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The Role of the Housing Market in the Migration Response to Employment Shocks

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Abstract

The United States is known for the ability of its residents to move to where the jobs are, and this has helped the nation maintain its position as the world's top economy. Households' decisions to move depend not only on job prospects but also on the relative cost of housing. I investigate how the housing market affects the flow of workers across cities. This occurs through at least two channels: the relative mobility of homeowners versus renters, and the relative cost of housing across markets. I use homeownership rates to measure the former, and use an index that measures house prices across metropolitan statistical areas (MSAs); the price elasticity of housing supply; and the growth rate of house prices to capture the latter.

To show how variation in these factors affects cross-city migration, I estimate a VAR model of migration, employment, wages, house prices, and new housing supply using data from 277 U.S. MSAs for 1990–2006. The impulse response functions based on employment supply and demand shocks show substantial variation when evaluated at different values of the homeownership rate, the price elasticity of housing supply, relative housing prices, and their growth rates. I also allow for spillover effects in the model that reflect the impact of a labor demand shock in the nearest city.

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The United States is known for the ability of its residents to move to where the jobs are, and that has helped the nation maintain its position as the world's leading economy. The following two quotes in *USA Today* from Mark Zandi, chief economist of Moody's Economy.com, and Mark Vitner, senior economist at Wachovia Securities, make this clear:

> The ability to move to a place where there are better opportunities is important to the health of the U.S. economy and has long made downturns in the USA shorter and shallower than those in other parts of the world.—Mark Zandi

> The ability of people to relocate throughout the country has been one of the United States' greatest competitive advantages. It's a thing unique to our economy.—Mark Vitner[1]

A classic example is the mass migration that occurred as the United States geared up to provide armaments for World War II. Millions of households moved from the eastern United States to war production centers in California, Oregon, and Washington, while 6 million people moved from rural to urban areas, and from the South to the North (Goodwin 1994).

The pace of the recovery from the most recent economic downturn will depend, in part, on households' ability to move to areas with excess demand for labor. Mills, Reynolds, and Reamer (2008) recently called for regional industry clusters as a "potent source of productivity at a moment of national vulnerability to global economic competition," because they produce "more commercial innovation and higher wage employment" (p. 1). Such a plan would entail a large relocation of workers to these new employment centers.

The housing market can significantly affect this household mobility, because the ability to move depends on the relative cost of housing across metropolitan statistical areas (MSAs). A major component of the recent recession was the unprecedented national downturn in the housing market. While some areas of the country have been relatively unscathed, other parts have seen major drops in housing prices. Those declines, in turn, have significantly altered the relative cost of housing across the United States.

The housing market can affect household mobility through at least two channels. The first is the relative mobility of subsets of households within cities. A well-established literature shows that homeowners are less likely to move than renters

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[1] See http://www.usatoday.com/money/economy/employment/2009-02-08-recession-unemployment-relocation_N.htm.

because of the higher costs of moving, the mortgage “lock-in” effect, and loss aversion (see below). The current economy has made moving even harder, because so many homeowners are “underwater”—that is, they have negative equity in their homes, making it very difficult to sell (*Economist* 2009). Ferreira, Gyourko, and Tracy (2008) show that such owners are 50 percent less likely to move than those with positive equity. This lower mobility rate can adversely affect the employment prospects of homeowners (Oswald 1997, Coulson and Fisher 2009).

A second channel is the relative cost of housing across markets: the likelihood that a household will move from one MSA to another depends on the relative cost of residing in each city.[2] A direct means for capturing the relative cost of housing is an index that measures relative house price across MSAs. An indirect means for doing so is the price elasticity of housing supply in each MSA. This measure reflects the new emphasis on the supply side of the housing market in explaining the large variation in the price of housing across the United States.

The relative cost of housing can also vary over time, as housing market cycles vary across MSAs. That is, there is considerable heterogeneity in the growth rate of housing prices (not just price levels) across MSAs. In fact, what is unique about the latest drop in the housing market is that it occurred at a national level. Further, transaction rates tend to be higher in “hot” markets, making it easier for homeowners to sell their houses and move.

In this paper, I analyze the role the housing market plays in people’s migration responses to employment shocks across MSAs in the United States. I pay particular attention to how homeownership rates, the price elasticity of housing supply, the condition of the housing market, and relative house prices affect migration rates.

The results of this analysis will be of considerable interest to policymakers. The recent stimulus package will generate job openings across the nation, and how these opportunities translate into actual employment will depend on the ability of workers to move to the new jobs.

The next section reviews the literature relevant to an analysis of migration and the housing market. In the following section I develop a model of migration, employment, and the housing market. I then discuss the data I use to estimate this model. My data set consists of information on 277 MSAs across the United States for 1990–2006, including data on house prices, wages, employment, in-migration, out-migration, and housing permits. My data also include estimates of the price elasticity of housing supply from Saiz (2008); a cross-city house price index using data from the American Housing Survey (AHS); and homeownership rates from the

[2] It is common in the housing literature to assume that MSAs constitute separate housing markets. I will make that assumption in this study.

1990 census. In the last two sections, I present my results and offer concluding remarks.

Literature Review

The study that is closest to the one I conduct here is by Saks (2008), who analyzes the effect of housing supply on metropolitan-area labor markets. She considers the scenario of a labor demand shock and its impact on employment, wages, and house prices. Saks notes that the ability of an MSA to increase the supply of housing to accommodate the increase in employment will affect the impact of this shock.

To capture the role of the responsiveness of housing supply in determining the impact of a labor demand shock on employment growth, Saks specifies a vector autoregressive (VAR) model of changes in employment, wages, and house prices (all in logs). She does not have an exogenous measure of the price elasticity of housing supply (a direct measure of housing supply responsiveness), so she develops a (cross-sectional) land-use regulation variable based on information from six sources.

Saks also follows Bartik (1991) in generating an exogenous labor demand variable. The VAR model thus includes two lags of the endogenous variables, the labor demand shock, interactions between the regulation variable and the lagged endogenous variables and the labor demand shock, time dummies, and MSA fixed effects.

Given the limited scope of the regulation data, the final data set consists of information on only 72 MSAs from 1980 to 2002. Impulse response functions are estimated to show the long-term impacts of an increase in labor demand on prices, wages, and employment. When she compares these responses at the 25^{th} and 75^{th} percentiles of the regulation index, she finds that long-run employment is relatively higher, and wages and house prices are relatively lower, in the metro area with regulations at the 25^{th} percentile. Note that this model does not account for the endogeneity of the regulation index.

Evenson (2004) claims that house price variability can distort housing decisions, and ultimately employment, productivity, and economic growth. Hence it is important to understand the determinants of house price variability. Evenson focuses on supply-side determinants that can affect responses to changes in (employment) demand, and hence price changes. In particular, Evenson models housing stock and prices using VAR and error-correction models. Like Saks, she tracks the path of housing stock and prices over time, using the impulse response function when the system is subject to an employment shock. The data consist of annual observations from 1975 to 1999 for 47 MSAs.

Evenson calculates the housing supply elasticity as the ratio of the percentage difference in housing stock values to housing price values obtained from the impulse response functions. This produces a time series of supply elasticities for each metro area. The elasticities increase monotonically and take widely varying paths across metro areas.

The supply elasticities are generally inelastic in the first period, but by year 12, 40 percent are estimated to be fairly elastic. Evenson then regresses the supply elasticity at years 1, 3, 6, 9, and 12 on a number of characteristics: 1990 population, land area, past employment growth, average January temperature, median age of the housing stock, market structure, and region dummies. When the supply elasticity is regressed on the market structure variable alone, the result is a negative and significant coefficient. When the other variables are included, this variable is significant only in years 1 and 3. Evenson concludes that policies that allow for more local government coordination can increase supply elasticities.

Hwang and Quigley (2006) estimate a three-equation model of (inverse) housing demand, supply (permits), and vacancies of single-family housing at the MSA level. These analysts are the first to provide evidence on the importance of vacancies in determining housing demand and supply. Hwang and Quigley use their results to simulate the effect of an exogenous income shock (similar to the impulse response function in VAR models). They show that when regulatory stringency is high, the house price response is higher, and persists longer, than when the regulatory stringency is low.

Johnes and Hyclak (1994) estimate a four-equation model of wage inflation, the unemployment rate, net migration, and house price inflation. They estimate the model by three-stage least squares using annual data for the southeast UK for 1973–1992. Instruments include current and lagged price inflation and regional growth, lagged national real growth, net in-migration, regional unemployment, and national house price and wage inflation. The results show that a demand shock will increase wages and house prices and decrease unemployment, but will also lead to a net out-migration owing to higher house prices. Because an increase in net-migration has a negative impact on unemployment, the authors conclude that employed workers replace nonparticipants as a result of the (positive) demand shock.

Johnes and Hyclak (1999) estimate a four-equation model of wages, the unemployment rate, labor force, and house prices, using quarterly data for Houston, Hartford, Milwaukee, and Fort Lauderdale for 1979–1991. Exogenous variables include the national value of wages, the unemployment rate, net migration, and house prices, and the price level, interest rate, and lagged housing stock. Each equation is specified as an error correction model and estimated by OLS.

Results indicate that the changes in unemployment and labor force affect house prices, and that house prices affect changes in the labor force. Further, a demand shock has a much larger impact on unemployment and house prices than on wages and the labor force. Unlike the previous study by these analysts, this one does not find that house prices affect in-migration. This might be due to the use of the labor force variable rather than migration as an endogenous variable in the model.

Sasser (2009) models state-to-state migration using Internal Revenue Service (IRS) data for 1976–2004. She attempts to answer the question, "Have high house prices led to an out-migration of residents from New England in recent years?" She finds that the impact of housing affordability on migration has increased over time.

A Model of Migration, Employment, and the Housing Market

Two approaches have been used to model employment and the housing market: the VAR model and the economic structural model. The VAR model is a multivariate, atheoretical model that includes lags of all dependent variables as regressors.

The structural model typically derives from underlying economic theory. This means that the coefficients have economic interpretations that can give rise to testable restrictions of the underlying economic theory. The structural model also includes current values of dependent variables as regressors, which allows it to capture the contemporaneous relationship among the endogenous variables.

This also leads to a difference in how the two approaches determine causality. In the case of the economic structural model, causality is contemporaneous, and determined by the rejection of the tests that the coefficients on other contemporaneous endogenous variables are zero. The use of structural models also allows for a more direct analysis of short- and long-term relationships among the endogenous variables in the system of equations.

In the case of VAR, causality is determined using Granger causality tests. This establishes if endogenous variable X responds to a lagged change in endogenous variable Y conditional on lagged responses to X. Based on the results of these tests, one can find unidirectional causality, feedback, or no causality. Vermeulen and van Ommeren (2008) claim that there are limitations to Granger causality. They state that "in particular, in the context of our research, it may be difficult to empirically identify the causal relationship between population growth and housing supply, because houses must be built before they can be occupied and new housing supply tends to be almost immediately occupied after completion" (footnote 3). The drawback of the structural model is that it requires valid instruments to identify the model. That is not the case with the VAR, as it includes only lagged regressors.

