ANALYZING RENT CONTROL: THE CASE OF LOS ANGELES

Michael P. Murray, C. Peter Rydell, C. Lance Barnett, Carol E. Hillestad, Kevin Neels

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The RAND Corporation, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138
I. INTRODUCTION

Rent control is among the most heatedly contested local political issues in America. In the past two decades, the number of jurisdictions with rent control ordinances has swelled to more than 125, and the decision to adopt such laws is currently being debated in still more communities.

Despite the clamor surrounding rent control, there has been surprisingly little empirical analysis of the economic consequences of existing rent control ordinances. Polemical treatises abound; theoretical analyses are easily found; but only a few empirical studies are available—and those are either descriptive in nature or sharply limited in scope. We believe the analysis of Los Angeles' rent controls that we describe here provides the first quantitative forecast of the housing market effects of an actual rent control ordinance.1

Our study is applicable beyond the confines of Los Angeles. The modeling framework developed to study Los Angeles entails analytical considerations that would arise in any study of rent control, and the qualitative results offer insights that are likely to prove of more general applicability.

We offer the pivotal analytical insight that no accurate quantitative appraisal of a rent control law's effects is possible without careful consideration of both the law's specific provisions and the specific market environment in which the law is set. The peculiarities of a given law or of a given environment have much influence upon how the law will affect housing markets. We give detailed descriptions in Sec. II of the Los Angeles rent control ordinance and of the Los Angeles housing market of the late 1970s and early 1980s.

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1 This paper was prepared for presentation at the conference on "Rent Control: The International Experience," John Deutsch Institute of Economic Policy, Queen's University, Kingston, Canada, September 1-4, 1987. The paper follows RAND's study of the rent controls in Los Angeles (Rydell et al., 1981). The appendices to this paper are drawn from the theoretical portions of that study.
Our forecasts about rent control in Los Angeles were important for the city of Los Angeles. The comparison of alternative laws described below, coupled with still further comparisons described in Rydell et al. (1981), provided the City Council with a more detailed appraisal of the economic consequences of the rent control ordinances before them than had ever been available to lawmakers. This information did not replace the political and emotional arguments for and against the various proposals, but it did provide a backdrop against which the council could better judge the merits of various claims.

We believe that two of our empirical findings apply to other communities with rent control. First, the bulk of the transfers from landlords to tenants achieved by a rent control law are realized early in the law's life, but the bulk of the economic cost of the law—the housing stock lost through inefficient workings of the market mechanism under rent control—is incurred later in the law's life. Second, legal provisions that ameliorate rent control's deleterious effect on landlords' incentives to maintain their dwellings reduce the benefits of rent control to tenants.

The first finding echoes the frequent contention that rent controls imposed during a brief period of unusual market conditions, as in the United States during World War II, can achieve large transfers with little economic inefficiency. But the finding also supports the oft-heard claim that rent controls left in place too long, as in New York after World War II, can eventually harm the very people they were intended to help.

The second finding raises questions about the efficacy of "second generation" rent control laws. Second generation laws go beyond the mere prescription, "Thou shalt not raise rents". They add exceptions and exclusions that mitigate rent control's most deleterious effects on landlords' incentives to construct and maintain dwellings. We find that second generation adjustments in rent control laws increase landlords' incentives only by eating into tenants' benefits. In the extreme, second generation controls are no controls at all.
The balance between transfers made from landlords to tenants and the economic inefficiencies induced by rent controls is very sensitive to both housing market conditions in the community and the specific provisions of the rent control ordinance. To accurately assess benefits and costs of rent control, careful attention must be given to each. Moreover, the effects of rent control vary over an ordinance's life. To accurately assess the benefits and cost of rent control, the ordinances' effects over time must be analyzed (see Sec. II). In Secs. III and IV we describe how our model manages these analyses. In Sec. V we present the results of our Los Angeles analysis, and in Sec. VI we conclude. Appendixes A and B provide additional information on the rent control model. For a complete description of the model see Rydell, et al. (1981).
II. THE LOS ANGELES RENT CONTROL ORDINANCE AND THE LOS ANGELES HOUSING MARKET

Rent control began in the City of Los Angeles in August 1979 with rents initially frozen at their May, 1978 level. This initial law was renewed annually by the City Council with minor amendments. In 1981 the City Council contemplated alternative rent control laws, ranging from immediate decontrol to considerable stiffening of the law. Here we focus our attention on two central proposals: an extension of the existing law until 1990, and a stiffening of the law to further restrict allowed annual rent increases.¹

Four key features characterize these two Los Angeles proposals. First, the ordinances permitted annual increases in rents for continuing tenants: the original law permitted a 7.6 percent annual increase, while the stiffer law proposed a maximum 5.6 percent annual increase. Second, both laws allowed the landlord to raise rents more freely when an apartment became vacant, but safeguarded new tenants against further annual increases in excess of the 7.6 or 5.6 percent limits: the original allowed new tenants to be charged whatever the market would bear, while the stiffer law allowed rent increases of up to 10 percent for new tenants. Third, both laws exempted from coverage new construction, hotels, single family dwellings, and units with initial rents above specific levels (called "luxury units"). Fourth, both laws contained "sunset" provisions, which would end rent control if the vacancy rate in Los Angeles rental housing rose above 5 percent.

The Los Angeles rent control law was precipitated by tenant concern that landlords were not passing on their savings from the 1978 California constitutional amendment that reduced property taxes (Proposition 13). As worded, however, the city’s rent control ordinance cited a rental housing shortage of "crisis level" as the reason for the law. The stated objectives of rent control were the prevention of

¹ Other revisions of the ordinance were also considered. See Rydell, et al., 1981.
"excessive" rent increases while allowing landlords a "just and reasonable" return on their investment in rental housing. The ordinance's characterization of the Los Angeles housing market was quite misleading.

Historically, rent controls have usually been used to limit rent increases caused by sudden surges in demand. For example, the controls introduced in the United States during the world wars and the Korean conflict and, more recently, the controls applied in Alaska during the construction of the pipeline, had this purpose. However, there is no evidence that in the mid-1970s Los Angeles was experiencing any such sudden surge in the demand for rental housing. Rather, rent controls were introduced into Los Angeles during a period of double-digit inflation that increased the costs of all goods and services, including rental housing. It was these inflation-induced rent increases that were stifled by the rent control ordinance.

Perhaps the most striking evidence in support of the contention that there was no sudden surge in rental housing demand is that from May 1974 to May 1978 real rents in Los Angeles were actually falling slightly, although less so than in other California cities or in the United States as a whole. Table 1 records the average annual changes in the Consumer Price Index (CPI) and in the residential rent component of the CPI for Los Angeles, San Francisco, San Diego, and the United States rents rose substantially in those four years; increases in rents accelerated from 1974 to 1978, but from 1978 to 1981 were consistently less than increases in prices in general.

That real rents fell more slowly in Los Angeles than elsewhere is at least partially explained by the fact that vacancy rates in Los Angeles were falling somewhat more quickly than elsewhere. Table 2 shows the rental vacancy rates for Los Angeles and the United States from 1974-1980. The U.S. vacancy rate fell from 6.2 percent to 5.0 percent between 1974 and 1978, while the Los Angeles rate fell from 6.9

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2 The Supreme Court has ruled rent control to be a valid exercise of the state's police power but has limited the circumstances in which controls are acceptable. The language of ordinances is influenced by these limitations.
percent to 3.8 percent. These figures indicate that the Los Angeles housing market was moderately tight when rent control was introduced but that the bulk of the market pressure for increased rents was fueled by inflation rather than by excess demand.

The available evidence indicates that from 1978 to 1981 market conditions eased in Los Angeles. During those years the vacancy rate actually rose in Los Angeles from 3.8 percent to 4.6 percent. Furthermore, during those years there were no sudden changes in the size or composition of the Los Angeles population that would indicate a surge in the demand for housing.

This evidence suggests that without rent control, rent increases in Los Angeles would have tracked general price inflation, as seems to have been the case for other California cities and for the United States as a whole (see Table 1). This is important for our analysis because it means that we do not need a dynamic price adjustment model to explain how rents would have risen in the absence of rent controls; we can use other California cities’ experiences as indicators of what would have happened to rents in Los Angeles without rent control.
Table 1

ANNUAL CHANGE IN RENT AND CONSUMER PRICES: LOS ANGELES, SAN FRANCISCO, AND SAN DIEGO STANDARD METROPOLITAN STATISTICAL AREAS AND UNITED STATES, MAY 1974 TO MAY 1981

<table>
<thead>
<tr>
<th>Location</th>
<th>Annual Change (%)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residential Rent Index</td>
<td>Consumer Price Index</td>
<td>Ratio</td>
</tr>
<tr>
<td>May 1974 to May 1978</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles SMSA</td>
<td>7.4</td>
<td>8.0</td>
<td>.93</td>
</tr>
<tr>
<td>San Francisco SMSA</td>
<td>6.5</td>
<td>8.4</td>
<td>.77</td>
</tr>
<tr>
<td>San Diego SMSA</td>
<td>6.8</td>
<td>7.7</td>
<td>.88</td>
</tr>
<tr>
<td>United States</td>
<td>5.8</td>
<td>7.4</td>
<td>.78</td>
</tr>
<tr>
<td>May 1978 to May 1981</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los Angeles SMSA</td>
<td>10.5</td>
<td>12.1</td>
<td>.87</td>
</tr>
<tr>
<td>San Francisco SMSA</td>
<td>10.5</td>
<td>10.7</td>
<td>.98</td>
</tr>
<tr>
<td>San Diego SMSA</td>
<td>10.0</td>
<td>14.6</td>
<td>.68</td>
</tr>
<tr>
<td>United States</td>
<td>8.1</td>
<td>11.7</td>
<td>.69</td>
</tr>
</tbody>
</table>

SOURCE: Rydell et al. (1981), Table 2.12.

