Equilibrium Eviction*

Dean Corbae
University of Wisconsin - Madison and NBER
Andrew Glover
Federal Reserve Bank of Kansas City
Michael Nattinger
University of Wisconsin - Madison

August 14, 2022
Preliminary and Incomplete

Abstract

We develop a simple equilibrium model of rental markets for housing in which eviction occurs endogenously. A landlord chooses whether to evict a delinquent renter and may do so because the landlord incurs fixed costs for maintaining a housing unit and has the option of posting a new vacancy. Renters who are persistently delinquent are more likely to be evicted and they pay more per quality-adjusted unit of housing than renters who are less likely to be delinquent. Evictions are never socially optimal once a match has been made, since the housing services accruing to the renter must be larger than the landlord's costs in order for a lease to be signed in the first place. If rents can be set sufficiently high, optimal eviction policy forbids evictions completely, while if rents are constrained then optimal policy allows some evictions to support landlord profits and ensure sufficient rental supply. In general, the decentralized equilibrium with constraints on how much rent can be charged features both socially inefficient evictions and too few vacancies. We also consider the welfare implications of state dependent policies during aggregate crisis events. Finally, we show that neighborhood externalities can widen the gap between rich and poor renters.

1 Introduction

While there is currently a fair amount of empirical work on evictions in economics and sociology (witness the popular book Evicted: Poverty and Profit in the American City by

*The views expressed in this paper do not necessarily reflect those of the Federal Reserve Bank of Kansas City or the Federal Reserve System. We wish to thank Carter Braxton, Lu Han, Paolo Martellini and seminar participants at the Midwest Macro, SED Meetings, and the Wisconsin Real Estate Research Conference for helpful comments. Deepak Venkatasubramanian and Emily Pollard provided excellent research assistance.

sociologist Matthew Desmond [3]), there are virtually no structural frameworks to understand the social costs of eviction.[1] A structural framework also provides a laboratory for conducting policy counterfactuals like the effect of eviction moratoriums.

To this end, we build a structural model borrowing methods from the labor search literature and plan to estimate its parameters using data from several sources. Our paper proposes a model of directed search as in Menzio and Shi [11] in which households with idiosyncratic income fluctuations transition between renting and homelessness. They are matched with properties of varying quality owned by landlords who bear the costs of creating vacancies of varying quality. The block-recursive model can be easily solved in and out of the steady state, and hence, it can be used to study the behavior of renters' transitions over the business cycle. We can use the model to measure the positive and normative response of evictions and vacancy creation in the rental market to cyclical fluctuations in business cycle changes in income or job-finding rates. These responses will depend on the "quality" of a renter-landlord match. Endogenous separations may arise after renters experience a drop in their income, lowering the landlord's expected value of continuing the match below their outside value of posting a new rental vacancy.

In our model, the search process is directed to a particular submarket - as in Moen [12] - rather than random - as in Mortensen and Pissarides [13]. On one side of the market, landlords choose the quality of the rental and offer a menu of rental contracts creating vacancies. On the other side of the market, renters choose what type of housing vacancies to apply to and pay rent as long as they are employed, but face heterogeneous risks of unemployment spells, during which they cannot pay rent. Renters and landlords searching for each other are brought into contact by a constant returns to scale matching function, with search directed on both sides to submarkets. Each submarket is defined by the quality of the rental unit (both of the individual unit and an externality that captures heterogeneity in neighborhood quality), the monthly rent that renters agree to pay, and renter characteristics or "type" (here proxied by their employment prospects.[2] In this way we will be able to consider downturns associated with events like the COVID pandemic by increasing the probability of renters becoming unemployed (or reducing the probability that unemployed renters find

[1]The only other structural paper we are aware of is by Abramson [1]. Unlike our search approach, he builds an overlapping generations model of households who face idiosyncratic income and divorce risk. Households rent houses from real-estate investors by signing long-term noncontingent leases specifying a per-period rent which is fixed for the duration of the lease. Since contracts are non-contingent, households may endogenously default on rent (and do so in equilibrium). An eviction case is filed against a default. Each period in which the household defaults, it is evicted with an exogenous probability that captures the strength of tenant protections against evictions in the city.

[2]As discussed in Desmond and Gershenson [4], neighborhood effects are an important aspect to capture in the data.

new jobs).

Our environment contains two critical frictions: two-sided lack of commitment and neighborhood externalities. With regard to the commitment frictions: first, barring legal constraints, there is no commitment on the part of a landlord who is not being paid rent not to evict her renter and find a paying renter; and second, there is no commitment outside the length of the contract for a renter to remain in the rental unit. We contrast the decentralized equilibrium with what a benevolent social planner would choose for the efficient (first best) matching of renters with housing units.

Our model delivers realistic features of rental markets as well as relevant policy insights. First, our model predicts that renters who are more likely to become persistently delinquent on rent, and therefore be evicted, will be charged higher rent relative to the quality of their housing. This is consistent with evidence from Desmond and Wilmers [5]. Second, we show that evictions are suboptimal from a societal perspective and should only be allowed to the extent that they incentivize landlords to supply more housing by limiting their losses from delinquent tenants.

To make this point, consider an extreme example in which a renter is currently employed, but will be unemployed for ever after this month. A social planner would give that renter the exact same probability of finding housing of the same quality as anybody else and would never evict them. However, a landlord would only post a vacancy for such a renter if they could recoup posting costs in that first month of rent payment, but even then would evict the renter immediately upon job loss. If that one month of rent can be sufficiently high, the optimal eviction policy would be to ban them altogether to force ex-post commitment. However, if rents are capped, either by having to meet a subsistence level of non-housing consumption (i.e. a rent burden significantly less than 1) or by policy, then the optimal eviction policy must balance the goal of avoiding the destruction of matches that have positive surpluses against the reduction in profits for a landlord who cannot recoup expected future losses with a large upfront payment. Therefore, the optimal eviction policy allows some evictions in order to incentivize the creation of rental vacancies, but not all in order to avoid ex-post surplus destruction. In summary, our model can help us understand some aspects of long-term homelessness and mobility since policies which tax landlords can also limit entry of new rental units (along the lines of the unintended consequences of firing costs to deter firms from separating from a match but which also deter firms from posting vacancies as in Hopenhayn and Rogerson [7]).

We calibrate the model to match salient features of rental and labor markets. In labor markets, we group renters into two groups with high versus low employment propensities and estimate their job-finding and job-separation rates, as well as income when employed.

In rental markets, we match aggregate eviction rates as well as rental burdens by income, defined as the share of monthly income paid in rent. We then use the model to measure the effect of eviction restrictions on the overall supply of rental units for people of different incomes, as well as the quality of their units and the overall welfare consequences of such a policy.

The paper is organized as follows. Section 2 describes data facts. Section 3 lays out the model environment. Section 4 solves for the first best level of rental quality and tightness. Critically, it shows that under our parameterization the planner chooses an egalitarian outcome independent of household type. Section 5 considers decentralized competitive search equilibria. To isolate the two frictions in our model, we break the section into several parts. In the absence of externalities, Subsection 5.1 shows that backloaded rental contracts can solve the landlord commitment problem but they cannot be implemented since they violate renter commitment and feasibility along possible employment paths. Given two-sided lack of commitment makes implementation of variable rate rental contracts difficult, Subsection 5.2 considers fixed rental rate contracts and examines the role of restrictions on eviction in the absence of externalities. Section 6 considers the role of aggregate fluctuations in employment opportunities with fixed rate contracts. Finally, Section 7 adds neighborhood externalities to the decentralized equilibrium with fixed rate contracts. Finally, Section 8 concludes.

2 Data

We use a combination of existing empirical facts and our own statistical analysis to motivate and discipline our structural model. We first list these facts and then describe the data analysis that we performed using data from the Survey of Consumer Finance (SCF) and the Current Population Survey (CPS).[3]

- About 35% of U.S. households rent rather than own their homes (CPS).

- Rent as a share of income (the rent burden) is declining in renter income, ranging from $30-50\%$ for households below median income (SCF).[4]

- Renters have low net worth - about \$6300 for the median renter in 2019 (SCF). Of this, the median renter had only \$1100 in cash-like assets (checking and savings accounts) and a quarter of renters had under \$120. The median rent was \$830.

[3] Appendix A provides details of variable definitions and further discussion of sample selection used in our statistics from the SCF and the CPS.

[4] Abramson [1] finds slightly higher numbers for specific cities.

- Among renters, we estimate that 43% are hand-to-mouth (based on the definition from Kaplan, Violante, and Weidner [9]) and 57% would be unable to cover rent plus half of their typical bi-weekly income. For renters below median income, 72% are hand-to-mouth.

- In a typical year, between $2 - 3\%$ of renting households are evicted (Eviction Lab).

- Eviction is more likely among low-income renters. Collinson and Reed [2] find that weekly earnings of people who have an eviction filed against them are only $250 during the two years preceeding eviction.

- Renters are twice as likely to be evicted after losing their jobs (Desmond and Gershenson [4]).

- Rent is more similar between poor and nonpoor neighborhoods than property values which are substantially higher in nonpoor neighborhoods (Desmond and Wilmers [5]). This leads to higher rent to property values for poor than nonpoor neighborhoods (see Figure 1).

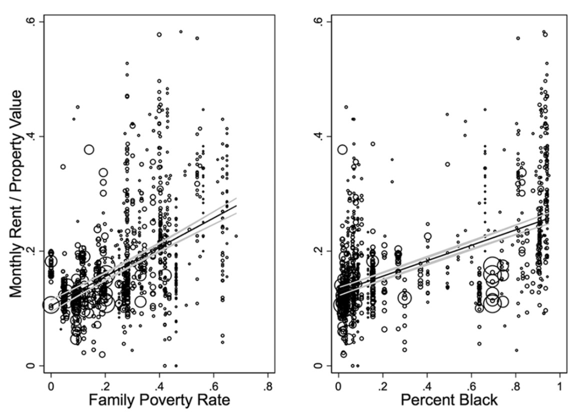


Fig. 1.—Renter exploitation and neighborhood characteristics (Milwaukee). Observations are scaled by survey weights. Fitted values are from bivariate median regressions. Data are from the Milwaukee Area Renters Study (2009–11), Milwaukee Master Property Record (2013), Milwaukee Treasurer's Tax Record (2013), and the American Community Survey (2013).

Figure 1: Rent-to-Price Ratios Across Neighborhood Characteristics
Source: Desmond and Wilmers, 2019.

