MOVING COSTS, SECURITY OF TENURE AND EVICTION

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ABSTRACT

We contrast equilibrium and welfare analysis in the rental housing market under two property rights regimes – eviction rights and security of tenure – when tenants face moving costs. A tenant's idiosyncratic benefit from his unit and a landlord's idiosyncratic profit from conversion are treated as private information. The two regimes differ when a tenant wants to stay in his unit but the landlord wants to redevelop it. North American housing markets have been characterized by eviction rights and many European housing markets by security of tenure. Under eviction rights, a landlord who evicts a tenant imposes a negative externality on him, which can be imperfectly internalized through a demolition (conversion) tax. Similarly, under security of tenure efficiency can be improved by subsidizing the moving costs of tenants.

Key words: Moving costs, eviction, tenure security, rental housing markets

JEL classification: D61, D62, D82, H21, R21, R31

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1. Introduction

A sitting tenant wishes to stay in her apartment. The landlord wishes to redevelop it. How is the conflict resolved? How should it be resolved? There are three general approaches to answering such questions. The first is to apply the Coase Theorem [Coase (1960), Farrell (1987), de Meza (1988), Anderlini and Felli (2001)] which states that, in the absence of bargaining or contracting costs and with perfect information, the conflict will be resolved efficiently if the government does no more than allocate property rights. The allocation of property rights affects the division of surplus between the two parties, but not the Pareto efficiency of the negotiated outcome. This is a strong result obtained by employing strong assumptions.

The second approach is to model the negotiation process between the two parties, treating explicitly the bargaining/contracting costs and the asymmetries of information. Unfortunately, the properties of negotiation games are sensitive to the specification of the game [Osborne and Rubinstein (1990)] and reasonable people will differ on the appropriate specification of the landlord-tenant negotiation game.

The third approach, which this paper adopts, is to examine an extreme case of contractual incompleteness [e.g. Grossman and Hart (1986), Hart (1990), Hart and Moore

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(1990)] in which bargaining/contracting costs are so high and/or informational asymmetries are so severe that there is no scope for negotiation.[2] Resolution of the conflict is completely determined by the property rights spelled out in landlord-tenant law. We consider two extreme property rights regimes: either all landlords have unqualified eviction rights or all tenants have unqualified security of tenure.

Three casual types of evidence suggest that our assumption of no negotiation between landlord and tenant provides a good approximation to reality. The first concerns common experience with rental housing markets in North America. A tenant dealing with a large landlord is almost invariably offered a take-it-or-leave-it lease providing only the minimum tenant rights consistent with the jurisdiction's landlord-tenant law. While small landlords may show more flexibility in lease terms than large ones, there is still considerably less contractual diversity than would be observed if the conditions of the Coase Theorem applied.[3]

The second type of casual evidence is the contrast in operation between North American and North European rental housing markets, and how well this contrast can be related to differences in landlord-tenant law. North American rental housing markets come close to one extreme in which under law landlords have unqualified eviction rights; giving due notice, the landlord may simply choose not to renew a tenant's lease.

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[2] The basic idea is that, in the presence of asymmetric information, if all landlords are offering contracts of type x and one landlord deviates by offering contract y, then either the deviating landlord is exceptional in a way that is harmful to tenants (e.g. if contract x is security of tenure and contract y is eviction rights, the landlord offering contract y likely has an exceptional propensity to evict) or the tenant who finds the deviating contract attractive is exceptional in a way that is harmful to the landlord (e.g. if contract x is eviction rights and contract y is security of tenure, tenants who find contract y particularly attractive are those who plan to stay in their units for an exceptionally long period of time.)

[3] For example, at least for the jurisdictions with which we are familiar (Pennsylvania, Massachusetts, New York, Illinois, and Ontario) residential leases longer than one year are very uncommon. Lease renegotiation in the middle of a lease is also uncommon.

European rental housing markets come close to the other extreme in which, under law, tenants have complete security of tenure; as long as a tenant pays her rent and is not a nuisance to neighbors, she may stay in her apartment indefinitely. If landlord-tenant law determines the form of lease, one would expect to observe greater tenant turnover and more redevelopment in North America. Furthermore, in Northern Europe one would expect to observe many highly profitable but unexploited redevelopment opportunities, and indeed, this is what is observed.

The third type of casual evidence is the importance tenants attach to legislation or regulatory changes that improve security of tenure [Miron and Cullingworth (1988) and Miron (1990)]. It could be that tenant groups are misguided in their vociferous appeals for greater legal security of tenure, or recognize that it improves their bargaining power. Our interpretation, however, is that tenant groups understand that high bargaining costs severely curtail the individual tenant's freedom to contract, and consequently that the most effective way for them to achieve improved security of tenure is through legislation.

To examine these issues, we employ a stationary-state model of the housing market with durable housing and household moving costs. Moving costs are central to the concern of this paper since without them there would essentially be no conflict between landlord and tenant, and full eviction rights would be efficient. Previous literature has developed theoretical models of household mobility with moving costs as a basis for empirical work on housing demand; almost all of this has focused on owner-occupied housing [Amundsen (1985), Clark and Onaka (1983), Dynarski (1985), Edin and Englund (1991), Goodman (1989, 1995), Hanushek and Quigley (1978), Quigley and Weinberg (1977), Venti and Wise (1984), Weinberg, Friedman and Mayo (1981), Henderson and Ioannides (1989)]. This paper, in contrast, examines the effect on rental housing market equilibrium of the property rights regime in the presence of moving costs.[4]

Section 2 provides a description of the model's assumptions and structure, and section 3 a technical description of the microeconomic behavior. Sections 4 and 5 examine the equilibrium conditions of the two regulatory regimes and summarize the comparative static analysis. Section 6 reports on the welfare analysis of the two regimes. Numerical examples are presented in section 7 and extensions pointed out in section 8.

2. Assumptions

We treat a stationary housing market with some vacant land and two types of durable housing (or two *submarkets* i=1,2). All houses of a given type are identical. To simplify the model, we assume symmetry between the two types of housing. For example, the two housing types might differ only in floor plans or in location, but be identical in all other respects. Time is treated as an infinite sequence of discrete periods. The timeline in Figure 1 shows how the tenant and landlord decisions (to be discussed below) are sequenced within a representative time period. Note that outcomes occurring at the end of the period are discounted to the beginning of the period, while outcomes occurring in the beginning of the period are not.

There is a given number of infinitely lived tenants, N. Each tenant rents one housing unit in each time period, and makes a moving decision each period. A tenant moves when she wants to change location or floor plan. Tenants are identical in income and in tastes except for idiosyncratic taste components that measure the strength of their

[4] Pitchford and Snyder (2003) examine how property rights affect decisions under land use externalities.

preference for type of housing. For each tenant and in each time period, the realized values of these two idiosyncratic utilities are independent draws from a Gumbel distribution with a dispersion (inverse standard deviation) parameter μ. (see Appendix 1)[5]. Each tenant is risk neutral and looks ahead to the end of the current period when she expects to receive a discounted expected lifetime utility for the future. Tenants begin the time period committed to stay in their current dwelling for the period. After the period begins, a tenant realizes new idiosyncratic utilities for the two housing types that apply for the next period and, on the basis of this information and the cost of moving, makes a moving decision which is acted upon at the end of the period.

The time-invariant housing technology is described by maintenance, demolition and construction costs. A housing unit is constructed on a unit area of land. At the end of each period, if the housing unit is not demolished, a fixed maintenance cost must be incurred, in which case the unit provides the same level of housing service in the next period. If it is demolished, the land on which it was constructed must remain vacant for one period before subsequent construction is possible. Conversion from one type of housing unit to another can happen only by demolishing one unit in this period and building the other unit in the next. Costs consist of additive systematic and idiosyncratic components. The idiosyncratic costs of maintenance and demolition in submarket i are i.i.d. Gumbel across landlords with mean zero and dispersion parameter Φ_i for a unit of type i=1,2. The idiosyncratic costs of construction and land maintenance are also i.i.d.

[5] Appendix 1 reviews the definition of the Gumbel distribution and its properties that are relevant to later derivations in this paper. The advantage of assuming a Gumbel distribution is that it leads to logit choice probabilities which are easy to work with analytically and computationally.

Gumbel across landowners with mean zero and dispersion parameter ϕ. Each period, a landlord who owns an existing housing unit makes an independent draw of the idiosyncratic maintenance and demolition cost from the Gumbel distribution for his submarket. Similarly, a landowner who owns a unit vacant land parcel makes three independent draws from the Gumbel distribution for the land market: the idiosyncratic maintenance cost for land and the idiosyncratic construction cost of each type of housing unit.

Asset prices are determined at the beginning of each period, before the realization of the idiosyncratic component of costs, under the assumption that investors (i.e. the landlords and landowners) are risk neutral and have perfect foresight about asset prices at the end of the period and rational expectations about as yet unrealized idiosyncratic costs for the end of the period. The process of idiosyncratic cost realization and asset price determination repeats recursively every period (see Figure 1).

Before the end of the period, if subject to eviction, each tenant first learns whether the landlord will evict or not, which depends on the realization of her landlord's maintenance and demolition costs. At the end of the period, all evicted tenants choose a submarket (housing type) in which to rent for the next period, while all tenants who are not evicted either stay in their dwelling for the next period or voluntarily move to the other submarket. The process repeats in the next period and each tenant anticipates that the process will recur forever. Landlords with voluntarily vacated units decide to either demolish or maintain them, while owners of vacant land either keep the land vacant or construct one of the two types of housing units on the land. Since eviction occurs only when demolition is profitable, landlords who have evicted their tenants demolish their units.

