Seller Financing of Temporary Buydowns

Part 1: Effects on Sales Prices of Homes

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

FINAL REPORT

Seller Financing of Temporary Buydowns
Part 1: Effects on Sales Prices of Homes

by
Robert F. Cotterman

Submitted to:

U.S. Department of Housing and Urban Development
Office of Policy Development and Research
451 7th Street, S.W., Room 8212
Washington, D.C. 20410

Unicon Research Corporation
1640 Fifth Street, Suite 100
Santa Monica, California 90401
(310) 393-4636

November 10, 1992

This research was funded by the U.S. Department of Housing and Urban Development under contract number HC-5835. Views and opinions expressed herein are those of the author and do not necessarily reflect those of the Department of Housing and Urban Development.

TABLE OF CONTENTS

Section	Page
ACKNOWLEDGEMENTS	vii
EXECUTIVE SUMMARY	viii
I. Introduction and Background	1
II. Theoretical and Empirical Perspectives	4
III. The Sample and the Setting	10
IV. Aspects of Model Specification and Estimation	21
A. Functional Form Considerations	21
B. Variable Definitions and Construction	24
V. Empirical Findings: Estimates of Hedonic Regressions	31
VI. Conclusions	52
BIBLIOGRAPHY	54
APPENDIX: A Digression on the Usefulness of the Hedonic Price Regression as an Appraisal Tool	56

LIST OF TABLES

		Page
1	Cell Sizes by Stratum	14
2	FHA Buydowns and New Home Sales	17
3	A Comparison of Buydown Amounts with Loan Discounts	17
4	Characteristics of Buydown and Nonbuydown (in Parentheses) FHA Loan Originations in Sample Cities and Time Periods	18
5	Variable Definitions and Abbreviations	25
6	Variable Means and Standard Deviations	26
7a	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; Phoenix 1982	32
7b	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; Phoenix 1985/86	33
7c	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; Denver 1982	34
7d	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; San Antonio 1982	35
7e	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; San Antonio 1985/86	36
7f	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; Phoenix	37
7g	Weighted Least Squares Regression Estimates; Dependent Variable: Sales Price of Home; San Antonio	38
8a	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; Phoenix 1982	39
8b	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; Phoenix 1985/86	40
8c	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; Denver 1982	41
8d	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; San Antonio 1982	42
8e	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; San Antonio 1985/86	43
8f	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; Phoenix	44

LIST OF TABLES
(Continued)

		Page
8g	Weighted Least Squares Regression Estimates; Dependent Variable: Log of Sales Price of Home; San Antonio	45
9	Extended List of Variable Definitions and Abbreviations	57
10	Extended List of Variable Means and Standard Deviations	59
11a	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; Phoenix 1982	63
11b	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; Phoenix 1985/86	65
11c	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; Denver 1982	67
11d	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; San Antonio 1982	69
11e	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; San Antonio 1985/86	71
11f	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; Phoenix	73
11g	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Sales Price of Home; San Antonio	75
12a	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; Phoenix 1982	77
12b	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; Phoenix 1985/86	79
12c	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; Denver 1982	81
12d	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; San Antonio 1982	83
12e	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; San Antonio 1985/86	85
12f	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; Phoenix	87
12g	Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Log of Sales Price of Home; San Antonio	89

LIST OF TABLES
(Continued)

Page

13 Weighted Least Squares Regression Estimates; Dependent Variable: Appraised Value of Home 94

14 Weighted Least Squares Regression Estimates with Extended Variable List; Dependent Variable: Appraised Value Minus Predicted Price; Phoenix 1982 96

15 Standardized Values of D at Various Percentiles of the Distribution 101

LIST OF FIGURES

Page

1 Median Interest Rates on 30-Year FHA-Insured Loans, by Office and Month 12

2 Number of 30-Year FHA-Insured Loan Transactions in Total and on New Homes, by Month 13

3 Fraction Having Temporary Buydowns among FHA-Insured, 30-Year Loans on Old and New Homes, by Month 15

4 Appraised Values versus Regression Predictions of Sales Prices 93

ACKNOWLEDGEMENTS

Several individuals and organizations made significant contributions to this study. Funding for this research was provided by the U.S. Department of Housing and Urban Development under contract number HC-5835. Under separate contract, Westat undertook the substantial burden of coding data from FHA case binders and producing machine-readable files. Bill Jackson of Westat kept detailed notes on coding conventions and problems. Lisa Puhl of Westat provided codebooks and other helpful information on the nature of the resulting computer files.

Heather Leicester of Unicon served as the project programmer, designing programs that drew random case lists from which the ultimate samples were constructed, linking together files of data from a variety of sources, providing several levels of data screening and cleaning, and writing programs that performed all statistical analyses.

Special gratitude is due Bill Reeder of HUD, who provided guidance and aid throughout the project. Bill participated in an integral way in deciding both the general direction and the details of the research. His oversight of the Westat data gathering and coding operation, as well as the Unicon analysis work, gave continuity to the project and ensured that the early data formation met ultimate analytical needs. He later provided special data corrections that could be obtained only by retrieving information from the hardcopy case files. Bill gave extensive guidance in understanding FHA rules and regulations and in understanding and interpreting FHA data. Finally, he provided insightful comments on the draft reports that led up to this final report.

Neither these individuals nor the U.S. Department of Housing and Urban Development is responsible for the content of this report. The author retains sole responsibility for all errors.

EXECUTIVE SUMMARY

A temporary buydown is one of many creative financing techniques which enjoyed growing popularity in the late 1970s and early 1980s. Under a typical temporary buydown, a homebuyer's mortgage payments during the early years of the mortgage are subsidized by the seller, who pays a portion of the mortgage payments that would otherwise be paid solely by the borrower. This arrangement is effected by the seller's funding an escrow account that is depleted as funds are used to supplement the payments made by the mortgagor to the lender.

Because a temporary buydown offers monetary benefits to the homebuyer, a homebuyer would be willing to pay more for a home offering a temporary buydown as a part of the sales transaction. Unless a similar buydown were offered as part of subsequent sales transactions, however, any financing premium capitalized into the original sales price of the home would not be recaptured at resale, a possibility leaving the mortgage insurer more vulnerable to loss in the event of foreclosure. Temporary buydowns may also increase the likelihood of mortgage default for two reasons. First, inability to recapture the financing premium in subsequent sales reduces the mortgagor's equity incentive not to default. Second, to the extent that loan underwriters compare initial housing expenses to income, buydowns that reduce initial mortgage expenses facilitate larger loans, resulting in higher housing expense burdens after the buydown subsidy has terminated.

These logical arguments suggesting at least partial capitalization and increased default activity are supported by indirect empirical evidence on related phenomena. Until now, however, direct evidence on the effect of buydowns has been unavailable. The purpose of this research is to begin to fill this empirical void by estimating empirically the extent to which house prices include the capitalized value of temporary buydowns. A companion report examines the effect of buydowns on default probabilities.

The study opens by examining possible motivations for temporary buydowns; this pre-

liminary analysis provides clues as to likely capitalization effects and helps guide the empirical work to follow. Prior reasoning suggests that selling prices could, but need not, reflect more than the fully capitalized value of a temporary buydown. In particular, if a temporary buydown is offered to help a buyer circumvent restrictions on the amount that could otherwise be borrowed, the buyer would be willing to pay, via a higher house price, a sum larger than the present value of the buydown payments. If property taxes vary with the sales price of the home, however, buyers who do not face these lending constraints would be unwilling to pay the fully capitalized buydown value in the form of a higher house price. For their part, sellers may be willing to accept less than the fully capitalized value of the temporary buydown, either because the buydown permits a quicker sale by facilitating loans to lower income buyers, or because the buydown is used to avoid public disclosure of an effectively reduced net price. These arguments suggest that capitalization effects may vary from transaction to transaction according to differing motivations and market conditions.

Turning to the estimation of capitalization effects, this study utilizes coded data from FHA casebinders for five samples of FHA-insured, 30-year, level-payment mortgages. Three samples consist of sales transactions for mortgages starting in 1982 in Denver, Phoenix, and San Antonio, respectively. The remaining two samples are for mortgages beginning in 1985 and the first seven months of 1986 in Phoenix and San Antonio, respectively. Data drawn for these samples include information on characteristics of the home, the sales transaction, and the buyer.

Estimation proceeds via weighted least squares regressions of sales prices on house characteristics, measures of market strength, and the present value of temporary buydowns. The statistical evidence confirms two basic features of buydown capitalization. First, temporary buydowns tend to be reflected in house prices, but generally at less than full present value. Estimated capitalization rates are generally in the 50 to 75 percent range. By implication, sellers must generally receive at least 25 to 50 percent of the value of the buydown in other forms: reduced holding costs from a more rapid sale and whatever advantages accrue from having stable advertised prices. Second, as suggested on theoretical grounds, there is evidence of variation in effects from sample to sample, presumably reflecting different mixes of motivations for buydowns and different mixes of market strength. The 1982 sample for Phoenix, for example, has an estimated capitalization rate of nearly 200 percent, which is significantly higher than the 1985/86 estimate of about 50 percent for the same city.

The findings in this report are broadly consistent with those in the companion report which finds that buydown capitalization results in ultimately higher default rates for homes purchased under temporary buydown arrangements. A statistical contrast of default behavior for buydown purchases with default behavior in the absence of buydowns typically implies approximately full capitalization of the buydown. Although estimates obtained through the latter comparison are generally somewhat larger than those obtained by contrasting sales prices of homes with and without buydowns, as in this report, such differences are not surprising given the very different methods for arriving at capitalization effects.

SELLER FINANCING OF TEMPORARY BUYDOWNS

Introduction. In the fall of 1986, the Department tightened FHA appraisal and underwriting standards by requiring that appraisers deduct seller concessions in excess of 5 percent from prices of comparables when figuring appraised value and that underwriters deduct any similarly excess concessions from the sale price when figuring acquisition cost. Moreover, underwriters were required to use the mortgage note rate (rather than the "bought down" rate) when figuring the maximum mortgage a buyer's income would support. The rules were later relaxed to permit seller concessions of 6 percent without penalty and qualification at an interest rate 2 percentage points below the mortgage note rate.

These policies were adopted out of concern that excessive seller concessions, particularly in the form of temporary buydowns, were being built (i.e., capitalized) into the sale prices of properties thereby reducing homebuyer equity and making default more likely. Adoption of the policies was based mainly on logical arguments and indirect empirical evidence. There was, however, as the homebuilding industry argued, no direct empirical evidence regarding the effect of seller-financed temporary buydowns on the sale prices of homes or the likelihood of default. To fill this void, the Office of Policy Development and Research undertook a contract study of Seller Financing of Temporary Buydowns resulting in a two part report. Part 1 studies the Effects on Sales Prices of Homes. Part 2 examines the Effects on Mortgage Default. The results are based upon analyses of approximately 3,000 FHA-insured purchase transactions in the cities of Phoenix, San Antonio, and Denver in 1982 and again in 1985/86 prior to the policy change.

What is a Buydown? Under a typical temporary buydown, the homebuyer is subsidized with payments from an escrow account funded by the seller, which lower the homebuyer's mortgage payments during the early years of the mortgage to amounts corresponding to lower interest rates than the mortgage note rate received by the lender. Typically, the subsidy payment amounts decline each year so that the homebuyer pays a progressively higher mortgage payment until the escrowed funds are exhausted and the homebuyer must make the full note rate payment.

Why Might Homebuyers Like Buydowns? Homebuyers value buydowns for two principal reasons. First, the buydown increases the homebuyer's income by the amount of the escrowed buydown subsidy. Alternatively, the escrowed subsidy can be viewed as a rebate lowering the net sales price of the home to the buyer. Second, lenders allow homebuyers using buydowns to qualify for larger loans than their incomes would support if the income-qualification rules were applied using the higher mortgage note rates. Hence, borrowers with too little income to qualify for a loan large enough to purchase their desired home at the mortgage note rate can utilize the qualifying advantage of the buydown to obtain the loan sufficient to purchase the desired home. Homebuyers in this situation might be willing to pay more than the actual cost of the buydown for this advantage.

Why Might Homesellers Like Buydowns? Homesellers typically bear the cost of funding the escrowed buydown subsidy. However, the buydown benefits the seller in two principal ways. First, a buydown lowers the effective sale price to attract potential homebuyers without explicitly undermining the values of homebuyers who purchased their homes earlier when the market was stronger. Second, the buydown's qualifying advantage substantially increases the number of potential buyers and may hasten sales thus reducing the length of time the seller must finance and maintain the property--i.e., it reduces the seller's holding costs.

Why FHA Would be Concerned About Buydowns? Mortgage insurers worry about temporary buydowns because logic and economic theory predict that homebuyers will pay higher prices for homes with a seller-financed buydown than they will for homes without a buydown to capture the benefit of the payment savings and qualifying advantage. In the absence of price appreciation, this "financing premium" cannot be recovered on resale of the home once the buydown subsidy payments have been spent. Hence, the protection of the homebuyer's down payment or equity contribution is eroded to the extent the home sale prices (inclusive of financing premiums) exceed their resale prices and mortgage insurers are more vulnerable to borrower default and foreclosure loss. Furthermore, the buydown's increase in homebuyer mortgage payments approximating 9 percent a year over the first few years is more likely to create situations which trigger defaults.

What Effect do Buydowns Have on Home Prices? In Part 1 of the study, regressions were run relating home sale prices to the dollar amount of the escrowed buydown subsidy along with other financing concessions and defining characteristics of the homes. The study found that the degree to which the buydown subsidy was reflected (capitalized) in home prices generally fell in the range of 50 to 75 percent, which implies that homesellers generally recover at least 25 to 50 percent of the buydown's cost in the form of reduced holding cost from a more rapid sale. The degree to which buydowns are capitalized in house prices varies across cities and over time, presumably reflecting different mixes of market conditions and motivations for buydowns. The measured rates of capitalization may also vary simply because the regression technique relies on existence of adequate control variables for contrasting sale prices of homes sold with buydowns with those presumed to be free of any influence from buydowns. This becomes more problematic as buydowns and their influence become more prevalent in the market.

Using an alternative methodology in Part 2, which statistically contrasted default behavior for buydown purchases with defalut behavior in the absence of buydowns, the study found that homebuyers behave as if the buydown subsidy was fully capitalized in the home sale price.

What Effect do Buydowns Have on Mortgage Default? Logic predicts that temporary buydowns will have two potential effects on default. First, if buydowns are capitalized into sales prices and cannot be recovered upon resale, homebuyer equity will be reduced and the incentive to default increased. Second, the incentive to default will be reduced over the initial period of the buydown because the buydown subsidy payments initially help to defray the homebuyer's monthly payments and the buydown escrow reverts to the lender in the event of a default.

In Part 2 of the study, a proportional hazards model is specified, such that the probability of default at each point in time is assumed dependent upon the intial home sales price, the initial and current values of the buydown balance, the contemporaneous principal balance and value of the mortgage, and other factors. Model estimates confirm that in their default behavior, homebuyers act as if temporary buydowns are fully capitalized in house prices and cannot be recovered upon resale. This effect alone acts to increase the probability of default under buydowns. In addition, estimates confirm that the remaining buydown balance deters default behavior. In general, the two effects together initially lower default rates but ultimately raise default rates of buydown mortgages relative to nonbuydown mortgages.

The estimated models were used to simulate cumulative default rates for buydowns of varying size under alternative economic scenarios, which assumed differing patterns of price appreciation and unemployment. Cumulative default rates ten years from mortgage origination increased with the size of the buydown and the contrast between default rates for nonbuydown and buydown mortgages was greatest (on the order of 25 to 60 percent higher) for intermediate economic conditions, ranging from no price appreciation in the early years (Stagnation) to 3.5 percent price appreciation in the early years (Mild Expansion).

I. INTRODUCTION AND BACKGROUND

A temporary buydown is one of many creative financing techniques which collectively grew in importance during the late 1970s and early 1980s. Under a typical temporary buydown, a homebuyer's mortgage payments during the early years of the mortgage are set at levels that correspond to lower mortgage interest rates than the rate recorded on the mortgage note and paid to the lender. The difference between the lower monthly payments made by the borrower and the higher fixed payment actually received by the lender is typically provided by the seller of the home. For loan transactions insured by the FHA, the difference must be fully funded at the time of sale by making an escrow deposit consisting of the full amount of the aggregate difference in payments. This escrow account, which may or may not bear interest, is gradually drawn down through the life of the buydown as escrow funds are used to supplement the payments made by the mortgagor to the lender.

