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Chapter 5

Demand Dynamics in a Model with Heterogeneous Borrowers and Collateral Constraints

Abstract

What are the costs of abstracting from borrower heterogeneity in a business cycle model with frictions in household finance? I study the behavior of aggregate demand for housing and mortgage loans in a partial equilibrium model with heterogeneous borrowers who move infrequently. Mortgage debt is limited by a collateral requirement that is renewed only when the agent moves. A key prediction of the model is that transitions in aggregate demand for housing and mortgage debt occur very gradually. I then investigate how closely these predictions are matched by two alternative models that make the more convenient but less realistic assumption of a representative borrower. The first alternative model features a standard borrowing constraint that implies a full renewal of the collateral requirement in every period. This model does not match the sluggish transitions in aggregate housing demand and mortgage debt. The second representative borrower model features a collateral constraint like in Chapter 4, that implies only a partial renewal of the borrowing limit in a given period. With this constraint, the representative borrower model does generate gradual transitions in aggregate debt, as observed in the heterogeneous agent model. However, the constraint is less helpful in reducing the excess sensitivity of aggregate housing demand. Price effects that would be obtained in a general equilibrium model seem much more important in reducing this sensitivity.

5.1 Introduction

There exists a vast literature that incorporates frictions in firm finance into business cycle models. Famous examples include Bernanke, Gertler, and Gilchrist (1999) and

Kiyotaki and Moore (1997). Fewer authors have paid attention to frictions in household finance, but it has been argued that such frictions deserve much greater emphasis (den Haan, Sumner, and Yamashiro (2007) and Mian and Sufi (2010)). The literature that does analyze the role of household finance in the business cycle usually follows Iacoviello (2005). He considers a model with a representative borrower and a representative saver. Debt is restricted by a collateral constraint that is assumed to be always binding and to be renewed in each period. Chapters 2 and 4 in this thesis also follow this setup, which has the great benefit of simplicity. In particular, the model can be solved using standard perturbation methods and with representative households it is easy to characterize the wealth distribution.

It has been observed that in some key aspects, economic aggregates behave similarly in heterogeneous agent models and representative agent models (Krusell and Smith (1998)). Moreover, the setup of Iacoviello (2005) may be viewed as less restrictive than standard models in the sense that with savers and borrowers there is some degree of wealth heterogeneity among households. Thus, one may be inclined to believe that if the representative agent assumption is innocuous in standard models, then this will certainly be the case in saver-borrower models.

However, there are two factors that may limit the degree to which the model with a representative saver and borrower provides a close approximation to a more realistic model without any representative household assumption. First, in the presence of uninsurable idiosyncratic shocks, the collateral constraint is less likely to be always binding. Second, in the underlying heterogeneous agent economy, households do not refinance their loans in every period. This has direct implications for the evolution of aggregate debt, since a reduction in the borrowing limit caused by a fall in house prices only directly affects those agents who refinance their loans in the current period. The ones who do not refinance are able to sustain their previous level of borrowing, regardless of changes in the value of their house. But in the standard saver-borrower model, the representative agent is subject to a fully renewed collateral constraint in each period. Thus, one can expect aggregate debt

to be much more elastic with respect to house prices changes in the standard model than in the heterogeneous agent economy.

Chapter 4 proposes an alternative borrowing constraint that requires mortgage debt to be refinanced only partially in a given period. In particular, the rate at which mortgage loans are refinanced equals the mobility rate. With this specification of the borrowing constraint, the model can be expected to imply a much more sluggish law of motion for aggregate debt than with a standard collateral constraint. However, the setup in Chapter 4 preserves the representative borrower assumption, which is very attractive for computational reasons.

This chapter presents a model with heterogeneous borrowers who face uninsurable income shocks and who move infrequently. Moreover, they only adjust levels of debt and housing in the event of moving and I allow the borrowing constraint to be non-binding. Taking this model as the truth, I then investigate the extent to which its predictions are matched by the aforementioned models with a representative borrower. I analyze the long-run properties of the models as well as transitions. Given that the heterogeneous borrower model is relatively difficult to solve, I consider partial equilibrium settings.

Section 5.2 describes the models and the results are presented in section 5.3. Section 5.4 links the findings to those in Chapter 4.

5.2 The models

In this section, I first present a heterogeneous borrower model in which borrowers move infrequently, and only refinance their mortgages when they move. Then I discuss a representative borrower model with a collateral constraint that is similar to the one in Chapter 4, which is a generalization of a representative borrower model with a standard collateral constraint.

5.2.1 A model with heterogeneous borrowers

There is a continuum of borrowers who consume non-durables and housing services. The utility flow of borrower i in period t is:

$$U\left(c_{t,i}, h_{t,i}\right) = \ln c_{t,i} + \alpha \ln h_{t,i},$$

where $c_{t,i}$ is the amount of non-durables consumed in period t, $h_{t,i}$ is the stock of housing, and α is a housing preference parameter. Agents can trade in housing and can take on mortgage debt, but the amount of mortgage debt cannot exceed a certain borrowing limit. No other assets than housing and mortgage loans are available. There is no aggregate risk, but borrowers face two types of idiosyncratic risk. First, their labor income is stochastic. Second, in each period borrowers receive idiosyncratic shocks that determine whether they move or not. With probability θ a borrower moves and with probability $1-\theta$ the borrower does not move. So unlike the model in Chapter 4, mobility is an exogenous event that borrowers have no control over.