3. The Model

We begin by specifying the expected lifetime utility of a tenant in the current period *t*, discounted to the beginning of the period and contingent on moving or staying for the next period. Let *i* index this period's submarket and also next period's if the tenant does not change submarkets and i' denote next period's submarket if the tenant changes submarket at the end of period *t*. *Y* is the tenant's earned income and remains exogenous (income from the housing market will be endogenous)[6], R_i or $R_{i'}$ is the rent, $\alpha>0$ is the marginal utility of income, U_i or $U_{i'}$ the lifetime expected utilities from period *t*+1 on, conditional on being in housing of type *i* (or *i*′) and on information available at the beginning of this period *t*. δ is the one-period discount factor for utility or for costs, $m_{ii'}$ is the monetary cost of moving from submarket i to submarket i', and u_i and $u_{i'}$ are the idiosyncratic utilities associated with submarkets *i* and i' respectively. If the tenant (a "stayer") occupies housing of type *i* in the current and the next period and does not move, her expected lifetime utility at the start of the current period is $\alpha(Y-R_i)+\delta U_i+\delta u_i$. If the tenant moves from housing type *i* in this period to housing of type i' at the end of the period, expected lifetime utility at the start of this period is $\alpha(Y-R_i-\delta m_{ii'})+\delta U_{i'}+\delta u_{i'}$. Note that when $i'=i$, the move is from one housing unit to another in the same submarket (a possible outcome in the regime of full eviction rights, if the tenant is evicted but

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[6] Although our model does not have income effects, we still carry income *Y* in our notation, to indicate that $Y-R_i$ is the income left over after paying rent that can be used to buy non-housing goods.

continues to prefer the same submarket). As already noted, for each time period and each tenant, u_1 and u_2 are i.i.d. Gumbel with dispersion parameter μ (see Appendix 1).

Now impose the symmetry assumption, and $m_{12} = m_{21} = m_{11} = m_{22} = m$. The resulting stationary equilibrium has the property that $R_1 = R_2 = R$ and $U_1 = U_2 = U$. In this situation, a tenant who is evicted and a tenant who is considering moving voluntarily, each face a binary choice between the two submarkets. In the non-symmetric case, a tenant evicted from a unit in submarket i moves to another unit in i if, for the realized values of u_1 and u_2, $\alpha(Y - R_i - \delta m_{ii}) + \delta U_i + \delta u_i > \alpha(Y - R_i - \delta m_{ii'}) + \delta U_{i'} + \delta u_{i'}$ holds for $i' \neq i$, or moves to a unit in i' if the opposite inequality holds. However, because of symmetry, the above inequality reduces to just a comparison of the idiosyncratic utilities: stay in submarket i if $\delta u_i > \delta u_{i'}$ or move to i' if the opposite holds. Therefore, under symmetry, the expected maximized idiosyncratic utility from moving, net of the disutility of moving, for an evicted tenant is (see Appendix 1):

$$E[\max(\delta u_1, \delta u_2)] - \alpha\delta m = (\delta/\mu) \ln 2 - \alpha\delta m \equiv \hat{k}(m) . \quad (1)$$

Voluntarily moving within the same submarket is irrational since all units in the same submarket are identical in all respects, and moving cost would be incurred needlessly. Hence, a voluntary mover either stays in his unit or moves to the other submarket. He moves from i to i' ($i' \neq i$) if $\alpha(Y - R_{i'} - \delta m_{ii'}) + \delta U_{i'} + \delta u_{i'}$ $> \alpha(Y - R_i) + \delta U_i + \delta u_i$ or stays in i if the opposite inequality holds. Under symmetry, the inequality reduces to $-\alpha\delta m + \delta u_{i'} > \delta u_i$. Then, applying the calculus of Appendix 1, the probability that a tenant voluntarily moves is $P(m)$ (with $1 - P(m)$, the probability of staying) and is binary logit:

(2) $$P(m) = \frac{e^{-\mu\alpha m}}{1 + e^{-\mu\alpha m}}.$$

The expected maximized idiosyncratic utility from moving net of moving cost for such a voluntary mover is (see Appendix 1):

(3) $$E[\max(\delta u_i, \delta u_{i'} - \alpha\delta m; i \neq i')] = (\delta/\mu) \ln [1+e^{-\alpha\mu m}] \equiv k(m).$$

Obviously, $k(m) > \hat{k}(m)$. For a forward-looking tenant who moves voluntarily, U must satisfy the following condition under symmetry, at the beginning of any time period:

(4) $$U = \alpha (Y - R) + k(m) + \delta U.$$

The first term on the right is the utility derived from the current housing unit during the period, $Y - R$ being the quantity of the numeraire non-housing good. The second term is the expected maximized utility of moving net of moving cost, prior to the realization of the idiosyncratic utilities (and, hence, prior to knowing the outcome of the moving decision) and the third term is the expected lifetime utility from the end of the period on, discounted to the start of the period. For a tenant who is subject to eviction, U satisfies:

(5) $$U = \alpha(Y - R) + [(1 - Q_D)k(m) + Q_D\hat{k}(m)] + \delta U$$

Corresponding to the second term in (4), the bracketed term in (5) measures the expected net utility of moving for a tenant who is subject to eviction. Q_D (to be derived below) is the probability that the landlord will want to demolish the unit and, hence, will evict the tenant. Therefore, the expected net utility from moving, as perceived at the beginning of the period, prior to the realization of the idiosyncratic utilities and prior to the realization of the eviction decision, equals the probability that the tenant will not be evicted times the expected maximized net idiosyncratic utility from the voluntary moving decision, plus the probability that the tenant will be evicted times the expected value of the maximized net idiosyncratic utility from being forced to move due to eviction.

Consider now the stationary discounted profits of a landowner in the current period. Let *r* be the exogenous land rent, *v* and V_i the stationary prices of land and of each type of housing, and B_i, D_i, M_i the recurring systematic (or mean) fixed costs of construction, demolition and maintenance respectively. The idiosyncratic costs have zero means and are measured as deviations from these systematic costs. Where *i*= 1,2 (construction), the discounted profit at the beginning of the period is $\pi_i = -v + r + \delta(V_i - B_i - b_i)$. Where *i*=0, the land is kept vacant and the profit is $\pi_0 = -v + r + \delta(v - b_0)$. The terms b_1 and b_2 are the idiosyncratic costs of construction and b_0 is the idiosyncratic cost of maintaining the land vacant. The profit for a landlord who owns a housing unit of type *i* (with a tenant who is either evicted or moved out voluntarily) is $\hat{\pi}_i = -V_i + R_i + \delta(V_i - M_i - n_i)$ if the unit is not demolished and $\tilde{\pi}_i = -V_i + R_i + \delta(v - D_i - d_i)$ if the unit is demolished, where n_i and d_i are the idiosyncratic costs of maintenance and demolition respectively.

We assume that the asset markets for housing and land are competitive and that landlords and landowners are risk-neutral investors who expect to earn a normal rate of return, $\rho = \dfrac{1-\delta}{\delta}$. Hence, the expected economic profit from land in the beginning of the period, prior to the realization of the idiosyncratic costs, is: $E\left[\max\left(\pi_0, \pi_1, \pi_2\right)\right] = 0$.

When landlords have full eviction rights, the profit from an existing housing unit of type *i*= 1,2 is: $E\left[\max\left(\hat{\pi}_i, \tilde{\pi}_i\right)\right] = 0$. Recalling that all idiosyncratic costs are i.i.d. Gumbel distributed and serially uncorrelated, we impose symmetry and apply the properties summarized in Appendix 1 to derive the asset prices by solving the appropriate zero-profit equation for v or V_i (of which, the one solved for V_i, equation (7) below, holds in the case of full eviction rights).

(6) $$v = g_0(v,V) + r, \text{ where } g_0(v,V) \equiv \frac{\delta}{\phi} \ln\left[e^{\phi v} + 2e^{\phi(V-B)}\right],$$

(7) $$V = g_1(v,V) + R, \text{ where } g_1(v,V) \equiv \frac{\delta}{\Phi} \ln\left[e^{\Phi(V-M)} + e^{\Phi(v-D)}\right].$$

The left side of each equation is the asset price that must be bid at the beginning of the period, so that, given the rent received for the period, the uncertainty at the beginning of the period about idiosyncratic costs, and the known end-of-period asset prices for housing and land, expected economic profits at the beginning of the period are zero. The terms $g_0(v,V)$ and $g_1(v,V)$ measure the part of the asset price which is due to discounted future rents net of conversion costs, and r or R are the rental return during the period.

When tenants have full security of tenure, landlords cannot evict them. The expected profit of such a landlord in submarket i when the tenant does not move out is given by $E[\ \delta(V_i - M_i - n_i) - V_i\ ] = \delta\,(V_i - M_i) - V_i$, since $E[n_i]=0$. But if the tenant does move out voluntarily, the landlord becomes unconstrained and his expected profit is determined in the same way as the profit of a landlord with full eviction rights.

