Discussion Papers
Department of Economics
University of Copenhagen

No. 17-06

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Marcus Mølbak Ingholt

Øster Farimagsgade 5, Building 26, DK-1353 Copenhagen K., Denmark
Tel.: +45 35 32 30 01 – Fax: +45 35 32 30 00
http://www.econ.ku.dk

ISSN: 1601-2461 (E)

House Prices, Geographical Mobility, and Unemployment

Marcus Mølbak Ingholt*

April 2017

Abstract

Geographical mobility correlates positively with house prices and negatively with unemployment over the U.S. business cycle. I present a DSGE model in which declining house prices and tight credit conditions impede the mobility of indebted workers. This reduces the workers' cross-area competition for jobs, causing wages and unemployment to rise. A Bayesian estimation shows that this channel more than quadruples the response of unemployment to adverse housing market shocks. The estimation also shows that adverse housing market shocks caused the decline in mobility during the Great Recession. Absent this decline, the unemployment rate would have been 0.5 p.p. lower.

JEL classification: D58, E24, E32, E44, R21, R23.

Keywords: Refinancing collateral constraint. Geographical mobility. Wage setting. DSGE model.

*Department of Economics, University of Copenhagen. *Address*: Øster Farimagsgade 5, 1353 København K, Denmark. *E-mail*: mi@econ.ku.dk. *Website*: sites.google.com/site/marcusingholt/.
I would like to thank, but not implicate, Henrik Jensen, Søren Hove Ravn, Peter Kjær Kruse-Andersen, Michael Amior, and participants at seminars at the University of Copenhagen, the University of Cambridge, and the 10$^{\text{th}}$ RGS Doctoral Conference in Economics for useful comments and suggestions.

1 Introduction

A characteristic of the U.S. business cycle is the positive correlation between labor mobility and house prices and the negative correlation between labor mobility and unemployment. This was most evident around the Great Recession when real house prices decreased by 28 pct., the unemployment rate increased by 4.5 p.p., and the geographical mobility rate of homeowners decreased by 2.3 p.p. or one-third. These correlations were, however, more general economic phenomena during 1987-2015, according to Table 1. In addition to this aggregate time-series evidence, a large body of microeconometric literature studies the effects of house price slumps on geographical mobility. According to some of the recent contributions, technical insolvency makes homeowners 20 pct. to one-third less mobile (see Ferreira et al. (2010, 2012) and Goetz (2013)).

Table 1: Correlations of the Geographical Mobility Rate of Homeowners

Period	1987-2015		Excluding 2006-2010	
Detrending (all variables)	Linear	HP	Linear	HP
Real House Price Growth Rate	0.70	0.70	0.62	0.58
Unemployment Rate	-0.55	-0.36	-0.53	-0.38

Note: Data sources are explained in Section 4.1 and Tabel 4.

I interpret these business cycle facts in a New Keynesian dynamic stochastic general equilibrium (DSGE) model through a novel link between labor mobility and wage setting. The link proves to significantly increase the propagation from the housing market to the labor market. The paper thus contributes to an understanding of how housing market crises can generate large recessions. In addition to this, the paper contributes to an understanding of what determines the geographical mobility of homeowners.

The model incorporates the following dynamics. Unemployment results from workers setting their wages above the perfectly competitive levels under monopolistic competition. Workers who anticipate unemployment can avoid unemployment by relocating to new areas where they have job offers, but relocating requires indebted workers to refinance their mortgage loans. House price drops render indebted workers technically insolvent, and credit tightenings raise loan-to-value limits. Such adverse housing market movements therefore make indebted workers who anticipate unemployment less willing to accept long-distance job offers, as they require that the workers reduce consumption in order to pay back their excess debt. When fewer workers relocate, an economy-wide representative firm is less able to lay-off current workers from high-wage areas, and attract new workers from low-wage areas. Thus, the workers' competition across areas for jobs is lower, which makes the firm less wage elastic. The workers respond to their strengthened market power by targeting higher wage markups. This *ceteris paribus* results in higher wages that reduce aggregate employment.

The model is estimated by Bayesian maximum likelihood. This allows me to empirically substantiate the mobility-wage channel. The channel is introduced by allowing the geographical mobility of workers to have an effect on the ability of the economy-wide representative firm to substitute between employment from different areas. The model does not *a priori* specify the sign and magnitude of this effect. It is first when the model is estimated with a noninformative prior on the relevant parameter that the positive relationship between the geographical mobility of workers and the spatial labor substitutability of the firm is discovered. It is conditional on this finding that lower mobility reduces the workers' cross-area competition for jobs. Lower mobility thereby raises the real wage, as in Bhaskar et al. (2002), and increases the geographical wage dispersion, as in Topel (1986), Blanchard and Katz (1992), and Beaudry et al. (2014).

The annual geographical mobility rate of homeowners declined by 2.0 p.p. from 1987 to 2002 and then by 2.3 p.p. from 2005 to 2010. These declines each roughly correspond to one-fourth compared to the level in 1987. A growing literature is trying to understand the causes of the low mobility.[1] The present model explains the entire decline that occurred around the Great Recession. The decline is mostly caused by a mortgage lock-in of homeowners. Negative housing preference shocks that drove house prices down account for two-fifths of the decline. Negative collateral constraint shocks that lowered the loan-to-value limits account for half of the decline. The decline in mobility prior to 2002 is mostly captured by relocation preference shocks. These shocks are highly persistent. This suggests that the decline prior to 2002 had a secular nature, which was unrelated to the cyclical employment motive of the model.

The mobility-wage channel is a novelty to the business cycle literature. It greatly amplifies the response of the economy to housing market shocks. For instance, the theoretical unemployment rate increases by 3.9 p.p. with the channel vs. 0.8 p.p. without the channel during the Great Recession if the model is driven by housing market shocks only.

The mobility-wage channel endogenizes the mobility-related wage markup shocks, which the previous literature considers exogenous. It thereby offers an explanation of the countercyclicality of wage markups and "the missing disinflation" following the Great Recession.[2] Declines in mobility during recessions encourage workers to target higher wage markups, resulting in higher wages. This comovement was observed during the Great Recession when the mobility declined and the average wage markup increased by approx. 14 pct., according to Karabarbounis (2014). The mobility-wage channel thus constitutes

[1] For instance, Molloy et al. (2011) document the decline in geographical mobility, but then find that compositional changes in the U.S. population cannot explain it.

[2] The countercyclicality of wage markups has been documented by Karabarbounis (2014). He decomposes the labor wedge into price and wage markups, and shows that the wage markup had a -62 pct. cyclical correlation with GDP per capita during 1964-2011. The puzzle of missing disinflation following the Great Recession has been raised by, i.a., Hall (2013).

a real wage rigidity that reduces the countercyclicality of real wages.

A counterfactual simulation quantifies the consequences of the decline in geographical mobility during the Great Recession. A fiscal authority offers lump-sum-financed relocation subsidies to workers who anticipate unemployment. I apply the estimated historical shock innovations to the model, and calibrate the subsidies so that the mobility rate is constant at its steady-state level during the recession. Since mobility no longer declines, the workers' cross-area competition for jobs is more intense than during the historical baseline, and the real wages are consequently lower. Through higher labor demand, employment and GDP are 0.5 pct. and 0.4 pct. higher, and the unemployment rate is 0.5 p.p. lower, all during 2010-2013. The simulation speaks clearly to the adverse consequences of procyclical labor mobility. Unemployment would have been approx. 770,000 persons lower if mobility had been constant through the recession.

The results in the paper advocate policies, such as countercyclical loan-to-value limits, that can make mobility less procyclical. Less procyclical mobility will – through the mobility-wage channel – reduce the countercyclicality of desired wage markups, and make wages more procyclical. This will moderate the cyclical fluctuations in (un)employment since a larger share of the cyclical adjustments at the labor market will be facilitated through adjustments in wages.

The model builds on four strands of the macroeconomic literature. First, it draws on the vast literature that studies interactions between financial markets and the macroeconomy through collateral constraints, such as Kiyotaki and Moore (1997), Iacoviello (2005), Iacoviello and Neri (2010), Liu et al. (2013), Sterk (2015), and Liu et al. (2016). Second, the model adopts the New Keynesian paradigm with respect to monopolistic competition, nominal price and wage rigidities, and unemployment formation, as it is presented in Erceg et al. (2000), Galí (2011) and Galí et al. (2012). Third, the model assumes that workers relocate for employment purposes, following Topel (1986), Blanchard and Katz (1992), Beaudry et al. (2014), and Sterk (2015). Four, the model allows geographical mobility to conditional on parameterization affect wage setting, as in Bhaskar et al. (2002).

The paper is closest to Sterk (2015). He also studies how workers who anticipate unemployment avoid this by relocating, and applies a collateral constraint that restricts the workers' relocation choice based on the state of the housing market. The papers deviate in that Sterk (2015) studies spatial matching in a labor market with search unemployment, while I study mobility-dependent wage setting under monopolistic competition. The papers also deviate in that Sterk (2015) focuses exclusively on housing preference and technology shocks in a calibrated setting, whereas I distinguish between housing preference, collateral constraint, and nine other shocks in an estimated setting.

The rest of the paper is structured as follows. Section 2 relates some of the assumptions essential for the mobility-wage channel to the existing literature. Section 3 presents the theoretical model. Section 4 presents the Bayesian estimation of the model. Section 5 examines the implications of the mobility-wage channel for the links between the housing and labor markets. Section 6 conducts the counterfactual simulation. Section 7 contains concluding remarks.

2 Relation to the Existing Literature

In the model, workers who anticipate unemployment migrate to new local labor markets in order to be employed. This assumption is in line with Molloy et al. (2011) who find that employment status is the most important determinant of mobility rates across population groups after homeownership status, which is not considered by the model since all workers are assumed to be homeowners. The assumption is also in line with Blanchard and Katz (1992) who study the adjustments of local labor markets to local labor demand shocks. They find that a permanent positive shock increases wages and reduces unemployment. Over time, however, net immigration ensures a decline in wages and an increase in unemployment. Blanchard and Katz (1992) furthermore emphasize that it is the geographical differences in employment conditions (not wage conditions) which drive labor migration, and that job creation and job migration do not play any particular part in the adjustments of local labor markets. Beaudry et al. (2014) corroborate this by demonstrating that the effects of changes in employment rates on net-migration are three times as large as the effects of changes in wages. The theoretical models in Blanchard and Katz (1992) and Beaudry et al. (2014) both assume that workers relocate for employment purposes.

The model captures frictions in the allocation of workers across local labor markets by assuming that the workers are specialized in geography. This enables them to exercise market power in monopolistic competition over an economy-wide monopsonistic representative firm, which hires labor. Similar assumptions can be found in Topel (1986), Blanchard and Katz (1992), and Beaudry et al. (2014). Here, both workers and firms are specialized in geography because of relocation frictions. This causes them to have bilateral monoposony and monopoly positions when determining wages at each local labor market.

The estimation of the model shows that higher geographical mobility among workers eases the spatial labor substitutability of the representative firm. The cross-area competition of workers for jobs is intensified, which results in lower wages and higher employment. This mechanism is similar to the effect of higher mobility in Bhaskar et al. (2002). Here, workers are heterogeneous because of heterogeneity in, i.a., locations and mobility costs. This worker heterogeneity causes oligopsonistic firms, which hire the workers, to face upward-sloping labor supply curves. An increase in labor mobility (i.e., less worker heterogeneity) flattens the labor supply curve, which in equilibrium causes the real wage to fall and employment to rise.

The result that higher geographical mobility eases the spatial labor substitutability of the representative firm has some theoretical implications. Eased spatial labor substitutability causes the firm to reduce its labor demand from high-wage areas and increase its labor demand from low-wage areas. This reduces the geographical wage dispersion. The distortions generated by workers' monopolistic competition are relieved, and the economy is brought closer to its Pareto efficient allocation. These effects of higher mobility are identical to the effects of higher mobility on wage dispersion and Pareto efficiency in Topel (1986), Blanchard and Katz (1992), and Beaudry et al. (2014).

Indebted homeowners in the model are forced to refinance their mortgage loans when relocating, which affects their willingness to do so. A vast microeconometric literature finds evidence of this lock-in effect of technical insolvency.[3] Some of the original contributions include Stein (1995) and Henley (1998). Chan (2001) and Ferreira et al. (2010) use pre-recession data, and find that technical insolvency makes homeowners 24 pct. to one-third less mobile. Ferreira et al. (2012) reexamine this conclusion with recession data, and conclude that it continues to hold. Goetz (2013) finds that homeowners who experienced a decline in their homevalues during 2002-2010 were 20-25 pct. less likely to accept new jobs outside their current Metropolitan Statistical Areas (MSA). He likewise finds that for every 20 pct. decline in house prices in a MSA, the out-migration propensity decreased by 7.5 pct. Monras (2015) finds that, across MSAs during 2006-2010, being more severely affected by the crisis had a strong negative effect on in-migration rates, while out-migration rates were unchanged. This indicates that the existing inhabitants were locked in. Brown and Matsa (2016) find that technical insolvency made homeowners more than 50 pct. less likely to apply for jobs outside their current commuting zones, using data for the financial services industry between May 2008 and December 2009.

