J. K.
F.Y. I.

N-1338-HUD

October 1980

SUPPLY RESPONSE TO THE HOUSING ALLOWANCE PROGRAM

C. Peter Rydell

HOUSING ASSISTANCE SUPPLY EXPERIMENT

A RAND NOTE

This Note was prepared for the Office of Policy Development and Research, U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, under Grant No. H-5099RG. Its views and conclusions do not necessarily reflect the opinions or policies of the sponsoring agency.

Rand
SANTA MONICA, CA. 90406

The Rand Publications Series: The Report is the principal publication documenting and transmitting Rand's major research findings and final research results. The Rand Note reports other outputs of sponsored research for general distribution. Publications of The Rand Corporation do not necessarily reflect the opinions or policies of the sponsors of Rand research.

Published by The Rand Corporation

N-1338-HUD

October 1980

SUPPLY RESPONSE TO THE HOUSING ALLOWANCE PROGRAM

C. Peter Rydell

HOUSING ASSISTANCE SUPPLY EXPERIMENT

A RAND NOTE

This Note was prepared for the Office of Policy Development and Research, U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT, under Grant No. H-5099RG. Its views and conclusions do not necessarily reflect the opinions or policies of the sponsoring agency.

Rand
SANTA MONICA, CA. 90406

PREFACE

This note was prepared for the session on Housing Market Behavior at the twenty-sixth North American Meetings of the Regional Science Association, held in Los Angeles, November 9-11, 1979. It draws on research conducted by The Rand Corporation as part of the Housing Assistance Supply Experiment, sponsored and funded by the Office of Policy Development and Research, U.S. Department of Housing and Urban Development (HUD), under Contract No. H-1789. The note is a product of basic research on housing market behavior, sponsored by HUD under Grant No. H-5099RG. William McNaught and Ira S. Lowry reviewed an earlier draft and made helpful suggestions. Janice Newman typed the drafts; Henrietta L. Morales was the production typist. Jane Abelson edited the note and supervised its production.

SUMMARY

The demand shift caused by the housing allowance program is large enough to cause a serious increase in the price of standard housing services, if there were no supply response to the program. However, three supply responses prevent the potential price increase from occurring: repair of substandard housing, supply adjustment, and occupancy rate adjustment. The first supply response reduces the potential price increase by two-thirds, the first and second together reduce it by four-fifths, and all three together reduce it by 97 percent.

CONTENTS

TABLES

I. INTRODUCTION

The housing allowance program currently serves 9,300 households on an experimental basis in two north-central metropolitan areas of the United States.* All low-income households are offered a housing allowance equal to the difference between the standard cost of adequate housing and one-fourth of their adjusted incomes, provided that they choose to live in housing that meets program standards.**

The program promotes housing consumption by offering subsidy incentives for low-income tenants to find (and landlords to provide) housing that meets minimum standards, and it reduces rent burdens of households paying large portions of their income for housing. Subsidy administration costs are kept low by requiring tenants to find their own housing in the market.

However, some housing policymakers and analysts fear that the program has an undesirable side effect that outweighs its benefits. In particular, they argue that the program's wholesale subsidization

---

*Brown County, Wisconsin, containing the city of Green Bay, and St. Joseph County, Indiana, containing the city of South Bend, are served by the Housing Assistance Supply Experiment (HASE). Individuals in other cities were given housing allowances by the now completed Housing Allowance Demand Experiment (HADE) and Administrative Agency Experiment (AAE). The three experiments together constitute the Experimental Housing Allowance Program (EHAP). Only the HASE counties received fullscale housing allowance programs. Allowances began in 1974 for Brown County and in 1975 for St. Joseph County. They are funded by a ten-year annual contributions contract between HUD and the local public housing authority in each location. See *Fourth Annual Report* (1978) for a review of the experiment's purposes, scope, and preliminary findings.

**Adequate housing is a dwelling that passes periodic evaluations by the housing allowance office, judged as to spaciousness, presence of essential facilities in good working order, and absence of hazards to health or safety. The specific standards were adapted from American Public Health Association standards and the Building Officials and Code Administrators' model codes. The standard cost used in the allowance payment formula is an estimate of the full market price of rental dwellings that meet the standards. The estimates are based on periodic surveys of local housing markets.

of housing demand drives up the price of housing services and these price increases, even if confined to the program's initial years, would give unacceptable windfall profits to landlords, reduce allowance recipient benefits, and injure nonrecipients.* For example, DeLeeuw and Ekanem (1971) concluded that a housing allowance program would "drive rents up" (p. 817), and Henry Aaron, testifying at Congressional hearings on housing, predicted a 10-percent price increase (see U.S. Congress, 1972).

Three simulation studies support the price increase argument. First, the initial application of the Urban Institute's (UI) housing market model concluded that "In seven of the eight cases [simulations] . . . 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). Second, the National Bureau of Economic Research (NBER) market simulation predicted that a fullscale housing allowance program in either Pittsburgh or Chicago would cause price increases of over 10 percent in substantial portions of those housing markets.** Third, the UI model, this time applied to the HASE sites, predicted that the actual housing allowance program in Brown County, Wisconsin, would cause the price of housing services for recipients to rise by 4 to 9 percent and that the program in St. Joseph County, Indiana, would cause the price of housing services for recipients to rise by 20 to 27 percent (Vanski and Ozanne, 1978).

Whether the price increase fears are justified depends upon the flexibility of the housing market. If supply responds readily to changed demand, no serious price increases will be caused by the

---

*For a review of the inflation concerns expressed by housing policymakers and analysts in the 1970s, and a discussion of the assumptions underlying those concerns, see Barnett and Lowry (1979).