It is clear that a temporary buydown is worth something to a prospective homebuyer, and thus a homebuyer would be willing to pay more for a home offering a temporary buydown as a part of the sales transaction than if no buydown were offered. Unless a similar buydown were offered as part of subsequent sales transactions, however, any financing premium capitalized into the original sales price of the home would not be recaptured at resale. This possibility apparently leaves the mortgage insurer more vulnerable to loss in the event of foreclosure.

Not only do temporary buydowns leave the insurer more susceptible to loss in the event of mortgage foreclosure, they may also increase the likelihood of foreclosure for two reasons. First, the aforementioned inability to recapture the financing premium in subsequent sales reduces the mortgagor's equity incentive not to default; and second, buydowns facilitate loans that result in relatively heavier housing expense burdens. In particular, if underwriting criteria focus on initial housing expenses relative to income, then the reduction in initial monthly mortgage payments resulting from a temporary buydown permits a homebuyer to qualify for a larger loan and obligates him/her to an ultimately higher market-rate mortgage payment than would be permitted absent the buydown.

Indirect evidence on the likely effect of buydowns reinforces the logical arguments that suggest (a) at least partial capitalization of the buydown into the selling price of the home, and (b) increased default activity. The first piece of evidence is that other seller-provided financing benefits appear to be partially capitalized into sales prices of homes. For example, recent empirical studies show that a substantial fraction of seller-provided assumption and mortgage revenue bond financing is capitalized into house prices (see Durning and Quigley [1985]). The evidence also suggests that borrower's equity is an important deterrent to default (see, for example, Foster and Van Order [1984]). If borrowers are unable to recapture the value of the buydown upon resale, they would be expected to exhibit a higher probability of default. A third source of evidence is the default behavior of buyers who have graduated payment mortgages (GPMs). The rise in borrower's payments in the early years of a mortgage with a buydown mimics the behavior of payments under GPMs like those issued under the FHA 245(b) program; such GPMs have been found to have unusually high default rates.

In 1986, reasonable concerns over the effect of buydowns on the health of the FHA mortgage insurance fund led HUD to tighten appraisal and underwriting criteria so as to (a) limit the extent of seller financing contributions included in the prices of comparables and in the determination of maximum mortgage amounts, and (b) end the use of temporarily lower initial mortgage interest rates for loan-qualification purposes. These restrictive changes, instituted in August 1986, were later relaxed somewhat in 1987.

Despite the introduction of policies to cope with perceived problems of temporary buydowns, and the apparent reduction in the use of seller financing concessions in general and temporary buydowns in particular, there remain questions regarding the actual behavior engendered by temporary buydowns. As noted, prior policy prescriptions and actions have been guided mainly by logical arguments and by indirect empirical evidence on somewhat similar phenomena, rather than by direct empirical evidence on the effects of buydowns *per* *se.* This report seeks to fill part of this empirical void by measuring the extent to which the full present value of a buydown is capitalized into the selling price of the home. A companion report (Cotterman [1992]) examines the related question of default experience under temporary buydowns.

II. THEORETICAL AND EMPIRICAL PERSPECTIVES

The housing finance literature contains numerous studies examining reasons for, and the effects on sales prices of, various kinds of creative finance techniques and seller financing concessions in general. Examples include the papers by Jaffee (1984), Brueckner (1984), Agarwal and Phillips (1983 and 1984), Schwartz and Kapplin (1984), Sirmans, Smith, and Sirmans (1983), and Durning and Quigley (1985). Related work (by, for example, Zerbst and Brueggeman [1977]) has examined the extent to which discount points on FHA or VA loans are reflected in the selling prices of homes. Particularly useful is the survey article by Sirmans, Sirmans, and Smith (1985), which summarizes a large number of studies and empirical findings regarding the effects of creative finance on house prices.

Although this literature discusses a variety of creative financing techniques, temporary buydowns in particular are rarely mentioned, and some of the reasons offered for the existence of creative financing in general seem to be of limited applicability to temporary buydowns. Specifically, the tax considerations involved in converting to installment sales or invoking lower capital gains tax rates (under the old tax code) seem likely to be of little importance in explaining the existence of temporary buydowns. Instead, temporary buydowns seem more likely to be motivated by credit availability considerations or by the cost of making adjustments to publicly announced prices.

As to the first of these reasons, the presumption is that a homebuyer wishes to borrow more than would ordinarily be permitted by underwriting criteria that compare income to initial housing expenses. By reducing initial mortgage payments, and thus initial housing expenses, a temporary buydown offers a way around these underwriting restrictions on the size of the loan. In this way the use of a temporary buydown expands the seller's potential market by reaching to lower income buyers who would otherwise not qualify for a loan large enough to finance the purchase of the home.

The second of these reasons may apply when demand conditions are uncertain or highly variable, and there are costs of changing announced prices. In these circumstances sellers may wish to retain the flexibility of being able to negotiate effective prices at the time of sale. There remains the question, however, of why temporary buydowns are used in negotiations rather than house price itself or other financial aspects of the transaction. When the sales transaction involves a builder or other seller who expects to make multiple sales transactions, a partial answer may be that actual sales prices are easily discovered by other potential buyers, and a builder would be reluctant to set the precedent of selling at a lower price than might be obtained on subsequent sales of similar homes. Builders may also pursue this policy to avoid publicly undermining the equity of earlier buyers.

The reasons for the existence of temporary buydowns offer some clues as to whether, and by how much, sales prices of homes will be affected by their presence. We note at the outset, however, that while an examination of motivations for buydowns may permit us to place bounds on their likely effect, we will be unable to predict a uniform capitalization rate that can be expected to hold in all times and places. The source of the problem is that, as noted by Durning and Quigley (1985) in a related context, the temporary buydown and the selling price are reached in negotiation over a highly differentiated product composed of numerous characteristics. For this reason it is impossible to predict on prior grounds the market tradeoff between price and the buydown amount. In particular, given the bundling feature of the commodity, the price of the commodity need not be the cost of provision of each separate component, as would be the case in a competitive market for a homogeneous product.[1] Hence, we examine the motivations of buyers and sellers with the purpose of placing limits on possible capitalization effects, while recognizing that actual impacts may vary across transactions.

If a temporary buydown is offered to help a buyer circumvent restrictions on the amount that could otherwise be borrowed, the buyer would be willing to pay, via a higher house price, a sum larger than the present value of the buydown payments. To see this, note

[1]One can, however, question how much competition is required among potential homebuyers and sellers to generate an approximately competitive outcome.

that any buyer with sufficient income to qualify for a loan large enough to purchase the desired home without a buydown would not be willing to pay, in the form of an increased home price, any more than the present value of seller financing concessions. The qualifying advantage of the buydown would be redundant and thus have zero value. When the buyer's income would not otherwise support a loan large enough to purchase the desired home, however, the qualifying advantage of the buydown is of value. The buyer would then be willing to pay more than the present value of the buydown amount for the right to obtain not only the financing subsidy, but also the larger loan needed to complete the purchase.

In the scenario in which a temporary buydown originates solely for the buyer to obtain a larger loan, the seller may also demand a sales price that is higher by more than the present value of the buydown payments received by the borrower. In particular, if the buydown arrangement is one in which the escrow account does not pay interest, then the cost to the seller is the sum of the future buydown payments in undiscounted dollars—a sum that clearly exceeds the present value of these same payments.

There are, however, reasons for the house price to reflect less than the full present value of the buydown, particularly if the buydown is simply part of the sales negotiation package and is not needed for circumventing restrictions on mortgage amounts. One such reason is that increasing the sales price of the home may also result in a higher property tax obligation on the part of the buyer. As a result, a buyer would be willing to trade off smaller initial mortgage payments for a higher initial house price at less than dollar-for-dollar in present value terms.

Similarly, a seller may be willing to accept a sales price that does not reflect the full present value of his contributions to the temporary buydown escrow. The seller is, in effect, willing to accept less than full recovery of the buydown escrow in return for reducing the time required to sell the property. The cost savings of obtaining a wider market and a correspondingly more rapid sale offsets part of the cost of the buydown. The seller obtains a higher price net of holding and buydown costs than would otherwise be obtained in the absence of the buydown.

A more detailed exposition of the latter point is useful to help fix ideas. Suppose that a seller expects that if he offers a buydown of B_0, and acts optimally conditional on continuing to offer the buydown,[2] he will bear holding costs of H_0 before selling his home at an expected price of P_0. (We ignore other transactions costs.) If he chooses not to offer a buydown, and acts optimally conditional on not offering a buydown, the seller expects to bear holding costs of H_* before receiving an expected price of P_*. Putting aside questions of attitudes towards risk, the seller will pursue the strategy of offering a buydown only if $P_0 - B_0 - H_0 \geq P_* - H_*$. That is, the net price to the seller after deducting holding and buydown costs must exceed the net price obtainable without a buydown. Rearranging the inequality,

$$P_0 \geq P_* + B_0 - (H_* - H_0). \qquad (1)$$

In other words, the expected price to be received with a buydown must exceed the expected nonbuydown price by the amount of the buydown minus the savings in holding costs. If a buydown permits homes to sell faster by enabling lower income buyers to qualify for loans, then we might expect holding costs to be less for the buydown transaction than for the nonbuydown transaction, *i.e.*, $H_0 < H_*$. If so, then the final term on the right-hand side of (1), inclusive of the leading minus sign, is negative. Thus, the strategy of offering a buydown could be optimal for the seller even if the expected selling price with a buydown exceeds the nonbuydown selling price by less than the buydown amount, *i.e.*, even if there is less than full capitalization of the buydown.

Notice that inequality (1) suggests the possibility of negative capitalization. In particular, if expected holding costs in the optimal nonbuydown transaction exceed expected holding costs in the optimal buydown transaction by more than the amount of the buydown, *i.e.*, $H_* - H_0 > B_0$, then a seller would be willing to offer a buydown even if the expected sales price in the buydown transaction is less than the expected nonbuydown price. The

[2] We ignore the issue of choosing the size of the buydown.

realization of this possibility quite clearly hinges on the existence of large differences in holding costs. For example, for a buydown that is five percent of the value of the home, the difference in holding costs must exceed five percent as well.[3] Differences in holding costs of this magnitude suggest an inactive housing market in which offers arrive only infrequently. In addition such a market must contain a substantial fraction of potential buyers near the margin of loan qualification, for only then will a buydown significantly reduce time on the market by permitting additional borrowers to qualify for loans.

Although we cannot rule out negative capitalization as a theoretical possibility, partial (less than full) capitalization seems to be more likely. Even in an active housing market in which offers arrive fairly frequently, a buydown may speed up sales somewhat, leading sellers to be willing to accept a somewhat smaller price net of the buydown. Notice, however, that in the case in which there is no difference in holding costs, there must be full (or more than full) capitalization. In particular, no seller would be willing to forego an existing nonbuydown offer in favor of an existing buydown offer that did not fully capitalize the buydown.

In addition to outlining the theoretical limits on capitalization of buydowns, the discussion in this section serves to reinforce the idea that capitalization rates may well vary from time to time and place to place according to market conditions and the reasons for the buydown. The fact that financial characteristics are embedded in a unique multidimensional commodity implies that we need not find a single capitalization rate that applies to all buydown transactions, but this is only part of the story. Prior reasoning suggests that buyers seeking to circumvent lending constraints will be willing to accept sales prices that embody full or more than full capitalization. To the extent that property taxes for potential buyers are adversely affected by buydown capitalization, however, buyers who are not attempting to skirt loan qualification standards would be unwilling to accept full capitalization. On the other side of the transaction, sellers may be willing to accept less

[3]As will be seen below, buydowns in the samples used in this study averaged about five percent of the value of the home.

than full capitalization of a buydown in an effort to reduce holding costs through a quicker sale to lower income buyers. If, on the other hand, holding costs are insignificantly different for buydown transactions, sellers would be unwilling to accept less than full capitalization.

This discussion clearly leaves the resolution of the capitalization question to empirics. We now turn to a framework for estimating the capitalization of temporary buydowns.

III. THE SAMPLE AND THE SETTING

The empirical work to follow is based upon data on individual FHA-insured loans. These data reside in hardcopy form in casebinders maintained at HUD headquarters. To begin the process of translating the hardcopy data into a form suitable for analysis, we utilized automated (A43) files maintained by HUD to select a sample of loans meeting the criteria discussed below. For this sample of loans, Westat coded and entered the data extracted from the individual casebinders. Analysis files were produced by merging the coded casebinder data with portions of the automated data that were already available.

The original sample design called for standard FHA-insured mortgages originating in two offices—Denver and San Antonio—during 1982 and 1985/86. More precisely, the sample was restricted to 30-year, level-payment, non-coinsured mortgages for single-family dwellings located in the largest SMSAs serviced by each of the two offices, and having a loan amortization start date in 1982 (for the first part of the observation interval), or from January 1, 1985, through July 31, 1986, inclusive (for the second part of the observation interval).[4] Loan-to-value ratios were restricted to lie between 0.6 and 1.2.[5] Although limitations of the automated data precluded the elimination of refinancing transactions at the time that the sample was drawn, refinancing transactions were later dropped when the data were coded from the FHA casebinders.

To construct the strata from which samples were drawn, each case was categorized according to the office of origination, the time period (1982 or 1985/86), whether the loan terminated in default by September 30, 1989,[6] and whether the home was "new" or "old."

[4]The second part of the observation interval stops in mid-year in an attempt to avoid sales transactions taking place under the revised HUD rules that placed restrictions on underwriting and appraisal in the presence of buydowns.

[5]Use of the loan-to-value (LTV) ratio, as defined in the A43 data, is a bit problematic because the definition of the numerator depends on the nature of the loan processor. The financed portion of the up-front mortgage insurance premium is included in the numerator of LTV for HUD-processed cases, but is excluded from the numerator for direct endorsement cases.

[6]Separation by default status was dictated by other uses to which this sample was to be put. Note also that our separation according to default status was based on whether the original borrower defaulted. That is, our major interest was centered on the characteristics of the home and the homebuyer, and because such information was not available for those who assumed an already existing loan, loans that were assumed before a default ultimately occurred were classified as a nondefault by the original mortgagor.

Homes were categorized as "new" if they were classified by FHA as new dwellings being sold by a builder, or existing but not previously occupied homes. Other homes were considered "old" homes. Within each stratum defined by the office, time period, default status, and new/old status, cases were randomly selected for inclusion in the sample.