3 The Model

The basic structure of the model is based on Iacoviello and Neri (2010). The model has a discrete infinite time-horizon with time indexed by t. The economy is populated by two representative households: a patient household and an impatient household. Households consume goods and housing, supply labor, and relocate for employment purposes. This latter assumption follows Topel (1986), Blanchard and Katz (1992), Beaudry et al. (2014), and Sterk (2015). Patient workers are restricted in their mobility by a utility loss, and impatient workers are restricted in their mobility by a utility loss and a refinancing requirement, both following Sterk (2015). Goods and housing are produced by a representative intermediate firm by combining employment, non-residential capital, and land. The time preference heterogeneity implies that the patient household lends funds to the impatient household. The patient household also owns and operates the firm, non-residential capital, and land.

[3] In addition to this literature, some studies have questioned the size of the lock-in effect on homeowners' geographical mobility (see Molloy et al. (2011), Farber (2012), and Demyanyk et al. (2017)).

Price and wage setting decisions follow Erceg et al. (2000), Smets and Wouters (2003, 2007), Galí (2011) and Galí et al. (2012). Retail firms unilaterally set prices subject to downward-sloping goods demand curves. Workers unilaterally set nominal wages subject to downward-sloping labor demand curves. Prices and wages are set in Calvo (1983) contracts with price indexation. Geographical mobility can – conditional on parameterization – affect wage setting, as in Bhaskar et al. (2002). The dynamic and steady-state equilibrium conditions of the model are derived in the Online Appendix.

3.1 The Patient and Impatient Households

Variables and parameters without (with) a prime refer to the representative patient (impatient) household. The household types differ with respect to their pure time discount factors, $\beta \in (0,1)$ and $\beta' \in (0,1)$, since $\beta > \beta'$. The economic size of each household is measured by its wage share: $\alpha \in (0,1)$ for the patient household and $1-\alpha$ the impatient household.

Each household consists of a continuum of members represented by the unit cube and indexed by the triplet $(\mathfrak{i}, \mathfrak{j}, \mathfrak{k}) \in [0,1] \times [0,1] \times [0,1]$. The dimension indexed by $\mathfrak{i}$ represents the individual disutility from labor supply. The disutility from labor supply of member $\mathfrak{i}$ is $\mathfrak{i}^{\varphi}$ if she supplies labor and zero otherwise, where $\varphi \in \mathbb{R}_+$ measures the elasticity of marginal disutility of supplying labor. The dimension indexed by $\mathfrak{j}$ represents the individual disutility from relocating. The disutility from relocating of member $\mathfrak{j}$ is $\mathfrak{j}^{\psi}$ if she relocates and zero otherwise, where $\psi \in \mathbb{R}_+$ measures the elasticity of marginal disutility of relocating. The households choose the labor force participation and geographical mobility rates of their members.[4] All labor market participating members supply one unit of time. The dimension indexed by $\mathfrak{k}$ represents the professional and geographical specialization of each member. This dimension is elaborated in Subsection 3.5.

The patient and impatient households maximize their utility functions:

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t s_{I,t} \left[\chi \log(c_t - \eta c_{t-1}) + \omega_H s_{H,t} \log(h_t) - \frac{\omega_L s_{L,t}}{1+\varphi} l_t^{1+\varphi} - \frac{\omega_R s_{R,t}}{1+\psi} m_t^{1+\psi} \right] \right\} \quad (1)$$

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta'^t s_{I,t} \left[\chi' \log(c'_t - \eta c'_{t-1}) + \omega_H s_{H,t} \log(h'_t) - \frac{\omega_L s_{L,t}}{1+\varphi} l_t'^{1+\varphi} - \frac{\omega_R s_{R,t}}{1+\psi} m_t'^{1+\psi} \right] \right\}, \quad (2)$$

where $\chi \equiv \frac{1-\eta}{1-\beta\eta}$ and $\chi' \equiv \frac{1-\eta}{1-\beta'\eta}$,[5] c_t and c'_t denote goods consumption, h_t and h'_t denote housing, l_t and l'_t denote labor force participation rates, m_t and m'_t denote the average geographical mobility rates of the workers,[6] $s_{I,t}$ denotes an intertemporal preference shock, $s_{H,t}$ denotes a housing preference shock, $s_{L,t}$ denotes a labor preference shock, and $s_{R,t}$

[4] The heterogeneous disutility of relocating captures heterogeneity in pecuniary and psychological costs across workers. It will always be the workers with the lowest disutility who relocate.

[5] The scaling factors ensure that the marginal utilities of consumption are $\frac{1}{c}$ and $\frac{1}{c'}$ in steady-state.

[6] The disutilities from labor supply and relocation at household levels are computed in the following

denotes a relocation preference shock. $\eta \in (0,1)$ measures habit formation in goods consumption. $\omega_H \in \mathbb{R}_+$, $\omega_L \in \mathbb{R}_+$, and $\omega_R \in \mathbb{R}_+$ weight the (dis)utilities of housing, labor force participation, and relocation relative to the utility of goods consumption.[7]

In the beginning of each period, a share of random workers in each household ($u_{a,t}$ and $u'_{a,t}$) are selected to be unemployed in the current period. I refer to these workers as that they "anticipate unemployment" in the current period. Out of these shares of workers, a share in each household ($m_{u,t}$ and $m'_{u,t}$) chooses to avoid unemployment by relocating to new areas where the workers have job offers. All staying workers who anticipated to be unemployed become unemployed, and all relocating workers become employed. Staying and relocating employed workers earn identical wages. Household wage incomes consequently become:

$$(1-u_{a,t})w_t l_t + u_{a,t}m_{u,t}w_t l_t \qquad \text{and} \qquad (1-u'_{a,t})w'_t l'_t + u'_{a,t}m'_{u,t}w'_t l'_t, \tag{3}$$

where $u_{a,t}$ and $u'_{a,t}$ denote unemployment anticipation rates, w_t and w'_t denote real wages, and $m_{u,t}$ and $m'_{u,t}$ denote the geographical mobility rates of the workers who anticipate unemployment.

Utility maximization of the patient household is subject to a budget constraint:

$$\begin{aligned} c_t + q_t h_t + \frac{R_{t-1}}{\pi_{P,t}} b_{t-1} + \frac{k_t}{s_{AK,t}} + \frac{f(z_t)}{s_{AK,t}} k_{t-1} + \frac{g(k_t,k_{t-1})}{s_{AK,t}} k_{t-1} + v_t + p_{x,t}x_t + \alpha s_{G,t} \\ = (1-u_{a,t})w_t l_t + u_{a,t}m_{u,t}w_t l_t + div_t + (1-\delta_H)q_t h_{t-1} + b_t \\ + \left(R_{K,t}z_t + \frac{1-\delta_K}{s_{AK,t}}\right)k_{t-1} + p_{v,t}v_t + (R_{x,t}+p_{x,t})x_{t-1}, \end{aligned} \tag{4}$$

where $f(z_t) \equiv R_K\left[\frac{1}{2}\frac{\zeta}{1-\zeta}z_t^2 + \left(1-\frac{\zeta}{1-\zeta}\right)z_t + \frac{1}{2}\frac{\zeta}{1-\zeta} - 1\right]$ captures capital utilization costs, and $g(k_t,k_{t-1}) \equiv \frac{\iota}{2}\left[\frac{k_t}{k_{t-1}} - 1\right]^2$ captures capital adjustment costs. Not previously mentioned variables in (4) denote: q_t is the real house price, R_t is the nominal gross interest rate, $\pi_{P,t}$ is gross price inflation, b_t is borrowing, k_t is non-residential capital, $s_{AK,t}$ is an investment-specific technology shock, z_t is the utilization rate of non-residential capital, $R_{K,t}$ is the real gross rental rate of non-residential capital, R_K is the steady-state real gross rental rate of non-residential capital, v_t are intermediate housing inputs, $p_{v,t}$ is the real price of intermediate housing inputs, x_t is land, $p_{x,t}$ is the real price of land, $R_{x,t}$ is the real gross rental rate of land, $\alpha s_{G,t}$ is a government spending lump-sum tax, and div_t are dividends from retail firms. $\zeta \in (0,1)$ measures capital utilization costs, and $\iota \in \mathbb{R}_+$ measures capital adjustment costs.

way: $\int_0^{l_t} \mathrm{i}^{\varphi} d\mathrm{i} = \frac{1}{1+\varphi} l_t^{1+\varphi}$, $\int_0^{l'_t} \mathrm{i}^{\varphi} d\mathrm{i} = \frac{1}{1+\varphi} l_t'^{1+\varphi}$, $\int_0^{m_t} \mathrm{j}^{\psi} d\mathrm{j} = \frac{1}{1+\psi} m_t^{1+\psi}$, and $\int_0^{m'_t} \mathrm{j}^{\psi} d\mathrm{j} = \frac{1}{1+\psi} m_t'^{1+\psi}$.

[7]The calibration of ω_R ensures that, conditional on the size of the shocks hitting the economy, the geographical mobility rate is always positive.

Utility maximization of the impatient household is subject to a budget constraint,

$$c'_t + q_t h'_t + \frac{R_{t-1}}{\pi_{P,t}} b'_{t-1} + (1-\alpha) s_{G,t} \\ = (1-u'_{a,t}) w'_t l'_t + u'_{a,t} m'_{u,t} w'_t l'_t + (1-\delta_H) q_t h'_{t-1} + b'_t, \tag{5}$$

and to a refinancing collateral constraint,

$$b'_t \leq (1-m'_t)\left((1-\rho) b'_{t-1} + \rho \xi s_{C,t} \mathbb{E}_t\left\{\frac{\pi_{P,t+1} q_{t+1} h'_t}{R_t}\right\}\right) + m'_t \xi s_{C,t} \mathbb{E}_t\left\{\frac{\pi_{P,t+1} q_{t+1} h'_t}{R_t}\right\}. \tag{6}$$

Not previously mentioned variables in (5) and (6) denote: b'_t is borrowing, $(1-\alpha)s_{G,t}$ is a government spending lump-sum tax, and $s_{C,t}$ is a collateral constraint shock. $\rho \in [0,1]$ measures the share of staying workers who refinance, and $\xi \in [0,1]$ measures the steady-state loan-to-value limit on newly issued debt. The assumption $\beta > \beta'$ implies that the impatient household wishes to decumulate wealth quickly enough in order for (6) to hold with equality around the steady-state.

The refinancing collateral constraint ties the borrowing ability of the share of workers who relocate (m'_t) to the expected discounted value of their housing wealth. In the share of workers who do not relocate ($1-m'_t$), an exogenous share (ρ) nonetheless refinance their mortgage loans, and an exogenous share ($1-\rho$) roll over their existing mortgages. (6) has the important implication that the relocation choice of the impatient workers is conditioned on the state of the housing market (including the existing mortgage debt).

(6) is a generalization of the refinancing collateral constraint in Sterk (2015). He assumes that only relocating homeowners refinance; i.e., $\rho = 0$. I allow for $\rho > 0$ since homeowners in reality also refinance their mortgage loans without relocating. Thus, assuming $\rho = 0$ will imply too little correspondence between the collateral value (and consequently house prices) and the actual debt.

3.2 Geographical Mobility

The households choose the geographical mobility rates of the workers who anticipate unemployment ($m_{u,t}$ and $m'_{u,t}$) when they maximize utility. However, it is the average mobility rates of all workers in the households (m_t and m'_t) that yield disutility and affects borrowing. The average mobility rates are:

$$\begin{aligned} m_t &\equiv (1-u_{a,t}) \cdot 0 + u_{a,t} m_{u,t} \\ &= u_{a,t} m_{u,t} \end{aligned} \quad \text{and} \quad \begin{aligned} m'_t &\equiv (1-u'_{a,t}) \cdot 0 + u'_{a,t} m'_{u,t} \\ &= u'_{a,t} m'_{u,t}. \end{aligned} \tag{7}$$

The households hence choose geographical mobility subject to (7). The resulting first order conditions with respect to mobility are:

$$u_{c,t} w_t l_t = \omega_R s_{R,t} s_{I,t} (u_{a,t} m_{u,t})^{\psi}$$
$$u'_{c,t} w'_t l'_t + (1-\rho)\lambda_t \left[\xi s_{C,t} \mathbb{E}_0 \left\{ \frac{\pi_{t+1} q_{t+1} h'_t}{R_t} \right\} - b'_{t-1} \right] = \omega_R s_{R,t} s_{I,t} (u'_{a,t} m'_{u,t})^{\psi},$$

where $u_{c,t}$ and $u'_{c,t}$ denote the marginal utilities of goods consumption. For the patient household, optimality requires that the marginal utility of consumption made possible by avoiding unemployment via relocating (the left-hand side) is equal to the marginal disutility of relocating (the right-hand side). For the impatient household, in addition to this, the mobility choice depends on the difference between the currently loanable amount and the level of outstanding debt. Technical insolvency discourages the workers from relocating since it requires them to reduce consumption in order to pay back their excess debt. Home equity encourages the workers to relocate since it gives them an opportunity to take on additional debt and increase consumption.