What remains is to derive the probabilities, prior to the revelation of the idiosyncratic costs, that construction and demolition are profitable. The probability that, at any time period, the demolition of an existing house is profitable is $Q_{iD} = \text{Prob}\left[\tilde{\pi}_i > \hat{\pi}_i\right]$ for each i=1,2. The probability that construction of a housing unit of type i on a vacant unit land parcel is profitable is $Q_{iB} = \text{Prob}\left[\pi_i > \max(\pi_0, \pi_{i'}; i' \neq i)\right]$. As Appendix 1 explains, these are binomial logits (for demolition) and trinomial logits (for construction) respectively. Applying symmetry:

(8) $$Q_D(v,V) \equiv \frac{e^{\Phi(v-D)}}{e^{\Phi(v-D)} + e^{\Phi(V-M)}},$$

(9) $$Q_B(v,V) \equiv Q_{1B}(v,V) + Q_{2B}(v,V) \equiv \frac{2e^{\phi(V-B)}}{e^{\phi v} + 2e^{\phi(V-B)}}.$$

We will now formulate the symmetric and stationary market equilibrium conditions for each of the two regimes. First, we will consider the regime in which all landlords have *full eviction rights* (or, equivalently, tenants have *no security of tenure*). We will then move to the second regime in which all tenants have *full security of tenure* (or, equivalently, landlords have *no eviction rights.*)

In each case, the equilibrium conditions must be solved for four variables: the rent of housing, R, the asset price of land, v, the asset price of housing, V, and the discounted utility, U. The parameters governing the equilibria are: population, N (which is also equal to housing units), the marginal utility of income, α, moving cost, m, the discount factor, δ, the systematic conversion costs, B, D and M, the amount of vacant plus built-up land, L ($> N$), the land rent, r, the dispersion parameters for idiosyncratic utilities, μ, and the dispersion parameters of the idiosyncratic costs of converting housing, Φ, and converting vacant land, ϕ.

As already noted, N is the number of tenants and also the number of housing units under the assumption that each tenant occupies one housing unit. Hence, with the number of tenants exogenous, the aggregate demand for housing is inelastic and with the housing market clearing, the number of housing units is also N and remains the same under each regime. Because of the symmetry, the number of tenants moving from i to i' and those moving from i' to i are equal. We close the model by assuming that the investment return from aggregate asset values is distributed equally among the N tenants at the end of each period. This rent dividend, discounted to the beginning of the period is $\Omega(v,V) = (1-\delta)\dfrac{NV + (L-N)v}{N}$.

4. Eviction rights

In this regime, we must solve:

(10a) $$NQ_D(v,V) - (L-N)Q_B(v,V) = 0\,,$$

(10b) $$v - g_0(v,V) - r = 0\,,$$

(10c) $$V - g_1(v,V) - R = 0\,,$$

(10d) $$U - \alpha\left[Y + \Omega(v,V) - R\right] - \left\{\left[1 - Q_D(v,V)\right]k(m) + Q_D(v,V)\hat{k}(m)\right\} - \delta U = 0\,.$$

(10a) expresses the requirement that the stocks of vacant land and housing must be unchanging over time, by the flow quantity of housing demolished in each period, NQ_D, equaling the flow quantity that is built, $(L-N)Q_B$. (10b) and (10c) are the asset price (or normal return) equations for vacant land and for housing respectively. (10d) expresses the fact that the expected lifetime utility is stable over time, and includes asset income.

Let us examine the properties of (10a)-(10d). First, note that (10a) and (10b) together provide two equations in two unknowns, V and v. Once these are solved for, R can be found directly from (10c) and then, using the V, v and R just found, one can get U from (10d). Writing (10b) as V as a function of v (see (6)):

(10b′) $$V = B + \frac{1}{\phi}\ell n\left(e^{\frac{\phi}{\delta}(v-r)} - e^{\phi v}\right) - \frac{1}{\phi}\ell n 2$$

Note that V approaches –∞ as v approaches $\frac{r}{1-\delta}$ from above, and for $v > \frac{r}{1-\delta}$ and $\delta \in (0,1)$, that

(10b″) $$\left.\frac{dV}{dv}\right|_{(10b')} = \left(\frac{\frac{1}{\delta}e^{\frac{\phi}{\delta}(v-r)} - e^{\phi v}}{e^{\frac{\phi}{\delta}(v-r)} - e^{\phi v}}\right) > 1 .$$

Meanwhile, (10a) can be rewritten as:

(10a′) $$\frac{\frac{1}{2}e^{\phi(v-V+B)} + 1}{1 + e^{\Phi(V-v-M+D)}} = \frac{L-N}{N},$$

which is a linear equation in $v - V$ space with slope one. From these results, shown in Figure 2, we can see that (10a) and (10b) have a unique solution, with $v > \frac{r}{1-\delta}$.

Next, write (10c) in full:

(10c′) $$R = V - \frac{\delta}{\Phi}\ln\left(e^{\Phi(V-M)} + e^{\Phi(v-D)}\right).$$

From this,

(10c′) $$\frac{dR}{dV} = 1 - \frac{\delta e^{\Phi(V-\mathrm{M})}}{e^{\Phi(V-\mathrm{M})} + e^{\Phi(v-D)}} = \delta Q_D(v,V),$$

(10c″) $$\frac{dR}{dv} = -\frac{\delta e^{\Phi(v-D)}}{e^{\Phi(V-\mathrm{M})} + e^{\Phi(v-D)}} = -\delta Q_D(v,V).$$

The full comparative static properties are worked out in Appendix 2 and are recorded in Table 1. It will be useful to examine the economics of the changes in V, v and R with respect to one of the exogenous variables. Consider M, the cost of maintenance. An increase in M has no effect on the land valuation equation (10b), but causes the stationarity equation (10a′) to shift up, which (from Figure 2) causes an increase in both housing and land values. This may seem strange, since intuition might suggest that a rise in any conversion cost should lower both housing and land values. This intuition, however, ignores the endogeneity of housing rent. The explanation is as follows. Holding V and v constant, the rise in M causes the demolition probability to increase, and hence the number of housing units demolished to exceed the number of housing units constructed. To restore stationarity, $V - v$ must rise, since this both decreases the demolition probability and increases the construction probability (see (8) and (9)). To continue satisfying the land valuation equation (10b), both V and v must increase (see Figure 2); the increase in $V - v$ effectively increases the option value of the land. Housing rent rises, too, for two related reasons: first, the cost of maintaining housing increases, and second, the opportunity cost of the land used in housing increases. Put alternatively, to obtain the normal rate of return, in the face of a higher housing price and higher maintenance costs, the landlord must raise housing rents.

Turning to welfare (given by (10d)), it can be written after substituting out R by using equation (10c):

(10d′)

$$U = \frac{1}{1-\delta}\left\{\alpha\left[Y - \delta V + (1-\delta)\left(\frac{L-N}{N}\right)v + g_1(V,v)\right] + \left[1 - Q_D(V,v)\right]k(m) + Q_D(V,v)\hat{k}(m)\right\}$$

(10d′) gives U as a function of V, v, and exogenous parameters. The effect of an increase in an exogenous parameter on welfare can be decomposed into *direct* and *allocative* effects. The direct effect occurs holding the allocation (as characterized by $Q_D(V,v)$ and

$Q_B(V,v)$) fixed. The allocative effect derives from the induced change in the equilibrium allocation. Consider, again, the effect of a rise in *M*. The direct effect is $-\frac{\alpha\delta(1-Q_D)}{1-\delta}$; a unit increase in maintenance costs, holding Q_D fixed, causes per capita resource costs to increase by $1-Q_D$ per period, and discounted per capita utility to fall by $\frac{\alpha\delta}{1-\delta}$ times this amount. The allocative effect is the change in discounted per capita utility due to the induced change in the equilibrium allocation, and equals α times the change in discounted per capita deadweight loss. The allocative effect is also negative. The rise in *M* makes demolition more attractive and hence increases the equilibrium demolition rate, which leads to more tenants being evicted and hence an increase in the deadweight loss associated with uncompensated eviction. Thus, a rise in maintenance costs is unambiguously harmful. In contrast, the effect of a rise in demolition costs is ambiguous. The direct effect is negative, the allocative effect is positive because demolition and hence uncompensated eviction are discouraged. The same is true of building costs, which discourage eviction (demolition) indirectly by discouraging construction. An increase in the supply of land has the opposite effect, the allocative effect encouraging construction. A rise in land rent has only a positive direct effect, and a rise in moving costs only a negative direct effect since these changes do not affect the equilibrium allocation.

5. <u>Security of tenure</u>

In this case, we must solve:

(11a) $$NP(m)Q_D(v,V)-(L-N)Q_B(v,V)=0\,,$$

(11b) $$v - g_0(v,V) - r = 0,$$

(11c) $$V - \{P(m)g_1(v,V) + [1 - P(m)]\delta(V - M)\} - R = 0,$$

(11d) $$U - \alpha[Y + \Omega(v,V) - R] - k(m) - \delta U = 0.$$

The roles of the equations are the same as in the previous regime. Note that the equation for asset price of land (11b) is identical to (10b) because eviction limitations on landlords who own housing units do not directly affect the conversion options of those who own vacant land parcels. (11a), like (10a), states that the flow of demolition must be matched by the flow of construction, where the stock of housing units available for demolition now consists only of those voluntarily vacated by the tenants. Equation (11c) gives the asset price for housing. The terms in {•} are values net of conversion cost expected in the beginning of the period. These are equal to the probability that the tenant will move out voluntarily multiplied by the unrestricted expected net-of-conversion-cost values, $g_1(v,V)$, that can be realized from demolition or maintenance once the tenant has moved out, plus the probability that the tenant will stay in the unit multiplied by the net-of maintenance-cost value, $\delta(V–M)$, that will accrue from the maintenance of the occupied unit, recalling that the idiosyncratic maintenance cost has zero mean: $E[n_1]=E[n_2]=0$. Finally, the last equation, expresses the constancy of lifetime utility and includes asset income, given that tenants are free to move voluntarily and recalling that $k(m)$, derived earlier, is the expected utility from moving voluntarily, net of the cost of moving.