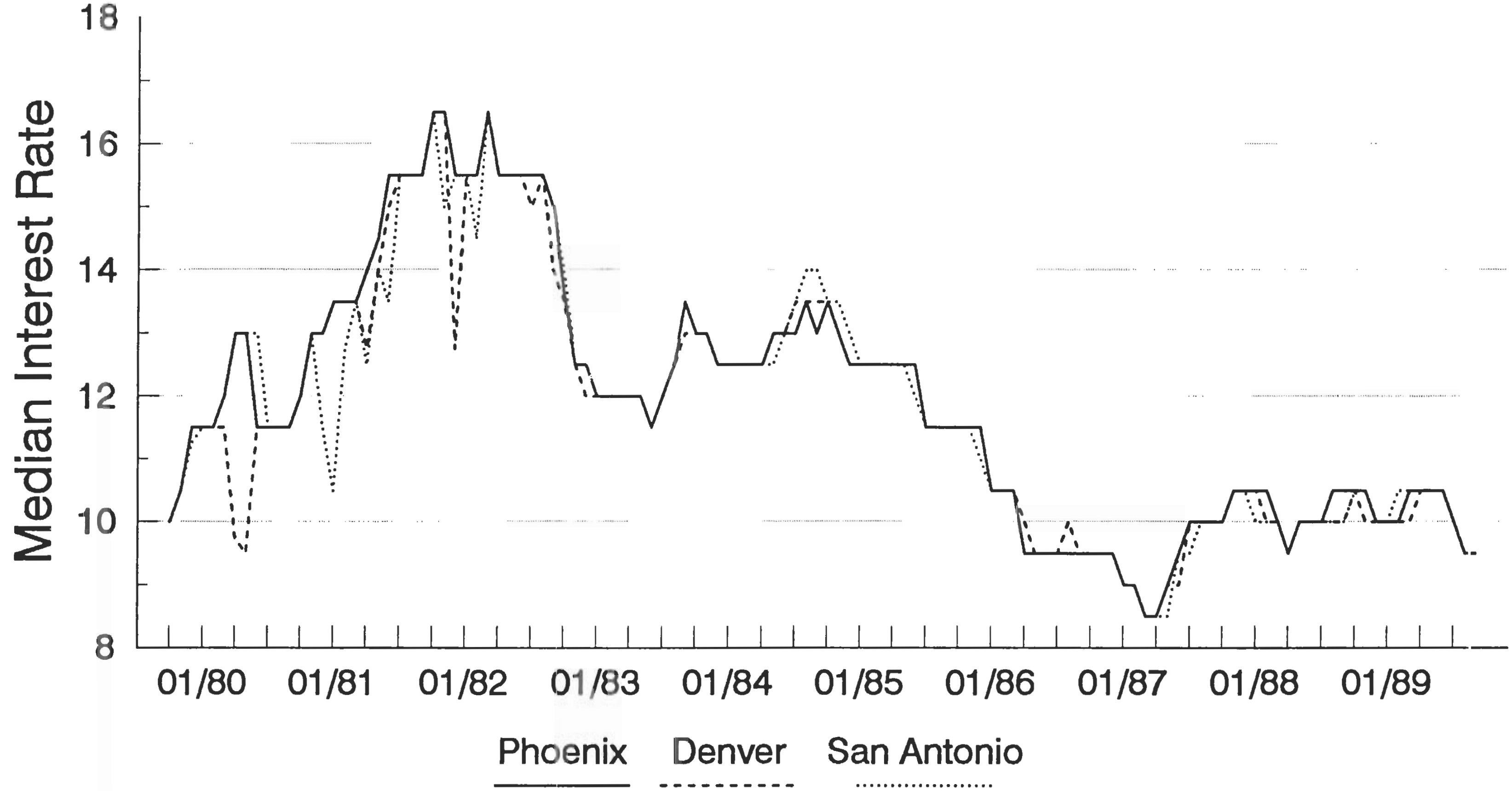
Some of the cases selected for inclusion in the sample turned out to be unusable for a variety of reasons: incorrect automated data led to including some cases that did not meet the sample selection criteria; some loans turned out to be refinances; critical forms were missing from some cases; etc. Indeed, missing forms proved to be a large enough problem for the 1985/86 Denver cases that coding was suspended for the corresponding strata. Having been forced to abandon this portion of the sample, we added additional cells for Phoenix in both 1982 and 1985/86. Table 1 below summarizes features of the original cell sizes, the final sample sizes, and the number of cases that were utilized to reach the ultimate sample for each stratum.

Utilizing the same criteria that were used to select the sample of FHA-insured loans, but broadening the time period covered, Figures 1 and 2 demonstrate features of the housing market in the three sample cities during the ten-year period starting in October 1979 and ending in September 1989. Figure 1 shows the median mortgage interest rate for each city. Note that interest rates in the first portion of the sample observation interval (1982) were high by historic standards—reaching levels of about 17 percent—while interest rates were substantially lower during the 1985/86 period, dipping to about 10 percent.

Not surprisingly, the behavior of FHA loan transactions over this ten-year interval mirrors the behavior of mortgage interest rates. In particular, as shown in the three panels of Figure 2, the numbers of FHA loan transactions in total and for new homes alone were low in the early 1980s, when interest rates were high, but rebounded to high levels in the 1985/86 period as interest rates declined.

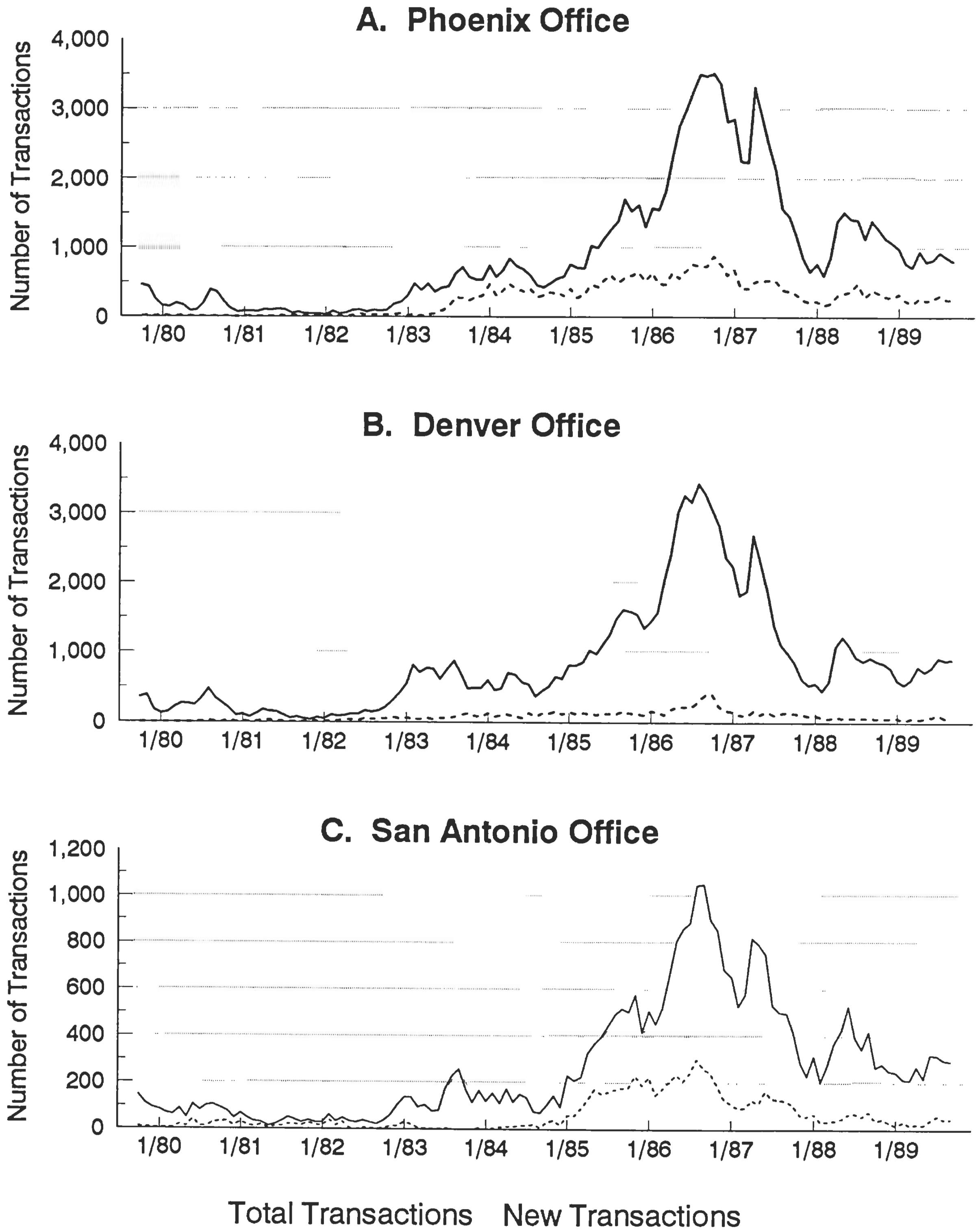
The use of temporary buydowns in these local markets changed over time and differed

Figure 1
Median Interest Rates on 30-Year FHA-Insured Loans, by Office and Month*



*See text for other sample restrictions.

Figure 2
Number of 30-Year FHA-Insured Loan Transactions in Total and on New Homes, by Month*



*See text for other sample restrictions.

TABLE 1

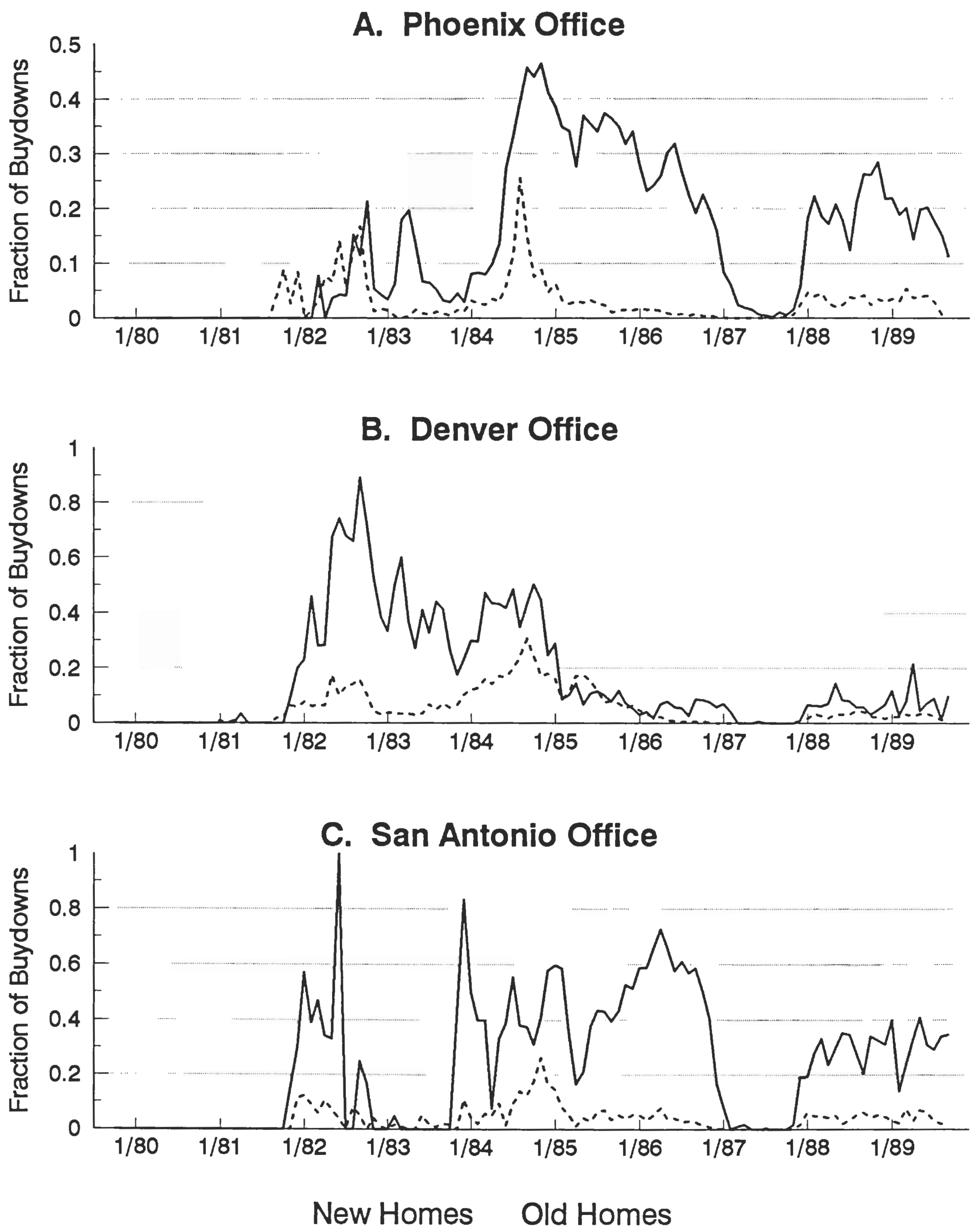
Cell Sizes by Stratum

Office	Year	Default Occurred?	New/Old Home	Original Cell Size	Final Sample	Cases Used
Denver	82	no	old	1,302	174	394
Denver	82	no	new	418	187	394
Denver	82	yes	old	202	63	131
Denver	82	yes	new	96	44	96
San Antonio	82	no	old	339	256	339
San Antonio	82	no	new	134	102	134
San Antonio	85/86	no	old	5,471	296	606
San Antonio	85/86	no	new	2,839	264	968
San Antonio	82	yes	old	39	33	39
San Antonio	82	yes	new	30	23	30
San Antonio	85/86	yes	old	714	96	229
San Antonio	85/86	yes	new	386	83	249
Phoenix	82	no	old	742	226	461
Phoenix	82	no	new	284	65	284
Phoenix	85/86	no	old	19,012	252	669
Phoenix	85/86	no	new	9,507	247	412
Phoenix	82	yes	old	130	71	130
Phoenix	82	yes	new	51	8	51
Phoenix	85/86	yes	old	1,292	83	154
Phoenix	85/86	yes	new	658	86	117

across cities as well. The panels of Figure 3 show, for new and old home sales separately, the fraction of transactions in which a temporary buydown occurred. Note that buydowns tended to be more common among new home sales than among old home sales. For new home sales transactions, the periods of substantial buydown activity occurred later in Phoenix than in Denver, while San Antonio exhibited three distinct periods of heavy buydown activity. Among old home sales, buydown activity appears to have peaked in mid-to-late 1984 in all three cities.

Table 2 summarizes some of the data contained in the figures above but focuses solely on the sample periods, 1982 and 1985/86. The first row of the table shows that new home

Figure 3
Fraction Having Temporary Buydowns among FHA-Insured, 30-Year Loans on Old and New Homes, by Month*



*See text for other sample restrictions.

transactions were about one-quarter to one-third of all FHA transactions within each sample period and city, but they tended to be a larger share of the transactions in San Antonio than in Phoenix, and lower still in Denver. The second row shows that buydowns were present in a larger share of all FHA transactions in the 1985/86 sample periods than in 1982. The breakdown by old and new homes, as shown in the third and fourth lines, illustrates that this increase in the popularity of buydown transactions is reflected principally in the dramatic increases in the share of buydowns among new home transactions; the share of buydowns among old homes changes little from the 1982 to the 1985/86 sample periods.

While Table 2 illustrates the potential importance of buydowns in the market by measuring their relative frequency, Table 3 illustrates their importance in another dimension. Table 3 attempts to give an indication of the monetary significance of the average buydown by comparing it to average loan discount points. The top two rows of the table express the buydown amount as a percentage of the sales price of the home, on average, for new and old home buydown transactions separately in each of the sample cities and time periods. The bottom two rows provide the analogous figures for loan discount points, *i.e.*, discount points paid by the seller relative to the sales price of the home, on average, among all home sales in which the seller paid discount points. Notice that the orders of magnitude are quite similar. Buydowns, when present, tend to be about five percent of the sales price of the home, which is the approximate cost of a 3-2-1 buydown. There appears to be more cross-sample variation in loan discount points; differentials between new and old homes are especially dramatic for the San Antonio samples.

Table 4 carries the investigation one step further by presenting buyer characteristics and behavior associated with, or perhaps engendered by, the existence of buydowns. Each number in the body of the table presents, for a particular sample cell, an average value for those borrowers who used buydowns; the number immediately below (in parentheses) is the corresponding average in that same sample cell for borrowers who did not use buydowns. The first pair of rows shows that with only one exception borrowers who used buydowns

TABLE 2

FHA Buydowns and New Home Sales

Characteristics of FHA Loan Originations	Phoenix 1982	Phoenix 1985/86	Denver 1982	San Antonio 1982	San Antonio 1985/86
Percent New Homes	27.8	33.4	25.5	30.3	34.3
Percent Buydowns	6.0	11.6	21.0	11.8	20.6
Among New Homes	7.5	31.5	58.0	29.3	50.9
Among Old Homes	5.5	1.6	8.4	4.2	4.9

Source: Computations based on A43 automated data.

TABLE 3

A Comparison of Buydown Amounts with Loan Discounts

Characteristics of FHA Loan Originations	Phoenix 1982	Phoenix 1985/86	Denver 1982	San Antonio 1982	San Antonio 1985/86
Buydown Amount as Percent of Sales Price of Home:					
Among New Homes with Buydowns	5.2	5.4	4.7	5.3	5.1
Among Old Homes with Buydowns	5.0	4.0	4.7	4.7	4.8
Loan Discount Points Paid By Seller as Percent of Sales Price of Home:					
Among New Homes with Loan Discount Points	6.9	5.4	5.6	10.4	7.7
Among Old Homes with Loan Discount Points	5.6	2.2	5.2	4.0	2.6

Source: Calculations based on sample data coded from FHA case files.