2.1 Survey of Consumer Finance Data

We use the 2019 Survey of Consumer Finance to decompose the median renter's financial networth into liquid assets (checking and savings accounts), illiquid assets, and debt. We define a renter as someone who reports a positive monthly rent for housing services and restrict our sample to households between the ages of 25 and 70. We also use the definition of hand-to-mouth from Kaplan, Violante, and Weidner [9] (i.e. liquid wealth less than half of bi-weekly income) to estimate that the share of renters who are hand-to-mouth is 43% overall and upwards of 72% if we include rent commitments and look at lower income renters in the SCF. Table 1 reports the median and bottom quartile value for rent, liquid assets, and income for all renters, but also for low income renters (i.e. those below median income).

Table 1: Summary Statistics for Renters in SCF

	Overall		Low Income	
Variable	Median	25th%	Median	25th%
Rent	\$860	\$600	\$690	\$500
Liquid Assets	\$1020	\$100	\$250	\$0
Networth	\$6700	\$10	\$2590	\$0
Income	\$38,688	\$21,380	\$21,380	\$14,254

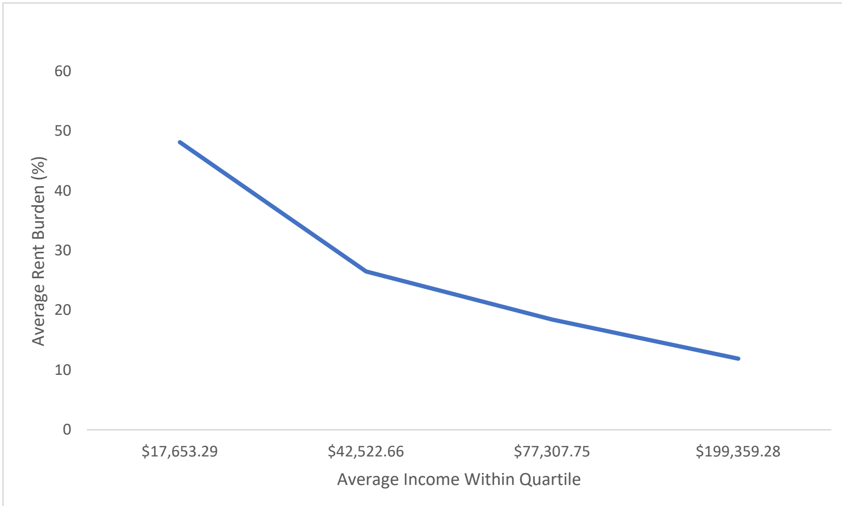
The first thing to notice is how little variation there is in rent. Overall the median rent in 2019 was \$860, which was only 43% higher than the bottom quartile \$600. On the other hand, median liquid assets was over ten times the bottom quartile and median income was nearly twice the bottom quartile, meaning that the rent burden is falling with income. In fact, the rent burden falls from 48% to just 27% as we move from the bottom to the second quartile of household income and continues to fall with income, as can be seen in Figure 2.

Our takeaway from this data is that, for the population of low-income renters for whom our model is most appropriate, it is unlikely that missed rent could feasibly be capitalized into future payments. Furthermore, an unemployed renter would be unable to pay rent out of liquid savings and has little wealth even including illiquid assets.

2.2 Current Population Survey

Renters in our model will differ by income when employed, but also in the probabilities of finding or keeping a job. We use the panel dimension of the Current Population Survey to estimate transition matrices and relative incomes for renters with high and low employment propensities. We use data from 2018-2019 and restrict the sample to include only those

Figure 2: Rent Burden by Income, 2019 SCF



individuals aged 25-70 who reported renting their housing for at least one month, were in the labor force for at least one month (out of a possible eight), and had reported positive average earnings that were below the median. Within that group, we characterize $L-$types as those who were employed less than half of their interview months, which represents the bottom decile of employment rates. After defining our types in this way, we have the following earnings and job finding/keeping rates:

Table 2: Average Labor Market Outcomes for Low-Income Renters in CPS

	High Employment	Low Employment
Monthly Earnings When Employed	$1780	$1300
Job Finding Rate	0.89	0.17
Job Separation Rate	0.04	0.43
Fraction of each type	0.9	0.1

From this data, we use the ratio of $L-$type earnings to $H-$type earnings (we normalize the $L-$type's level in the model) as well as the finding and keeping rates to discipline the Markov Chain on employment status for each type in Table 2. By definition, then, the share of $L-$type households in the population we focus on in our model is 10% and the share of $H-$type is 90%. Table 2 documents that type H finding rates are over 4 times that of type L (i.e. $p_{H,0} = 0.89$ and $p_{L,0} = 0.17$) and type H retention rates are almost double that of type L (i.e. $p_{H,1} = 0.96$ and $p_{L,1} = 0.57$).

3 Environment

There is a unit measure of people of two types $i \in \{H, L\}$ who live for an infinite number of discrete periods. The fraction of type i is denoted μ_i. People can be either housed ($j = h$) or unhoused ($j = u$) and either employed ($e = 1$) or unemployed ($e = 0$), meaning they can be in one of four states at any point of time.

The two types of people differ in the probability of being employed in the next period, $p_{i,e} = Pr(e' = 1|i, e)$ where $(e', e) \in \{0, 1\} \times \{0, 1\}$. They also differ in their income from employment $y_{i,e=1} = y_i$. We assume that $H-$types are more likely to keep or find a job, i.e. $p_{H,e} > p_{L,e}$ for all e. Further, conditional on being employed, type H have higher income $y_H > y_L > \alpha$. Thus, type H have a higher job finding rate, a lower separation rate, and higher expected lifetime earnings than type L. An unemployed household generates $y_{i,e=0} = \alpha$ units of the consumption good.

People have linear utility over housing $\mathcal{U}_i^j$ and their consumption of non-housing goods c above a subsistence threshold α. That is, flow utility is given by $c - \alpha + \mathcal{U}_i^j$ with $c \geq \alpha$. Housed utility depends on both the quality of one's own housing as well as the housing of all other people of their type, which we interpret as a neighborhood externality. Denoting Q_i as the total quality of all housing of type i individuals, the period utility for a given person of type i living in housing of quality q is $\mathcal{U}_i^h = q \cdot Q_i^\xi$. An unhoused person receives flow utility $\mathcal{U}_i^u = \upsilon$ regardless of type. We think of Q_i^ξ as capturing positive neighborhood quality externalities in the case where $\xi > 0$. People discount utility across periods with factor β.

Matching unhoused people to new housing takes time due to search frictions. Specifically, if there are V vacant housing units and U unhoused people in period t, then $M(U, V)$ new matches between houses and unhoused people will be created for $t + 1$. We assume that M has constant returns to scale and define tightness as $\theta = \frac{U}{V}$, the rental finding rate as $\phi(\theta) = \frac{M(U,V)}{U} = M(1, \theta^{-1})$ with $\phi'(\theta) < 0$, and the rental filling rate as $\psi(\theta) = \frac{M(U,V)}{V} = M(\theta, 1)$ and $\psi'(\theta) > 0$.[5] Hence it is hard (easy) to find (fill) a rental unit in a tight market. A housed person separates from her housing unit with exogenous probability σ in each period. Once a separation occurs, the unit's quality depreciates fully.

Creating a new housing unit costs κ units of utility. Furthermore, the unit's quality, q, requires a one-time investment $c(q)$ units of utility after the match occurs with $c'(q) \geq 0, c''(q) \geq 0, c(f + \upsilon) = 0$, and $c'(f + \upsilon) = 0$. There is also a fixed cost incurred for each period that a unit is occupied given by f.

The timing in any given period is as follows:

1. New housing is created at cost κ.

[5] We note that the housing definition of "tightness" is opposite that of its definition in labor search.

2. People receive income y_i if employed and income α if unemployed.
3. Housed people receive utility $q \cdot Q_i^{\xi}$ from housing services while unhoused people receive utility υ.
4. Unhoused people match with housing according to $M(U, V)$.
5. Newly matched housing units receive quality investment q at cost $c(q)$.
6. Housed people become unhoused with probability σ.
7. Employment status changes according to Markov process described above, independent from housing status.

4 Socially Optimal Housing

Consider a social planner who chooses housing outcomes $(q_{i,e}, \theta_{i,e})$ for $(i, e) \in \{H, L\} \times \{0, 1\}$ to maximize the discounted utility of households. At any date, the planner begins in a state with neighborhoods of quality Q_i and measures of the population $\mu_{i,e}^{j}$.[6] Appendix B provides the full statement of the planner's problem.

We study a social planner's problem in which evictions never occur. This is logically true since the social surplus $q - f - \upsilon$ of a match is constant over time, therefore if the planner ever chose to create a match with quality q then she would never optimally destroy it. Further, our assumption that additional quality is costless at $q = f + \upsilon$ implies that the planner chooses to create matches (all of which have positive surplus). This implies that every unhoused person will have a positive probability of being matched.

The socially optimal (or first-best) stationary allocation solves

$$c'(q_{i,e}) = \frac{\beta(1+\xi)Q_i^{\xi}}{1-\beta(1-\sigma)} \tag{1}$$

$$\kappa - \theta_{i,e}^2 \phi'(\theta_{i,e}) c(q_{i,e}) = -\beta\theta_{i,e}^2\phi'(\theta_{i,e}) \left[\frac{(1+\xi)q_{i,e}Q_i^{\xi} - f - \upsilon + \theta_{i,e}^{-1}\big(\kappa + c(q_{i,e})\psi(\theta_{i,e})\big)}{1-\beta(1-\sigma-\phi(\theta_{i,e}))} \right] \tag{2}$$

$$Q_i = (1-\sigma)Q_i + \sum_{e\in\{0,1\}} \mu_{i,e}^{u} \phi(\theta_{i,e}) q_{i,e} \tag{3}$$

The socially optimal quality choice in (1) sets the marginal cost of providing housing quality to its expected marginal benefit. The socially optimal choice of rental tightness in (2) sets

[6] By definition $Q_i = \int_{f+\upsilon}^{\infty} q dG_i(q)$ where $G_i(q)$ is the CDF of i types over housing qualities.

the marginal cost of posting a vacancy to the expected marginal increase in social surplus. Finally, equation (3) determines the neighborhood externality in a stationary allocation.

Importantly, notice that equations (1)-(3) do not depend on employment status e explicitly (i.e. the only place e enters (1) and (2) is in $q_{i,e}$ and $\theta_{i,e}$ and not in the functions themselves while e is integrated out in (3)). However, there may be type i dependence simply because the size of the externality depends on the number of each type. To summarize, in the presence of neighborhood externalities, the social planner chooses quality and tightness to be type dependent but not employment dependent (i.e. q_i and θ_i).