3.3 The Intermediate and Retail Firms

The firm sector is a variant of the firm sector developed in Erceg et al. (2000) most notably expanded with transformation of goods production into housing. The representative intermediate firm produces intermediate goods by hiring labor from the patient and impatient households and renting capital from the patient household. The intermediate firm also transforms intermediate goods and land into final housing. The intermediate firm operates under perfect competition.

The intermediate firm maximizes profits,

$$\frac{Y_t}{M_{P,t}} + q_t I_{H,t} - w_t n_t - w'_t n'_t - R_{K,t} z_t k_{t-1} - p_{v,t} v_t - R_{x,t} x_{t-1}, \tag{8}$$

subject to the available goods production and housing transformation technologies,

$$Y_t = (z_t k_{t-1})^{\mu} (s_{Y,t} n_t^{\alpha} n_t'^{1-\alpha})^{1-\mu} \tag{9}$$
$$I_{H,t} = v_t^{\nu} x_{t-1}^{1-\nu}, \tag{10}$$

where Y_t denotes goods production, $M_{P,t}$ denotes an average gross price markup over marginal costs set by the retail firms, $I_{H,t}$ denotes housing production, n_t and n'_t denote employment rates, and $s_{Y,t}$ denotes a labor-augmenting technology shock.[8] $\mu \in (0,1)$ measures the goods production elasticity with respect to non-residential capital, and $\nu \in$

[8]Non-residential capital and labor are not used directly in the housing transformation technology since they have already been used in the production of intermediate housing inputs.

$(0,1)$ measures the housing transformation elasticity with respect to intermediate housing inputs. (9) is identical to the goods production function in Iacoviello and Neri (2010). They thus also aggregate the labor inputs from the two households through a Cobb-Douglas function. This assumption implies a complementarity across the labor skills of the two households, but simplifies the dynamic and steady-state equilibrium conditions of the model considerably.

Retail firms are distributed over an unit continuum by specialization. They purchase and assemble intermediate goods into retail firm-specific final goods at no additional cost. The final goods are sold as goods consumption, non-residential investments, intermediate housing inputs, and government spending. The specialization allows the firms to operate under monopolistic competition. The retail firms pay dividends to their owner (the patient household):

$$div_t = \left(1 - \frac{1}{M_{P,t}}\right) Y_t.$$

3.3.1 The New Keynesian Price Phillips Curve

The solution to the retail firms' price setting problem yields a hybrid New Keynesian Price Phillips Curve:

$$\hat{\pi}_{P,t} = \gamma_P \pi_{P,t-1} + \beta \mathbb{E}_t \{ \pi_{P,t+1} - \gamma_P \pi_{P,t} \} - \lambda_P \big(\log M_{P,t} - \log M_P \big) + s_{P,t},$$

where $\lambda_P \equiv \frac{(1-\theta_P)(1-\beta\theta_P)}{\theta_P}$, $\hat{\pi}_{P,t}$ denotes net price inflation, $M_P \equiv \frac{\epsilon_P}{\epsilon_P - 1}$ denotes the average desired gross price markup, and $s_{P,t}$ denotes a price markup shock. $\epsilon_P > 1$ measures the price elasticity of retail firm-specific goods demand. $\gamma_P \in (0,1)$ measures backward price indexation, and $\theta_P \in (0,1)$ measures the Calvo probability of a fixed contract.

3.4 Labor Market Equilibrium

The labor market equilibrium conditions require that total household employment is equal to the sum of employment stemming from workers who anticipate to be employed and workers who anticipate to be unemployed but who become employed by relocating:

$$n_t = (1 - u_{a,t}) l_t + u_{a,t} m_{u,t} l_t \tag{11}$$

$$n'_t = (1 - u'_{a,t}) l'_t + u'_{a,t} m'_{u,t} l'_t. \tag{12}$$

The labor market equilibrium conditions determine the unemployment anticipation rates. They also determine the unemployment rates as:

$$\begin{aligned} u_t &\equiv 1 - \frac{n_t}{l_t} \\ &= (1 - m_{u,t}) u_{a,t} \end{aligned} \qquad \text{and} \qquad \begin{aligned} u'_t &\equiv 1 - \frac{n'_t}{l'_t} \\ &= (1 - m'_{u,t}) u'_{a,t}. \end{aligned}$$

Disregarding any equilibrium effects of mobility (e.g., via the mobility-wage channel), a decline in the mobility rates of workers who anticipate unemployment ($m_{u,t}$ and $m'_{u,t}$) causes a decline in the unemployment anticipation rates ($u_{a,t}$ and $u'_{a,t}$), thereby leaving unemployment (u_t and u'_t) unchanged.

3.5 Wage Setting

The wage setting model is a variant of the wage setting model developed in Erceg et al. (2000). The workers are distributed over an unit continuum $\mathfrak{k} \in [0, 1]$ by specialization with respect to profession and geography. The specialization allows the workers to set the wage $w(\mathfrak{k})$ at each local labor market $\mathfrak{k}$ under monopolistic competition. The representative intermediate firm aggregates its specialized labor inputs through two Dixit and Stiglitz (1977) aggregators:

$$n_t = \left(\int_0^1 n_t(\mathfrak{k})^{\frac{e_{W,t}-1}{e_{W,t}}} d\mathfrak{k} \right)^{\frac{e_{W,t}}{e_{W,t}-1}} \qquad \text{and} \qquad n'_t = \left(\int_0^1 n'_t(\mathfrak{k})^{\frac{e'_{W,t}-1}{e'_{W,t}}} d\mathfrak{k} \right)^{\frac{e'_{W,t}}{e'_{W,t}-1}}, \tag{13}$$

where $n_t(\mathfrak{k})$ and $n'_t(\mathfrak{k})$ denote the area- and profession-specific employments of labor-type $\mathfrak{k}$, and $e_{W,t}$ and $e'_{W,t}$ denote endogenous wage elasticities of area- and profession-specific labor demand. The wage elasticities measure the degree of labor substitutability between employment from different areas and professions that is available to the firm.[9]

It is not *a priori* clear how the geographical mobility of the workers should affect the spatial labor substitutability and equivalently the wage elasticity of the firm. The effect depends on the direction in which the relocating workers predominantly move in order to get jobs. If relocating workers predominantly move from high-wage areas to low-wage areas, higher mobility will make it *easier for the firm to substitute* high-wage workers for low-wage workers. If relocating workers predominantly move from low-wage areas to high-wage areas, higher mobility will make it *more difficult for the firm to substitute* high-wage workers for low-wage workers.

Because it is *a priori* unclear how the wage elasticity should depend on geographical mobility, I allow for a flexible setup that nests both cases above. More specifically, I allow the wage elasticities of labor demand to depend on the geographical mobility rates without

[9] In their original seminal contribution, Dixit and Stiglitz (1977) formulated the aggregator in terms of a substitution parameter. This substitution parameter is equal to $\frac{e_{W,t}-1}{e_{W,t}}$.

specifying the sign and magnitude of this dependence:

$$e_{W,t} = \left(\frac{m_t}{m}\right)^{\kappa} \epsilon_W \qquad \text{and} \qquad e'_{W,t} = \left(\frac{m'_t}{m'}\right)^{\kappa} \epsilon_W, \tag{14}$$

where m and m' denote the steady-state average geographical mobility rates of the workers, $\kappa \in \mathbb{R}$ measures the geographical mobility elasticity of the wage elasticity, and $\epsilon_W > 1$ measures the wage elasticity in steady-state. (14) allows me to investigate the sign and magnitude of the link between the mobility of the workers and the spatial labor substitutability of the intermediate firm by estimating κ. This happens in Section 4 with this result: $\kappa > 0$.

The solution to the intermediate firm's labor input maximization problem yields based on (13) the following area- and profession-specific labor demand functions:

$$n_t(\mathfrak{k}) = \left(\frac{w_t(\mathfrak{k})}{w_t}\right)^{-e_{W,t}} n_t \qquad \text{and} \qquad n'_t(\mathfrak{k}) = \left(\frac{w'_t(\mathfrak{k})}{w'_t}\right)^{-e'_{W,t}} n'_t. \tag{15}$$

The labor demand functions capture the intuition of how there may be opposing links between the geographical mobility of workers and the wage elasticities of firms. If $\kappa > 0$, higher mobility among the workers makes it *easier for the firm to substitute* workers from high-wage areas with workers from low-wage areas. This makes the firm more wage elastic. It is able to reduce its labor demand from high-wage areas ($\frac{w_t(\mathfrak{k})}{w_t} > 1$) and increase its labor demand from low-wage areas ($\frac{w_t(\mathfrak{k})}{w_t} < 1$). Thus, the market power of the workers is weakened, and the labor market moves closer to the perfectly competitive equilibrium. Reversely, if $\kappa < 0$, higher mobility among the workers makes it *more difficult for the firm to substitute* workers from high-wage areas with workers from low-wage areas. This makes the firm less wage elastic. It is forced to increase its labor demand from high-wage areas and reduce its labor demand from low-wage areas. Thus, the market power of the workers is strengthened, and the labor market moves further away from the perfectly competitive equilibrium.

3.5.1 The New Keynesian Wage Phillips Curves

The solutions to the workers' wage setting problems yield based on (15) two hybrid New Keynesian Wage Phillips Curves:

$$\pi_{W,t} = \gamma_W \pi_{P,t-1} + \beta \mathbb{E}_t\{\pi_{W,t+1} - \gamma_W \pi_{P,t}\} - \lambda_{W,t}\big(\log M_{W,t} - \log M^D_{W,t}\big) + s_{W,t} \tag{16}$$

$$\pi'_{W,t} = \gamma_W \pi_{P,t-1} + \beta \mathbb{E}_t\{\pi'_{W,t+1} - \gamma_W \pi_{P,t}\} - \lambda'_{W,t}\big(\log M'_{W,t} - \log M^{D\prime}_{W,t}\big) + s_{W,t}, \tag{17}$$

where $\lambda_{W,t} \equiv \frac{(1-\theta_W)(1-\beta\theta_W)}{\theta_W(1+e_{W,t}\varphi)}$, $\lambda'_{W,t} \equiv \frac{(1-\theta_W)(1-\beta'\theta_W)}{\theta_W(1+e'_{W,t}\varphi)}$, $\pi_{W,t}$ and $\pi'_{W,t}$ denote nominal wage inflation, $M^D_{W,t} \equiv \frac{e_{W,t}}{e_{W,t}-1}$ and $M^{D\prime}_{W,t} \equiv \frac{e'_{W,t}}{e'_{W,t}-1}$ denote endogenous average desired gross wage markups, and $s_{W,t}$ denotes a wage markup shock. $\gamma_W \in (0,1)$ measures backward price indexation, and $\theta_W \in (0,1)$ measures the Calvo probability of a fixed contract. (14) and (16)-(17) comprise the mobility-wage channel. (14) endogenizes any mobility-related wage markup shocks. The wage markup shock term ($s_{W,t}$) hence captures the shifts in the desired wage markups that are unrelated to the geographical mobility of homeowners.

Interpretation of unemployment and identification of the wage markups are based on the Galí (2011) extension of the Erceg et al. (2000) labor market model. With this extension, unemployment is a result of the wage being set above its perfectly competitive level by the workers. The wage markups are identified through the unemployment rates:

$$\log M_{W,t} = \varphi u_t \qquad \text{and} \qquad \log M'_{W,t} = \varphi u'_t. \tag{18}$$

The relations in (18) are derived in the Online Appendix. The natural unemployment rates are defined as the unemployment rates that prevail in absence of nominal wage rigidities, thus making it possible for the workers to keep the wage markups at the desired levels. Hence, the wage markups in steady-state are identified by:

$$\log M_W = \log M'_W = \varphi u = \varphi u', \tag{19}$$

where $M_W \equiv \frac{\epsilon_W}{\epsilon_W - 1}$ and $M'_W \equiv \frac{\epsilon_W}{\epsilon_W - 1}$ denote steady-state average desired gross wage markups, $u \equiv \log l - \log n$, and $u' \equiv \log l' - \log n'$ denote the natural unemployment rates in steady-state.