TABLE 4

Characteristics of Buydown and Nonbuydown (in Parentheses) FHA Loan Originations in Sample Cities and Time Periods

	OLD HOMES					NEW HOMES				
	Phoenix		Denver	San Antonio		Phoenix		Denver	San Antonio	
	1982	1985/86	1982	1982	1985/86	1982	1985/86	1982	1982	1985/86
Mean Age of Mortgagor	31.4 (32.2)	29.3 (33.8)	29.4 (32.1)	28.8 (29.9)	30.1 (33.8)	36.2 (35.4)	29.8 (34.5)	29.4 (30.1)	30.1 (33.3)	31.5 (32.3)
Mean Monthly Base Pay of Morgagor	1,976 (2,095)	1,870 (2,226)	1,903 (2,226)	1,356 (1,581)	1,944 (1,972)	1,910 (2,323)	1,954 (2,435)	2,316 (2,377)	2,026 (2,257)	1,869 (1,979)
Mean Monthly Net Effective Income of Mortgagor and Co-Mortgagor	2,264 (2,387)	2,092 (2,654)	2,678 (2,555)	1,966 (1,991)	2,274 (2,354)	2,224 (2,381)	2,479 (2,802)	2,509 (2,718)	2,515 (2,486)	2,272 (2,479)
Mean Sales Price of Home	65,020 (58,255)	61,436 (69,904)	72,285 (70,312)	46,365 (40,026)	67,289 (56,664)	71,490 (66,650)	77,569 (81,325)	76,509 (78,002)	58,676 (65,269)	70,321 (70,776)
Mean Loan Amount	61,855 (54,257)	60,778 (67,269)	65,526 (62,525)	42,962 (37,371)	66,289 (54,742)	65,769 (58,895)	76,599 (76,760)	70,097 (68,323)	54,402 (56,289)	69,429 (68,986)
Difference between Mean Sales Price of Home & Mean Loan Amount	3,165 (3,998)	658 (2,635)	6,759 (7,787)	3,403 (2,655)	1,000 (1,922)	5,721 (7,755)	970 (4,565)	6,412 (9,679)	4,274 (8,980)	892 (1,790)
Percent Defaulting as of 9/30/89	16.7 (14.8)	12.2 (6.3)	16.7 (13.1)	31.3 (9.4)	13.3 (11.5)	12.0 (15.5)	8.5 (5.5)	22.2 (13.9)	13.8 (18.1)	11.6 (12.4)

Source: All figures other than percent defaults are based on sample data coded from FHA case files. Percent defaulting is calculated from A43 automated data.

were younger on average than those who did not. The second and third pair of rows show that, with few exceptions, mortgagors who used buydowns tended to have lower incomes than those who did not, a finding which suggests the use of buydowns to help buyers qualify for loans. This idea is reinforced in the fourth pair of rows, which illustrates that despite having lower average incomes, borrowers who used buydowns in their purchase of old homes tended (with one exception) to buy more expensive homes than buyers who did not use buydowns. The situation is reversed for purchasers of new homes: sales prices were, with one exception, lower on average for transactions with buydowns than for those without. Comparisons of average loan amounts for transactions with and without buydowns generally follow the same pattern as that of sales prices. There are two exceptions, however: for new home transactions in 1982 for Denver and in 1985/86 for San Antonio, average loan amounts for buydown transactions exceeded those for nonbuydowns even though average sales prices are higher for the nonbuydown transactions.

Skipping to the last pair of rows in Table 4, we see that in all but two cases a larger fraction of buydown transactions than of nonbuydown transactions terminated in default by September 30, 1989.[7] This relationship is consistent with the idea that sales prices incorporate at least part of the value of any associated temporary buydown, but that the capitalized value of the buydown can not be recaptured on resale. However, the pattern of defaults may be reflecting other differences between average buydown and nonbuydown transactions. As shown in the second to the last pair of rows, the difference between the mean sales price of the home and the mean loan amount—measured initial equity—is generally higher for nonbuydown transactions. This difference in itself would tend to lead to higher default rates among buydown transactions. In addition, lower incomes are coupled with higher loan amounts for buydown transactions in many of the sample cells, suggesting that payment-to-income ratios are ultimately higher among the buydown transactions (*i.e.*, after buydown termination). To the extent that payment-to-income ratios matter in default

[7] National data for FHA endorsements in 1982, 1985, and 1986 show that annual conditional default rates for buydowns are ultimately higher than for nonbuydowns. See Cotterman (1992).

behavior, the observed pattern of defaults may also be partly traceable to these differences in payment-to-income ratios.

Thus, while the pattern of defaults observed in Table 4 is consistent with buydown capitalization, it is subject to other interpretations as well. We next turn to a more systematic estimation framework for isolating the effect of buydowns on house prices.

IV. ASPECTS OF MODEL SPECIFICATION AND ESTIMATION

A. Functional Form Considerations

The data set obtained from the FHA casebinders, containing a large number of variables describing the characteristics of the home, the demographic and economic characteristics of the buyer(s), and the financial aspects of the sales and loan transactions, was drawn primarily from FHA application, appraisal, and settlement forms. Our principal approach to isolating the effect of temporary buydowns on the sales prices of homes is via estimation of a hedonic price regression that relates the price of the home to financial characteristics of the transaction and features of the home. The literature provides a large number of precedents (see, for example, Agarwal and Phillips [1983 and 1984], Sirmans, Sirmans, and Smith [1983], Asabere, Hachey, and Grubaugh [1989], and Asabere [1990]), but the hedonic regressions in such studies vary in terms of functional form and in terms of independent variables, presumably partly because of differences in data availability.

Consider first the question of functional form. Specifications that are logarithmic in house prices have enjoyed popularity in the literature and have received some statistical support. For example, Asabere, Hachey, and Grubaugh (1989) and Asabere (1990) report that Box-Cox and Box-Tidwell transformations suggest specifications that are logarithmic in price and in square footage. In addition, others such as Agarwal and Phillips (1983 and 1984) note the presumed superiority of the semilogarithmic form but state that the linear form gives results that are very similar.

In contrast with some of the previous work, however, a special feature of the current study is that some variables seem likely to operate with multiplicative or proportionate effects on price while others seem likely to operate arithmetically.[8] In particular, it seems reasonable to view the effects of financial terms, such as temporary buydowns and loan discount points, as having arithmetic effects on sales prices. We view each additional dollar

[8]Taken to its logical extreme, the argument that prices are determined by negotiation over unique commodities implies that even seemingly reasonable assumptions about functional form need not be correct.

of temporary buydown funding as having a constant dollar (rather than proportionate) effect on the sales price of the home: that is, an additional dollar of temporary buydown funding is expected to be associated with some fixed increase in the sales price of the home. In contrast, a proportionate effect on price would imply a dollar value of a particular buydown amount that varies with the sales price of the home.

As suggested by previous work, however, effects of various other factors on sales prices are likely to be multiplicative or proportionate, abstracting from financial considerations such as buydowns. Changes in the general price level and in the size of the home, for example, seem likely to exert proportional (though not necessarily equiproportional) effects on sales prices. A doubling of the general price level seems likely to double home prices, rather than to increase prices by a constant dollar amount regardless of original value. Similarly, we imagine a doubling of the size of a home to increase value by some fixed proportion of its original price,[9] rather than by a fixed dollar amount independent of its original price.[10]

Assuming that all factors can be classified as either financial factors F_k that affect price additively or as quality (or other intrinsic) factors Q_j that affect price multiplicatively (perhaps after a transformation), we express the observed sales price as

$$P = \prod_j Q_j^{\beta_j} + \sum_k \alpha_k F_k,$$

where the β_j and α_k are unknown coefficients that give the influence of the quality and financial factors, respectively, on sales price. Although we could use this equation as the basis for a nonlinear least squares estimation procedure, we instead opt for the simpler estimation route of approximating this function and applying linear least squares. The approximation begins by multiplying the final term on the right-hand side by $\prod_j Q_j^{\beta_j} / \prod_j Q_j^{\beta_j} [= 1]$, factoring

[9]Assuming that our regression controls effectively for other differences across homes, we may view the regression as performing the conceptual experiment of asking how prices would vary by changing each individual feature of a given home. The regression performs this experiment by controlling for other factors and then making comparisons across different homes.

[10]The alternative of a function that is linear in price and in square footage seems reasonable as well: the implicit assumption in that case is that each additional square foot adds a fixed dollar amount to the sales price. The difficulty with the latter assumption is that value of additional square footage seems likely to vary with the quality of the remainder of the home, *i.e.*, square footage is not standardized in quality terms.

out $\prod_j Q_j^{\beta_j}$ from both terms, and taking logs of both sides to obtain

$$\ln P = \sum_j \beta_j \ln Q_j + \ln(1 + \frac{\sum_k \alpha_k F_k}{\prod_j Q_j^{\beta_j}}).$$

Since the value of the financial aspects of the transaction (temporary buydowns, loan discount points, etc.) is expected to be a relatively small fraction of the sales price of the home exclusive of seller financing concessions ($\approx \prod_j Q_j^{\beta_j}$), and since $\ln(1+x) \approx x$ for small x, we may approximate as follows:

$$\ln P = \sum_j \beta_j \ln Q_j + \frac{\sum_k \alpha_k F_k}{\prod_j Q_j^{\beta_j}}.$$

Using a Taylor's series approximation and evaluating at a point at which $Q_j = Q_{j0}$, all j, and $F_k = 0$, for all k, we have

$$\ln P = A_0 + \sum_j \beta_j \ln Q_j + \frac{1}{\prod_j Q_{j0}^{\beta_j}} \sum_k \alpha_k F_k,$$

where A_O is a constant that depends on the evaluation point. Provided that $\prod_j Q_{j0}^{\beta_j}$ (*i.e.*, the point around which we approximate) is close to the actual price, we may further approximate the latter by

$$\ln P = A_0 + \sum_j \beta_j \ln Q_j + \sum_k \alpha_k (F_k/P).$$

Notice that in the latter expression, financial terms, such as temporary buydown amounts, are entered as their share of the sales price. The major question of interest is in the value of the α_k, and in particular, whether there is full capitalization of temporary buydown amounts (*i.e.*, whether the value of α for temporary buydowns is unity).

In the empirical work for this study we provide parallel semilogarithmic and arithmetic specifications. As suggested by the development above, the semilogarithmic specifications utilize the log of price as the dependent variable and measure financial terms as fractions of the sales price. The corresponding arithmetic specifications are linear in price and in dollar amounts of buydowns and other financial aspects of the sales transactions.

B. Variable Definitions and Construction

We next turn to the particular variables utilized to explain sales prices of homes in the various cities and time periods. Table 5 below defines the independent variables included in one or more of the regression specifications and gives the abbreviations utilized in subsequent tables.[11] Simple summary statistics for these variables are presented in Table 6. In general, variables describing features of the home or its contents were obtained from the residential appraisal report, and variables capturing financial aspects of the transaction were obtained from the settlement statement. The major exceptions are the information on the amount and timing of buydown payments, which was obtained from the buydown or escrow agreement, and information on the mortgage interest rate, which was obtained from the mortgage note or deed of trust.[12] Several comments on variable definitions are in order here.

The above discussion concerning the regression specification does not fully answer the question of how to enter variables like temporary buydown amounts. The specifications that follow utilize the present value of the temporary buydown in which the discount rate is chosen to be the coupon rate on the mortgage.[13] This formulation represents from the buyer's perspective the full initial buydown value which is later dispensed over time. The undiscounted sum of buydown amounts would better represent costs to the seller when the buydown escrow is held in a noninterest bearing account.

Notice also that the semilogarithmic specification as implemented here assumes that explanatory variables such as numbers of bathrooms, presence of a fireplace, etc., have a fixed relative, rather than fixed dollar, effect on the price of the home. The rationalization for this assumption is that features such as these are worth more in high-priced homes than in low priced homes because the quality of such features will tend to be in keeping with

[11]Regression specifications utilizing a more detailed list of controls are presented in the Appendix.

[12]The values of the mortgage interest rate used in computing the median rate by month (see MEDINT) were obtained from the HUD automated A43 data.

[13]It is unclear what interest rate to use in discounting. The mortgage rate has the desirable features of (a) properly reflecting the reduced payment burden facing the mortgagor who receives a temporary buydown, and (b) moving in accordance with overall market forces.

TABLE 5

Variable Definitions and Abbreviations

Variable Abbreviation	Variable Definition
VBO	The present discounted value of the monthly buydown payments using the mortgage interest rate as the discount rate.
BRATIO	The present discounted value of the monthly buydown payments (VBO) divided by the sales price of the home.
DISCSELL	Discount points paid by the seller.
DSRATIO	Discount points paid by the seller (DISCELL) divided by the sales price of the home.
LAG1BUYP	One month lag in the fraction of FHA-insured homes in that office which sell with temporary buydowns.
SQFT	Square footage of home.
LSQFT	Log of square footage of home.
SQFTMISS	Indicator variable = 1 if square footage is missing.
FACTFAB	Indicator variable = 1 if factory fabricated home.
CENTLAIR	Indicator variable = 1 if central air conditioned.
BEDRMS	Number of bedrooms.
BATHS	Number of bathrooms.
AGEHSE	Age of house in years.
LOTSIZE	Size of lot in square feet.
LLOTSIZE	Log of LOTSIZE.
LOTSZMIS	Indicator variable = 1 if lot size is missing.
POOL	Indicator variable = 1 if swimming pool is present.
GARAGE1	Indicator variable = 1 if single-car garage is present.
GARAGE2	Indicator variable = 1 if two-car garage is present.
BRICK	Indicator variable = 1 if brick exterior.
NEW	Indicator variable = 1 if home classified as new.
TIME82	Indicator variable = 1 if from 1982 time period.
MEDINT	Median interest rate on new 30-year FHA loans during the month in which sales transaction occurred.
INT0	Interest rate on mortgage note.
BLDi	Indicator variable = 1 if a new home constructed by large builder i, i = 1,...,9.

TABLE 6

Variable Means and Standard Deviations

	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
VBO	333.3464	1124.983	685.6626	7086.083	704.3323	1826.624	315.1975	846.2628	811.4232	3300.589
DISCSELL	3315.187	4057.355	2099.546	11766.44	2996.577	3683.735	3019.504	3214.200	2137.4	6352.548
SQFT	1345.620	437.8234	1397.788	1621.724	1214.766	565.1571	1207.828	371.2090	1311.494	920.0498
SQFTMISS	0	0	0.001658	0.186827	0.001160	0.047635	0.017156	0.130015	0.003942	0.143628
LAG1BUYP	0.075252	0.062387	0.164622	0.741192	0.161309	0.1996	0.095710	0.128333	0.157651	0.410598
BLD1	0	0	0.047521	0.976866	0	0	0	0	0	0
BLD2	0	0	0	0	0	0	0.225490	0.418417	0.054974	0.522414
BLD3	0	0	0	0	0	0	0	0	0.017552	0.300982
BLD4	0.001969	0.052006	0.016946	0.592632	0	0	0	0	0	0
BLD5	0	0	0	0	0.146556	0.494915	0	0	0	0
BLD6	0	0	0.010354	0.464796	0	0	0	0	0.042237	0.46098
BLD7	0	0	0.032596	0.815362	0	0	0	0	0	0
BLD8	0.019694	0.162992	0.012416	0.508457	0.032215	0.247093	0	0	0	0
BLD9	0.001969	0.052006	0.009504	0.445501	0	0	0	0	0.008776	0.213775
FACTFAB	0.001969	0.052006	0.003316	0.263994	0.001160	0.047635	0.002450	0.049507	0.003089	0.127196
CENTLAIR	0.798270	0.470732	0.906795	1.334856	0.079598	0.378774	0.563725	0.496531	0.718215	1.03109
BEDRMS	2.944236	0.785358	2.983935	2.921193	2.627689	1.093460	2.779411	0.607381	2.896977	1.256284
BATHS	1.734258	0.562070	1.911849	1.714452	1.576555	0.896677	1.514705	0.501623	1.722162	1.162338
AGEHSE	14.25251	20.18344	9.631604	59.28847	19.13188	31.05938	20.3725	20.87845	17.16697	43.41629
LOTSIZE	8737.524	9591.956	6335.739	34581.84	6354.694	22941.26	8281.373	4966.13	7690.766	12071.42
LOTSZMIS	0.11109	0.368631	0.233587	1.942749	0.290243	0.635150	0.019607	0.138818	0.068455	0.578785
POOL	0.075214	0.309376	0.14678	1.624931	0.003613	0.083967	0.007352	0.085538	0.006674	0.186627
GARAGE1	0.084630	0.326495	0.075916	1.216143	0.37401	0.677123	0.321078	0.46746	0.273856	1.022081
GARAGE2	0.287897	0.531135	0.524212	2.293089	0.429453	0.692698	0.433823	0.496209	0.538773	1.142545
BRICK	0.030498	0.201710	0.023438	0.694665	0.31866	0.652061	0.191176	0.39371	0.248607	0.990611
MEDINT	15.33573	0.916916	11.45867	4.820494	14.90158	1.665719	15.25857	0.692128	11.4614	2.461474
INT0	13.73682	1.810494	10.80349	5.617060	13.7069	1.893551	13.97487	1.497996	10.64856	3.29180
NEW	0.143769	0.411569	0.435276	2.276466	0.265043	0.617632	0.303921	0.460513	0.232461	0.968141
PRICE	60180.09	20612.99	73817.37	77793.70	72283.11	21351.52	47345.49	19268.52	60973.70	43299.7

TABLE 6
Variable Means and Standard Deviations
(Continued)

Variable	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
BRATIO	0.005008	0.016536	0.009201	0.091406	0.009509	0.024600	0.005714	0.014870	0.011693	0.046300
DSRATIO	0.054045	0.056405	0.028355	0.14797	0.042981	0.051574	0.057123	0.042534	0.03315	0.088962
LSQFT	7.165861	0.328687	7.201586	1.767081	7.0460	0.546833	6.956226	0.957927	7.118646	1.190729
LLOTSIZE	8.051653	3.372329	6.833836	17.38651	6.343142	5.696762	8.789561	1.291821	8.314850	5.234961
LNPRICE	10.95896	0.366178	11.18160	1.104293	11.16488	0.309649	10.67738	0.430370	10.96531	0.768316

the remainder of the home. Thus, for example, adding a bathroom will add the same in percentage terms, but more in dollar terms, to a high-priced home than to a low-priced home because bathroom quality will be correspondingly higher for the high-priced home.

