PRICE EFFECTS OF A HOUSING ALLOWANCE PROGRAM

C. PETER RYDELL, KEVIN NEELS, AND C. LANCE BARNETT

R-2720-HUD

SEPTEMBER 1982

A FINAL REPORT OF THE

HOUSING ASSISTANCE SUPPLY EXPERIMENT

Sponsored by

The Office of Policy Development and Research
U.S. Department of Housing and Urban Development

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PREFACE

This document reports on research conducted by The Rand Corporation as part of the Housing Assistance Supply Experiment (HASE). It is the last in a series analyzing the effect of the HASE experimental housing allowance program on the price of housing services in two midwestern markets. It both draws on other reports in the series and extends them with final evidence from the experiment.

The other Rand publications in the series are C. Peter Rydell, *Effects of Market Conditions on Prices and Profits of Rental Housing* (P-6008, September 1977); C. Lance Barnett, *Expected and Actual Effects of Housing Allowances on Housing Prices* (P-6184, January 1979); James P. Stucker, *Rent Inflation in Brown County, Wisconsin, 1973-78* (N-1134-HUD, March 1981); C. Lance Barnett and Ira S. Lowry, *How Housing Allowances Affect Housing Prices* (R-2452-HUD, September 1979); D. Scott Lindsay and Ira S. Lowry, *Rent Inflation in St. Joseph County, Indiana, 1974-78* (N-1468-HUD, November 1980); C. Peter Rydell, *Supply Response to the Housing Allowance Program* (N-1338-HUD, October 1980); C. Peter Rydell, John E. Mulford, and Lawrence Helbers, *Price Increases Caused by Housing Assistance Programs* (R-2677-HUD, October 1980); and C. Peter Rydell, *Price Elasticities of Housing Supply* (R-2846-HUD, September 1982).

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Charlotte Cox edited the report. Toby O'Brien, Pauline McGee, and Beverly Westlund produced the final copy.

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SUMMARY

The Housing Assistance Supply Experiment (HASE) was undertaken primarily to determine the effect of a full-scale housing allowance program on local housing markets: in particular, its effect on housing price. This study demonstrates that even during its initial, maximum-impact years, the experimental program increased the price of rental housing services by at most a few percent.

HASE operated full-scale housing allowance programs in both a tight housing market (Brown County, Wisconsin, which had a 4 percent rental vacancy rate) and a loose one (St. Joseph County, Indiana, which had a 10 percent vacancy rate). The program offered subsidies (housing allowances) to eligible households who lived in dwellings that met the program's requirements. The allowance payment to a household equaled the difference between an administratively determined standard cost of adequate housing and a fourth of the household's income. The allowance did not depend on the actual rent of the dwelling chosen by the household; that is, the tenant paid the marginal rent dollar. Consequently, the program motivated the tenant to pay no more than the market price for housing services.

Before the experimental allowance program began, some experts argued that it would cause serious price increases for participants (and others) by driving up market prices. The price increase would result from the program's reliance on the market to satisfy the subsidized demand, given the short-run inelasticity of housing supply. However, the experiment showed that the market supply of housing services is

elastic enough, even in the short run, to prevent program-induced demand from greatly increasing market rents.

Annual surveys of households in a fixed set of dwellings provided rent-change information over the first three years of program operations. (Because most dwellings change very little from year to year, the average percentage change in rent approximates the average percentage change in the price paid for housing services.) During the first three years, the average price of rental housing services rose 26 percent in Brown County; however, the study found that the increases were entirely due to background price inflation in the economy. After correcting for background inflation, it found no remaining real price increases to indicate that housing allowances caused marketwide price increases.

In the submarkets patronized by allowance recipients, the study found very small real price increases--2 or 3 percent at most. Those small increases were not annual ones that cumulated over time, but rather constitute the total price increase caused by the program.

The housing allowance program caused only small price increases, even in the short run, for two reasons. First, it caused modest increases in the demand for housing services. Poverty dynamics kept participation in the program low, and households that participated used much of their allowance income to reduce their rent burden rather than increase their housing demand. Moreover, the demand increase that occurred was diffuse rather than focused on a narrow segment of the market; much substandard housing could readily be repaired to standard condition.

Second, the supply of housing services rapidly expanded to accommodate program-induced demand. In the short run, the primary supply response was occupancy change. In the long run, the primary response was inventory change. Repair of substandard dwellings increased the supply of housing services in both the short and long runs.

Although the experiment was run in only two metropolitan areas, its finding that there were no serious price increases from the allowance program can be generalized for two reasons: (a) the experimental program shocked the housing market more than a nationwide program would; and (b) the experimental locations had representative housing-market conditions. Debates over the desirability of a nationwide housing allowance program can now shelve the issue of price increases and focus solely on whether the benefits to allowance recipients would be worth such a program's subsidy and administration costs.

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I. INTRODUCTION

The Housing Assistance Supply Experiment (HASE) was undertaken primarily to demonstrate how a full-scale housing allowance program would affect local housing markets: in particular, how it would affect the price of housing services.[1] If program-induced price increases were large, they would disrupt the housing market and divert program subsidies from their intended recipients. In the outcome, however, price effects caused by the experimental program were so small as to be negligible. This report presents the evidence.

A household participating in the experimental allowance program received the difference between the standard cost of adequate housing (which varied with household size) and a fourth of its income, provided its housing met the program's minimum quality and safety requirements.[2] The "standard cost" in the allowance formula was an estimate of the full market rent of dwellings that met program standards. It did not depend on the rent of a particular dwelling chosen by a particular allowance recipient. A recipient therefore had an incentive to seek a

[1] HASE is one of three experiments that tested the housing allowance program. The others were the Housing Allowance Demand Experiment run in Pittsburgh, Pennsylvania, and Phoenix, Arizona; and the Administrative Agency Experiment, run in eight jurisdictions. The three experiments together constitute the Experimental Housing Allowance Program (EHAP). Only the two HASE sites received full-scale housing allowance programs, beginning in 1974 in Brown County, Wisconsin, and in 1975 in St. Joseph County, Indiana. HASE monitored both programs until 1979. The programs are continuing in the two sites until 1984, however, funded by a ten-year annual contributions contract between the U.S. Department of Housing and Urban Development (HUD) and the local public housing authorities.

[2] The standards were adapted from those of the American Public Health Association and from the Building Officials and Code Administrators' model codes.

housing bargain. If he found a dwelling that met program requirements and rented for less than the standard cost, he could keep the difference (the rent savings). Consequently, the program motivated a tenant to pay no more than the market price for housing services.

However, the program contained no guarantee against market price increases. Rather, it relied on the market itself to accommodate the program-induced demand for more housing services. Given that the supply of housing services is less than perfectly elastic (at least in the short run), the program would clearly cause some price increases. The size of the increases has been at issue since early debates on the housing allowance concept.

While EHAP was in the planning stages, it was widely expected that housing allowances would have serious market price effects. Frank DeLeeuw, for example, judged that "subsidizing the demand for low-income housing [by means of housing allowances] would drive up rents" (DeLeeuw and Ekanem, 1971, p. 817). Another eminent observer, Henry Aaron, predicted in testimony to the U.S. Congress that a housing allowance program would cause a 10 percent price increase (U.S. Congress, 1972).

The housing-market simulation model of the National Bureau of Research predicted that a full housing allowance program operated in either Pittsburgh or Chicago would have quite serious effects: a fifth of the housing market would experience price increases exceeding 10 percent, and a tenth would experience increases of more than 20 percent (Kain and Apgar, 1977, Table 9-5). After the first test of its housing-market model, the Urban Institute (UI) reported that "in seven of the eight cases . . . housing prices for recipients of the housing

allowance rise. They rise by more than 10 percent in five of the eight cases. . . . The results thus do confirm the fear that a large-scale housing allowance program carries the danger of upward pressure on prices. . ." (DeLeeuw and Struyk, 1975, p. 131). In subsequent applications, the UI model predicted that the housing allowance program being run in Brown County, Wisconsin, would cause the price of recipients' housing services to rise by 4 to 9 percent, and that the program in St. Joseph County, Indiana, would cause the price to rise by 20 to 27 percent (Vanski and Ozanne, 1978, Tables 3.5 and A.2).[3]

Program-induced price increases were also foreseen by government planners. In 1974, HUD initiated the Section 8 Existing Housing program, which closely resembles the one tested by HASE. However, rather than trust the market to set rents, HUD set them administratively (the "Fair Market Rent"), relying on direct negotiations between local housing authorities and landlords. Further, HUD allowed the amount of the subsidy to vary with actual rent. Unfortunately, instead of preventing price increases those features of the Section 8 program had the opposite effect, causing an average price increase for recipients of 26 percent (Rydell, Mulford, and Helbers, 1980).

In Sec. II of this report, we examine the changes in the price of rental housing services that occurred in the experimental sites during the first three years of the allowance program. We find that although the price changes themselves were large, all of the marketwide change--

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[3] For a review of the economic arguments behind the price-increase predictions of both housing-market experts and computer simulation models, see Barnett and Lowry (1979, pp. 2-4).

and most of the recipient submarket change--can be attributed to factors other than the allowance program.

Section III determines that the allowance program had such a small effect on housing prices first, because it caused only a modest increase in housing demand, and second, because housing supply responds to demand shifts with surprising ease. The findings are based on a model of the rental housing market presented in the Appendix.

Section IV assesses the generalizability of the price effects found in the HASE sites, and discusses the ways in which the results improve our understanding of housing-market behavior.

II. EXPERIMENTAL EVIDENCE

The Supply Experiment operated full-scale housing allowance programs in Brown County, Wisconsin (whose central city is Green Bay), and in St. Joseph County, Indiana (whose central city is South Bend). Those locations were chosen because of their contrasting market conditions. Brown County had a tight housing market (4 percent rental vacancy rate), while St. Joseph County had a loose market (10 percent rental vacancy rate).

In this section we investigate evidence of program-induced price increases during the first three years of the allowance program, when its effect on prices was maximal. We analyze price both marketwide and in submarkets open to allowance recipients. Although we find no evidence of marketwide effects, we do find slight increases in submarket prices.

Evidence on price increases in the two experimental sites comes from rent data gathered in four annual surveys of the households in a fixed set of dwellings in each location (the total sample was about 2,300 dwellings). The surveys spanned roughly the first three years of program operations. We linked the records for dwellings whose occupants responded to two or more surveys, then calculated the annual percentage change in rent for each pair of records. Because most dwellings change very little from year to year, the average percentage change in rent approximates the average percentage change in the price paid per unit of housing service.

MARKETWIDE PRICE INCREASES

We found that during the first three years of the allowance program, the average price of rental housing services rose 26 percent in Brown County and 19 percent in St. Joseph County; those increases, however, are entirely explained by background price inflation in the economy. After correcting for such inflation, there remain no differential increases to indicate that housing allowances caused marketwide price increases (marketwide changes are reported in Table 2.1.).

We estimated the average increase in the price of rental housing services by measuring the average increase in gross rent (the amount paid to landlords plus any utility payments) between linked surveys of the same dwellings (see Table 2.2 for details of annual changes). Tracking the rent of a dwelling over time, however, biases the estimated price increases downward, because part of the rent change reflects quantity loss due to dwelling deterioration. Adding an estimate of net deterioration removes that bias and yields the price increase estimates.[1]

Estimates of net deterioration come from an Urban Institute analysis (Follain and Malpezzi, 1980, pp. 89-98) of data collected by the U.S. Bureau of the Census in the Annual Housing Survey. Applying the UI age-specific net deterioration rates for rental housing to the age distribution in Brown and St. Joseph counties yields the corrections

[1] Price equals rent divided by quantity. Relative change in price therefore equals relative change in rent, less relative change in quantity. Because deterioration causes a decrease in quantity, the absolute value of deterioration must be added to the rent change to yield the price change.