**Kain and Apgar (1977) show that one-fifth of each housing market has price increases of over 10 percent, and one-tenth has price increases of over 20 percent, with compensating price decreases in other parts of the markets.

housing allowance program. On the other hand, if supply responds poorly, price increases are inevitable. The literature on housing market behavior lends support to both sides of the response question. Arguments for a supply response are that (a) demand shifts occur gradually enough to give supply some time to adjust (Muth, 1960; DeLeeuw and Ekanem, 1973), (b) supply can be added with little change in price (Muth, 1960; 1973), and (c) occupancy rate changes absorb fluctuations in demand (Rapkin, Winnick, and Blank, 1953; DeLeeuw and Ekanem, 1973; Rydell, 1979). Arguments against a supply response are that (a) demand changes caused by the housing allowance program focus on specific submarkets (DeLeeuw and Ekanem, 1973; Kain and Apgar, 1977; DeLeeuw and Struyk, 1975),* (b) supply will only be altered under the incentive of large price changes (DeLeeuw and Ekanem, 1973; Ozanne and Struyk, 1978),** and (c) vacancy rates do not fluctuate much with market conditions.***

In fact, no measurable program-induced price increases were found in the Housing Assistance Supply Experiment. Observed rent changes in both metropolitan areas are accounted for by background price inflation in the economy (Barnett and Lowry, 1979).† That

---

*The NBER and UI housing market models predict large price increases for housing allowance recipients in part because they make many submarket distinctions. The additional demand from the housing allowance program gets bottled up in small parts of the housing market, causing large price increases there.

**To study the supply of housing services from existing housing during the 1960-1970 decade, Ozanne and Struyk (1978) exclude "units changed by merger or conversion over the decade," units built or demolished since 1960," and units that "were vacant in either 1960 or 1970" (p. 114). Having excluded most of the ways that markets adjust the supply of housing services, it is not surprising that the study finds supply to be extremely inflexible. However, the study argues that the excluded adjustment mechanisms do not affect the supply of housing services to low-income households.

***DeLeeuw and Ekanem (1971) suggest that the observed variation in vacancy rates across housing markets is due to structural characteristics of the markets rather than to the relationship between demand and supply.

†Allowance recipients did experience an average increase of 2 percent immediately upon joining the program (*Fourth Annual Report*, 1978, p. 21), but that could be the normal result of signing a new lease (program procedures required a month-to-month lease that spells out landlord and tenant responsibilities).

result is particularly striking because the two areas are very different. Brown County has a growing, nonsegregated population and a tight housing market (4-percent rental vacancy rate), whereas St. Joseph County has a shrinking, segregated population and a loose housing market (10-percent rental vacancy rate).

Some postexperiment critics question whether the experimental program caused enough demand shock to constitute a fair test of the price impact. Others question the representativeness of the experiment's cities, suggesting that different results might have been obtained in other areas. The experiment's designers understood that testing a single program in two cities does not permit simple generalization, but observing an actual program in two contrasting housing markets does offer considerable information to housing policymakers.

Section II demonstrates that the demand shifts caused by the housing allowance program in Brown and St. Joseph counties were large enough to cause serious price changes in the absence of supply responses. Therefore, the experiment was a real test of the housing market's ability to cope with demand shocks. Section III analyzes the supply responses that prevented the potential price changes: repair of substandard housing, supply adjustment, and occupancy rate adjustment.

An overall qualification to the analysis must be kept in mind. The discussion deliberately uses the best available point estimates of the necessary market behavior parameters as if they were known with certainty. The objective is to offer the crispest possible explanation of why the housing allowance program did not cause price changes. Future research will undoubtedly alter some parameter estimates, changing the quantitative results. However, the qualitative findings on supply response should be unaffected.

II. DEMAND SHIFTS

To explain how supply response prevents the housing allowance program from causing serious price increases, rental housing market behavior is simulated in a series of accounting tables. The purpose of the simulation is to find the price changes required to restore short-run equilibrium after a housing allowance program disturbs the existing equilibrium. At each step of the simulation "excess demand" is computed. The excess is the percent difference of demand (at preprogram prices) from the occupied supply (total supply less vacancies). The percentage price change required to equilibrate demand and supply is double the excess demand percentage based on the conclusion in the housing demand literature that a 1-percent increase in price causes about a 0.5-percent decrease in demand.* Consequently, to accommodate an excess demand of 1 percent, with a fixed supply, requires a price increase of 2 percent.

PREPROGRAM CONDITIONS

The simulations are carried out separately for the two HASE counties because their housing markets have very different characteristics. According to five preprogram measures, St. Joseph County's rental housing market is in poorer condition than Brown County's. Compared with Brown County, St. Joseph County has more substandard housing (33 vs. 20 percent), more vacant housing (9.7 vs. 4.2 percent), and more poverty, whether measured by the size of the allowance program (14.7 vs. 13.3 percent of the population), the proportion of recipients living in substandard housing before they joined the program (52 vs. 41), or the amount the program has to increase recipient income to achieve comparable standards (30.5 vs. 21.4 percent).

---

*Mayo (1978) provides a recent literature review of the price elasticity of the demand for rental housing services. Most estimates lie between 0.2 and 0.8, centering on 0.5.

Table 2.1, which provides the point of departure for the simulation, indicates the average demand for rental housing services and the average supply of rental housing services in Brown and St. Joseph counties before the experimental housing allowance program began. Housing services are divided into two quality levels: substandard housing, which does not meet the program's minimum standards, and standard housing, which does. Expressing quantities of housing service as percentages of the market's total supply of housing services yields the numbers in the table's total supply row: 20.0 substandard units of housing service and 80.0 standard units in Brown County, and 33.0 and 67.0, respectively, in St. Joseph County (see Lowry, Woodfill, and Repnau, 1974; and Lowry, Woodfill, and Dade, 1975).