The properties of (11a) are similar to those of (10a), derived earlier. They follow by rewriting (11a) as:

(11a′) $$\frac{\frac{1}{2}e^{\phi(\nu - V + \mathrm{B})} + 1}{1 + e^{\Phi(V - \nu - \mathrm{M} + D)}} = \left(\frac{1 + e^{-\mu\alpha m}}{e^{-\mu\alpha m}}\right)\left(\frac{L - N}{N}\right),$$

which is a linear equation in $v-V$ space with slope one. Comparing (11a′) and (10a′) shows that replacing eviction rights with security of tenure has the same effect on the stationarity condition as an increase in the quantity of vacant land.

Since (11b) is the same as (10b), for a given set of parameter values, plotting (11a′) and (11b) would yield the same graph as Figure 2, with only one difference – (11a′) would be below (10a′) for all *v*. Thus, for a given set of exogenous parameter values, security of tenure results in lower housing and land values than eviction rights. From Figure 2, because the slope of (10b') is greater than one, the premium of housing value over land value is lower under security of tenure. Thus, relative to eviction rights, security of tenure results in a lower construction rate and a higher (desired) demolition rate. However, since only units voluntarily vacated are eligible for demolition, the actual number of demolitions is lower relative to eviction rights. The welfare of this regime can be written by using (11c) to substitute out *R*:

(11d′)

$$U=\frac{1}{1-\delta}\left\{\alpha\left[Y-\delta V+(1-\delta)\left(\frac{L-N}{N}\right)v+\left[1-P(m)\right]\delta(V-M)+P(m)g_1(V,v)\right]+k(m)\right\}.$$

The comparative static properties of the equilibrium with security of tenure are, in terms of sign, almost the same as those under eviction rights. The only major difference is that under security of tenure, in contrast to eviction rights, an increase in moving costs has allocative effects from (11a′), reducing the demolition and construction rates.

An important set of results, included in Table 1 in the θ column and explained in Appendix 2, concerns the effects of a switch in regimes, a greater θ corresponding to greater security of tenure. For example, what effect does the switch from eviction rights to security of tenure have on housing rent? There are two opposing effects. On one hand, housing value falls, and consequently its opportunity rent. On the other hand, security of tenure prevents the landlord from fully exploiting his profit opportunities. Then, holding asset values constant, housing rent rises to maintain a normal rate of return.

6. Welfare analysis

In both equilibria, there are uninternalized externalities. Under eviction rights, landlords do not compensate tenants for the moving costs they must incur when evicted. And under security of tenure, tenants do not compensate landlords for the profitable conversions they must forego, from not being able to evict tenants. These externalities remain uninternalized because of bargaining costs which we have assumed to be prohibitive. In this section, we investigate the potential efficiency gains from policy intervention, on the assumption that individuals' idiosyncratic utilities and landlords' idiosyncratic costs remain private information. While we restrict our analysis to Pigouvian taxation/subsidization, the same allocations could also be achieved with a system of tradable permits.

In the regime of full eviction rights, when a Pigouvian tax, T, is levied on demolitions, (10a)-(10d) are modified by replacing the demolition cost, D, with $D+T$ and by distributing the proceeds of the tax to consumers so that $\Omega(v,V)$ is replaced by $\Omega(v,V)+\delta Q_D(v,V)T$. Under security of tenure, when a mover subsidy equal to S is given, the moving cost, m, is replaced by $m-S$ in the market equilibrium equations (11a)-(11d) and the income dividend from asset values is modified to reflect the cost of the subsidy, by replacing $\Omega(v,V)$ with $\Omega(v,V)-\delta P(m)S$. The demolition tax, T, and the moving subsidy, *S*, are optimized to maximize the lifetime discounted expected utility level, *U*, under the corresponding regime.

Under full eviction rights, the optimal demolition tax, T^**,* makes demolition less profitable, causing the marginal landlord to postpone demolition and thus conferring an expected benefit to the tenant in the unit. This benefit is the gain in expected utility the tenant enjoys from moving (or not) voluntarily less the expected utility of moving by eviction. The tax must be set so that the disutility of the tax paid by the landlord (or the social marginal cost of the tax) just equals the expected marginal benefit to the tenant. Hence, discounting the tax to the start of the period:

$$\alpha\delta T^* = k(m) - \hat{k}(m)\,. \tag{12}$$

The Pigouvian prescription to internalize the externality is to tax (subsidize) the landlord this amount when he demolishes (maintains) the unit. The resulting allocations are identical. We considered the tax solution since it would be administratively simpler to keep track of evictions than maintained units and since it would be viewed as fairer to have landlords pay for the cost they impose on tenants.

The comparative static derivatives $\frac{dV}{d\chi}$, $\frac{dv}{d\chi}$, and $\frac{dR}{d\chi}$, where χ denotes any exogenous variable, are the same since the only change is that $D' = D + \frac{1}{\alpha}(k(m) - \hat{k}(m))$ has replaced *D*. What about the comparative static derivatives for U^*, the efficient welfare level? Note that after substitution of D', U becomes:

$$U^* = \frac{1}{1-\delta}\left\{\alpha\left[Y - \delta V + (1-\delta)\left(\frac{L-N}{N}\right)v + g_1(v,V)\right] + k(m)\right\} \tag{13}$$

Consider $\frac{dU^*}{dD} = \frac{\partial U^*}{\partial D} + \frac{\partial U^*}{\partial V}\frac{dV}{dD} + \frac{\partial U^*}{\partial v}\frac{dv}{dD}$. Routine manipulation indicates that the last two terms on the right side reduce to zero. Thus:

(14) $$\frac{dU^*}{dD} = \frac{\alpha}{1-\delta}\frac{\partial g_1}{\partial D} < 0.$$

Recall, from our earlier discussion, that the derivative was of ambiguous sign under eviction rights. Why does the imposition of the Pigouvian demolition tax eliminate the ambiguity? In the absence of the tax, $\frac{dU^*}{dD}$ can be decomposed into two effects, a direct effect (holding $Q_B(V,v)$ and $Q_D(V,v)$ fixed), which is unambiguously negative, and an allocative effect due to the increase in *D* decreasing Q_D. By minimizing the deadweight loss from uncompensated evictions, the imposition of the optimal Pigouvian tax eliminates the latter effect via the Envelope Theorem. The ambiguity of the effect on welfare of a rise in building costs and in the amount of vacant land is also eliminated, so that $\frac{dU^*}{dB} < 0$ and $\frac{dU^*}{dL} > 0$.

How might the real-world analog of the paper's demolition tax be implemented in practice? What we have modeled as demolition corresponds to any change in a unit's status that requires that the sitting tenant vacate the unit, which includes rehabilitation, tenure conversion, sale (when this entails eviction of some or all sitting tenants), and occupancy by a friend or relative of the landlord. Requiring that landlords file a non-renewal of lease form with the authorities giving the cause of non-renewal would in principle give the authorities the information needed to apply the tax. Evasion would no doubt be a problem. Landlords would have an incentive to state that leases were not renewed because tenants behaved badly, or to persuade tenants to move by providing a financial inducement or by withholding services. Such evasive tactics would have to be countered through landlord-tenant law; for example, the law could require that the burden of proof for eviction due to bad behavior be on the landlord.

In the regime of unqualified security of tenure, the optimal moving subsidy, S^*, induces the marginal tenant to decide to move this period, conferring an expected marginal benefit on the landlord. This benefit is the expected profit from the landlord becoming free to demolish or maintain the unit less the expected profit of forced maintenance were the tenant to have stayed in the unit. Hence,

(15) $$\delta S^* = g_1(v,V) - \delta(V - M).$$

The tenant can be brought to face the social cost of staying through either a tax on staying or a subsidy for moving. Since a subsidy for moving would be administratively simpler, that is the one we consider. If a tenant moves, the landlord's expected conversion profit is $E\left(\max\left(V - M - n_i, v - d_i\right)\right)$. If the tenant stays, expected conversion profits are $E\left(V - M - n_i\right) = V - M$. Thus, the expected cost the tenant imposes on the landlord by staying, measured at the end of the period, is $\frac{1}{\delta} g_1(V,v) - (V - M)$. By receiving a moving subsidy of this amount, the tenant faces the expected social cost of staying. The tenant's probability of moving is

(16) $$P^*(m) = \Pr[u_1 < u_2 - \alpha(m - S^*)] = \frac{e^{-\mu\alpha(m-S^*)}}{1 + e^{-\mu\alpha(m-S^*)}},$$

and the optimized stationary utility after substitutions is

(17) $$U^* = \frac{1}{1-\delta}\left\{\alpha\left(Y + (1-\delta)\frac{L-N}{N}v - M\delta\right) + k(m')\right\}.$$

The comparative static derivatives $\frac{dV}{d\chi}, \frac{dv}{d\chi},$ and $\frac{dR}{d\chi}$ are the same, since the only difference is that $m' = m - S^*$ replaces m. The comparative static derivatives for U^* are qualitatively unchanged from those under eviction rights. Thus, for example,

(18) $$\frac{dU^*}{dD} = \frac{\alpha}{1-\delta}P(m)\frac{\partial g_1}{\partial D} < 0.$$

The moving subsidy is set at a level which neutralizes the allocative effect, and what remains is the direct effect. Since the moving subsidy is set at a level that minimizes the deadweight loss associated with sitting tenants preventing profitable redevelopment, the effect of a marginal change in an exogenous parameter on this deadweight loss is zero.