3.6 Monetary Policy

A central bank sets the nominal gross interest rate according to a Taylor-type monetary policy rule:

$$R_t = R_{t-1}^{\tau_R} R^{1-\tau_R} \pi_{P,t}^{(1-\tau_R)\tau_\pi} \left(\frac{GDP_t}{GDP_{t-1}} \right)^{(1-\tau_R)\tau_{\Delta Y}} \exp(\varepsilon_{M,t}), \tag{20}$$

where R denotes the steady-state nominal gross interest rate, GDP_t denotes the gross domestic product,[10] and $\varepsilon_{M,t}$ denotes a monetary policy innovation.[11]

[10] The gross domestic product is defined as the sum of value-added from goods production and housing transformation.

[11] Like in Christiano et al. (2014), I do not model a zero lower bound on the nominal interest rate. An inspection of the endogenous nominal interest rate confirms that it does not become negative in the experiments that I do in Sections 5 and 6.

3.7 Equilibrium

The model contains a final goods market, a housing market, and a loan market in addition to the two labor markets. The market clearing conditions are:

$$c_t + c'_t + \frac{k_t - (1-\delta_K)k_{t-1}}{s_{AK,t}} + \frac{f(z_t)}{s_{AK,t}}k_{t-1} + \frac{g(k_t, k_{t-1})}{s_{AK,t}}k_{t-1} + v_t + s_{G,t} = Y_t \tag{21}$$

$$h_t + h'_t - (1-\delta_H)(h_{t-1} + h'_{t-1}) = I_{H,t} \tag{22}$$

$$b_t = -b'_t, \tag{23}$$

where $s_{G,t}$ denotes a government spending shock. The government finances its spending shocks in each period by lump-sum taxation of the households (see (4) and (5)).

3.8 Stochastic Processes

The intertemporal preference, housing preference, collateral constraint, government spending, labor-augmenting technology, investment-specific technology, price markup, labor preference, and wage markup shocks follow AR(1) processes. The relocation preference shock follows an ARMA(1,1) process. The MA term in this process is highly significant (see Table 3), and improves the numerical stability of the estimation considerably. Each shock process has an independent and identically distributed normal stochastic innovation with a constant standard deviation.

The stochastic monetary policy innovation is independent and normally identically distributed with a constant standard deviation. Exogenous monetary policy does not have an autoregressive component since I assume that any persistence in this policy is captured by deterministic interest rate smoothing, following Christiano et al. (2014).

4 Estimation

4.1 Data

I estimate the model by Bayesian maximum likelihood, such as surveyed in An and Schorfheide (2007). The sample frequency is quarterly, and the sample covers the U.S. economy in 1987Q1-2015Q4. The estimation sample contains the following eleven variables: 1. Real gross domestic product per capita.[12] 2. Real personal consumption expenditures per capita. 3. Real private non-residential investment per capita. 4. Real residential mortgage debt outstanding per capita. 5. Real house prices. 6. Quartered effective federal funds rate. 7. Log-change in GDP price deflator. 8. Log-change in average hourly earnings.

[12] To be consistent with the model, GDP is defined as the sum of personal consumption expenditures, private non-residential investment, private residential investment, and government consumption expenditures and gross investment.

Table 2: CALIBRATED PARAMETERS

Description		Value	Previous Study or Steady-State Target
Wage share, pt. household	α	0.65	Other data,[a] Iacoviello (2005), Iacoviello and Neri (2010)
Time discount factor, pt. household	β	0.9964	Sample data[b]
Time discount factor, impt. household	β'	0.97	Iacoviello and Neri (2010), Sterk (2015)
Housing utility weight	ω_H	0.112	Sample data[c]
Labor supply disutility weight	ω_L	5.40	Other data[d]
Relocation disutility weight	ω_R	460.25	Sample data[e]
Refinancing share of staying workers	ρ	0.0125	Chang and Nothaft (2007)[f]
Steady-state loan-to-value limit	ξ	0.90	Iacoviello and Neri (2010)
Depreciation rate, residential capital	δ_H	0.01	Iacoviello and Neri (2010)
Depreciation rate, non-residential capital	δ_K	0.025	Iacoviello and Neri (2010)
Housing transformation elasticity	ν	0.90	Davis and Heathcote (2005), Iacoviello and Neri (2010)

[a] Share of households with loan-to-value ratios below 80 pct. (68 pct.) during 1987-2015, according to the Monthly Interest Rate Survey of the U.S. Federal Housing Finance Agency.
[b] Quartered real effective federal funds rate (0.37 pct.) during 1987-2015.
[c] Ratio of residential investment to the sum of consumption and non-residential and residential investments (5.2 pct.) during 1987-2015.
[d] Civilian labor force participation rate (66 pct.) during 1987-2015, according to the U.S. Bureau of Labor Statistics.
[e] Geographical mobility rate of homeowners (1.8 pct.) during 2000-2005.
[f] Chang and Nothaft (2007) report the average refinance share of conventional prime mortgage originations (i.e., relating to staying homeowners) to be 50 pct. during 1990-2005. The refinance share of mortgage loans in the model is: $\frac{(1-m_t')\kappa}{m_t'}$.

9. Log employment-population ratio. 10. Unemployment rate. 11. Geographical mobility rate by tenure of owners.[13] The initial date of the sample is restricted by the data on the geographical mobility rate, which is not available before 1987. Sterk (2015) also compares the performance of his model to this series.

All volume series and the real house prices (i.e., series 1.-5.) are normalized relative to 1987Q1, then log-transformed, and then detrended by series-specific linear trends. The federal funds rate, price and wage inflation, log employment-population ratio, unemployment rate, and geographical mobility rate series have been demeaned. Detailed names of the series and data sources are reported in the Online Appendix.

4.2 Calibration and Prior Distribution

Some parameters are difficult for the estimation to identify. These parameters are calibrated using previous studies or steady-state targets. Table 2 reports the calibrated parameters and information on their calibration.

Table 3 reports the prior distributions of the estimated parameters. The geographical mobility elasticity of the wage elasticity has a uniform prior distribution with a broad

[13]The geographical mobility rate by tenure of owners is from the Annual Social and Economic Supplement of the Current Population Survey. It is only available at an annual frequency. I therefore use Denton's (1971) method to quarter the series and to interpolate it to a quarterly frequency, following Liu et al. (2013). The data for, e.g., 1987 covers mobility between April 1987 and March 1988. Data is missing for 1994, which necessitates me to interpolate 1994 by an arithmetic average of 1993 and 1995.

Table 3: Prior Distribution and Posterior Distributions

	Prior Distribution			Posterior Distributions							
				Baseline Estimation				Restricted Estimation ($\kappa = 0$)			
	Type	Mean	SD	Mode	Mean	5 pct.	95 pct.	Mode	Mean	5 pct.	95 pct.
Structural Parameters											
η	B	0.50	0.10	0.40	0.40	0.33	0.47	0.40	0.40	0.33	0.47
φ	N	3.69	0.50	4.01	4.17	3.41	4.94	3.95	4.09	3.34	4.87
ψ	N	1.00	0.10	1.57	1.54	1.46	1.64	1.61	1.56	1.48	1.64
ζ	B	0.50	0.10	0.62	0.62	0.51	0.74	0.62	0.62	0.51	0.74
ι	G	10.0	2.50	23.1	23.4	18.1	28.5	23.1	23.4	18.2	28.6
ϵ_P	N	5.00	0.25	5.12	5.13	4.73	5.53	5.12	5.13	4.73	5.53
ϵ_W	N	5.00	0.25	4.80	4.85	4.42	5.27	4.79	4.81	4.39	5.25
κ	U	0.00	5.77	1.78	1.88	0.29	3.63	–	–	–	–
γ_P	B	0.50	0.10	0.19	0.21	0.12	0.31	0.19	0.21	0.12	0.30
θ_P	B	0.66	0.05	0.71	0.72	0.66	0.78	0.72	0.72	0.66	0.78
γ_W	B	0.50	0.10	0.27	0.28	0.18	0.39	0.26	0.27	0.17	0.38
θ_W	B	0.66	0.05	0.63	0.67	0.60	0.74	0.64	0.67	0.59	0.75
μ	B	0.33	0.05	0.28	0.29	0.23	0.35	0.28	0.29	0.22	0.35
τ_R	B	0.75	0.10	0.75	0.75	0.70	0.80	0.75	0.75	0.70	0.80
τ_π	N	1.50	0.20	1.73	1.76	1.54	1.98	1.70	1.76	1.54	1.99
$\tau_{\Delta Y}$	G	0.50	0.20	0.77	0.80	0.65	0.95	0.76	0.80	0.65	0.95
Deterministic Structure of Shock Processes											
IP_{AR}	B	0.50	0.20	0.94	0.93	0.91	0.96	0.94	0.93	0.91	0.96
HP_{AR}	B	0.50	0.20	0.97	0.97	0.95	0.98	0.97	0.97	0.95	0.98
CC_{AR}	B	0.50	0.20	0.88	0.87	0.82	0.92	0.84	0.84	0.79	0.90
GS_{AR}	B	0.50	0.20	0.99	0.99	0.98	0.99	0.99	0.99	0.98	0.99
AY_{AR}	B	0.50	0.20	0.96	0.95	0.92	0.98	0.96	0.95	0.92	0.98
AK_{AR}	B	0.50	0.20	0.93	0.93	0.90	0.96	0.93	0.93	0.90	0.96
PM_{AR}	B	0.50	0.20	0.88	0.87	0.79	0.95	0.87	0.86	0.77	0.94
LP_{AR}	B	0.50	0.20	0.99	0.99	0.98	1.00	0.99	0.99	0.98	1.00
RP_{AR}	B	0.50	0.20	0.95	0.94	0.90	0.98	0.96	0.95	0.92	0.98
RP_{MA}	N	0.00	0.20	−0.44	−0.40	−0.56	−0.24	−0.34	−0.32	−0.47	−0.17
WM_{AR}	B	0.50	0.20	0.90	0.84	0.72	0.96	0.91	0.86	0.77	0.96
Standard Deviations of Innovations											
IP	IG	0.001	0.01	0.015	0.016	0.012	0.019	0.015	0.015	0.012	0.018
HP	IG	0.001	0.01	0.080	0.084	0.063	0.104	0.081	0.086	0.065	0.107
CC	IG	0.001	0.01	0.162	0.165	0.147	0.183	0.165	0.166	0.148	0.184
MP	IG	0.001	0.01	0.002	0.002	0.001	0.002	0.002	0.002	0.001	0.002
GS	IG	0.001	0.01	0.011	0.012	0.008	0.016	0.010	0.012	0.008	0.016
AY	IG	0.001	0.01	0.007	0.007	0.006	0.008	0.007	0.007	0.006	0.008
AK	IG	0.001	0.01	0.014	0.015	0.012	0.018	0.014	0.015	0.012	0.018
PM	IG	0.001	0.01	0.010	0.011	0.008	0.015	0.011	0.012	0.008	0.016
LP	IG	0.001	0.01	0.013	0.014	0.011	0.016	0.013	0.013	0.011	0.016
RP	IG	0.001	0.01	0.092	0.095	0.084	0.105	0.093	0.094	0.084	0.104
WM	IG	0.001	0.01	0.061	0.095	0.043	0.153	0.059	0.089	0.036	0.151

Abbreviations: U: Uniform. N: Normal. B: Beta. G: Gamma. IG: Inverse-Gamma.

Note: The model is solved and estimated in `Dynare 4.4.3` executed in `MATLAB R2016b`. Four parallel Markov chains are generated. Each Markov chain contains 250,000 realizations with the 125,000 initial realizations being discarded. The variance scale factor of the jumping distribution is set to 0.3. The resulting acceptance rates are 28.8, 29.0, 28.4, and 29.0 pct. in the baseline estimation and 30.5, 30.3, 29.9, and 30.6 pct. in the restricted estimation.

positive and negative support ($\kappa \in [-10, 10]$ with an implied standard deviation of 5.77). I choose a noninformative prior for this parameter (even though Bhaskar et al. (2002)

suggest $\kappa > 0$) since an objective of the estimation is to empirically identify the sign and magnitude of the effect of mobility on wages. The elasticity of marginal disutility of relocating has a normal prior distribution with mean $\psi = 1$. This is a common prior mean for parameters that govern the curvature on disutility (see, e.g., Christiano et al. (2014)).