The table's supply account subdivides supply into occupied and vacant. The starting vacancy rate for both quality levels is taken to be the preprogram average vacancy rate in each location.* Those rates imply 19.2 units of occupied substandard housing services and 76.6 units of occupied standard housing services in Brown County, and 29.8 and 60.5 in St. Joseph County. The occupied supply numbers are replicated in the total demand row because, by definition, realized demand equals occupied supply.

The table's demand account divides total demand for housing services into demand from households who will be housing allowance recipients by the program's third year,** and demand from nonrecipients. Three years after the allowance program began, 13.3 percent of Brown County renter households and 14.7 percent of St. Joseph County renter households received housing allowances (Rydell, 1979, p. 29). Applying those percentages to total demand yields the total preprogram demand for housing services by future recipients (12.7 in

---

*The vacancy rate for housing services is measured operationally by the percent of rent lost because of vacancies (Rydell, 1979, p. 4). Separate vacancy rate estimates for substandard and standard housing are not available.

**The analysis focuses on the program's third year because the program's net impact on the housing market peaks between years two and three (see the Appendix).

Table 2.1

PREPROGRAM CONDITIONS

Item	Brown County Rental Housing			St. Joseph County Rental Housing		
	Sub-standard	Standard	All	Sub-standard	Standard	All
Demand						
Recipients	5.2	7.5	12.7	6.9	6.4	13.3
Nonrecipients	14.0	69.1	83.1	22.9	54.1	77.0
Total	19.2	76.6	95.8	29.8	60.5	90.3
Supply						
Occupied	19.2	76.6	95.8	29.8	60.5	90.3
Vacant	0.8	3.4	4.2	3.2	6.5	9.7
Total	20.0	80.0	100.0	33.0	67.0	100.0
Result						
Excess demand[a]	0.0	0.0	0.0	0.0	0.0	0.0
Price increase[b]	0.0	0.0	0.0	0.0	0.0	0.0

SOURCE: I. S. Lowry, B. M. Woodfill, and T. Repnau, *Program Standards for Site I*, The Rand Corporation, WN-8574-HUD, January 1974; I. S. Lowry, B. M. Woodfill, and M. A. Dade, *Program Standards for Site II*, The Rand Corporation, WN-8974-HUD, February 1975; C. P. Rydell, *Shortrun Response of Housing Markets to Demand Shifts*, The Rand Corporation, R-2453-HUD, September 1979; and J. L. McDowell, *Housing Allowances and Housing Improvement: Early Findings*, The Rand Corporation, N-1198-HUD, September 1979.

NOTE: Demand and supply are measured in units of housing services as a percent of total supply.

[a]Percent difference between total demand and occupied supply.

[b]Price change required to equilibrate supply and demand.

Brown County and 13.3 in St. Joseph County).* The demand account is completed making use of the facts that before joining the housing allowance program 41 percent of Brown County recipients and 52 percent

*The demand account totals to less than 100 percent because we measure units of housing services as a percent of total supply rather than of occupied supply.

of St. Joseph County recipients lived in substandard housing.* Finally, the entire line describing nonrecipient demand is set equal to the difference between the total demand line and the recipient line. When the market is in short-run equilibrium, excess demand must be zero, as it is in Table 2.1. During the simulation, however, before the market fully adjusts to the program-induced demand shift, excess demand will differ from zero. When all supply responses have been exhausted, the market is assumed to eliminate the remaining excess demand by changing prices by a percentage that is double the excess demand percentage. Similarly, at any point in the simulation, the price changes that would be caused if no further supply responses occurred can be found simply by doubling the excess demand percentage.

DEMAND CHANGES CAUSED BY THE HOUSING ALLOWANCE PROGRAM

The housing allowance program causes two kinds of change in the demand for housing services. First, the increase in recipients' income causes an increase in their demand for housing services. Second, the program's requirement that recipients occupy standard housing causes those living in substandard housing to shift to standard housing. Table 2.2 shows the effect of these demand changes. Brown County recipient demand increases from 12.7 (Table 2.1) to 14.0 (Table 2.2), and St. Joseph County recipient demand increases from 13.3 to 15.3.** Moreover, because program recipients are required to live in standard housing, all recipient demand in Table 2.2 is in the standard housing column and none is in the substandard housing column.

---

*Those percentages for recipients were derived from the corresponding percentages for enrollees in McDowell (1979), pp. 18-21, by deleting enrollees who terminated before receiving an allowance payment.

**The allowance payment averages 21.4 percent of recipients' nonallowance income in Brown County and 30.5 percent in St. Joseph County (see Rydell, 1979, p. 29). Estimating that the income elasticity of demand for housing services is 0.5, we conclude that recipient demand for housing expands by 10.7 percent in Brown County and 15.2 percent in St. Joseph County. The supply experiment's data show that 0.5 is a generous estimate of the income elasticity of demand for housing services; see Mulford (1979).

Table 2.2

POSTPROGRAM OUTCOME: GIVEN NO SUPPLY RESPONSE

Item	Brown County Rental Housing			St. Joseph County Rental Housing		
	Sub-standard	Standard	All	Sub-standard	Standard	All
Demand						
Recipients	0.0	14.0	14.0	0.0	15.3	15.3
Nonrecipients	14.0	69.1	83.1	22.9	54.1	77.0
Total	14.0	83.1	97.1	22.0	69.4	92.3
Supply						
Occupied	19.2	76.6	95.8	29.8	60.5	90.3
Vacant	0.8	3.4	4.2	3.2	6.5	9.7
Total	20.0	80.0	100.0	33.0	67.0	100.0
Result						
Excess demand[a]	-27.1	8.5	1.4	-23.2	14.7	2.2
Price change[b]	-54.2	17.0	2.8	-46.4	29.4	4.4

SOURCE: Table 2.1; C. P. Rydell, *Shortrun Response of Housing Markets to Demand Shifts*, The Rand Corporation, R-2453-HUD, September 1979; and J. E. Mulford, *Income Elasticity of Housing Demand*, The Rand Corporation, R-2449-HUD, July 1979.