We can summarize our analysis in terms of a diagram in $(n_1 - d_1, u_1 - u_2)$ space. Consider Figure 3. It portrays four relevant regions of the $(n_1 - d_1, u_1 - u_2)$ space.[7] In region I $n_1 - d_1 > V - M - v + D \Leftrightarrow v - D - d_1 > V - M - n_1$, so that demolition is more profitable than maintenance, and $u_1 - u_2 \Leftrightarrow u_1 > u_2 - \alpha m$, so that the tenant would like to stay. Region I is where the conflict between landlord and tenant occurs. In region II, the landlord wishes to maintain and the tenant wishes to stay, so there is no conflict. In region III, the landlord wishes to maintain and the tenant wishes to move, so again there is no conflict. Finally, in region IV, the landlord wishes to demolish and the tenant wishes to move, so again there is no conflict.

[7] The corresponding diagram for type 2 housing is symmetric.

Now imagine the corresponding diagram for the first-best, full information optimum, which is of interest only as a point of reference. There are three possible *outcomes*: tenant stays/landlord maintains, tenant moves/landlord maintains, tenant moves/landlord demolishes. The optimum may be characterized by a partitioning of $\left(n_1 - d_1, u_1 - u_2\right)$ - space into regions for each of these three outcomes,[8] and the deadweight loss associated with a particular property rights regime defined with reference to this.

Now return to Figure 3. Under unqualified eviction rights, tenant stays/landlord maintains occurs in region II, tenant moves/landlord maintains occurs in region III, and tenant moves/landlord demolishes occurs in region I and IV. This partitioning is different from that in the first-best optimum and hence entails a deadweight loss relative to the first-best optimum. Now impose a demolition tax. This alters the position of the $n_1 - d_1 =$ constant locus separating regions I and IV from regions II and III[9], and also the deadweight loss relative to the first-best optimum. The optimal demolition tax minimizes the deadweight loss for this property rights regime. The optimal demolition tax is set so that the landlord faces the expected social cost of his actions, and both tenants and landowners face the social cost of their actions since under eviction rights their choices generate no external costs.

Now consider complete security of tenure. Tenant stays/landlord maintains occurs in regions I and II, tenant moves/landlord maintains occurs in region III, and tenant moves/landlord demolishes occurs in region IV. This allocation involves a

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[8] Observe that such a partitioning implies a particular probability of demolition which, via the stationary state condition, implies a particular probability of construction.

different deadweight loss. Now impose a moving subsidy. This alters the position of not only the $u_1 - u_2$ = constant locus separating regions I and II from regions III and IV, but also the $n_1 - d_1 = V - M - v + D$ locus (through the induced changes in the stationary-state values of V and v) and hence the deadweight loss. The optimal moving subsidy minimizes the deadweight loss for this property rights regime. The optimal moving subsidy is set so that the tenant faces the expected social cost of her actions, and both landlords and landowners face the social cost of their actions since under security of tenure their choices generate no external costs.

Of central interest — to which we turn in the next section — is quantitative comparison of the deadweight losses under the two property rights regimes and with and without the relevant Pigouvian tax/subsidy.

7. Numerical examples

Table 2 shows a set of best-guess parameters we have selected for numerical analysis of the two regimes. The first numerical exercise is to compare how a switch in regime affects the values of the endogenous variables under the parameter values of Table 2. These results are shown in Table 3 (compare columns 1 and 3).

In the regime of full eviction rights, we see that 2 % of the vacant land is built on each period, while 1 % of the housing stock is demolished. This implies a construction rate of 1% of the existing stock per year, which is realistic for the United States. A little under 7 % of tenants move voluntarily each period, which is the average moving rate in the U.S. housing market. The rent-to-value ratio for housing is about 1/9, also reasonable. Switching to full security of tenure, housing value falls by about 8.2% while the land

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[9] Not only is D replaced by $D' = D + T^* = D + \frac{1}{\alpha}\,(k(m) - \hat{k}(m))$ but the values of V and v change.

value falls by only 1.8%. Rent falls by 4.3%. These effects reflect that holding housing units becomes less attractive when landlords cannot evict tenants. The change in relative asset prices makes holding housing less attractive relative to holding land, which increases the proportion of housing units landlords would like to demolish (the "desired demolition rate") from about 1% to 4.8%. However, the number of housing units actually demolished decreases, since only voluntarily vacated units are eligible for demolition when there is security of tenure. The result is that $NQ_D \approx 1006$ units are demolished when landlords have full eviction rights but only $NP(m)Q_D \approx 324$ units are demolished when tenants have security of tenure. So the drop in the asset price of housing relative to the asset price of land, which occurs with the switch from eviction rights to security of tenure, induces a nearly fivefold increase in the desired demolition rate but a 68 % drop in the number of actual demolitions. The rate of new construction falls accordingly.

In the numerical example, eviction protection hurts tenants. The reason is that although rent falls when tenants are protected from eviction, asset prices also fall and tenants become worse off because their dividends from asset ownership are reduced.[10]

The effects of the optimal tax or subsidy in the respective regime are shown in Table 3 (compare columns 2 and 1, and 4 and 3). The demolition tax decreases the demolition rate (and consequently also the construction rate) while leaving unchanged the

[10] That a policy A leads to a higher level of stationary-state utility than policy B does not ordinarily imply that policy A is superior to policy B, since the utility along much of the transient path to the stationary-state equilibrium under policy A might be considerably lower than that along the transient path to stationary state equilibrium under policy B. Here however, since the housing stock is the same under the two regimes, and along the transient paths as well as in stationary-state equilibrium, it would appear that in the example an unanticipated switch from full security of tenure to full eviction rights would unambiguously increase expected utility.

probability of moving voluntarily, $P(m)$. The moving subsidy increases the probability of moving by 24% (from 0.067 to 0.083) and, indirectly, decreases the desired demolition rate by 11.5% because it causes the price of housing to rise by 0.65%. Because, under eviction protection, landlords can demolish only voluntarily vacated units, the net effect on the number of demolitions is unclear in general, but demolitions are decreased in the reported simulations.

Next, Figures 2a and 2b show how optimal Pigouvian intervention becomes more beneficial according to the level of moving cost or demolition cost. In Figure 4a, as the demolition cost is increased from zero toward infinity the improvement in utility caused by the moving subsidy decreases asymptotically toward zero. Correspondingly, in Figure 4b, as the cost of moving is increased from zero to $ 10,000, the improvement in utility from the demolition tax increases.

8. Concluding Remarks

This paper presented a highly simplified dynamic model of the rental market for durable housing with tenant mobility costs. To our knowledge, the model is the first to look at mobility in the housing market from a market equilibrium perspective.

North American rental housing markets of the fifties and sixties approximated full eviction rights, and most European markets of the fifties, sixties and seventies, full security of tenure. The most significant – though hardly surprising – result was that the property rights regime has a substantial impact on tenant mobility, which partially explains why, over that period, rental housing mobility rates were so much higher in North America than in Europe. A numerical example with rough, best-guess parameters suggested that full eviction rights lead to a more efficient outcome than full security of tenure (which is not to say that there may not be intermediate regimes which are more efficient than either) but the dollar-equivalent welfare difference between the two regimes was not found to be large under the parameters used. Under full eviction rights, the landlord imposes an uninternalized negative externality on a tenant who wishes to stay. Analogously, under full security of tenure, a sitting tenant imposes an uninternalized externality on a landlord who wishes to modify his unit. These externalities can be partially internalized through Pigouvian taxes and subsidies, but the numerical examples suggest that the welfare gains are small.

Several directions for future research suggest themselves. The first is to enrich the model in order to provide a more descriptively realistic conceptual basis for empirical work on housing mobility and for housing policy simulation. Some enrichments are the treatment of housing differentiation by quality and type and tenant differentiation by income-demographic group, as presented in Anas and Arnott (1997). Others such as life-cycle decision making by households, serial correlation in the idiosyncratic component of costs and utilities, and recognition that modification of a building often requires the simultaneous eviction of all its tenants, are more challenging.

A second direction is to give further attention to the form of the landlord-tenant law (and contract) vis-à-vis household mobility. In the paper, we took the form of the contract, and in particular whether there are full eviction rights or full security of tenure as exogenous, and examined the implications for market equilibrium of the two contract types. We defended the assumption on the grounds that many contract forms may be stable. This argument needs to be further developed and scrutinized. As well, work needs to be done which endogenizes the form of contract. While some work has been done on rental housing contract theory (that of Hubert (1989) is particularly noteworthy), much remains to be done. Exploring the analogy between housing and labor markets may prove powerful, as it has in other contexts (Hubert (1989), Igarashi (1990)). For example, job security is analogous to security of tenure, and labor economic models have been developed which treat idiosyncratic job attachment (e.g. Hashimoto (1981)). In this context, treating tenant heterogeneity is important, as is treating the cost to the landlord of obtaining a new tenant, which the current tenant neglects when deciding whether to move.

A third, related direction is to focus on public policy with respect to rental housing regulation. A common view is that asymmetric information and negotiation/bargaining costs lead to endemic and systematic contractual failure. What regulations could help achieve more efficient landlord-tenant contracting? What taxes and subsidies should be introduced to induce superior contracting or to offset inefficiencies induced by contracting? And might there even be a role for government as dominant landlord? For example, should a public agency act as a central matchmaker (Anas (1997)), as is observed in Scandinavia and some other European countries, matching tenants who are unlikely to move in the future with landlords who are unlikely to make conversions? Also, should governments subsidize homeownership as is done in many countries? If the occupant of a dwelling owns the unit, he has security of tenure and also the right to convert; the bilateral landlord-tenant externality is internalized.

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Appendix 1 (Not intended for publication but will appear in downloadable version of the paper).