Table 2

RENTAL VACANCY RATE: LOS ANGELES VS. UNITED STATES AVERAGE, 1974-1980

<table>
<thead>
<tr>
<th>Year</th>
<th>Rental Vacancy Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Los Angeles</td>
</tr>
<tr>
<td>1974</td>
<td>6.9</td>
</tr>
<tr>
<td>1975</td>
<td>6.5</td>
</tr>
<tr>
<td>1976</td>
<td>6.1</td>
</tr>
<tr>
<td>1977</td>
<td>4.4</td>
</tr>
<tr>
<td>1978</td>
<td>3.8</td>
</tr>
<tr>
<td>1979</td>
<td>4.0</td>
</tr>
<tr>
<td>1980</td>
<td>4.6</td>
</tr>
</tbody>
</table>

SOURCE: Rydell et al. (1981), Table 2.6.
III. ANALYTICAL ISSUES IN MODELING RENT CONTROL

We resolve seven major analytical issues to accurately portray rent control's effects on the Los Angeles housing market. First, we distinguish rent controls from price controls. Second, we establish the principle that landlords will not maintain housing capital unless that capital's services are being paid for. Third, we account for the rent discounts ordinary market operations grant to continuing tenants. Fourth, we explore the consequences of allowing rents to rise freely when a unit becomes vacant. Fifth, we consider the effects of exempting new construction from controls. Sixth, we decompose the effects of rent control on the rental housing stock into induced deterioration, removals, and condominium conversions. Seventh, we assume future rental prices in Los Angeles would follow general price inflation over the ordinance's life.¹

In this section we detail each of these issues. In the next section, we present the models that cope with these seven important features of rent controls.

Rent Control, Not Price Control

Despite the popular classroom use of rent controls to illustrate classic price ceilings, rent control is not a price control. Rent control ordinances restrict the revenues a landlord can receive from a particular dwelling. If the controlled landlord undermaintains the unit, the flow of "housing services"² provided will decline, and the reduced rent may eventually be fully offset by a reduction of quantity;

¹ To apply our models to other cities would frequently require one major extension. In cities experiencing a surge in housing demand, the price of housing would not follow general inflation. In addition to the models described in the next section, for those cities one would need a model of housing demand to forecast the path of rental housing prices in the absence of rent controls.

² "Housing Services" is a summary measure of shelter, amenities and convenience provided by a dwelling. More formally, it is a composite commodity defined over all the attributes of a dwelling that a tenant values.
in the interim, the rent reduction will be divided between a lower price for housing services and a lower quantity of services provided.

For the tenant, this distinction between price reductions and quantity reductions implies that the gain from rent control is less than the total reduction in rent paid; some of the reduced rent payment is offset by reduced housing services. For the landlord, this distinction implies that the loss from rent control is less than the total reduction in rent received; some of the lost rent is offset by reduced maintenance expenditures.

For the analyst, this distinction implies that predicted rent reductions realized under rent controls must be decomposed into price reductions and service reductions. Figures 1 and 2 depict the short- and long-run effects of rent control. Rent control that requires rents to be, say $P_Q$, which is less than the equilibrium rent $P_e Q_e$, precludes price-quantity combinations that lie outside the rectangular hyperbola for which $PQ = P_Q$ (shown by the dotted lines in Figures 1 and 2). In the short run, the supply of housing services provided by a particular landlord is fixed, so the rent controlled price of housing services is initially depressed from $P_e$ to $P_o$, as shown in Figure 1. But over time, the landlord can adjust the quantity of housing services supplied. If the long-run supply of housing services is perfectly elastic, the landlord will eventually reduce services to $Q_s$, and the price of housing services will return to its original equilibrium level, as shown in Figure 2. The long-run effect of rent control will then be to limit the quantity of housing services supplied. If long-run supply is less than perfectly elastic, the long-run effect of rent control will be to reduce both price and quantity.

**Maintenance Behavior**

If dwellings were eternally durable, rent controls on existing dwellings would not differ from price controls; landlords would be unable to adjust the housing services they offer tenants. And if dwellings were perfectly malleable, rent control would never lower the price of housing; landlords would instantly adjust the housing services they offered to accommodate lower rents. The key, then, to the division
Fig. 1—The demand and supply of housing with a revenue constraint: the case of perfectly inelastic supply

Fig. 2—The demand and supply of housing with a revenue constraint: the case of perfectly elastic supply
of rent reductions between price reductions and deterioration is the
linkage between deterioration of the dwelling and the maintenance
expenditures of the landlord.

Landlords will choose to undermaintain their dwellings until their
output of housing services declines to a level that is supported by
controlled rents. For example, if rent control reduces rents by 10
percent, landlords realize that they are, in effect, selling 10 percent
of their housing services for nothing, and they will stop maintaining
that portion of their output. The unmaintained portion of their output
deteriorates, and eventually disappears.

However, there is an optimal policy of undermaintenance. A
landlord may allow the walls in common areas to become dirty and
pockmarked from neglect. But he will not choose to hasten this end by
hiring hooligans to come in and break up the wall; that would be
foolishly costly. Similarly, a landlord faced with a 10 percent rent
reduction may continue to maintain the furnace because losing its
services would reduce the housing services he has to offer by more than
10 percent.3

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3Rent control laws can cause landlords to overmaintain a dwelling.
For example, rent control provisions that exempt luxury units may give
some landlords incentive to upgrade their units to luxury status and to
maintain them as such. Similarly, cost pass-through provisions that
allow landlords to amortize, say, carpets over a three year period, may
give landlords an incentive to invest in higher quality carpets (with a
longer economic life) than they might have otherwise selected. In
general, if the provisions of a law permit the landlord to raise rents
by more than the cost of some maintenance activity, that activity will
be undertaken more under rent control than in the absence of rent
control.

Edgar Olsen has suggested (Olsen, 1987) that landlord
undermaintenance may be replaced by tenant maintenance. The Israeli
experience (Werczberger, 1987) with rent control sheds some light on
this phenomenon. Common areas of Israeli rental buildings are often in
a ruinous state, but individual units are well kept up. This reflects
two features of tenant substitution for landlord maintenance. First,
free rider behavior will lead to undermaintenance of common facilities.
Second, tenants will make investments in their units that can be
amortized over the tenants' expected stay. Since the average Israeli
renter stays in one apartment for almost twenty years, almost all
investments in one's unit can be amortized during the tenant's stay. In
countries like the United States, where rental turnover is very high,
tenants have less incentive to replace landlord undermaintenance. In
The implication for the analysis of rent control is that one needs a model of landlord behavior that ties maintenance to revenues, and one then needs a model that ties together maintenance and the rate of a dwelling's deterioration.

Longevity Discounts in Rental Housing

When one reports that the rental housing component of the Consumer Price Index (CPI) rose 5 percent in a given year, everyone realizes that this is an average over all units, and that some rents rose by more than this and some by less. This variance in rent increases would be of little importance for an analysis of rent control if those variations were uncorrelated with the operations of the law. But in truth, there is a pronounced tendency in most U.S. cities for continuing tenants to receive smaller rent increases than new tenants. For example, in Los Angeles between 1974 and 1977, continuing tenants in multi-family rental housing saw their rents rise at about 80 percent of the rate of increase in the rental housing component of the CPI; in single-family dwellings, the figure was about 65 percent. This protection from rent increases is greatest in the early years of tenancy, and declines thereafter, nearly disappearing after about six or seven years, by which time the household can have accumulated a considerable "tenure discount."

The importance of tenure discounts for analyzing rent control in Los Angeles is that continuing tenants, who are protected by the L.A. law, would in the absence of rent control receive below-average rent increases, while new tenants, who are unprotected, would receive above-average rent increases. Failure to account for these differences would

any case, the commonplace assignment of maintenance to the landlord in unconstrained settings evidences the cost advantages of the landlord in maintenance, so tenant substitution will not fully offset the inefficiency arising from landlord undermaintenance.

Maintenance in Israel's rent controlled market is also affected by the payments of "key money": new tenants pay a lump sum for the privilege of obtaining a controlled unit. Israel law mandates that key money be divided between the prior tenant and the landlord. Such payments, legal in some jurisdictions and not in others, give an incentive for maintaining dwellings. Vacancy decontrol makes key money an unimportant phenomenon in Los Angeles.
lead one to markedly overstate the efficacy of controls in reducing rents.

**Vacancy Decontrol and Recontrol**

Some communities have used vacancy decontrol as a means of phasing out rent control. The high mobility rate of renters ensures that removing dwellings from control upon vacancy will sharply reduce the stock of the controlled housing in a short time. The Los Angeles decontrol provision does not have this intent. Since a new tenant will benefit from rent control in the future, the dwelling is not removed from the controlled stock. Nevertheless, even with the immediate reinstatement of controls once a dwelling is reoccupied, the impact of rent control is greatly reduced by the L.A. decontrol provision.

First, as noted above, dwellings with new tenants experience the largest rent increases. Consequently a substantial portion of inflation in rents is not controlled by the L.A. law.

Second, and more subtly, tenants and landlords both know that rent controls will be reimposed once the tenant is in residence. The landlord will be reluctant to accept the tenant unless the expected present value of future rent receipts is adequate, while the tenant knows that future rent increases will be limited by the rent control ordinance. The result will be that the landlord will demand a higher initial rent from the tenant as "compensation" for the lower rent increases permitted in the future, and the tenant will acquiesce in anticipation of limited future rent increases due to rent control.

This strategic behavior yields curious results for both tenants and landlords. Tenants who stay longer than anticipated will reap benefits from rent control in the future. Tenants who stay a shorter time than anticipated, however, will confer windfalls on the landlords by paying higher rents than in the absence of rent control.

Partially offsetting the ameliorating effects of vacancy decontrol is the incentive created by this provision for households to move less often than they would in the absence of controls. In the absence of vacancy decontrol, households considering a move compare one rent-controlled dwelling with another. But with decontrol, households
already in place for several years must choose between their current
dwelling with its accumulated benefits from restricted rent increases,
and another dwelling where the rent charged will be all the market will
currently bear. The ultimate impact of rent control on mobility will
depend on the balance of tenants' incentives to stay longer and
landlords' success in undermaintaining (or in harassing tenants to force
a move).