NOTE: Demand and supply are measured in units of housing services as a percent of total supply.

[a]Percent difference between total demand and occupied supply.

[b]Price change required to equilibrate supply and demand (estimated by doubling the excess demand percentage).

Adding the revised recipient demand to the unchanged nonrecipient demand yields the new total demand for housing services. Subtracting that from occupied supply produces the excess demands reported at the bottom of Table 2.2. The overall excess demand is small (1.4 percent in Brown County and 2.2 percent in St. Joseph County), but it is not distributed evenly. The shift of recipients from substandard housing has made demand considerably less than supply there (27 percent in Brown County and 23 percent in St.

Joseph County), and considerably greater than supply for standard housing (8.5 and 14.7 percent in the two counties).

If the market were forced to reach a new short-run equilibrium solely by price adjustments, very large ones would be required. The price of substandard housing would fall by 54 percent in Brown County and by 46 percent in St. Joseph County. The price of standard housing would rise by 17 percent in Brown County and by 29 percent in St. Joseph County.

Two qualifications must be kept in mind when using these estimates of the potential price increases. First, nonrecipient demand is assumed to be unaffected by the housing allowance program. Yet, faced with an increased price of standard housing, some recipients surely switch from standard to substandard housing. Second, recipient demand is assumed to be spread equally throughout the standard supply. However, even with the program's assistance, recipients are among the poorest occupants of standard housing. Their demand must focus to some extent on lower quality standard housing (housing that just barely meets program standards). Those assumptions cause offsetting errors. The first makes the estimated price increase paid by the recipients too high, and the second makes it too low. On balance, the former effect is probably the strongest, meaning that the price change estimates (here and in the rest of the analysis) are upper bounds. In any case, the qualitative conclusion is clear: Without supply responses to mitigate the demand shifts, the housing allowance program would cause large price increases for program recipients. Substantial amounts of the program's benefits would be diverted from the intended recipients to landlords.

III. SUPPLY RESPONSE

Three supply responses counteract the housing allowance program's demand shifts, preventing serious price increases. The first, repair of substandard housing by recipients, is measured directly. Administrative records of the housing allowance offices in Brown and St. Joseph counties contain inspection histories of all recipient housing. The second and third, supply and occupancy rate adjustments, are measured indirectly by applying housing market theory to demand shift evidence.*

REPAIR OF SUBSTANDARD HOUSING

The major supply response to the changed demand is an extensive upgrading of substandard housing: Faced with having to find standard housing in order to qualify for housing allowance payments, a large majority of the recipients living in substandard housing (75 percent in Brown County; 77 percent in St. Joseph County) fix their current housing (or persuade their landlords to fix it) rather than move (see McDowell, 1979, pp. 18-21).** That astonishingly high repair rate is made possible by the low average cost of the necessary repairs: only about $100 per housing unit repaired (McDowell, 1979, p. 37). Clearly, although health and safety hazards are common in housing, they are easily and inexpensively remediable, provided that tenants and landlords are appropriately motivated.

Future recipients occupied 5.2 units of substandard housing services before the allowance program began in Brown County (see Table 2.1). Taking 75 percent of that amount shows that the repair supply

---

*Supply and occupancy rate adjustments caused by the housing allowance program cannot be observed directly because they are confounded with background changes in the experiment's housing markets, e.g., Brown County's expanding population and St. Joseph County's shrinking population.

**The reported enrollee percentages were adjusted to recipient percentages by deleting enrollees who terminated before receiving a payment.

response causes 3.9 units of housing service to shift from the substandard to the standard category. (The corresponding numbers for St. Joseph County are 6.9, 77, and 5.3.) The normal turnover process that causes vacancies is assumed to continue to operate, so a proportional amount of vacant housing services also shifts from the substandard to the standard category.

The consequences of that supply response are presented in Table 3.1. Demand for substandard housing is now only 8.5 percent less than supply in Brown County and 6.5 percent less than supply in St. Joseph County. Demand for standard housing is now only 3.2 percent greater than supply in Brown County and 5.5 percent greater than supply in St. Joseph County. The overall excess demand remains unchanged because shifting housing from the substandard to the standard category does not change total supply.* The price changes required to achieve short-run equilibrium are still large, however. For example, the price of standard housing would have to rise 6.4 percent in Brown County and 11.0 percent in St. Joseph County. Additional supply responses, however, make those price changes unnecessary.

SUPPLY ADJUSTMENT

The demand shift caused by the housing allowance program accumulates over several years as the program grows to its equilibrium level (see the broken line in Fig. 3.1).** Because the demand shift does not occur instantly, the housing market has time to offset it by adjusting the housing supply.*** The net demand shift (total demand shift less

---

*The total supply of housing services does increase if the flow of housing services from upgraded units is larger. However, the low repair cost per unit suggests that this component of supply response, though important, is small. In any case, it is not estimated in this analysis.

**Fig. 3.1 presents graphically the results in Appendix Table A.1.

***The supply of standard rental housing services can change in four ways. First, new construction can exceed demolition. Second, upgrading via repairs and capital additions can exceed deterioration. Third, changes of tenure from owner-occupied to renter-occupied can exceed changes from renter-occupied to owner-occupied. Fourth, conversions of substandard units to standard units can exceed conversion of standard units to substandard units.