Table 2.1

MARKETWIDE RENT AND COST CHANGES DURING ALLOWANCE PROGRAM, YEARS 1-3

Item	Percentage Change Over Three Years	
	Brown County	St. Joseph County
Gross rent per dwelling[a]	24.4	18.3
Housing services per dwelling[b]	-1.6	-1.0
Rent per unit of housing service[c]	26.0	19.3
Cost per unit of housing service[d]	27.2	23.4
Difference between rent and cost charge[e]	-1.2 (±.6)	-4.1 (±.9)

SOURCE: Estimated by HASE staff from linked records of annual surveys of rental dwellings and from price indexes of components of annual housing costs during 1974, 1975, and 1976 in Brown County, and 1975, 1976, and 1977 in St. Joseph County. For additional details, see Tables 2.2 through 2.5.

NOTE: Numbers in parentheses are standard errors of estimate due to sampling variability in measuring rent changes. They indicate a 66 percent confidence interval. Doubling the standard errors indicates a 95 percent confidence interval.

[a]Gross rent consists of tenant payments to landlords (contract rent) plus any fuel and utility costs that tenants pay directly.

[b]Housing services per dwelling decline because of normal deterioration.

[c]Gross rent per dwelling minus housing services per dwelling.

[d]Price indexes for components of rent weighted by size of component.

[e]Rent per unit of housing service minus cost per unit.

Table 2.2

ANNUAL CHANGES IN MARKETWIDE GROSS RENT DURING ALLOWANCE PROGRAM, YEARS 1-3

Period	Brown County		St. Joseph County	
	Annual Rate of Increase in Gross Rent (%)	Standard Error of Estimate	Annual Rate of Increase in Gross Rent (%)	Standard Error of Estimate
Period 1	5.98	.39	4.61	.66
Period 2	9.98	.39	7.73	.60
Period 3	7.47	.35	5.26	.47
All periods	7.70	.20	5.71	.27
Three-year analysis period[a]	7.56	.20	5.76	.27

SOURCE: Lindsay and Lowry (1980, p. 29) and an unpublished parallel analysis for Brown County.

NOTE: In Brown County, period 1 = December 1973 - December 1974; period 2 = January 1975 - December 1975; period 3 = January 1976 - July 1977. In St. Joseph County, period 1 = November 1974 - December 1975; period 2 = January 1976 - December 1976; period 3 = January 1977 - July 1978.

[a] Mid-1973 to mid-1976 in Brown County, mid-1974 to mid-1977 in St. Joseph County. Rent inflation rates for those three-year analysis periods were estimated using the inflation rates for periods 1, 2, and 3, and assuming that rent inflation in the half-year before period 1 occurred at the period 1 rate.

necessary to transform our rent-change observations into unbiased estimates of price changes (reported in Table 2.3).

As noted, however, the price increases are attributable to background price inflation rather than to the allowance program. During the first three years of the Brown County program, the Consumer Price Index for the North-Central United States rose 27.4 percent; in St. Joseph County, it rose 22.9 percent. Moreover, during the same period, the

Table 2.3

AVERAGE DETERIORATION RATES FOR RENTAL HOUSING IN HASE SITES

Housing Age (years)	Age-Specific Deterioration Rate (percent per year)	Brown County		St. Joseph County	
		Distribution of Units	Contribution to Average Deterioration Rate (percent per year)	Distribution of Units	Contribution to Average Deterioration Rate (percent per year)
Less than 30	1.11	.408	.452	.210	.233
30 to 59	0.19	.330	.063	.338	.064
60 or more	0.11	.262	.029	.452	.050
All ages	(a)	1.000	.544	1.000	.347

SOURCE: Age distribution from Rydell (1977, p. 17). Age-specific deterioration rates from Follain and Malpezzi (1980, p. 94).

NOTE: The UI hedonic index analysis shows that quantity of housing services is related to housing age, A, by the factor $A^{-.08}$. The age-specific annual deterioration rate is therefore -.08/A. Using integration to get the average annual deterioration rates in the age intervals 0.5 to 30 years, 30 years to 60 years, and 60 years to 90 years yields the age-specific deterioration rates given in the table. For example,

$$\frac{1}{29.5}\int_{A=.5}^{29}\frac{-.08}{A}\,dA = \frac{-.08}{29.5}\left[\ln(30) - \ln(.5)\right] = -.0111.$$

[a]Not applicable.

cost of producing housing services rose 27.2 percent in Brown County and 23.4 percent in St. Joseph County. Fuel and utility costs rose the most--because of the energy crisis--whereas real estate taxes rose the least (changes in the components of gross rent are detailed in Tables 2.4 and 2.5). The cost of all inputs to the production of housing services rose by essentially the same amount as the Consumer Price Index.

Table 2.4

ANNUAL CHANGES IN COST OF PRODUCING RENTAL HOUSING SERVICES, BROWN COUNTY, YEARS 1-3

Component of Gross Rent	Fraction of Initial Gross Rent	Annual Percentage Change	Contribution to Annual Percentage Change in Cost
Capital Costs			
Current return	.337	6.2[a]	2.09
Maintenance	.113	9.1	1.21
Real estate tax	.169	4.0[b]	.68
Insurance	.023	6.2[a]	.14
Service Costs			
Fuel and utilities	.205	14.9	3.06
Management	.055	8.7	.48
Janitorial service	.031	10.2	.32
Losses			
Vacancy rent loss	.042	7.7[c]	.32
Uncollectable rent	.005	7.7[c]	.04
Total gross rent	1.000	--	8.34

SOURCE: Components of gross rent from Rydell (1977, p. 12). Price changes of components from unpublished extensions of Noland (1981a).

[a] Boeckh index of construction costs.

[b] Change in actual taxes for rental property.

[c] Change in gross rent.

Table 2.5

ANNUAL CHANGES IN COST OF PRODUCING RENTAL HOUSING SERVICES, ST. JOSEPH COUNTY, YEARS 1-3

Component of Gross Rent	Fraction of Initial Gross Rent	Annual Percentage Change	Contribution to Annual Percentage Change in Cost
Capital Costs			
Current return	.241	7.3[a]	1.76
Maintenance	.156	8.2	1.25
Real estate tax	.107	-4.9[b]	-.52
Insurance	.033	7.3[a]	.24
Service Costs			
Fuel and utilities	.256	11.8	3.02
Management	.058	9.2	.53
Janitorial service	.034	10.0	.34
Losses			
Vacancy rent loss	.097	5.7[c]	.55
Uncollectable rent	.018	5.7[c]	.10
Total gross rent	1.000	--	7.27

SOURCE: Components of gross rent from Rydell (1977, p. 12). Price changes of components from unpublished extensions of Noland (1981b).

[a]Boeckh index of construction costs.

[b]Change in actual taxes for rental property in Brown County.

[c]Change in gross rent.

Overall, cost increases exceeded price increases (refer to Table 2.1), which implies that the allowance program did not cause price increases. Moreover, the observed relationship between price and cost increases was not unique to Brown and St. Joseph counties; national data covering the 1970s display the same pattern (see Lowry, 1982).

SUBMARKET PRICE INCREASES

The absence of program-induced price increases at the marketwide level does not rule out price increases at other levels, particularly in the areas where recipients chose to live (program regulations prevented them from living in substandard housing, and low incomes prevented them from living in the very best housing). If the submarket recipients participated in was sufficiently insulated and small enough, then the program could have caused large price increases there.[2]

However, as Table 2.6 shows, there is little evidence of submarket price increases from the Supply Experiment. Annual rent increases for dwellings occupied by program participants were only a few percentage points higher than for those occupied by nonparticipants. Moreover, all the difference cannot be attributed to price increases: at least part was due to an increase in the quantity of housing services resulting from program-induced repairs.

The evidence presented in Table 2.6 indicates that the extra demand for housing caused by the allowance program was not very focused. Independent evidence that allowance recipients shopped for their housing throughout the market comes from the housing evaluations carried out by each county's Housing Allowance Office (HAO). The HAOs inspected the dwellings that potential recipients occupied or were considering occupying to determine whether they met program standards. By mid-1979, as

[2] The National Bureau of Economic Research housing-market simulation model (Kain and Apgar, 1977) and the Urban Institute model (DeLeeuw and Struyk, 1975) both predict large price increases for housing allowance recipients, in part because the models make many submarket distinctions. In those models, the additional demand from the housing allowance program concentrates in small parts of the housing market, where it causes large price increases.

Table 2.6

RENT CHANGES FOR RECIPIENT AND NONRECIPIENT DWELLINGS IN ALLOWANCE PROGRAM, YEARS 1-3

Period[a]	Average Annual Percentage Change in Gross Rent		
	Recipient Dwellings[b]	Nonrecipient Dwellings[c]	Difference
Brown County			
Period 1	8.8	5.6	3.2 (±1.7)
Period 2	12.2	9.6	2.6 (±1.3)
Period 3	9.2	7.2	2.0 (±1.1)
All periods	9.9	7.4	2.5 (± .8)
St. Joseph County			
Period 1	7.4	4.3	3.1 (±2.5)
Period 2	9.5	7.4	2.1 (±2.1)
Period 3	6.3	5.3	1.0 (±1.5)
All periods	7.5	5.5	2.0 (± .9)

SOURCE: Estimated by HASE staff from linked records of annual surveys of rental dwellings. For additional details, see Lindsay and Lowry (1980).

NOTE: Numbers in parentheses are standard errors of estimate due to sampling variability in measuring rent changes.

[a] In Brown County, period 1 = December 1973 - December 1974; period 2 = January 1975 - December 1975; period 3 = January 1976 - July 1977. In St. Joseph County, period 1 = November 1974 - December 1975; period 2 = January 1976 - December 1976; period 3 = January 1977 - July 1978.

[b] Average rent changes for dwellings occupied by allowance recipients during at least part of an observation period.

[c] Average rent changes for dwellings not occupied by recipients during an observation period.

much as 68 percent of the rental units in Brown County and 51 percent of the rental units in St. Joseph County had been evaluated at least once.

Because the dwellings occupied by program participants changed from year to year, we cannot estimate the extent to which the different annual rent increases shown in Table 2.6 accumulated. However, we think they did not accumulate. Rather, the increases occurred when or shortly after participants entered the program, as shown by their decline during the study period (the later years had fewer newly participating tenants and more continuing ones).

Table 2.7 provides direct evidence about the rent increases occurring when a dwelling's occupants joined the allowance program. The table distinguishes between dwellings that did not require repairs to meet program standards and those that did. In both counties, the rent increases for dwellings requiring repairs exceeded those for dwellings not requiring repairs. We conclude that part of the average rent increase caused by the program was due to quantity increases rather than to price increases.

The rent increases for dwellings requiring no repairs provide unbiased estimates of the immediate price effect of the housing allowance program: a 1.6 percent increase in Brown County and a 0.7 percent increase in St. Joseph County. By any standard, those increases are small. Moreover, immediate increases are all the allowance program appeared to cause. That is, the allowance program seems not to have caused annual price increases that accumulated over time, but rather to have induced only a small, one-time increase at the start.

Table 2.7

RENT CHANGES FOR DWELLINGS WHEN OCCUPANTS JOINED ALLOWANCE PROGRAM

Required Repair Status	Average Monthly Gross Rent ($)		Average Rent Increase (%)
	Preprogram Amount	Program Amount	
	Brown County		
No repairs	164	167	1.6
Repairs	151	155	2.5
Average	159	162	1.9
	St. Joseph County		
No repairs	157	158	.7
Repairs	152	155	1.7
Average	155	156	1.2

SOURCE: Brown and St. Joseph County HAO records. For additional details, see Rydell, Mulford, and Helbers (1980).

NOTE: Entries are for renter households who did not move when they entered the allowance program. The households reported their contract rent when they enrolled and again when their dwellings were certified for occupancy; the HAO estimated the cost of tenant-paid utilities from standard tables. The average interval between enrollment interview and first certification was 1.6 months in Brown County and 2.1 months in St. Joseph County.

III. EXPLANATORY MODEL

The Supply Experiment also constructed models of how the program affected demand, how supply responded to the increased demand, and how prices changed as a consequence.[1] Our purpose was not to precisely predict the program's effect on prices, but to ensure that our understanding of processes at work in a housing market were consistent with the observed outcomes. In fact, they were. The models predict virtually no effect on marketwide prices and only a small effect (2 to 3 percent) on prices for housing demanded by program participants.