A. Properties of the Gumbel distribution and the logit model

Definition: A random variable x is said to have the Gumbel distribution with mean zero and dispersion parameter $\psi > 0$, if the c.d.f. is $F(x) = \exp[-\exp - \psi(x + \gamma)]$. $\psi = \pi/(\sigma\sqrt{6})$, where σ is the standard deviation of x. $\gamma = 0.577$ is Euler's constant.

Proofs of properties a and b below, can be found in Johnson and Kotz (1970) and proof of property c can be found in Domencich and McFadden (1975).

Property a: If x is Gumbel distributed with mean zero and dispersion parameter ψ, and if $\beta > 0$ and X are any constants, then the random variable $X + \beta x$ is also Gumbel distributed with mean X and dispersion parameter ψ/β.

Property b: Suppose that $\beta > 0$ is any positive scalar and that $X_1, X_2,\ldots,X_n$ are any constants. If $x_1, x_2 \ldots, x_n$ are independently Gumbel distributed each with mean zero and common dispersion parameter, ψ, then $\max(X_1 + \beta x_1, X_2 + \beta x_2 \ldots, X_n + \beta x_n)$ is Gumbel distributed with mean $(\beta/\psi) \ln \sum_{j=1\ldots n} \exp(\psi/\beta)X_j$ and dispersion parameter ψ/β.

Property c: Suppose that property b holds. Then, $\text{Prob.}[X_i + \beta x_i > X_j + \beta x_j;\ \forall j \neq i] = \exp(\psi/\beta)X_i / \sum_{j=1\ldots n} \exp(\psi/\beta)X_j$. This is known as the multinomial logit (MNL) model.

B. Derivation of equations (1), (2), (3), (6), (7), (8) and (9).

We encountered three separate instances of the MNL model. *First*, in each period, each tenant's moving behavior is described by a binomial logit model: a tenant who is evicted decides which submarket to move to, and a tenant who moves voluntarily decides whether to stay in his current unit or move to the other submarket. *Second*, in each period, each landlord in the regime of full eviction rights and each landlord whose tenant has moved out voluntarily in the security of tenure regime, decides whether to demolish his unit or continue to maintain it at its current quality. This is also described by the binomial logit model. *Third*, in each period, each landowner decides whether to keep his land vacant for the next period, or whether to construct one of the two housing types. This is described as a trinomial logit model. Each of these are derived by applying the properties in part A of this Appendix. In each case, the constant β in part A, corresponds to the discount factor δ used by the agents in the model.

Tenants: The Gumbel random variables x_1, x_2 are the idiosyncratic utilities u_1, u_2, and we define their dispersion parameter ψ to be μ which measures idiosyncratic tenant heterogeneity. Under conditions of symmetry, for a tenant who moves involuntarily out of his unit because he is evicted, X_1, X_2 are the systematic components of utility, and $X_1 =$

$X_2 = \alpha\ (Y–R–\delta m) + \delta\ U$. Hence, applying Property b yields equation (1) which is expected net utility of moving, and applying Property c gives a binomial submarket choice probability equal to ½. For a tenant who is currently located in submarket i and considers moving voluntarily (under the conditions of symmetry), the systematic components of utility are $X_i = \alpha\ (Y – R) + \delta U$ and $X_j = \alpha\ (Y – R – \delta m) + \delta U$, where j is the other submarket. Then, applying Property b yields the expected net utility of moving given by equation (3), and applying Property (c) yields equation (2) which is the probability that the tenant will choose not to move.

Landlords**:** The Gumbel random variables x_1, x_2 for a landlord in submarket i are the idiosyncratic costs $-d_i$ and $-n_i$ respectively (corresponding to demolition and maintenance). We define the dispersion parameter of these idiosyncratic costs to be Φ_i (corresponding to the ψ in part A). The systematic parts of profits in submarket i are $X_1 = -V_i + R_i + \delta\ (v - D)$ and $X_2 = -V_i + R_i + \delta\ (V_i - M)$. Then, Property c can be applied to derive the demolition probability given by equation (8). Applying Property b, the expected maximized profit is calculated and setting this equal to zero and solving for V_i , yields equation (7) which gives the asset price of a house in submarket i.

Landowners**:** The Gumbel random variables x_1, x_2, x_3 for a landowner are the idiosyncratic costs $-n_0$ and $-b_1$, $-b_2$ respectively (which correspond to keeping the land vacant, building a type 1 house and building a type 2 house). We define the dispersion parameter of these idiosyncratic costs to be ϕ (which corresponds to ψ in part A).The systematic profits are $X_1 = -v + r + \delta\ v$, and $X_2 = -v + r + \delta\ (V_1 - B_1)$ and $X_3 = -v + r + \delta\ (V_2 - B_2)$. Then, property c can be applied to get the construction probability given by equation (9). From property b, the expected maximized profit is found, and setting this equal to zero and solving for v yields equation (6) giving the asset price of land.

<u>Appendix 2</u>:Comparative Statics (Not intended for publication but will appear in downloadable version of the paper).

Rather than derive the comparative statics results separately for the two property rights regimes, we write out the set of equations (10a)-(10c) and (11a)-(11c) with θ as a parameter, recalling that under eviction rights $\theta = 0$ while under security of tenure $\theta = 1 - P(m)$:

(A2.1) $$(1-\theta)Q_D(V,\nu)N - Q_B(V,\nu)(L-N) = 0$$

(A2.2) $$V - \theta\delta(V - M) - (1-\theta)g_1(V,\nu) - R = 0$$

(A2.3) $$\nu - g_0(V,\nu) - r = 0,$$

Totally differentiating the above equation system:

$$\begin{bmatrix} I & II & III \\ IV & V & VI \\ VII & VIII & IX \end{bmatrix}\begin{bmatrix} dV \\ d\nu \\ dR \end{bmatrix} = \begin{bmatrix} X \\ XI \\ XII \end{bmatrix} dM + \begin{bmatrix} XIII \\ XIV \\ XV \end{bmatrix} dD + \begin{bmatrix} XVI \\ XVII \\ XVIII \end{bmatrix} dB + \begin{bmatrix} XIX \\ XX \\ XXI \end{bmatrix} d\Phi$$

$$+\begin{bmatrix} XXII \\ XXIII \\ XXIV \end{bmatrix} d\left(\frac{L}{N}\right) + \begin{bmatrix} XXV \\ XXVI \\ XXVII \end{bmatrix} d\phi + \begin{bmatrix} XXVIII \\ XXIX \\ XXX \end{bmatrix} dr + \begin{bmatrix} XXXI \\ XXXII \\ XXXIII \end{bmatrix} d\delta + \begin{bmatrix} XXXIV \\ XXXV \\ XXXVI \end{bmatrix} d\theta + \frac{\theta}{1-P(m)}\begin{bmatrix} XXXVII \\ XXXVIII \\ XXXIX \end{bmatrix} d(\mu m).$$

Although the algebra looks intimidating, the special properties of the logit render it manageable. These properties are:

$$\frac{\partial Q_D}{\partial V} = -\Phi Q_D(1-Q_D) \qquad \frac{\partial Q_B}{\partial V} = \phi Q_B(1-Q_B)$$

$$\frac{\partial Q_D}{\partial \nu} = \Phi Q_D(1-Q_D) \qquad \frac{\partial Q_B}{\partial \nu} = -\phi Q_B(1-Q_B)$$

$$\frac{\partial g_1(V,\nu)}{\partial V} = \delta(1-Q_D) \qquad \frac{\partial g_0(V,\nu)}{\partial V} = \delta Q_B$$

$$\frac{\partial g_1(V,v)}{\partial v} = \delta Q_D \qquad \frac{\partial g_0(V,v)}{\partial v} = \delta(1-Q_B)$$

$$\frac{\partial P(m)}{\partial(m\mu)} = -\alpha(1-P(m))P(m)$$

The derivatives with respect to V, v, and R are:

$$I = (1-\theta)\frac{\partial Q_D}{\partial V}N - \frac{\partial Q_B}{\partial V}(L-N)$$

$$= -(1-\theta)\Phi Q_D(1-Q_D)N - \phi Q_B(1-Q_B)(L-N)$$

$$= -N\left((1-\theta)\Phi Q_D(1-Q_D) + \phi Q_B(1-Q_B)\frac{(1-\theta)Q_D}{Q_B}\right) \qquad \text{(using (A2.1))}$$

$$= \; -(1-\theta)NQ_D\left[\Phi(1-Q_D)+\phi(1-Q_B)\right] < 0,$$

$II = -I > 0$, $III = 0$,

$$IV = 1-\theta\delta-(1-\theta)\frac{\partial g_1}{\partial V}$$

$$= 1-\theta\delta-(1-\theta)\delta(1-Q_D) = 1-\delta\left(1-Q_D(1-\theta)\right) > 0$$

$V = -(1-\theta)\frac{\partial g_1}{\partial v} = -(1-\theta)\delta Q_D < 0$, $VI = -1 < 0$, $VII = -\frac{\partial g_0}{\partial V} = -\delta Q_B < 0$

$VIII = 1-\frac{\partial g_0}{\partial v} = \left(1-\delta(1-Q_B)\right) > 0$, $IX = 0.$

Thus,

$$\Delta \equiv \begin{vmatrix} I & II & III \\ IV & V & VI \\ VII & VIII & IX \end{vmatrix} = -(II)(VII) + (I)VIII = (I)(VII + VIII) = (I)(1-\delta) < 0\,.$$

The derivatives with respect to the exogenous parameters are:

$X = -(1-\theta)\Phi Q_D(1-Q_D)N < 0$, $XI = -\theta\delta-(1-\theta)\delta(1-Q_D) < 0$,

$XII = 0$, $XIII = (1-\theta)\Phi Q_D(1-Q_D)N > 0$, $XIV = -(1-\theta)\delta Q_D < 0$,