The mobility status of a borrower affects her choices in two ways. First, only movers can change their housing stock, that is:

$$h_{t,i} = h_{t-1,i} \quad \text{if borrower } i \text{ does not move in } t.$$

Second, movers must refinance their loans and therefore face a renewed borrowing limit. As housing serves as collateral for loans, the borrowing limit in case of moving is a fraction χ of the value of their house. Borrowers who do not move do not refinance their loans and therefore sustain their previous borrowing limits:[1]

$$\begin{aligned} d_{t,i} &\leq \chi p_h h_{t,i} && \text{if borrower } i \text{ moves in period } t, \\ d_{t,i} &\leq d_{t-1,i} && \text{if borrower } i \text{ does not move in period } t, \end{aligned}$$

[1] I abstract from home equity loans.

where p_h is the relative price of housing. The budget constraint is:

$$c_{t,i} + p_h \left(h_{t,i} - h_{t-1,i}\right) + r d_{t-1,i} = y_{t,i} + d_{t,i},$$

where $y_{t,i}$ is labor income and r is a fixed gross interest rate. Labor income is exogenous and follows an autoregressive process of order one in logs:

$$\ln y_{t,i} = \rho \ln y_{t-1,i} + \varepsilon_{t,i}, \qquad \varepsilon_{t,i} \sim N\left(0, \sigma_\varepsilon\right).$$

First-order conditions

The optimization problem of the borrowers involves maximizing the present value of their expected future utility, using a factor β. The value of the agent is:

$$\begin{aligned}
V_{t,i} \quad = \quad & \max_{c_{t,i}, h_{t,i}, d_{t,i}} E_0 \sum_{t=0}^{\infty} \beta^t U\left(c_{t,i}, h_{t,i}\right), \\
& s.t. \\
& c_{t,i} + p_h \left(h_{t,i} - h_{t-1,i}\right) + r d_{t-1,i} = y_{t,i} + d_{t,i}, \\
& d_{t,i} \leq \chi p_h h_{t,i} \quad \text{if } m_t = 1, \\
& d_{t,i} \leq d_{t-1,i} \quad \text{if } m_t = 0, \\
& h_{t,i} = h_{t-1,i} \quad \text{if } m_t = 0, \\
& P\left[m_t = 1\right] = 1 - P\left[m_t = 0\right] = \theta, \\
& \ln y_{t,i} = \rho \ln y_{t-1,i} + \varepsilon_{t,i}, \qquad \varepsilon_{t,i} \sim N\left(0, \sigma_\varepsilon\right),
\end{aligned}$$

where m_t is an indicator variable that is one if the borrower moves in period t and is zero if the borrower does not move in period t. Let $\lambda_{t,i}$ be the Lagrange multiplier on the borrowing constraint, let subscript m denote the choice variables of the mover, and let subscript s denote the variables of households who stay at their current location. The

first-order conditions of the non-mover's optimization problem are:

$$\frac{1}{c_{s,t,i}} = \beta\theta E_t \frac{r}{c_{m,t+1,i}} + \beta(1-\theta) E_t \left(\frac{r}{c_{s,t+1,i}} - \lambda_{s,t+1,i} \right) + \lambda_{s,t,i}, \tag{5.1}$$
$$\lambda_{s,t,i}(d_{t-1,i} - d_{s,t,i}) = 0,$$
$$\lambda_{s,t,i} \geq 0.$$

Equation (5.1) is the non-mover's Euler equation for debt. With probability θ, the borrower will move in the next period and refinance the mortgage loan. With probability $1-\theta$, the borrower will not move in the next period. In that case, the borrower makes interest payments but the borrowing limit on mortgage debt remains unchanged. The equation reduces to a standard Euler equation if the borrowing constraint is not binding, i.e. when $\lambda_{s,t,i}$ equals zero in both the current and the next period.

The first-order conditions for the mover are:

$$\frac{1}{c_{m,i,t}} = \beta\theta E_t \frac{r}{c_{m,i,t+1}} + \beta(1-\theta) E_t \left(\frac{r}{c_{s,i,t+1}} - \lambda_{s,t+1,i} \right) + \lambda_{m,t,i}, \tag{5.2}$$
$$\frac{p_h}{c_{m,t,i}} = \frac{\alpha}{h_{m,t,i}} + \beta\theta E_t \frac{p_h}{c_{m,t+1,i}} + \beta(1-\theta) E_t \frac{\partial V_{s,t+1,i}}{\partial h_{m,t,i}} + \lambda_{m,t,i}\chi p_h, \tag{5.3}$$
$$\lambda_{m,c,t}(\chi p_h h_{m,t,i} - d_{t,i}) = 0,$$
$$\lambda_{m,t,i} \geq 0,$$