MARKETWIDE DEMAND SHIFT

As we model it, the marketwide shift in rental demand caused by the allowance program equals the product of three factors: eligibility rate, participation rate, and demand shift per recipient. The eligibility rate is the fraction of renter households who are eligible for assistance under allowance program regulations. The participation rate is the fraction of eligibles who receive allowance payments when the program reaches its equilibrium level. The demand shift per recipient

[1] Using program data, we model the time-path of program-induced demand changes; using data that come mostly from the Annual Housing Survey, we model the time-path of suppliers' aggregate responses to market signals of excess demand. We then estimate the time-path of price changes that would be needed to continuously balance the shifting demand for housing services against the available supply. All changes (in demand, supply, and prices) are expressed relative to initial market conditions, and abstract entirely from the effects of background inflation in the economy (for details of market construction and operation, see the Appendix).

is the percentage increase in housing consumption caused by giving recipients housing allowances and requiring them to live in adequate housing.

Table 3.1 shows that slightly more than a fourth of the renter households in Brown and St. Joseph counties were eligible for housing allowances, that slightly less than 60 percent of the eligible households participated in the program, and that the participants increased their housing consumption by about 8 percent. The consequent marketwide shift in rental demand was 1.2 percent.

Table 3.1

RENTAL MARKET DEMAND SHIFT CAUSED BY ALLOWANCE PROGRAM

Factor Causing Demand Shift	Brown County	St. Joseph County
Eligibility rate[a]	.257	.295
Participation rate[b]	.594	.498
Demand shift per recipient (%)	7.8	8.2
Marketwide demand shift (%)	1.19	1.15

SOURCES: Eligibility rates from Balch and Carter (1981); participation rates from appendix Table A.6, present report; demand shift per recipient from Mulford et al. (1982).

[a]Fraction of all renter households eligible for allowances.

[b]Fraction of eligible renter households receiving allowance payments at program equilibrium.

The eligibility rates are not surprisingly low. Rather, if anything, they seem high: an open-enrollment transfer program that made between 25 and 30 percent of all renter households eligible for assistance was quite generous. The low levels of the other two factors, however, are among the biggest surprises of HASE. Before the findings of the experiment were reached, housing experts and market-simulation models tended to assume that all eligible households would participate in the program. They also assumed that considerable increases in housing consumption would be necessary for participants to obtain housing that met program standards.

The low participation rates resulted from the dynamics of poverty. Eligible households did not, on the average, stay eligible very long. Each year about a third of the eligible renter households became ineligible, primarily through escape from poverty, but also through out-migration or household dissolution. Newly eligible households replaced those leaving eligibility, of course, since the proportion of eligible households remains roughly constant over time. However, a newly eligible household did not usually join the allowance program immediately. Rather, such households learned about the program, decided to join, and passed the program's housing inspections at a rate of only about 3.3 percent per month (40 percent per year). Hence, at any given time, a considerable proportion of the eligible households was not receiving housing allowances.

Although the average renter spends only a fourth of his income on rent, HASE revealed that the average low-income renter spends over half his. Consequently, most households entering the housing allowance program already spent nearly enough on rent to pay for standard housing. Only a small increase in demand (about 8 percent, on the average) was needed to acquire housing that satisfied program requirements.[2]

Table 3.2 shows the growth of the allowance program during the its five years. The increases are smaller each year. By the fifth year, participation nearly reaches its equilibrium level.

The program-induced demand shift occurs gradually, driven by the buildup in participation.

SUBMARKET DEMAND SHIFTS

In modeling the market effect of the allowance program, we divide the rental housing market into two submarkets: the recipient and the nonrecipient. We define the recipient submarket as the set of dwellings that recipients could afford and that either met program standards or could be inexpensively brought to standard. We use HAO records to estimate the size of the recipient submarket. The HAO conducted evaluations not only of dwellings already occupied by program participants, but also of dwellings participants were considering as possible residences. As noted, during the first five program years, 68 percent of all renter dwellings in Brown County and 51 percent in St. Joseph County were

[2] Mulford (1979), in a full discussion of the issue, finds that the income elasticity of rental housing demand is only 0.2. Such a low figure means that as income falls, households do not noticeably cut back their housing consumption.

Table 3.2

RENTER PARTICIPATION IN ALLOWANCE PROGRAM, YEARS 1-5

Years Since Program Began	Number of Households			Participation Rate[a] (%)
	Ineligible	Nonrecipient Eligible	Recipient Eligible	
Brown County				
0	10,663	3,679	0	0
1	10,663	2,472	1,207	32.8
2	10,663	2,074	1,605	43.6
3	10,663	1,801	1,878	51.0
4	10,663	1,662	2,017	54.8
5	10,663	1,553	2,126	57.8
St. Joseph County				
0	11,005	4,614	0	0
1	11,005	3,796	818	17.7
2	11,005	2,923	1,691	36.6
3	11,005	2,640	1,974	42.8
4	11,005	2,627	1,987	43.1
5	11,005	2,521	2,093	45.4

SOURCE: HAO administrative records for years 1-5, and HASE surveys of tenants as analyzed in Balch and Carter (1981).

NOTE: Counts of eligible and noneligible households are for 1977 in both locations (program year 4 in Brown County and year 3 in St. Joseph County). Small positive trends in those counts in both locations are ignored in this analysis. The counts of eligibles exclude nonelderly single-person households because they were categorically excluded from the housing allowance program before August 1977 (i.e., they were excluded from the first three years of the Brown County program and the first 2.5 years of the St. Joseph County program).

[a]Ratio of renter households receiving housing allowance payments at end of each program year to total number of eligible renter households (sum of nonrecipient and recipient households).

evaluated at least once. The remainder of the rental inventory in each location constitutes the nonrecipient submarket.

According to our estimates, the program caused the demand for rental housing service in the recipient submarket to increase by 4.6 percent in Brown County and by 5.6 percent in St. Joseph County.[3] Most of the increase was due to the small proportion of recipients who, because their enrollment dwellings were irremediably substandard, moved from the nonrecipient to the recipient submarket. The much larger number of recipients who did not change submarkets contributed only modest program-induced demand increases to the total for the recipient submarket. Demand in the nonrecipient submarket decreased by an estimated 6.0 percent in Brown County and 3.5 percent in St. Joseph County, as potential recipients living in irremediably substandard dwellings moved to the recipient submarket.[4]

The marketwide demand increases were very small--about 1.2 percent--in each site (the marketwide change is the weighted sum of the submarket changes, one of which is positive, the other negative). Although at its equilibrium level the allowance program served about 15 percent of all renters in each site, participants in the program increased their housing consumption by only 8 percent on the average--not enough to substantially change the marketwide totals.

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[3] These and other demand-change estimates reported later in the text constitute the total changes caused by the allowance program when it reached its equilibrium size (four to five years after its start). Figures 1 and 2 illustrate the demand changes in the recipient submarket during the program's initial years.

[4] Our model assumes that there is no reverse flow of nonrecipients from the recipient submarket to the nonrecipient submarket.

SUPPLY RESPONSE

When the aggregate demand for housing service in a market or submarket increases, the price per unit of that service is bid up enough to clear the market during the short run, while the supply is fixed. However, landlords soon notice such price increases and find it profitable to expand the supply of housing services. As the supply expands, prices are bid downward and consumption increases until the market again clears.

We distinguish three ways the supply of rental housing services responded to demand shifts caused by the allowance program. First, some existing dwellings were repaired to meet program standards. Second, the inventory of rental housing changed as a result of new construction, demolition, or conversion; such changes included dwellings that shifted between the rental and ownership markets. Third, the occupancy rate for the rental inventory rose and fell to accommodate greater or lesser consumption.

Program records yield information on the number of rental dwellings that were repaired each year after a housing evaluation. For all rental dwellings occupied by allowance recipients, the average annual bill to repair deficiencies was $33 per unit (McDowell, 1979). However, even at maximum program size, only a fifth of the dwellings in the recipient submarket were occupied by recipients. The total annual bill for required repairs in that submarket therefore never exceeded about 0.5 percent of the preprogram rental value of housing services produced in the same submarket.[5]

[5] When recipients increased their housing consumption by moving, they occupied dwellings that would otherwise have been used by nonrecip-

Demolishing redundant dwellings, building new ones, converting large houses to small apartments, and so on, takes time. Various studies have shown that the rate of inventory adjustment varies with the size of the gap to be filled. Combining time-series and cross sectional data from the Annual Housing Survey, we estimate the rate of change in the number of rental dwellings as a function of the rental occupancy rate. We find that stock adjustments (the net result of new construction, demolition, conversion, and tenure change) typically close 16 percent of the gap between the current and the equilibrium occupancy rate each year (Rydell et al., 1981). At that speed, more than 15 years would pass before stock adjustments alone could restore a market to equilibrium after a one-time demand shift.[6]

Using data both from the HASE surveys and from the nationwide Annual Housing Survey, we find that the way occupancy rates adjust to short-run demand shifts depends on initial market conditions (Rydell, 1982). The tighter the market, the smaller the fraction of a given demand shift that is accommodated by changes in occupancy rates, and the larger the fraction that is absorbed by price changes. Applying our findings to the HASE sites, we estimate that a 0.1 percent increase in submarket demand would cause the occupancy rate to rise by 0.35 percent

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ients. To meet the continuing nonrecipient demand for housing of that size and quality, landlords might have voluntarily improved dwellings not occupied by recipients. If we had been able to model such a supply response, our estimates of program-induced price changes in the recipient submarket would have been lower.

[6] More precisely, 95 percent of the initial gap would be closed in 15 years. Our estimate of the annual rate of stock adjustment is about half the rate (32 percent) estimated by Muth (1960) from aggregate national data. We cannot presently account for the difference; but substituting Muth's parameter for our own would only reduce the range of price fluctuations yielded by the model.

in Brown County and by 0.61 percent in St. Joseph County. The effect is symmetrical for a demand decrease.

Because the three supply responses occur at different rates, our model estimates the time-path of each response separately, then sums them. The results for the recipient submarket are plotted in Figs. 1 and 2, along with the time-path of the demand shift to which supply responds.

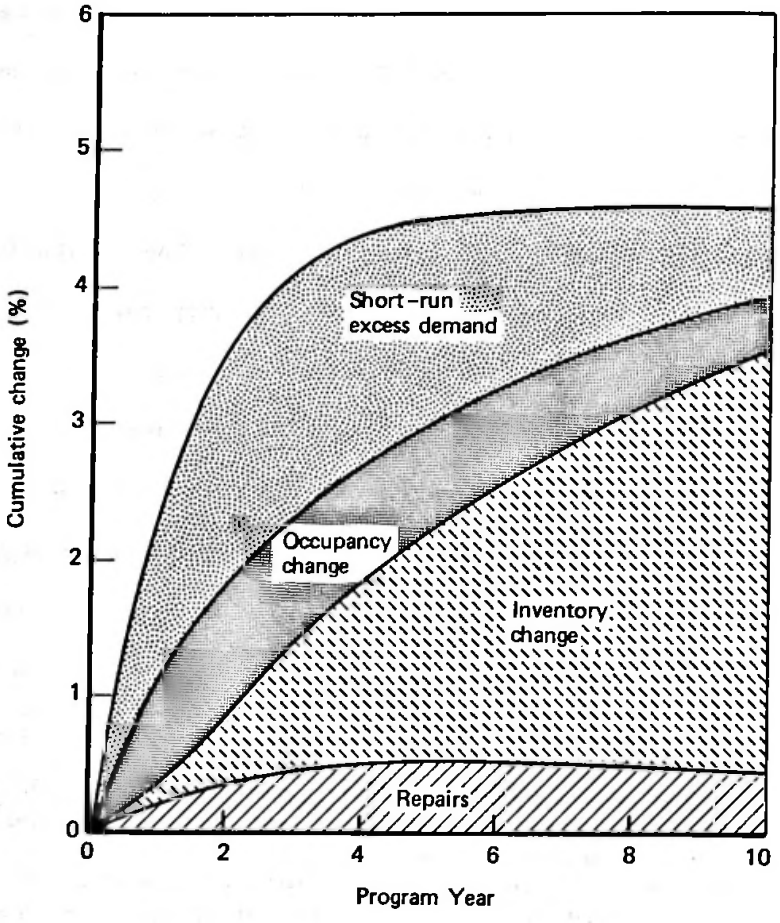

Fig. 1 — Demand shift and supply response caused by housing allowance program: model of Brown County rental housing market, recipient submarket