At the same time, we enter the square footage of the home (see SQFT and LSQFT) and square footage of the lot (see LOTSIZE and LLOTSIZE) in logarithmic form when using the log of price as the dependent variable. The implicit assumption is that given percentage changes in square footage of the home or the lot translate into fixed percentage changes in price. That is, we assume that SQFT and LOTSIZE, like the Q_j in the functional form derivation above, have multiplicative effects on price and thus log linear effects on the log of price.

The basis for including most of the variables in Table 5 is fairly obvious because most are straightforward measures of the quality, size, or features of the home. A few variables merit additional discussion, however. In addition to using indicator variables to show the presence or absence of certain features of a home, *e.g.*, the POOL variable to show the presence of a swimming pool, we also use dummy variables to indicate that some other variable should be present but is missing. This procedure is followed when the variable of interest is judged to be important but is missing in a non-trivial fraction of the cases (so that the cases with missing values can not easily be excluded). As an example, the variable SQFT (square footage of the house) must be positive. When we find SQFT to be missing or zero in our data, we set SQFT to zero and set the indicator SQFTMISS to one. We offer additional interpretation of these missing value indicators below in our discussion of empirical findings.

For new home cases we use indicator variables for several individual builders.[14] The idea is that builders tend to construct homes of roughly similar quality, but the quality differences among builders are largely unmeasured with the variables at hand. Including

[14] An indicator for an individual builder was included if the builder was noted on the VA Request in 20 or more cases. The search for individual builders was conducted using character strings that were judged to be equivalent alternative representations of the builder's name.

builder indicators helps correct for these unobserved quality differences across homes.

Three variables help to control for differences in the strength of the local housing market.[15] The first is MEDINT, the median mortgage coupon rate in the same city for the month in which the home was sold. These rates are computed over 30-year FHA-insured loans with amortization start dates coinciding with the month of sale of the subject property. Because the amortization start dates are expected to follow loan commitments by perhaps 2-3 months, we are implicitly permitting a 2-3 month lag in the effect of the interest rate environment on house prices.

As a second proxy for the strength of the housing market we include INT0, the mortgage coupon rate for the loan on the subject property. This variable may help correct for deficiencies in MEDINT that are due to possible timing problems in the latter. That is, if INT0 differs from MEDINT, it may be that INT0 gives a more accurate indication of the actual interest rate environment at the time that the subject home was sold. However, a difference between INT0 and MEDINT may also reflect idiosyncrasies of the particular loan transaction at issue. That is, if the coupon rate for an individual loan differs from what is typical in the market, it may indicate, given the control for DISCSELL, that there is something unusual about the borrower or the subject property.

The final control for market conditions is the variable LAG1BUYP, a one month lag in the fraction of FHA-insured homes in that city that sold with buydowns. LAG1BUYP is computed over 30-year FHA-insured mortgages for which the amortization start date is in the month prior to the month of sale of the subject property.[16] Assuming again that sales transactions precede amortization start dates by 2-3 months, LAG1BUYP measures the prevalence of buydowns among sales transactions which precede the sale of the subject property by 3-4 months. Such sales transactions presumably would be used as comparables

[15] The discussion above noted that the effect of buydowns may vary with the motivation for buydowns and the strength of the housing market. This argument suggests that the buydown variable be interacted with measures of market strength and proxies for buydown motivation. As discussed below, our experiments along these lines were unsuccessful.

[16] Both MEDINT and LAG1BUYP are computed over data that are separated according to new/old home status as well.

to establish the subject property's value. This variable may pick up two effects. The first is that extensive buydown activity may temporarily mislead unaware buyers, sellers, and appraisers into overestimating home values by unknowingly using comparables that have sold with buydowns to judge the prices of homes that do not feature buydowns. Presumably, such ignorance would eventually vanish, if indeed it is present at all, as the market becomes aware of the possible presence of buydowns among comparables.[17]

The fraction of buydowns in the market may pick up another effect as well. If buydowns tend to be offered only when the housing market is relatively weak, the relative frequency of buydowns may serve as an inverse indicator of the health of the housing market.

[17]If this effect wanes as buyers, sellers, and appraisers adjust, then additional lags should be present. Experimentation with alternative lag structures yielded results that were similar to those presented below.

V. EMPIRICAL FINDINGS: ESTIMATES OF HEDONIC REGRESSIONS

Tables 7a through 7g and Tables 8a through 8g present weighted regression[18] estimates of the hedonic price equations based on pooled samples of old and new homes. The weights used in estimation are the inverses of the sampling rates for each stratum.[19] Table 7 regressions are arithmetic in house price; Table 8 regressions are semilogarithmic.

While all samples maintain separation among cities, the first five tables in each series (Tables 7a through 7e, and Tables 8a through 8e) are separated according to time period as well. The final two regressions in each series (Tables 7f and 7g, and Tables 8f and 8g) merge the 1982 and 1985/86 samples for the Phoenix and San Antonio offices, permitting only differences in intercepts for the two observation intervals. Although pooling offers the advantage of obtaining more efficient estimates of parameters that are truly the same, it runs the risk of forcing equality of coefficient estimates for which the underlying parameters are in fact different. That is, the assumption in pooling across observation intervals is that effects of all independent variables, other than the intercept, are identical in the two different time periods.[20]

Two possible sources differences in parameters across time periods are especially noteworthy. The first is changes in the price level over time, which seem likely to be problematic

[18]Note that the statistical procedure assumes that the explanatory variables are uncorrelated with the disturbance term in the regression. Arguments raised by Durning and Quigley (1985) and by Clauretie (1983) imply that the buydown amount is statistically endogenous because of a mechanical relationship between the present value of the buydown and the selling price of the home. In particular, the present value of the buydown can written as the product of the loan amount and a factor that depends on the coupon rate on the mortgage and the buydown interest rates. Since the loan amount, in turn, is the selling price of the home less the downpayment, the explanatory variable that measures the present value of the buydown amount essentially includes the dependent variable (the selling price). We have shown elsewhere (Cotterman [1991]) that this argument is fallacious.

[19]Recall that cells are defined in part by default status. The concern is that default may be correlated with the regression error term, *i.e.*, that homes that are high-priced (or low-priced) for reasons not well explained by the explanatory variables are disproportionately likely to end in default. Thus, samples that are selected nonrandomly according to default status may lead to bias if used in unweighted form. One could, of course, argue that an equally severe, but uncorrected, source of selection bias is in constructing a sample of FHA-insured loans. The results must be interpreted as conditional on this sample selection rule, *i.e.*, as regressions within the universe of FHA-insured loans, which may differ from the larger universe of all mortgages.

[20]We do not attempt to aggregate across cities under the assumption that, because of climatic differences and differences in construction practices, identical (as measured) housing features are worth more in some areas than in others.

TABLE 7a

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

PHOENIX 1982

Variable	Coefficient Estimate	Standard Error	T-statistic *
INTERCEPT	22154.000	12089.684	1.832
VBO	1.943	0.447	4.339
DISCSELL	0.329	0.150	2.194
SQFT	27.516	2.214	12.427
LAG1BUYP	3455.035	12211.182	0.283
BLD4	-2791.459	9202.193	-0.303
BLD8	69.968	3313.137	0.021
BLD9	-974.292	9218.375	-0.106
FACTFAB	-7098.548	9152.106	-0.776
CENTLAIR	6658.089	1250.200	5.326
BEDRMS	-842.910	899.231	-0.937
BATHS	1911.181	1277.626	1.496
AGEHSE	-107.094	32.392	-3.306
LOTSIZE	0.168	0.055	3.010
LOTSZMIS	1900.476	1509.326	1.259
POOL	8414.504	1681.346	5.005
GARAGE1	3598.673	1499.184	2.400
GARAGE2	5091.406	1142.713	4.456
BRICK	5581.147	2460.888	2.268
MEDINT	465.195	741.921	0.627
INT0	-1255.130	374.065	-3.355
NEW	1736.860	1473.329	1.179

Number of Observations: 370
R^2: 0.8196
Root MSE: 9015.19412

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7b

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

PHOENIX 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	24688.000	5043.341	4.895
VBO	0.566	0.252	2.243
DISCSELL	0.404	0.147	2.746
SQFT	31.501	1.484	21.220
SQFTMISS	56532.000	8043.388	7.028
LAG1BUYP	-18094.000	9471.816	-1.910
BLD1	3292.486	1696.357	1.941
BLD4	-569.614	2672.485	-0.213
BLD6	-1506.353	3197.486	-0.471
BLD7	-987.927	1866.692	-0.529
BLD8	7433.799	2979.664	2.495
BLD9	7770.856	3363.227	2.311
FACTFAB	-11228.000	5606.946	-2.003
CENTLAIR	6944.231	1295.492	5.360
BEDRMS	-3147.924	683.004	-4.609
BATHS	4853.703	1112.035	4.365
AGEHSE	-11.056	37.292	-0.296
LOTSIZE	0.078	0.050	1.549
LOTSZMIS	183.380	975.744	0.188
POOL	4702.453	1015.320	4.631
GARAGE1	-1055.270	1266.785	-0.833
GARAGE2	6054.102	883.889	6.849
BRICK	-1769.665	2230.355	-0.793
MEDINT	-293.591	557.953	-0.526
INT0	-568.740	500.391	-1.137
NEW	13026.000	3168.504	4.111

Number of Observations: 661

R^2: 0.7773

Root MSE: 37424.08031

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7c

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

DENVER 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	44824.000	7360.214	6.090
VBO	0.476	0.461	1.032
DISCSELL	0.028	0.216	0.130
SQFT	20.866	1.871	11.151
SQFTMISS	23789.000	13800.785	1.724
LAG1BUYP	-613.499	4959.742	-0.124
BLD5	4457.095	2544.282	1.752
BLD8	-5908.371	3206.139	-1.843
FACTFAB	-4790.517	13816.677	-0.347
CENTLAIR	1104.212	1843.193	0.599
BEDRMS	-3051.280	862.027	-3.540
BATHS	2887.982	1072.363	2.693
AGEHSE	-145.649	27.093	-5.376
LOTSIZE	-0.027	0.030	-0.932
LOTSZMIS	3640.282	1708.182	2.131
POOL	-13707.000	8014.812	-1.710
GARAGE1	4474.115	1344.255	3.328
GARAGE2	9222.571	1323.414	6.969
BRICK	3341.125	1084.096	3.082
MEDINT	858.142	442.285	1.940
INT0	-979.580	437.048	-2.241
NEW	2185.515	2334.163	0.936

Number of Observations: 468

R^2: 0.5904

Root MSE: 13982.43094

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7d

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

SAN ANTONIO 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	22833.000	8271.400	2.761
VBO	0.098	0.498	0.197
DISCSELL	0.585	0.189	3.084
SQFT	26.911	1.711	15.723
SQFTMISS	34287.000	3438.216	9.972
LAG1BUYP	2001.956	3120.348	0.642
BLD2	-3931.655	1716.507	-2.290
FACTFAB	-19585.000	7182.273	-2.727
CENTLAIR	8275.954	1073.421	7.710
BEDRMS	-979.466	754.357	-1.298
BATHS	1868.624	1185.805	1.576
AGEHSE	-27.040	23.845	-1.134
LOTSIZE	-0.034	0.075	-0.459
LOTSZMIS	-260.058	2721.280	-0.096
POOL	5548.441	4313.149	1.286
GARAGE1	2723.083	931.182	2.924
GARAGE2	6334.702	1097.825	5.770
BRICK	6195.232	1049.897	5.901
MEDINT	-377.460	589.253	-0.641
INT0	-1053.143	302.295	-3.484
NEW	6783.852	1621.651	4.183

Number of Observations: 408

R^2: 0.8750

Root MSE: 6985.86147

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7e

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

SAN ANTONIO 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	16135.000	4911.065	3.285
VBO	0.722	0.324	2.223
DISCSELL	0.689	0.217	3.171
SQFT	11.704	1.156	10.118
SQFTMISS	26763.000	6079.719	4.402
LAG1BUYP	751.306	4784.216	0.157
BLD2	-2249.275	2013.487	-1.117
BLD3	-819.791	3112.008	-0.263
BLD6	3220.780	2194.388	1.468
BLD9	4597.654	4177.177	1.101
FACTFAB	383.503	6909.878	0.056
CENTLAIR	8077.611	1230.096	6.567
BEDRMS	35.107	826.136	0.042
BATHS	7152.834	1137.519	6.288
AGEHSE	-57.171	28.830	-1.983
LOTSIZE	0.230	0.080	2.845
LOTSZMIS	2905.782	1657.253	1.753
POOL	3987.274	4565.450	0.873
GARAGE1	2807.335	1131.083	2.482
GARAGE2	12316.000	1245.462	9.889
BRICK	4643.807	961.259	4.831
MEDINT	-291.433	649.786	-0.449
INT0	257.171	585.835	0.439
NEW	-121.765	2394.184	-0.051

Number of Observations: 738
R^2: 0.7299
Root MSE: 22864.61838

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7f

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

PHOENIX

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	27822.000	3848.531	7.229
VBO	0.589	0.202	2.919
DISCSELL	0.391	0.115	3.403
SQFT	31.282	1.187	26.354
SQFTMISS	56923.000	6528.681	8.719
LAG1BUYP	-6278.180	5938.763	-1.057
BLD1	3226.706	1374.468	2.348
BLD4	-640.376	2160.191	-0.296
BLD6	-1280.801	2596.501	-0.493
BLD7	-985.640	1516.407	-0.650
BLD8	6645.356	2349.984	2.828
BLD9	7480.257	2718.506	2.752
FACTFAB	-10911.000	4502.175	-2.423
CENTLAIR	6738.792	1015.659	6.635
BEDRMS	-2999.711	544.907	-5.505
BATHS	4731.663	881.549	5.367
AGEHSE	-17.004	29.034	-0.586
LOTSIZE	0.080	0.039	2.006
LOTSZMIS	434.269	778.499	0.558
POOL	4698.000	813.641	5.774
GARAGE1	-783.208	1006.765	-0.778
GARAGE2	6180.570	700.508	8.823
BRICK	-1268.481	1766.430	-0.718
MEDINT	-431.395	432.197	-0.998
INT0	-713.194	379.501	-1.879
NEW	9013.750	1989.079	4.532
TIME82	-3051.962	1780.553	-1.714

Number of Observations: 1,031

R^2: 0.7811

Root MSE: 30413.94157

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 7g

Weighted Least Squares Regression Estimates
Dependent Variable: Sales Price of Home

SAN ANTONIO

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	16368.000	3932.530	4.162
VBO	0.642	0.259	2.475
DISCSELL	0.667	0.161	4.129
SQFT	12.459	0.934	13.333
SQFTMISS	24093.000	4210.008	5.723
LAG1BUYP	-346.793	3370.477	-0.103
BLD2	-2206.846	1491.749	-1.479
BLD3	-1266.017	2548.247	-0.497
BLD6	3225.780	1795.462	1.797
BLD9	4822.756	3435.070	1.404
FACTFAB	-2112.578	5456.174	-0.387
CENTLAIR	8223.017	955.942	8.602
BEDRMS	30.799	643.912	0.048
BATHS	6943.631	898.077	7.732
AGEHSE	-49.279	22.227	-2.217
LOTSIZE	0.194	0.063	3.072
LOTSZMIS	2571.573	1335.765	1.925
POOL	3353.989	3574.552	0.938
GARAGE1	2596.521	873.398	2.973
GARAGE2	11850.000	963.444	12.300
BRICK	5088.750	759.842	6.697
MEDINT	-76.479	466.653	-0.164
INT0	-17.861	392.752	-0.045
NEW	660.277	1698.790	0.389
TIME82	-7818.018	1502.617	-5.203