The choice between VAR and structural models depends on 1) the (economic) question being answered; and 2) the availability of valid instruments. Structural models result in parameters with particular economic content that can be of use in testing hypotheses directly related to economic policies. The parameters in VAR models do not have economic interpretations, and hence are not particularly useful per se. On the other hand, the use of the structural approach is limited by the availability of valid instruments. In many contexts, such instruments are hard to justify.

The Relationship between Structural and VAR Models[3]

Consider the following (dynamic p^{th} order) structural model:

$$Y_t = \alpha_0 + \beta_0 Y_t + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_p Y_{t-p} + u_t \quad (1)$$

where Y_t is a vector of k endogenous variables, u is a structural shock (so the k individual shocks are uncorrelated, and hence the contemporaneous covariance matrix is diagonal), and

$$\beta_0 = \begin{bmatrix} 0 & \beta_{012} & \cdots & \beta_{01k} \\ \beta_{021} & 0 & \cdots & \beta_{02k} \\ \vdots & \vdots & \ddots & \vdots \\ \beta_{0k1} & \beta_{0k2} & \cdots & 0 \end{bmatrix} \quad (2)$$

The values of the parameters in β_0 determine the causal relationship between the k endogenous variables. Non-zero values of parameters $\beta_{0ij},\ j \neq i = 1,\ldots,k$ for the i^{th} equation (row) indicate a causal relationship from the j^{th} endogenous variable to the i^{th}
endogenous variable.

The problem with equation (1) is that because contemporaneous values of endogenous variables are included as regressors, OLS is not consistent. The consistent estimator requires valid instruments for the endogenous explanatory variables.

One solution to the "identification problem" of the structural model is to calculate the reduced form. This is what is referred to as the standard (p^{th} order) VAR model:

$$Y_t = \delta_0 + \delta_1 Y_{t-1} + \delta_2 Y_{t-2} + \ldots + \delta_p Y_{t-p} + v_t \quad (3)$$

where v_t now has a contemporaneous covariance matrix that is no longer diagonal. Thus a shock to one variable in the system can affect all variables in the system.

This is the motivation behind impulse response functions, whereby a shock is induced in one component of v_t by setting it equal to one and all other components

[3] Inspired by http://en.wikipedia.org/wiki/Vector_autoregression.

of v_t to zero. Because the contemporaneous covariance matrix is not diagonal, this shock will affect the other components of v_t and hence all the endogenous variables in the system. Given the dynamic nature of the model, one can trace the changes in the values of these endogenous variables over time. The response is typically based on an orthogonalization of the error matrix. This orthogonalization is a recursive system that determines the causal ordering of the variables in the model. The problem is that the ordering of the response is not unique.

A VAR Model of Migration, Employment, and the Housing Market

This paper focuses on the role of the housing market in the migration response to labor demand and supply shocks. The components of the housing market I consider are the price and supply of housing. On the labor market side, I also model employment and wages. Finally, I treat in-migration and out-migration as separate variables, as both components of migration can respond differently to changes in labor demand and supply.

I use the VAR model because finding valid instruments is very difficult in this context. Thus, an MSA-level VAR model for in-migration, *inm*, out-migration, *outm*, housing prices, *P*, housing supply, *h*, employment, *e*, and wages, *w*, is specified as:

$$Y_{jt} = \begin{bmatrix} inm_{jt} \\ outm_{jt} \\ P_{jt} \\ h_{jt} \\ e_{jt} \\ w_{jt} \end{bmatrix} = \beta_{0t} + \beta_1 Y_{jt\text{-}1} + \ldots + \beta_p Y_{jt\text{-}p} + u_j + v_{jt} \tag{4}$$

where j indexes MSAs and t time, and u_j is an MSA fixed effect. All variables are measured in logs. Note that the intercept varies across time; this is equivalent to including time dummies in the model.

From an economic efficiency standpoint, households should migrate across MSAs in response to employment shocks. In particular, workers should move from cities with low employment demand or high employment supply to cities with high employment demand or low employment supply.

A positive employment demand shock in city A will lead to higher wages, which will induce workers to move to city A from city B. However, the story doesn't end here, as the housing market can influence the migration rate through at least two channels. First, the increase in population in city A relative to city B will lead to a relative increase in housing demand in city A, and an increase in house prices in city A relative to city B. This relative increase in house prices will make it more difficult for workers in city B to move to A, as they find it more expensive. I investigate how the relative price of housing affects migration using a cross-MSA house price index denoted *Index*.

The increase in house prices in city A will lead to a housing supply response that should mitigate the price increase, and ultimately make it easier for workers to move from city B to city A. The recent literature has traced the variation in this response to the different land-use restrictions in place across metropolitan areas (e.g., Glaeser and Gyourko 2002). In MSAs with high levels of land-use restrictions, it is more costly to build new housing. This lower supply will result in higher house prices. I capture the housing supply response in the model by including the (estimated) price elasticity of housing supply, ${}_{h}\hat{\eta}_{p}$. This supply response will differ across MSAs, as there is considerable variance in the price elasticity of housing supply. That is, the supply response in cities with high supply elasticities will be greater than in cities with low supply elasticities, and ultimately the former will be able to attract more workers.

The rate at which homeowners in city B move to city A will depend on their ability to sell their homes. If the housing market is "hot"—that is, prices are rising rapidly and transactions are occurring frequently—it should be easier for homeowners to sell their houses and move. If, on the other hand, the market is "cold," homeowners may find it more difficult to sell and move. This is particularly relevant for the current housing market, wherein the drop in prices has left many homeowners with negative equity, making it nearly impossible for them to sell their homes. I will use the first and second lags in the growth rate in house prices to capture the economic condition of the housing market in each city: that is ΔP_{jt-1} and ΔP_{jt-2}.

The second channel through which the housing market can affect migration is in its differential effect on the mobility of owners versus renters. Assume there is a negative labor demand shock. Wages will fall, and residents will have an incentive to move to other cities. Homeowners will be less likely to move, as the cost of moving is higher than for renters, owing to the direct transaction costs of selling a house.

Further, owners with relatively low interest rates on their mortgages will be less inclined to move, as they will incur an additional cost with the higher interest rate on their new mortgage. This is the so-called mortgage "lock-in" effect (Quigley 1987). Finally, in down markets, owners who suffer nominal losses in house prices are less likely to sell because of loss aversion (Genesove and Mayer 2001).

Thus one expects cities with higher homeownership rates to experience less out-migration as a response to a negative labor demand shock. Coulson and Fisher (2009) show that higher aggregate homeownership rates are related to higher unemployment rates and lower wages. I can determine whether a negative demand shock will exacerbate this outcome by including the homeownership rate, denoted *hown*, in the model.

In this analysis, I investigate the role of the housing market in the migration response to labor demand and supply shocks. Thus, I add a labor demand shock, $\hat{\varepsilon}^{d}_{jt}$, to the model to see how such an exogenous shock affects the dependent variables.

Note that the literature finds that jobs follow people, not that people follow jobs—though that is more likely to apply to movement within MSAs (Deitz 1998) than across MSAs.[4] Still, it would be interesting to see how the model responds to a labor supply shock, and compare that to the response to a labor demand shock. Suppose the area establishes a policy to retain college graduates. What is the migration and employment response (and the response of the other endogenous variables) in that case?

An increase in population should increase the demand for housing, and hence housing prices. Further, the increased labor supply should lead to a decrease in wages and an increase in employment. How this affects house prices is an empirical question, as the incomes of new workers will rise but those of current workers might fall as wages fall. Both the drop in wages and the rise in house prices should lead to a rise in out-migration and a decrease in in-migration. Again, we expect the characteristics of the housing market to affect the migration responses to this labor supply shock, denoted $\hat{\varepsilon}^{s}_{jt}$.

The four housing characteristics—the homeownership rate in 1990, $hown_{j,1990}$; the price elasticity of housing supply, ${}_{h}\hat{\eta}_{p}$; the state of the housing market, ΔP_{jt-1} and ΔP_{jt-2}; and the relative price of housing, $Index_{j}$—are interacted with the labor demand and supply shocks. Thus the VAR model is now specified as:

$$Y_{jt} = \begin{bmatrix} inm_{jt} \\ outm_{jt} \\ P_{jt} \\ h_{jt} \\ e_{jt} \\ w_{jt} \end{bmatrix} = \begin{matrix} \beta_{0t} + \beta_{11}Y_{jt-1} + \ldots + \beta_{1p}Y_{jt-p} + \beta_{21}Y_{jt-1}\cdot V_j + \ldots + \beta_{2p}Y_{jt-p}\cdot V_j \\ + \delta_1\hat{\varepsilon}^{d,s}_{jt} + \delta_2\hat{\varepsilon}^{d,s}_{jt}\cdot {}_{h}\hat{\eta}_{p,j} + \delta_3\hat{\varepsilon}^{d,s}_{jt}\cdot hown_{j,1990} + \delta_4\hat{\varepsilon}^{d,s}_{jt}\cdot Index_j \\ + \delta_5\hat{\varepsilon}^{d,s}_{jt}\cdot \Delta P_{jt-1} + \delta_6\hat{\varepsilon}^{d,s}_{jt}\cdot \Delta P_{jt-2} + u_j + v_{jt} \end{matrix} \qquad (5)$$

[4] Blanchard and Katz (1992) find evidence that most of the response to a negative labor demand shock occurs through out-migration of households rather than in-migration of jobs/firms. However, in response, Robert Shiller has commented that he expects firms to be more elastic than workers because of the inelasticity of the housing stock.

where V_j is a vector that includes ${}_h\hat{\eta}_{p,j}$, $hown_{j,1990}$, and $Index_j$, and $\hat{\varepsilon}^{d,s}_{jt}$ is a vector that includes both the labor demand and supply shocks. Note that this model includes only contemporaneous values of the labor demand and supply shocks. One can argue that demand shocks tend to be persistent, and hence that a more accurate model would include lags of these shocks. I discuss this further in the empirical section of the paper.