Equation (5.2) is the first-order condition for debt and Equation (5.3) is the first-order condition for housing. The term $\frac{\partial V_{s,t,i}}{\partial h_{t-1,i}}$ is the shadow value of housing conditional on not moving. This variable can be expressed recursively as follows:

$$\frac{\partial V_{s,t,i}}{\partial h_{t-1,i}} = \frac{\alpha}{h_{t-1,i}} + \beta\theta E_t \frac{p_h}{c_{m,t+1,i}} + \beta(1-\theta) E_t \frac{\partial V_{s,t+1,i}}{\partial h_{t-1,i}}.$$

Solution method

The policy rules that maximize the value of the agent are functions of four state variables. The state variables are the amount of debt in the previous period, d_{t-1}, the amount of housing in the previous period, h_{t-1}, the current amount of labor income, $y_{t,i}$, and the current mobility status. m_t. Given that the borrowing constraint is potentially non-binding, I do not use standard perturbation methods to solve for the optimal policy rules. Instead, I use a projection method. These methods typically perform well in terms of accuracy and speed of the numerical algorithm (see e.g. Aruoba, Fernandez-Villaverde, and Rubio-Ramirez (2006)).

My approach is to approximate the policy functions on a grid, using linear interpolation to evaluate the functions between the nodes. I approximate the policy functions, conditional on the mobility status, on a grid for each of the remaining state variables, with ten grid points in each dimension. The numerical algorithm iterates on the policy functions and is carried out following five steps:

1. Guess initial values for the policy functions on the grid and specify a convergence criterion.

2. On each grid point, use the policy functions to evaluate the conditional expectations in the first-order conditions of the agent's optimization problem.[2]

3. Given the values of the conditional expectations, use the first-order conditions to solve for the new values of the policy function on each grid point.[3]

[2] To numerically approximate the conditional expectation, I use Gauss-Hermite quadrature with five nodes.

[3] I apply the *time iteration* method and therefore use the policy functions of the previous iteration for nothing else than evaluating the conditional expectations. The new values of the policy functions are then solved for using a non-linear equation solver. The use of the solver is computationally intensive and may be avoided by applying *fixed point iteration*. This method uses the policy functions to evaluate values of both the conditional expectations and certain current-period variables. However, applying the fixed point iteration method makes convergence of the algorithm less likely.

4. Update the values of the policy functions on each grid point. Check if convergence has been reached. If not, go back to step 2.[4]

5. Carry out a Monte Carlo simulation of a panel of agents and check for accuracy in the simulation.[5]

The accuracy test follows Judd (1992) and is based on errors in the Euler equation for debt. At each point in the simulation, I evaluate the left- and the right-hand side of this equation and calculate the difference.

5.2.2 A model with a representative borrower

This subsection discusses a version of the model with a representative borrower. In this model there is no idiosyncratic risk or, alternatively, borrowers are able to insure among each other against the effects of idiosyncratic shocks on consumption. The representative borrower faces the following collateral constraint:

$$d_t \leqslant \theta \chi p_h h_t + (1 - \theta)\, d_{t-1}.$$

As in Chapter 4, the borrower needs to refinance a fraction of the outstanding mortgage debt in each period. One can think of the representative household as consisting of a continuum of members that share consumption of non-durables and housing, with θ being the mobility rate among the household members. Note that with θ equal to one, the constraint reduces to a standard borrowing constraint that assumes a full renewal of the borrowing limit in each period.

[4] I require the minimum of the mean absolute change in the two policy functions for consumption to be smaller than 10^{-5}.

[5] Given that the model is a partial equilibrium one, one can also simulate one agent over many time periods.

The first-order conditions of the representative household's problem are:

$$\frac{1}{c_t} = \beta E_t \left(\frac{r}{c_{t+1}} - (1-\theta)\,\lambda_{t+1} \right) + \lambda_t, \tag{5.4}$$

$$\frac{p_h}{c_t} = \frac{\alpha}{h_t} + \beta E_t \frac{p_h}{c_{t+1}} + \theta \lambda_t \chi p_h, \tag{5.5}$$

$$\lambda_{c,t} \left(\theta \chi p_h h_{m,t,i} - (1-\theta)\, d_{t-1} \right) = 0,$$

$$\lambda_t \geq 0,$$

Note that the first-order condition for housing, Equation (5.5), is different from its equivalent in the heterogeneous agent model, Equation (5.3); only in Equation (5.5) θ enters the third term of the shadow value of housing. The reason is that with a representative household, a marginal unit of housing purchased is shared among all household members, but only a fraction θ of the members can use it as collateral for new loans. In the heterogenous agent model, the entire marginal unit of housing can be used as collateral, *conditional* on being a mover.

General equilibrium version

In the models described above, the house price p_h and the interest rate r are fixed and exogenous. They can thus be treated as parameters. Calibrated values are taken from a general equilibrium model with a representative borrower and a representative saver. In this model, the representative saver is the same as the borrower, except that the saver has a higher discount factor. As a result, the saver is a net lender in equilibrium. The collateral constraint is assumed to be the standard one ($\theta = 1$), and the borrowers are assumed to make up 20 percent of the population. The supply of housing is fixed and normalized to one.