Table 3.1

POSTPROGRAM OUTCOME: GIVEN REPAIR RESPONSE ONLY

Item	Brown County Rental Housing			St. Joseph County Rental Housing		
	Sub-standard	Standard	All	Sub-standard	Standard	All
Demand						
Recipients	0.0	14.0	14.0	0.0	15.3	15.3
Nonrecipients	14.0	69.1	83.1	22.9	54.1	77.0
Total	14.0	83.1	97.1	22.9	69.4	92.3
Supply						
Occupied	15.3	80.5	95.8	24.5	65.8	90.3
Vacant	0.7	3.5	4.2	2.6	7.1	9.7
Total	16.0	84.0	100.0	27.1	72.9	100.0
Result						
Excess demand[a]	- 8.5	3.2	1.4	- 6.5	5.5	2.2
Price change[b]	-17.0	6.4	2.8	-13.0	11.0	4.4

SOURCE: Table 2.2; and J. L. McDowell, *Housing Allowances and Housing Improvement: Early Findings*, The Rand Corporation, N-1198-HUD, September 1979.

NOTE: Demand and supply are measured in units of housing services as a percent of total supply.

[a]Percent difference between total demand and occupied supply.

[b]Percent change required to equilibrate supply and demand (estimated by doubling the excess demand percentage).

supply adjustment) peaks two years after the program's start at about half the maximum demand shift. In other words, the supply adjustment cuts the allowance program's maximum demand shock approximately in half (see the solid line in Fig. 3.1).

At the end of the program's third year, the time of our simulation, the supply response has satisfied 45 percent of the demand

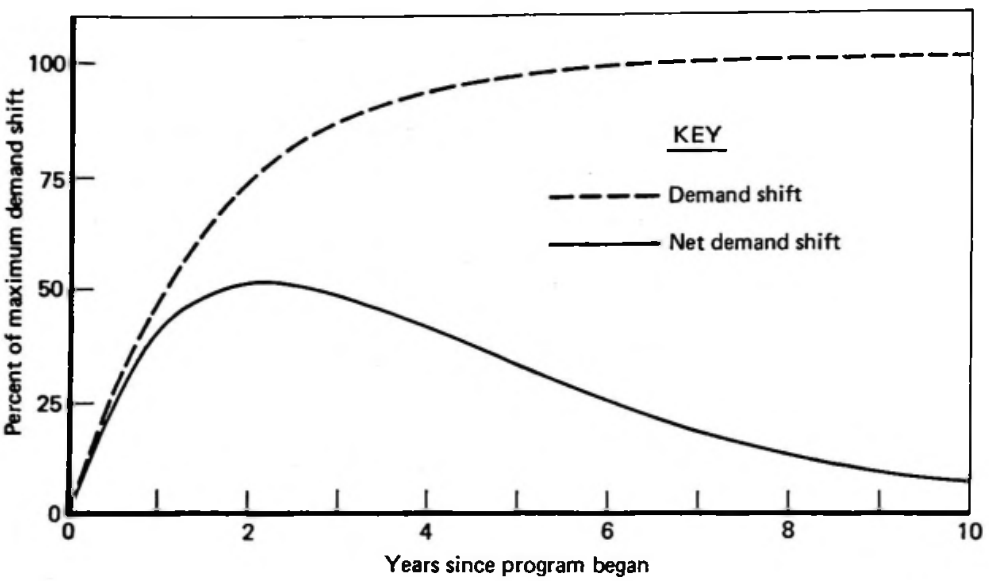

Fig. 3.1—Demand shifts by time since the housing allowance program began

shift that has occurred.* Accordingly, to model supply response, excess demand has been decreased by 45 percent, and the supply of occupied housing services has changed by that amount as well. As was the case with the repair adjustments, vacant supply is assumed to change by the same proportion as occupied supply in order to accommodate turnover (see Table 3.2). The result is that the price changes required to equilibrate supply and demand are cut roughly in half. If there were no more supply responses, the price of standard housing services would have to rise by 3.6 percent in Brown County and by 6.0 percent in St. Joseph County. However, a final supply response reduces the required price changes to considerably lower levels.

OCCUPANCY RATE ADJUSTMENT

In the long run, the supply of housing services adjusts to completely accommodate a demand shift. However, by year three of the

*The estimate comes from the ratio of Eq. (A.5) to Eq. (A.3) evaluated at year three; see Appendix Table A.1.

Table 3.2

POSTPROGRAM OUTCOME: GIVEN REPAIR AND SUPPLY ADJUSTMENTS

Item	Brown County Rental Housing			St. Joseph County Rental Housing		
	Sub-standard	Standard	All	Sub-standard	Standard	All
Demand						
Recipients	0.0	14.0	14.0	0.0	15.3	15.3
Nonrecipients	14.0	69.1	83.1	22.9	54.1	77.0
Total	14.0	83.1	97.1	22.9	69.4	92.3
Supply						
Occupied	14.7	81.6	96.3	23.8	67.4	91.2
Vacant	0.6	3.6	4.2	2.6	7.2	9.8
Total	15.3	.85.2	100.5	26.4	74.6	101.0
Result						
Excess demand[a]	-4.7	1.8	0.8	-3.6	3.0	1.2
Price change[b]	-9.4	3.6	1.6	-7.2	6.0	2.4

SOURCE: Constructed from Table 2.2 using Eqs. (A.3) and (A.5).

NOTE: Demand and supply are measured in units of housing service as a percent of preprogram total supply.