The prior means of the price elasticity of goods demand and steady-state wage elasticity of labor demand ($\epsilon_P = \epsilon_W = 5$) imply that prices and wages are marked up by 25 pct. over the marginal costs and marginal rates of substitution in steady-state, following Galí et al. (2012). The prior mean of the elasticity of the marginal disutility of labor supply is set to a value consistent with the prior steady-state wage markup and the average unemployment rate over the sample (6.04 pct.): $\varphi = \frac{\log 1.25}{0.0604} \simeq 3.69$.

The prior means of the remaining estimated parameters are identical to the calibrated or prior mean values of the corresponding parameters in Iacoviello and Neri (2010). I will therefore not comment further on them.

4.3 Posterior Distribution

Two posterior distributions of the model are reported in Table 3: One from a baseline estimation and one from a restricted estimation where the mobility-wage channel is inactive ($\kappa = 0$). I will be able to assess the implications of the channel clearly by comparing the two posterior distributions.

The geographical mobility elasticity of the wage elasticity ($\kappa = 1.88$) is significantly positive. Thus, higher geographical mobility among workers eases the spatial labor substitutability of the intermediate firm, and equivalently increases its area- and profession-specific wage elasticity. The firm reduces its labor demand from high-wage areas, and increases its labor demand from low-wage areas. This reduces the geographical wage dispersion. The cross-area competition of workers for jobs is intensified, which weakens the workers' local market power. This relieves the distortions brought about by the workers' monopolistic competition, and brings the economy closer to its Pareto efficient allocation. The workers target lower wage markups, which through the Phillips curve causes nominal and real wages to decline. As discussed in Section 2, these effects of higher labor migration are similar to the effects in Topel (1986), Bhaskar et al. (2002), Blanchard and Katz (1992), and Beaudry et al. (2014). The effects also explain the countercyclicality of wage markups that Karabarbounis (2014) finds (see Footnote 2).

The standard deviation of the collateral constraint shocks is high (16.5 pct.). This is not surprising considering that the *refinancing* collateral constraint only restricts the loan-to-value ratio of the newly originated share of total debt. In comparison, a regular collateral constraint restricts the loan-to-value ratio of all debt. Since only a small share of the total debt is affected by the shocks, the shocks must be much larger in order to make the theoretical debt match the fluctuations in its empirical counterpart.

The remaining posterior distributions are broadly in line with the existing literature (compare with the prior distributions). I will therefore not comment further on them.

4.4 Model Fit

I perform an additional estimation of the model where I exclude the geographical mobility rate from the sample. This estimation allows me to examine the ability of the model to predict the mobility rate. Table 4 and Figure 1 compare the resulting theoretical mobility rate to its empirical counterpart.

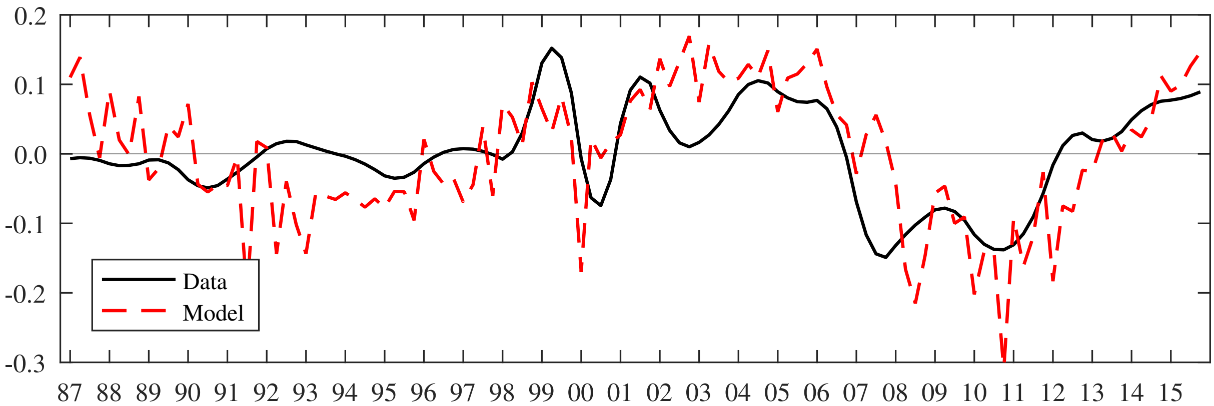
Table 4: Business Cycle Statistics of the Geographical Mobility Rate

	Data	Model
Standard deviation	0.067	0.096
Correlation with data	1.00	0.64
Correlation with data (1995-2015)	1.00	0.71
Correlation with real house price growth rate	0.70	0.60
Correlation with unemployment rate	-0.36	-0.51

Note: The geographical mobility and unemployment rates have been log-transformed. All variables have then been Hodrick–Prescott filtered with a smoothing parameter equal to 10^5. These transformations when assessing model fit follow Shimer (2005) and Sterk (2015).

The model reasonably precisely predicts the cyclical movements of the geographical mobility rate. The correlation between the empirical and theoretical sequences is 64 pct. Furthermore, the theoretical cross-variable correlations of the mobility rate, which motivate the paper in Section 1, are similar to their empirical counterparts. Thus, real house price growth and mobility have a positive correlation (70 pct. vs. 60 pct.), and unemployment and mobility have a negative correlation (−36 pct. vs. −51 pct.) in the data and the model. Lastly, the cyclical volatilities of the empirical and theoretical mobility rates are similar (0.067 vs. 0.096).

Figure 1: Business Cycle Sequences of the Geographical Mobility Rate



Note: The second axis measures deviations from the Hodrick–Prescott trends in percent, following the note to Table 4.

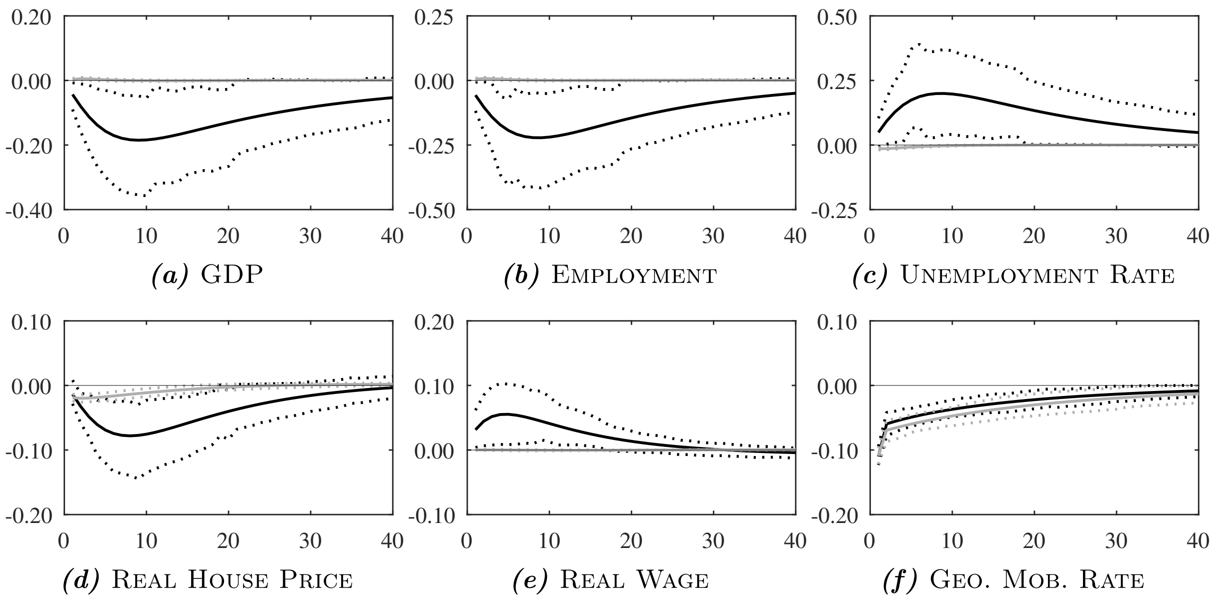
The reasonably precise fit of the model is not surprising. Molloy et al. (2011) find that homeownership status, employment status, education, and age are the four most important determinants of mobility rates across population groups. The predictions of the model are compared to the mobility rate of homeowners (consistent with the model assumptions), and the education and age distributions in the U.S. population are likely to be roughly time-constant during 1987-2015. This leaves employment status as the only important time-varying determinant of mobility. Hence, if the model accurately captures the employment-related mobility decisions of homeowners, it should accurately capture the overall mobility decisions of homeowners.

5 Model Dynamics

I now use the estimated models to assess the implications of the mobility-wage channel. I first discuss how the channel affects the propagation of shocks. I then decompose the volatility in geographical mobility. I lastly analyze the effects of housing market shocks (i.e., housing preference and collateral constraint shocks) around the Great Recession, in light of the mobility-wage channel.

5.1 Relocation Preference and Housing Market Shocks

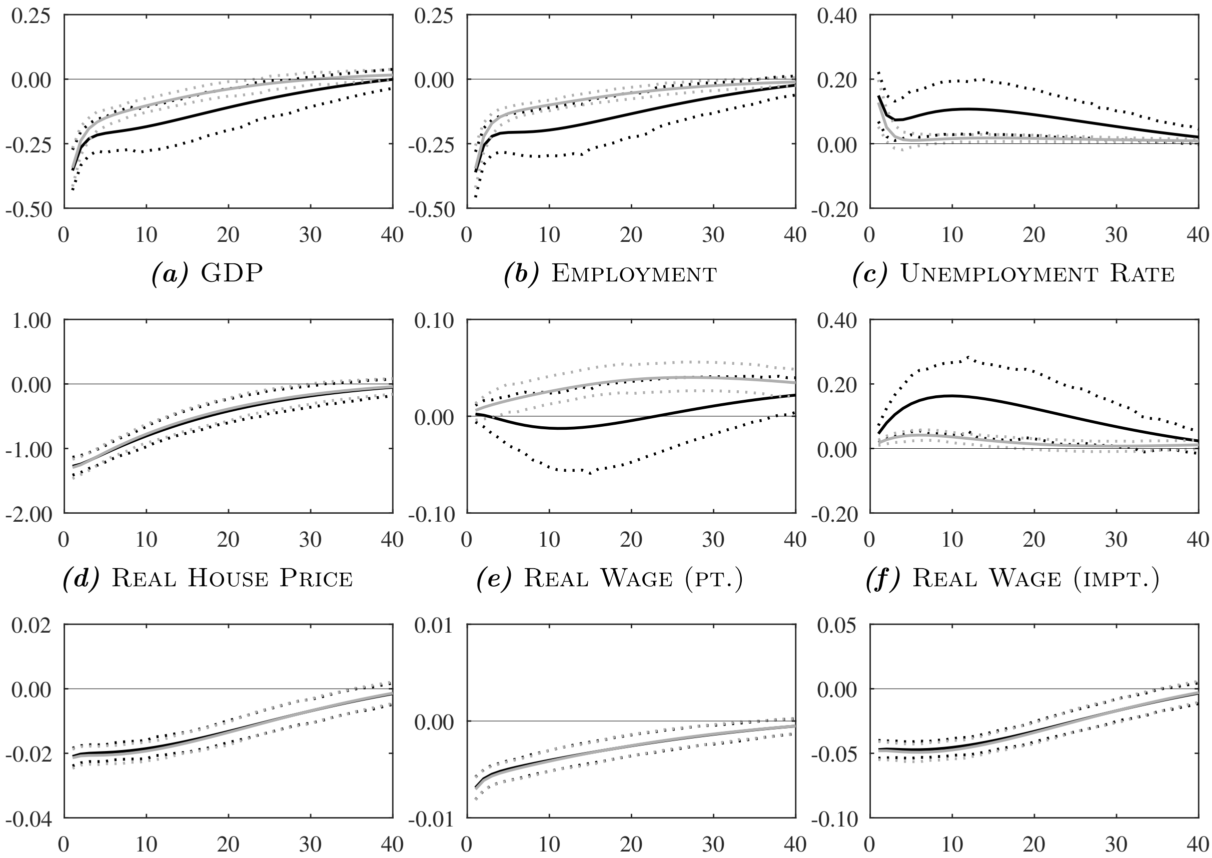
Figure 2: A Positive Relocation Preference Shock



Note: The figures plot the 5 pct. bound, mean, and 95 pct. bound of the impulse responses of the posterior distribution from the baseline (black curves) and restricted (grey curves) estimations, following an unit standard deviation shock. Second axes measure deviations from the steady-state in percent (Figures 2a-2b and 2d-2e) or percentage points (Figures 2c and 2f).

Figures 2-4 plot the impulse responses of the relocation preference, housing preference, and collateral constraint shocks, respectively, from the baseline and restricted estimations. A positive relocation preference shock increases the marginal disutility of relocating. Workers in both households who anticipate unemployment become less willing to accept long-distance job offers. Thus, the geographical mobility declines. If the mobility-wage channel is active, the intermediate firm is less able to substitute workers from high-wage areas with workers from low-wage areas. The associated smaller wage elasticity causes the workers to target higher wage markups. Nominal and real wages consequently increase. The intermediate firm reduces its labor demand, and the economy goes into a contraction. If the mobility wage-channel is inactive, the relocation preference shock does not have any significant effects on growth and (un)employment.