New Construction and Single Family Exemption

It is frequently argued that rent control inhibits the production
of new rental housing because it lowers the expected return from such
investments. This is clearly true if newly constructed units are
covered by the law, and it is frequently argued that it is true even if
new units are exempted because developers will discount any assurances
that could be removed later. However, the skeptics' claim is too
simple. To the extent that rent controls induce deterioration in the
existing stock of rental housing, an excess demand for rental housing is
created. Consequently, counterbalancing the developers' concern about
being controlled in the future is the prospect of higher-than-usual
returns in the near future. Given the historical tradition of honoring
new construction exclusions for extensive periods of time, it would seem
that rent control with an exemption for new construction would encourage
rather than discourage production.⁴

⁴Fallis and Smith (1984) present a theoretical model that shows
that rents for rent control exempt units will tend to be higher than in
the absence of rent control. Their empirical application of this model
to Los Angeles founders on their failure to account for either longevity
discounts or the effect of recontrol on contract rent. They treat
vacated units in Los Angeles as decontrolled and find that actual rents
in these units after two years of rent control in the Los Angeles market
were much higher than forecast from past rent increases.

But, as they admit, there is little constraint of housing consumed
after two years of control. Quantity constraints in controlled units
are much less likely to account for the unexpected rent increase among
"decontrolled" units than are the premiums on initial rents for new
tenancies. Those premiums are set by landlords and accepted by new
tenants in anticipation of the low rent increases that will be
experienced during the years that the new tenants remain in the unit.

⁵We know of no instance of a jurisdiction reneging on an exclusion
anytime soon after it was granted. Ontario, Canada, the quickest
reversal we know of, did not extend coverage to previously excluded
The exemption of single family dwellings is largely a practical matter: it would be almost impossible to keep those units from shifting out of the rental market and into the owner-occupied market. But the practical impact is to offer owners of single-family rental dwellings a windfall when the deterioration of the controlled stock induces an excess demand for rental units.

Decomposition of Quantity Changes

While it is informative to say that the value of the rental housing stock in 1990 would be 10 percent higher in the absence of rent control, the statement is ambiguous. Would the number of rental dwellings be 10 percent higher, or would the original number of units just be in 10 percent better condition? And if the number of rental dwellings were 10 percent higher, would there simply be fewer owner-occupied dwellings, or would the total housing stock be larger? The measure of total value, and the artifice of "housing services" as a homogeneous good, are informative at one level, but obfuscating at another. We therefore decompose the effects of rent control on the housing stock into: (a) deterioration of existing dwellings, (b) net removal of dwellings from the housing stock, and (c) conversions from renter- to owner-occupied.

Benefits and Costs of Rent Control

The intended beneficiaries of rent controls are the tenants: resources are to be transferred to them from landlords. These transfers are $P_e Q_e - P_s Q_s$, where $P_e$ is again the equilibrium price of housing services and $P_s$, $Q_s$ the price and quantity of housing services under rent control.

The economic costs of these transfers are five: (1 and 2) the lost consumer and producer surpluses resulting from the decline in housing services from $Q_e$ to $Q_s$; (3) the administrative costs associated with rent control; (4) distortions in producers' use of housing inputs; and dwellings until ten years after the initial exclusion. New York City did not extend its rent control until 30 years after the initial exclusion of newly constructed dwellings.

6 For example, cost pass through provisions in the rent-control
(5) distortions in consumers' location choices. In our analyses, we forecast the first, second and third cost components.

law in Ontario, Canada, give landlords an incentive to undermaintain and then replace appliances. The services provided tenants aren't altered, but the economic cost of proper maintenance would be lower than the costs incurred under rent control.
IV. THE RENT CONTROL MODELS

Landlords can respond to rent reductions\(^1\) caused by rent control in three ways. First, landlords could operate their properties the same as they would without controls. In that case, tenants would continue to receive the same quantity of housing services. Since tenants would pay less rent for the same quantity of housing services, the "price" of those services would be reduced. Second, landlords could reduce maintenance to offset, at least in part, their revenue losses. As a result of the lowered maintenance, dwellings would deteriorate, causing a drop in the quantity of housing services landlords provide. We call this the "quantity loss due to deterioration." Finally, landlords could remove their dwellings from the rental market by abandoning them or converting them to other uses, such as condominiums. We call this the "quantity loss due to removals and conversions." In fact, all three responses occur: some of the rent reductions benefit tenants as price reductions; some result in cuts in the quality of existing housing; some result in fewer dwellings.

Consequently, we need a set of models that can estimate these three primary impacts of rent control laws:

- Rent reductions
- Housing deterioration caused by rent reductions
- Housing losses caused by rent reductions

From these primary impacts a variety of summary measures can readily be produced. Two examples of important summary measures are the price reductions enjoyed by tenants of controlled housing, and the present values of the tenant gains and landlord losses caused by rent control.

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\(^1\) Rent control limits the amount by which rents can increase. As a consequence, rents of controlled dwellings are less than they would be in the absence of rent control. We call this difference the "rent reduction" caused by rent control.
In this section we describe the three interlocking models that provide the desired estimates.

RENT REDUCTION

We use a rent simulation model to estimate the percentage of rent reduction caused by rent control. After first estimating what the average rent would have been without rent control, we then estimate average controlled rents. The percentage difference constitutes our estimate of the rent reduction caused by rent control. Appendix A contains a detailed specification for the rent reduction model. In this section, however, we will give an overview of our modeling strategy.

Because landlords set initial rents higher than the average market rent, and later raise rents by less than the growth in average rent, limiting rent increases for dwellings with continuing tenants reduces rents less than if uncontrolled rent increases were the same for all units. In light of this, projected average rent increases without rent control must be split between the two types of units: rents for units that keep the same tenant increase by less than rents for units that acquire a new tenant. We found from historical data that in Los Angeles during eight years of 10 percent average rent inflation, rents for units keeping the same tenant would increase by only 8.2 percent, while rents of those obtaining a new tenant would increase by 14.3 percent.

As we noted above, this rent-setting behavior in uncontrolled markets has two important implications for assessing the impact of rent control. First, a limit on rent increases for units that keep the same tenant during a year can be less than the average growth in uncontrolled market rate and still not cause rent reductions overall. Second, since landlords are accustomed to raising rents above average market rents upon a vacancy, they continue to do so under a rent control law that has a vacancy decontrol provision. However, under rent control, landlords set first rents even farther above the market average to compensate for the smaller subsequent rent increases allowed by control. (Tenants are willing to pay somewhat higher first rents because they know the subsequent annual increases will be low.)
The rent simulation model is a discrete-time iterative model. It takes housing market conditions at the beginning of a year and applies the above market behavior principles and any rent control constraints to estimate market conditions at the end of the year. These year-end conditions become the starting conditions for the next year's simulation.

The rent simulation model is general enough to estimate both rent increases under rent control and rent increases that would have happened if there had never been any rent control. The difference between the two estimates is the rent reduction caused by rent control.

Two parameters in the model describe rent control: the annual percentage rent increase allowed for units with no vacancy during a year, and the percentage increase allowed at a vacancy. For the rent increases from 1978 to 1982 that would have occurred in Los Angeles in the absence of rent control, we used Bureau of Labor Statistics and California Government estimates of the rates of increase in rents in uncontrolled markets whose experience of population and income growth were similar to Los Angeles'. Because Los Angeles experienced no unusual demand surge in the period under study--nor in the preceding several years--there were ample benchmarks to give convincing evidence regarding how Los Angeles' rents would have risen in the absence of rent control. For the simulation period 1983-1990, we used an annual rate of increase of 10 percent.

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2 In a more general setting, establishing the path of market rents in the absence of rent control would be less simple. In particular, sudden shifts in demand can influence market rents in complicated ways. In such cases one would need a demand module for the rent reduction model that could incorporate these more complex conditions.

3 The 10 percent forecast was that of Security Pacific National Bank. Wharton, Data Resources and Chase Econometrics all forecast inflation in the 8.0 - 8.5 percent range. We used the higher forecast because our report's purpose was to determine whether the likely environmental impact of Los Angeles' rent control ordinance was small. By choosing a conservatively high inflation estimate, we provided an upper bound on the likely impact of rent control.
The rent reduction model accounts for the fact that in the absence of rent control, landlords raise rents for units that retain the same tenants during a year by less than the market-wide average, and raise rents for units that obtain new tenants during a year by more than the market-wide average. The earlier discussion of the differential treatment of new and continuing tenants shows that even though rent control laws may look simple (involving only two parameters), their interaction with uncontrolled market behavior is complex enough to require explicit simulation to forecast consequent rent reductions.

HOUSING DETERIORATION

Rent control encourages landlords to undermaintain their properties. When the rent reduction caused by rent control is 4 percent, landlords can charge the market price for only 96 percent of the housing services they produce. In the long run, landlords will allow the portion of their output that yields no revenue to disappear through deterioration.

However, knowing that in the long run landlords will allow their properties to deteriorate in proportion to the size of the rent reduction tells us little about deterioration in the short or intermediate run. Rent control usually lasts for only a brief part of the life of a housing structure. If the pace at which housing deteriorates is slow enough, the effect of rent control on housing quality will be negligible: before housing deteriorates seriously, rent control will be gone, taking with it the incentive for landlords to undermaintain.

Hence, the question is not whether rent control induces deterioration, or by how much, but rather how rapidly it does so. Data from the Housing Assistance Supply Experiment enabled us to estimate the pace of deterioration through deterioration's link with changes in landlords' maintenance expenditures. We combine these data with assumptions about the link between revenues and maintenance expenditure to forecast the effect of rent control on housing deterioration. Appendix B contains a detailed presentation of the deterioration model;
in this section, as in the last, we restrict ourselves to providing an overview of our modeling strategy.

The housing deterioration model estimates the percentage reduction in the quantity of rent-controlled housing services caused by rent control. That reduction is the difference between the annual housing services that would have been produced per dwelling without rent control and the annual housing services produced per dwelling under rent control.