[a]Percent difference between total demand and occupied supply.

[b]Percent change required to equilibrate supply and demand (estimated by doubling the excess demand percentage).

housing allowance program, supply has only partially adjusted to the additional demand caused by the program. To equate realized demand and occupied supply in the short run, the housing market must either change realized demand (by changing the price of housing services) or change occupied supply (by changing the occupancy rate for housing services).*

*The occupancy rate for housing services is measured operationally by 1.0 less the fraction of rent lost because of vacancies. It can increase in three ways. First, households living in units providing small amounts of housing services can move into vacant units

Researchers have long been aware that occupancy rates vary with housing market condition (in fact, the rates are often used as a measure of market condition). Consequently, at least some of the adjustment to short-run equilibrium is probably achieved by changing occupancy rates. What is not well known, however, is that much of the adjustment to short-run equilibrium is achieved by occupancy rates. Empirical evidence from the supply experiment's data base, interpreted by a theory of landlords' profit maximizing behavior, indicates that each percentage point of excess demand causes the occupancy rate to change by 0.87 percent (Rydell, 1979).*

The final supply response to the housing allowance program, then, is change in the occupied supply of housing services via change in occupancy rates. For example, the 3.0 percent excess demand for standard housing services in St. Joseph County causes the occupancy rate to increase from 0.903 to 0.927.** Applying the revised occupancy rate to the fixed total supply shows that occupied supply changes from 67.4 units of housing service to 69.1 units of housing service. Excess demand falls from 3.0 percent to 0.4 percent, and the price change required to achieve short-run equilibrium falls from 6.0 percent to 0.8 percent (see Table 3.3).

With this final supply response, the demand for substandard housing is within 1 percent of occupied supply, and the demand for

---

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 theory, calibrated by the experiment's data on rents and occupancy rates, shows that landlords find it more profitable to accept vacancy losses than to cut prices enough to fill all vacancies. Therefore it is mostly changes in vacancy rates, rather than changes in rental prices, that equilibrate supply and demand. Earlier discussions of the occupancy rate's ability to absorb demand shocks and moderate price changes can be found in Rapkin, Winnick, and Blank (1953) and DeLeeuw and Ekanem (1973). Note, however, that the occupancy rate can never exceed 100 percent, so in very tight markets this supply response ceases to operate.

**The required calculation is $[0.903][1.03]^{0.87} = 0.927$.

Table 3.3

POSTPROGRAM OUTCOME: GIVEN REPAIR, SUPPLY, AND OCCUPANCY RATE ADJUSTMENTS

Item	Brown County Rental Housing			St. Joseph County Rental Housing		
	Sub-standard	Standard	All	Sub-standard	Standard	All
Demand						
Recipients	0.0	14.0	14.0	0.0	15.3	15.3
Nonrecipients	14.0	69.1	83.1	22.9	54.1	77.0
Total	14.0	83.1	97.1	22.9	69.4	92.3
Supply						
Occupied	14.1	82.9	97.0	23.1	69.1	92.2
Vacant	1.2	2.3	3.5	3.3	5.5	8.8
Total	15.3	85.2	100.5	26.4	74.6	101.0
Result						
Excess demand[a]	-0.7	0.2	0.1	-0.8	0.4	0.1
Price change[b]	-1.4	0.4	0.2	-1.6	0.8	0.2

SOURCE: Constructed from Table 3.2.

NOTE: Demand and supply are measured in units of housing service as a percent of preprogram total supply.

[a]Percent difference between total demand and occupied supply.

[b]Percent change required to equilibrate supply and demand (estimated by doubling the excess demand percentage).

standard housing is within 0.5 percent of occupied supply in both locations. Consequently, the price changes required to make consumers fit their demands to the available supply are very small: less than 2 percent decrease for substandard housing and less than 1 percent increase for standard housing.

IV. CONCLUSIONS

The housing allowance program increases overall demand for housing services by increasing the income of low-income households. The program also shifts demand from substandard to standard housing by requiring that recipients live in standard housing. The result in the HASE counties was a 23- to 27-percent decrease in demand for substandard housing and a 9- to 15-percent increase in the demand for standard housing. If there were no compensating adjustments in the supply of housing services, the price of substandard housing would fall 46 to 54 percent and the price of standard housing would rise 17 to 29 percent. However, supply responses to the allowance program's demand shifts reduce the potential price decreases for substandard housing to less than 2 percent, and reduce the potential price increases for standard housing to less than 1 percent.

Table 4.1 summarizes the process that prevents serious price changes. In both locations, repair of substandard housing to standard condition reduces the potential price increase for standard housing by two-thirds. Repair and supply adjustment together reduce the potential price increase by four-fifths. Repair, supply adjustment, and occupancy rate adjustment together reduce the potential price increase by 97 percent.

Those findings support two summary conclusions. First, the housing allowance program tested by HASE would have caused serious price increases if there had been no supply response. Thus, the experiment was a real test of the preprogram price inflation predictions. Second, the supply responses prevented the housing allowance program from causing price changes in two very different housing markets, so it is not unreasonable to expect them to prevent price changes elsewhere.

Table 4.1

INCREASES IN THE PRICE OF STANDARD HOUSING SERVICES CAUSED BY THE HOUSING ALLOWANCE PROGRAM

Assumptions	Brown County	St. Joseph County
Price Increase (%)		
No supply response	17.0	29.4
Repair response only	6.4	11.0
Repair and supply adjustment	3.6	6.0
Repair, supply, and occupancy rate adjustments	0.4	0.8
Ratio to Worst Case		
No supply response	1.000	1.000
Repair response only	0.376	0.374
Repair and supply adjustments	0.211	0.204
Repair, supply, and occupancy rate adjustments	0.024	0.027

SOURCE: Tables 2.2, 3.1, 3.2, and 3.3.