5.2.3 Calibration

The model period is one quarter. Otherwise, the calibration follows Chapter 4. The loan-to-value parameter χ is set to 0.8. The mobility parameter θ is calibrated to be 0.0193, which corresponds to an annual mobility rate of 7.5 percent. The discount factor, β, is set to 0.97. The parameters of the idiosyncratic income shock process, ρ_y and σ_y, are set to 0.7 and 0.03, respectively. This generates income volatility of about 3.5 percent on an annual basis.[6]

The calibrations of r, α and p_h are based on the steady state of the general equilibrium model described in the previous subsection. The representative saver in this model is assumed to have a discount factor of 0.99, which results in parameter value of 1.01 for the interest rate r. Given that $\frac{1}{\beta} > r$, the collateral constraint of the borrower binds in the absence of any risk. The housing preference parameter α is set to be 0.06. In the general equilibrium model, this calibration yields a value of the aggregate housing stock that is about 140 percent of output. Based on the same model, I set p_h equal to 5.69.

5.3 Results

This section compares the properties of four models. Model one is the heterogeneous borrower model with infrequent mobility as described in Section 5.2.1. Model two is a version of the heterogeneous borrower model in which all borrowers move in every period. This model is obtained by setting θ equal to one. In that case, the collateral constraint is completely standard. Model three is the model described in Section 5.2.2, in which a representative borrower refinances a fraction θ of its debt in each period. In this model, θ can be interpreted as a mobility rate among the members that make up the representative borrower household. Model four is a version of this model in which all debt has to be

[6] This is less than what is typically assumed in the literature on incomplete market models. However, my heterogeneous agent model does feature an additional source of idiosyncratic income risk, namely mobility risk.

Table 5.1: Ergodic distributions.

		heterogeneous agents		representative agent	
refinancing		partial	full	partial	full
Debt	mean	3,4243	3,3822	1,9946	3,3610
	standard deviation	0,0671	0,2646	0	0
Housing	mean	0,7513	0,7421	0.4376	0,7374
	standard deviation	0,0147	0,0581	0	0
Non-durables	mean	0,9664	0,9668	0,9800	0,9668
	standard deviation	0,0419	0,0278	0	0
Borrowing constraint	percentage binding	100	100	100	100
Euler equation	root mean squared error	0,0004	0,0001	0	0

Notes: numbers are based on a simulation are of one agent of length one million.

refinanced in each period. So in the fourth model θ equals one, in which case the collateral constraint reduces to a standard one.

Subsection 5.3.1 describes the ergodic distributions of the four models and transitions are presented in subsection 5.3.2.

5.3.1 Ergodic distributions

What implications does the presence of borrower heterogeneity have for the long-run properties of the model? Column 1 of Table 5.1 displays statistics describing the ergodic distributions of debt, housing and non-durables in the model with uninsurable income risk and infrequent mobility. The mean value of the house owned by the borrower is about equal to annual labor income. Column 2 displays the statistics for the model with heterogeneous borrowers who all move in every period. The means of the ergodic distributions of housing, non-durable consumption and debt are very similar to those predicted by the model with infrequent mobility. However, when borrowers move in every period, the cross-sectional dispersion of debt and housing is much higher than with infrequent mobility. In contrast, the cross-sectional dispersion of non-durable consumption is lower than with infrequent mobility. The borrowing constraint binds at all points in the simulation in both models. The table also shows that Euler equation errors in the

simulation are reasonably small.[7]

Columns 3 and 4 of Table 5.1 display steady-state values for the two representative agent models. Since there is no aggregate or idiosyncratic risk, these models are completely deterministic. The steady-state values for housing and debt in the model with partial mortgage refinancing, as displayed in the third column, are substantially lower than the long-run means in the other models. This seems directly related to the fact that in this model, only a fraction θ of a marginal unit provides collateral services, which reduces incentives to buy housing. The fourth column shows that the steady-state values of the representative borrower model with the standard collateral constraint are only somewhat lower than in its heterogeneous agent counterpart. Thus, without idiosyncratic income risk, borrowers accumulate slightly less wealth.