$XV = 0$, $XVI = -\phi Q_B(1-Q_B)(L-N) < 0$, $XVII = 0$, $XVIII = -\delta Q_B < 0$,
$XIX = (1-\theta)Q_D(1-Q_D)(V-M-v+D) > 0$,

$$XX = -(1-\theta)\frac{g_1}{\Phi} + (1-\theta)\frac{\delta}{\Phi}\frac{(V-M)e^{\Phi(V-M)} + (v-D)e^{\Phi(v-D)}}{e^{\Phi(V-M)} + e^{\Phi(v-D)}}$$

$XXI = 0$,

$XXII = Q_B > 0$ $XXIII = 0$, $XXIV = 0$, $XXV = Q_B(1-Q_B)(v-V+B)(L-N) < 0$,

$XXVI = 0$, $XXVII = -\dfrac{g_0}{\phi} + (\dfrac{\delta}{\phi})\dfrac{ve^{\phi v} + 2(V-\mathrm{B})e^{\phi(V-B)}}{e^{\phi v} + 2e^{\phi(V-B)}}$, $XXVIII = 0$, $XXIX = 0$,

$XXX = 1 > 0$, $XXXI = 0$, $XXXII = \theta(V-\mathrm{M}) + (1-\theta)\dfrac{g_1}{\delta} > 0$,

$XXXIII = \dfrac{g_0}{\delta} > 0$, $XXXIV = Q_D N > 0$, $XXXV = \delta(V-\mathrm{M}) - g_1 < 0$, $XXXVI = 0$

$XXXVII = \alpha(1-P(m))P(m)Q_D(v,V)N < 0$,

$XXXVIII = -\alpha(1-P(m))P(m)\left[\delta(V-M) + g_1(V,v)\right] > 0$, $XXXIX = 0$.

The signs of the comparative static derivatives are shown in Table 1 and most are established on the basis of the sign pattern except in some cases, as in the case of $\dfrac{dR}{dM}$ whose ambiguity on the basis of the sign pattern is resolved through algebraic calculations.

The effects of changes in exogenous variables on welfare may be established by applying the above results to (10d) (the equation for social welfare under eviction rights) and (11d) (the equation for social welfare under security of tenure). Consider for example $\frac{dU}{dM}$ under eviction rights: $\frac{dU}{dM} = \frac{\partial U}{\partial M} + \frac{\partial U}{\partial V}\frac{dV}{dM} + \frac{\partial U}{\partial v}\frac{dv}{dM}$. The expression for U in full is:

$$U = \frac{1}{1-\delta}\left\{\alpha[Y - \delta V + (1-\delta)\left(\frac{L-N}{N}\right)v + g_1(V,v)] + [1 - Q_D(V,v)]\delta k(m) + Q_D(V,v)\delta \hat{k}(m)\right\}$$

Then

$$\frac{\partial U}{\partial M} = -\frac{\delta\alpha}{1-\delta}(1-Q_D) - \frac{\delta}{1-\delta}\Phi Q_D(1-Q_D)(k-\hat{k}),$$

$$\frac{\partial U}{\partial V} = -\frac{\delta\alpha}{1-\delta}Q_D + \frac{\delta}{1-\delta}\Phi Q_D(1-Q_D)(k-\hat{k}),$$

$$\frac{\partial U}{\partial v} = \alpha\frac{L-N}{N} + \frac{\delta\alpha}{1-\delta}Q_D - \frac{\delta}{1-\delta}\Phi Q_D(1-Q_D)(k-\hat{k}),$$

$$\frac{\partial V}{\partial M} = \frac{\Phi(1-Q_D)\big(1-\delta(1-Q_B)\big)}{\big(\Phi(1-Q_D)+\phi(1-Q_B)\big)(1-\delta)},$$

$$\frac{dv}{dM} = \frac{\Phi(1-Q_D)\delta Q_B}{\big(\Phi(1-Q_D)+\phi(1-Q_B)\big)(1-\delta)}.$$

Substituting these expressions into $\frac{dU}{dM}$ yields

$$\frac{dU}{dM} = -\frac{\alpha\delta(1-Q_D)}{1-\delta} - \frac{\delta}{1-\delta}\left(\frac{\Phi\phi Q_D(1-Q_D)(1-Q_B)(k-\hat{k})}{\Phi(1-Q_D)+\phi(1-Q_B)}\right).$$

which is unambiguously negative. The first term on the right side captures the direct effect, and the second, the allocative effect.

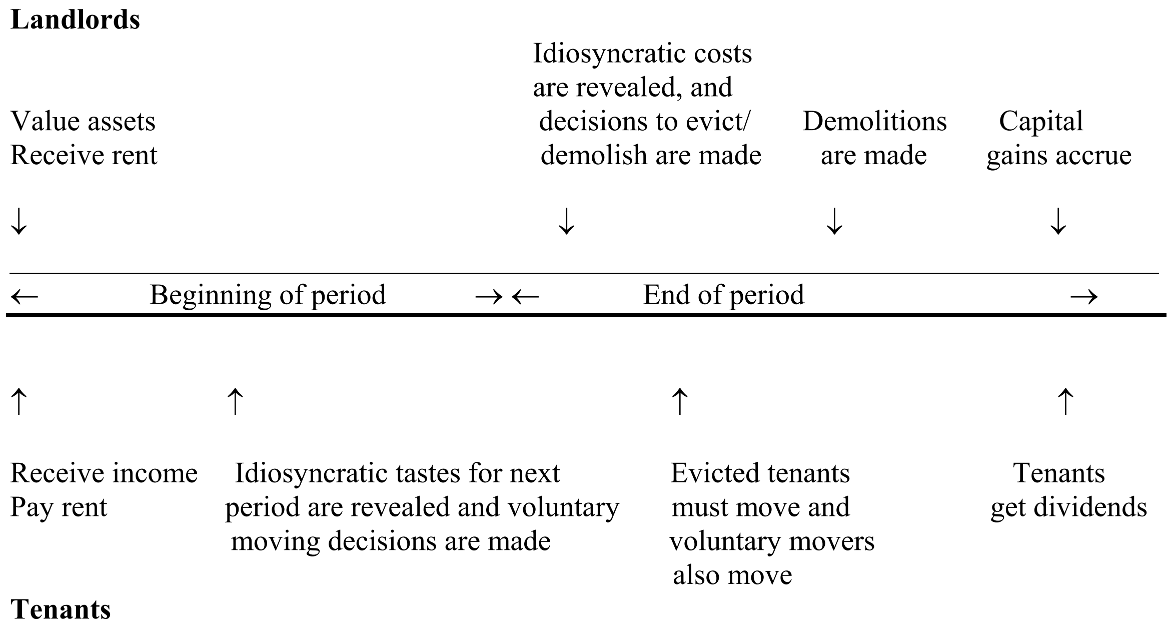


FIGURE 1: Timeline, showing sequencing of decisions and events within one time period. (Note: Outcomes which occur at the end of the period are discounted to the beginning of the period.)

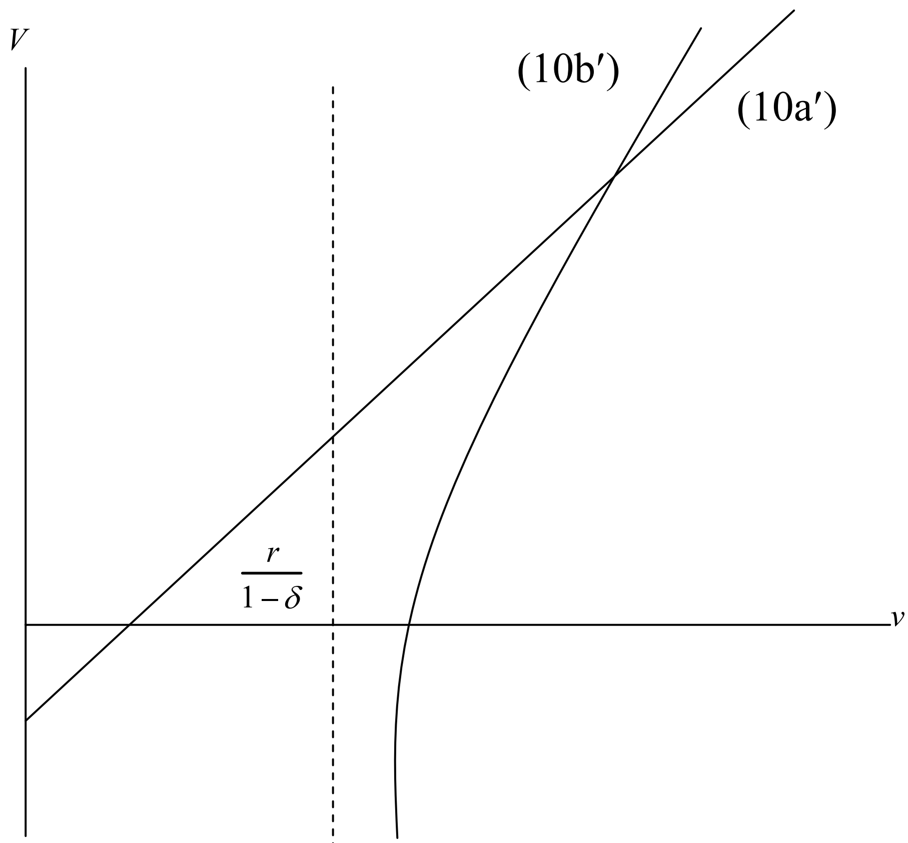


FIGURE 2: Equations (10a) and (10b) have a unique solution.