Appendix

DYNAMICS OF DEMAND AND SUPPLY CHANGE

Figure 3.1 summarized the dynamics of the housing allowance program's impact on the housing market. This appendix explains how that figure was constructed.

The analysis of dynamics is complete, even though it explicitly mentions only the second supply response, because the first and third supply responses take place so rapidly (relative to the second) that they can be considered to happen instantly. Repair of substandard housing occurs soon after the occupants join the allowance program because the housing must meet program standards before the allowance payments begin. Occupancy rates adjust rapidly because the turnover of rental units is high (over 50 percent per year).

The analysis has two specific objectives. First, it derives the estimate used in Sec. III that supply adjustment counteracts 45 percent of the allowance program's demand shift by year three. Second, it shows that under very general assumptions the maximum net demand shift (and hence the maximum price change) occurs within three years of the allowance program's start.

Demand Shift Dynamics

The curve presenting the demand shift over time in Fig. 3.1 results from the dynamics of participation in the housing allowance program. The program-induced demand shift is proportional to the number of participating households, and participation is the net result of newly eligible nonparticipants flowing into the program and no longer eligible participants flowing out of the program. Consequently, the demand shift obeys the following differential equation:*

*See Rydell, Mulford, and Kozimor (1979) for a more detailed analysis of this model, focusing on participation rates rather than demand shifts.

$$D'(t) = n[E - D(t)] - r\,D(t) \quad , \tag{A.1}$$

where t = years since the housing allowance program began,

$D(t)$ = demand shift generated by households participating in the housing allowance program $(D(0) = 0)$,

$D'(t)$ = derivative of the demand shift with respect to time,

E = demand shift that would occur if all eligible households were in the program,

n = annual enrollment rate of eligible nonparticipants,

r = annual termination rate of participants.

Equation (A.1) can be simplified by solving $D'(t) = 0$ to find that the maximum demand shift, M, equals $nE/[n+r]$. Substituting $[n+r]M$ for nE in Eq. (A.1) transforms the equation to

$$D'(t) = \alpha[M - D(t)] \quad , \tag{A.2}$$

where M = maximum demand shift,

$\alpha = m+r$ = the pace of the demand shift (fraction of the gap between maximum and current demand shift closed per year).

Equation (A.2) tells us that the annual change in the demand shift is proportional to the gap between the maximum demand shift and the current demand shift. Moreover, the proportionality constant, the "pace of the demand shift," equals the sum of the enrollment and termination rates for the housing allowance program. Since those rates are, on average, $m = 0.35$ and $r = 0.33$, the pace of the demand shift is $\alpha = 0.68$.* About two-thirds of the gap between maximum and current demand shift is closed each year.

*Rydell, Mulford, and Kozimor (1979) analyze elderly and nonelderly households separately and find enrollment rates of 0.51 and 0.20 and termination rates of 0.45 and 0.21. Because eligible households are half elderly and half nonelderly, a simple average of those findings shows that the average enrollment rate is 0.35 and that the average termination rate is 0.33. Modeling elderly and nonelderly (and possibly other demand groups) separately would yield a sharper model of the demand shift, but at the cost of increased analytical complexity.

The solution to Eq. (A.2) defines the broken line in Fig. 3.1. The solution is expressed as a fraction of the maximum demand shift, since that is what is graphed:

$$\frac{D(t)}{M} = 1 - e^{-\alpha t} \quad . \tag{A.3}$$

Supply Adjustment Dynamics

We use Muth's (1960) supply adjustment model to estimate the supply adjustment caused by the allowance program's demand shifts. Abstracting from the details of how the adjustment occurs, Muth found that housing supply adjusts at a rate proportional to the gap between desired and actual supply:

$$H'(t) = \beta[D(t) - H(t)] \quad , \tag{A.4}$$

where t = years since the housing allowance program began,

$H(t)$ = supply response to the allowance program's demand shift $(H(0) = 0)$,

$H'(t)$ = derivative of the supply response with respect to time,

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

Muth estimated that the pace of the supply adjustment is $\beta = 0.32$, i.e., that about one-third of the gap between desired and actual supply is closed per year.

Substituting Eq. (A.2) into Eq. (A.4) permits solving for supply response as an explicit function of time. The supply response is strictly proportional to the maximum demand shift so, like the demand-shift solution, it can be expressed as a fraction of that maximum,*

*In the special case of $\alpha = \beta$, the solution becomes

$$H(t)/M = 1 - e^{-\alpha t} - \alpha t e^{-\alpha t} \quad .$$

$$\frac{H(t)}{M} = 1 + \left[\frac{\beta}{\alpha-\beta}\right] e^{-\alpha t} - \left[\frac{\alpha}{\alpha-\beta}\right] e^{-\beta t} \quad . \tag{A.5}$$

Finally, subtracting Eq. (A.5) from Eq. (A.3) yields the formula for the net demand shift graphed as the solid line in Fig. 3.1:

$$\frac{D(t)}{M} - \frac{H(t)}{M} = \left[\frac{\alpha}{\alpha-\beta}\right]\left[e^{-\beta t} - e^{-\alpha t}\right] \quad . \tag{A.6}$$

Results

Table A.1 evaluates Eqs. (A.3), (A.5), and (A.6) for the first ten years after the start of the housing allowance program, using the parameter estimates $\alpha = 0.68$ and $\beta = 0.32$. The solid line in Fig. 3.1 graphs the first column in the table; the broken line graphs the third column. The estimate used in Sec. III that supply adjustment counteracts 45 percent of the demand shift by year three is in the table's fourth column.