Given that a demand shock in one MSA should affect migration in other MSAs, I allow for spillover effects in the model.[5] An extension of the VAR model that allows for spatial interactions/spillover effects is:

$$Y_{jt} = \begin{bmatrix} inm_{jt} \\ outm_{jt} \\ P_{jt} \\ h_{jt} \\ e_{jt} \\ w_{jt} \end{bmatrix} \begin{aligned} &\beta_{0t} + \beta_{1,p}Y_{jt-1,p} + \beta_{2,p}Y_{jt-1,p}\cdot V_j + \alpha_{1,p}W_jY_{jt-1,p} + \alpha_{2,p}W_jY_{jt-1,p}\cdot V_j \\ &= + \delta_1\hat{\varepsilon}^{d,s}_{jt} + \delta_2\hat{\varepsilon}^{d,s}_{jt}\cdot {}_h\hat{\eta}_{p,j} + \delta_3\hat{\varepsilon}^{d,s}_{jt}\cdot hown_{j,1990} + \delta_4\hat{\varepsilon}^{d,s}_{jt}\cdot Index_j \\ &\quad + \delta_5\hat{\varepsilon}^{d,s}_{jt}\cdot \Delta P_{jt-1} + \delta_6\hat{\varepsilon}^{d,s}_{jt}\cdot \Delta P_{jt-2} + u_j + v_{jt} \end{aligned} \qquad (6)$$

where $\beta_{j,p} = (\beta_{j1},...,\beta_{jp})$, $\alpha_{j,p} = (\alpha_{j1},...,\alpha_{jp})$, $j=1,2$, $Y_{jt-1,p} = (Y_{jt-1},...,Y_{jt-p})$, and W_j is a spatial weights matrix that captures spillover effects from "nearby" MSAs.

This will allow me to trace the migration response in Detroit, say, to a labor demand shock in Chicago. I analyze spillover effects based on a demand shock to the "closest" MSA. First, I use the closest MSA in terms of distance. I also follow Saks, who suggests using migration rather than distance to link the "closest" MSA.[6] For each MSA, the "closest" MSA is the one with the largest number of out-migrants in 1990. I then normalize this as a percentage of total out-migration in 1990 in the MSA.

Once I have estimated the VAR model, I can use the results to evaluate how the characteristics of the housing market affect the response of the system to one-standard-deviation changes in the labor demand and supply shocks.

To do so, I evaluate the impulse response functions for the six dependent variables at different values of the four housing market characteristics. Given that the price elasticity of housing supply, the condition of the housing market, and the relative price of housing are all measures of the relative cost of housing, the corresponding impulse response functions will likely produce similar results. Still, each should contribute to the story of how the housing market affects cross-MSA migration. It is likely that the magnitude of the migration, employment, and house price responses

[5] See, for example, Pollakowski and Ray (1997).

[6] Personal conversation.

to positive and negative demand shocks will differ. Thus, as in Saks (2008), I allow for asymmetrical effects of positive and negative labor demand and supply shocks.

This VAR model is similar to the one developed by Saks (2008), in that it uses MSA-level panel data to estimate how house price responsiveness affects the long-term response of employment, house prices, and wages to an exogenous labor demand shock.
The model I have developed makes the following additions. First, I include in- and out-migration and new housing as additional endogenous variables. Second, I use actual estimates of the price elasticity of housing supply as my measure of house price responsiveness versus an index of land-use regulation.

Third, I include three more characteristics of the housing market: the homeownership rate, the relative price of housing, and market conditions. Fourth, I consider the response to a labor supply shock as well as a labor demand shock. Fifth, I include spillover effects. Sixth, I include many more MSAs for more recent years in my data set.

Data and Preliminary Analysis

The data used in this analysis consist of information on in- and out-migration, house prices, new housing supply, employment, and wages at the MSA-level (across the United States) for 1990–2006. Table 1 provides information on each of these data series. When possible, I collect data at the county level and aggregate them to the MSA level using the most recent (November 2007) MSA definitions. This allows for a consistent data series, as MSA definitions change over time.

The house price index is from the Federal Housing Finance Agency (FHFA). It is based on repeat sales transactions on single-family homes. The mortgages for these homes have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975. The house price index is put in real terms using the Consumer Price Index (this is also the case for real wages). The 11 MSAs with populations greater than 2.5 million are divided into metropolitan divisions (MDs). Because the FHFA index is reported at this level, I do so for all the other variables as well. To get a balanced panel, I can include data for only 277 MSAs/MDs for 1990–2006.

The migration data come from the IRS, which provides annual extracts of individual tax returns to the U.S. Census Bureau. I use the county-to-county migration data based on these extracts. For two reasons these data do not represent total population flows. First, the extracts include only about 95–98 percent of all tax returns, though they do include the filer, spouse, and all exemptions. Second, the very rich, the poor, and the elderly are underrepresented in the sample. Still, the former group is very small, while the latter two groups are less likely to move across MSAs, so their under-representation should have a small impact on the migration data.

I measure new housing using data on housing permits from the Manufacturing and Construction Division of the U.S. Census Bureau. These data include the total number of permits issued for all single-family and multi-family units (some values are imputed).

I obtain the employment data from the U.S. Census Bureau's County Business Patterns. These data do not include the following types of employment: self-employment, private household employment, railroad and agricultural employment, and most government employment. The wage data come from the Regional Economic Accounts of the U.S. Commerce Department's Bureau of Economic Analysis.

I follow Saks (2008) in generating the labor demand shock (she cites Bartik 1991):

$$\hat{\varepsilon}_{it}^{d} = \sum_{j=1}^{J} \frac{e_{ij,t-1}}{e_{i,t-1}} \cdot \left(\frac{\tilde{e}_{ijt} - \tilde{e}_{ij,t-1}}{\tilde{e}_{ij,t-1}} - \frac{e_t - e_{t-1}}{e_{t-1}} \right) \qquad (7)$$

where j indexes industry and J is the total number of industries. Thus e_t is national employment in year t, e_{it} is employment in MSA i, e_{ijt} is employment in industry j in MSA i, and $\tilde{e}_{ijt} = e_{jt} - e_{ijt}$.

The labor demand shock is the sum of the lagged proportions of total MSA employment in specific industries (2-digit SIC or 3-digit NAICS), weighted by the national growth rate in employment in each industry relative to the overall national growth rate in employment.

Note that I exclude an MSA's own employment when calculating each industry's employment growth rate. One problem is that the industry classification code was changed in 1998 from SIC to NAICS. This means that the exact formula given in equation (7) cannot be applied in 1998. (See the Appendix for details on the calculation for 1998.) Given the switch from SIC to NAICS coding in 1998, the demand shock is standardized to have a mean of zero and a variance of one in each year.

Generating an appropriate labor supply shock requires care. Changes in current population stemming from migration are clearly not exogenous. I consider change in the population that occurred 20 years in the past. To do so, I collect population data from two sources to generate a supply shock: the U.S. Census Bureau and the National Center for Health Statistics at the Centers for Disease Control and Prevention. From the Census, I collect annual county-level data on the population-age distribution starting in 1970, and on births starting in 1980. From the National

Center for Health Statistics, I collect annual county-level data on births for 1970–1979.

I first generate the five-year moving average of the percent change in the birth rate (relative to the percent change in the national birth rate). I define the birth rate as births divided by last year's population (times 1,000). I then generate the growth rate in 0–14-year-olds (relative to the national growth rate for this age group). I calculate the supply shock as the sum of these two growth rates from 20 years prior. I standardize this to have a mean of zero and a variance of one. These 0–14-year-olds in 1970 will be 20–34 years old in 1990, and should affect the housing and labor markets as they look for jobs and houses for the first time.[7]

Given that the growth rate occurred 20 years prior, I can treat it as an exogenous supply shock. Twenty years is a fairly long time, and it might seem that this supply shock will dissipate over this time period, to the point that it might have little impact on the housing and employment markets two decades later. However, Bartik (2009) shows that almost 50 percent of children spend their adulthood in the city where they grew up, so this labor supply shock is still likely to have a meaningful impact.

Because the "shock" actually occurred 20 years prior, there is the possibility that it can be anticipated. But DellaVigna and Pollet (2007) show that investors are inattentive to changes in cohort sizes that can lead to excess profits stemming from increases in demand for goods in age-sensitive sectors that will occur 5 to 10 years in the future. Because I am considering impacts that will occur 20 years in the future, this evidence supports the notion that this supply effect is really an unanticipated "shock."

The housing supply elasticity is available for 277 MSAs/MDs from Saiz (2008). The problem is that these are based on the 1999 MSA definitions. I translate them into the 2007 definitions for MSAs/MDs by first determining the counties that make up the 1999 MSAs, and then aggregating up to the 2007 definitions. This provides 277 MSAs/MDs (I use the same elasticity for all metro divisions in a core-based statistical area).

The price elasticity of supply has a mean of 2.74 and a standard deviation of 1.77. The smallest value is 0.71, for the Los Angeles–Long Beach–Glendale MSA. Other MSAs with a price elasticity of supply less than 0.9 include Boston; Fort Lauderdale–Pompano Beach–Deerfield Beach; Oakland–Fremont–Hayward; Oxnard–Thousand Oaks–Ventura; San Diego–Carlsbad–San Marcos; and San Francisco–San Mateo–Redwood City. The largest value is 11.37, for the St. Joseph MO-KS MSA. Other MSAs with a price elasticity of supply greater than 8 include Columbia, MO; Alexandria, LA; Joplin MO; and Fargo, ND-MN.

[7] Note that because I generate a five-year moving average of births, the supply shock is available starting only in 1995.

I use the national version of the American Housing Survey (NAHS) to generate the cross-MSA house price index.[8] The NAHS is a national survey of housing units conducted every two years. It includes detailed information on the unit and the residents, but limited geographic information. For example, it provides the MSA in which the unit is located but not the county.

To obtain enough observations for each MSA, I merge data from the 1985, 1987, 1989, and 1991 surveys. This also gives an average price over this period, so that individual MSA housing cycles are not as likely to influence the results. To create the index, I regress the natural log of the house value on vectors of housing and individual characteristics, year dummies, and MSA dummies.[9] The house price index is 100 times the anti-log of the estimated MSA coefficient. The left-out MSA has an index value of 100 (Akron, OH).

Because the definition of an MSA changes over time, I translate the definition used in these surveys into the one used in 2007, which I use for the other data. I also give the same index value to each metro division in an MSA. The result is an index for 143 MSAs/MDs. The median value of the index is 141.65. Boston, in the 95th percentile, has a value of 296.39, while Knoxville, TN, in the 10th percentile, has a value of 108.93.

The current homeownership rate is clearly not exogenous to the model, so I include the homeownership rate at the beginning of the period—1990 in this case. I use the homeownership rate from the 1990 Decennial Census. The mean is 65.53 percent, and the standard deviation is 6.08. The largest homeownership rate is 80.71 percent, in Holland/Grand Haven, MI, while the smallest homeownership rate is 36.86, in the New York City MSA.

Before I estimate the model, it is important to determine if differencing is required for each endogenous variable. To do so, I conduct Augmented Dickey-Fuller tests for unit roots for each series. This determines that the price index, employment, and wages should be differenced. Given that new house permits and in- and out-migration are flows, this means that all variables now measure changes (versus

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[8] Note that it is not possible to use the FHFA index because it is valid only within a single MSA. That is, the index is normalized to 100 for one year for every MSA, and all values are relative to this year for each MSA.