The housing deterioration model is a difference equation applied iteratively to estimate the decline in housing quantity over time. We construct the model in three steps. First, we specify and estimate the relationship between the level of annual maintenance and the annual change in housing quantity due to deterioration. Second, we find the amount of undermaintenance that will eventually cause housing quantity to deteriorate to the level that controlled rents support, relying on the observation that if rent control reduces rent by X percent, then landlords have no long-run incentive to maintain more than (100 - X) percent of their output of housing services. Third, we link short-run maintenance behavior to long-run incentives.

We have no empirical evidence on the short-run maintenance decisions of landlords who experience a decline in their revenues. One can envision technologies for which the optimal short-run maintenance response is to reduce maintenance to zero until the quantity supplied drops to the new long-run optimum level. However, our experience with housing makes us believe that the optimal strategy for landlords is to continue to maintain services and facilities that they will provide in the long run (in the face of mild rent controls, heating, plumbing, and elevators are obvious examples). Hence, we expect maintenance to fall when revenues fall, but not to zero.

We posit a link between revenues and maintenance such that landlords in the short run select the constant level of maintenance that will in the long run lead to the optimal long-run level of output. We assume the long-run supply of housing is perfectly elastic, so the long-run quantity supplied is X percent of the uncontrolled equilibrium quantity when rent control reduces rents to X percent of their uncontrolled level.
RENTAL HOUSING LOSSES

Regardless of the cause--declining demand or rent control--rent reductions motivate landlords to consider alternative uses for their apartments. Some remove their apartments from the housing stock; others convert their apartments to condominiums. Only a small fraction, however, make such changes in any one year, even in the face of large rent reductions. So, as in the case of deterioration, the question of rental housing losses caused by rent control becomes a question of the pace at which change occurs.

The model we use for removals and conversions estimates the rent control-induced reduction in the quantity of rental housing services due to removal of dwellings from the housing stock--by either demolition or conversion of rental to owner-occupied housing (condominiums). (See App. C for a detailed technical discussion.) Data from the Annual Housing Survey enabled us to relate variations in removal and tenure-conversion rates to variations in revenue caused by different housing market conditions. Combining the results of that analysis with the revenue losses forecast under rent control gives us forecasts of losses from the rent-controlled housing supply.

The stock exchange model also forecasts the rent control-induced gain in rental housing services resulting from new construction carried out in response to the demand pressure caused by the loss of rent-controlled housing. We used data from the Annual Housing Surveys to obtain sketchy evidence on this process.

RENT REDUCTION LESS DETERIORATION: THE PRICE REDUCTION

If landlords undermaintain rent-controlled units, the resulting housing deterioration offsets, in part or entirely, the tenant's seeming rent bargain. We therefore require a measure of how much of a bargain rent control actually creates for a tenant; that is, we must measure how much rent control lowers the price of rental housing services.

When landlords allow their units to deteriorate, their tenants receive fewer housing services. If the landlords lower rents by even more than the amount of deterioration, we say the price of housing has
fallen. In this study, the difference between the percentage reduction in rent caused by rent control and the percentage reduction in housing services due to rent control-induced deterioration is termed the "price reduction" caused by rent control. For example, when rent control causes a 3.5 percent rent reduction and a 2.2 percent deterioration, it causes approximately 1.3 percent price reduction.

TENANT GAINS AND LANDLORD LOSSES

Tenant gains from rent control are the price reductions (net rent reductions after deterioration) less lost consumer surplus from reduced housing and any rent control fees paid by tenants. Landlord losses are the revenue losses from rent reductions and stock removal plus rent control fees paid by landlords, less savings from reduced maintenance expenditures.

We measure lost consumer surplus using Marshallian consumer surplus and a constant elasticity aggregate demand curve with a price elasticity of 0.7.

The value of landlord losses is greater than the present value of tenant gains. This "transfer inefficiency" of rent control has two causes. First, landlord losses exceed tenant gains by at least total rent control fees. Second, the losses of housing benefits to tenants from deterioration always exceed the savings to landlords from undermaintenance.
V. CONSEQUENCES OF ALTERNATIVE RENT CONTROL ORDINANCES IN LOS ANGELES

In this section, we report our 1981 forecasts of the consequences of alternative rent control ordinances in Los Angeles. The first ordinances compared are used to quantify the benefits and costs of controls and to make the point that rent control extracts its benefits early and imposes its costs late. A third ordinance is then introduced to illustrate how second generation rent control provisions trade off tenant benefits and landlord incentives.

All the results given here were derived directly from the models described above; readers interested in the specific assumptions made for Los Angeles in establishing parameters for the models will find a detailed discussion in Rydell et al. (1981).

The first ordinance analyzed permits an average annual rent increase of 7.6 percent in apartments with continuing tenants and permits rents to rise freely in apartments with new tenants. This ordinance is thus called the "7.6, no cap law". The second ordinance restricts rent increases to 5.6 percent for continuing tenants and 10 percent for new tenants. It is called the "5.6, 10 law".

Table 3 records the rent reductions the two rent control ordinances would induce over a period of eight years. Under the 7.6, no cap law, rents in 1990 would be only 3.5 percent lower than they would be in the absence of controls. But under the 5.6, 10 law, rents would be 18.5 percent lower than in the absence of controls. (All figures in the table are cumulative.)

Table 3 pointedly reminds us that rent reductions are a two-edged sword. If rent falls and a dwelling continues to be maintained as before, the tenant reaps a clear gain. But if as rent falls the landlord cuts back on maintenance, then deterioration of the dwelling may largely offset the benefits of reduced rent.
Under the 7.6, no cap law, 2.2 percent of the 3.5 percent rent reduction in 1990 is accumulated deterioration; the value of a fixed quantity of housing services (the "price of housing services") would have fallen only 1.3 percent. Under the 5.6, 10 law, deterioration amounts to 6.9 percent, so the 18.5 percent rent reduction reflects only a 12.5 percent decline in the price of housing services.

Table 3 also contains one of our striking lessons. In the early years of both rent control ordinances, rent reductions are dominated by reductions in the price of housing services; in the later years the pendulum shifts, and rent reductions are dominated by induced deterioration of the rental stock. The lesson, then, is that the financial transfers from landlord to tenant under rent control are achieved early, while the real cost in terms of lost housing services is incurred later.

The loss of rental housing services induced by rent control is not limited to deterioration; half the losses forecast under the Los Angeles ordinances arise from induced removals and condominium conversions. Table 4 depicts the predicted losses due to deterioration, removals, and conversions under the two laws; the figures in the table for the eight years are cumulative. Under the 7.6, no cap law, 4.8 percent of the controlled rental housing stock would be lost by 1990; under the 5.6, 10 law, 14 percent of the controlled rental stock would be lost by 1990.

Table 5 offers an alternative way of summarizing the effects of rent control according to the benefits gained by tenants and the costs incurred by landlords.¹

Tenants benefit from the real rent reductions imposed by rent control. Those benefits, however, are partially offset by the housing services lost through deterioration and by rent control administration fees paid by tenants. Landlords are injured by the real rent reductions they suffer, by the property value losses incurred in removing dwellings

¹ Table 5 does not address the distribution of benefits among tenants. Rydell et al., 1981, does address this issue and finds that rent control is very poorly targeted if its goal is to improve the well-being of poor households.
Table 3

PRICE REDUCTIONS AND DETERIORATION CAUSED BY RENT CONTROL: CONTROLED RENTAL HOUSING, LOS ANGELES--7.6, NO CAP LAW AND 5.6, 10 LAW

<table>
<thead>
<tr>
<th>Year</th>
<th>Component of Rent Reduction</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price Reduction (%)</td>
<td>Deterioration (%)</td>
<td>Rent Reduction (%)</td>
</tr>
<tr>
<td>1983</td>
<td>2.9</td>
<td>1.0</td>
<td>3.9</td>
</tr>
<tr>
<td>1984</td>
<td>2.7</td>
<td>1.3</td>
<td>3.9</td>
</tr>
<tr>
<td>1985</td>
<td>2.4</td>
<td>1.5</td>
<td>3.8</td>
</tr>
<tr>
<td>1986</td>
<td>2.1</td>
<td>1.6</td>
<td>3.7</td>
</tr>
<tr>
<td>1987</td>
<td>1.8</td>
<td>1.8</td>
<td>3.6</td>
</tr>
<tr>
<td>1988</td>
<td>1.7</td>
<td>1.9</td>
<td>3.6</td>
</tr>
<tr>
<td>1989</td>
<td>1.5</td>
<td>2.1</td>
<td>3.5</td>
</tr>
<tr>
<td>1990</td>
<td>1.3</td>
<td>2.2</td>
<td>3.5</td>
</tr>
</tbody>
</table>

7.6, No Cap Law

<table>
<thead>
<tr>
<th>Year</th>
<th>Component of Rent Reduction</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Price Reduction (%)</td>
<td>Deterioration (%)</td>
<td>Rent Reduction (%)</td>
</tr>
<tr>
<td>1983</td>
<td>5.1</td>
<td>1.2</td>
<td>6.3</td>
</tr>
<tr>
<td>1984</td>
<td>6.4</td>
<td>1.8</td>
<td>8.1</td>
</tr>
<tr>
<td>1985</td>
<td>7.7</td>
<td>2.4</td>
<td>9.9</td>
</tr>
<tr>
<td>1986</td>
<td>8.8</td>
<td>3.2</td>
<td>11.7</td>
</tr>
<tr>
<td>1987</td>
<td>9.9</td>
<td>4.0</td>
<td>13.5</td>
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<tr>
<td>1988</td>
<td>10.8</td>
<td>4.9</td>
<td>15.2</td>
</tr>
<tr>
<td>1989</td>
<td>11.7</td>
<td>5.9</td>
<td>16.9</td>
</tr>
<tr>
<td>1990</td>
<td>12.5</td>
<td>6.9</td>
<td>18.5</td>
</tr>
</tbody>
</table>


NOTE: All entries are the percentage difference between what would have prevailed without rent control and what occurred under rent control as of May of each year. The entries are related by the formula \((1 - p/100)(1 - q/100) = 1 - r/100\), where \(p\) = percentage price reduction, \(q\) = percentage deterioration, and \(r\) = percentage rent reduction.