Figure 3: A Negative Housing Preference Shock



(a) GDP *(b)* Employment *(c)* Unemployment Rate

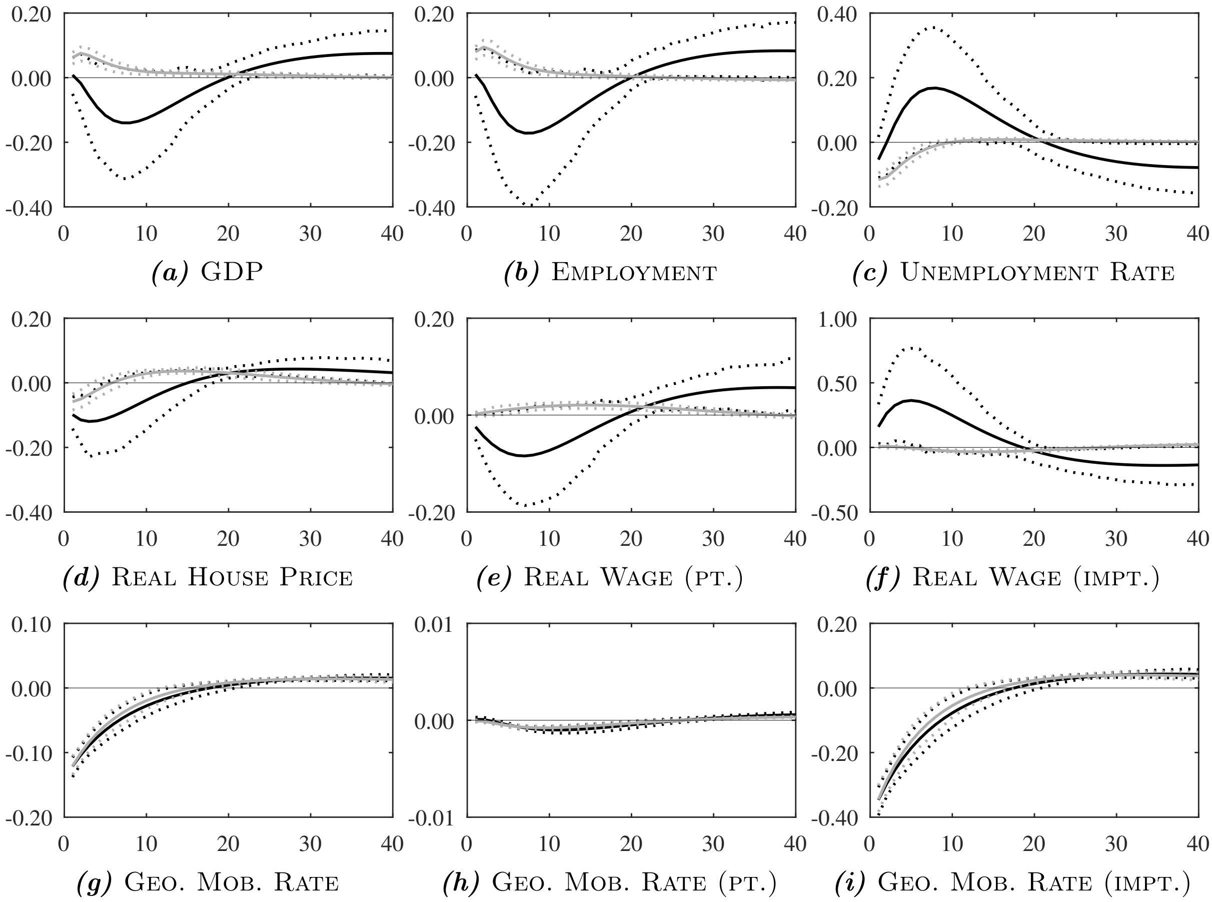
(d) Real House Price *(e)* Real Wage (pt.) *(f)* Real Wage (impt.)

(g) Geo. Mob. Rate *(h)* Geo. Mob. Rate (pt.) *(i)* Geo. Mob. Rate (impt.)

Note: The figures plot the 5 pct. bound, mean, and 95 pct. bound of the impulse responses of the posterior distribution from the baseline (black curves) and restricted (grey curves) estimations, following an unit standard deviation shock. Second axes measure deviations from the steady-state in percent (Figures 3a-3b and 3d-3f) or percentage points (Figures 3c and 3g-3i).

A negative housing preference shock lowers the marginal utility of housing. Both households decrease their housing demand, thereby causing a house price slump. Employment falls and unemployment rises because of low demand for intermediate housing inputs. The impatient household is rendered technically insolvent, which makes those impatient workers who anticipate unemployment less willing to accept long-distance job offers. If the mobility-wage channel is active, analogously to the relocation preference shock, the

Figure 4: A Negative Collateral Constraint Shock



Note: The figures plot the 5 pct. bound, mean, and 95 pct. bound of the impulse responses of the posterior distribution from the baseline (black curves) and restricted (grey curves) estimations, following an unit standard deviation shock. Second axes measure deviations from the steady-state in percent (Figures 4a-4b and 4d-4f) or percentage points (Figures 4c and 4g-4i).

decline in the impatient household's geographical mobility causes the impatient workers to target higher wage markups. The resulting higher impatient real wages amplify the drop in employment in both households because of the complementarity in Cobb-Douglas labor inputs. Likewise, the drop in GDP and increase in unemployment are amplified.

A negative collateral constraint shock lowers the loan-to-value limit. The geographical mobility of workers who anticipate unemployment declines for two reasons. Firstly, for a given level of housing wealth, relocating impatient workers may not leverage themselves to the same extent as previously. Secondly, house prices decline since homes are less able to act as collateral, which causes refinancing impatient homeowners to demand less housing. Because of both mechanisms, the impatient workers who anticipate unemployment are not able to refinance, which makes them less willing to accept long-distance job offers.

If the mobility-wage channel is active, again analogously to the relocation preference shock, the decline in the impatient household's geographical mobility causes the impatient workers to target higher wage markups. The resulting higher impatient real wages cause employment to fall in both households again because of the Cobb-Douglas complementarity. The economy consequently goes into a contraction. If the mobility-wage channel is inactive, the spill-over effects of collateral constraint shocks are very limited. The effects only relate to the repayment of loans. The economy expands slightly since the patient household becomes more liquid, which makes it increase its consumption of goods and housing.

The impulse responses yield important advice to macroprudential policymakers. Macroprudential policy may at first sight not appear to have large adverse effects on growth and employment since the policy only affects the small share of homeowners that are refinancing. However, this conclusion is misguided since it does not consider the spill-over effects on geographical mobility and wage setting. Several academics and policymakers have recently argued to reduce the amplitude of the housing and financial business cycle through an introduction of countercyclical loan-to-value limits.[14] The impulse responses in Figure 4 provide an additional rationale for such policy. Countercyclical loan-to-value limits can – through the mobility-wage channel – reduce the countercyclicality of desired wage markups, which, in consequence, will reduce the real wage rigidity, and make wages more procyclical. This will moderate the cyclical fluctuations in (un)employment since a larger share of the cyclical adjustments at the labor market will be facilitated through adjustments in wages.

5.2 What Drives Geographical Mobility?

Table 5: Variance Decomposition of the Geographical Mobility Rate

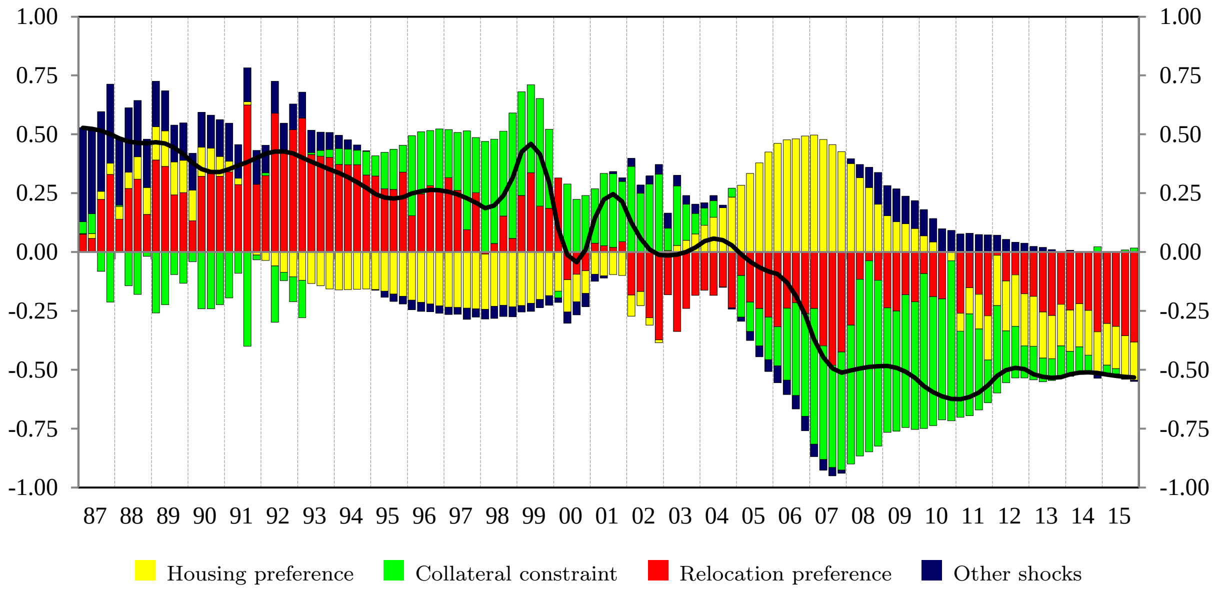
	Aggregate				Patient Household				Impatient Household			
	HP	CC	RP	OT	HP	CC	RP	OT	HP	CC	RP	OT
Q4	3	66	30	1	1	0	94	6	2	90	7	0
Q12	5	60	32	3	1	0	91	7	5	85	9	1
Q24	7	54	35	4	1	0	90	7	8	81	10	1
Q800	8	53	33	6	2	0	86	11	9	78	10	3

Abbreviations: HP: Housing preference. CC: Collateral constraint. RP: Relocation preference. OT: Other.
Note: The table reports the mean conditional variance decomposition from the baseline estimation in percent.

I now decompose the volatility in geographical mobility. The variance decomposition is reported in Table 5. Geographical mobility is driven by different sets of shocks transversely to the types of households. In the patient household, mobility is primarily driven by relocation preference shocks. These shocks affect the trade-off between the disutility of relocating and the utility of consumption made possible by avoiding unemployment via relocating. The impatient household also faces this trade-off, but it is relatively less

[14] The (Basel) Committee on the Global Financial System (2010) and the IMF (2011) recommend to employ loan-to-value limits as countercyclical automatic stabilizers around a fixed cap. Lambertini et al. (2013) demonstrate that a loan-to-value limit which responds countercyclically to credit growth moderates the fluctuations in output. They furthermore show that this is Pareto improving compared to a constant loan-to-value limit.

Figure 5: Historical Shock Decomposition of the Geographical Mobility Rate



Note: The model is calibrated to the mean of the estimated baseline posterior distribution. Each bar indicates the contribution from the respective shock(s) to the geographical mobility rate. Hence, in each quarter, the sum of the four bars is equal to the mobility rate. Second axes measure deviations from the steady-state in percentage points.

crucial for this household. Instead, mobility decisions are here largely driven by collateral constraint shocks and to a small extent also by housing preference shocks. As explained in Subsection 5.1, these shocks affect the availability of mortgage refinancing when relocating. Aggregate geographical mobility is primarily driven by the shocks that drive the impatient household's mobility decisions even though the patient household is the largest household, measured by wage shares. This reflects that the volatility of mobility decisions is highest for the impatient household.