[9] The housing characteristics include the age of the unit and its square; interior square feet and its square; lot size and its square; the number of full bathrooms, bedrooms, and total number of rooms; and whether the unit has a garage, leaks, cracks, or broken plaster or peeling paint greater than one square foot. I include the characteristics of the residents to proxy for neighborhood quality. Those characteristics include how long the residents have lived in the unit and its square; the natural log of household income; and the age, highest grade completed, race, and marital status of the household head.

levels). Table 2 provides summary statistics for the six endogenous variables in the model.

I then run regressions of each variable on two own lags and two lags of the other five variables, MSA fixed effects, and year dummies. I perform Granger causality tests for the significance of the two lags of the other five variables. Table 3 provides the test statistics and corresponding p-values.

The two other lags are not significant at the 1 percent level in only a few cases: a change in employment does not Granger cause new housing or in-migration; a change in wages does not Granger cause out-migration; new housing and a change in wages do not Granger cause a change in employment (though the p-value for the latter is 0.012); and a change in employment does not Granger cause a change in wages.

While the high degree of significance might simply reflect the large sample size (4,774) versus the actual underlying relationship between the variables, this is still evidence of a strong relationship among these six variables. Note that the results indicate that employment does not Granger cause in-migration (though it does Granger cause out-migration), while in-migration does Granger cause employment. This is evidence that jobs follow people and not the reverse.

Results

I first run the VAR model without the spillover variables. Initially, I also exclude the NAHS house price index, because it is available for only 143 MSAs/MDs. Table 4 provides the coefficient estimates for the demand and supply shocks, and for the interactions with the housing supply elasticity, homeownership rate, and lagged house price growth variables.[10] I allow for asymmetric responses to negative and positive demand and supply shocks. However, for the most part, they are not significantly different in magnitude. Hence, in the spirit of parsimony, I do not include asymmetric responses in the model.

Table 4 includes the p-values for the tests that the coefficients for the demand and supply shocks and their interactions with the housing market characteristics are jointly zero. In all but two of the twelve tests, the null is rejected at the 5 percent significance level or better. The demand shock is positive and significant in the in-migration and wage growth regressions. This is consistent with the fact that the

[10] The regressions include two lags of the endogenous variables, interactions between these lags and the supply elasticity and the homeownership rate, MSA fixed effects, and year dummies as explanatory variables. I follow Saks (2008) in including two lags of the dependent variables in the equation. She states that she does this because of the relatively short time dimension of her data. She notes that adding a third lag has little impact on the results, and that the coefficients are mostly small and insignificant.

labor demand shock will initially raise wages and induce households to move into the MSA. The supply shock is negative and significant in the in-migration and wage growth regressions. This is consistent with the fact that the labor supply shock will initially lower wages, and hence fewer households will be induced move into the MSA.

It is quite likely that the demand and supply shocks are persistent over time, and that a model that includes lagged shocks will better fit the data. In fact, when I regress the demand and supply shocks on their own lags, the coefficient estimates are 0.77 and 0.83, respectively, and highly significant. Further, when I add lags to the above regressions, the lags are significant in some cases. Still, given the complexity of the VAR model as it is, I do not pursue the dynamics of the demand and supply shocks here, leaving that for future work.

The key component of the analysis is the long-run responses of the endogenous variables (I also include net migration) to an increase in employment shocks, evaluated at different values of the price elasticity of housing supply, the relative price of housing, housing market conditions (as measured by lagged house price growth), and the homeownership rate. Except when noted, the impulse response functions are generated given a one-standard-deviation increase in the labor demand and supply shocks over a 20-year period. I convert the percent changes in the house price index, employment, and wages to levels by setting the initial values to zero.

In the next sections I discuss the results for the impulse response functions for the two channels through which the housing market affects migration. The first channel relates to differences in the cost of housing across MSAs. The second channel relates to differences in migration rates across subgroups within an MSA, determined by housing tenure. In particular, all else equal, homeowners are expected to be less likely to move than renters. Finally, I generate and analyze the spillover effects.

Note that for each dependent variable and housing market factor, the scales for the impulse response functions for the supply and demand shocks are the same. Also note, though, that the scales differ across factors (though they tend to be similar), to enhance the visual appeal of each graph.

The Relative Cost of Housing

The three factors that affect the relative cost of housing are the price elasticity of housing supply, the relative price of housing, and the market condition. These three factors are clearly related. The correlations between the NAHS house price index and the price elasticity of housing supply is -0.52. This is expected, as a lower price elasticity is consistent with a smaller housing supply and a higher price of housing. The correlation between the growth rate of housing prices and the NAHS house price index is 0.31, and with the price elasticity of housing supply is -0.24. I first discuss the results for each factor separately, and then use all three results to comment on the impact of the relative cost of housing on migration.

Price Elasticity of Housing Supply

I consider two scenarios for the price elasticity of housing supply: an elasticity of 0.87 (the value for Boston), and an elasticity of 8.30 (the value for Fargo, ND-MN).[11] These are very low and high values for this variable. I refer to these as the Boston and Fargo scenarios, though, to be clear, only the price elasticities are specific to these two MSAs. Figure 1a shows the results of the impulse response function for the demand shock.

In-migration shows a positive response for about the first eight years, and then is zero in both Boston and Fargo. Surprisingly, this response is higher in Boston. Out-migration is negative for the first three years, and then is slightly positive before dropping to zero around year fifteen in both Boston and Fargo. Again, the response is slightly higher in Boston. Net migration is slightly higher in the first five years and slightly lower in the following ten years in Boston, such that the long-run change in population is similar in both MSAs. The initial positive net-migration in both Boston and Fargo supports the result that people follow jobs at the inter-metropolitan level.

The house price response to the labor demand shock is considerably higher in Boston than in Fargo, and the new housing and employment responses are lower. This supports the notion that cities such as Boston with low price elasticities of housing supply, where increasing the housing supply is relatively difficult, will experience higher house price growth and lower employment growth in response to a labor demand shock than cities with high price elasticities of housing supply.

It is interesting to compare these impulse response functions to those in Saks (2008). She generates results for employment, wages, and house prices from a 1 percent increase in labor demand at the 25th and 75th percentiles of her housing supply regulation index. She finds a sustained employment response, a positive wage response that gradually falls to zero by year 25, and a house price response that is initially positive but then turns negative in year 10 before slowly converging back to zero. My results show a sustained positive response in house prices, employment, and wages. Further, whereas the impacts that Saks generates are very similar at the 25th and 75th percentiles of her housing supply regulation index, I get quite different house price and employment responses in Boston and Fargo.

Figure 1b shows the results for the labor supply shock. As expected, there is a positive out-migration response in both Boston and Fargo. There is also an increase

[11] The homeownership rate and the house price growth rate are set at their mean values of 65 percent and 2.5 percent, respectively

in in-migration in Fargo, which may be a response to the rise in employment. There is no in-migration in Boston, so net migration is negative, as expected, in response to a positive labor supply shock.

There are positive house price, new house, and employment responses to the labor supply shock in Fargo, but no wage response. There is no response by any of these variables in Boston. The positive employment response indicates that employment follows people at the inter-metropolitan level (this is consistent with the results of the Granger causality tests noted above). But this is true only for Fargo—the MSA with the large price elasticity of housing supply. Thus there is evidence that people follow jobs and that jobs follow people, but only in MSAs where it is relatively easy to build new housing.

It is interesting that there are very similar positive net migration, house price, and employment responses in Fargo to the demand and supply shocks. Thus it is not possible to say that people's response to an increase in labor demand or firms' response to an increase in labor supply, dominates in Fargo—the case with a high price elasticity of housing supply. On the other hand, there is little response to the supply shock in Boston. Thus it appears that people's response to an increase in labor demand dominates the response of jobs to an increase in labor supply in Boston, where it is relatively difficult to build new housing.

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Hot and Cold Housing Markets

The next scenario considers the response to labor demand and supply shocks under different housing market conditions. I evaluate the impulse response functions at the 10^{th} and 90^{th} percentiles of the house price growth distribution. I refer to these as hot and cold housing markets.

Figure 2a presents the results for the demand shock. Both in-migration and out-migration show positive responses to the labor demand shock in the first 10 years, when the housing market is hot. There is a small positive in-migration response, and a negative out-migration response, when the market is cold. The result is that net migration is similar in the hot and cold market, but that there is more churning in the hot market in response to the labor demand shock.

This could be evidence of more efficient matching in the labor market, as more households migrate in and out of MSAs. There is a sustained positive house price response and a short-lived positive new house response when the housing market is hot, and little response when the market is cold. Interestingly, there is a comparable positive sustained employment response in the hot and cold markets, whereas wages rise in the hot market and show little response in the cold market to the labor demand shock.

In the hot market, there is a short-term negative in-migration response, a positive out-migration response, and hence a negative net migration response to the labor supply shock (see Figure 2b). This is accompanied by a short-term decline in new housing and a long-term decline in house prices. In the cold market, there are short-term positive in-migration and out-migration responses and a small positive net-migration response to the labor supply shock. There is also a long-term increase in house prices, but no new housing response.

Finally, in both markets there is little employment or wage response to the labor supply shock. So it does not appear that firms respond to the increase in labor supply by creating new jobs in hot or cold housing markets.

House Price Index

The final scenario looks at the response to labor demand and supply shocks in MSAs with high and low house prices. The VAR regressions include only the NAHS house price index (and not the supply elasticities and homeownership rate), to maximize the number of MSAs that I can include in the model.

The interaction of the labor demand shock and the NAHS index is positive and significant in the out-migration equation, and the interaction of the labor supply shock and the NAHS index is negative and significant in the new housing equation. I evaluate the impulse response functions for Knoxville, which is in the 10th percentile of the house price distribution, and for Boston, which has very high housing prices (95th percentile). I refer to these as the Boston and Knoxville scenarios, though, to be clear again, only the house prices are specific to these two MSAs.

Initially, in-migration exhibits a positive response to the demand shock in both Knoxville and Boston. There is a positive out-migration response in Boston but a negative response in Knoxville (see Figure 3a). The positive response in Boston could be due to the fact that residents take advantage of the positive in-migration to sell their houses and move to lower-cost areas. For example, Sum et al. (2008) show that Florida and New Hampshire are the top two states to which Massachusetts residents moved in 2005—both states having lower costs than Massachusetts. The result is that net migration is greater in Knoxville. Interestingly, and possibly because of the greater net migration, house prices rise more in Knoxville even though more new homes are built there.

Finally, while wages show comparable gains in both cities, the (sustained) employment response is about twice as large in Knoxville. In sum, the city with high house prices (Boston) shows lower net migration, house price, and employment responses to a demand shock than the city with low house prices (Knoxville).

Knoxville sees positive in-migration and out-migration responses to the labor supply shock, with the result being positive net migration (see Figure 3b). In Boston, there is a slightly negative in-migration response to the labor supply shock. In both cities there is a sustained increase in house prices. There is a sustained increase in employment in Knoxville, and a sustained loss in employment in Boston. Further, there is no wage response in Knoxville, while wages actually rise slightly in Boston. One interpretation is that, in the presence of a labor supply shock, employers are less attracted to cities with high house prices compared with cities with low house prices.

