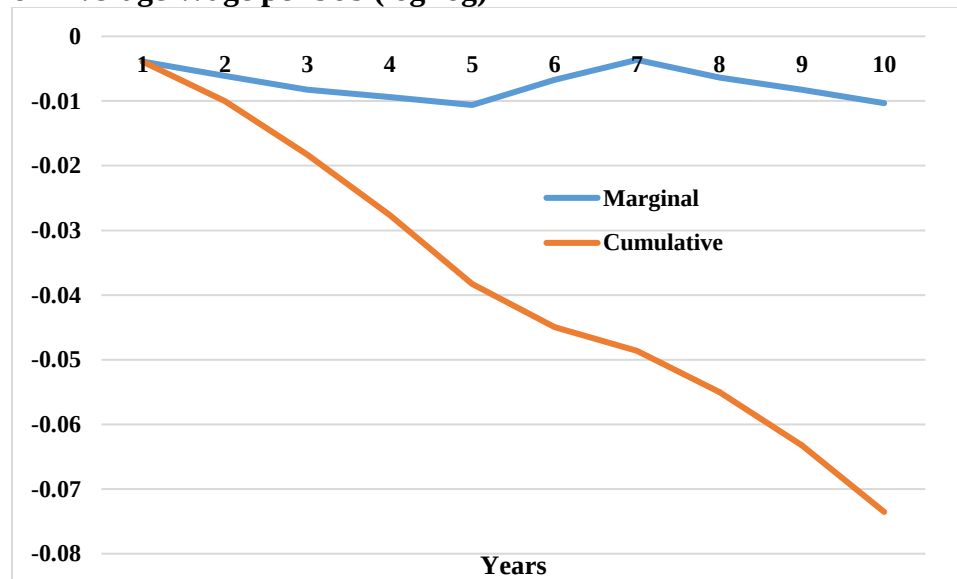
This distributed lag model is introduced only to suggest a lengthy effect of shocks on home prices, a finding of Glaeser and Gyourko, 2005. However, it appears a single negative employment shock in the tradable sector generates a 0.1 change in home prices, which grows over seven years and persists throughout the sample period. This implies a very lengthy adjustment period, especially when observed patterns of shocks are rarely confined to single years. In the Midwest for example it would be common to observe several runs of adverse labor demand shocks. Thus, observed persistence in home prices declines should be anticipated.

Labor Demand Shocks and Average Wages

Turning to average wages, a common proxy for productivity in spatial equilibrium models, we find an opposite role of symmetry. The positive demand shocks tend to all increase wages more than negative demand shocks reduce them. This result held in our full sample and in the Midwest and southeast, and was confirmed through a series of Wald tests. This differs from Notowidigdo (2011) findings, which report symmetry in the wage effect of labor demand shocks.

The result that wages are affected by labor demand shocks is also susceptible to a simple distributed lag test, but differs from the home price effect. The wage impact of a labor demand shock (here a negative shock) persists over a decade. See Figure 3.

Figure 3, Results of Distributed lag of Negative Employment Shocks on Average Wage per Job (log-log)



Again, this estimate should be viewed with some caution, since the time series are relatively short, but the persistence of the effect of labor demand shocks on wages appears here to be longer than commonly thought. Importantly, this estimate is not performed within the spatial equilibrium framework, so this finding does not imply that market adjustments are not reflective of equilibrium wages. In fact, the dynamic effects of population change, home prices and wages may return markets to equilibrium wages quickly (see Blanchard and Katz, 1992) from the 1980's).

These two graphics instead suggest that when markets return to spatial equilibrium, declining wages and home prices may result. This is the observed feature of persistent housing (Glaeser and Gyourko, 2005) and the increasing attractiveness of declining regions to low skilled workers (Notowidigdo, 2011; Glaeser and Gyourko, 2005).