Table A.1

DYNAMICS OF DEMAND SHIFT AND SUPPLY ADJUSTMENT

Years Since Program Began	Percent of Maximum Demand Shift			Ratio of Supply Adjustment to Demand Shift
	Demand Shift	Supply Adjustment	Net Demand Shift	
0	0	0	0	--
1	49.3	7.8	41.5	0.16
2	74.3	23.2	51.1	0.31
3	87.0	39.2	47.8	0.45
4	93.4	53.3	40.1	0.57
5	96.7	64.9	31.8	0.67
6	98.3	73.8	24.5	0.75
7	99.1	80.6	18.5	0.81
8	99.6	85.8	13.8	0.86
9	99.8	89.6	10.2	0.90
10	99.9	92.4	7.5	0.92

Source: Equations (A.3), (A.5), and (A.6) evaluated with $\alpha = 0.68$ and $\beta = 0.32$.

Setting the derivative of Eq. (A.6) with respect to time equal to zero, and solving the resulting equation, yields a formula for the number of years until the net demand reaches its maximum:

$$t_m = \frac{ln(\alpha/\beta)}{\alpha-\beta} \quad , \tag{A.7}$$

where t_m = years to maximum net demand.

Table A.2 evaluates the formula, varying the parameters 25 percent up and down from the point estimates of $\alpha = 0.68$ and $\beta = 0.32$. The maximum net demand always occurs within three years of the allowance program's start.

Table A.2

YEARS TO MAXIMUM NET DEMAND SHIFT

Pace of Supply Response[b]	Pace of Demand Shift[a]		
	.51	.68	.85
.24	2.8	2.4	2.1
.32	2.5	2.1	1.8
.40	2.2	1.9	1.7

SOURCE: Equation (A.7).

[a] Fraction of the gap between maximum and current demand closed per year.

[b] Fraction of the gap between desired and actual supply closed per year.

REFERENCES

Barnett, C. L., and I. S. Lowry, *How Housing Allowances Affect Prices*, The Rand Corporation, R-2452-HUD, September 1979.

Blank, D. M., and L. Winnick, "The Structure of the Housing Market," *Quarterly Journal of Economics*, Vol. 67, No. 2, May 1953, pp. 181-208.

DeLeeuw, F., and N. F. Ekanem, "The Supply of Rental Housing," *The American Economic Review*, Vol. 61, No. 5, December 1971, pp. 806-817.

DeLeeuw, F., and N. F. Ekanem, "Time Lags in the Rental Housing Market," *Urban Studies*, Vol. 10, No. 1, 1973, pp. 39-68.

DeLeeuw, F., and R. J. Struyk, *The Web of Urban Housing: Analyzing Policy with a Market Simulation Model*, The Urban Institute, Washington, D. C., September 1975.

Fourth Annual Report of the Housing Assistance Supply Experiment, The Rand Corporation, R-2302-HUD, May 1978.

Kain, J. F., and W. C. Apgar, Jr., *Simulation of the Market Effects of Housing Allowances, Vol. II, Baseline and Policy Simulation for Pittsburgh and Chicago*, National Bureau of Economic Research, New York, January 1977.

Lowry, I. S., B. M. Woodfill, and M. A. Dade, *Program Standards for Site II*, The Rand Corporation, WN-8974-HUD, February 1975.

Lowry, I. S., B. M. Woodfill, and T. Repnau, *Program Standards for Site I*, The Rand Corporation, WN-8574-HUD, January 1974.

Mayo, S. K., *Theory and Estimation in the Economics of Housing Demand*, Paper presented at the American Economic Association Meetings, Chicago, Illinois, 29-31 August 1978.

McDowell, J. L., *Housing Allowances and Housing Improvement: Early Findings*, The Rand Corporation, N-1198-HUD, September 1979.

Mulford, J. E., *Income Elasticity of Housing Demand*, The Rand Corporation, R-2449-HUD, July 1979.

Muth, R., "Capital and Current Expenditure in the Production of Housing," in C. L. Harris (ed.), *Government Spending and Land Values*, University of Wisconsin Press, Madison, 1973, pp. 65-78.

-----, "The Demand for Non-Farm Housing," in A. C. Harberger (ed.), *The Demand for Durable Goods*, University of Chicago Press, Chicago, 1960, pp. 29-96.

Ozanne, L., and R. J. Struyk, "The Price Elasticity of Supply of Housing Services," in L. S. Bourne and J. R. Hitchcock (eds.), *Urban Housing Markets: Recent Directions in Research and Policy*, University of Toronto Press, Toronto, Canada, 1978, pp. 109-138.

Rapkin, C., L. Winnick, and D. M. Blank, *Housing Market Analysis: A Study of Theory and Methods*, The Institute for Urban Land Use and Housing Studies, Columbia University, New York, 1953.

Rydell, C. P., *Shortrun Response of Housing Markets to Demand Shifts*, The Rand Corporation, R-2453-HUD, September 1979.

Rydell, C. P., J. E. Mulford, and L. Kozimor, "Participation Rates in Government Transfer Programs: Application to Housing Allowances," *Management Science*, Vol. 25, No. 5, May 1979, pp. 444-453.

U.S. Congress, Hearings before the Subcommittee on Priorities and Economy in Government of the Joint Economic Committee, *Housing Subsidies and Housing Policies*, 92nd Congress, 2nd sess., Government Printing Office, Washington, D. C., 4,5,7 December 1972, pp. 306-310.

Vanski, J. E., and L. Ozanne, *Simulating the Housing Allowance Program in Green Bay and South Bend*, The Urban Institute, Working Paper 249-5, Washington, D. C., October 1978.