\(a\) Control extended to 1990; 7.6 percent limit if no vacancy, no limit at a vacancy.

\(b\) Control extended to 1990; 5.6 percent limit if no vacancy, 10 percent limit at a vacancy.
Table 4

LOSS IN HOUSING SERVICES CAUSED BY RENT CONTROL:
CONTROLLED RENTAL HOUSING, LOS ANGELES--7.6, NO CAP LAW AND 5.6, 10 LAW

<table>
<thead>
<tr>
<th>Year</th>
<th>Deterioration (%)</th>
<th>Removal (%)</th>
<th>Condominium Conversion (%)</th>
<th>Total Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>1.0</td>
<td>.6</td>
<td>.4</td>
<td>2.0</td>
</tr>
<tr>
<td>1984</td>
<td>1.3</td>
<td>.7</td>
<td>.5</td>
<td>2.4</td>
</tr>
<tr>
<td>1985</td>
<td>1.5</td>
<td>.9</td>
<td>.6</td>
<td>2.9</td>
</tr>
<tr>
<td>1986</td>
<td>1.6</td>
<td>1.0</td>
<td>.7</td>
<td>3.3</td>
</tr>
<tr>
<td>1987</td>
<td>1.8</td>
<td>1.1</td>
<td>.8</td>
<td>3.7</td>
</tr>
<tr>
<td>1988</td>
<td>1.9</td>
<td>1.3</td>
<td>.8</td>
<td>4.1</td>
</tr>
<tr>
<td>1989</td>
<td>2.1</td>
<td>1.4</td>
<td>.9</td>
<td>4.4</td>
</tr>
<tr>
<td>1990</td>
<td>2.2</td>
<td>1.6</td>
<td>1.0</td>
<td>4.8</td>
</tr>
</tbody>
</table>

7.6, No Cap Law\(^a\)

<table>
<thead>
<tr>
<th>Year</th>
<th>Deterioration (%)</th>
<th>Removal (%)</th>
<th>Condominium Conversion (%)</th>
<th>Total Loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>1.2</td>
<td>.7</td>
<td>.4</td>
<td>2.3</td>
</tr>
<tr>
<td>1984</td>
<td>1.8</td>
<td>1.0</td>
<td>.6</td>
<td>3.4</td>
</tr>
<tr>
<td>1985</td>
<td>2.4</td>
<td>1.3</td>
<td>.9</td>
<td>4.7</td>
</tr>
<tr>
<td>1986</td>
<td>3.2</td>
<td>1.8</td>
<td>1.2</td>
<td>6.2</td>
</tr>
<tr>
<td>1987</td>
<td>4.0</td>
<td>2.3</td>
<td>1.5</td>
<td>7.8</td>
</tr>
<tr>
<td>1988</td>
<td>4.9</td>
<td>2.9</td>
<td>1.9</td>
<td>9.7</td>
</tr>
<tr>
<td>1989</td>
<td>5.9</td>
<td>3.5</td>
<td>2.4</td>
<td>11.8</td>
</tr>
<tr>
<td>1990</td>
<td>6.9</td>
<td>4.3</td>
<td>2.8</td>
<td>14.0</td>
</tr>
</tbody>
</table>

5.6, 10 Law\(^b\)

SOURCE: Rydell et al. (1981), Tables 4.9 and 4.10.

NOTE: All entries are the percentage difference between what would have prevailed without rent control and what occurred under rent control as of May of each year. Entries may not add to totals because of rounding.

\(^a\)Control extended to 1990; 7.6 percent limit if no vacancy, no limit at a vacancy.

\(^b\)Control extended to 1990; 5.6 percent limit if no vacancy, 10 percent limit at a vacancy.
from the stock that would otherwise have remained viable, and by rent control administration fees they pay. However, partially offsetting these losses are the savings in maintenance expenditures they realize from induced undermaintenance.

Table 5 tabulates these various costs and benefits in constant dollar terms for 12 years of the 7.6, no cap and 5.6, 10 laws. The column in the table that refers to "After Rent Control" reflects the predicted future value (beyond the 12 years of controls) of the housing deterioration induced by undermaintenance during the years of control.

Under the 7.6, no cap law, we find net tenant benefits of $227.3 million and net landlord costs of $286.9 million. Under the 5.6, 10 law, tenant benefits leap to $595.9 million, and landlord costs soar to $911 million. The difference between landlord costs and tenant benefits arises from the inefficiencies associated with interfering with the free workings of the market-place and, to a lesser extent, from administrative costs. Under the 7.6, no cap law, 21 percent of landlord costs are not realized as gains by tenants; under the 5.6, 10 law, 35 percent of the landlord costs do not reach tenants as gains.

The 5.6, 10 law would dramatically reduce the Los Angeles rental housing stock. One might expect such an ordinance, if introduced, to stir considerable controversy. Calls for ameliorative provisions would be likely. Table 6 reports the consequences for tenant benefits and landlord costs of one seemingly mild adjustment to the 5.6, 10 law. The proposed adjustment is to remove the 10 percent cap on rent increases for new tenants. Such a provision would be very successful in reducing losses of rental housing caused by the 5.6, 10 law. We estimate that net losses would be halved by such a provision, from 14 percent in 1990 to 7.2 percent.

However, Table 6 makes clear that this softening of rent control's deleterious effect on rental housing would only come at considerable expense to tenants. Tenant benefits would be cut nearly in half, from $595 million to $333 million.
Table 5

BENEFITS AND COSTS OF RENT CONTROL IN LOS ANGELES:
7.6, NO CAP LAW AND 5.6, 10 LAW

<table>
<thead>
<tr>
<th>Sources of Benefit or Cost</th>
<th>During Rent Control</th>
<th>After Rent Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Millions of 1978 Dollars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6, No Cap Law&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>384.5</td>
<td>124.6</td>
<td>509.1</td>
</tr>
<tr>
<td>Deterioration</td>
<td>-135.7</td>
<td>-124.6</td>
<td>-260.3</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>-7.3</td>
<td>0</td>
<td>-7.3</td>
</tr>
<tr>
<td>Lost Consumer Surplus&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-7.4</td>
<td>-6.8</td>
<td>-14.2</td>
</tr>
<tr>
<td>Total</td>
<td>234.0</td>
<td>-6.8</td>
<td>227.3</td>
</tr>
<tr>
<td>Landlord costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>384.5</td>
<td>124.6</td>
<td>509.1</td>
</tr>
<tr>
<td>Undermaintenance saving</td>
<td>-234.5</td>
<td>0</td>
<td>-234.5</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>7.0</td>
<td>0</td>
<td>7.0</td>
</tr>
<tr>
<td>Removal losses</td>
<td>5.4</td>
<td>0</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>162.3</td>
<td>124.6</td>
<td>286.9</td>
</tr>
<tr>
<td>5.6, 10 Law&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>966.7</td>
<td>373.3</td>
<td>1339.9</td>
</tr>
<tr>
<td>Deterioration</td>
<td>-268.9</td>
<td>-373.3</td>
<td>-642.2</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>-7.2</td>
<td>0</td>
<td>-7.2</td>
</tr>
<tr>
<td>Lost Consumer Surplus&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-39.6</td>
<td>-55.0</td>
<td>-94.6</td>
</tr>
<tr>
<td>Total</td>
<td>650.9</td>
<td>-55.0</td>
<td>595.9</td>
</tr>
<tr>
<td>Landlord costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>966.7</td>
<td>373.3</td>
<td>1339.9</td>
</tr>
<tr>
<td>Undermaintenance saving</td>
<td>-483.9</td>
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<td>-483.9</td>
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<tr>
<td>Rent control fees</td>
<td>6.9</td>
<td>0</td>
<td>6.9</td>
</tr>
<tr>
<td>Removal losses</td>
<td>48.6</td>
<td>0</td>
<td>48.6</td>
</tr>
<tr>
<td>Total</td>
<td>538.2</td>
<td>373.3</td>
<td>911.5</td>
</tr>
</tbody>
</table>

SOURCE: Rydell et al. (1981), Tables E.2 and E.3.

<sup>a</sup> Control extended to 1990; 7.6 percent limit if no vacancy, no limit at a vacancy.

<sup>b</sup> Control extended to 1990; 5.6 percent limit if no vacancy, 10 percent limit at a vacancy.

<sup>c</sup> Lost consumer surplus was not included in the measurement of benefits and costs in Rydell et al. (1981).
This finding is not peculiar to the new tenant rent provision. Second generation rent control laws generally reduce housing losses by reducing benefits to tenants. Second generation rent control provisions can increase the housing stock only by increasing landlords' incentives for maintaining dwellings. It is tenants' rents that give landlords their incentives. The rent reductions offered tenants by rent control tend to be lowered if landlords' incentives rise.

Since deterioration erodes the benefits to tenants from rent controls, and eventually leaves tenants only lost consumer surplus as the effect of rent control, there can come a point in the life of a rent control ordinance when tenants, too, can gain from restoring landlords' incentives to maintain their dwellings. However, too much can be made of this. Rent control provisions that reward landlords for restoring deteriorated dwellings generally create incentives to undermaintain and later rehabilitate; in such cases the average quality of dwellings may be (but need not be) higher than it would be in the absence of such provisions, but net tenant gains will generally be lower.

The stark differences in the costs and benefits of rent controls under the three ordinances considered here make clear the importance of accounting for the specific provisions of a rent control ordinance when evaluating the economic effects of controls. Less obvious from these numbers is the parallel point that analysts must account for the specific conditions of the market in which rent control is imposed.

We have already remarked that the premia paid by new tenants in the absence of controls sharply increase the quantitative effect of the Los Angeles ordinance's vacancy rent increase provisions. But even more important for the Los Angeles ordinance's effects is the rate of price inflation in the absence of rent control.