However, it is important to note that in the absence of neighborhood externalities (i.e. with $\xi = 0$), equations (1)-(2) do not depend on Q_i, so that the planner's allocation is completely egalitarian. That is, quality and tightness is independent of type i. In that case, (1) can be solved closed form for q^{SP} and after substituting into (2), yields one equation in one unknown θ^{SP} to solve for the social planner's allocation.

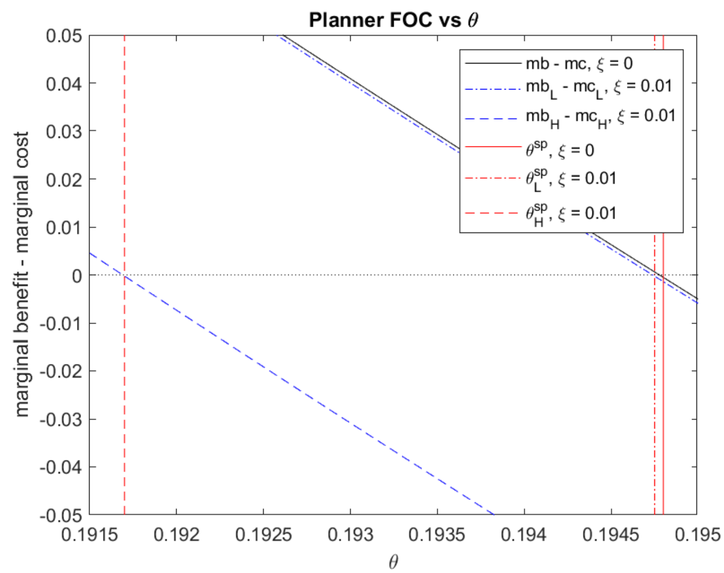
In Figure 3 we plot the the marginal benefit of posting a vacancy (i.e. right hand side of (2)) minus the marginal cost of posting a vacancy (i.e. left hand side of (2)) for the case of no externality (i.e. $\xi = 0$) as a function of θ^{SP} after substituting q^{SP} from (1)). The social planner's choice of tightness θ^{SP} occurs at the zero of that function. The figure documents (for the parameterization we use in Table 3) a unique solution $\theta^{SP} = 0.125$, which corresponds to a rental finding rate $\phi(\theta^{SP}) \approx 0.9$. The figure also illustrates the effect of the presence of a positive externality (i.e. neighborhood effect). Specifically, the figure plots (2) after substituting in the optimal solution to (1) and (3) for $\xi = 0.05$. Given the positive externality, it is not surprising that the planner chooses an even lower tightness and higher finding rate, more so for type H.

5 Decentralized Equilibrium Without Externalities

To isolate the two critical model frictions, two-sided lack of commitment and neighborhood externalities, we begin by asking whether the first-best allocation can be decentralized in a competitive search equilibrium without externalities and, if not, what types of policy can improve the equilibrium outcomes.

In the decentralized equilibrium, landlords post vacancies and invest in the quality of the rental units they create. We assume that renters must pay rent whenever employed. A landlord cannot evict somebody in a period when rent is paid, but can choose to do so after the person misses rent. Unhoused people direct their search to rentals of quality $q_{i,e}$ in submarkets of tightness $\theta_{i,e}$. The terms of the rental contracts must compensate the landlord for the vacancy creation, quality creation, and upkeep costs $(\kappa, c(q), f)$.

Figure 3: Planner Optimality



In this section we consider several different types of rental contracts. The first type of contract allows for variable payments contingent on type and employment status much like the literature on endogenous incomplete markets. Specifically, we embed a bilateral recursive dynamic contracting problem between the landlord and renter into the matched stage of our competitive search model. The endogenous promised value from the optimal contract in the matched stage influences vacancy and quality creation in the unmatched stage. We ask whether these contracts can implement the first best where there are no evictions and egalitarian allocations. The second, more realistic contract, allows rental terms to depend on a person's type but non-contingent on employment status much like the literature on exogenous incomplete markets.

5.1 Variable Rate Rental Contracts

Since the first best contract calls for no evictions, we first consider a contract that compensates the landlord for missed payment in the case of renter unemployment by backloading the payment to a future state of employment in order to induce the landlord not to evict in the absence of commitment. We allow for transferable utility and impose renter commitment in this model, which will allow landlords to capitalize missed rent into future payments by reducing the discounted value of remaining in the apartment for the renter. The expectation of higher future rent incentivizes the landlord to keep renters who miss payments. These contracts are presented not because they are realistic, but because they highlight the difficulty of backloading in reality: renters cannot pay ever higher rent in the future due to income constraints, nor would they choose to remain in a contract with abysmal terms if they could walk away and rent elsewhere.

Landlords post contracts promising renter utility value V in submarkets based on (i, e, q, V), which have tightness $\theta_{i,e}(V, q)$. The initial promised value posted by landlords can be thought of as front-loaded payments, such as security deposits, and in fact will differ by renter types in equilibrium since $L-$types pay rent less frequently (i.e. they pay higher up front deposits). Post-match, landlords maximize profits subject to promise-keeping but still have the option of evicting a delinquent renter, which delivers the renter's outside option next period.

A landlord matched with an employed renter whose contract promised V chooses the rent r and future promised utility $v'_{e'}$ contingent on the renter's future employment state e' to solve

$$\begin{aligned} L_{i,1}(V,q) &= \max_{r,v'_0,v'_1} r - f + \beta(1-\sigma)\Big[p_{i,1}L_{i,1}(v'_1,q) + (1-p_{i,1})L_{i,0}(v'_0,q)\Big] && (4)\\ &\quad \text{s.t.}\\ q - r &+ \beta\Big[(1-\sigma)\Big(p_{i,1}v'_1 + (1-p_{i,1})v'_0\Big) + \sigma\Big(p_{i,1}V^*_{i,1} + (1-p_{i,1})V^*_{i,0}\Big)\Big] \geq V && (5)\\ &\quad L_{i,e'}(v'_{e'},q) \geq -f, \forall e' \in \{0,1\} && (6) \end{aligned}$$

while a landlord matched with an unemployed renter solves

$$\begin{aligned} L_{i,0}(V,q) &= \max_{\epsilon\in\{0,1\},v'_0,v'_1} -f + \beta(1-\epsilon)(1-\sigma)\Big[p_{i,0}L_1(v'_1,q) + (1-p_{i,0})L_0(v'_0,q)\Big] && (7)\\ &\quad \text{s.t.}\\ q &+ \beta\Big[(1-\epsilon)(1-\sigma)\Big(p_{i,0}v'_1 + (1-p_{i,0})v'_0\Big) && (8)\\ &+ (1-(1-\epsilon)(1-\sigma))\Big(p_{i,0}V^*_{i,1} + (1-p_{i,0})V^*_{i,0}\Big)\Big] \geq\\ &\quad (1-\epsilon)V + \epsilon\Big[q + \beta\Big(p_{i,0}V^*_{i,1} + (1-p_{i,0})V^*_{i,0}\Big)\Big]\\ &\quad L_{i,e'}(v'_{e'},q) \geq -f, \forall e' \in \{0,1\} && (9) \end{aligned}$$

where $V^*_{i,e}$ is the value of being unhoused for someone of type i and employment status e. Notice that we capture the limited commitment of the landlord in the promise-keeping constraints (5) and (8) by saying they must deliver at least V utility, unless they evict, in which case the constraint is weakly slack by construction. However, the option to evict places a restriction on how much value the planner can credibly promise to the renter, which is captured in inequalities (6) and (9); since eviction is always an option, the landlord cannot credibly promise the renter a value that would deliver less profit than incurring the fixed cost f and then evicting them.[7]

A solution to (4)-(8) implies not only rental rates r conditional on (i, e, V, q) but also laws of motion for future promised utility $v'_{e'}$ as a function of (i, e, V, q). This policy function $v'_{e'} = G_{e'}(i, e, V, q)$ is key to inducing the landlord to not evict following a non-payment; the renter's future promised utility v'_0 can fall relative to current promised utility V implying a higher future rental burden. It is also evident from (7) that an eviction $\epsilon = 1$ may be optimal if the unemployment state is persistent. That is, if $1 - p_{i,0}$ is large. Recall that we have assumed that $p_{H,e} \geq p_{L,e}$ so that $1 - p_{i,0}$ is larger for type L than type H. Thus, evictions are more likely to happen for type L.

Moving to the problem of an unmatched person, quality q, tightness θ, and initial rental contract promised value $V_{e'}$ are chosen to maximize the unhoused utility $V^*_{i,e}$ of given type i and employment status e in (10) subject to a participation constraint for landlords in (11):

$$\begin{aligned} V^*_{i,e} = \max_{q,\theta,V_1,V_0} \upsilon \quad &+ \quad \phi(\theta)\beta\Big[p_{i,e}V_1 + (1-p_{i,e})V_0\Big] \\ &+ \quad \beta\Big(1-\phi(\theta)\Big)\Big[p_{i,e}V^*_{i,1} + (1-p_{i,e})V^*_{i,0}\Big] \end{aligned} \tag{10}$$

s.t.

$$\kappa \leq \psi(\theta)\beta\Big[p_{i,e}L_{i,1}(V_1, q) + (1-p_{i,e})L_{i,0}(V_0, q) - c(q)\Big] \tag{11}$$

Free entry requires (11) holds with equality.