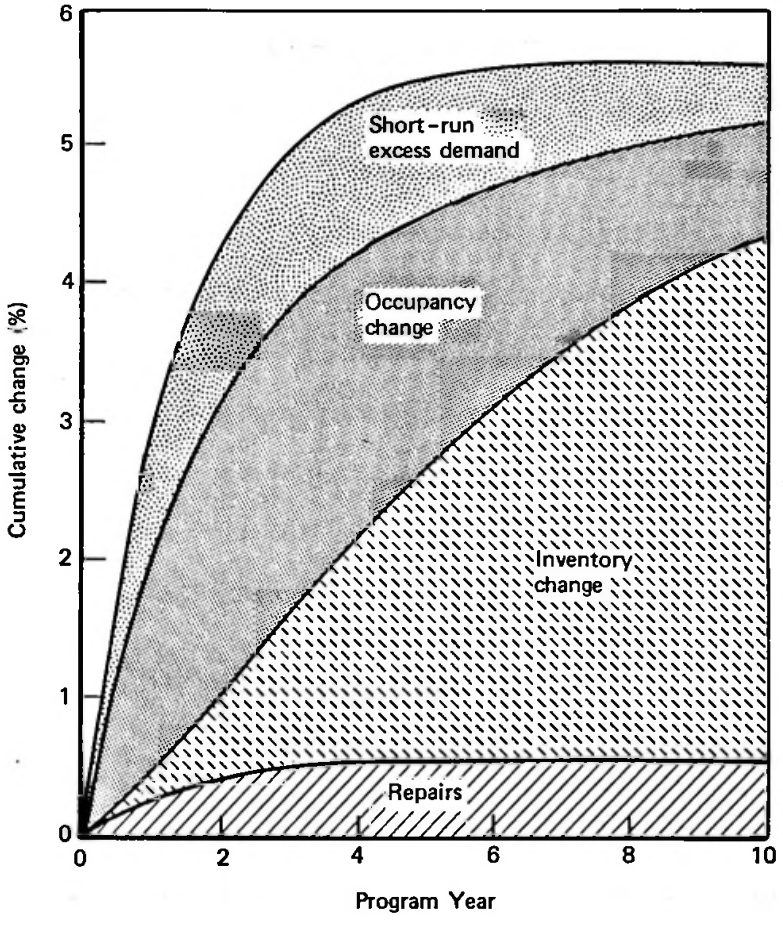

Fig. 2 — Demand shift and supply response caused by housing allowance program: model of St. Joseph County rental housing market, recipient submarket

The pattern is similar for both counties. The demand increase levels off in less than five years, when allowance program enrollment reaches equilibrium. The repair response grows as the program grows, but is always relatively small. The inventory change grows steadily,

but slowly, each year accommodating more of the program-induced demand shift. It takes years, however, to eliminate the difference between actual and desired supply. The occupancy rate adjusts to accommodate between a third and two-thirds of the residual demand change not attributable to repair and inventory responses.

The occupancy change is smaller in the tight Brown County market than in the loose St. Joseph County market because Brown County had a high initial occupancy rate (96 percent). Since occupancy rates can never, by definition, exceed 100 percent, the higher they are initially, the less increased demand they can absorb. By way of contrast, St. Joseph County's initial occupancy rate was low (90 percent), so it could change to absorb a correspondingly greater proportion of the demand increase.

PROGRAM-INDUCED PRICE CHANGES

In our model, supply response lags behind demand changes. Consequently, to clear the market at any time requires price changes. The price of rental housing services must rise in the recipient submarket to eliminate excess demand, and must fall in the nonrecipient submarket to eliminate excess supply.

With excess demand, the percentage price increase needed to clear the market (by reducing the amount demanded) is the product of two figures: the inverse of the price elasticity of demand, and the excess demand expressed as a percentage of supply. (Note that in estimating excess demand, we use the demand that would exist if price remains at

its preprogram level. Of course, once price changes to clear the market, excess demand becomes zero.)

Estimates of the price elasticity of the demand for rental housing service vary considerably, from 0.17 to 1.28 (Mayo, 1981). Most estimates lie between 0.3 and 0.7, however, with their central tendency 0.5. Our model uses the central value, which implies that a 10 percent increase in market price causes a 5 percent reduction in consumption.

To estimate the percentage price increase, we multiply the inverse (2.0) of the elasticity by the percentage difference between supply and demand in each submarket of our two experimental sites (the "excess demand" in Figs. 1 and 2). In the recipient submarket of Brown County during program year 1, for example, we estimate excess demand at 1.3 percent. The price increase needed to clear the market is therefore 2.6 percent (2.0 x 1.3). The results for the first 10 program years in each site are plotted in Figs. 3 and 4. The maximum price increase always occurs between program years 2 and 3; thereafter, prices gradually return to their preprogram values, while supply approaches demand.[7]

However, the maximum price changes are small. In the recipient submarkets, we estimate a short-run increase of up to 3.5 percent for Brown County and 2.5 percent for St. Joseph County. In the nonrecipient submarkets, we estimate price decreases of up to 5.0 percent in Brown County and 2.4 percent in St. Joseph County.

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[7] Given the relatively small size of the demand shifts caused by the allowance program, there is no reason to expect a long-run increase in the average cost of supplying the additional housing services. The long-run equilibrium price should therefore not rise significantly.

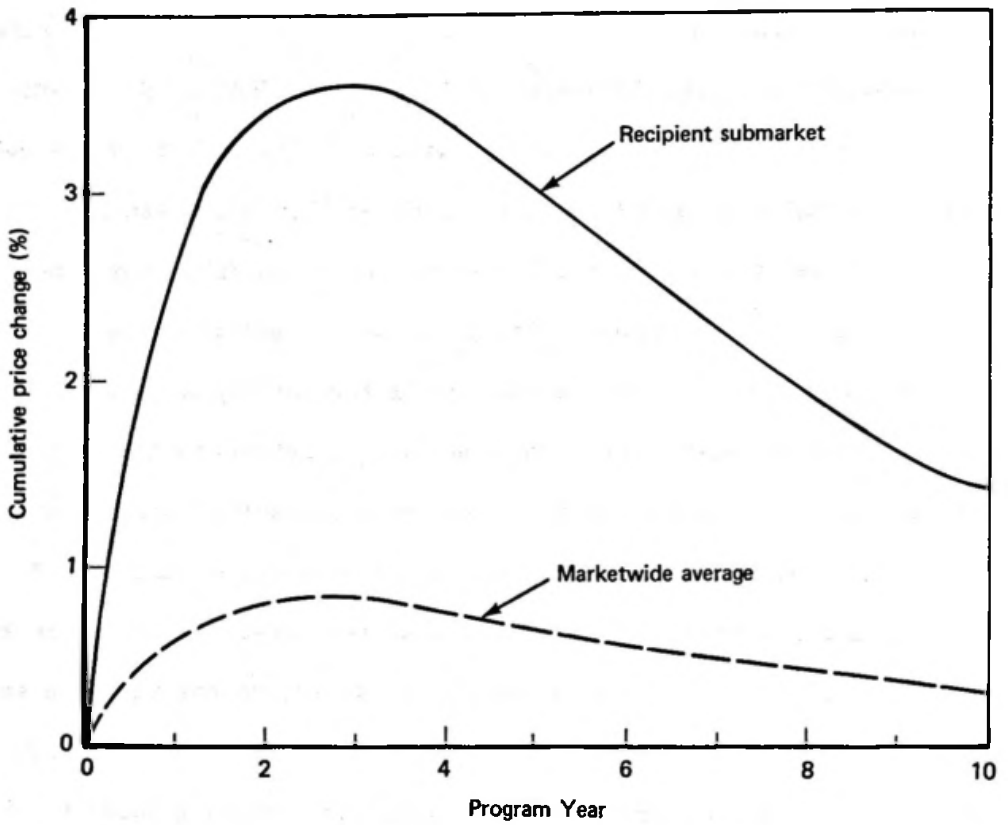

Fig. 3 — Price increases caused by housing allowance program: model of Brown County rental housing market

The program-induced price changes predicted by our model, although small, exceed those calculated from the empirical evidence presented earlier. The main reason for the discrepancy is that our model does not allow the nonrecipient occupants of dwellings in the recipient submarket to move to the nonrecipient submarket should prices there fall. If it did so, modeled prices would not rise by as much in the recipient submarket and would not fall by as much in the nonrecipient submarket.

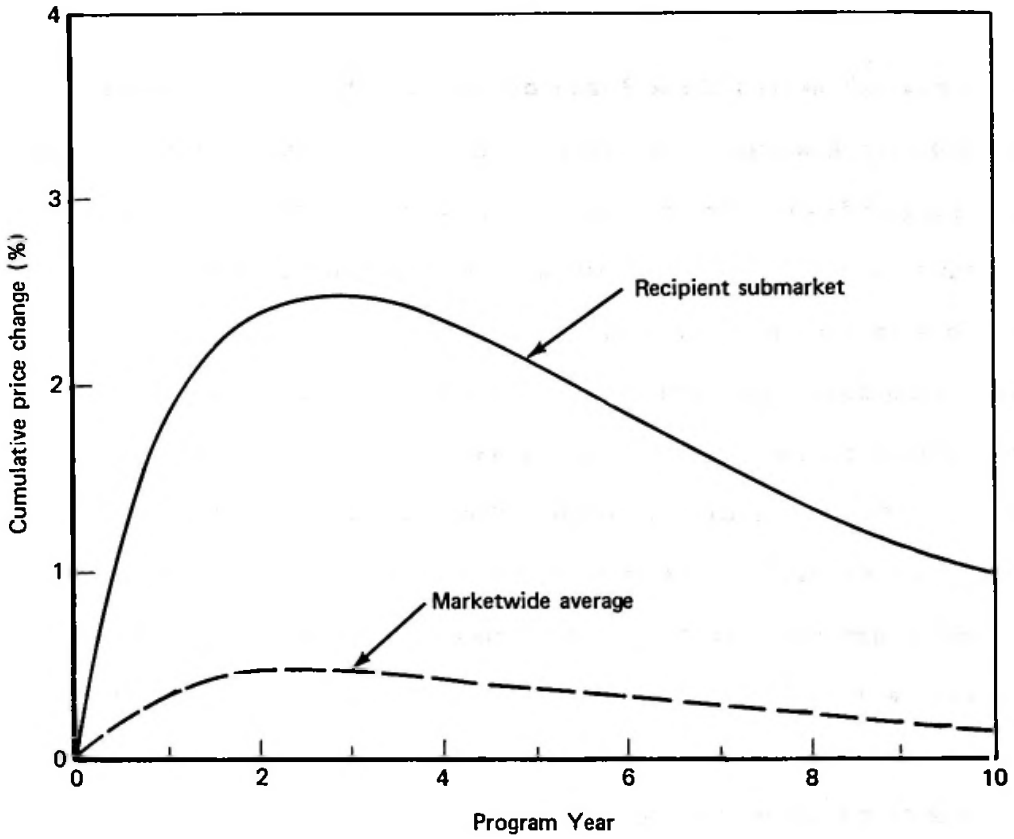

Fig. 4 — Price increases caused by housing allowance program: model of St. Joseph County rental housing market

Such a result would strengthen our finding that the allowance program caused only small price changes.

IV. CONCLUSIONS

We have presented three kinds of evidence bearing on the price effects of the housing allowance program: measurements of marketwide price changes during the program, analyses of submarket price changes, and estimates obtained from a model of market processes calibrated to conditions in each experimental location. The only conclusion consistent with all three types of evidence is that the program had very little effect on the price of rental housing service in either Brown County's tight market or St. Joseph County's loose market. The maximum program-induced market disturbance was a price increase of a few percent, which was confined to the portion of the market accessible to allowance recipients and that lasted only through the first few years of the program.

Because the Supply Experiment was conducted in just two metropolitan areas (to make costs feasible), the sample does not permit statistical generalization of the results. Nevertheless, the finding that the experiment had no serious price effects can be generalized judgmentally, both because (a) the experimental program shocked the housing market more than a national program would, and because (b) the experimental locations had representative housing-market conditions.