Overall Comparison across Three Relative Housing Cost Factors

The migration responses for the three relative housing cost factors (price elasticity of housing supply, market condition, and relative price of housing) are generally similar.
One could categorize the low price elasticity of housing supply, the hot housing market, and the high-priced market as high-housing-cost scenarios, and the others as low-housing-cost scenarios. Then the responses under the high-cost scenarios for each factor are similar, as are those under the lost-cost scenarios.[12] This is true for both the labor supply and the labor demand shocks.

In response to the labor demand shock, net migration is positive for the first 10 years, and approximately zero thereafter, under both scenarios for all three factors. The in-migration and out-migration responses tend to be greater in the high-cost scenarios than in the low-cost scenarios, indicating more churning in the former cases.

In response to the labor supply shock, net migration is positive (negative) in the first seven years, and approximately zero thereafter under the low-cost (high-cost) scenarios. In contrast to the labor demand shock, the in-migration and out-migration responses to the labor supply shock tend to be lower in the high-cost scenarios than in the low-cost scenarios, indicating more churning in the latter cases.

The outcome under the labor demand shock—that house prices are higher, and employment and new housing are lower, when the price elasticity of housing supply is low (Boston) than when it is high (Fargo)—is not repeated under the other two factors. Prices are higher when the housing market is hot than when it is cold, but so are new housing and employment (slightly).

For high-priced markets, the house price response is actually lower, as are the new house and employment responses. The responses of house prices and employment to the labor supply shock are generally greater under the low-housing-cost scenarios

[12] To ensure clarity in the figures, the line pattern for each impulse response function is the same in the high-cost and low-cost scenarios (i.e., a dashed line for Boston in Figures 1a and 1b, for the "hot" market in Figures 2a and 2b, and for the high priced market in Figures 3a and 3b).

than under the high-housing-cost scenarios. House prices rise under all three low-cost scenarios, while employment rises in two of three of these low-cost scenarios.

Under the high-cost scenarios, house prices rise in one case, show little change in a second case, and actually fall in the third scenario in response to a labor supply shock. Employment falls under two of the three high-cost scenarios. These different responses reveal that while the role of the housing market is relatively straightforward when it comes to the response of migration to a labor demand or supply shock, this role is more nuanced in the response of the housing and labor markets.

Homeownership Rates

The second channel through which I investigate the impact of the housing market on migration is based on housing tenure: homeownership versus renting. I consider the response to the demand and supply shocks at different homeownership rates: the 10th and 90th percentiles of the homeownership rate distribution. These values are 58 percent and 73 percent (the rate in Colorado Springs, CO, and Jefferson City, MO, respectively). I expect homeownership to affect out-migration, so I generate the impulse response functions for the endogenous variables given a one-standard-deviation decrease in the labor demand shock, and a one-standard-deviation increase in the labor supply shock, given that both should induce households to move out.[13]

While the impact of the homeownership rate on migration is seen as acting through a different channel of the house market, it is still correlated with the three factors that characterize the first channel. In particular, the correlation between the homeownership rate and the price elasticity of housing supply, the NAHS index, and the condition of the housing market is 0.27, -0.55, and -0.14, respectively. That the homeownership rate tends to be lower in cities with higher house prices is not surprising. This is why I include the interaction of the homeownership rate with the demand and supply shocks, along with the interactions of the price elasticity of housing supply and the market condition with these shocks, in the same regression. Then the coefficients on the interaction terms are conditional on holding the other interaction terms constant.

Contrary to expectations, there is a negative out-migration response to the negative labor demand shock when the homeownership rate is low, and a small positive out-migration response when the homeownership rate is high. Further, the in-migration response is negative until year 10 when the homeownership rate is low, and there is no in-migration response when the homeownership rate is high. The result is that net-migration is negative for the first 5 years under both scenarios, though more negative when the homeownership rate is low.

[13] The price elasticity of labor supply and the house price growth rate are set at their mean values of 2.5 percent and 2.5 percent, respectively.

Note that the result that homeowners are less likely to move than renters is based on a ceteris paribus assumption. In fact, the above results may not be so surprising, as homeowners may be more mobile than renters in at least two ways. First, homeowners are at a point in their lifecycle where households tend to be more mobile, and second, homeowners tend to have higher incomes than renters, which also makes them more mobile. I intend to address this in future work, where I consider the relationship between demographic characteristics, migration, and the housing market.

There are sustained decreases in house prices, employment, and wages in response to the negative labor demand shock under both homeownership scenarios. Whiles house prices exhibit a sustained drop in both cases, the loss of employment is greater, and the loss of wages less, when the homeownership rate is higher. This relationship between high homeownership rates and lower employment and higher wages is consistent with Coulson and Fisher (2009), who develop two search-theoretic models of the link between housing tenure and labor market outcomes in an effort to test the Oswald hypothesis (that homeowners are less likely to be employed).

There are positive in-migration and out-migration responses to the labor supply shock, and a sustained positive house price response, but no employment or wage responses in the high-homeownership case. Generally, there is little response to the supply shock in the low-homeownership case. Again, differences in demographic characteristics between homeowners and renters might explain the unexpected result that homeowners are more mobile.

Spillover Effects

Next, I add the spillover variables to the VAR model. To simplify matters, I include only the interactions with the price elasticity of housing supply (results are available on request). To capture the spillover effects, I include the lags of the endogenous variables in the "closest" MSA.

I consider two scenarios where the weights are the inverse of the distance to the nearest MSA and the percentage of out-migration for the MSA with the highest value for this variable.[14] Thus one can think of the weighting matrix, W, as including only one non-zero element in each row (see equation 6). For the impulse response functions, I allow for a demand shock in the "closest" MSA only.

I consider two cases where the nearby MSA (denoted the host city) has a price elasticity of housing supply of 0.87 (Boston) and 8.3 (Fargo). I then plot out the

[14] Note that for metro divisions, the "closest" MSA cannot be another metro division in the same MSA.

response to these demand shocks in a city with a low price elasticity of housing supply equal to 0.87 (i.e., Boston) and a high price elasticity of housing supply equal to 8.3 (i.e., Fargo). Figures 5a and 5b show the results for the case where the weights are based on out-migration.

As expected, the spillover responses are generally smaller than the comparable responses in the host city. In this case, out-migration is positive and in-migration is negative in the first eight to ten years in Fargo, when the host city has a low housing supply elasticity. The result is negative net migration in Fargo, as residents supposedly move to the MSA receiving the positive demand shock (Figure 1a shows the response in the host city[15]).

Further, there is a drop in new housing during the first 10 years, and a sustained drop in wages in Fargo, under this scenario. There is relatively little out-migration response in Fargo when the host city has a high housing supply elasticity, with the result that Fargo does not lose as much population as when the host city has a low housing supply elasticity. This is consistent with a smaller positive response in net migration in this host city compared with when the host city has a low housing supply elasticity.

In the scenario where the host MSA has a high supply elasticity, the new house, employment, and wage responses in Fargo are similar to those that occur when the host city has a low supply elasticity, but house prices actually fall in this case, which is surprising given that there is less population loss. There is little response in Boston when the host city has a low or a high housing supply elasticity. Thus the responsiveness to a demand shock in the host city appears to depend on the housing supply elasticity in the spillover MSA, and not on the housing supply elasticity in the host MSA.

Conclusion

In this paper I have investigated the role of the housing market in the cross-MSA migration response to labor demand and supply shocks. The migration response is affected by the housing market through at least two channels, characterized by within- and across-MSA differences in the relative cost of housing. The across-MSA differences are captured by three factors: the price elasticity of housing supply, the housing market condition (hot or cold market), and the relative price of housing. To see how these three factors affect migration, I calculate impulse response functions to demand and supply shocks interacted with high and low values of these factors. I consider the low value of the price elasticity of housing supply, the hot market, and

[15] The response in the host city is not exactly that shown in Figure 1, because I allow for feedback from the spillover city to the host city. However, given that the spillover effect is small, this has little impact in the host city.

the high-priced market the high-housing-cost scenarios, and the opposite values of these factors the low-housing-cost scenarios.

Generally, these three factors have similar impacts on the migration responses to the demand and supply shocks. Net migration shows a positive response to the demand shock in both the high- and low-cost scenarios, but there are generally higher levels of both in- and out-migration in the high-cost scenarios. This is indicative of a more efficient outcome, in the sense that more mobility is consistent with more efficient matching in the labor market.

As expected, the largest response to the labor supply shock is in out-migration. This is evidence that, at the MSA level, people tend to follow jobs. This is consistent with the view of Americans as a mobile society that is willing to pick up and move in response to employment opportunities. But I also find significant employment responses to a labor supply shock in MSAs with low housing supply elasticities and low house prices. This is evidence that firms respond to labor supply as well.

I also look at the impacts in the housing and labor markets. I find that an MSA such as Boston, with a low price elasticity of housing supply, displays a relatively lower employment response and a relatively higher house price response to a demand shock than an MSA such as Fargo, with a high price elasticity of housing supply, because Boston is less able to supply new housing. But this result does attain when comparing the high-and low-cost scenarios for the other two housing market factors. The conclusion to be drawn is that the housing and labor market responses to the demand shock are more complicated than is the case for the migration response to this shock. The same holds true for the responses to the labor supply shock. Hence, to determine households' responses, policies that attempt to stimulate employment in particular areas—such as the current stimulus package—need to pay particular attention to the characteristics of the housing market.

Finally, I evaluate the spillover responses to labor demand shocks. The results show that, as expected, these responses are small compared with those in the city where the demand shock occurs. Further, whereas these spillover responses occur in cities with high price elasticities of labor supply, there appears to be no response in cities with a low value of this supply elasticity.

My findings suggest at least four areas for future research. First, the role of the homeownership rate in the migration response to the labor demand and supply shocks is, at first blush, contrary to expectations. That is, outmigration is higher at the higher homeownership rate. But the result that homeowners are less mobile than renters requires a ceteris paribus assumption, and the demographic characteristics of homeowners are likely to mean that they are more mobile than renters. So the outcome of the response functions may well reflect this reality. In future research, I plan to investigate the relationship between demographic characteristics, migration, and the housing market.

Second, there is likely persistence in the labor demand and supply shocks. Hence a better model would include lagged values of these shocks.

Third, while I find limited evidence of asymmetric responses to the demand and supply shocks, this is likely a fruitful area of research. For example, the homeownership rate might well have a different impact on the migration response to a positive demand shock than to a negative demand shock, as only in the latter case should homeownership play a role in inducing residents to move.

Fourth, it is useful to have a large number of MSAs in the data set, as this not only increases the number of observations but produces a result that is more representative of the entire country. However, this raises a concern that the 277 MSAs do not constitute 277 distinct labor markets, and hence do not allow me to measure the appropriate migration responses across such markets. I will consider limiting the number of MSAs to the major metropolitan areas and investigate how this affects the results.