In Appendix C we show that we can implement the social planner's allocation (q^{SP}, θ^{SP}) with $\epsilon = 0$ provided the law of motion for promised utility conditional on employment status follows:

$$v'_1 = G_1(i, e, V, q) \quad = \quad \frac{V}{1-\sigma} \tag{12}$$

$$v'_0 = G_0(i, e, V, q) \quad = \quad \frac{V - q - \beta\sigma\big(p_{i,e}V^*_{i,1} + (1-p_{i,e})V^*_{i,0}\big)}{\beta(1-\sigma)} \tag{13}$$

Note that (13) implies that $v'_0 < V$ since the difference $v'_0 - V$ is equal to

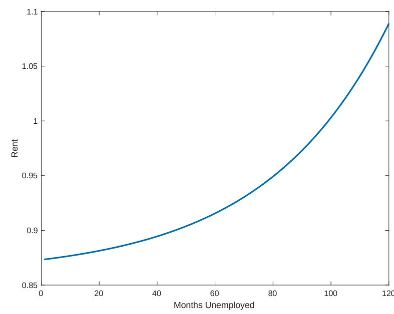
$$\frac{q + \beta\sigma\big(p_{i,e}V^*_{i,1} + (1-p_{i,e})V^*_{i,0}\big) - (1-\beta(1-\sigma))V}{\beta(1-\sigma)}$$

which must be negative since otherwise the renter would have been promised a $V > \frac{q}{1-\beta(1-\sigma)}$ which is itself larger than the entire match surplus (implying the landlord would have made

[7] See Lagakos and Ordonez [10] for a similar model with limited commitment that accommodates the possibility of a match dissolving endogenously.

a promise that delivered negative profits up front). This implies that future rent in the absence of current payment must rise, as seen in Figure (4).[8]

Figure 4: Rent Over Unemployment Spell



Hence across certain employment realizations (i.e. long term unemployment spells), the implied rental burden becomes so large that it is not credible for a renter to commit to that contract and instead exits the rental to enter an unhoused state where they can obtain $V^*_{i,0}$. Note that even if the delinquent renter is punished by future exclusion from rental, the lower bound of their utility is given by $\frac{v}{1-\beta}$.

5.2 Fixed Rate Rental Contracts

In reality, renters have limited ability to repay missed rent - median renter networth was only \$6300 (e.g. a used car) in 2019 (SCF). Even if rent could be increased with delinquency length as in subsection 5.1, a finite bound on the PDV of income means that evictions eventually occur. Borrowing constraints impose an even lower bound. For instance, if a renter is unemployed, they would be unable to borrow to pay rent under Aiyagari's natural borrowing limit given the possibility of permanently low α income which must be spent on subsistence consumption. Given the presence of subsistence consumption, a hand-to-mouth renter of type i can afford to pay at most rent $r_i = y_i - \alpha$.

[8]This model implicitly allows for transferable utility, so there are many potential rent functions that deliver the same values for renters and landlords. We impose that all transfers post-match must be done through rents to create Figure (4).

5.2.1 Competitive Equilibrium

A landlord who has a renter with constant rent r and housing quality q has the following values:

$$L_{i,1}(r,q) = r - f + \beta(1-\sigma)\Big[p_{i,1}L_{i,1}(r,q) + (1-p_{i,1})L_{i,0}(r,q)\Big], \tag{14}$$

$$L_{i,0}(r,q) = \max_{\epsilon\in\{0,1\}} -f + \beta(1-\sigma)(1-\epsilon)\Big[p_{i,0}L_{i,1}(r,q) + (1-p_{i,0})L_{i,0}(r,q)\Big] \tag{15}$$

Note that unemployed renters pay 0 and may be evicted in (15). The landlord chooses to evict ($\epsilon = 1$) if expected discounted profits are negative since posting a new vacancy has zero net profit for landlord:

$$p_{i,0}L_{i,1}(r,q) + (1-p_{i,0})L_{i,0}(r,q) < 0 \iff$$
$$p_{i,0}\underbrace{\left[L_{i,1}(r,q) - L_{i,0}(r,q)\right]}_{>0} + \underbrace{L_{i,0}(r,q)}_{<0} < 0$$

It is clear from above that eviction is more likely for $L-$type renters since they have a lower job finding rate since $p_{L,0} = 0.17 < p_{H,0} = 0.89$ from Table 2.

A renter in a unit of quality q with constant rent r has the following values:

$$R_{i,1}(r,q) = y_i - \alpha + q - r + \beta(1-\sigma)\Big[p_{i,1}R_{i,1}(r,q) + (1-p_{i,1})R_{i,0}(r,q)\Big], \tag{16}$$

$$\begin{aligned} R_{i,0}(r,q) &= q + \beta\Big[(1-\sigma)(1-\epsilon)\big(p_{i,0}R_{i,1}(r,q) + (1-p_{i,0})R_{i,0}(r,q)\big) \\ &+ (1-(1-\sigma)(1-\epsilon))\big(p_{i,0}V^*_{i,1} + (1-p_{i,0})V^*_{i,0}\big)\Big] \end{aligned} \tag{17}$$

Note that unemployed renters receive q, pay 0, and may be evicted in (17). If evicted, the person becomes unhoused and searches next period obtaining $V^*_{i,e}$.

Landlords post contracts $(r_{i,e}, q_{i,e})$ to which unhoused people direct their search to a submarket with tightness $\theta_{i,e}$. The decentralized equilibrium allocations maximize unhoused utility in (18) subject to landlord participation in (19):

$$\begin{aligned} V^*_{i,e} &= y_{i,e} - \alpha + \upsilon + \max_{r\le y_i-\alpha,q,\theta} \beta\Big[\phi(\theta)\Big(p_{i,e}R_{i,1}(r,q) + (1-p_{i,e})R_{i,0}(r,q)\Big) \\ &+ \big(1-\phi(\theta)\big)\Big(p_{i,e}V^*_{i,1} + (1-p_{i,e})V^*_{i,0}\Big)\Big] \end{aligned} \tag{18}$$

s.t.

$$\kappa \leq \beta\psi(\theta)\Big[p_{i,e}L_{i,1}(r,q) + (1-p_{i,e})L_i^0(r,q) - c(q)\Big], \tag{19}$$

Free entry requires (19) holds with equality.

Given $(r_{i,e}, q_{i,e}, \theta_{i,e})$, the laws of motion for the fraction of individuals in different employment and housing states are given by

$$\mu_{i,1}^{h\prime} = p_{i,1}\Big[(1-\sigma)\mu_{i,1}^h + \phi(\theta_{i,1})\mu_{i,1}^u\Big] + p_{i,0}\Big[(1-\sigma)\mu_{i,0}^h + \phi(\theta_{i,0})\mu_{i,0}^u\Big] \tag{20}$$

$$\mu_{i,0}^{h\prime} = (1-p_{i,1})\Big[(1-\sigma)\mu_{i,1}^h + \phi(\theta_{i,1})\mu_{i,1}^u\Big] + (1-p_{i,0})\Big[(1-\sigma)\mu_{i,0}^h + \phi(\theta_{i,0})\mu_{i,0}^u\Big] \tag{21}$$

$$\mu_{i,1}^{u\prime} = p_{i,1}\Big[\sigma\mu_{i,1}^h + \big(1-\phi(\theta_{i,1})\big)\mu_{i,1}^u\Big] + p_{i,0}\Big[\sigma\mu_{i,0}^h + \big(1-\phi(\theta_{i,0})\big)\mu_{i,0}^u\Big] \tag{22}$$

$$\mu_{i,0}^{u\prime} = (1-p_{i,1})\Big[\sigma\mu_{i,1}^h + \big(1-\phi(\theta_{i,1})\big)\mu_{i,1}^u\Big] + (1-p_{i,0})\Big[\sigma\mu_{i,0}^h + \big(1-\phi(\theta_{i,0})\big)\mu_{i,0}^u\Big] \tag{23}$$

Notice that equilibrium choices of $\theta_{i,e}$ influence the equilibrium distribution of housed and unhoused individuals in our economy.

Definition 1. *A steady state competitive search equilibrium with constant rent contracts and no externalities is*

- *rents $r_{i,e}$ on units of quality $q_{i,e}$ and vacancy posting for those contracts with tightness $\theta_{i,e}$ that satisfy (18)-(19) given (14) - (17),*
- *eviction choices $\epsilon_{i,0}$ satisfy (15)*
- *a fixed point of the laws of motion over employment and housing $\mu_{i,e}^j$ from (20) through (23)*
- *neighborhoods of quality $Q_i = q_{i,1}\sum_{e\in\{0,1\}}\mu_{i,e}^h(q_{i,1}) + q_{i,0}\sum_{e\in\{0,1\}}\mu_{i,e}^h(q_{i,0})$*

Notice that in the absence of externalities, neighborhood quality Q_i does not enter (14)-(17). Thus, $(r_{i,e}, q_{i,e}, \theta_{i,e}, \epsilon_{i,0})$ are independent of $\mu_{i,e}^j$. This is the property that generates block recursivity.

5.2.2 Parameterized Example

Here we illustrate the workings of the model through a parameterized example in Table 3. We use $M(U,V) = \frac{U\cdot V}{\left(U^\nu+V^\nu\right)^{\frac{1}{\nu}}}$ which gives finding and filling rates of $\phi(\theta) = \frac{\theta}{(1+\theta^\nu)^{\frac{1}{\nu}}}$

and $\psi(\theta) = \frac{1}{(1+\theta^\nu)^{\frac{1}{\nu}}}$.[9] The cost function is $c(q) = e^{C_0\left(q-f-b\right)} - 1$.[10] Key are the earnings parameters of the two types of renters that came from the CPS in Table 1. Consistent with our assumptions $p_{H,e} > p_{L,e}$ and $y_H > y_L$ so that type H have higher expected income than type L. Another important parameter is the level of subsistence consumption α which we take equal to 1.

Table 3: Parameterized Example

Parameters	Values
$(p_{L,0}, p_{H,0})$	(0.17,0.89)
$(p_{L,1}, p_{H,1})$	(0.57,0.96)
(y_L, y_H)	(2,3)
α	1
β	$0.96^{1/12}$
C_0	$\frac{0.004}{1-\beta}$
κ	0.1
f	0.325
υ	0
σ	0.01
ν	1
(μ_L, μ_H)	(0.1,0.9)

Policies	$\xi = 0$	$\xi = 0.01$
$(r_{H,1}, q_{H,1})$	(1.203,3.845)	(1.227,3.867)
$(r_{H,0}, q_{H,0})$	(1.211,3.851)	(1.215,3.855)
$(r_{L,1}, q_{L,1})$	(1,0.6207)	(1,0.6285)
$(r_{L,0}, q_{L,0})$	$\emptyset$	$\emptyset$
$\epsilon_H(r_{H,e}, q_{H,e})$	0	0
$\epsilon_L(r_{L,0}, q_{L,0})$	1	1
$(\theta_{H,1}, \phi(\theta_{H,1}))$	(0.2106,0.826)	(0.1767,0.8498)
$(\theta_{H,0}, \phi(\theta_{H,0}))$	(0.1978,0.8348)	(0.2015,0.8323)
$(\theta_{L,1}, \phi(\theta_{L,1}))$	(2.342,0.2992)	(3.373,0.2287)
(Q_L, Q_H)	(0.00868,3.419)	(0.007194,3.44)
$V^*_{H,1}$	1632	1646
$V^*_{H,0}$	1628	1642
$V^*_{L,1}$	171.4	170.2
(q^{sp}_L, q^{sp}_H)	(3.847,3.847)	(3.847,3.866)
$(\theta^{sp}_H, \phi(\theta^{sp}_H))$	(0.1948,0.837)	(0.1917,0.8391)
$(\theta^{sp}_L, \phi(\theta^{sp}_L))$	(0.1948,0.837)	(0.1947,0.837)
(Q^{sp}_L, Q^{sp}_H)	(0.3802,3.421)	(0.3802,3.438)