The program had a stronger effect on the market than a national program would because it allowed completely open enrollment of all eligible households, had high housing standards, provided a generous allowance formula, and was speedily implemented. A national program could have no broader coverage than open enrollment, and might well be

targeted on special groups (as are all current housing assistance programs). Since recipients in the experimental program had to live in housing that met virtually all the standards set forth in national model codes, a national program would be unlikely to require more. Moreover, the allowance formula would probably be less generous in a national program than it was in the experiment; HUD has received authorization from Congress to increase the tenant contribution to rent from 25 percent of income to 30 percent (*Federal Register*, 1980). Finally, a national program would presumably start up slowly. For one thing, a national program would not use the television and radio advertisements and other outreach techniques employed to expedite the experimental program.

Table 4.1 places the experimental locations in the context of the 21 nationwide metropolitan areas that were included in the 1975 Annual Housing Survey. Those areas are a randomly chosen subset of 156 large Standard Metropolitan Statistical Areas (SMSAs) that compose a rotating panel, some of which the Census Bureau surveys each year. From records for individual renter respondents in each place, we computed values for five variables that bear directly on program outcomes. From our 1975 household surveys in Brown and St. Joseph counties, we then computed comparable values for the same variables.

The first two columns rank Brown and St. Joseph counties within the national sample, on two scores: renters' eligibility for assistance, and ratio of allowance entitlement to nonallowance gross income. Those two factors are prime determinants of an allowance program's effect on the demand for rental housing. Eligibility rates (for renters) range

Table 4.1

PROGRAM AND RENTAL MARKET CHARACTERISTICS OF 21 SMSAs COMPARED WITH HASE SITES, 1975

Standard Metropolitan Statistical Area	Eligible Renters[a] (% of total)	Allowance/ Gross Income[b] (median %)	Dwellings Built before 1949 (%)	Rental Vacancy Rate (%)	Black or Latin Renters (% of total)
Atlanta, GA	22.0	22.2	27.4	15.0	31.8
Chicago, IL	26.2	23.5	66.2	6.7	34.3
Cincinnati, OH-KY-IN	19.5	22.1	58.5	7.0	20.2
Colorado Springs, CO	24.7	13.0	25.5	17.6	11.9
Columbus, OH	22.4	24.3	43.0	10.7	15.4
Hartford, CT	24.5	18.9	57.3	6.8	19.5
Kansas City, MO-KS	17.8	15.9	46.7	11.3	17.7
Madison, WI	14.3	15.2	36.1	5.2	3.2
Miami, FL	42.9	22.9	29.5	11.2	47.5
Milwaukee, WI	20.4	17.6	57.5	3.6	16.1
New Orleans, LA	20.9	22.8	59.8	7.8	43.5
Newport News, VA	17.6	15.1	36.3	13.2	34.0
Paterson-Clifton-Passaic, NJ	28.3	17.9	61.2	3.3	20.2
Philadelphia, PA-NJ	27.6	23.8	59.9	7.1	29.0
Portland, OR	20.0	17.6	41.2	7.3	3.6
Rochester, NY	26.6	19.1	58.6	8.6	16.4
San Antonio, TX	29.1	24.5	45.5	9.6	46.4
San Bernardino-Riverside -Ontario, CA	28.8	15.7	33.1	10.4	21.8
San Diego, CA	27.7	15.9	30.2	5.7	14.7
San Francisco-Oakland, CA	22.3	20.1	51.7	7.2	21.4
Springfield-Chicopee -Holyoke, MA-CT	26.8	20.7	69.7	6.5	13.4
Brown County, WI	21.9	14.9	54.7	5.1	.6
St. Joseph County, IN	24.7	23.0	67.5	11.0	17.3

SOURCE: Tabulated by HASE staff from records of the 1975 Annual Housing Survey conducted by the U.S. Bureau of the Census; and from records of the 1976 HASE surveys of households (wave 3 for Brown County, wave 2 for St. Joseph County).

NOTE: Statistics for Brown and St. Joseph counties may not agree with those elsewhere in this book because they were computed here by methods that could also be used on records of the Annual Housing Survey.

[a]Adjusted gross incomes less than 4 × standard cost of adequate housing - $120; nonelderly singles and occupants of subsidized housing are excluded.

[b]Estimated median entitlement of eligible renters, divided by median gross income of eligible renter households.

among the 23 listed areas from a low of 14 percent to a high of 43 percent; the two HASE sites closely bracket the median value. Income augmentation ranges from 13 percent to 24 percent; the HASE sites are near the extremes of the distribution.

The rest of the table presents similar comparisons for three variables that bear on market responsiveness: age of rental inventory (a proxy for physical condition that indicates the general difficulty of bringing dwellings up to program standards); rental vacancy rate (an important factor in determining how landlords respond to increased housing demand); and percentage of minority (black or Latin) renters (an indicator of the degree of submarket segmentation and of the possible focusing of program effects). The HASE sites span the upper half of the range on dwelling age, most of the range on vacancy rate, and the lower half of the range on minority representation.

From those comparisons, we judge that program outcomes in 20 of the 21 metropolitan areas would be similar to those observed in either Brown or St. Joseph County. The exception is Miami, Florida, where refugee immigration has added a large population of very poor Latins to the previous population of poor blacks; we estimate that 43 percent of Miami's renters would be eligible for assistance. However, with a relatively new housing stock and a high vacancy rate, we suspect that even Miami's rental market would absorb an allowance program without much disturbance.

Our opinion is reinforced by a HUD analysis that considered a different sample of 20 metropolitan areas selected from among those surveyed in the 1976 and 1977 Annual Housing Surveys. The HUD study postulated a "housing voucher" program that differed only slightly from the HASE experimental allowance program, and simulated the voucher program's

effects on rents using a model similar to the one presented herein the Appendix.[1]

The HUD simulation study varied the values of key parameters, using HASE estimates as the central reference point. Two market characteristics accounted for the largest share of intersite variation in the simulation outcomes: proportion of rental dwellings substandard, and rental vacancy rate. In the worst-case simulations, program-induced price increases ranged from 1.4 to 11.3 percent. Using the parameters estimated from HASE data, the range was from 0.6 to 4.8 percent. The best-case simulations yielded price increases ranging from 0.3 to 3.8 percent. Those results suggest strongly that a national housing allowance program patterned on the HASE experimental program would cause only modest price increases.

With hindsight, the early forecasts of allowance-caused price increases seem to reflect fundamental misconceptions about housing-market behavior. A decade ago, it was commonly believed that once a household becomes poor it stays poor; that all poor households live in substandard housing; that once a dwelling becomes substandard it stays substandard; and that the short-run supply of housing services is perfectly inelastic.

The logical conclusion was that housing allowances would cause large price increases. A permanent poverty population would join an open-enrollment housing allowance program in large numbers; all recipients would have to upgrade their housing from substandard to standard,

[1] The unpublished analysis was conducted in the spring of 1981 by Howard Hammerman, Office of Policy Development and Research, HUD, and is cited here with his permission. The underlying model of short-run market adjustment is presented in Rydell (1980).

causing large increases in their demand for housing; the economic infeasibility of repairing substandard housing would focus the demand increase on the narrow segment of the rental market containing affordable standard housing; and the lack of short-run supply response would load the entire burden of clearing the market on price increases.

However, because of HASE, we now know that those beliefs about housing-market behavior were inaccurate. A third of the households that are poor today will not be poor a year from now; their place in the poverty population will be taken by a newly poor household. That poverty dynamic, combined with delays in newly poor households' joining a housing program, would result in only half the eligible households receiving allowance assistance at any given time, thereby reducing the potential demand shock of a housing allowance program by half (Rydell, Mulford, and Kozimor, 1979).

Only half the households that joined the experimental allowance program formerly lived in substandard housing (McDowell, 1979); they were able to live in standard housing by spending disproportionately large percentages of their incomes on housing (Mulford, 1979). Consequently, only a small part of a typical allowance payment went to increased housing consumption, and most went to reduce rent burdens (Rydell and Mulford, 1982).

Three-fourths of the allowance recipients who originally lived in substandard rental housing repaired that housing rather than move to qualify for the allowance program (McDowell, 1979). The housing stock thus quite proved to be flexible, with over half the rental housing market actually accessible to allowance recipients; that flexibility

prevented explosive focusing of the program's demand shock (Rydell, 1980). Finally, especially in loose housing markets, occupancy rates expand in the short run to absorb large parts of a demand shift. Consequently, small price increases served to clear the market while inventory expanded to permanently accommodate the increased demand caused by the allowance program (Rydell, 1979, 1980, and 1982).

Hindsight also clarifies why the Section 8 program caused large price increases (26 percent) whereas the housing allowance program did not. In the Section 8 program, landlords tended to raise rents of enrolled dwellings toward the permitted ceiling (the administratively set "Fair Market Rent"); tenants could have no objection, since they paid only a fourth of their income for housing no matter how large the rent. The result was that the supposedly prudent regulations (imposing a rent ceiling and limiting allowance payments to actual rent less one-fourth of income) actually caused the price increases they were designed to prevent.

In the housing allowance program, on the other hand, tenants effectively paid the marginal rent dollar, inasmuch as the allowance depended on the average cost of standard housing rather than on the actual rent of a recipient's dwelling. Tenants were therefore motivated to bargain with their landlords and pay no more than the market price for housing services.

The policy implications of the HASE findings are clear. Debates about the desirability of housing allowances can now set aside the issue of price increases and more properly focus on who participates in an

allowance program and how it affects them. The issue of how an allowance program affects nonparticipants can also be set aside; HASE showed that there is virtually no such effect.

Appendix

MODEL OF THE RENTAL HOUSING MARKET

This appendix details the model used in Sec. III to explain the price effects of housing allowances. The model estimates three quantities: (a) the demand shifts caused by a housing allowance program; (b) the supply responses to the demand shifts; and (c) the price changes required to eliminate excess demand (demand shift less supply response).

First we outline the theory for the components of the model. Then we give our estimate of the twelve parameters needed to implement the model. Finally, we report the results of applying the model to data from the experimental allowance programs conducted in Brown and St. Joseph counties.

In constructing the model, we resolve uncertainty about structure and parameter estimates by erring toward overestimating the price effects. Since the predicted price effects turn out to be small, we can conclude with that much greater force that the actual price effects of the housing allowance program were small.

DEMAND SHIFTS

In our model, the housing allowance program causes demand increases in the portion of the market where rental housing both meets program standards (or can readily be brought to standard) and is affordable to allowance recipients. We call that part of the market the recipient submarket. All recipients live there, along with many nonrecipients.

The rest of the market is the nonrecipient submarket; no recipients live there, only nonrecipients. The allowance program causes a decrease in the demand for rental housing services there, as households move from nonreparable substandard dwellings (which are in the nonrecipient submarket, by definition) to standard dwellings (which are in the recipient submarket, again by definition) in order to qualify for allowance payments.

To derive the demand changes by submarket, we distinguish between those caused by recipients who change submarkets when joining the allowance program and those caused by recipients who stay in the same submarket. Our analysis therefore estimates four numbers (in each program year): the percentage demand shifts from two sources (movers and stayers) in two submarkets (recipients and nonrecipients). The numbers are denoted by X(1,t), X(2,t), Y(1,t), and Y(2,t) in Table A.1. (The letters denote submarkets, and the subscripts denote source of demand change and program year.) Accounting identities then yield the rest of the numbers in the table. Summing the two sources of demand change gives total demand change in each submarket:

$$X(3,t) = X(1,t) + X(2,t), \qquad (A.1)$$

and

$$Y(3,t) = Y(1,t) + Y(2,t). \qquad (A.2)$$

The weighted average of changes in each submarket gives marketwide changes:

$$W(i,t) = KX(i,t) + [1 - K]\, Y(i,t), \text{ for } i = 1, 2, 3, \qquad (A.3)$$

where K = recipient submarket as a fraction of the entire rental market.