Number of Observations: 1,146

R^2: 0.7493

Root MSE: 18924.13450

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8a

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

PHOENIX 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	5.9836	0.3659	16.353
BRATIO	1.9529	0.5417	3.605
DSRATIO	-0.1418	0.1872	-0.758
LSQFT	0.6714	0.0533	12.595
LAG1BUYP	-0.1417	0.2190	-0.647
BLD4	0.0169	0.1635	0.104
BLD8	0.0467	0.0586	0.797
BLD9	-0.0426	0.1626	-0.262
FACTFAB	-0.2520	0.1619	-1.556
CENTLAIR	0.1471	0.0224	6.568
BEDRMS	-0.0274	0.0158	-1.734
BATHS	0.0391	0.0235	1.660
AGEHSE	-0.0022	0.0005	-3.869
LLOTSIZE	0.0486	0.0190	2.561
LOTSZMIS	0.4568	0.1732	2.637
POOL	0.1352	0.0296	4.557
GARAGE1	0.0727	0.0265	2.745
GARAGE2	0.0711	0.0199	3.575
BRICK	0.1136	0.0435	2.613
MEDINT	0.0010	0.0131	0.076
INT0	-0.0292	0.0065	-4.473
NEW	0.0113	0.0260	0.435

Number of Observations: 370

R^2: 0.8213

Root MSE: 0.15938

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8b

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

PHOENIX 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic *
INTERCEPT	6.3698	0.2087	30.518
BRATIO	0.5049	0.2657	1.900
DSRATIO	0.2210	0.1587	1.392
LSQFT	0.6034	0.0303	19.910
SQFTMISS	4.5115	0.2359	19.117
LAG1BUYP	-0.2232	0.1293	-1.726
BLD1	0.0402	0.0230	1.747
BLD4	0.0065	0.0365	0.179
BLD6	-0.0141	0.0435	-0.324
BLD7	-0.0117	0.0254	-0.464
BLD8	0.0865	0.0404	2.137
BLD9	0.1220	0.0458	2.662
FACTFAB	-0.1662	0.0764	-2.175
CENTLAIR	0.1437	0.0174	8.230
BEDRMS	-0.0513	0.0093	-5.474
BATHS	0.0749	0.0158	4.729
AGEHSE	-0.0005	0.0005	-1.176
LLOTSIZE	0.0381	0.0145	2.620
LOTSZMIS	0.3277	0.1289	2.542
POOL	0.0721	0.0137	5.255
GARAGE1	-0.0070	0.0172	-0.405
GARAGE2	0.0848	0.0120	7.070
BRICK	-0.0186	0.0304	-0.612
MEDINT	0.0010	0.0075	0.142
INT0	-0.0105	0.0067	-1.548
NEW	0.1755	0.0431	4.064

Number of Observations: 661

R^2: 0.7951

Root MSE: 0.50967

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8c

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

DENVER 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	8.6911	0.3029	28.691
BRATIO	-0.0883	0.4978	-0.177
DSRATIO	-0.7959	0.2225	-3.576
LSQFT	0.3478	0.0372	9.327
SQFTMISS	2.4093	0.3240	7.434
LAG1BUYP	-0.0384	0.0721	-0.533
BLD5	0.0360	0.0367	0.980
BLD8	-0.0561	0.0469	-1.197
FACTFAB	-0.1009	0.2031	-0.497
CENTLAIR	0.0165	0.0269	0.613
BEDRMS	-0.0339	0.0129	-2.621
BATHS	0.0435	0.0156	2.787
AGEHSE	-0.0025	0.0004	-6.046
LLOTSIZE	0.0012	0.0218	0.055
LOTSZMIS	0.0484	0.1978	0.245
POOL	-0.1467	0.1172	-1.252
GARAGE1	0.0826	0.0197	4.183
GARAGE2	0.1338	0.0194	6.890
BRICK	0.0471	0.0158	2.963
MEDINT	0.0164	0.0064	2.548
INT0	-0.0186	0.0063	-2.917
NEW	0.0400	0.0335	1.194

Number of Observations: 468

R^2: 0.5840

Root MSE: 0.20436

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8d

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	5.6709	0.4453	12.733
BRATIO	0.8026	0.7157	1.121
DSRATIO	-0.4231	0.3302	-1.281
LSQFT	0.7412	0.0550	13.459
SQFTMISS	5.2830	0.3951	13.370
LAG1BUYP	0.0410	0.0799	0.514
BLD2	0.0190	0.0447	0.427
FACTFAB	-0.4666	0.1843	-2.531
CENTLAIR	0.2178	0.0274	7.924
BEDRMS	-0.0172	0.0193	-0.891
BATHS	0.0475	0.0305	1.558
AGEHSE	-0.0006	0.0006	-1.106
LLOTSIZE	0.0148	0.0277	0.534
LOTSZMIS	0.1166	0.2585	0.451
POOL	0.1319	0.1103	1.196
GARAGE1	0.0906	0.0238	3.797
GARAGE2	0.1529	0.0281	5.436
BRICK	0.1020	0.0263	3.878
MEDINT	-0.0126	0.0150	-0.845
INT0	-0.0325	0.0076	-4.251
NEW	0.1276	0.0412	3.097

Number of Observations: 408

R^2: 0.8362

Root MSE: 0.17863

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8e

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	7.0289	0.2524	27.845
BRATIO	0.7037	0.3690	1.907
DSRATIO	0.2283	0.2409	0.948
LSQFT	0.4567	0.0324	14.079
SQFTMISS	3.4454	0.2466	13.967
LAG1BUYP	0.0046	0.0758	0.062
BLD2	-0.0403	0.0320	-1.259
BLD3	-0.0274	0.0494	-0.555
BLD6	0.0505	0.0349	1.445
BLD9	0.0748	0.0663	1.128
FACTFAB	0.0054	0.1098	0.049
CENTLAIR	0.1802	0.0195	9.229
BEDRMS	-0.0221	0.0133	-1.658
BATHS	0.0928	0.0186	4.970
AGEHSE	-0.0011	0.0004	-2.454
LLOTSIZE	0.0340	0.0181	1.874
LOTSZMIS	0.3129	0.1637	1.911
POOL	0.0664	0.0723	0.917
GARAGE1	0.0797	0.0179	4.436
GARAGE2	0.2059	0.0197	10.417
BRICK	0.0604	0.0153	3.950
MEDINT	0.0117	0.0103	1.131
INT0	-0.0135	0.0093	-1.451
NEW	0.0206	0.0379	0.543

Number of Observations: 738

R^2: 0.7841

Root MSE: 0.36274

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8f

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

PHOENIX

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.4037	0.1665	38.444
BRATIO	0.5601	0.2144	2.612
DSRATIO	0.1919	0.1240	1.547
LSQFT	0.6033	0.0244	24.691
SQFTMISS	4.5204	0.1910	23.657
LAG1BUYP	-0.0645	0.0819	-0.788
BLD1	0.0376	0.0188	1.995
BLD4	0.0070	0.0298	0.236
BLD6	-0.0112	0.0357	-0.314
BLD7	-0.0114	0.0208	-0.549
BLD8	0.0778	0.0322	2.411
BLD9	0.1196	0.0374	3.192
FACTFAB	-0.1658	0.0620	-2.671
CENTLAIR	0.1427	0.0138	10.289
BEDRMS	-0.0494	0.0075	-6.537
BATHS	0.0747	0.0126	5.891
AGEHSE	-0.0007	0.0003	-1.779
LLOTSIZE	0.0385	0.0116	3.324
LOTSZMIS	0.3349	0.1028	3.257
POOL	0.0716	0.0111	6.434
GARAGE1	-0.0024	0.0138	-0.180
GARAGE2	0.0865	0.0096	8.994
BRICK	-0.0109	0.0243	-0.450
MEDINT	0.0004	0.0059	0.080
INT0	-0.0139	0.0052	-2.685
NEW	0.1205	0.0273	4.400
TIME82	-0.0763	0.0245	-3.104

Number of Observations: 1,031
R^2: 0.7995
Root MSE: 0.41890

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 8g

Weighted Least Squares Regression Estimates
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.9011	0.2084	33.107
BRATIO	0.5482	0.3048	1.799
DSRATIO	0.1258	0.1859	0.677
LSQFT	0.4833	0.0268	17.985
SQFTMISS	3.5771	0.2008	17.808
LAG1BUYP	-0.0519	0.0558	-0.930
BLD2	-0.0202	0.0248	-0.814
BLD3	-0.0452	0.0422	-1.071
BLD6	0.0455	0.0298	1.527
BLD9	0.0694	0.0569	1.220
FACTFAB	-0.0410	0.0905	-0.454
CENTLAIR	0.1878	0.0158	11.847
BEDRMS	-0.0209	0.0108	-1.928
BATHS	0.0886	0.0153	5.760
AGEHSE	-0.0010	0.0003	-2.699
LLOTSIZE	0.0288	0.0148	1.945
LOTSZMIS	0.2692	0.1338	2.013
POOL	0.0636	0.0592	1.074
GARAGE1	0.0769	0.0144	5.311
GARAGE2	0.2004	0.0160	12.530
BRICK	0.0679	0.0126	5.373
MEDINT	0.0138	0.0077	1.787
INT0	-0.0169	0.0064	-2.617
NEW	0.0574	0.0281	2.041
TIME82	-0.1860	0.0250	-7.440

Number of Observations: 1,146
R^2: 0.7962
Root MSE: 0.31364

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

in the arithmetic specification. Because regression coefficients in specifications in which the dependent variable is in arithmetic (rather than logarithmic) form are interpreted in dollar terms, coefficients may vary according to variations in the general cost of living. In the semilogarithmic specification, however, permitting differences in the intercept across observation intervals may be adequate to handle differences in the cost of living. In regression specifications utilizing the log of the sales price as the dependent variable, coefficients are interpreted as impacts on relative prices, which should be invariant with respect to changes in the general price level.

A second potential source of differences in parameters across observation intervals is in the strength of the housing market. As noted earlier, the impact of temporary buydowns on house prices may well differ with the strength of the market. The effects of other features of the home may similarly vary with market conditions. Although we include variables that attempt to correct for differences in the strength of the housing market, these variables are probably inadequate proxies for variation in housing demand. Estimating over separate observation intervals helps correct for this inadequacy by measuring effects within a less varied housing market.

It is possible in principle to test jointly for equality of non-intercept coefficients, and thus for the appropriateness of aggregation across observation intervals. Standard F-tests fail to reject the hypothesis of equality at the five percent level in three of the four cases. The exceptional case is San Antonio in the semilogarithmic specification, where equality is rejected at the one percent level.[21] Even though these tests do not generally reject aggregation, they are, nonetheless, fairly weak tests in this context; they are designed to reject a null hypothesis of equality only when there is strong evidence against it.

Because the focus of this study is on the capitalization of buydowns, and because such effects may vary with market strength, we have also tested for equality of the buydown

[21] The relevant F-statistics are as follows for the arithmetic regressions (the Table 7 series): F(21,983) = 0.56 for Phoenix; F(20,1101) = 1.31 for San Antonio. For the semilogarithmic specifications in the Table 8 series, we find F(21,983) = 0.64 for Phoenix; F(20,1101) = 2.06 for San Antonio.

coefficient alone (*i.e.*, VBO or BRATIO) across the two observation intervals within San Antonio and Phoenix. Equality of the buydown effect across observation intervals is rejected for Phoenix in both the arithmetic and semilogarithmic specifications, but equality is not rejected in either specification for San Antonio.[22]

Because some of the test statistics suggest that the data do not wholeheartedly support aggregation, we urge caution in utilizing the pooled sample regression results in Tables 7f and 7g and Tables 8f and 8g. Within this context, the results in the pooled samples are viewed as useful summaries that may hide true underlying differences. Our discussion encompasses both the aggregated and the disaggregated results.

The coefficients on the buydown variables VBO (Table 7) and BRATIO (Table 8) are of primary interest and are discussed first. We note that the coefficients are generally though not always similar in the arithmetic and semilogarithmic specifications.[23] Although estimates are generally positive, as expected, there is an exception—Denver homes in the semilogarithmic specification. Note, however, that the t-statistic indicates that the Denver buydown coefficient is insignificantly different from zero; that is, the effect of the buydown on price can not be distinguished from zero. Estimated effects also tend to be smaller than one, indicating less than full capitalization of the value of the buydown into the house price. Once again there is an exception: in both specifications Phoenix homes in 1982 exhibit statistically significant capitalization at a rate almost double that necessary for full capitalization (Tables 7a and 8a). As argued above, more than full capitalization (a coefficient exceeding one) is surely possible if buydowns are used primarily to help homebuyers qualify for larger mortgages, rather than to reduce the time the home is on the market.

Because buydowns generally appear to be capitalized into sales prices at less than full

[22]The relevant t-statistics for testing equality of coefficients across the two observation intervals are as follows: for Phoenix, 2.68 in the arithmetic specification and 2.40 for the semilogarithmic specification; for San Antonio, 1.05 in the arithmetic specification and 0.12 in the semilogarithmic specification.

[23]Note that the interpretation of the coefficients on VBO and BRATIO is identical in the two specifications: the fraction of the present value of the buydown that is reflected in increased sales price of the home. The interpretation of coefficients on discount points paid by the seller (DISCSELL and DSRATIO) is also identical across specifications.

value, gains to the seller in other ways must make up the difference between partial and full capitalization. That is, sellers will not be willing to part with homes at prices that capture less than the full present value of the buydown unless there is some offsetting gain elsewhere: reduced holding costs from a more rapid sale, benefits from keeping stable advertised prices, etc. When we find that capitalization rates in general are in the range of, say, 50 to 75 percent, the implication is that these other gains to the seller must amount to at least 25 to 50 percent of the buydown amount.

It should be emphasized that even if there is no buydown capitalization—*i.e.*, gains to sellers from reduced holding costs, etc., are at least as large as the buydown amount—this would not imply that buydowns have no effect on the subsequent termination behavior of mortgages. Even in the absence of buydown capitalization, mortgage payments increase when the buydown is exhausted, possibly causing the buyer to reassess the home purchase in light of the higher required payment stream. The result may be a tendency towards mortgage termination—either prepayment or default.

The finding of a zero or negative impact of buydowns on house prices in Denver is possible though, as argued above, unlikely. Indeed, the arithmetic specification for the same sample yields an imprecisely measured positive effect. Nonetheless, this anomalous finding for Denver may be indicative of econometric problems that permeate all of our samples but that happen to occur with especially great force for one specification and one sample. One likely possibility is that our regressions incorrectly omit determinants of house prices that are especially important in some time periods and cities, and these omitted factors happen to be correlated with the size of buydowns (*i.e.*, larger buydown amounts are associated with lower values of those price-enhancing features that are omitted from the regression). The buydown amount then picks up part of the impact of the omitted variable, resulting in a downward bias in the estimated buydown effect. Attempts to introduce additional controls for home quality or the strength of the housing market met with little success, however.

An alternative explanation is that there is a simultaneous relationship between the size of the buydown and the price of the home. That is, the list of explanatory variables may be adequate to explain house prices, but the size of the buydown may depend (negatively) on house prices and other factors. This seems especially likely if buydowns tend to be offered mainly to lower income buyers who tend to purchase lower priced homes. Simultaneity bias reflects the spurious negative correlation between the buydown variable and the house price. Utilizing an instrumental variables procedure in which mortgagor's income and personal characteristics were used as instruments for the buydown amount failed to offer any substantial improvement.

While the latter econometric problems may have affected our estimates, prior reasoning suggests that capitalization effects may well differ across markets even if they are unlikely to be negative. In fact, even aside from the Denver anomaly, estimated capitalization rates in Tables 7 and 8 appear to differ across samples. As noted above, for example, estimated buydown effects differ significantly across the two observation intervals in Phoenix. Indeed, in the arithmetic specification, the estimate for Phoenix in 1982 is significantly different from the estimates in each of the other samples. Such empirical evidence, together with theoretical reasoning, suggests the possibility that capitalization effects may vary *within* the separate observation intervals as well. Even within each observation interval, unmeasured differences in market strength within more narrowly defined local housing markets and unobserved differences in buyer and seller motivation may cause differences in buydown effects. To allow for this possibility, we interacted the buydown amount with measures of market strength (MEDINT or LAG1BUYP) and proxies for buydown motivation (buyer's income). These attempts to parameterize differences in capitalization effects were generally unsuccessful.