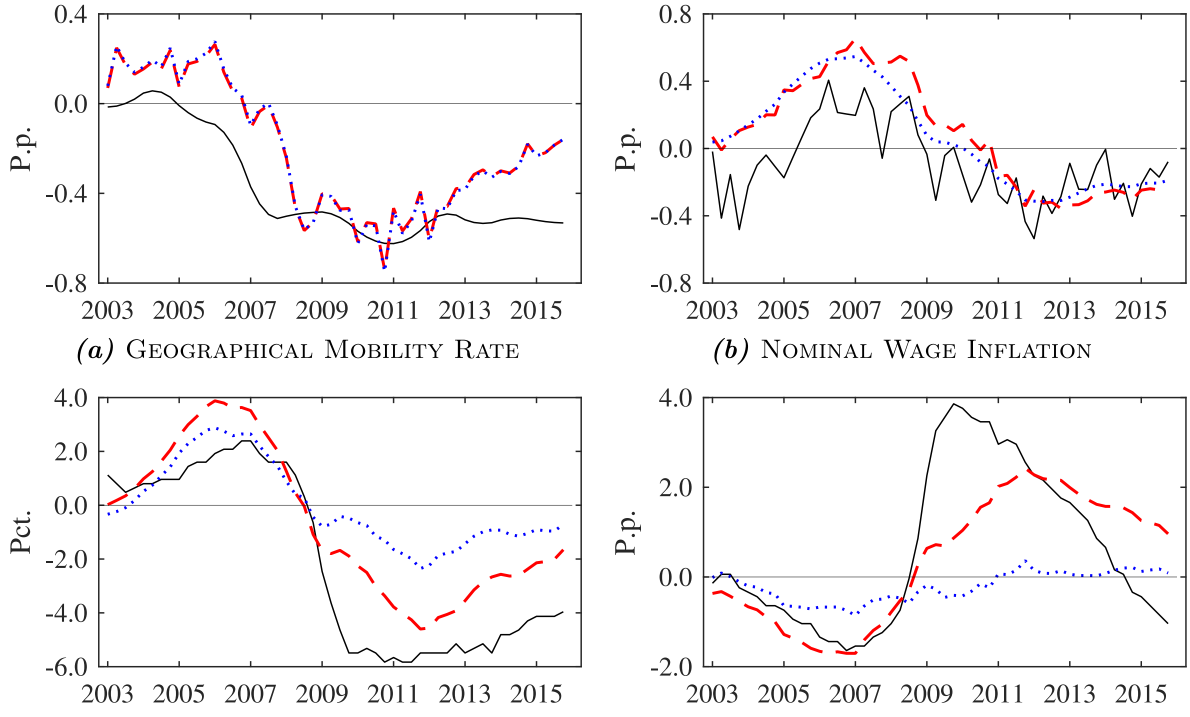
Figure 5 plots the historical shock decomposition of the geographical mobility rate. The annual geographical mobility rate declined by 2.0 p.p. from 1987 to 2002. In quarterly terms, this corresponds to a 0.47 p.p. decline. 83 pct. of the decline (corresponding to 1.7 p.p.) is accounted for by initially negative relocation preference shocks that gradually turned positive. This monotonic decay in the preference of workers for relocating suggests that the decline in mobility has a long-run nature which is unrelated to the cyclical employment motive of the model. The relocation preference shocks have remained stationery since 2002. This suggests that the exogenous long-run decline in mobility ended in the beginning of the 2000's.

The annual geographical mobility rate of homeowners again declined from 2005 to 2010; this time by 2.3 p.p. In quarterly terms, this corresponds to a 0.55 p.p. decline. 39 pct. of the decline was caused by housing preference shocks (corresponding to 0.9 p.p. annually), and 50 pct. was caused by collateral constraint shocks (corresponding to 1.2 p.p. annually). The adverse housing market shocks hindered the mortgage refinancing, which is necessary when relocating, by lowering house prices and loan-to-value limits. The remaining 11 pct. of the decline was caused by government spending, labor augmenting and investment-specific technology, and labor preference shocks (corresponding to 0.2 p.p. annually).

5.3 Housing Market Shocks and the Great Recession

The previous subsection attributed the decline in geographical mobility during the Great Recession to primarily collateral constraint shocks and secondarily housing preference shocks. The present subsection examines how these shocks – via the mobility-wage channel – were propagated through the economy.

Figure 6: Housing Market Shocks and the Great Recession



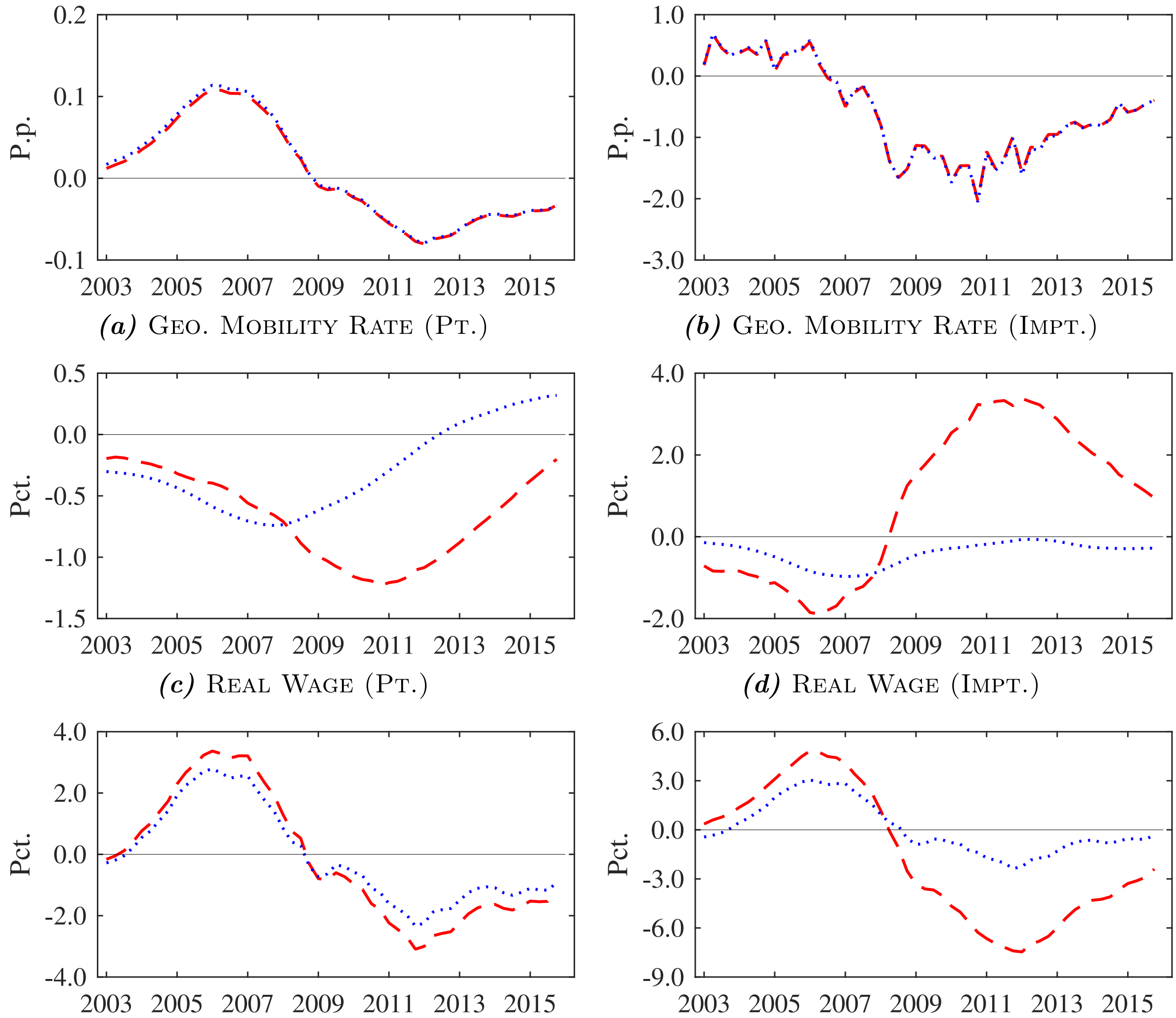
(d) Unemployment Rate

Note: Each figure displays the empirical path (solid black curve) and counterfactual paths based on only housing market shocks from the baseline estimation (dashed red curve) and restricted estimation (dotted blue curve) of the economy. The second axes measure deviations from the steady-state.

Figure 6 plots the counterfactual paths of four central variables around the Great Recession when the economy is driven by housing preference and collateral constraint shocks only. The figure plots the implied paths from the baseline and restricted estimations along with the data. As expected from the historical shock decomposition, the negative housing market shocks explain almost the entire decline in geographical mobility.

Regardless of the mobility-wage channel, the housing preference shocks cause employment to fall and unemployment to rise because of low demand for intermediate housing inputs. This causes wage disinflation through the usual Phillips curve slack mechanism.

Figure 7: Housing Market Shocks and the Great Recession



(a) Geo. Mobility Rate (Pt.)
(b) Geo. Mobility Rate (Impt.)
(c) Real Wage (Pt.)
(d) Real Wage (Impt.)
(e) Employment (Pt.)
(f) Employment (Impt.)

Note: Each figure displays the counterfactual paths based on only housing market shocks from the baseline estimation (dashed red curve) and restricted estimation (dotted blue curve) of the economy. The second axes measure deviations from the steady-state.

The magnitude of the wage disinflation depends on the mobility-wage channel. This is evident from Figure 7, which plots the household-level paths of the geographical mobility rate, real wage, and employment. The decline in mobility is most pronounced in the impatient household since only this household is directly affected by the impeded refinancing. It is consequently only in the impatient household that the decline in mobility so pronounced that real wages increase (rather than fall because of the high unemployment rate). This amplifies the economic contraction considerably in this household.

The mobility-amplified increase in real wages and decline in employment in the impatient household are propagated onto the patient household because of the complementarity in Cobb-Douglas labor inputs. The mobility-wage channel thus also amplifies the decline in employment and increase in unemployment in the patient household.

Employment dropped by 7.7 pct., and the unemployment rate rose by 4.4 p.p. historically from 2006 to 2011. Without the mobility-wage channel, the housing market shocks only explain a 4.5 pct. decline in employment and a 0.8 p.p. increase in unemployment. With the mobility-wage channel, the housing market shocks explain a 7.6 pct. decline in employment and a 3.9 p.p. increase in unemployment. Thus, the estimation ascribes a considerably larger part to housing market shocks in explaining the Great Recession if the mobility-wage channel is active during the estimation.[15] Without the mobility-wage channel, housing market shocks cannot explain the recession since the real wage in the impatient household becomes too low, leaving labor demand to be too high.

The prevalence of large positive wage markups during and after the Great Recession has previously been noted by Karabarbounis (2014) using a different identification strategy. He finds that the cyclical component of the average wage markup increased by approx. 14 pct. during 2007-2010.

6 Relocation Subsidies: Keeping Mobility Constant

I conduct a counterfactual policy simulation in which a fiscal authority offers relocation subsidies to the workers in each household who anticipate unemployment during the Great Recession. The simulation has two purposes. First, it quantifies the macroeconomic consequences of the decline in geographical mobility during the recession. Second, it demonstrates the potential of subsidies for eliminating the countercyclicality of desired wage markups completely by keeping mobility constant.

The relocation subsidies are measured in percent of steady-state wage income earned by relocating workers. The subsidies are financed by simultaneous household-specific lump-sum taxation in order to avoid any income effects. Household wage incomes (compare with (3)) are now:

$$(1 - u_{a,t})w_t l_t + u_{a,t} m_{u,t} w_t l_t + sub_t u_{a,t} m_{u,t} wn - tax_t \tag{24}$$