Equilibrium Statistics	$\xi = 0$	$\xi = 0.01$
$(r_{H,1}/(q_{H,1}Q^\xi_H))$	0.313	0.309
$(r_{L,1}/(q_{L,1}Q^\xi_L))$	1.611	1.692
$(r_{H,1}/Y_H)$	0.401	0.404
$(r_{L,1}/Y_L)$	0.5	0.5

In this section, we focus on the results for no externalities (i.e. $\xi = 0$) in Table 3. Type H renters pay higher rent, enjoy higher quality, and have higher rental finding rates than type L. On the other hand, type L have higher rent-to-quality $(r_{i,e}/q_{i,e})$ and higher rental burdens $(r_{i,e}/y_i)$ than type H. Type H are not evicted while type L are evicted following missed

[9] This matching function gives non-constant elasticities of the finding and filling rates with respect to θ. With $\nu = 1$, which is our baseline value, these elasticities are equal to $-\frac{\theta}{1+\theta}$ and $\frac{1}{1+\theta}$, respectively. In our calibration, the average elasticity of the filling rate to tightness is 0.84, which is the estimate of Genosove and Han [6] for the matching technology in the market for home sales.

[10] Note that for C_0 sufficiently small this specification is approximately consistent with the sufficient condition of $c'(f + b) = 0$ to ensure that the social planner posts positive vacancies for every type of person.

payment due to unemployment. Unemployed type L are shut out of the rental market. Our estimates of job finding rates ($p_{H,0} = 0.89$ implying an average duration of unemployment of 1.1 months and $p_{L,0} = 0.17$ implying an average duration of unemployment of 5.8 months) in Table 3 explain why landlords do not evict type H, but evict type L as well as why type L are shut out of the rental market; a landlord who is matched with a currently unemployed type H will soon be paid rent while it will take a long time to be paid again. In the former case, it is not worth evicting and then bearing the costs κ and $c(q)$ as well as a probability of finding a renter $\psi(\theta)$ of offering a new rental while the opposite is true for type L. Type L have a binding subsistence consumption constraint (i.e. $r_L = y_L - \alpha$) while type H do not. All these properties are very different from the egalitarian allocation of the planner's problem where everyone effectively receives the type H allocation with higher finding rates.

5.2.3 Eviction Policies

As evident in the previous subsection, unlike the social planner's solution, landlords evict low income types since they when unemployed they have a lower job finding rate and earn less (so once employed the landlord still cannot garner enough rent to cover the period of loss). Therefore, here we consider if an eviction moratorium (to implement one part of the planner's solution) is optimal in a decentralized competitive search environment.

Specifically, here we introduce a restriction on eviction: a landlord who wants to evict a delinquent renter is allowed to do so with probability $\lambda \in [0, 1]$.[11] The prior subsection set $\lambda = 1$ while an eviction moratorium corresponds to $\lambda = 0$ (which effectively imposes landlord commitment). A policy maker who sets λ trades off two forces: (i) increased social surplus from maintaining a match arising from a low λ; (ii) lower landlord profits (hence lower quality and/or vacancies) if landlords can't evict an unemployed person arising from a low λ.

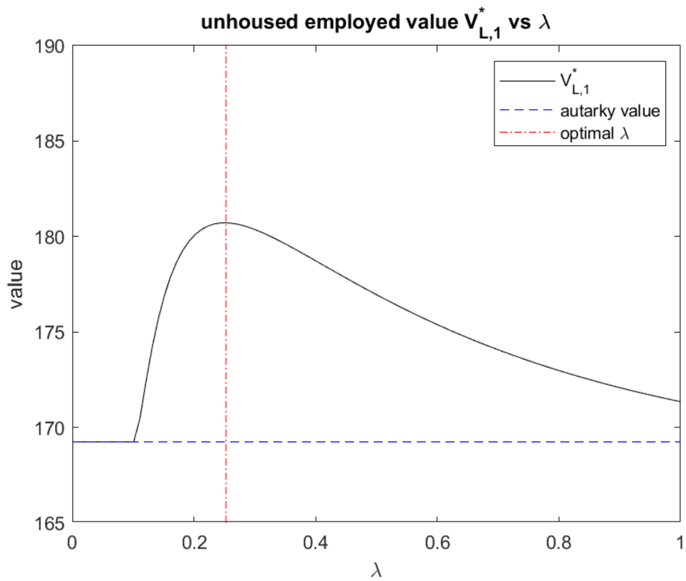
Figure 5 illustrates the effect of restricting evictions on equilibrium utility $V^*_{L,1}(r, q)$ an unhoused, employed type L person. Specifically, if there are no restrictions (i.e. $\lambda = 1$), utility is lower than if there is some degree of restrictions. In fact, as the example shows, utility is maximized at $\lambda = 0.25$. On the other hand, starting at $\lambda = 0.1$ down to $\lambda = 0$ an unhoused, employed L type person is so "costly" to a landlord that she does not find a rental unit. For $\lambda > 0.1$ the type L subsistence constraint $c_{L,e} = y_L - \alpha - r_L$ is binding implying $r_L = 1$. The binding constraint implies the landlord cannot recoup a future higher rental rate than r_L=1.[12] Thus, Figure 5 illustrates that some restrictions on eviction are

[11] As in Abramson [1] this probability captures the strength of tenant protections against evictions.

[12] In contrast type H do not face a binding constraint throughout $\lambda \in [0, 1]$ and pay approximately double the type L rent.

optimal since eviction destroys matches with positive social surplus but a full out eviction moratorium means all type L, both employed and unemployed, cannot find rental units.

Figure 5: Unhoused Employed Low-type Renter Value

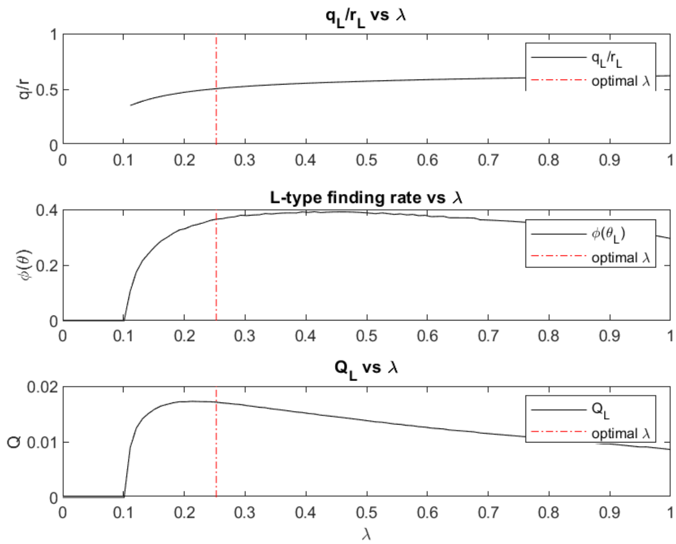


Notes: Black line: $V^*_{L,1}$ evaluated at equilibrium $(q_{L,1}, \theta_{L,1})$ computed for given $\lambda \in [0,1]$. Peak at $\lambda = 0.25$ (red line). Blue line: unhoused value $v/(1-\beta) + y/(1-p_{L,1}\beta)$ with $\theta_{L,1} = 0$ starting at $\lambda = 0.1$.

Figure 6 illustrates the properties of the competitive search equilibrium across λ to complement the previous figure. The top panel shows that quality-to-rental price for low type people drops with more restrictions on the ability to evict. The middle panel shows that rental finding rates drop ($\phi(\theta_L)$ falls since θ_L falls) as evictions are restricted. Finally, the bottom panel shows that total amount of low income neighborhood quality rentals Q_L is non-monotonic. This arises because while individual quality q (intensive margin) falls with eviction restrictions, the number of evictions (extensive margin) is also falling so it is a horse race between the two margins. The latter two outcomes provide an example of the unintended consequences of eviction restrictions similar to the unintended consequences of firing costs in Hopenhayn and Rogerson [7]; eviction restrictions which lower landlord profitability can result in less rental vacancies just as firing costs lower firm profitability resulting in higher unemployment.

Figure 7 illustrates the effect of a binding constraint on rental payments implied by the subsistence consumption requirement faced by all households. In particular, we consider the consequences of relaxing the constraint (in particular we set $\alpha = 0.9$ rather than $\alpha = 1$ as in prior experiments). The top left panel makes it clear that relaxing the rental constraint, which means the L type person can more easily afford to pay the landlord a higher rent

Figure 6: Unhoused Employed Low-type Renter Policies



(evident in the top right panel) enabling the landlord to better recoup from lost payments during type L unemployment spells, leads to even less eviction restrictions (i.e. the market incentivizes landlords rather than requiring outside forms of commitment). The higher rental payments lead landlords to post more vacancies in the middle left panel and offer higher quality rentals in the bottom left panel along with a higher total quantity of quality units in the bottom right panel.

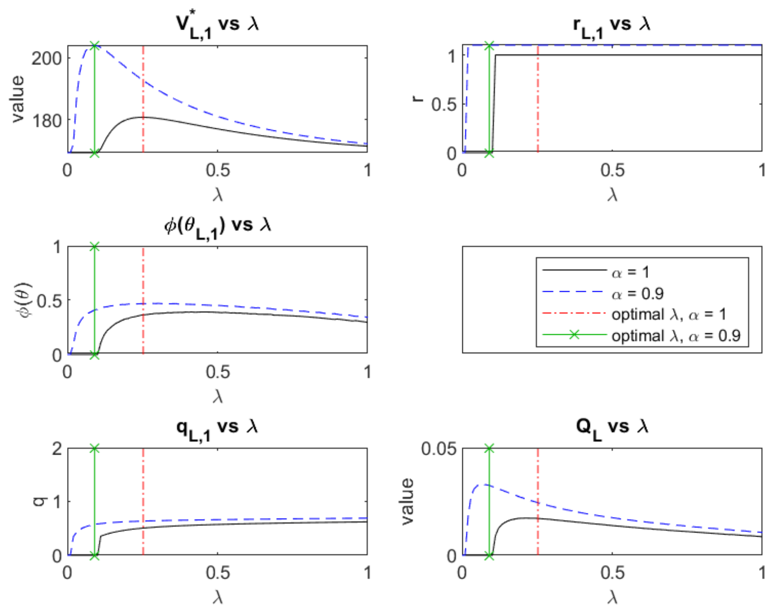
6 Decentralized Equilibrium with Fluctuations

The block-recursivity of our model in the no-externality case allows us to implement aggregate uncertainty in a straightforward way.[13] Thus, we are able to investigate the relationship between economic downturns and eviction policies.