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Table 1: Data Years and Sources

Name/Description	Years	Source
1. House Price Indices	1980-2007	Federal Housing Finance Agency
2. Housing Permits	1990-2007	U.S. Census Bureau: Manufacturing and Construction Division
3. Total Employment	1986-2006	U.S. Census Bureau: County Business Patterns
4. In- and Out-Migration	1990-2006	Internal Revenue Service
5. Wages	1980-2006	Bureau of Economic Analysis
6. Demand Shock	1987-2006	Bureau of Labor Statistics, U.S. Census Bureau: County Business Patterns
7. Supply Shock	1970-2006	U.S. Census Bureau and National Center for Health Statistics: Vital Statistics
8. Housing Supply Elasticities		Saiz (2008)
9. Homeownership Rate	1990	Decennial Census for 1990
10. House Price Index	1985-1991	American Housing Survey

Source locations:
1. http://www.fhfa.gov/Default.aspx?Page=87.
2. http://www.census.gov/const/www/C40/table3.html#annual.
3. http://www.census.gov/econ/cbp/download/.
4. http://www.irs.gov/taxstats/indtaxstats/article/0,,id=96816,00.html.
5. http://www.bea.gov/regional/reis/default.cfm?selTable=CA34&section=2.
6. National employment by industry from http://data.bls.gov/PDQ/outside.jsp?survey=ce.
7. http://www.census.gov/econ/cbp/download/.
8. Saiz (2008).
9. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=DEC&_submenuId=&_lang=en&_ts=.
10. www.icpsr.umich.edu.

Table 2: Summary Statistics

Variable	Mean	Std.Dev.	Min.	Max.
Change in House Price Index	3.97	7.07	-17.11	61.40
Total Housing Permits (in hundreds)	39.37	67.72	0.35	74.01
Change in Average Wage	3.72	6.19	-107.75	128.26
Change in Employment (in thousands)	3.89	16.07	-189.71	500.32
In-Migration (in thousands)	15.55	23.45	0.51	184.54
Out-Migration (in thousands)	15.52	27.53	0.59	316.60
Supply Elasticity	2.74	1.77	0.71	11.37
Homeownership Rate	65.53	6.08	36.86	80.71
House Price Index	162.04	63.04	87.89	387.64

Table 3: Granger Causality Test Statistics and P-Values

	Dependent Variable					
Regressor	ΔP	H	Migr._in	Migr._out	Δe	Δw
Change in House Price Index		12.873	15.764	9.925	27.175	26.080
p-value		0.000	0.000	0.000	0.000	0.000
Total Housing Permits	22.361		11.347	8.221	0.991	12.950
p-value	0.000		0.000	0.000	0.371	0.000
In-Migration	184.488	125.261		245.835	22.066	16.140
p-value	0.000	0.000		0.000	0.000	0.000
Out-Migration	40.980	32.865	32.741		29.161	16.593
p-value	0.000	0.000	0.000		0.000	0.000
Change in Employment	5.463	1.721	0.243	8.106		0.827
p-value	0.004	0.179	0.785	0.000		0.437
Change in Average Wage	10.546	16.449	0.616	0.037	4.452	
p-value	0.000	0.000	0.540	0.964	0.012	

Table 4: Results from VAR Model

	Dependent Variable					
	ΔP	h	Migr._in	Migr._out	Δe	Δw
Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Demand Shock (DS) and Interactions					
DS	-0.203	8.000	5.701**	-0.435	-1.900	1.396**
	(0.532)	(4.388)	(1.920)	(1.772)	(1.645)	(0.356)
DS*Elasticity	0.003	0.493	0.005	-0.009	0.027	0.013
	(0.031)	(0.260)	(0.114)	(0.105)	(0.097)	(0.021)
DS*Hown	0.003	-0.126	-0.080**	-0.004	0.033	-0.018**
	(0.008)	(0.069)	(0.030)	(0.028)	(0.026)	(0.006)
DS* ΔP_{-1}	0.056**	0.351*	0.094	0.075	-0.034	0.028*

	(0.017)	(0.143)	(0.063)	(0.058)	(0.054)	(0.012)
DS* ΔP_{-2}	0.001	-0.064	-0.036	0.021	0.051	0.035**
	(0.018)	(0.151)	(0.066)	(0.061)	(0.057)	(0.012)
P-value⁺	0.000	0.000	0.001	0.014	0.155	0.000
	Supply Shock (SS) and Interactions					
SS	-0.314	-2.643	-4.784*	-2.790	0.788	-1.023**
	(0.568)	(4.685)	(2.050)	(1.892)	(1.757)	(0.380)
SS*Elasticity	0.004	0.201	0.164	0.061	0.125	0.003
	(0.033)	(0.274)	(0.120)	(0.110)	(0.103)	(0.022)
SS*Hown	0.008	0.034	0.075*	0.046	-0.020	0.015**
	(0.009)	(0.071)	(0.031)	(0.029)	(0.027)	(0.006)
SS* ΔP_{-1}	-0.023	-0.423**	-0.145*	0.059	0.058	-0.001
	(0.017)	(0.139)	(0.061)	(0.056)	(0.052)	(0.011)
SS* ΔP_{-2}	-0.045*	0.304*	0.013	-0.033	-0.011	0.001
	(0.018)	(0.150)	(0.066)	(0.061)	(0.056)	(0.012)
P-value⁺	0.000	0.048	0.001	0.032	0.501	0.195
Observations	3878	3878	3878	3878	3878	3878
Number MSAs	277	277	277	277	277	277
Adj R-sq	0.702	0.558	0.557	0.522	0.236	0.337
SER	2.153	17.764	7.773	7.172	6.661	1.440
+ - p-value for test of joint significance of demand (supply) shock and interactions. Standard errors in parentheses; ** p<0.01, * p<0.05.						

Figure 1a: Responses to Labor Demand Shock
in Boston (elast=0.87) and Fargo (elast=8.3)

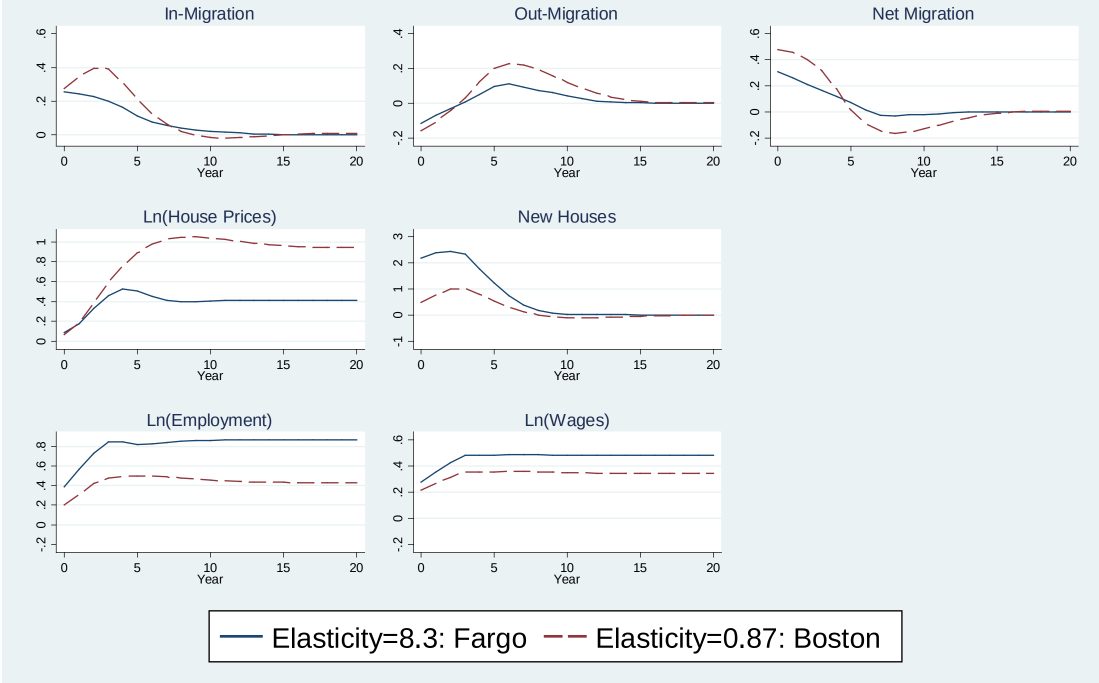


Figure 1b: Responses to Labor Supply Shock
in Boston (elast=0.87) and Fargo (elast=8.3)