Contrary to our 1981 assumptions, inflation in the United States (and Los Angeles) declined sharply after 1982. By 1983 the allowed rent increases of 7.6 percent exceeded the rate of inflation; landlords were legally able to raise real rents reducing both the benefits and the costs of rent control.
In 1985 the Los Angeles City Council amended the rent control ordinance, limiting allowed increases to the annual change in the All-Items Consumer Price Index for Los Angeles. But because sitting tenants receive lower than average rent increases, average real rents continued to rise. Market conditions in Los Angeles, coupled with the specific provisions of the Los Angeles ordinance, are rapidly eroding the economic effects of this second generation rent control law.\(^2\) In our 1981 study, we estimated that such a phasing out of rent control would reduce total tenant benefits to about 130 million dollars and total landlord costs to about 160 million dollars, far below the levels forecast for a continuation of the 7.6 percent, no cap ordinance.

Clearly, only by careful attention to both specific housing market conditions and the specific provisions of individual ordinances is it possible to evaluate the economic effects of rent control.

\(^2\)Indeed, we eagerly await the new Hollywood thriller, "Son of Rent Control: The Monster with No Teeth".
<table>
<thead>
<tr>
<th>Sources of Benefit or Cost</th>
<th>Millions of 1978 Dollars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>During Rent Control</td>
</tr>
<tr>
<td><strong>7.6, No Cap Law</strong></td>
<td></td>
</tr>
<tr>
<td>Tenant benefits</td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>546.6</td>
</tr>
<tr>
<td>Deterioration</td>
<td>-175.0</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>-7.3</td>
</tr>
<tr>
<td>Lost Consumer Surplus</td>
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<tr>
<td>Total</td>
<td>364.3</td>
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<tr>
<td>Landlord costs</td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>546.6</td>
</tr>
<tr>
<td>Undermaintenance saving</td>
<td>-318.5</td>
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<tr>
<td>Rent control fees</td>
<td>7.0</td>
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<tr>
<td>Removal losses</td>
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<tr>
<td>Total</td>
<td>247.4</td>
</tr>
<tr>
<td><strong>5.6, 10 Law</strong></td>
<td></td>
</tr>
<tr>
<td>Tenant benefits</td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>966.7</td>
</tr>
<tr>
<td>Deterioration</td>
<td>-268.9</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>-7.2</td>
</tr>
<tr>
<td>Lost Consumer Surplus</td>
<td>-39.6</td>
</tr>
<tr>
<td>Total</td>
<td>650.9</td>
</tr>
<tr>
<td>Landlord costs</td>
<td></td>
</tr>
<tr>
<td>Rent reduction</td>
<td>966.7</td>
</tr>
<tr>
<td>Undermaintenance saving</td>
<td>-483.9</td>
</tr>
<tr>
<td>Rent control fees</td>
<td>6.9</td>
</tr>
<tr>
<td>Removal losses</td>
<td>48.6</td>
</tr>
<tr>
<td>Total</td>
<td>538.2</td>
</tr>
</tbody>
</table>

SOURCE: Rydell et al. (1981), Tables E.2 and E.3.

*a* Control extended to 1990; 7.6 percent limit if no vacancy, no limit at a vacancy.

*b* Control extended to 1990; 5.6 percent limit if no vacancy, 10 percent limit at a vacancy.

*c* Lost consumer surplus was not included in the measurement of benefits in Rydell et al (1981).
VI. CONCLUSIONS

Our analysis of rent control in Los Angeles leads to three major conclusions. First, quantitative assessments of rent control's effects must pay careful attention to both the specific provisions of the ordinance and the specific conditions of the local housing market. Second, rent control confers most of its benefits early and extracts most of its costs late. Third, the benefits and costs of rent control go hand in hand: efforts to reduce the costs of rent control, namely the deterioration and removal of dwellings from the rental stock, will generally be accomplished only by reducing the benefits received by tenants.
Appendix A
THEORY OF THE RENT REDUCTION MODEL

THE MODEL

To build the rent simulation model, we divide the rental market into seven occupancy-duration categories according to how long the current tenant has lived in a dwelling. Category 1 has tenants living in a unit for zero to one years, category 2, one to two years, and so on to category 7, which has tenants living in a unit for six or more years.

For each year of the simulation, we subdivide the units in each occupancy-duration category into those that keep the same tenant for at least one more year and those that acquire a new tenant during the year. The units keeping the same tenant go to the next-higher occupancy-duration category (because by the end of the simulation year their tenants will have lived there one more year). The units acquiring a new tenant go to the first occupancy-duration category.

In the simulation model described here, 14 different rent increases occur each year. The increases are different for each occupancy-duration category, and within each of the categories they are different for the units keeping the same tenants and those acquiring new ones.

After estimating the 14 separate types of rent increase, we estimate average increases by whether the unit kept its tenant or got a new one, and then estimate the overall average rent increase. Finally, we compare the end-of-year average rent with the average rent without rent control to find the rent reduction caused by control.

To make the simulation explicit, we need formulas for six steps: (1) splitting unit counts by occupancy-duration category into those keeping the same tenants and those getting new tenants, (2) finding the rent increases for units keeping the same tenants, (3) finding the rent increases for units getting new tenants, (4) computing average rent increases, (5) computing the year-end unit counts and average rents by occupancy-duration category, and (6) computing the average rent reduction caused by rent control.
Splitting Unit Counts (for \(c = 1, 2, \ldots 7\))

\[
S(c) = Z(c)U(c) ,
\]

(A.1)

\[
N(c) = U(c) - S(c) ,
\]

(A.2)

where \(c\) = occupancy-duration category,

\(U(c)\) = units in occupancy-duration category at start of year,

\(S(c)\) = units keeping same tenant during year,

\(N(c)\) = units acquiring new tenant during year,

\(Z(c)\) = fraction of units in occupancy-duration category \(c\) keeping same tenant at least one more year.

Rent Increases for Units with Same Tenants (for \(c = 1, 2, \ldots 7\))

\[
A(c) = \min \left\{ \frac{[1 + F(c)L(t)]P(c)}{[1 + G(t)]P(c)} \right\} ,
\]

(A.3)

where \(P(c)\) = average rent per unit at start of year in occupancy-duration category \(c\),

\(A(c)\) = average rent per unit at end of year for units in occupancy-duration category \(c\) keeping the same tenant,

\(L(t)\) = price inflation fraction during year \(t\) (i.e., if the CPI increases 10 percent, \(L(t) = 0.10\),

\(F(c)\) = fraction of annual price inflation charged to a staying tenant in occupancy-duration category \(c\),

\(G(t)\) = rent control limit in year \(t\) for the fractional rent increase of a unit keeping the same tenant (i.e., if the limit is 7 percent, \(G(t) = 0.07\)).
The top half of Eq. (A.3) represents the rent increase occurring in an uncontrolled market. The bottom half is the rent control limit. The actual rent increase is the minimum of the two possibilities.

Equation (A.3) is sufficient to model the effects of a continuing rent control law, but it cannot model the consequences of relaxing or removing such a law. When rent control is relaxed (or removed), we assume that landlords will increase rents to where they would have been in the absence of rent control. (The uncontrolled rent levels are found by running the model using Eq. (A.3) with no rent control limits.) Consequently, to model the end of rent control, Eq. (A.4) must be used instead of Eq. (A.3):

\[
A(c) = \min \left\{ \begin{array}{c}
\max \{ M(c,t) \\
[1 + F(c)L(t)]P(c), \\
[1 + G(t)]P(c)
\} \\
\end{array} \right.
\]  
(A.4)

where \( M(c,t) \) = average rent per unit at end of year \( t \) for units in occupancy-duration category \( c \) at start of year \( t \) that keep the same tenants during the year.

Rent Increases for Units with New Tenants (\( c = 1, 2, \ldots 7 \))

\[
B(c) = \min \left\{ \begin{array}{c}
t \sum_{j=0}^{t} \frac{D(t)R(0)}{1 + L(j)} [1 + L(j)] \\
[1 + 0.5 \left( \frac{A(c)}{P(c)} - 1 \right)] [1 + H(t)]P(c)
\} \\
\end{array} \right.
\]  
(A.5)

where \( B(c) \) = average rent per unit at end of year for units in occupancy-duration category \( c \) that acquire a new tenant,
\[ D(t) = \text{ratio of first rent for new tenants (under a rent control law that has vacancy decontrol)} \]
\[ \text{to average market rent (under no rent control)}, \]
\[ R(0) = \text{average market rent at start of year 1}, \]
\[ H(t) = \text{rent control limit in year } t \text{ for the fractional rent increase at a vacancy (i.e., if the limit is 10 percent, } H(t) = 0.10). \]

The top half of Eq. (A.5) is the rent landlords will obtain from a new tenant if there is no limit on rent increases at a vacancy. The bottom half of the equation is the rent resulting from a limit on rent increases at a vacancy. (The first part of the formula recognizes that half the units getting a new tenant will have already received the annual increase for continuing tenants before the vacancy occurs, and hence before the limit on rent increases at a vacancy applies.) The actual rent increase is the minimum of the two possibilities.