We now add aggregate uncertainty to our environment. In particular there are two aggregate states, $s \in \{g, b\}$ where $s = g$ corresponds to a baseline state like that parameterized above and $s = b$ corresponds to a crisis state where there is a sudden spike in unemployment. The timing of our model with aggregate uncertainty matches exactly the timing without aggregate uncertainty, but the Markov process on employment states depends on the current aggregate state. Specifically, the job-finding rates $p_{i,0}(s)$ and job retention rates $p_{i,1}(s)$ are

[13]Block recursivity, as developed by Menzio and Shi [11], means that the equilibrium rental, tightness, quality, and eviction policies are independent of the distributions of individuals over employment and housing contracts. With directed search to submarkets $(r_{i,e}, q_{i,e})$, renters and landlords do not need to know $\mu^j_{i,e}$ to solve for $(r_{i,e}, q_{i,e}, \theta_{i,e}, \epsilon_{i,0})$ given that value functions and participation constraints do not involve $\mu^j_{i,e}$.

Figure 7: Interaction between Constraint and Policy



Notes: Black line: Outcomes for $\alpha = 1$ with peak at $\lambda = 0.25$ (red line) as in previous Figures. Dotted Blue line: Outcomes for $\alpha = 0.9$ with peak at $\lambda = 0.09$.

aggregate state dependent. The aggregate state itself evolves according to a Markov process.

Given the landlord and renter values conditional on matching, described in Appendix D, the unhoused renter solves the following:

$$V^*_{i,e}(s) = y_{i,e} - \alpha + \upsilon + \max_{r \leq y_i - \alpha, q, \theta} \beta \mathbb{E}_{s'|s} \Bigg[\phi(\theta) \Bigg(p_{i,e}(s) R_{i,1}(r,q;s') + (1 - p_{i,e}(s)) R_{i,0}(r,q;s') \Bigg)$$
$$+ \left(1 - \phi(\theta)\right) \Bigg(p_{i,e}(s) V^*_{i,1}(s') + (1 - p_{i,e}(s)) V^*_{i,0}(s') \Bigg) \Bigg]$$

s.t.

$$\kappa \leq \beta \psi(\theta) \mathbb{E}_{s'|s} \Bigg[p_{i,e}(s) L_{i,1}(r,q;s') + (1 - p_{i,e}(s)) L_{i,0}(r,q;s') - c(q) \Bigg],$$

As discussed above, state $s = g$ is parameterized as in the benchmark above which appears again in Table 4. As an example, we model the crisis event $s = b$ as having a job retention rate $p_{i,1}(b) = 0$ $\forall i$ (i.e. everyone employed loses their job). We maintain, however, job finding rates from the benchmark. We assume that state $s = g$ is very persistent (expected duration is 100 months) while the crisis state $s = b$ is transitory (expected duration is 2 months). In this environment, we consider three choices for eviction policies. Specifically, we allow for the eviction success rate to be aggregate-state dependent, $\lambda(s)$, and consider a no-moratorium policy $(\lambda(g), \lambda(b)) = (1, 1)$, moratorium in a b state but not in a g state $(\lambda(g), \lambda(b)) = (1, 0)$, and full moratorium $(\lambda(g), \lambda(b)) = (0, 0)$.

Table 4: Aggregate Uncertainty Parameterization

Parameters	Values
$(p_{L,0}(s), p_{H,0}(s))$	(0.17,0.89)
$(p_{L,1}(g), p_{H,1}(g))$	(0.57,0.96)
$(p_{L,1}(b), p_{H,1}(b))$	(0,0)
$Pr(s' = g \vert s = g)$	0.99
$Pr(s' = g \vert s = b)$	0.5
(y_L, y_H)	(2,3)
α	1
β	$0.96^{1/12}$
C_0	$\frac{0.004}{1-\beta}$
κ	0.1
f	0.35
b	0
σ	0.01
ν	1
(μ_L, μ_H)	(0.1,0.9)

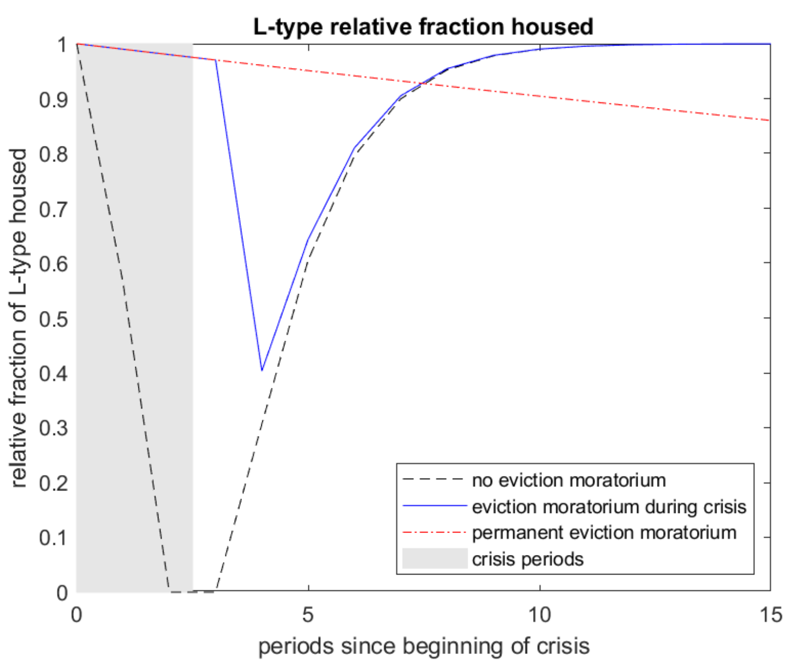
Table 5 lists the equilibrium outcomes with aggregate uncertainty. While type H are in general worse off in state b than state g (in fact an unemployed type H cannot find housing in the bad state), their outcomes (and welfare) are invariant across the different policies since landlords would not choose to evict them anyway given their high job finding rate even in state b. The different policies have an important effect, however, on type L hhs. Specifically, we see that the state dependent moratorium policy $(\lambda(g), \lambda(b)) = (1, 0)$ raises the welfare of the type L household relative to no moratorium policy $(\lambda(g), \lambda(b)) = (1, 1)$. While not unexpected given the results in subsection 5.2.3, the table also shows that imposing moratoria in all states $(\lambda(g), \lambda(b)) = (0, 0)$ leads to lower welfare since it collapses the rental market for the L-type hhs. This provides and example where temporary moratorium policy to alleviate the effects of severe economic downturns can be welfare improving.

Table 5: Aggregate Uncertainty Equilibrium Outcomes

	Eviction Moratorium in State: Neither	Bust Only	Both
$V^{*,g}_{L,1}$	**168.6**	**168.8**	**167.9**
$V^{*,b}_{L,1}$	**166.4**	**166.5**	**165.7**
$V^{*,g}_{H,1}$	1592	1592	1592
$V^{*,b}_{H,1}$	1586	1586	1586
$V^{*,g}_{H,0}$	1589	1589	1589
$V^{*,b}_{H,0}$	1583	1583	1583
$(r^g_{H,1}, q^g_{H,1})$	(1.217,3.843)	(1.217,3.843)	(1.217,3.843)
$(r^b_{H,1}, q^b_{H,1})$	(1.269,3.869)	(1.269,3.869)	(1.269,3.869)
$(r^g_{H,0}, q^g_{H,0})$	(1.248,3.869)	(1.248,3.869)	(1.248,3.869)
$(r^b_{H,0}, q^b_{H,0})$	$\emptyset$	$\emptyset$	$\emptyset$
$(r^g_{L,1}, q^g_{L,1})$	(1,0.6152)	(1,0.6131)	$\emptyset$
$(r^b_{L,1}, q^b_{L,1})$	$\emptyset$	$\emptyset$	$\emptyset$
$(r^s_{L,0}, q^s_{L,0})$	$\emptyset$	$\emptyset$	$\emptyset$
$\epsilon^s_H(r^s_{H,e}, q^s_{H,e})$	0	0	0
$\epsilon^s_L(r^s_{L,0}, q^s_{L,0})$	1	1	1
$(\theta^g_{H,1}, \phi(\theta^g_{H,1}))$	(0.2181,0.8209)	(0.2181,0.8209)	(0.2181,0.8209)
$(\theta^b_{H,1}, \phi(\theta^b_{H,1}))$	(0.1823,0.8458)	(0.1823,0.8458)	(0.1823,0.8458)
$(\theta^g_{H,0}, \phi(\theta^g_{H,0}))$	(0.1508,0.8689)	(0.1508,0.8689)	(0.1508,0.8689)
$(\theta^b_{H,0}, \phi(\theta^b_{H,0}))$	$\emptyset$	$\emptyset$	$\emptyset$
$(\theta^g_{L,1}, \phi(\theta^g_{L,1}))$	(2.455,0.2894)	(2.491,0.2864)	$\emptyset$
$(\theta^b_{L,1}, \phi(\theta^b_{L,1}))$	$\emptyset$	$\emptyset$	$\emptyset$
$(\theta^g_{L,0}, \phi(\theta^g_{L,0}))$	$\emptyset$	$\emptyset$	$\emptyset$
$(\theta^b_{L,0}, \phi(\theta^b_{L,0}))$	$\emptyset$	$\emptyset$	$\emptyset$

To demonstrate the effect of the aggregate state-dependent moratorium policy, we plot the response of the fraction of L-type renters housed during a 3 period crisis. In Figure 8 we plot the responses under a no-moratorium policy and under a crisis-moratorium policy. The difference in outcomes for the L-type renters is stark. At the beginning of the crisis, without the moratorium policy all housed L-type renters are evicted by period 2. In period 0, the onset of the crisis, 44 percent of the L-type renters are unemployed and these renters are evicted heading into period 1. The remaining 56 percent of L-type renters lose their jobs due to the crisis heading into period 1, so they all are evicted at the end of period 1 heading into period 2. Under the state-dependent moratorium policy, however, the L-type renters are allowed to remain housed throughout the crisis. Exogenous rental separations still occur, but by the beginning of period 3, the first post-crisis period, 97 percent of the L-type renters remain housed relative to 0 percent without the moratorium policy. While the lifting of the moratorium after the crisis leads to a later rise in evictions, causing the relative fraction housed to fall to 40 percent in period 4, this fraction is higher than the relative fraction housed in period 4 under the no-moratorium policy (30 percent). Overall, many more L-type renters are able to remain housed throughout the crisis under the crisis moratorium policy. By comparison, under a permanent moratorium policy, the L-type rental market shuts down and while the moratorium prevents a sudden wave of evictions, it results in disastrous long-run consequences. By period 15 under the permanent moratorium, the fraction of L-types housed is 86 percent of the baseline steady-state fraction, and the fraction housed under this policy eventually converges to a new steady state without any housed L-type renters.