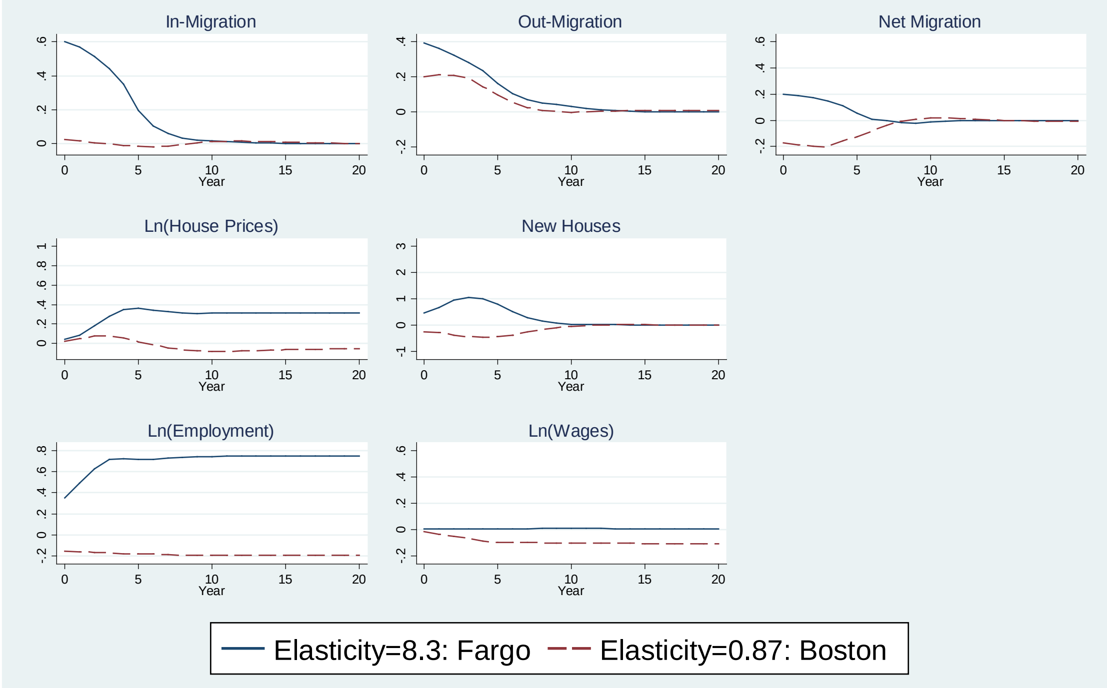


Figure 2a: Responses to Labor Demand Shock for Hot and Cold Housing Markets

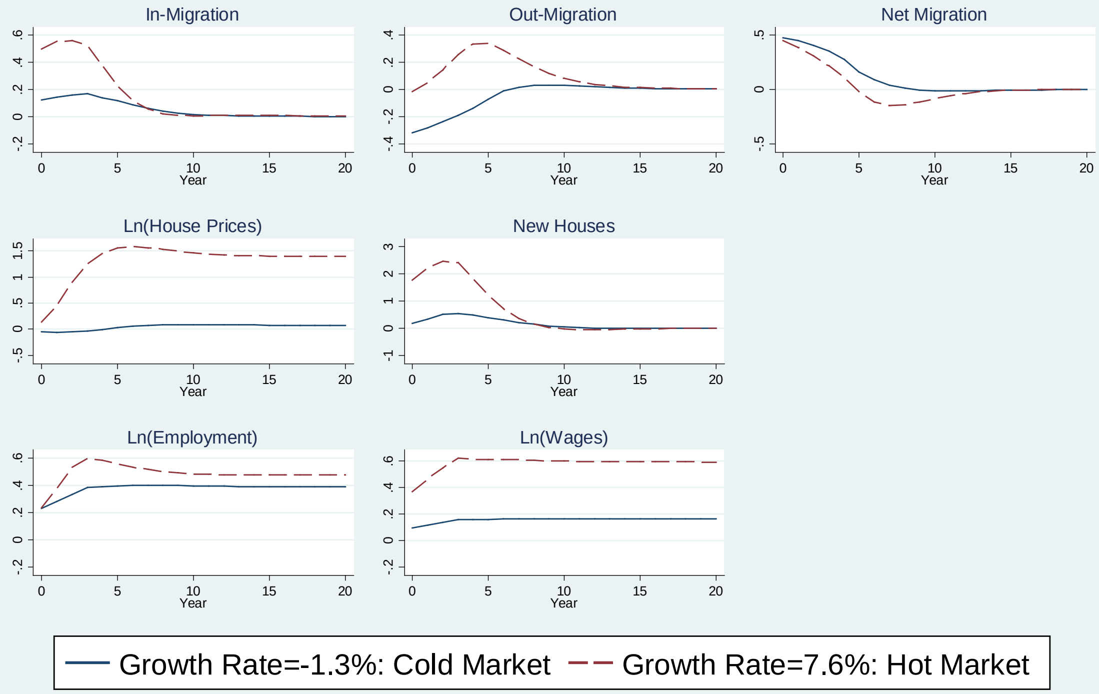


Figure 2b: Responses to Labor Supply Shock for Hot and Cold Housing Markets

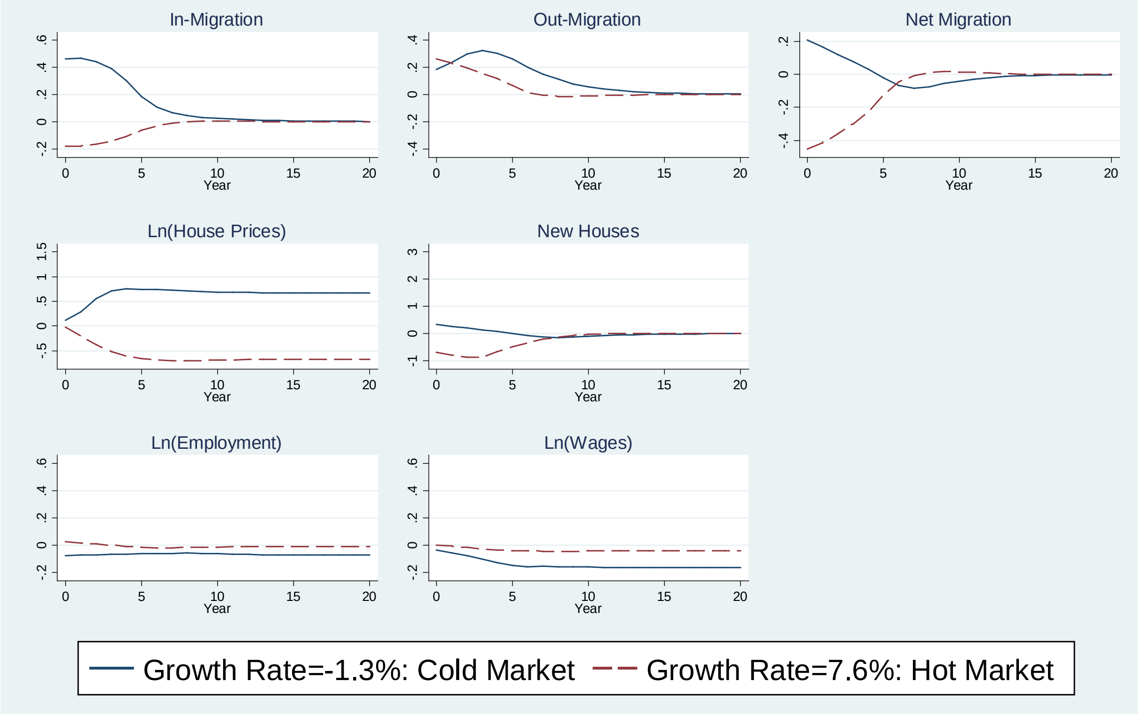


Figure 3a: Responses to Labor Demand Shock
for High- (Boston) and Low- (Knoxville) Priced Housing Markets

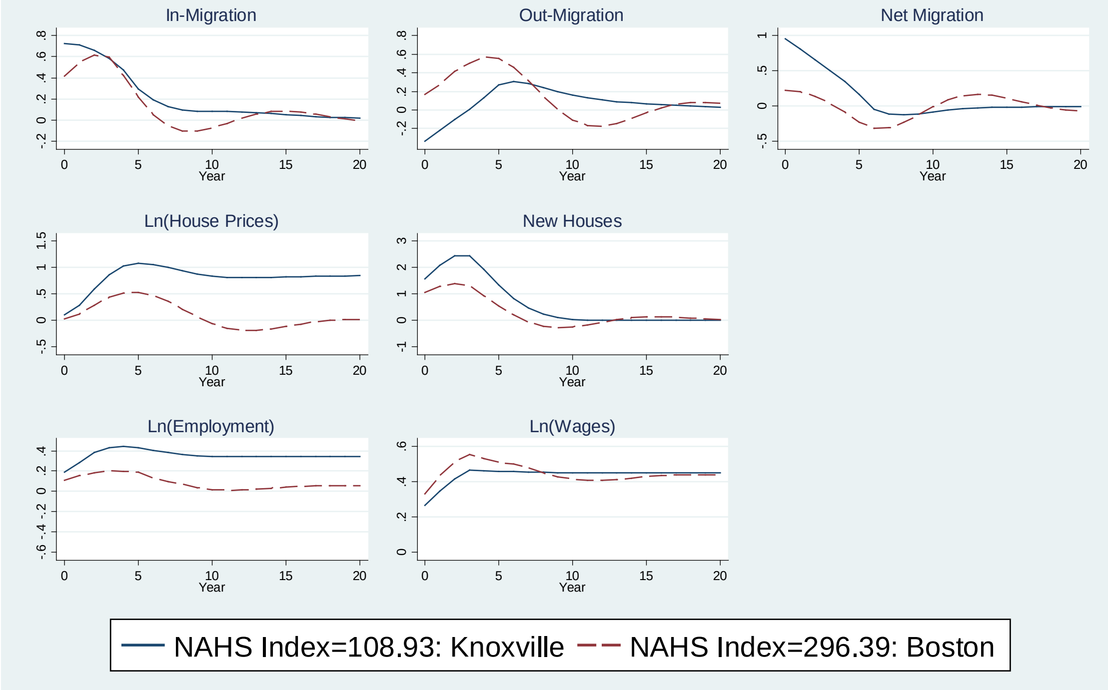


Figure 3b: Responses to Labor Supply Shock
for High- (Boston) and Low- (Knoxville) Priced Housing Markets