5.3.2 Transitions

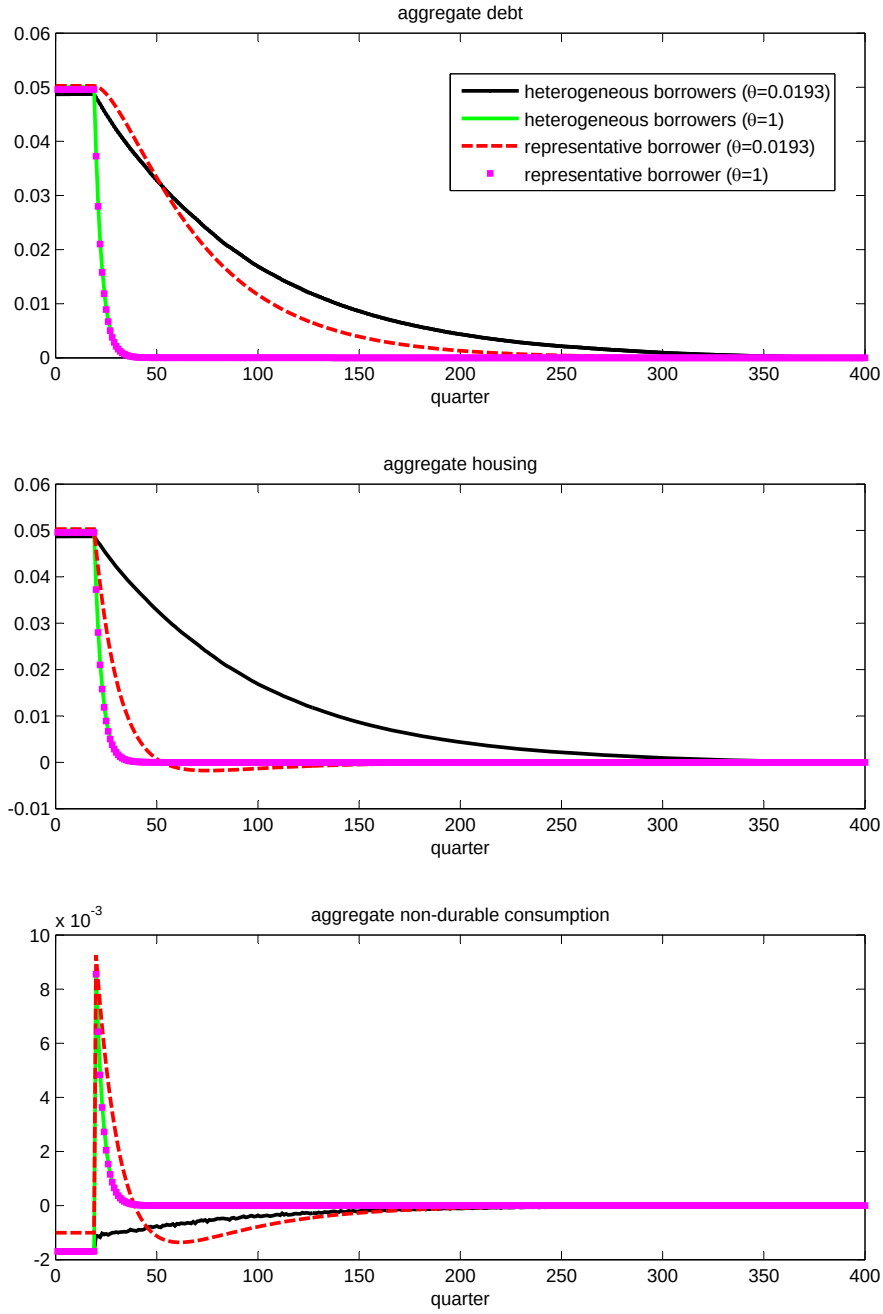
The models discussed in this chapter do not feature any aggregate risk. Introducing such risk is possible, but adds another element to the vector of state variables and therefore further complicates finding a solution. Instead, I carry out two exercises in which I compute transition paths following a permanent and unanticipated change in the parameters of the model.

In the first exercise, I consider a fall in the housing preference parameter from 0.06 to 0.057, causing a permanent reduction in the demand for housing, keeping the house price fixed. Figure 5·1 plots the transition to the new long-run levels in the four models for aggregate debt, aggregate housing, and aggregate non-durable consumption.

In the heterogeneous borrower model with infrequent mobility ($\theta = 0.0193$), the transition of housing and debt is very gradual. Aggregate non-durable consumption displays a minor fall following the shock, despite the increased preference for non-durables relative to housing. In the representative borrower model with partial refinancing ($\theta = 0.0193$),

[7] Scaled by the steady-state level of non-durable consumption the Euler equation errors are very similar, given that steady-state consumption of non-durables is close to one.

Figure 5·1: Transitions: decline in housing preference.



Notes: log deviations from the end-of-exercise steady state.