The ratio \( D(t) \) is estimated by assuming that landlords set first rents so that the rent discounted to continuing tenants over 10 years is the same as it would be if first rents were set at the average market level and then increased by the growth in the CPI. We also assume that each year landlords (and tenants) expect rent control to last two more years. The discount rate is the price inflation rate, \( L(t) \), plus a 4 percent real discount rate (see Neels and Rydell, 1981, p. 16, for the estimate of the real discount rate for rental housing):

\[
D(t) = \frac{1 + \sum_{j=1}^{10} \prod_{i=1}^{j} \frac{(1 + L(t))2(i)}{1.04 + L(t)}}{1 + \sum_{j=1}^{10} \prod_{i=1}^{j} \frac{(1 + E(i,t))2(i)}{1.04 + L(t)}}, \quad \text{(A.6)}
\]

where \( E(i,t) = \begin{cases} 
\min \left\{ F(i)L(t) \right\} & \text{if } i = 1 \text{ or } 2; \\
G(t) & \text{if } i > 2. 
\end{cases} \)
Average Rent Increases

\[ X_1(t) = 100 \left[ \frac{\sum_{\sigma=1}^{7} S(\sigma)A(\sigma)}{\sum_{\sigma=1}^{7} S(\sigma)P(\sigma)} - 1 \right], \quad (A.7) \]

where \( X_1(t) \) = average percentage rent increase for units with same tenants during year \( t \).

\[ X_2(t) = 100 \left[ \frac{\sum_{\sigma=1}^{7} N(\sigma)B(\sigma)}{\sum_{\sigma=1}^{7} N(\sigma)P(\sigma)} \right], \quad (A.8) \]

where \( X_2(t) \) = average percentage rent increase for units with same tenants during year \( t \).

\[ X_3(t) = 100 \left[ \frac{\sum_{\sigma=1}^{7} S(\sigma)A(\sigma) + N(\sigma)B(\sigma)}{\sum_{\sigma=1}^{7} U(\sigma)P(\sigma)} \right], \quad (A.9) \]

where \( X_3(t) \) = average percentage rent increase for all units during year \( t \).
New Unit Counts and Average Rents (c = 1, 2, ...7)

The new (year-end) unit counts and average rent by occupancy duration replace the old (start-of-year) unit counts and average rents by occupancy duration; they are used to conclude one year's simulation and create the initial conditions for the next year's.

All units with new tenants become category 1 units; the new rent in that category is the average of the rents for units with new tenants:

\[
U(1) = \sum_{c=1}^{7} N(c) , \quad (A.10)
\]

\[
P(1) = \frac{\sum_{c=1}^{7} N(c)B(c)}{\sum_{c=1}^{7} N(c)} . \quad (A.11)
\]

Units with the same tenant go to the next-higher occupancy-duration category:

\[
U(c) = S(c - 1) , \quad c = 2 \text{ to } 6 , \quad (A.12)
\]

\[
P(c) = A(c - 1) , \quad c = 2 \text{ to } 5 , \quad (A.13)
\]

except for category 7, which is an open interval that just goes into

\[
U(7) = S(6) + S(7) , \quad (A.14)
\]

\[
P(7) = \frac{S(6)A(6) + S(7)A(7)}{S(6) + S(7)} . \quad (A.15)
\]
Rent Reduction Caused by Rent Control \( t = 1, 2, \ldots, 12 \)

The average market rent that would exist if there were no rent control equals the initial average rent multiplied by the growth in the CPI:

\[
M(t) = R(0) \prod_{i=1}^{t} [1 + L(i)].
\]  
(A.16)

The average controlled rent is the unweighted average of the rents in all occupancy-duration categories:

\[
R(t) = \frac{\sum_{\sigma=1}^{\sigma} U(\sigma) P(\sigma)}{\sum_{\sigma=1}^{\sigma} U(\sigma)}.
\]  
(A.17)

The average percentage rent reduction caused by rent control by the end of year \( t \) can therefore be computed as \( 100[1 - R(t)/M(t)] \). Iterative operation of the simulation model produces the rent reduction for all 12 years.

**PARAMETER ESTIMATES**

Implementing the rent simulation model requires values for seven sets of parameters:

- The \( L(t), t = 1, 2, \ldots, 12 \), parameters, which give the annual fractional increase in average uncontrolled rent.
- The \( G(t), t = 1, 2, \ldots, 12 \), parameters, which give the annual fractional rent increases allowed under rent control for units keeping the same tenants.
- The \( H(t), t = 1, 2, \ldots, 12 \), parameters, which give the annual fractional rent increases allowed under rent control at a vacancy.
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- The $U(c)$, $c = 1, 2, \ldots 7$, parameters, which give the counts of units by occupancy-duration category at the start of rent control.
- The $P(c)$, $c = 1, 2, \ldots 7$, parameters, which give the rent per unit by occupancy-duration category at the start of rent control.
- The $Z(c)$, $c = 1, 2, \ldots 7$, parameters, which give the fraction of tenants staying at least one more year, by occupancy-duration category.
- The $F(c)$, $c = 1, 2, \ldots 7$, parameters, which give the fraction of annual price inflation charged to continuing tenants (if rent control limits do not apply), by occupancy duration.

We estimate the average uncontrolled rent increases to be $L(t) = 0.12$ for $t = 1$ to 4, and $L(t) = 0.10$ for $t = 5$ to 12. Those estimates result from our assumptions (1) that average uncontrolled rents increase with the CPI, and (2) that the CPI increases by 12 percent per year from May 1978 to May 1982 and by 10 percent per year from May 1982 to May 1990. If those estimates err, they err in being too large, in which case our estimates of the impacts of rent control are overstated.

The values of the parameters defining the rent control laws, $G(t)$ and $H(t)$, depend on the specific law analyzed. For example, for the current rent control law extended to 1990, $G(t) = 0.076$ and $H(t) = 5$ for all years. The number 0.076 is the sum of the 7 percent automatic rent increase allowed under the current law and the 0.6 percent increase, which is the weighted average of the special increases allowed for units in which the landlord pays the gas or electric bills. $H(t)$ is chosen to be so large (500 percent) that it is always larger than the market rent increase, thereby correctly modeling the effect of the vacancy decontrol provision in the current rent control law.

For the alternative rent control laws, we use different values of $G(t)$ and $H(t)$ for years $t = 5$ through 12 as necessary. For example, for the alternative that establishes a 5.6 percent limit if there is no vacancy and a 10 percent limit at a vacancy, we use $G(t) = 0.056$ for $t = 5$ through 8 and $H(t) = 0.10$. 
The remaining four sets of parameters are given in Table A.1. These parameters are based upon (1) the distribution of renters by occupancy duration, (2) renter mobility rates, (3) historical inflation pass-throughs for continuing tenants, and (4) rents by occupancy duration. For details, see Rydell et al. (1981).
Appendix B
THEORY OF THE DETERIORATION MODEL

THE MODEL
Annual change in housing quantity due to deterioration is governed by the difference equation\(^1\)

\[ H(t + 1) - H(t) = \alpha M(t)^\lambda - \beta H(t), \]  
(B.1)

where \( t = \) time (in years),
\( H(t) = \) housing services produced annually per rent-controlled dwelling,
\( M(t) = \) annual maintenance (\$ per rent-controlled dwelling),
\( \alpha = \) constant parameter,
\( \beta = \) gross deterioration rate parameter (fraction of housing services lost per year if there is no maintenance),
\( \lambda = \) diminishing-returns parameter \((0 < \lambda < 1)\).

We assume that at time zero (just before the start of rent control), the quantity of housing services produced per dwelling was economically optimal, and that just enough maintenance was being done to preserve that level of production. Solving Eq. (B.1) for the conditions under which the supply of housing services remains constant gives us the following relationship between initial maintenance and initial housing services:

\(^1\) As usual in model building, this equation was chosen for its theoretical tractability and its ability to adequately describe empirical evidence. Similar specifications can be found in Evans (1973), p. 104); Moorhouse (1972); and Kiefer (1980). The parameters \( \beta \) and \( \lambda \) are estimated at the end of this appendix.
\[ \alpha M(0)^{\lambda} = \beta H(0) \]  \hspace{1cm} (B.2)

This analysis judges that, given rent control, landlords undermaintain sufficiently for the production of housing services to eventually decline to the level supported by controlled rents.\(^2\) The desired amount of undermaintenance is defined by solving Eq. (B.1) for the conditions under which the production of housing services remains constant at the reduced level:

\[ \alpha [M(0) - U(t)]^{\lambda} = \beta F(t)H(0) \]  \hspace{1cm} (B.3)

where \( U(t) = \) annual undermaintenance (\$/per rent-controlled dwelling),
\( F(t) = \) average controlled rent as a fraction of average uncontrolled rent (equals \( 1 - 100X \), where \( X = \) percentage rent reduction caused by rent control).

Then, substituting Eq. (B.2) into Eq. (B.3), we obtain the following formula for the amount of undermaintenance at time \( t \):

\[ U(t) = M(0) \left[ 1 - F(t)^{1/\lambda} \right] \]  \hspace{1cm} (B.4)

Finally, to obtain the iterative equation that estimates the cumulative impact of undermaintenance, we use \( M(0) - U(t) \) in place of \( M(t) \) in Eq. (B.1), use Eq. (B.4) to define \( U(t) \), and solve for \( H(t + 1) \) as a function of \( H(t) \):

\[ H(t + 1) = \beta F(t)H(0) + [1 - \beta]H(t) \]  \hspace{1cm} (B.5)

\(^2\) To the extent that laws provide for rent increases to cover maintenance costs ("capital cost pass-throughs"), and to the extent that landlords use such a provision, this judgment leads to overestimates of deterioration.
Given values for rent reductions caused by rent control for each year (from the analysis in Appendix A), we obtain $F(t)$, controlled rent as a fraction of the rent that would have been charged without rent control. Using $F(t)$ in Eq. (B.5), we then iteratively estimate the quantity of housing services for each year of our analysis. The deterioration rate reported in Sec. IV equals $100[1 - H(t)/H(0)]$.

**PARAMETER ESTIMATES**

To implement Eq. (B.5), the housing deterioration model, we need estimate only a single parameter: the gross deterioration rate, $\beta$. However, to implement Eq. (B.4) and obtain estimates of the undermaintenance caused by rent control, we must also estimate the diminishing-returns parameter, $\lambda$.

Data from the Housing Assistance Supply Experiment yield the estimates reported in Table B.1. Those estimates are the result of regression analyses that estimate values of the parameter $\beta$ for alternative assumed values of $\lambda$. Note that the second regression run, which estimates $\beta$ to be 0.09, has the highest explanatory power. However, the explanatory power of the regression is almost the same for neighboring values of $\beta$.