To summarize, aside from the aforementioned rather typical caveats regarding potential biases or weaknesses in the statistical methodology, our findings highlight two salient features of buydown capitalization. First, temporary buydowns are generally capitalized into sales prices, but typically at less than full present value. Second, buydown effects differ across samples, a finding that we interpret as reflecting differences in the strength of housing markets and differences in the motivation for buydowns. With a more detailed and precise specification of the latter factors, one may be able to explain both cross-sample and within-sample variation in capitalization effects.

It is of interest to compare the capitalization estimates obtained here with those found in the default study (Cotterman [1992]) that comprises the second part of this project. Utilizing the same data base, the default study estimates an implied capitalization rate by contrasting default behavior under buydowns with that in the absence of buydowns. The findings there are that capitalization rates are typically around 100 percent, and thus somewhat larger than those generally found in the current study. The findings are broadly consistent with each other, and the differences that do exist can probably be attributed to the different biases associated with the two very different methodologies. In particular, estimated capitalization effects reported in this paper seem likely to be somewhat downward biased, as noted above. As discussed in the companion report, however, implied capitalization rates in the default study may be upward biased estimates of true structural parameters if buyers utilizing temporary buydowns have a higher default proclivity even in the absence of buydowns.

Turning to other variables, most other coefficient estimates appear to be generally reasonable, but there are, of course, anomalies. The likely explanation is again spurious correlations induced by an inadequate list of variables to capture both differences in home quality and variations in the strength of the local housing market.

A few additional comments and cautions are in order to help in interpreting these other coefficient estimates. First, as a general matter, we again emphasize that in Tables 7a through 7g the coefficients on house characteristics are interpreted as dollar values. For example, the coefficient on central air conditioning (CENTLAIR) gives the implied estimated dollar increase in price from adding that feature to an otherwise identical home. Similarly, the coefficient on SQFT shows the estimated effect on price from adding an additional square foot of interior space (holding constant other explanatory factors).

In contrast, and as explained above, coefficients on house characteristics from the semilogarithmic form underlying Tables 8a through 8g are, with some exceptions, interpreted as proportionate increases in house prices generated by a unit change in the house characteristic. For example, the coefficient on CENTLAIR is now the proportionate increase (or, when multiplied by 100, the percentage increase) in house prices associated with adding central air conditioning, other things the same. The exceptions occur for the variables LSQFT and LLOTSIZE. In the case of LSQFT, for example, the coefficient estimate is the estimated percentage increase in price associated with a one percent increase in interior square footage. (The interpretation of LLOTSIZE is analogous.)

Finally, coefficients on missing value indicators (*e.g.*, SQFTMISS) give, for cases missing the associated variable (*e.g.*, SQFT), the average difference between the observed dependent variable (price or the log of price) and a predicted dependent variable based on the remaining explanatory variables. In other words, we may think of the coefficient estimate on SQFTMISS in the following way. Consider all cases in which SQFT is missing, and for each of these cases form the predicted house price based on the values of the remaining independent variables. Deducting this predicted house price from the observed house price for each of these cases, and averaging the result, gives the average contribution of SQFT to house price among these missing value cases. The coefficient on SQFTMISS is this average contribution of SQFT to house price among those cases with missing values for the SQFT variable.

VI. CONCLUSIONS

Prior reasoning suggests that temporary buydowns are potentially valuable features of sales transactions; part or all of the dollar value may be capitalized in the sales price of the home. When buydowns are offered primarily to help buyers qualify for larger loans than they otherwise would, sales prices may be higher by more than the present value of the buydown. Because buydowns may reduce time on the market, however, sellers may find it profitable to accept less than full capitalization in exchange for savings from a quicker sale. When buydowns are used primarily as a means of avoiding public disclosure of price reductions or as a means of temporarily lowering prices, less than full capitalization is the likely outcome. If the mixture of motivations for offering buydowns differs from time to time and place to place, it would not be surprising to find capitalization effects that differ across time periods and cities.

The empirical work has attempted to identify capitalization effects by estimating hedonic price regressions in five samples of FHA-insured sales transactions: Phoenix in 1982 and 1985/86, Denver in 1982, and San Antonio in 1982 and 1985/86. The empirical findings in this report strongly suggest that temporary buydowns are at least partially capitalized into the sales prices of homes. We estimate that the sales price of the house is generally higher by about 50 to 75 percent of the present value of the buydown. The extent to which capitalization rates fall short of 100 percent places a lower bound on the gains that sellers must obtain in other dimensions: reduced holding costs from quicker sales, benefits from stable advertised prices, and so forth must generally amount to at least 25 to 50 percent of the buydown amount.

The estimated capitalization rates reported here are broadly consistent with, but somewhat below, the capitalization rates reported in the companion study of default (Cotterman [1992]). Implied capitalization rates from the default study, as revealed in ultimately higher default rates for homes purchased under temporary buydown arrangements, are typically on the order of 100 percent. Differences between the two sets of estimates are likely traceable to differences in underlying methodologies, each of which contains its own set of biases.

The evidence here points to substantial variation in the capitalization effect over time and across cities. For example, the estimated capitalization rate for Phoenix in 1982 is nearly 2, which is significantly larger than the rate of about 0.5 that is estimated for this same city in 1985/86. One interpretation of these differing effects is that they are traceable to different reasons for the presence of buydowns and differences in the strength of the housing market.

This logic suggests that capitalization effects may vary within the samples used for estimation in this paper, though this variation is buried in the average effect estimated for each individual sample. By utilizing better and more detailed measures of the strength of local housing markets, together with better proxies for possible motivations for buydowns, one may be able to estimate the way in which capitalization rates vary with these forces, thus explaining both the cross-sample differences uncovered in this study, as well as potentially hidden within-sample variation.

BIBLIOGRAPHY

Agarwal, Vinod B. and Richard A. Phillips. "The Effect of Mortgage Rate Buydowns on Housing Prices: Recent Evidence from FHA-VA Transactions." *Journal of the American Real Estate & Urban Economics Association* 11, no. 4 (Winter 1983): 491–503.

____________. "Mortgage Rate Buydowns: Further Evidence." *Housing Finance Review* 3, no. 2 (April 1984): 191–97.

Asabere, Paul K. "The Value of a Neighborhood Street with Reference to the Cul-de-Sac." *The Journal of Real Estate Finance and Economics* 3, no. 2 (June 1990): 185–93.

Asabere, Paul K., George Hachey, and Steven Grubaugh. "Architecture, Historic Zoning, and the Value of Homes." *The Journal of Real Estate Finance and Economics* 2, no. 3 (September 1989): 181–95.

Brueckner, Jan K. "Creative Financing and House Prices: A Theoretical Inquiry into the Capitalization Issue." *Journal of the American Real Estate & Urban Economics Association* 12, no. 4 (Winter 1984): 417–26.

Clauretie, Terrence M. "A Note on the Bias in House Price Capitalization Models." *Journal of the American Real Estate & Urban Economics Association* 11, no. 4 (Winter 1983): 521–24.

Cotterman, Robert F. "Evaluating Financial Terms in Hedonic House Price Regressions." Unicon Research Corporation Working Paper, December 1991.

____________. "Seller Financing of Temporary Buydowns, Part 2: Effects on Mortgage Default." Unicon Research Corporation, November 1992.

Durning, Dan and John M. Quigley. "On the Distributional Implications of Mortgage Revenue Bonds and Creative Finance." *National Tax Journal* 38, no. 4 (December 1985): 513–23.

Foster, and Robert Van Order. "An Option-Based Model of Mortgage Default." *Housing Finance Review* 3 (October 1984): 351–72.

Harris, Jack C. "The Effect of Real Rates of Interest on Housing Prices." *The Journal of Real Estate Finance and Economics* 2, no. 1 (February 1989): 47–60.

Jaffee, Dwight M. "Creative Finance: Measures, Sources, and Tests." *Housing Finance Review* 3, no. 1 (January 1984): 1–18.

Pace, R. Kelly and Otis W. Gilley. "Estimation Employing a Priori Information Within Mass Appraisal and Hedonic Pricing Models." *The Journal of Real Estate Finance and Economics* 3, no. 1 (March 1990): 55–72.

Schwartz, Jr., Arthur L. and Steven D. Kapplin. "Economic Implications of Alternative Home Financing." *Housing Finance Review* 3, no. 2 (April 1984): 165–75.

Sirmans, G. Stacy, Stanley D. Smith, and C.F. Sirmans. "Assumption Financing and Selling Price of Single-Family Homes." *Journal of Financial and Quantitative Analysis* 18, no. 3 (September 1983): 307–17.

Sirmans, G. Stacy, C.F. Sirmans, and Stanley D. Smith. "The Issues and Implications of Creative Financing and House Prices: A Survey." *Property Tax Journal* 4, no. 4 (December 1985): 383–415.

Zerbst, Robert H. and William B. Brueggeman. "FHA and VA Mortgage Discount Points and Housing Prices." *The Journal of Finance* 32, no. 5 (December 1977): 1766–73.

Zuehlke, Thomas W. "Transformations to Normality and Selectivity Bias in Hedonic Price Functions." *The Journal of Real Estate Finance and Economics* 2, no. 3 (September 1989): 173–80.

APPENDIX

A DIGRESSION ON THE USEFULNESS OF THE HEDONIC PRICE REGRESSION AS AN APPRAISAL TOOL

Although the major purpose in gathering the data for this study was to examine buydowns, HUD anticipated the possibility of using the resulting data to study other phenomena as well. For this reason, far more information was gathered than was utilized in the regressions presented above. In this appendix we assess briefly the possibility of utilizing more detailed information on house and neighborhood characteristics to estimate hedonic regressions that could be used for appraising homes.

Tables 11 and 12 parallel Tables 7 and 8 but include a much more extensive and detailed list of control variables. Variable definitions for all variables—both the new variables used here as well as those used earlier—are presented in Table 9, and summary statistics for the complete set of variables are presented in Table 10.

The interpretation of coefficients on variables that are common to both the old and new specifications is generally similar, except that the usual "other things the same" proviso includes more "other things" in the more detailed specifications in Tables 11 and 12. In a few instances, the change in interpretation is nontrivial and deserves explicit mention. One such instance is the interpretation of variables related to numbers of rooms. For both Tables 11 and 12, the specification now includes separate entries for the number of rooms (ROOMS), as well as the number of bathrooms (BATHS) and the number of bedrooms (BEDRMS). The conceptual experiment underlying each coefficient is to increase each variable by one unit while holding constant the others. Hence, in Table 11 the coefficient on BATHS measures the estimated dollar effect on house prices of adding an additional bathroom, while holding constant the number of bedrooms and the number of rooms in total. Thus, the coefficient implicitly asks the impact on house price of substituting a bathroom for another room, other than a bedroom. The interpretation of the coefficient on BEDRMS is similar: the impact on house price of substituting a bedroom for a room other than a bathroom. The

TABLE 9

Extended List of Variable Definitions and Abbreviations

Variable Abbreviation	Variable Definition
VBO	The present discounted value of the monthly buydown payments using the mortgage interest rate as the discount rate.
BRATIO	The present discounted value of the monthly buydown payments (VBO) divided by the sales price of the home.
DISCSELL	Discount points paid by the seller.
DSRATIO	Discount points paid by the seller (DISCELL) divided by the sales price of the home.
LAG1BUYP	One month lag in the fraction of FHA-insured homes in that office which sell with temporary buydowns.
SQFT	Square footage of home.
LSQFT	Log of square footage of home.
SQFTMISS	Indicator variable = 1 if square footage is missing.
FACTFAB	Indicator variable = 1 if factory fabricated home.
CENTLAIR	Indicator variable = 1 if central air conditioned.
FIREPL	Indicator variable = 1 if fireplace is present .
GOODCOND	Indicator variable = 1 if home in generally good condition (rather than average or poor) according to appraiser.
GDRMSIZE	Indicator variable = 1 if room sizes and layout are good (as opposed to average or poor) in opinion of appraiser.
BEDRMS	Number of bedrooms.
BATHS	Number of bathrooms.
ROOMS	Number of rooms.
AGEHSE	Age of house in years.
LOTSIZE	Size of lot in square feet.
LLOTSIZE	Log of LOTSIZE.
LOTSZMIS	Indicator variable = 1 if lot size is missing.
RANGE	Indicator variable = 1 if range is present.
REFRIG	Indicator variable = 1 if refrigerator is present.
DISHW	Indicator variable = 1 if dishwasher is present.
WASHDRY	Indicator variable = 1 if clothes washer or dryer is present.
GARBDISP	Indicator variable = 1 if garbage disposal is present.
ALARM	Indicator variable = 1 if alarm is noted on appraisal report.
SECSYS	Indicator variable = 1 if security system is present.
FENCE	Indicator variable = 1 if fence is present.
PATIO	Indicator variable = 1 if patio is present.
POOL	Indicator variable = 1 if swimming pool is present.
CARPORT1	Indicator variable = 1 if single-car carport is present.

TABLE 9
(Continued)

Variable Abbreviation	Variable Definition
GARAGE1	Indicator variable = 1 if single-car garage is present.
CARPORT2	Indicator variable = 1 if two-car carport is present.
GARAGE2	Indicator variable = 1 if two-car garage is present.
MICROWV	Indicator variable = 1 if microwave oven is present.
HRDWDFLR	Indicator variable = 1 if hardwood floors.
CONC	Indicator variable = 1 if foundation is concrete but not slab.
SLAB	Indicator variable = 1 if home is on slab.
BRICK	Indicator variable = 1 if brick exterior.
URBAN	Indicator variable = 1 if urban area.
RURAL	Indicator variable = 1 if rural area.
MISNEIGH	Indicator variable = 1 if neighborhood information is missing.
NEW	Indicator variable = 1 if home classified as new.
TIME82	Indicator variable = 1 if from 1982 time period.
MEDINT	Median interest rate on new 30-year FHA loans during the month in which sales transaction occurred.
INT0	Interest rate on mortgage note.
BLDi	Indicator variable = 1 if a new home constructed by large builder i, i = 1,...,9.
Countyi	Indicator variable = 1 if home is in county or city i. Counties/cities include Adams County (ADAMS), Arvanda (ARVANDA1 and ARVANDA2), Aurora (AURORA1 and AURORA2), Arapahoe County (ARAPAHOE), Englewood (ENGLEWD), Littleton (LTTLETON), Littleton South East (LTTLTNSE), Denver County (DENVERCO), Denver(DENVER), Douglas County (DOUGLAS), Jefferson County (JEFFERSN), and Lakewood (LAKEWOOD) for the Denver Office; Bexar (BEXAR), San Antonio (SANANTON), Comal County (COMAL), and Guadalupe County (GUADALUP) for the San Antonio Office; and Glendale (GLENDALE), Mesa (MESA), Phoenix (PHOENIX), Scottsdale (SCOTTSDL), Tempe (TEMPE), Avondale (AVONDALE), Chandler (CHANDLER), Gilbert (GILBERT), Goodyear (GOODYEAR), Kyrene (KYRENE), Litchfield Park (LTCHFLD), Paradise City (PRDISCTY), Peoria (PEORIA), Tolleson (TOLLESON), Youngstown (YNGSTWN), and other Maricopa County (PTHRMAR) in the Phoenix Office. Unknown counties are designated by UNKCNTY.