Table A.1

STRUCTURE FOR ANALYZING DEMAND SHIFTS

Years Since Program Began	Percentage Change in Demand for Housing Services		
	Source of Demand Change		
	Recipients from Nonrecipient Submarket	Recipients from Recipient Submarket	Total
Recipient Submarket			
t	X(1,t)	X(2,t)	X(3,t)
Nonrecipient Submarket			
t	Y(1,t)	Y(2,t)	Y(3,t)
Marketwide Average			
t	W(1,t)	W(2,t)	W(3,t)

Demand Shifts by Submarket

The demand change in the recipient submarket caused by recipients who move from the nonrecipient submarket and the recipient submarket, X(1,t), has two components. First, since the households change submarkets, all their preprogram demand counts as a demand increase in the recipient submarket. Second, the demand per recipient household increases by enough to obtain standard housing (requirements effect) or by enough to appropriately spend the housing allowance (income effect), whichever is larger. Summing the two components yields Eq. (A.4):

$$X(1,t) = \frac{\left[N_1[100] + N_1 D_1\right] A(t)}{K}, \qquad (A.4)$$

where A(t) = recipient households as a fraction of all households in the entire market (depends on the number of years, t, since the start of the program,

N_1 = fraction of recipients that originally live in substandard housing but move when joining the allowance program

D_1 = average percentage increase in demand for housing services by recipients originally living in substandard housing.

The numeration of Eq. (A.1) gives the demand change as a percent of the entire rental housing market. To convert that result into a percentage change in the recipient submarket, we divide by the ratio of the size of the recipient market to the size of the entire market, K.

The demand change in the recipient submarket caused by recipients who originally lived in the recipient submarket, X(2,t), also has two components. First, recipients originally living in substandard housing increase their demand by the requirements effect or by the income effect, whichever is larger. Second, recipients originally living in standard housing increase their demand by the income effect. Summing the two components yields Eq. (A.5):

$$X(2,t) = \frac{\left[N_2 D_1 + N_3 D_2\right] A(t)}{K}, \qquad (A.5)$$

where N_2 = fraction of recipients that both originally lived in substandard housing and repaired that housing when joining the allowance program,

N_3 = fraction of recipients that originally lived in standard housing,

D_2 = average percentage increase in demand for housing services by recipients originally living in standard housing.

The demand change in the nonrecipient submarket is caused by the departure of recipients who move to the recipient submarket when joining the allowance program. All that preprogram demand is subtracted from the nonrecipient submarket. To find the percentage change in demand, Y(1,t), we divide by the ratio of the size of the nonrecipient submarket to the size of the total market, 1 - K:

$$Y(1,t) = - \frac{N_1[100]\ A(t)}{1 - K} \qquad (A.6)$$

By definition, recipients of housing allowances must live in the recipient housing market. The percentage of demand changes in the nonrecipient submarket caused by recipients moving there from the recipient submarket, Y(2,t), is therefore zero.[1] That is, in Table A.1,

$$Y(2,t) = 0. \qquad (A.7)$$

To apply the preceding equations to the empirical evidence, we must estimate the recipient fractions, N_1, N_2, and N_3, the increases in recipient demand, D_1 and D_2, and the proportion of renter households receiving allowance payments, A(t). The fraction of recipients who move from

[1] Our specification of demand shifts caused by the allowance program assumes zero net shift of nonrecipients from the recipient submarket to the nonrecipient submarket. That shift is likely to be positive, as some nonrecipients seek to avoid program-induced price increases in the recipient market and take advantage of program-induced price decreases in the nonrecipient market. Unfortunately, we do not have an unbiased estimate of that shift. We resolve the uncertainty by deliberately underestimating the shift--implicitly setting it equal to zero--and hence ultimately overestimating the price changes caused by housing allowances.

substandard housing, N_1, repair substandard housing, N_2, or already live in standard housing, N_3, can be derived from two parameters, w and x, as follows:

$$N_1 = w[1 - x], \tag{A.8}$$

$$N_2 = wx, \tag{A.9}$$

and

$$N_3 = 1 - w, \tag{A.10}$$

where w = fraction of recipients originally living in substandard housing,

x = fraction of recipients originally living in substandard housing who repair rather than move when joining the program.

The percentage demand increases by recipients who come from substandard housing, D_1, and from standard housing, D_2, can be most conveniently estimated by the following expressions:

$$D_1 = \frac{D}{w} [1 - (1 - w)(1 - c)], \tag{A.11}$$

and

$$D_2 = D [1 - c] , \tag{A.12}$$

where D = average percentage increase in demand for housing services per recipient,

c = fraction of increase in recipients' housing demand due to program standards.

Note that the weighted average of the two demand increases equals the overall average demand increase,

$$wD_1 + (1 - w) D_2 = D. \qquad (A.13)$$

In fact, we obtained Eq. (A.11) by substituting Eq. (A.12) into Eq. (A.13).

Dynamics of the Demand Shift

In our model, the increased demand by recipients for housing services, D, does not occur immediately after the start of the allowance program. Rather, the program requires several years to build to its equilibrium level.

Two dynamic processes determine the size of the allowance program: the movement of households into and out of eligibility, and the movement of eligible households into and out of the program. To keep the model simple, we assume that the first process is in equilibrium and then trace the second's approach to equilibrium. That is, we assume that the total number of households and the proportion eligible are constant, even though particular households change eligibility status.

The annual change in program size equals the flow of eligible nonrecipients into the program less the flow of recipients out of the program:

$$A'(t) = n[E - A(t)] - qA(t), \qquad (A.14)$$

where E = fraction of renter households that are eligible to receive housing allowances,

A(t) = fraction of renter households that receive housing allowances,

n = annual rate at which eligible nonrecipient households join the program,

q = annual rate at which recipient households leave the program,

t = years since the allowance program began.

Solving Eq. (A.14), using A(o) = 0 as the initial condition, yields our model of program size as a function of time since the program began:

$$A(t) = E\left[\frac{n}{n+q}\right]\left[1 - e^{-[n+q]t}\right]. \qquad (A.15)$$

Using that formula in Eqs. (A.4), (A.5), and (A.6) completes our model of program-induced demand shifts.

SUPPLY RESPONSE

The supply of rental housing services responds to program-induced demand through three mechanisms: (a) repairs to substandard housing, (b) inventory changes, and (c) occupancy changes. Our analysis estimates the percentage of supply change caused by each response in two submarkets. Those estimates are denoted by X(4,t), X(5,t), X(6,t), Y(4,t), Y(5,t), and Y(6,t) in Table A.2. Accounting identities then yield the rest of the table. The sum of the three supply responses is the total supply response:

$$X(7,t) = X(4,t) + X(5,t) + X(6,t), \qquad (A.16)$$

and

$$Y(7,t) = Y(4,t) + Y(5,t) + Y(6,t). \qquad (A.17)$$

Table A.2

STRUCTURE FOR ANALYZING SUPPLY RESPONSE

Years Since Program Began	Percentage Change in Supply of Housing Services			
	Source of Supply Response			
	Repairs	Inventory Change	Occupancy Change	Total
Recipient Submarket				
t	X(4,t)	X(5,t)	X(6,t)	X(7,t)
Nonrecipient Submarket				
t	Y(4,t)	Y(5,t)	Y(6,t)	Y(7,t)
Marketwide Average				
t	W(4,t)	W(5,t)	W(6,t)	W(7,t)

The weighted average of changes in each submarket gives the marketwide changes:

$$W(i,t) = KX(i,t) + [1 - K]\, Y(i,t), \text{ for } i = 4, 5, 6, 7. \quad (A.18)$$

Repair Response

The model specifies that recipients who join the allowance program while living in substandard housing must either repair that housing to standard condition or move to standard housing. A substantial fraction, WX, choose to repair rather than move. The percentage increase in housing services in the recipient submarket caused by those repairs, X(4,t),

equals the fraction of recipients who join from substandard housing, W, times the portion of those who repair, X, multiplied by recipients as a fraction of the recipient submarket, A(t)/K, times the percentage increase in housing services per dwelling repaired, r:

$$X(4,t) = \left[\frac{wxr}{K}\right] A(t), \qquad (A.19)$$

where r = average percentage increase in the supply of housing services per dwelling repaired to meet program standards.[2]

No dwelling in the nonrecipient submarket can by definition have occupants in the allowance program, so the program-induced repair there, Y(4,t), is zero. That is,

$$Y(4,t) = 0. \qquad (A.20)$$

Inventory Response

Demand shifts not accommodated by the housing services created through repairs are ultimately met by inventory expansion: a combination of more new construction, fewer removals, and more net conversions of owner dwellings than would occur without the allowance program. However, inventory responses occur only gradually. Accordingly, we model the inventory responses, X(5,t) and Y(5,t), by multiplying the ultimate demand shift (taken to have occurred by program year 10), net of the

[2] Here we estimate only the repairs made to dwellings as their occupants join the allowance program. Presumably, other dwellings are also repaired by landlords who hope to attract allowance recipients as tenants. By implicitly assuming the other repair response to be zero, we are underestimating the total repair response and hence overestimating the program's price effects.

ultimate repair response, by a fraction indicating the amount of inventory response that occurs by program year t:

$$X(5,t) = [X(1,10) - X(4,10)]\ h(t), \qquad (A.21)$$

and

$$Y(5,t) = [Y(1,10) - Y(4,10)]\ h(t), \qquad (A.22)$$

where h(t) = fraction of the ultimate inventory response occurring in program year t.

To find the fraction of inventory response over time, we first use Eq. (A.15) to define the proportion of the ultimate demand shift occurring by program year t:

$$d(t) = 1 - e^{-\alpha t}, \qquad (A.23)$$

where d(t) = fraction of ultimate demand shift occurring by program year t,

$\alpha = n + q$ = pace of the demand shift (fraction of the gap between the maximum and current shift closed per year).[3]

We then assume that inventory adjusts at a rate proportional to the gap between desired and actual supply:

$$h'(t) = \beta[d(t) - h(t)], \qquad (A.24)$$

where β = pace of inventory adjustment (fraction of the gap between desired and actual inventory closed per year).

[3] This interpretation of α can be seen by differentiating Eq. (A.23) to yield $d'(t) = \alpha[1 - d(t)]$.

Substituting Eq. (A.23) into Eq. (A.24) and solving with the initial condition h(o) = 0 yields[4]

$$h(t) = 1 + \left[\frac{\beta}{\alpha - \beta}\right] e^{-\alpha t} - \left[\frac{\alpha}{\alpha - \beta}\right] e^{-\beta t}. \qquad (A.25)$$

Occupancy Response

If the short-run supply of housing services was perfectly inelastic, then the percentage price increase caused by a one percent increase in net demand would equal the inverse of the price elasticity of demand. That would happen because the entire increase in net demand would be accommodated by an upward movement along the demand curve. By definition, the price elasticity of demand, S, is the percentage decrease in demand per one percent increase in price. A movement along the demand curve sufficient to reduce realized demand by one percent would therefore be associated with a percentage price increase equal to 1/S.

However, the short-run supply of housing services is not perfectly inelastic. When a housing market experiences an increase in net demand, the occupancy rate increases and absorbs some of the excess demand.[5] The result is that only part of the net demand curve, and consequently

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[4] In the special case of $\alpha = \beta$, the solution is $h(t) = [1 - e^{-\alpha t}] - [\alpha + e^{-\alpha t}]$.

[5] The occupancy rate for housing services is measured operationally by 1.0 less the fraction of rent lost due to vacancies. It can increase three ways. First, households living in units providing small amounts of housing services can move into vacant units offering larger amounts of housing services. Second, households can subdivide, forming two or more households that consume more housing services per capita than the original household. Finally, households can move from a substandard housing unit into a vacant standard housing unit, increasing the occupancy rate for standard housing services while decreasing the occupancy rate for substandard housing services.

the short-run price increase, is smaller than the inverse of the price elasticity of demand.[6]

To determine how much of the potential short-run price increase is absorbed by increases in the occupancy rate, we first express the demand curve in terms of relative changes:

$$d = m - Sp, \tag{A.26}$$

where d = percentage realized change in demand for housing services,

m = percentage shift in demand, net of the repair and inventory responses,

p = percentage change in price,

S = price elasticity of demand (percentage decrease in demand per one percent increase in price).

Second, we note that by definition

$$Z = \frac{f}{p}, \tag{A.27}$$

where Z = price elasticity of the occupancy rate (percentage increase in occupancy rate per one percent increase in short-run equilibrium price),

f = percentage change in occupancy rate.