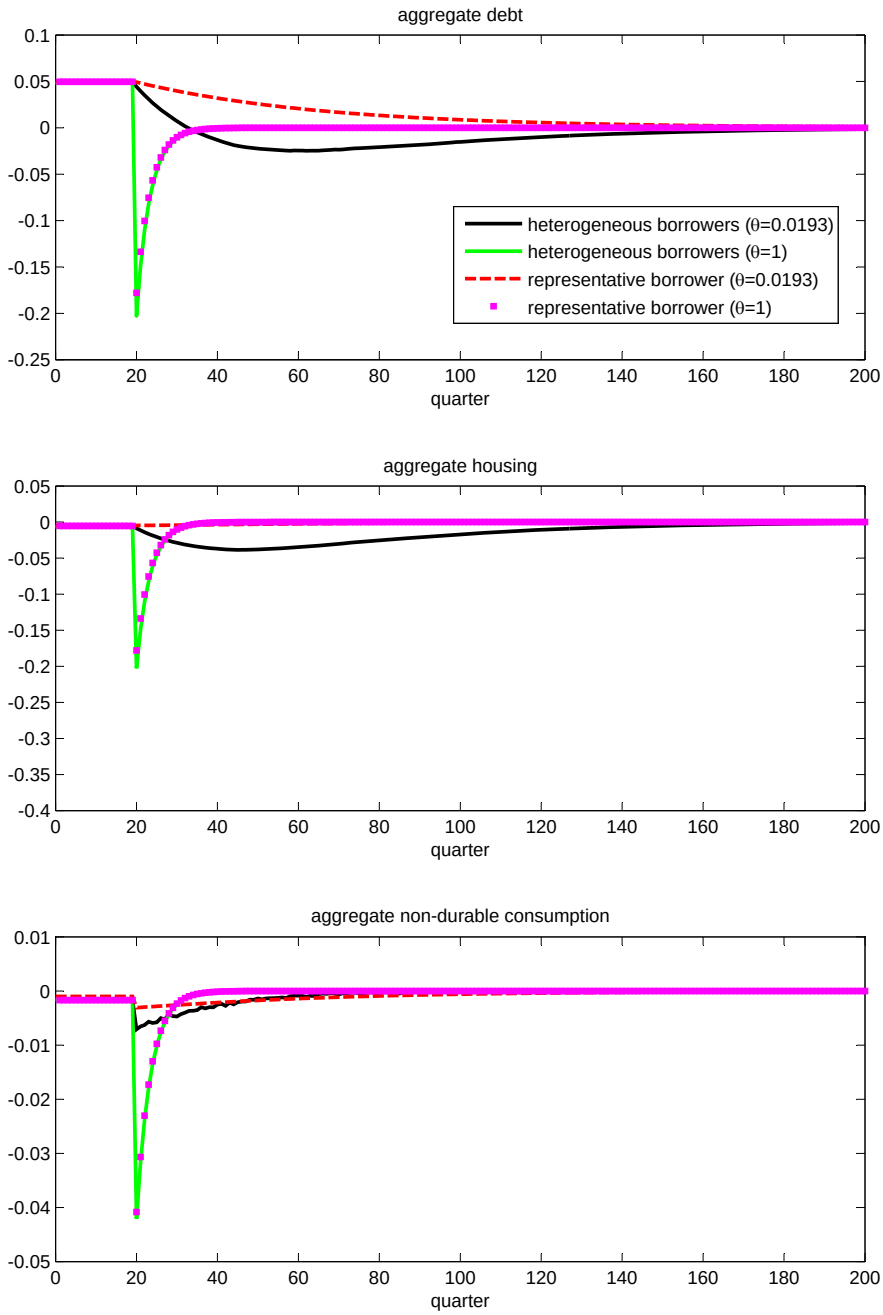
aggregate debt also converges to its new long-run level in a rather sluggish way. However, housing demand responds much quicker than in the heterogeneous borrower model. To understand this result, note that the representative borrower can freely adjust its housing stock, unlike the agents in the heterogeneous agent model who can only adjust their housing stock when they move. With a gradual decline in debt and a relatively rapid fall in housing, demand for non-durables by the representative borrower displays a brief spike following the fall in the relative preference for housing.

Now consider the models with the standard constraint ($\theta = 1$). Figure 5·1 shows that transitions in the heterogeneous agent version of the model, and in the representative agent version, are nearly identical. However, both models provide very poor approximations to the heterogeneous agent model that makes the more realistic assumption of infrequent mobility. In particular, debt and housing converge to their new steady-state levels very quickly. Moreover, both models predict a spike in non-durable consumption.

The exercise described above is somewhat unnatural in the sense that the relative preference for housing falls, but the relative price of housing does not. In a second exercise, I study a permanent and unanticipated fall in both housing preferences and the house price. The fall in the house price is set equal to the one that is obtained in the general equilibrium version of the representative agent model, as described in Subsections 5.2.2 and 5.2.3.

Figure 5·2 displays the transitions following the joint fall in housing preferences and the real house price. In the heterogeneous agent model with infrequent mobility, aggregate debt slowly converges to its new and lower long-run level, and there is some degree of overshooting. Housing also falls temporarily below its long-run level and there is a modest decline in non-durable purchases. In the representative borrower model with partial refinancing, debt gradually declines, but does not display any overshooting. Interestingly, housing hardly responds, despite of the lack of adjustment costs, and there is a very small decline in non-durable purchases. These observations contrast with the two models with the standard constraint ($\theta = 1$): both the representative agent and heterogeneous agent

Figure 5·2: Transitions: decline in housing preference and the house price.



Notes: log deviations from the end-of-exercise steady state. Simulation is based on a panel of 10.000 agents.

version display large negative spikes in debt, housing and non-durables.