To choose between alternative plausible values of $\beta$, given the Housing Assistance Supply Experiment evidence, we use the following theoretical relationship between $\lambda$ and $\beta$:

$$
\lambda = m \left[ 1 + \frac{\mu}{\beta} \right],
$$  

(B.6)

---

3 Note that Eq. (B.5) can alternatively be written as $H(t + 1) - H(t) = \beta [F(t)H(0) - H(t)]$, which shows that the gross deterioration rate, $\beta$, is the fraction of the gap between the desired quantity of housing services to be offered (given the current rent reduction) and the current quantity offered, which deteriorates each year.

4 The measures of housing services per dwelling used in the regression analysis are discussed in Neels and Rydell (1981) and Neels (1982).
Table B.1

ALTERNATIVE ESTIMATES OF PARAMETERS IN THE DETERIORATION MODEL

<table>
<thead>
<tr>
<th>Regression Run</th>
<th>Diminishing-Returns Parameter $\lambda$</th>
<th>Gross Deterioration Rate Parameter $\beta$</th>
<th>Variation Explained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.05</td>
<td>.092 (0.007)</td>
<td>5.90</td>
</tr>
<tr>
<td>2</td>
<td>.10</td>
<td>.089 (0.007)</td>
<td>5.92</td>
</tr>
<tr>
<td>3</td>
<td>.15</td>
<td>.084 (0.006)</td>
<td>5.76</td>
</tr>
<tr>
<td>4</td>
<td>.20</td>
<td>.077 (0.006)</td>
<td>5.47</td>
</tr>
<tr>
<td>5</td>
<td>.25</td>
<td>.069 (0.006)</td>
<td>5.12</td>
</tr>
<tr>
<td>6</td>
<td>.30</td>
<td>.062 (0.005)</td>
<td>4.72</td>
</tr>
<tr>
<td>7</td>
<td>.35</td>
<td>.055 (0.005)</td>
<td>4.40</td>
</tr>
<tr>
<td>8</td>
<td>.40</td>
<td>.048 (0.005)</td>
<td>4.07</td>
</tr>
<tr>
<td>9</td>
<td>.60</td>
<td>.029 (0.004)</td>
<td>3.00</td>
</tr>
<tr>
<td>10</td>
<td>.80</td>
<td>.018 (0.003)</td>
<td>2.27</td>
</tr>
<tr>
<td>11</td>
<td>1.00</td>
<td>.011 (0.003)</td>
<td>1.75</td>
</tr>
</tbody>
</table>

SOURCE: Regression analysis of Housing Assistance Supply Experiment data on changes in the quantity of housing services over time and in maintenance expenditures.

NOTE: The regression model is the following transformation of Eq. (B.1): $rac{[H(t + 1) - H(t)]}{H(t)} = \alpha H^\lambda / H(t) - \beta$. It was estimated with Ordinary Least Squares (OLS) regression for alternative of $\lambda$. Standard errors for $\beta$ are given in parentheses.
where \( m \) = optimal annual maintenance as a fraction of rent,  
\( r \) = real discount rate.

Estimating \( m \) and \( r \) makes Eq. (B.6) explicitly define a direct relationship between \( \lambda \) and \( \beta \).\(^5\) The alternative regression runs in Table B.1 define an inverse relationship. We let the intersection of the two relationships (\( \beta = 0.08, \lambda = 0.171 \)) determine the parameter estimates. The estimates thereby have both empirical and theoretical support. (Note that the chosen estimate of \( \beta \), 0.08, is very close to the one that maximizes the explanatory power of the regression.)

The theoretical relationship in Eq. (B.6) is a consequence of assuming that, without rent control, housing is maintained at a level that maximizes its present value, subject to the added assumption that short-run adaptations of maintenance are to a fixed level equal to the optimal long-run level of maintenance. We complete this appendix by deriving that equation.

The differential equation version in Eq. (B.1) is

\[
H'(t) = \lambda \dot{M} - \beta H(t) .
\]

Solving that differential equation for the time path of housing services as a function of initial housing services and a fixed maintenance level yields

\[
H(t) = \left[ H(0) - \frac{\lambda \dot{M}}{\beta} \right] e^{-\beta t} + \frac{\lambda \dot{M}}{\beta} .
\]

\(^5\) For example, the ratio of maintenance to gross rent for Los Angeles apartment buildings with 12+ units is 0.10, and the ratio of gross rent to contract rent for multiple-unit rental housing is 1.095. Multiplying these two factors together (and then multiplying by the association factor of 1.04 to account for the larger maintenance expenditures per unit in the small apartment buildings excluded from the Los Angeles study data base) yields an estimate that \( m \) = 0.114. An estimate of \( r \) can be drawn from Neels and Rydell (1981), who estimate \( r \) to be 0.04.
The present value of future revenues less expenses is

\[ V = \int_{t=0}^{\infty} \left[ PH(t) - M - C \right] e^{-rt} dt, \]  

(B.9)

where \( V \) = present value,
\( P \) = price per unit of housing services (depends on units of measure, and can be defined as equal to 1.0 in this analysis),
\( C \) = annual operating expenses besides maintenance.

Substituting Eq. (B.8) into Eq. (B.9) and integrating gives us present value as an explicit function of maintenance:

\[ V = \left[ \frac{1}{\beta + r} \right] \left[ PH(0) + \frac{Pa}{r} \lambda M - \frac{(\beta + r)}{r} M \right] - \frac{C}{r}. \]  

(B.10)

Setting the derivative of Eq. (B.10) with respect to maintenance, \( M \), equal to zero yields the first-order condition for optimal maintenance:

\[ \lambda PaM^{\lambda - 1} = \beta + r. \]  

(B.11)

Finally, assuming that the housing stock is not only being maintained optimally but is also at its optimal level--i.e., using Eq. (B.2)--enables us to transform Eq. (B.11) into Eq. (B.6). The transformation requires recognizing that \( m = M/PH \).

---

6 Requiring the second derivative of Eq. (B.10) with respect to maintenance to be less than zero yields the second-order condition \( 0 < \lambda < 1 \). That is why the parameter \( \lambda \) is called the diminishing-returns parameter; it must be less than 1.0. Note that with \( \lambda < 1 \), the first-order condition, Eq. (B.11), defines a direct relationship between price of housing services and optimal maintenance. Hence, the maintenance model is seen to be consistent with the common observation that maintenance is correlated with housing market conditions.
Appendix C
THEORY OF THE STOCK ADJUSTMENT MODEL

THE MODEL

We assess the loss in rent-controlled housing and the gain in noncontrolled housing by estimating annual changes. For the discussion in Sec. IV, we add those annual changes from the start of rent control to obtain rent control's total effect as of a given year.

The cumulative losses in rent-controlled housing services due to removals (Eq. (C.1) and conversion to owner-occupancy (Eq. C.2) are sums of the annual losses caused by the revenue reductions existing in each year:

\[ Z_1(t) = \sum_{i=1}^{t} \alpha_1 X(i) \quad \text{,} \tag{C.1} \]

where \( Z_1(t) \) = percentage loss in rent-controlled housing services due to removals caused by rent control through year \( t \),

\( \alpha_1 \) = annual percentage loss in rental housing services due to removals per 1 percent of revenue loss,

\( X(i) \) = percentage revenue loss per rent-controlled dwelling by year \( i \).

\[ Z_2(t) = \sum_{i=1}^{t} \alpha_2 X(i) \quad \text{,} \tag{C.2} \]

where \( Z_2(t) \) = percentage loss in rent-controlled housing services due to conversion to owner-occupancy caused by rent control through year \( t \),
\[ a_2 = \text{annual percentage loss in rental housing services due to conversion to owner-occupancy per 1 percent of revenue loss.} \]

The cumulative gain in rental housing services due to construction is the sum of the annual changes caused by excess demand for rental housing in each year. That excess demand equals the past losses of rent-controlled housing\(^7\) (as a percentage of all rental housing) less the past gain in rental housing from new construction:

\[ Z_3(t) = \sum_{i=1}^{t} a_3 \left[ F \left( Z_1(i - 1) + Z_2(i - 1) - Z_3(i - 1) \right) \right], \quad (C.3) \]

where \( Z_3(t) = \text{percentage gain in rental housing services due to construction of noncontrolled housing caused by rent control through year } t, \)

\[ a_3 = \text{annual percentage gain in rental housing services due to construction per 1 percent of excess demand,} \]

\[ F = \text{fraction of rental housing under rent control.} \]

**PARAMETER ESTIMATES**

We use the percentage rent reductions caused by rent control (obtained by the methods discussed in App. A) to estimate the percentage revenue loss caused by rent control, \( X(i) \). We assume that rent control has no effect on vacancy rates in rent-controlled housing; to the extent that rent control affects vacancy rates, it presumably reduces them (rent-controlled housing is a bargain, so demand for it should increase). Therefore, in ignoring the vacancy losses (if any) caused by rent control, we err on the side of overestimating the consequent revenue losses and hence the supply effects of rent control. The

---

\(^7\) Only the losses in rent-controlled housing services due to removals or conversion to owner-occupancy are included in the excess demand measure. The losses in rent-controlled housing services due to deterioration are excluded because rent-controlled tenants accept those losses in return for the rent reduction, given no excess demand.
fraction of rental housing under rent control, \( F \), will vary with law and local environment.

Stock adjustment models, in which annual percentage stock change is a linear function of a measure of percent of excess demand, are much discussed but infrequently estimated in the housing literature. The analysis by Muth (1960) remains the definitive empirical study, even though it uses aggregate national data, estimates only net change in housing supply (as opposed to the gross loss and gross gain changes needed here), and applies to housing market conditions of two decades ago. We used Los Angeles data to update these analyses, though we had only 27 data points.

The regression mode for the stock change analysis is

\[
Z_i = \alpha_i + \beta_i E
\]

where

- \( i \) = indicates type of stock change (e.g., removal, new construction),
- \( Z_i \) = annual percentage change in housing services resulting from stock change \( i \),
- \( E \) = percent of excess demand for housing services,
- \( \alpha \) = annual percentage change under zero excess demand (i.e., when demand is in long-run equilibrium with supply),
- \( \beta_i \) = annual percentage change in housing services resulting from stock change \( i \) per 1 percent of excess demand.
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