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[6] Rydell (1979, pp. 9-15) presents a theory of short-run occupancy adjustment that shows it to be consistent with the classic assumption that landlords set rents to maximize profits. The salient point of the theory is that landlords make larger profits by accepting vacancy losses on a few units than they would if they reduced rents sufficiently to fill all their units. As market conditions vary, the profit-maximizing vacancy rate changes.

Finally, we require that, in short-run equilibrium, the percentage increase in realized demand must equal the percentage increase in the occupancy rate; that is, d = f. By then solving Eqs. (A.26) and (A.27), we obtain

$$f = \left[\frac{Z}{S + Z}\right] m. \qquad \text{(A.28)}$$

From Eq. (A.28), the percentage change in occupancy rate per one percent net shift in demand equals the price elasticity of the occupancy rate divided by the sum of the price elasticity of demand and the price elasticity of the occupancy rate. Accordingly, to estimate the occupancy rate changes caused by the housing allowance program, X(6,t) and X(7,t), we need only compute the percentage shift in demand, net of the repair and occupancy rate responses, and multiply it by the indicated factor:

$$X(6,t) = \left[\frac{Z}{S + Z}\right]\left[X(3,t) - X(4,t) - X(5,t)\right], \qquad \text{(A.29)}$$

and

$$X(6,t) = \left[\frac{Z}{S + Z}\right]\left[Y(3,t) - Y(4,t) - Y(5,t)\right]. \qquad \text{(A.30)}$$

PRICE CHANGES

Table A.3 provides the structure for the final component of our model--estimation of price changes. Subtracting supply response from demand shift leaves the percentage excess demand, X(8,t), that would exist if price remained at its preprogram level:

$$X(8,t) = X(3,t) - X(7,t), \qquad \text{(A.31)}$$

and

$$Y(8,t) = Y(3,t) - Y(7,t). \qquad \text{(A.32)}$$

Table A.3

STRUCTURE FOR ANALYZING PRICE CHANGE

Years Since Program Began	Percentage Change			
	Demand	Supply	Excess Demand	Price
Recipient Submarket				
t	X(3,t)	X(7,t)	X(8,t)	X(9,t)
Nonrecipient Submarket				
t	Y(3,t)	Y(7,t)	Y(8,t)	Y(9,t)
Marketwide Average				
t	W(3,t)	W(7,t)	W(8,t)	W(9,t)

To bring realized demand into equilibrium with current supply, price must change. The required percentage price changes, X(9,t) and Y(9,t), equal the percentage excess demand times the inverse of the price elasticity of demand:[7]

$$X(9,t) = X(8,t)/S, \qquad (A.33)$$

and

$$Y(9,t) = Y(8,t)/S. \qquad (A.34)$$

[7] Our conclusion follows directly from the definition of the price elasticity of demand. However, it can also be obtained by substituting $f = d$ into Eq. (A.26) to find $p = [m - f]/S$. That equation shows that the percentage price increase needed to clear the market equals the percentage excess demand remaining after the occupancy-rate adjustment times the inverse of the price elasticity of demand.

To complete Table A.3, we again average the submarket effects to obtain the marketwide effects:

$$W(i,t) = KX(i,t) + [1 + K]\ Y(i,t), \text{ for } i = 3, 7, 8, 9. \quad (A.35)$$

PARAMETER ESTIMATES

Our model of the rental housing market requires estimates of twelve parameters. The parameters, together with their estimated values for Brown and St. Joseph counties, are listed in Table A.4, in order of first mention in this Appendix.

The first nine parameters were estimated using HASE data--either from marketwide surveys or from records on recipients. The final three were estimated using data from the Annual Housing Survey, as well as by drawing on the housing literature.

In our model, the recipient submarket consists of the rental dwellings that recipients can afford and that either meet program standards or can inexpensively be brought to standard. We estimated the size of the recipient submarket, K, in each experimental location from records of housing evaluations conducted by the HAOs. Such evaluations were conducted not only for dwellings already occupied by program participants, but also for dwellings participants were considering as possible residences. During the first five program years, 68 percent of all rental dwellings in Brown County and 51 percent in St. Joseph County were evaluated at least once.

As estimates of submarket size, those figures reflect two offsetting biases. On the one hand, some dwellings that recipients could

Table A.4

PARAMETERS IN MODEL OF RENTAL HOUSING MARKET

Symbol	Definition	Estimates	
		Brown County	St. Joseph County
K	Recipient submarket as fraction of total rental market	.68	.51
w	Fraction of recipients originally living in substandard housing	.50	.53
x	Fraction of recipients originally living in substandard housing who repair rather than move when joining the program	.75	.77
D	Average percentage increase in demand for housing services per recipient	7.8	8.2
c	Fraction of increase in recipient housing demand due to program standards	.45	.52
E	Fraction of renter households eligible to receive housing allowances	.257	.295
n	Annual rate at which eligible nonrecipient households join the program	.450	.351
q	Annual rate at which recipients leave the program	.308	.384
r	Average percentage increase in supply of housing services per dwelling repaired to meet program standards	5.4	4.7
β	Pace of inventory adjustment (fraction of gap between desired and actual inventory closed per year)	.16	.16
S	Price elasticity of demand	.5	.5
Z	Price elasticity of occupancy rates	.27	.89

SOURCE: HASE surveys, HAO records, Annual Housing Survey, and housing literature (see accompanying text for details).

afford and that would have met program standards may never have been evaluated. On the other hand, some dwellings that were evaluated failed and were not repaired, possibly because repairing was too expensive. We judge that the biases roughly cancel each other.

The five parameters describing where recipients live and how their consumption of housing services changes, w, x, D, c, and r, are estimated in the HASE report on housing consumption adjustments made by allowance recipients (Mulford et al., 1982). The eligibility rate, E, is estimated in the HASE report analyzing the households who qualified for housing allowances in the two experimental locations (Balch and Carter, 1981).

Estimates of the enrollment rate, n, and the termination rate, q, were made using HAO administrative records for both experimental locations (see Table A.5). Using those estimates to evaluate the participation rate over time, A(t)/E, yields the predictions in Table A.6. The actual participation rates come from Table 3.2 (Sec. III). Comparing the predicted with the actual rates shows that our model of program build-up performs adequately.

The pace of inventory adjustment, β, was estimated by linking the Annual Housing Surveys for 1974 and 1977 and analyzing the relationship between market conditions and inventory change, as reported in Rydell et al. (1981, Appendix D). Their analysis estimated that $\beta = 0.16$.

We chose not to use Muth's earlier estimate (1960) of $\beta = 0.32$ in the interest of resolving uncertainty by erring in the direction of overestimating the price effects (choosing a small price of inventory adjustment underestimates the supply response and hence overestimates the price effects).

Table A.5

RENTER ENROLLMENT AND TERMINATION RATES, YEARS 1-5

Program Years	Annual Enrollment[a]		Annual Termination[b]	
	Number of Households	Rate[c] (%)	Number of Households	Rate[d] (%)
Brown County				
1	1,300	42.3	93	15.4
2	1,042	45.8	644	45.8
3	917	47.3	644	37.0
4	683	39.4	544	27.9
5	691	50.4	582	28.1
Average	927	45.0	501	30.8
St. Joseph County				
1	861	20.5	43	10.5
2	1,522	45.3	649	51.7
3	1,151	41.4	868	47.4
4	828	31.4	815	41.1
5	952	37.0	846	41.5
Average	1,003	35.1	644	38.4

SOURCE: HAO administrative records for years 1-5.

NOTE: Counts exclude nonelderly single-person households because they were categorically excluded from the housing allowance program before August 1977.

[a]Households who began receiving housing allowance payments during the year.

[b]Estimated as a residual to make recipients at start of year plus enrollment during year less terminations during year equal recipients at end of year.

[c]Annual enrollment as fraction of non-recipient eligibles at mid-year (estimated by averaging counts in Table 4.3 at start and end of year).

[d]Annual terminations as fraction of recipients at mid-year (estimated by averaging counts in Table 4.3 at start and end of year).

Table A.6

PREDICTED VERSUS ACTUAL PARTICIPATION RATES, YEARS 1-5

Years Since Program Began	Percent of Eligibles Receiving Housing Allowance Payments		
	Predicted	Actual	Difference
Brown County			
1	31.6	32.8	-1.2
2	46.4	43.6	2.8
3	53.3	51.0	2.3
4	56.5	54.8	1.7
5	58.1	57.8	0.3
Equilibrium	59.4	(a)	(a)
St. Joseph County			
1	24.9	17.7	7.2
2	36.8	36.6	0.2
3	42.5	42.8	-0.3
4	45.3	43.1	2.2
5	46.6	45.4	1.2
Equilibrium	47.8	(a)	(a)

SOURCE: Equation (4.2), with n = .450 and q = .308 for Brown County and n = .351 and q = .384 for St. Joseph County, and Table 4.3.

[a]Not applicable.

Estimates of the price elasticity of rental demand, S, in the housing literature vary considerably. Mayo (1981) found that they ranged from 0.17 to 1.28. However, most lie between 0.3 and 0.7, with their central tendency 0.5. In light of that finding, we use S = 0.5 as the price elasticity of rental demand for housing services.

Two studies finding a 0.5 price elasticity of rental demand are the Straszheim (1973) analysis of data from a San Francisco Bay Area transportation study (the estimate was S = 0.53) and the Vaughn (1976) analysis of U.S. census data (the estimate was S = 0.48).

Those mid-decade estimates are both smaller than DeLeeuw's earlier finding that S = 0.71 (DeLeeuw, 1971) and larger than the S = 0.22 found later in the Housing Allowance Demand Experiment (Friedman and Weinberg, 1978) for low-income households. DeLeeuw's estimate was considered slightly too high by the mid-decade studies. Friedman and Weinberg concluded that the price elasticity of demand increases with income, and warned that their estimate was too low to be used in general market studies.

The estimates of the price elasticity of the occupancy rate, Z, come from a cross sectional analysis of Annual Housing Survey data for selected metropolitan areas. Rydell (1982) finds the relationship between the price of rental housing services and the rental occupancy rate to be

$$Z = 0.5 \left[F^{-10} - 1 \right], \qquad (A.36)$$

where F = rental occupancy rate.

Evaluating that formula for the tight Brown County market (where F = 0.958) yields the estimate Z = .27. Evaluating it for the loose St. Joseph County market (where F = 0.903) yields the estimate Z = 0.89.[8] The price elasticity of the occupancy rate is lower in the tight market

[8] These recent estimates of the price elasticity of the occupancy rate are based on data from 59 metropolitan areas, and are hence more reliable than an earlier estimate based on only the two HASE metropolitan areas (Rydell, 1979, estimate that Z = 3.4). The analysis of occupancy changes in Rydell (1979) and Rydell (1980) used the earlier esti-

because the occupancy rate is less able to absorb demand shifts as the occupancy rate approaches its theoretical maximum of 1.0.

RESULTS

Substituting the estimates of the twelve parameters in Table A.4 into the equations for demand shifts, supply response, and price change presented earlier in this Appendix yields the results reported below. (The tables form the basis for Figs. 1 through 4 in the text.) The housing allowance program achieved 95 percent of its equilibrium effect on demand by the fourth program year. The average marketwide demand change was a 1.2 percent increase in both locations. Demand increased by 4 to 5 percent in the recipient submarket and decreased by 4 to 6 percent in the nonrecipient submarket. Much of the demand increase in the recipient submarket and all of the demand decrease in the nonrecipient submarket was caused by potential recipients who moved from the nonrecipient to the recipient submarket when joining the allowance program (see Tables A.7 and A.8).

During the first few years of the allowance program, occupancy change was the largest of the three supply responses. Then, after program year 4, inventory change became the dominant supply response. In all program years, repair response played an important, but secondary, role (see Tables A.9 and A.10).

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mate of Z, and accordingly are now judged to have overestimated the response of occupancy rates to the housing allowance program. The qualitative conclusions of those analyses remain valid, but their quantitative findings are replaced by those of this final HASE report on the topic.