5.4 Discussion

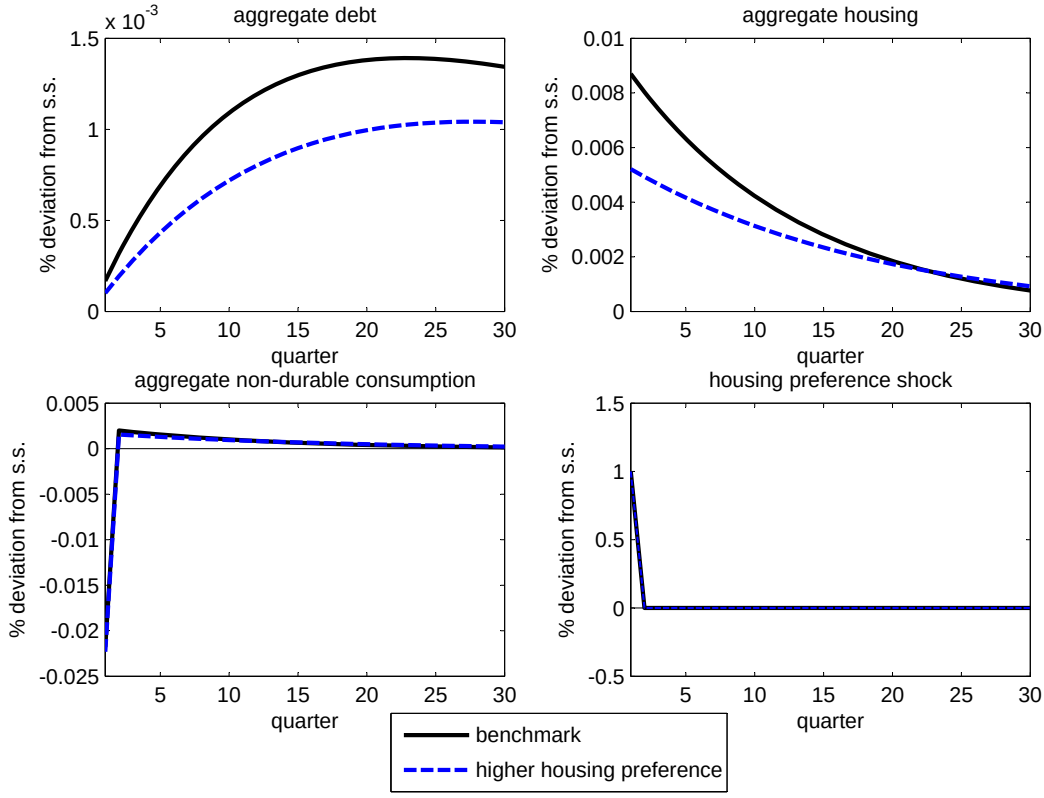
The results of the previous section indicate that introducing partial refinancing of mortgage debt allows a representative agent model to much better approximate the predictions of a heterogeneous agent economy with infrequent mobility. Still, the predictions of the representative agent model with partial refinancing do not coincide with those of the underlying heterogeneous agent economy. In particular, there are two issues. The first issue is that the representative agent model with partial refinancing predicts lower levels of housing and debt in the long run. Second, in the absence of any housing adjustment costs, the demand for housing is too flexible relative to the heterogeneous agent model in which agents can only adjust their housing stock when they move. This is true even though general equilibrium forces seem very powerful in dampening the sensitivity of housing demand. This subsection links these findings to calibration procedure in Chapter 4 and the results in that chapter.

5.4.1 Calibration of housing preferences

Recall that in Chapter 4, the housing preference parameters were calibrated such that the steady state value of the housing stock in the model matches the data. Moreover, the preference parameters were calibrated differently for borrowers and savers, in order to ensure that housing consumption of both types of households are equal. The analysis in the previous section suggests that in order to achieve these calibration targets, the housing preference parameter of the borrower, α, is chosen to be high relative to the parameter value one would use in a version of the model with heterogeneous borrowers. The question arises how this changes the dynamics of the model.

Figure 5·3 displays the responses of housing and debt to a positive and temporary

Figure 5·3: Transitory housing preference shock.



Notes: Impulse reseponse functions to a temporary increase in housing preferences in a partial equilibrium model with only borrowers. In the model with "higher housing preference", the housing preference parameter α is set to 0.1 instead of 0.06.

housing preference shock in the representative borrower model with $\theta = 0.0193$.[8] The same figure displays the responses to the shock for an alternative calibration of the housing preference parameter α. In this version of the model, the housing preference parameter is set to 0.10 instead of 0.06, in order to match the steady-state level of debt in the model with the standard constraint. With a higher level of α, housing demand increases less during the first five years following the shock. Thus, setting a high value of α may be preferable both in order to obtain reasonable steady-state values, and in order to reduce the elasticity of housing demand with respect to housing preference shocks.

[8] The autocorrelation coefficient of the shock is 0.95.

5.4.2 Relation with Chapter 4

How could the results in Chapter 4 be affected if aggregate housing demand of the borrowers is too elastic? I revisit the benchmark model of Chapter 4, but also consider a version of the model with a utility cost on adjusting housing. This cost takes the following form:

$$\frac{\tau}{2}\left(h_t - h_{t-1}\right)^2.$$

Figure 5·4 displays responses to a housing preference shock in the model with and without adjustment cost.[9]

The response of housing owned by the borrowers is indeed slower when the adjustment cost is in place. But note that in neither of the two models, the stock of housing owned by the borrowers displays a large jump, emphasizing the importance of general equilibrium effects in dampening the sensitivity of housing demand.