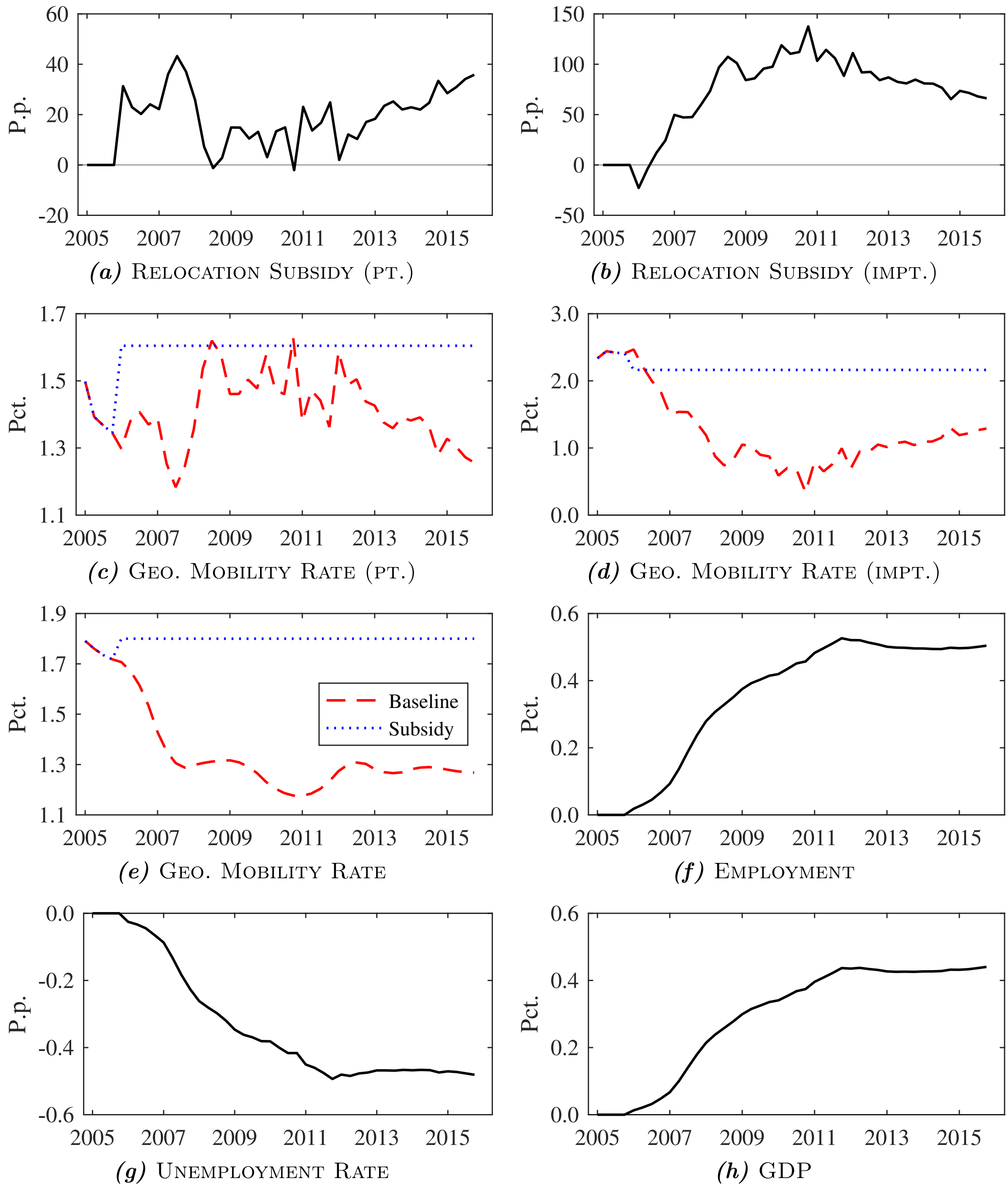
$$(1 - u'_{a,t})w'_t l'_t + u'_{a,t} m'_{u,t} w'_t l'_t + sub'_t u'_{a,t} m'_{u,t} w'n' - tax'_t, \tag{25}$$

where sub_t and sub'_t denote the subsidies, wn and $w'n'$ denote steady-state wage incomes, and $tax_t = sub_t u_{a,t} m_{u,t} wn$ and $tax'_t = sub'_t u'_{a,t} m'_{u,t} w'n'$ denote subsidy-related taxation. I apply the estimated historical shock innovations from the baseline estimation to the model. I then calibrate the subsidies during 2006-2015 so that the household-specific geographical mobility rates are constant at their steady-state levels (1.61 pct. and 2.16 pct. per quarter, respectively).

Figure 8 displays the effects of the subsidies. The sizes of the subsidies are 44 pct. of steady-state wage income for the patient household and 102 pct. for the impatient

[15] The small lag in the explanatory power of the housing market shocks in Figures 6c-6d results from a delayed effect of higher desired wage markups on nominal wages due to nominal wage rigidities.

Figure 8: Effects of Counterfactual Relocation Subsidies



Note: The model is calibrated to the mean of the estimated baseline posterior distribution. In Figures 8a-8b and 8f-8h, the curves depict the differences between the baseline (i.e., no subsidies) and subsidy sequences. In Figures 8c-8e, the curves depict the baseline and subsidy sequences.

household, both on average during 2008-2011. The large value for the impatient household is realistic considering that its relocating workers need to be compensated for a large (28 pct.) decline in real house prices. With these sizes, the aggregate cost of the subsidies would have been approx. \$30 billions per quarter.[16]

[16] The aggregate cost estimate is based on the average annual nominal GDP during 2008-2011 (\$14,905 billions), the labor share of total factor income (0.66 pct.), the household wage shares (0.65 pct. and 0.35

The relocation subsidies increase the quarterly geographical mobility rates by 0.1 p.p. in the patient household and 1.4 p.p. in the impatient household, both on average during 2008-2011. The subsidies primarily affect the impatient household directly since only this household is directly affected by the impeded refinancing during the recession. Since mobility no longer declines, the cross-area competition of workers for jobs is more intense, which causes them to target smaller wage markups. This effect gradually accumulates on the nominal and real wages, causing them to be lower than they were historically during the recession. The intermediate firm in consequence demands more labor. Employment and GDP are 0.5 pct. and 0.4 pct. higher, and the unemployment rate is 0.5 p.p. lower, all on average during 2010-2013.

The simulation speaks clearly to the adverse consequences of procyclical labor mobility. Unemployment would have been approx. 770,000 persons lower if mobility had been constant through the Great Recession.[17] Thus, stabilization of fluctuating mobility rates – either through countercyclical loan-to-value limits or a relocation subsidy – would be welfare improving.

7 Concluding Remarks

The link between geographical mobility and wage setting, which is proposed in this paper, has so far been unexplored in the business cycle literature. The paper offers an analysis of the link. The estimation demonstrates that declining mobility – through a reduction in the cross-area competition of workers for jobs – imposes real wage rigidities that amplify contractions. Policymakers should have this in mind when they implement structural and stabilization policies that influence labor mobility.

The paper also contributes to an understanding of the decline in the geographical mobility of homeowners since 1987. The estimation demonstrates that the gradual decline prior to 2002 is best understood as a long-run phenomenon. The estimation furthermore demonstrates that the more rapid decline from 2005 to 2010 can be explained by a mortgage lock-in due to adverse housing demand and credit shocks.

Two directions of further research appear from the analysis. The model assumes that the refinancing share of staying homeowners is exogenous. In reality, the refinancing share is cyclical, depending on the prevailing interest rates, home equity, and loan-to-value limits. Thus, an endogenous refinancing share can amplify the effects of higher collateral values and abate the effects of lower collateral values. One direction of further research is to embed such endogeneity into macroeconomic models. Another direction of further research is to combine search unemployment under spatial matching (as in Sterk (2015)) and the

pct.), and the geographical mobility rates in the simulation (1.61 pct. and 2.16 pct. per quarter).

[17] The average size of the civilian labor force was 154.5 million persons during 2010-2013, according to the U.S. Bureau of Labor Statistics (source code: LNS11000000).

mobility-wage channel. In a resulting framework, the macroeconomic consequences of fluctuating mobility rates can potentially be much larger if the effects of spatial matching and mobility-dependent wage setting amplify each other.

References

An, S. and F. Schorfheide (2007). Bayesian Analysis of DSGE Models. *Econometric Reviews 26*(2-4), 113–172.

Beaudry, P., D. A. Green, and B. M. Sand (2014). Spatial equilibrium with unemployment and wage bargaining: Theory and estimation. *Journal of Urban Economics 79*(C), 2–19.

Bhaskar, V., A. Manning, and T. To (2002, Spring). Oligopsony and Monopsonistic Competition in Labor Markets. *Journal of Economic Perspectives 16*(2), 155–174.

Blanchard, O. J. and L. F. Katz (1992). Regional Evolutions. *Brookings Papers on Economic Activity 23*(1), 1–75.

Brown, J. and D. A. Matsa (2016, December). Locked in by Leverage: Job Search during the Housing Crisis. NBER Working Papers 22929, National Bureau of Economic Research.

Calvo, G. A. (1983, September). Staggered Prices in a Utility-Maximizing Framework. *Journal of Monetary Economics 12*(3), 383–398.

Chan, S. (2001, May). Spatial Lock-in: Do Falling House Prices Constrain Residential Mobility? *Journal of Urban Economics 49*(3), 567–586.

Chang, Y. and F. E. Nothaft (2007). De-Mystifying the Refi-Share Mystery. *Journal of Real Estate Research 29*(4), 511–545.

Christiano, L. J., R. Motto, and M. Rostagno (2014, January). Risk Shocks. *American Economic Review 104*(1), 27–65.

Committee on the Global Financial System (2010, May). *Macroprudential instruments and frameworks: a stocktaking of issues and experiences*. Number 38 in CGFS Papers. Bank for International Settlements.

Davis, M. A. and J. Heathcote (2005, August). Housing and the Business Cycle. *International Economic Review 46*(3), 751–784.

Demyanyk, Y., D. Hryshko, M. J. Luengo-Prado, and B. E. Sørensen (2017, April). Moving to a Job: The Role of Home Equity, Debt, and Access to Credit. *American Economic Journal: Macroeconomics 9*(2), 149–181.

Denton, F. T. (1971, March). Adjustment of Monthly or Quarterly Series to Annual Totals: An Approach Based on Quadratic Minimization. *Journal of the American Statistical Association 66*(333), 99–102.

Dixit, A. K. and J. E. Stiglitz (1977, June). Monopolistic Competition and Optimum Product Diversity. *American Economic Review 67*(3), 297–308.

Erceg, C. J., D. W. Henderson, and A. T. Levin (2000, October). Optimal Monetary Policy with Staggered Wage and Price Contracts. *Journal of Monetary Economics 46*(2), 281–313.

Farber, H. S. (2012, May). Unemployment in the Great Recession: Did the Housing Market Crisis Prevent the Unemployed from Moving to Take Jobs? *American Economic Review: Papers & Proceedings 102*(3), 520–525.

Ferreira, F., J. Gyourko, and J. Tracy (2010, July). Housing busts and household mobility. *Journal of Urban Economics 68*(1), 34–45.

Ferreira, F., J. Gyourko, and J. Tracy (2012). Housing Busts and Household Mobility: An Update. *Economic Policy Review* (November), 1–15.

Galí, J., F. Smets, and R. Wouters (2012). Unemployment in an Estimated New Keynesian Model. *NBER Macroeconomics Annual 2011 26*, 329–360.

Galí, J. (2011, June). The Return of the Wage Phillips Curve. *Journal of the European Economic Association 9*(3), 436–461.

Goetz, C. F. (2013, August). Falling House Prices and Labor Mobility: Evidence from Matched Employer-Employee Data. Working Papers 13-43, Center for Economic Studies, U.S. Census Bureau.

Hall, R. E. (2013). The Routes Into and Out of the Zero Lower Bound. *Proceedings – Economic Policy Symposium – Jackson Hole*.

Henley, A. (1998, March). Residential Mobility, Housing Equity and the Labour Market. *Economic Journal 108*(447), 414–27.

Iacoviello, M. (2005, June). House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle. *American Economic Review 95*(3), 739–764.

Iacoviello, M. and S. Neri (2010, April). Housing Market Spillovers: Evidence from an Estimated DSGE Model. *American Economic Journal: Macroeconomics 2*(2), 125–64.

IMF (2011, March). *Macroprudential Policy: An Organizing Framework.* International Monetary Fund (IMF).

Karabarbounis, L. (2014, April). The labor wedge: MRS vs. MPN. *Review of Economic Dynamics 17*(2), 206–223.

Kiyotaki, N. and J. Moore (1997, April). Credit Cycles. *Journal of Political Economy 105*(2), 211–48.

Lambertini, L., C. Mendicino, and M. Teresa Punzi (2013). Leaning against boom–bust cycles in credit and housing prices. *Journal of Economic Dynamics and Control 37*(8), 1500–1522.

Liu, Z., J. Miao, and T. Zha (2016, June). Land prices and unemployment. *Journal of Monetary Economics 80*, 86–105.

Liu, Z., P. Wang, and T. Zha (2013, May). Land-Price Dynamics and Macroeconomic Fluctuations. *Econometrica 81*(3), 1147–1184.

Molloy, R., C. L. Smith, and A. Wozniak (2011, Summer). Internal Migration in the United States. *Journal of Economic Perspectives 25*(3), 173–96.

Monras, J. (2015, February). Economic Shocks and Internal Migration. IZA Discussion Papers 8840, Institute for the Study of Labor (IZA).

Shimer, R. (2005, March). The Cyclical Behavior of Equilibrium Unemployment and Vacancies. *American Economic Review 95*(1), 25–49.

Smets, F. and R. Wouters (2003, September). An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area. *Journal of the European Economic Association 1*(5), 1123–1175.

Smets, F. and R. Wouters (2007, June). Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. *American Economic Review 97*(3), 586–606.

Stein, J. C. (1995, May). Prices and Trading Volume in the Housing Market: A Model with Down-Payment Effects. *The Quarterly Journal of Economics 110*(2), 379–406.

Sterk, V. (2015, September). Home Equity, Mobility, and Macroeconomic Fluctuations. *Journal of Monetary Economics 74*, 16–32.

Topel, R. H. (1986, June). Local Labor Markets. *Journal of Political Economy 94*(3), S111–S143.