Table A.7

DEMAND SHIFTS CAUSED BY BROWN COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Percentage Shift in Demand for Housing Services, by Source		
	Recipients from Nonrecipient Submarket	Recipients from Recipient Submarket	Total
Recipient Submarket			
1	1.66	.76	2.42
2	2.44	1.12	3.55
3	2.80	1.29	4.09
4	2.97	1.36	4.34
5	3.05	1.40	4.45
6	3.09	1.42	4.51
7	3.11	1.43	4.53
8	3.11	1.43	4.54
9	3.12	1.43	4.55
10	3.12	1.43	4.55
Nonrecipient Submarket			
1	-3.17	.00	-3.17
2	-4.65	.00	-4.65
3	-5.35	.00	-5.35
4	-5.67	.00	-5.67
5	-5.83	.00	-5.83
6	-5.90	.00	-5.90
7	-5.93	.00	-5.93
8	-5.95	.00	-5.95
9	-5.95	.00	-5.95
10	-5.96	.00	-5.96
Marketwide Average			
1	.11	.52	.63
2	.17	.76	.93
3	.19	.87	1.07
4	.21	.93	1.13
5	.21	.95	1.16
6	.21	.96	1.18
7	.21	.97	1.18
8	.22	.97	1.19
9	.22	.97	1.19
10	.22	.97	1.19

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The demand shifts are relative to the demand that would have existed without the allowance program; they are cumulative.

because the occupancy rate is less able to absorb demand shifts as the occupancy rate approaches its theoretical maximum of 1.0.

RESULTS

Substituting the estimates of the twelve parameters in Table A.4 into the equations for demand shifts, supply response, and price change presented earlier in this Appendix yields the results reported below. (The tables form the basis for Figs. 1 through 4 in the text.) The housing allowance program achieved 95 percent of its equilibrium effect on demand by the fourth program year. The average marketwide demand change was a 1.2 percent increase in both locations. Demand increased by 4 to 5 percent in the recipient submarket and decreased by 4 to 6 percent in the nonrecipient submarket. Much of the demand increase in the recipient submarket and all of the demand decrease in the nonrecipient submarket was caused by potential recipients who moved from the nonrecipient to the recipient submarket when joining the allowance program (see Tables A.7 and A.8).

During the first few years of the allowance program, occupancy change was the largest of the three supply responses. Then, after program year 4, inventory change became the dominant supply response. In all program years, repair response played an important, but secondary, role (see Tables A.9 and A.10).

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Table A.7

DEMAND SHIFTS CAUSED BY BROWN COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Percentage Shift in Demand for Housing Services, by Source		
	Recipients from Nonrecipient Submarket	Recipients from Recipient Submarket	Total
Recipient Submarket			
1	1.66	.76	2.42
2	2.44	1.12	3.55
3	2.80	1.29	4.09
4	2.97	1.36	4.34
5	3.05	1.40	4.45
6	3.09	1.42	4.51
7	3.11	1.43	4.53
8	3.11	1.43	4.54
9	3.12	1.43	4.55
10	3.12	1.43	4.55
Nonrecipient Submarket			
1	-3.17	.00	-3.17
2	-4.65	.00	-4.65
3	-5.35	.00	-5.35
4	-5.67	.00	-5.67
5	-5.83	.00	-5.83
6	-5.90	.00	-5.90
7	-5.93	.00	-5.93
8	-5.95	.00	-5.95
9	-5.95	.00	-5.95
10	-5.96	.00	-5.96
Marketwide Average			
1	.11	.52	.63
2	.17	.76	.93
3	.19	.87	1.07
4	.21	.93	1.13
5	.21	.95	1.16
6	.21	.96	1.18
7	.21	.97	1.18
8	.22	.97	1.19
9	.22	.97	1.19
10	.22	.97	1.19

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The demand shifts are relative to the demand that would have existed without the allowance program; they are cumulative.

Table A.8

DEMAND SHIFTS CAUSED BY ST. JOSEPH COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Percentage Shift in Demand for Housing Services, by Source		
	Recipients from Nonrecipient Submarket	Recipients from Recipient Submarket	Total
Recipient Submarket			
1	1.96	.97	2.93
2	2.90	1.43	4.34
3	3.35	1.66	5.01
4	3.57	1.76	5.33
5	3.68	1.81	5.49
6	3.72	1.84	5.56
7	3.75	1.85	5.60
8	3.76	1.86	5.62
9	3.77	1.86	5.62
10	3.77	1.86	5.63
Nonrecipient Submarket			
1	-1.82	.00	-1.82
2	-2.70	.00	-2.70
3	-3.12	.00	-3.12
4	-3.32	.00	-3.32
5	-3.42	.00	-3.42
6	-3.46	.00	-3.46
7	-3.48	.00	-3.48
8	-3.49	.00	-3.49
9	-3.50	.00	-3.50
10	-3.50	.00	-3.50
Marketwide Average			
1	.11	.49	.60
2	.16	.73	.89
3	.18	.84	1.03
4	.19	.90	1.09
5	.20	.93	1.13
6	.20	.94	1.14
7	.20	.94	1.15
8	.21	.95	1.15
9	.21	.95	1.15
10	.21	.95	1.15

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The demand shifts are relative to the demand that would have existed without the allowance program; they are cumulative.

Table A.9

SUPPLY RESPONSES TO DEMAND SHIFTS CAUSED BY BROWN COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Percentage Change in Supply of Housing Services, by Source			
	Repairs	Inventory Change	Occupancy Change	Total
Recipient Submarket				
1	.24	.19	.69	1.12
2	.35	.57	.91	1.83
3	.41	1.00	.93	2.33
4	.43	1.41	.86	2.71
5	.44	1.79	.77	3.00
6	.45	2.12	.67	3.24
7	.45	2.41	.58	3.44
8	.45	2.66	.50	3.61
9	.45	2.87	.43	3.75
10	.45	3.05	.36	3.87
Nonrecipient Submarket				
1	.00	-.27	-1.02	-1.29
2	.00	-.82	-1.35	-2.18
3	.00	-1.45	-1.38	-2.83
4	.00	-2.05	-1.28	-3.33
5	.00	-2.60	-1.14	-3.74
6	.00	-3.08	-.99	-4.07
7	.00	-3.50	-.85	-4.36
8	.00	-3.86	-.73	-4.59
9	.00	-4.17	-.63	-4.80
10	.00	-4.44	-.53	-4.97
Marketwide Average				
1	.16	.04	.14	.35
2	.24	.12	.19	.55
3	.28	.21	.19	.68
4	.29	.30	.18	.77
5	.30	.38	.16	.85
6	.31	.46	.14	.90
7	.31	.52	.12	.95
8	.31	.57	.10	.98
9	.31	.62	.09	1.01
10	.31	.66	.08	1.04

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The supply changes are relative to the supply that would have existed without the allowance program; they are cumulative.

Table A.10

SUPPLY RESPONSES TO DEMAND SHIFTS CAUSED BY ST. JOSEPH COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Percentage Change in Supply of Housing Services, by Source			
	Repairs	Inventory Change	Occupancy Change	Total
Recipient Submarket				
1	.28	.23	1.55	2.05
2	.41	.69	2.06	3.16
3	.47	1.22	2.11	3.80
4	.50	1.74	1.97	4.21
5	.52	2.21	1.76	4.48
6	.52	2.62	1.54	4.69
7	.53	2.98	1.33	4.84
8	.53	3.29	1.14	4.97
9	.53	3.56	.98	5.07
10	.53	3.79	.84	5.15
Nonrecipient Submarket				
1	.00	-.15	-1.07	-1.23
2	.00	-.48	-1.43	-1.90
3	.00	-.84	-1.46	-2.30
4	.00	-1.19	-1.36	-2.56
5	.00	-1.52	-1.22	-2.74
6	.00	-1.80	-1.07	-2.87
7	.00	-2.05	-.92	-2.97
8	.00	-2.26	-.79	-3.05
9	.00	-2.44	-.68	-3.12
10	.00	-2.60	-.58	-3.18
Marketwide Average				
1	.14	.04	.26	.44
2	.21	.12	.35	.68
3	.24	.21	.36	.81
4	.26	.30	.34	.89
5	.26	.38	.30	.95
6	.27	.45	.26	.99
7	.27	.52	.23	1.01
8	.27	.57	.20	1.04
9	.27	.62	.17	1.06
10	.27	.66	.14	1.07

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The supply changes are relative to the supply that would have existed without the allowance program; they are cumulative.

The occupancy changes were smaller in the tight Brown County market than in the loose St. Joseph County market. Consequently, the overall supply response was smaller and the price change was greater in Brown County than in St. Joseph County. The maximum price increases occurred in the recipient market in program year 3 in both locations--3.5 percent in Brown County and 2.4 percent in St. Joseph County. The marketwide price increases were negligibly small in both places (see Tables A.11 and A.12).

Table A.11

PRICE CHANGE CAUSED BY BROWN COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Demand Shift (%)	Supply Response (%)	Excess Demand (%)	Price Change (%)
Recipient Submarket				
1	2.42	1.12	1.30	2.60
2	3.55	1.83	1.72	3.44
3	4.09	2.33	1.75	3.51
4	4.34	2.71	1.63	3.26
5	4.45	3.00	1.45	2.90
6	4.51	3.24	1.26	2.53
7	4.53	3.44	1.09	2.18
8	4.54	3.61	.94	1.87
9	4.55	3.75	.80	1.60
10	4.55	3.87	.68	1.37
Nonrecipient Submarket				
1	-3.17	-1.29	-1.88	-3.75
2	-4.65	-2.18	-2.47	-4.95
3	-5.35	-2.83	-2.52	-5.04
4	-5.67	-3.33	-2.34	-4.68
5	-5.83	-3.74	-2.09	-4.17
6	-5.90	-4.07	-1.82	-3.64
7	-5.93	-4.36	-1.57	-3.15
8	-5.95	-4.59	-1.35	-2.70
9	-5.95	-4.80	-1.16	-2.31
10	-5.96	-4.97	-.99	-1.98
Marketwide Average				
1	.63	.35	.29	.57
2	.93	.55	.38	.76
3	1.07	.68	.39	.77
4	1.13	.77	.36	.72
5	1.16	.85	.32	.64
6	1.18	.90	.28	.55
7	1.18	.95	.24	.48
8	1.19	.98	.20	.41
9	1.19	1.01	.17	.35
10	1.19	1.04	.15	.30

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The price changes are relative to the price that would have existed without the allowance program; they are cumulative.

Table A.12

PRICE CHANGE CAUSED BY ST. JOSEPH COUNTY ALLOWANCE PROGRAM

Years Since Program Began	Demand Shift (%)	Supply Response (%)	Excess Demand (%)	Price Change (%)
Recipient Submarket				
1	2.93	2.05	.88	1.77
2	4.34	3.16	1.18	2.36
3	5.01	3.80	1.21	2.42
4	5.33	4.21	1.13	2.25
5	5.49	4.48	1.01	2.01
6	5.56	4.69	.88	1.76
7	5.60	4.84	.76	1.52
8	5.62	4.97	.65	1.30
9	5.62	5.07	.56	1.11
10	5.63	5.15	.48	.95
Nonrecipient Submarket				
1	-1.82	-1.23	-.60	-1.20
2	-2.70	-1.90	-.80	-1.59
3	-3.12	-2.30	-.82	-1.63
4	-3.32	-2.56	-.76	-1.52
5	-3.42	-2.74	-.68	-1.36
6	-3.46	-2.87	-.60	-1.19
7	-3.48	-2.97	-.52	-1.03
8	-3.49	-3.05	-.44	-.89
9	-3.50	-3.12	-.38	-.76
10	-3.50	-3.18	-.32	-.65
Marketwide Average				
1	.60	.44	.16	.31
2	.89	.68	.21	.42
3	1.03	.81	.22	.43
4	1.09	.89	.20	.40
5	1.13	.95	.18	.36
6	1.14	.99	.16	.31
7	1.15	1.01	.13	.27
8	1.15	1.04	.11	.23
9	1.15	1.06	.10	.20
10	1.15	1.07	.08	.17

SOURCE: Estimated using the model and parameter values presented in this Appendix.

NOTE: The price changes are relative to the supply that would have existed without the allowance program; they are cumulative.

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