The effect of the adjustment cost on the decline of the mobility rate is negligible on impact. However, at intermediate horizons the adjustment cost leads to a smaller fall of the mobility rate. But the effects become more persistent, since the fall in the mobility rate is larger at longer horizons.

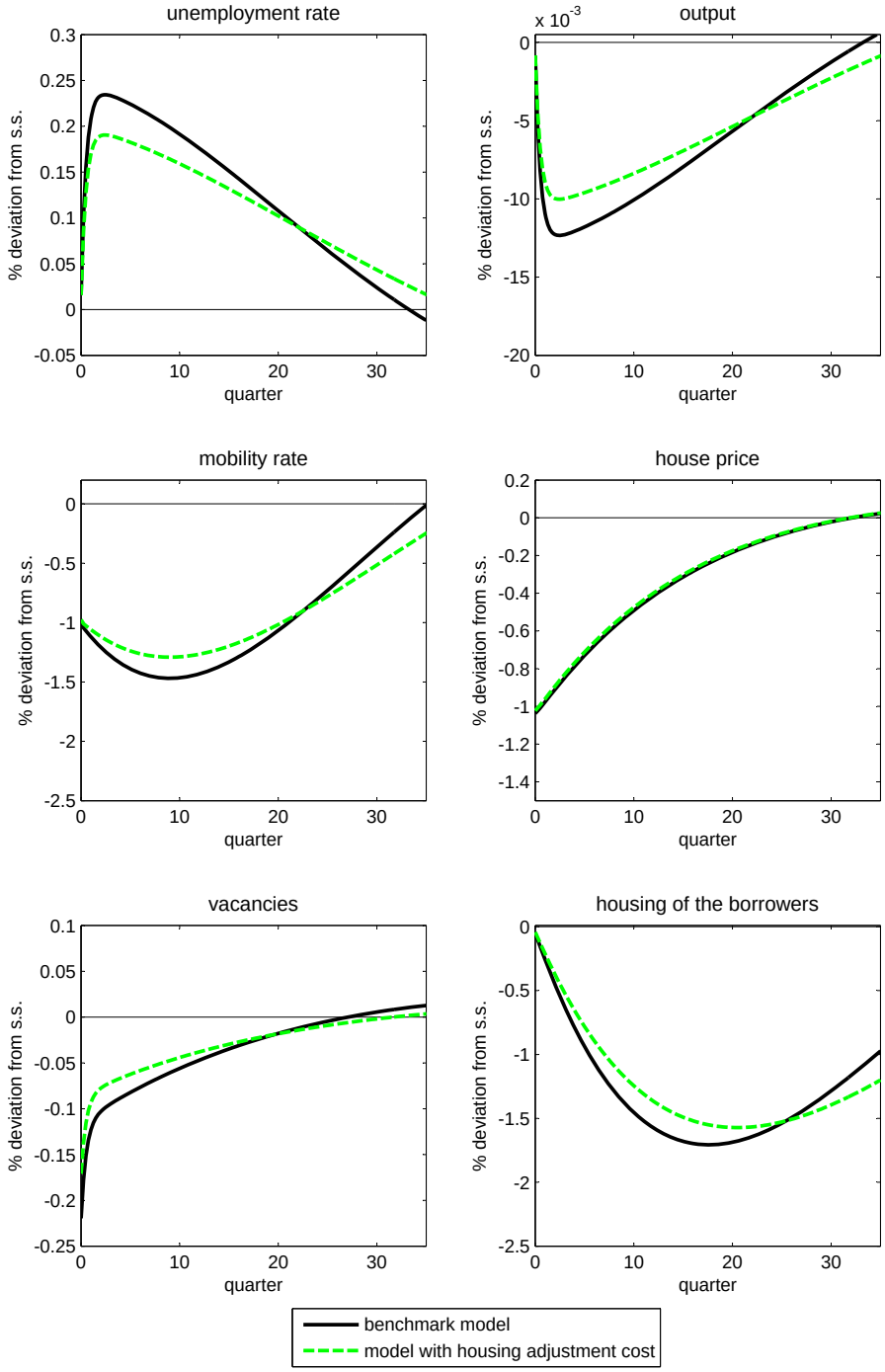
Figure 5·4 also shows that vacancies fall less in the presence of the adjustment cost. Recall from Chapter 4 that the fall in vacancies is due to the fact that following the shock, the savers decide to purchase more housing and invest less in vacancies. With the adjustment cost in place, such substitutions are more costly and thus less attractive.

5.5 Conclusion

In this chapter, I have compared representative borrower models to heterogeneous borrower models. The results indicate that a borrowing constraint with partial refinancing brings the representative borrower model much closer to the "true" underlying heteroge-

[9] The parameter τ in the adjustment cost function is set to 2.5.

Figure 5·4: Transitory housing preference shock in the model of Chapter 4.



Notes: Responses to a negative housing preference shock in the benchmark model of Chapter 4.

neous borrower economy than a standard collateral constraint. However, it is important to emphasize that the results are based on partial equilibrium analysis. Comparing general equilibrium versions of the models remains a challenge for future work.