Figure 8: Aggregate Uncertainty Experiment



Notes: Dashed Black line: L-type response to 3-period crisis with $(\lambda(g), \lambda(b)) = (1, 1)$. Blue line: L-type response to 3-period crisis with $(\lambda(g), \lambda(b)) = (1, 0)$. Dash-dotted red line: L-type response to 3-period crisis with $(\lambda(g), \lambda(b)) = (0, 0)$.

7 Neighborhood Externalities

Now we consider the effect of positive neighborhood externalities; the flow utility of having individual housing quality q is affected by the total quality of agents of the same type, with spillover factor ξ, so that total flow utility for type i in housing of quality q is qQ_i^{ξ}. Section 4 considered the allocation chosen by a social planner who internalizes this externality. That section showed that while the planner still chooses not to evict anyone, unlike the $\xi = 0$ case quality and tightness will in general depend on type i but not employment status e. As evident in equation (3) the dependence on i is linked to asymmetries in the fraction of each type of people (i.e. $\mu^u_{i,e}$). With symmetry however, Q_i will be independent of i and hence equations (1) and (2) will be independent of i. Table 3 contrasts the effect of externalities on the social planner's allocation in the asymmetric case where (μ_L, μ_H)=$(0.1, 0.9)$. Specifically, it verifies that per unit quality (weakly) rises (from 3.847 to 8.64 for type L and 3.866 for type H) as well as finding rates (from 0.837 to 0.837 for type L and 0.8391 for type H). Hence, as expected the planner internalizes the presence of positive neighborhood effects.

Table 3 also calculates the effect of the externality on the decentralized equilibrium with constant rent contracts. As in the planner's problem, quality rises but so do unconstrained rents for type H. Type L quality also rises, but finding rates fall since rents stay fixed by the constraint to meet subsistence consumption. Importantly, the externality has a large impact on inequality between type L and H. Specifically, we note that the rent-to-neighborhood value ratio decreases for type H by over 1% while it increases by over 5% for type L. In terms of normative measures, the percentage change in lifetime utility of type i (i.e. $(V^*_{i,e}(\xi = 0.01) - V^*_{i,e}(\xi = 0))/V^*_{i,e}(\xi = 0)$) rises approximately 0.9% and 0.9% for type H in $e = 0$ and $e = 1$ states, while it drops approximately 0.7% for type L in state $e = 1$. Thus, the gap between rich and poor renters widens in the presence of neighborhood externalities.

8 Conclusion

We present an equilibrium theory of rental markets in which the quality and tightness of the rental market is endogenous. The theory can rationalize high rents for low-quality housing for poorer tenants who are likely to be evicted, which itself is an endogenous outcome. Importantly, the model is a useful laboratory for considering policies that make it harder to evict delinquent renters and highlights the non-trivial interaction between constraints on rental rates and the social desirability of eviction restrictions. The model illustrates that there can be important unintended consequences of eviction moratoriums emanating from the supply side of the rental market; eviction restrictions to keep people in rentals, even if ex-post socially optimal, result in lower supply of both vacancies and quality of rentals. We also show that state dependent policies during a crisis may be welfare increasing and that neighborhood externalities can widen the gap between rich and poor renters.

References

[1] Abramson, B. (2021) "The Welfare Effects of Eviction and Homelessness Policies," mimeo.

[2] Collinson, R. and D. Reed (2018) "The Effects of Evictions on Low-Income Households," mimeo.

[3] Desmond, M. (2016) *Evicted: Poverty and Profit in the America City*, New York: Crown.

[4] Desmond, M. and C. Gershenson (2016) "Who gets evicted? Assessing individual, neighborhood, and network factors," *Social Science Research*, http://dx.doi.org/10.1016/j.ssresearch.2016.08.017.

[5] Desmond, M. and Wilmers, N. (2019). "Do the poor pay more for housing? Exploitation, profit, and risk in rental markets," American Journal of Sociology, 124(4), pp.1090-1124.

[6] Genesove, D. and Han, L., 2012. "Search and matching in the housing market." *Journal of Urban Economics*, 72(1), pp.31-45.

[7] Hopenhayn, H. and R. Rogerson (1993) "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," *Journal of Political Economy*, vol. 101, pp. 915-938.

[8] Humphries, J., N. Mader, D. Tannenbaum, and W. van Dijk (2019) "Does Eviction Cause Poverty? Quasi-Experimental Evidence from Cook County, IL," mimeo.

[9] Kaplan, G., Violante, G.L. and Weidner, J., 2014. The wealthy hand-to-mouth (No. w20073). National Bureau of Economic Research.

[10] Lagakos, D. and Ordonez, G.L., 2011. "Which workers get insurance within the firm?" *Journal of Monetary Economics*, 58(6-8), pp.632-645.

[11] Menzio, G. and S. Shi (2011) "Efficient Search on the Job and the Business Cycle," *Journal of Political Economy*, vol. 119, pp. 468-510.

[12] Moen, E. (1997) "Competitive Search Equilibrium," *Journal of Political Economy*, vol. 105, pp. 385-411.

[13] Mortensen, D. and C. Pissarides (1994) "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, vol. 61, pp. 397-415.

A Appendix: SCF and CPS Data

We describe the variables and sample selection for the Survey of Consumer Finance and Current Population Survey.

A.1 Survey of Consumer Finance

The Board of Governors provides a cleaned version of the Survey of Consumer Finance that provides useful variables defined at the household level. We use the following:

Table 6: SCF Variables

Name	Description
Rent	Monthly rent spending on all housing
Liquid Assets	Value of checking and savings balances
Networth	Value of all real and financial assets less all debts
Income	Income from all sources

A.2 Current Population Survey

We have matched individuals from 2018 to 2019 from monthly interviews in the CPS using their household identifier, individual identifier, state of residence, sex, race, and age. We then used the following variables to classify individuals by renter status, select working-age renters with below-median earnings, calculate average earnings, and estimate transition rates between employment statuses:

Table 7: CPS Variables

Name	Description
Housing type (hetenure)	Whether person owns housing, rents, or neither
Age (prtage)	Age of individual in years
Earnings (maximum value of prernwa)	Reference week's earnings
Employment (lfs)	Labor force status

B Appendix: Social Planner's Problem

Recalling that the flow utility to a person of type i in a housing unit of quality q is $q \cdot Q_i^{\xi}$, the total flow housing utility to the planner is $\int_{f+b}^{\infty} q \cdot Q_i^{\xi} dG_i(q)$, where $G_i(q)$ is the CDF of i

types over rental qualities. However, this is just equal to $Q_i \cdot Q_i^{\xi} = Q_i^{1+\xi}$ since by definition $Q_i = \int_{f+b}^{\infty} q dG_i(q)$.

The social planner solves:

$$
\begin{aligned}
& W\Bigg(Q_i, (\mu_{i,e}^{j})_{i\in\{H,L\},e\in\{0,1\}}^{j\in\{u,h\}}\Bigg) = \max_{(q_{i,e},\theta_{i,e})_{i,e\in\{H,L\}\times\{0,1\}}} Q_H^{1+\xi} + Q_L^{1+\xi} \\
+ \quad & \sum_{i\in\{H,L\}} \Bigg[\mu_{i,1}^{h} \cdot (y_i - \alpha - f) + \mu_{i,0}^{h} \cdot (-f) + \mu_{i,1}^{u} \cdot (y_i - \alpha + \upsilon) + \mu_{i,0}^{u} \cdot (b)\Bigg] \\
- \quad & \sum_{i\in\{H,L\},e\in\{0,1\}} \Bigg[\kappa + c(q_{i,e})\psi(\theta_{i,e})\Bigg]\theta_{i,e}^{-1} \cdot \mu_{i,e}^{u} \\
+ \quad & \beta \cdot W\Bigg(Q_i', (\mu_{i,e'}^{j\prime})_{i\in\{H,L\},e'\in\{0,1\}}^{j\in\{u,h\}}\Bigg)
\end{aligned} \tag{24}
$$

s.t.

$$
Q_i' = (1-\sigma) \cdot Q_i + \sum_{e\in\{0,1\}} \mu_{i,e}^{u} \cdot \phi\big(\theta_{i,e}\big) \cdot q_{i,e} \tag{25}
$$

$$
\mu_{i,1}^{h\prime} = p_{i,1}\Bigg[\mu_{i,1}^{h}(1-\sigma) + \mu_{i,1}^{u}\phi(\theta_{i,1})\Bigg] + p_{i,0}\Bigg[\mu_{i,0}^{h}(1-\sigma) + \mu_{i,0}^{u}\phi(\theta_{i,0})\Bigg] \tag{26}
$$

$$
\begin{aligned}
\mu_{i,0}^{h\prime} = {} & (1-p_{i,1})\Bigg[\mu_{i,1}^{h}(1-\sigma) + \mu_{i,1}^{u}\phi(\theta_{i,1})\Bigg] \\
& +(1-p_{i,0})\Bigg[\mu_{i,0}^{h}(1-\sigma) + \mu_{i,0}^{u}\phi(\theta_{i,0})\Bigg]
\end{aligned} \tag{27}
$$

$$
\begin{aligned}
\mu_{i,1}^{u\prime} = {} & p_{i,1}\Bigg[\mu_{i,1}^{h}\sigma + \mu_{i,1}^{u}\Bigg(1-\phi(\theta_{i,1})\Bigg)\Bigg] \\
& +p_{i,0}\Bigg[\mu_{i,0}^{h}\sigma + \mu_{i,0}^{u}\Bigg(1-\phi(\theta_{i,0})\Bigg)\Bigg]
\end{aligned} \tag{28}
$$

$$
\begin{aligned}
\mu_{i,0}^{u\prime} = {} & (1-p_{i,1})\Bigg[\mu_{i,1}^{h}\sigma + \mu_{i,1}^{u}\Bigg(1-\phi(\theta_{i,1})\Bigg)\Bigg] \\
& +(1-p_{i,0})\Bigg[\mu_{i,0}^{h}\sigma + \mu_{i,0}^{u}\Bigg(1-\phi(\theta_{i,0})\Bigg)\Bigg]
\end{aligned} \tag{29}
$$