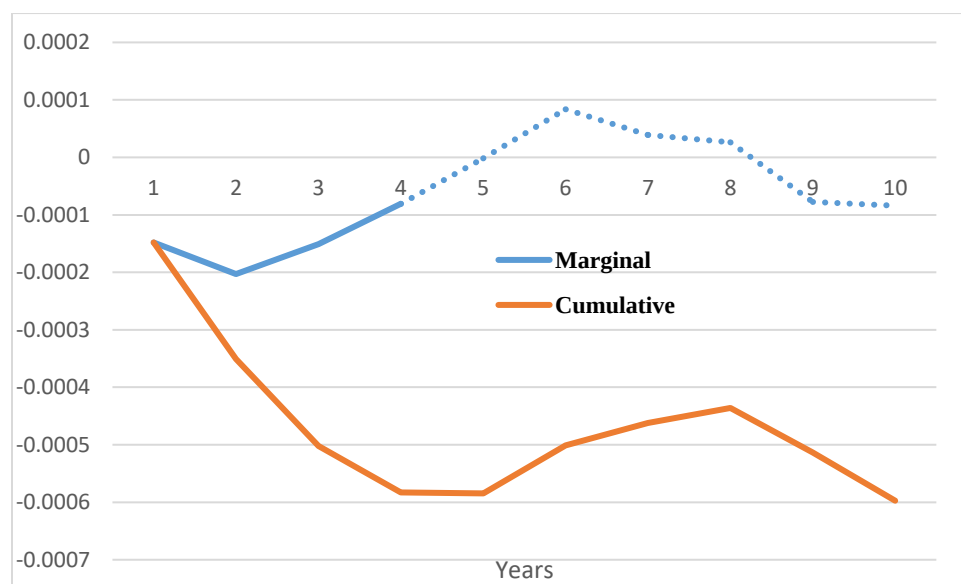
Also, as the spatial equilibrium model calls for the use of nominal wages, it is useful to consider the unrelated wage stickiness literature in interpreting these data. The adjustment of wages could well be asymmetric due to price level considerations (downward wage stickiness). We will explore those issues in subsequent research.

Labor Demand Shocks and Population Change

Turning finally to population, we observe the same asymmetry in population effects as in wages, with positive demand shocks exhibiting a much larger (elastic) range, while the negative demand shocks are inelastic. This is also consistent with Glaeser and Gyourko, 2005 but not Notowidigdo, 2011, who reports symmetry in his spatial model.

The population effects appear more downwardly sticky, a finding substantiated by considerable observation. The effect is also more sustained, exhibiting lower volatility.

Figure 4 Results of Distributed lag of Negative Employment Shocks on population (log-log) (dashed lines, not statistically significant)



Amenities, housing prices, wages and population

The role of amenities in this reduced form model is also important, but challenges easy interpretation. The scale is the USDA natural amenities index differs from both the Glaeser and Gyourko (2005) use of mean January temperature, though both are fixed across time. It is to that model we compare results in the home price and population estimates.

Across our three samples, housing prices exhibit strong causal links to amenity endowment. This is similar to Glaeser and Gyourko. In the full sample, the marginal willingness to pay to move one standard deviation across the natural amenities scale is roughly \$39,000 or 45 percent

of the home value of \$136,741. In this sample, the home price and the standard deviation of the natural amenities scale is much larger than in either of the Midwest or southeastern sub samples. In the case of the Midwest, the coefficient is much smaller as well

The marginal willingness to pay to move one standard deviation across the natural amenities scale is roughly \$6,805 in the Midwest and \$30,992 in the Southeast. Again, these smaller values combine both lower home prices (\$110,674 and \$106,056 respectively) and smaller standard deviations of the natural amenities index (1.23 and 1.14 respectively). In the case of the Midwest, the estimated coefficient is also smaller, but there is no difference between the amenity coefficient in the full sample and the Southeast.