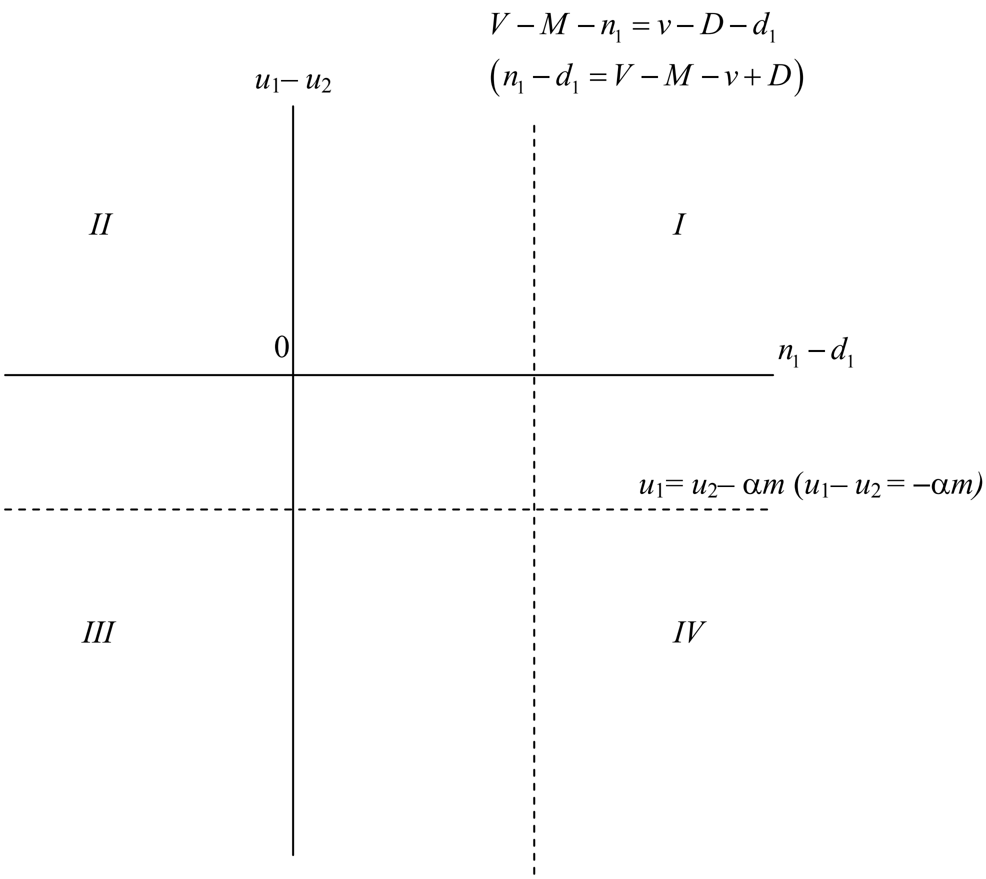


FIGURE 3: Diagrammatic summary

FIGURE 4a: Utility Gain From Optimal Moving Subsidy Under Full Security of Tenure

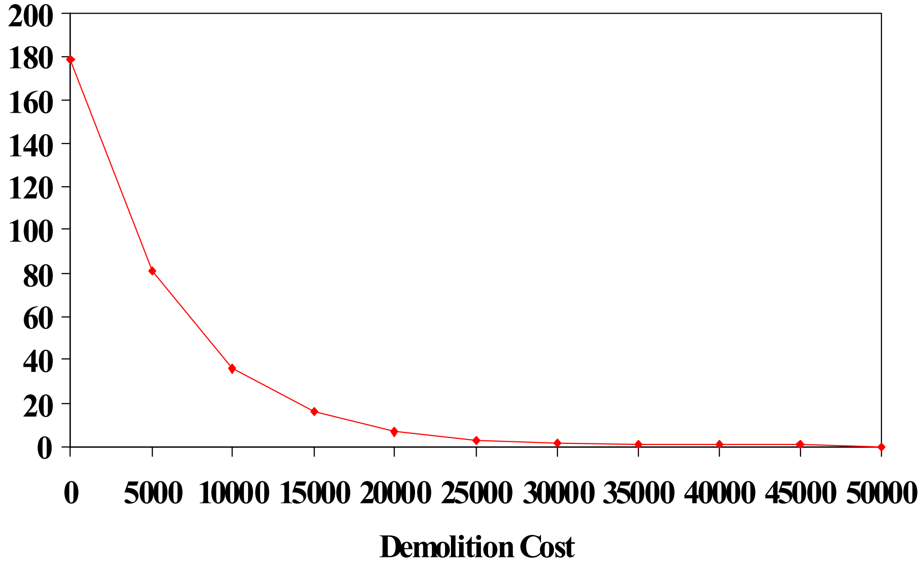
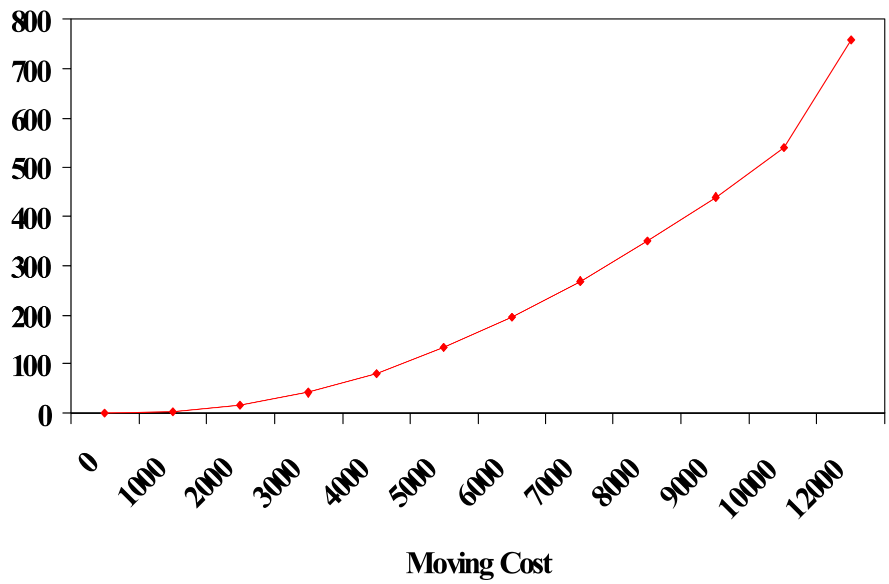


FIGURE 4b: Utility Gain From Optimal Demolition Tax Under Full Eviction Rights



	M	D	B	Φ	$\frac{L}{N}$	ϕ	r	δ	m or μ	θ^{**}
V	+	–	?	?	–	?	+	+	–(0)*	–
v	+	–	?	?	–	?	+	+	–(0)*	–
R	+	?	?	?	–	?	+ (=1)	?	?	?
U	–	?	?	?	?	?	$+ (=\frac{1}{1-\delta})$	n.a	–	?

TABLE 1: Comparative Statics

*Denotes results in $(\bullet)$ apply only with eviction rights.

**With eviction rights, θ=0, while under security of tenure $\theta = 1 - P(m)$.Thus, an increase in θ may be interpreted as improved security of tenure.

N = 100,000 L = 150,000*

Y = \$ 45,000 per year m = \$ 2,500 per move

$\alpha = 1$; $\delta = 0.95$; $\mu = 0.001055 \Rightarrow \sigma_T$ = \$ 1214;

$\Phi = \frac{1}{7000} \Rightarrow \sigma_D$ = \$ 8,971; $\phi = \frac{1}{5000} \Rightarrow \sigma_B$ = \$ 6,408

B = \$ 50,000 D = \$ 10,000 M = \$ 5,000 r = \$ 5,000

TABLE 2: Values of parameters used in the simulations ($\sigma_D = \frac{\pi}{\Phi\sqrt{6}}$: standard deviation of idiosyncratic demolition costs; $\sigma_B = \frac{\pi}{\phi\sqrt{6}}$: standard deviation of idiosyncratic construction costs; $\sigma_T = \frac{\pi}{\mu\sqrt{6}}$: standard deviation of idiosyncratic utilities of tenants.)

* *N/L* is the proportion of land that is occupied.

	1 Eviction Rights	2 Eviction Rights with Optimal Demolition Tax	3 Tenure Security	4 Tenure Security With Optimal Moving Subsidy
v	\$ 102,703	\$ 102,307	\$ 100,861	\$ 100,944
V	\$ 120,649	\$ 119,136	\$ 110,754	\$ 111,479
R	\$ 10,734	\$ 10,666	\$ 10,272	\$ 10,307
U	858,189	858,216	856,987	857,023
$Q_D(v,V)$	0.01006	0.0086	0.0484	0.0428
$Q_B(v,V)$	0.02012	0.0172	0.00645	0.00707
$N\,Q_D$ $NP(m)\,Q_D$	1,006	860	324	287
$1-P(m)$	0.933	0.933	0.933	0.917
$k(m)$	62.1	62.1	62.1	77.6
$\hat{k}(m)$	−1,751.2	−1,751.2	−1,751.2	−1,543.3
$\Omega(v,V)$	\$ 8,600	\$ 8,530	\$ 8,059	\$ 8,080
$g_0(V,v)$	\$ 97,703	\$ 97,307	\$ 95,861	\$ 95,944
$g_1(v,V)$	\$109,915	\$ 108,470	\$ 100,702	\$ 101,363
$\delta(V-M)$	\$109,867	\$ 108,429	\$ 100,466	\$ 101,155
T^*		\$ 1,909		
S^*				\$ 219

TABLE 3: Comparison of the two regimes with and without optimal taxation.