C Appendix: Backloaded Contracts with Renter Commitment

In general, the optimal contracting problem has many solutions given the linearity of preferences of both the renter and landlord. We now fully solve for a solution that has all transfers post-match occur through rent payments. The solution has the form:

$$
\begin{aligned}
\epsilon_i(V,q) &= 0 && (30)\\
r_i(V,q) &= q+\beta\sigma V^* - (1-\beta)V && (31)\\
G_{i,1}(V) &= G_1(V) = \frac{V}{1-\sigma} && (32)\\
G_{i,0}(V) &= G_0(V) = \frac{V-q-\beta\sigma V^*}{\beta(1-\sigma)} && (33)\\
L_{i,e}(V) &= L(V) = \frac{q-f+\beta\sigma V^*}{1-\beta(1-\sigma)} - Vs && (34)
\end{aligned}
$$

It is straight-forward to plug these functions into the programming problems for landlords and verify that they satisfy the functional equations as well as all first order and envelope conditions. We then solve for the competitive search equilibrium in which firms post (V, θ, q):

$$
V_i^{e*} = \max_{q,\theta,V^1,V^0} \upsilon + \phi(\theta)\beta\Big[p_i^e V^1 + (1-p_i^e)V^0\Big] + \beta\Big(1-\phi(\theta)\Big)\Big[p_i^e V_i^{1*} + (1-p_i^e)V_i^{0*}\Big] \quad (35)
$$

s.t.

$$
\kappa \le \psi(\theta)\beta\Big[p_i^e L^1(V^1,q) + (1-p_i^e)L^0(V^0,q) - c(q)\Big] \quad (36)
$$

Letting Γ be the multiplier on (36), this problem has first-order conditions:

$$
\begin{aligned}
c'(q_i^e) &= \frac{\beta}{1-\beta(1-\sigma)} && (37)\\
\phi'(\theta_i^e)\Big[V^e - V_i^{e*}\Big] &= -\Gamma\psi'(\theta_i^e)\Big[\frac{q-f}{1-\beta(1-\sigma)} - V^e - c(q)\Big] && (38)\\
\phi(\theta) = \psi(\theta)\Gamma & && (39)
\end{aligned}
$$

Further note that $\phi(\theta) = \psi(\theta)\theta^{-1}$, so $\Gamma = \theta^{-1}$ and

$$
\phi'(\theta) = -\psi(\theta)\theta^{-2} + \psi'(\theta)\theta^{-1}, \quad (40)
$$

which means

$$
V^e - V_i^{e*} = \frac{\psi'(\theta)\theta}{\psi(\theta)}\Big[L_i^e(V_i^e) + V_i^e - V_i^{e*}\Big] \quad (41)
$$

This says that the renter's surplus is proportional to the total surplus of the match, where the proportionality term is the elasticity of the matching function with respect to the number of unmatched renters. Combining these conditions, we can write the equations determining

(q, θ) as

$$c'(q_i^e) = \frac{\beta}{1-\beta(1-\sigma)} \tag{42}$$

$$c(q_i^e)\phi'(\theta_i^e) - \kappa\theta^{-2} = \beta\phi'(\theta_i^e)\frac{q_i^e - f - \upsilon + \theta_{i,e}^{-1}\big(\kappa + c(q_i^e)\psi(\theta_i^e)\big)}{1-\beta(1-\sigma-\phi(\theta_i^e))}. \tag{43}$$

Clearly, these equations are independent of i and e. Furthermore, they are the same as the simplified conditions from the planner's problem, so this decentralization is able to implement the first-best.

D Appendix: Aggregate Uncertainty

A landlord who has a renter with constant rent r and housing quality q has the following values:

$$L_{i,1}(r,q;s) = r - f + \beta(1-\sigma)\mathbb{E}_{s'|s}\Big[p_{i,1}(s)L_{i,1}(r,q;s') + (1-p_{i,1}(s))L_{i,0}(r,q;s')\Big],$$

$$L_{i,0}(r,q;s) = \max_{\epsilon\in\{0,1\}} -f + \beta(1-\sigma)(1-\epsilon)\mathbb{E}_{s'|s}\Big[p_{i,0}(s)L_{i,1}(r,q;s') + (1-p_{i,0}(s))L_{i,0}(r,q;s')\Big].$$

A renter in a unit of quality q with constant rent r has the following values:

$$R_{i,1}(r,q;s) = y_i - \alpha + q - r + \beta(1-\sigma)\mathbb{E}_{s'|s}\Big[p_{i,1}(s)R_{i,1}(r,q;s') + (1-p_{i,1}(s))R_{i,0}(r,q;s')\Big],$$

$$\begin{aligned} R_{i,0}(r,q;s) &= q + \beta\mathbb{E}_{s'|s}\Big[(1-\sigma)(1-\epsilon)\big(p_{i,0}(s)R_{i,1}(r,q;s') + (1-p_{i,0}(s))R_{i,0}(r,q;s')\big) \\ &+ (1-(1-\sigma)(1-\epsilon))\big(p_{i,0}(s)V_{i,1}^*(s') + (1-p_{i,0}(s))V_{i,0}^*(s')\big)\Big]. \end{aligned}$$

E Appendix: Computation

Here we summarize the algorithm used to compute equilibria in the model without aggregate uncertainty. The version with aggregate uncertainty is solved in a near-identical way, however the ex-post landlord value function is computed numerically under aggregate uncertainty rather than analytically.

The landlord problems can be solved in closed form. Consider the landlord's value under an eviction policy:

$$L^{\eta}_{i,0}(r,q) = -f + (1-\lambda)(1-\sigma)\beta\Big[p_i^0 L^{\eta}_{i,1}(r,q) + (1-p_i^0)L^{\eta}_{i,0}(r,q)\Big]$$
$$L^{\eta}_{i,1}(r,q) = r - f + (1-\sigma)\beta\Big[p_i^1 L^{\eta}_{i,1}(r,q) + (1-p_i^1)L^{\eta}_{i,0}(r,q)\Big]$$

One can show that:

$$L^{\eta}_{i,0}(r,q) = \frac{(1-\sigma)\beta(1-\lambda)p_i^0(r-f) + (1-(1-\sigma)\beta p_i^1)(-f)}{((1-\sigma)\beta)^2(1-\lambda)(p_i^1-p_i^0) + (1-\sigma)\beta(1-\lambda)p_i^0 - (1-\sigma)\beta(1-\lambda) - (1-\sigma)\beta p_i^1 + 1}$$
$$L^{\eta}_{i,1}(r,q) = \frac{(1-(1-\sigma)\beta(1-\lambda)(1-p_i^0))(r-f) + (1-\sigma)\beta(1-p_i^1)(-f)}{((1-\sigma)\beta)^2(1-\lambda)(p_i^1-p_i^0) + (1-\sigma)\beta(1-\lambda)p_i^0 - (1-\sigma)\beta(1-\lambda) - (1-\sigma)\beta p_i^1 + 1}$$

Under a non-eviction policy, the landlord's value satisfies:

$$L^{n}_{i,0}(r,q) = -f + (1-\sigma)\beta\Big[p_i^0 L^{n}_{i,1}(r,q) + (1-p_i^0)L^{n}_{i,0}(r,q)\Big]$$
$$L^{n}_{i,1}(r,q) = r - f + (1-\sigma)\beta\Big[p_i^1 L^{n}_{i,1}(r,q) + (1-p_i^1)L^{n}_{i,0}(r,q)\Big]$$

These equations can also be solved:

$$L^{n}_{i,0}(r,q) = \frac{(1-\sigma)\beta p_i^0 r}{(1-(1-\sigma)\beta(p_i^1-p_i^0))(1-(1-\sigma)\beta)} + \frac{(-f)}{1-(1-\sigma)\beta}$$
$$L^{n}_{i,1}(r,q) = \frac{(1-(1-\sigma)\beta(p_i^1-p_i^0))(-f) + (1-(1-\sigma)\beta(1-p_i^0))r}{(1-(1-\sigma)\beta)(1-(1-\sigma)\beta(p_i^1-p_i^0))}$$

A landlord will choose to evict if:

$$L^{\eta}_{i,0}(r,q) > L^{n}_{i,0}(r,q)$$

Thus,

$$L_{i,0}(r,q) = \begin{cases} L^{\eta}_{i,0}(r,q), & \text{if } L^{\eta}_{i,0}(r,q) \quad > L^{n}_{i,0}(r,q) \\ L^{n}_{i,0}(r,q), & \text{o.w.} \end{cases}$$
$$L_{i,1}(r,q) = \begin{cases} L^{\eta}_{i,1}(r,q), & \text{if } L^{\eta}_{i,0}(r,q) \quad > L^{n}_{i,0}(r,q) \\ L^{n}_{i,1}(r,q), & \text{o.w.} \end{cases}.$$

Therefore, we can compute the tightness and eviction policy of any (r, q) submarket for any household type i and employment status e analytically by inverting the landlord free entry condition. This allows us to solve the renter's problem numerically using value function iteration. For cases with the externality, Q_i is computed at the end of each iteration. Since it is not defined directly by a contraction, we find it faster to update Q_i and other equilibrium objects gradually to avoid oscillation. Hence, we set $\rho \in (0, 1]$ and compute the equilibrium using the following algorithm:

1. Discretize $(r, q) \in \mathcal{R} \times \mathcal{Q}$ for appropriate grids $\mathcal{R}$, $\mathcal{Q}$.

2. Compute $\theta_i(r, q)$ for each i and each (r, q) by computing landlord values.

3. Initialize guesses: $Q^0_i, V^{*,0}_{i,e}, R^0_{i,e}$.

4. Given guesses $Q^n_i, V^{*,n}_{i,e}, R^n_{i,e}$ compute updates $Q^{n+1,u}_i, V^{*,n+1,u}_{i,e}, R^{n+1,u}_{i,e}$ using (16), (17), (18), and by computing the stationary distribution of households given $\theta^{n+1,u}_{i,e}$ to integrate the quality.

5. Check for convergence. If not converged, update guesses for equilibrium objects x by $x^{n+1} = \rho x^{n+1,u} + (1 - \rho)x^n$ and return to 4.