These finding generally confirm earlier studies, but add to the literature in suggesting very large willingness to pay differentials for natural amenities across regions. This should be an important question for future research.

The wage equation is more difficult to interpret with confidence, as the literature on amenities and wages is more diffuse in its empirical findings. Wages serve both as evidence of productivity differentials and as a compensating differential to less amenity rich locations (Glaser and Gyourko, 2005). However, the empirical findings are mixed. Rappaport (2009) reports that higher incomes accommodate migration to higher amenity locations. Thus, in a reduced form equation like those reported in Table 4, this would flip the sign of the estimated coefficient.

Likewise, in some spatial modeling (Yoon, 2017) amenities effects are permitted to vary across human capital levels. So, a low human capital (or decreasing human capital) location might observe negative relationships between wages and amenities. Moreover, if the productivity effect dominates wages, we would observe a positive empirical relationship between wages and amenities because of migration. Moreover, the exclusion of endogenous amenities may generate specification problems that cloud interpretation. For these reasons recent research (Yoon, 2017) suggests more empirical work in these areas as a fruitful area of research.

These estimates across the full sample suggest higher amenities generate higher wages, a finding repeated with more strength in the southeast. The opposite is true in the Midwest, with a tradeoff of wages amenities. The clearest interpretation of this, is that Midwestern natural amenities are sufficiently low to require a significant compensating wage differential. Though entirely plausible, this model does not shed sufficient light on this relationship, despite the strength of the labor demand shocks outlined above. More work in this area is needed.

Finally, we examine amenities and population shocks, noting a number of studies report strong links between natural amenities and population change, including Epple and Sieg, (1999), Sieg, et. al (2004), Bayer, et. al. (2007) and Hicks and Faulk (2015). These results are borne out across all three samples, reported in Table 4. These are also similar to results reported by Glaser and Gyourko, 2005 in their temperature only model of amenities. Results of the amenity coefficients in equation 2 appear below, in Table 4.

Table 4
Results of Amenities across three sample geographies

	Full Sample n=25,337	Midwest n=5,142	Southeast n=6,071
Housing price	0.179585 (17.37)	0.049718 (2.25)	0.1723981 (9.31)
Average wages	0.007882 (3.81)	-0.02314 (-3.32)	0.094447 (5.63)
Population	0.087608 (11.63)	0.111311 (3.40)	0.052772 (1.92)

Summary and Conclusions

This work builds upon the observation of asymmetric effects of labor demand shocks (Hicks, 2018) and population shocks (Glaeser and Gyourko, 2005) to construct a spatial equilibrium model in the framework of Rosen and Roback. We find compelling evidence of asymmetries in labor demand shocks across all the effected variables; nominal home prices, nominal wages and population change.

We find much evidence that confirms Glaeser and Gyourko's report of long adjustment periods, both in the inference of the spatial model, and in the distributed lag model's illustrations. We also find significant evidence of willingness to pay for amenities as evidence by home prices. We also find amenities positively affect population, which is among the oldest of the reported findings in this literature.

Our work on the evidence of natural amenities and wages did not deliver strong results. Wages reflect both productivity impacts and compensating differentials for workers. In our overall model, the productivity impact seems to dominate, as is also true in the Southeast. In the amenity-starved Midwest, the compensating differential interpretation seems most fitting. We are very cautious of interpreting any of these findings.

Finally, we find significant geographic differences that hint at the opening paragraph, in which concerns over the end of regional economic convergence seem warranted.

To explore this issue, we believe researchers should link the role of wage stickiness, perhaps by occupation or industry, to a spatial equilibrium model. Research on the role of endogenous amenities alongside natural amenities might provide more useful insight in to the role amenities play on population, wages and rents. We also believe that analysis which decomposes the role of wages as a compensating differential to disamenities with its role as a measure of labor productivity will be fruitful. We also believe that expanding this model in space and time, and incorporating fiscal effects might better explain the observed variation in population, housing prices and wages.

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