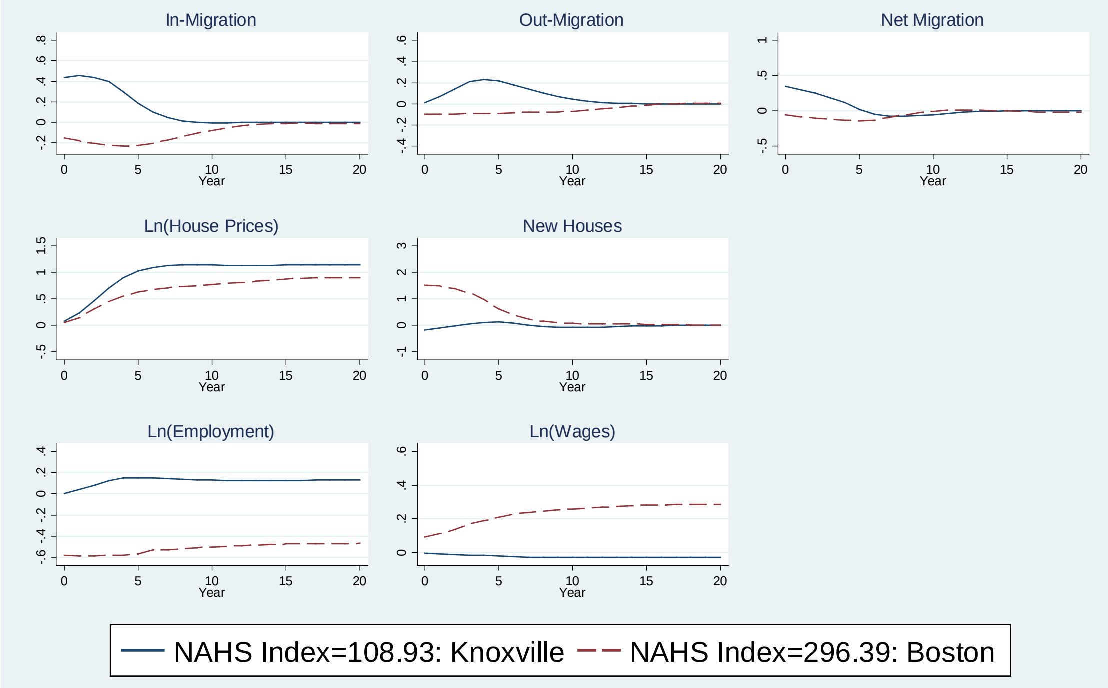


Figure 4a: Responses to Labor Demand Shock for Two Homeownership Rates

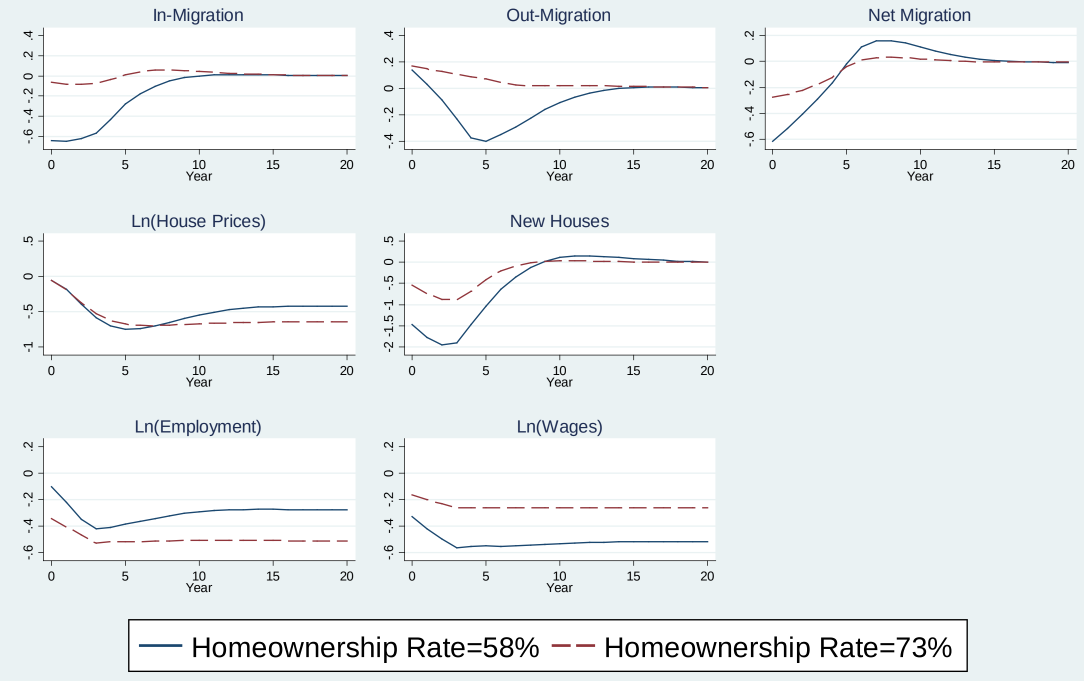


Figure 4b: Responses to Labor Supply Shock for Two Homeownership Rates

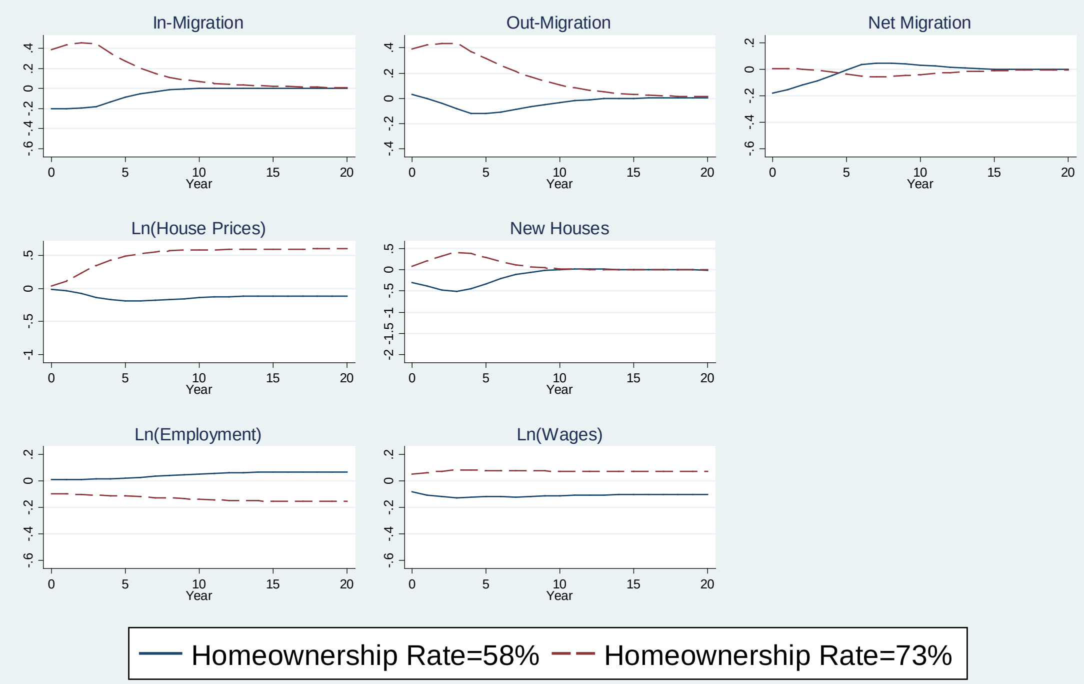
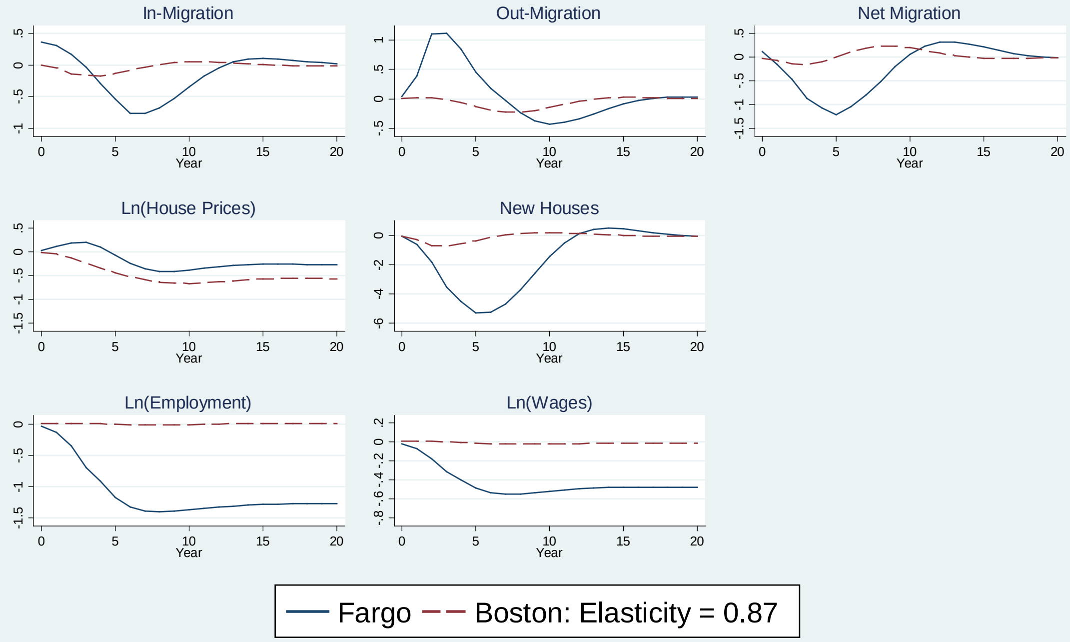
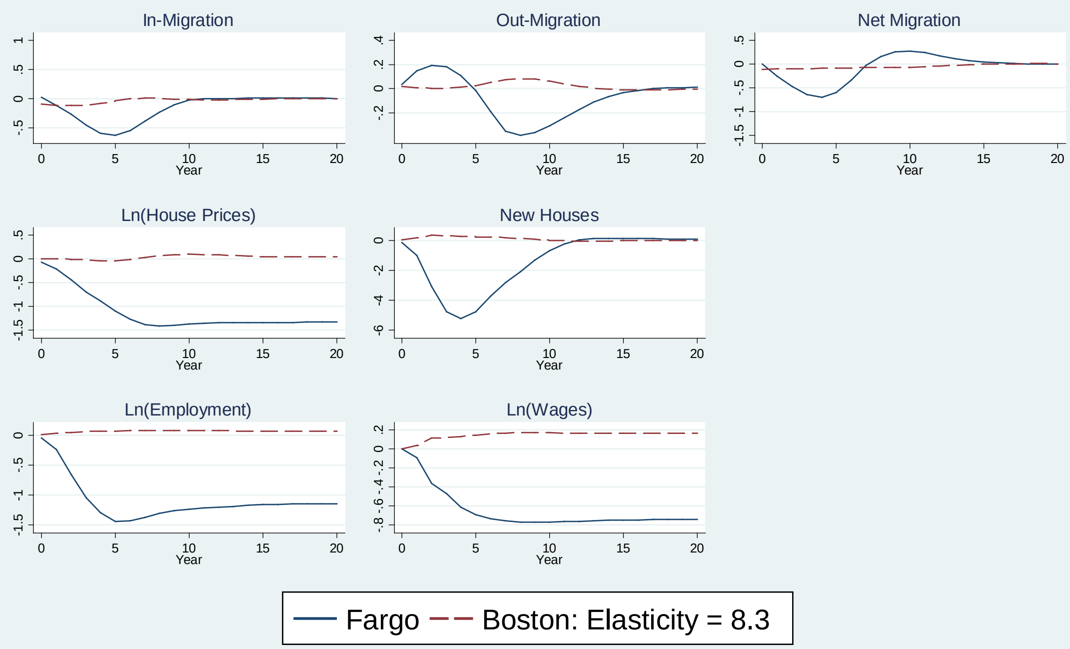


Figure 5a: Spillover Responses to Labor Demand Shocks in MSAs with Low Supply Elasticity



Notes: Weight Based on Out-Migration. Impacts are multiplied by 10 so the scale on vertical axis is readable.

Figure 5b: Spillover Responses to Labor Demand Shocks in MSAs with High Supply Elasticity



Notes: Weight Based on Out-Migration. Impacts are multiplied by 10 so the scale on vertical axis is readable.

Appendix:
Calculation of Labor Demand Shock in 1998, owing to Change from SIC to NAICS Industrial Coding

The industrial classification code changed in 1998 from SIC to NAICS. That means it is not possible to apply the formula given in equation (7) for generating the demand shock in 1998. Thus for 1998 I use the following formula:

$$\hat{\varepsilon}^{d}_{i,1998} = \sum_{j=1}^{59} \frac{e_{ij,1997}}{e_{i,1997}} \cdot \left(\frac{e_{j,1998} - e_{j,1997}}{e_{j,1997}} - \frac{e_{1998} - e_{1997}}{e_{1997}} \right) \qquad \text{(A1)}$$

instead of:

$$\hat{\varepsilon}^{d}_{i,1998} = \sum_{j=1}^{59} \frac{e_{ij,1997}}{e_{i,1997}} \cdot \left(\frac{\tilde{e}_{j,1998} - \tilde{e}_{j,1997}}{\tilde{e}_{j,1997}} - \frac{e_{1998} - e_{1997}}{e_{1997}} \right) \qquad \text{(A2)}$$

where what I cannot compute using the SIC codes is $\tilde{e}_{j,1998} = e_{j,1998} - e_{ij,1998}$

Note that I can compute (A2) for 1997 using SIC codes, and for 1999 using NAICS codes.