TABLE 10

Extended List of Variable Means and Standard Deviations

	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
VBO	333.3464	1124.983	687.0658	7090.025	709.4595	1828.607	315.9719	847.159	811.4262	3300.589
LAG1BUYP	0.075252	0.062387	0.164922	0.741130	0.162173	0.199516	0.095946	0.128403	0.157651	0.410598
DISCSELL	3315.187	4057.355	2102.092	11772.53	3016.935	3676.374	3023.306	3217.237	2137.4	6352.548
SQFT	1345.620	437.8234	1397.681	1622.918	1216.635	565.2839	1208.557	371.3731	1311.494	920.0498
SQFTMISS	0	0	0.00166	0.186968	0.001168	0.047737	0.017199	0.130172	0.003942	0.143628
BLD1	0	0	0.047619	0.977557	0	0	0	0	0	0
BLD2	0	0	0	0	0	0	0.22604	0.418782	0.054974	0.522414
BLD3	0	0	0	0	0	0	0	0	0.017552	0.300982
BLD4	0.001969	0.052006	0.016980	0.593071	0	0	0	0	0	0
BLD5	0	0	0	0	0.147623	0.495668	0	0	0	0
BLD6	0	0	0.010375	0.46514	0	0	0	0	0.042237	0.46098
BLD7	0	0	0.032663	0.815952	0	0	0	0	0	0
BLD8	0.019694	0.162992	0.012442	0.508836	0.03244	0.247594	0	0	0	0
BLD9	0.001969	0.052006	0.009523	0.445834	0	0	0	0	0.008776	0.213775
FACTFAB	0.001969	0.052006	0.003323	0.264193	0.001168	0.047737	0.002457	0.049568	0.003089	0.127196
CENTLAIR	0.798270	0.470732	0.906604	1.335728	0.080177	0.379469	0.565110	0.496352	0.718215	1.03109
FIREPL	0.231365	0.494679	0.33489	2.166432	0.457596	0.696146	0.37100	0.4836	0.541051	1.142127
GOODCOND	0.631260	0.565951	0.351284	2.191303	0.686353	0.648323	0.678132	0.467767	0.597331	1.124073
GDRMSIZE	0.333477	0.553038	0.212170	1.876741	0.432367	0.692241	0.395577	0.489576	0.35424	1.096222
BEDRMS	2.944236	0.785358	2.983902	2.923407	2.635898	1.085835	2.776412	0.605096	2.896977	1.256284
BATHS	1.734258	0.562070	1.911669	1.715654	1.580752	0.89595	1.51597	0.501589	1.722162	1.162338
ROOMS	5.697358	1.368832	5.804659	5.165608	5.524048	1.704161	5.624078	1.066142	5.751812	2.329965
AGEHSE	14.25251	20.18344	9.594012	59.21045	19.01273	30.77477	20.299	20.85224	17.16697	43.41629
LOTSIZE	8737.524	9591.956	6332.841	34606.82	6383.893	22983.84	8286.364	4971.219	7690.766	12071.42
LOTSZMIS	0.11109	0.368631	0.234065	1.943616	0.28871	0.633220	0.019656	0.138986	0.068455	0.578785
WASHDRY	0.044284	0.241327	0.085543	1.28387	0.134574	0.476862	0.063882	0.244843	0.07619	0.608090
RANGE	0.84726	0.42198	0.935446	1.128018	0.772964	0.585361	0.648648	0.477980	0.762518	0.975333
REFRIG	0.053794	0.26465	0.053608	1.033943	0.350098	0.666525	0.095823	0.294710	0.10548	0.704044
DISHW	0.561240	0.582106	0.804693	1.819781	0.461482	0.696586	0.525798	0.499948	0.660288	1.085512

TABLE 10
Extended List of Variable Means and Standard Deviations
(Continued)

	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
GARBDISP	0.621712	0.568879	0.8257	1.741400	0.722051	0.625984	0.511056	0.50049	0.655552	1.089147
FENCE	0.550287	0.58354	0.716438	2.068993	0.044888	0.289330	0.361179	0.480933	0.358420	1.09909
ALARM	0.007108	0.098551	0	0	0.010146	0.140035	0.014742	0.120666	0.106971	0.708401
SECSYS	0	0	0	0	0	0	0.002457	0.049568	0.068223	0.577879
PATIO	0.406197	0.576108	0.447247	2.282366	0.143945	0.490509	0.280098	0.449599	0.385644	1.115620
POOL	0.075214	0.309376	0.145042	1.616462	0.003639	0.084147	0.007371	0.085642	0.006674	0.186627
CARPORT1	0.300334	0.537727	0.192858	1.811090	0.035399	0.258209	0.066339	0.249180	0.056289	0.528257
GARAGE1	0.084630	0.326495	0.076072	1.216963	0.373099	0.675786	0.321867	0.467767	0.273856	1.022081
CARPORT2	0.255955	0.511913	0.17039	1.72587	0.002866	0.074709	0.034398	0.182473	0.015601	0.284043
GARAGE2	0.287897	0.531135	0.525285	2.29223	0.432579	0.692282	0.434889	0.496352	0.538773	1.142545
MICROWV	0.013448	0.135118	0.024701	0.712486	0.013013	0.158359	0.02702	0.162361	0.056484	0.529118
HRDWDFLR	0	0	0.002046	0.207449	0.289690	0.633853	0.191646	0.394080	0.085561	0.641105
CONC	0.012679	0.131249	0.007801	0.403861	0.850838	0.497793	0.007371	0.085642	0	0
SLAB	0.985350	0.140933	0.587769	2.259538	0.081424	0.382149	0.710073	0.454286	0.827671	0.865607
BRICK	0.030498	0.201710	0.02348	0.695174	0.317346	0.650376	0.191646	0.394080	0.248607	0.990611
MEDINT	15.33573	0.916916	11.46063	4.820032	14.88995	1.658305	15.25798	0.692876	11.4614	2.461474
INT0	13.73682	1.810494	10.80514	5.618838	13.70661	1.886108	13.97113	1.497924	10.64856	3.29180
NEW	0.143769	0.411569	0.436167	2.276395	0.266973	0.618146	0.304668	0.460833	0.232461	0.968141
URBAN	0.593465	0.576184	0.289817	2.082540	0.335713	0.659872	0.48402	0.500359	0.466181	1.14337
RURAL	0.015849	0.146505	0.008186	0.413621	0.016451	0.177745	0.009828	0.098769	0.007753	0.201029
MISNEIGH	0.007108	0.098551	0.405871	2.254138	0.012087	0.152695	0.014742	0.120666	0.005821	0.174368
UNKCNTY	0	0	0.007436	0.394384	0.002866	0.074709	0.009828	0.098769	0.000757	0.063058
ADAMS	0	0	0	0	0.106180	0.430472	0	0	0	0
ARVANDA1	0	0	0	0	0.004808	0.096659	0	0	0	0
AURORA1	0	0	0	0	0.019427	0.192860	0	0	0	0
ARAPAHOE	0	0	0	0	0.153391	0.503546	0	0	0	0
AURORA2	0	0	0	0	0.021234	0.201445	0	0	0	0
ENGLEWD	0	0	0	0	0.015148	0.170676	0	0	0	0
LTTLETON	0	0	0	0	0.01532	0.171649	0	0	0	0

TABLE 10
Extended List of Variable Means and Standard Deviations
(Continued)

	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
LTTLTNSE	0	0	0	0	0.012087	0.152695	0	0	0	0
DENVERCO	0	0	0	0	0.178137	0.534656	0	0	0	0
DENVER	0	0	0	0	0.164541	0.518080	0	0	0	0
DOUGLAS	0	0	0	0	0.087730	0.395307	0	0	0	0
JEFFERSN	0	0	0	0	0.198298	0.557138	0	0	0	0
ARVANDA2	0	0	0	0	0.001698	0.05753	0	0	0	0
LAKEWOOD	0	0	0	0	0.019124	0.191379	0	0	0	0
BEXAR	0	0	0	0	0	0	0.746928	0.435306	0.904779	0.672743
SANANTON	0	0	0	0	0	0	0.203931	0.403414	0.054086	0.518423
COMAL	0	0	0	0	0	0	0.017199	0.130172	0.02179	0.334639
GUADALUP	0	0	0	0	0	0	0.022113	0.147232	0.018584	0.309534
GLENDALE	0.083092	0.083092	0.164504	1.701792	0	0	0	0	0	0
MESA	0.156244	0.156244	0.150059	1.63935	0	0	0	0	0	0
PHOENIX	0.522526	0.522526	0.416353	2.262830	0	0	0	0	0	0
SCOTTSDL	0.038807	0.038807	0.053529	1.033231	0	0	0	0	0	0
TEMPE	0.064504	0.064504	0.050069	1.001098	0	0	0	0	0	0
AVONDALE	0.005139	0.005139	0.000604	0.112796	0	0	0	0	0	0
CHANDLER	0.069550	0.069550	0.071875	1.185601	0	0	0	0	0	0
GILBERT	0.021326	0.021326	0.01485	0.555278	0	0	0	0	0	0
GOODYEAR	0	0	0.004093	0.293077	0	0	0	0	0	0
KYRENE	0.006339	0.006339	0	0	0	0	0	0	0	0
LTCHFLD	0	0	0.00166	0.186968	0	0	0	0	0	0
PRDISCTY	0	0	0.00166	0.186968	0	0	0	0	0	0
PEORIA	0.013448	0.013448	0.05156	1.015174	0	0	0	0	0	0
TOLLESON	0	0	0.002650	0.236022	0	0	0	0	0	0
YNGSTWN	0.003169	0.003169	0	0	0	0	0	0	0	0
OTHRMAR	0.015849	0.015849	0.009078	0.435381	0	0	0	0	0	0
PRICE	60180.09	60180.09	73794.49	77817.99	72354.80	21225.5	47415.14	19240.75	60973.70	43299.7
BRATIO	0.005008	0.005008	0.009220	0.091455	0.009578	0.024627	0.005729	0.014885	0.011693	0.046300

TABLE 10
Extended List of Variable Means and Standard Deviations
(Continued)

	PHOENIX				DENVER		SAN ANTONIO			
	1982		1985/86		1982		1982		1985/86	
Variable	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
DSRATIO	0.054045	0.056405	0.028393	0.14803	0.043259	0.051479	0.057073	0.042574	0.03315	0.088962
LSQFT	7.165861	0.328687	7.201427	1.768347	7.047431	0.547235	6.956574	0.959081	7.118646	1.190729
LLOTSIZE	8.051653	3.372329	6.829494	17.394	6.358552	5.681079	8.789682	1.293408	8.314850	5.234961
LNPRICE	10.95896	0.366178	11.18126	1.104574	11.16618	0.306906	10.67941	0.428944	10.96531	0.768316
APPRVALU	61889.356	21103.356	76103.709	82548.723	71767.009	21365.832	47836.285	19134.330	62267.883	44029.078
PRICEHAT	60226.628	19087.275	73701.093	70824.282	72354.800	17853.451	47415.144	18286.118	60973.702	38728.918

TABLE 11a

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

PHOENIX 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	27160.000	16238.990	1.672
VBO	2.028	0.434	4.667
LAG1BUYP	6215.000	12128.613	0.512
DISCSELL	0.215	0.150	1.432
SQFT	20.373	2.844	7.161
BLD4	-6465.873	8697.722	-0.743
BLD8	-1220.570	3540.400	-0.345
BLD9	4111.538	8861.326	0.464
FACTFAB	-7067.709	8648.226	-0.817
CENTLAIR	3833.240	1293.176	2.964
FIREPL	2871.001	1077.180	2.665
GOODCOND	2421.116	936.933	2.584
GDRMSIZE	2272.443	1007.191	2.256
BEDRMS	-1019.554	1044.146	-0.976
BATHS	1734.639	1288.832	1.346
ROOMS	864.681	856.362	1.010
AGEHSE	-33.237	35.283	-0.942
LOTSIZE	0.223	0.087	2.549
LOTSZMIS	164.184	1548.777	0.106
WASHDRY	508.347	2903.196	0.175
RANGE	1014.835	1292.218	0.785
REFRIG	-367.209	2497.825	-0.147
DISHW	2069.445	1360.625	1.521
GARBDISP	3073.629	1488.033	2.066
FENCE	-538.354	836.287	-0.644
ALARM	-5369.368	5563.699	-0.965
PATIO	1748.223	864.868	2.021
POOL	6590.636	1638.893	4.021
CARPORT1	2166.346	1583.392	1.368
GARAGE1	4099.001	1877.441	2.183
CARPORT2	3289.786	1844.813	1.783
GARAGE2	6622.026	1908.826	3.469
MICROWV	5872.443	3888.634	1.510
CONC	-11455.000	11029.940	-1.039
SLAB	-7233.226	10425.932	-0.694
BRICK	4091.640	2356.005	1.737

TABLE 11a
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
MEDINT	336.324	720.657	0.467
INT0	-1013.976	363.585	-2.789
NEW	2748.015	1537.001	1.788
URBAN	-724.359	1051.788	-0.689
RURAL	1008.374	4105.252	0.246
MISNEIGH	-2389.546	4752.496	-0.503
GLENDALE	-3601.803	4133.957	-0.871
MESA	-1576.657	3929.156	-0.401
PHOENIX	-1144.363	3963.773	-0.289
SCOTTSDL	4374.895	4403.722	0.993
TEMPE	529.160	4287.569	0.123
AVONDALE	-5470.641	6647.954	-0.823
CHANDLER	-2646.742	4259.678	-0.621
GILBERT	-6275.765	4220.123	-1.487
KYRENE	-4861.802	6323.765	-0.769
PEORIA	-186.501	4868.136	-0.038
YNGSTWN	-2884.840	7903.915	-0.365

Number of Observations: 370

R^2: 0.8587

Root MSE: 8360.59051

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11b

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

PHOENIX 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	37739.000	8352.043	4.519
VBO	0.434	0.236	1.839
LAG1BUYP	-21450.000	8848.810	-2.424
DISCSELL	0.359	0.140	2.556
SQFT	29.688	1.727	17.189
SQFTMISS	59185.000	8240.615	7.182
BLD1	3667.365	1654.440	2.217
BLD4	-2728.039	2566.644	-1.063
BLD6	-2286.157	2995.437	-0.763
BLD7	-2498.634	1878.923	-1.330
BLD8	4851.158	2852.372	1.701
BLD9	5554.808	3135.188	1.772
FACTFAB	-13124.000	5585.595	-2.350
CENTLAIR	4288.236	1317.216	3.256
FIREPL	4123.980	707.219	5.831
GOODCOND	2697.481	952.860	2.831
GDRMSIZE	-258.679	974.411	-0.265
BEDRMS	-1213.841	792.469	-1.532
BATHS	3184.011	1068.898	2.979
ROOMS	-383.180	534.783	-0.717
AGEHSE	-26.568	39.594	-0.671
LOTSIZE	0.122	0.071	1.707
LOTSZMIS	-504.449	991.282	-0.509
WASHDRY	-29.626	1319.804	-0.022
RANGE	-1375.734	1437.343	-0.957
REFRIG	1217.081	1546.008	0.787
DISHW	3080.825	1117.272	2.757
GARBDISP	-2796.401	1216.788	-2.298
FENCE	-1580.786	729.598	-2.167
PATIO	676.256	761.736	0.888
POOL	3988.088	965.232	4.132
CARPORT1	2282.987	1319.630	1.730
GARAGE1	2795.209	1363.451	2.050
CARPORT2	4698.729	1391.969	3.376
GARAGE2	8250.083	1357.680	6.077
MICROWV	-1822.968	1968.812	-0.926

TABLE 11b
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
HRDWDFLR	30883.000	6809.365	4.535
CONC	1762.616	7080.200	0.249
SLAB	-5120.032	6093.912	-0.840
BRICK	111.327	2115.554	0.053
MEDINT	-376.830	526.457	-0.716
INT0	-591.692	475.312	-1.245
NEW	13765.000	3334.472	4.128
URBAN	-1590.616	878.576	-1.810
RURAL	-7406.021	5967.206	-1.241
MISNEIGH	-1864.099	5876.830	-0.317
UNKCNTY	-9933.000	4765.054	-2.085
GLENDALE	-6600.201	3372.652	-1.957
MESA	-3658.340	3391.990	-1.079
PHOENIX	-6254.359	3363.072	-1.860
SCOTTSDL	-208.021	3568.753	-0.058
TEMPE	-3929.183	3606.731	-1.089
AVONDALE	-4492.747	12367.757	-0.363
CHANDLER	-2877.315	3502.543	-0.821
GILBERT	-10053.000	4210.013	-2.388
GOODYEAR	-5284.926	6033.540	-0.876
LTCHFLD	-24694.000	8362.210	-2.953
PRDISCTY	3453.879	7940.178	0.435
PEORIA	-10135.000	3569.358	-2.839
TOLLESON	-4511.209	7502.683	-0.601

Number of Observations: 660
R^2: 0.8235
Root MSE: 34264.20804

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11c

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

DENVER 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	48016.000	7633.852	6.290
VBO	0.260	0.429	0.606
LAG1BUYP	-1135.767	4524.767	-0.251
DISCSELL	-0.143	0.204	-0.705
SQFT	16.364	2.160	7.573
SQFTMISS	17728.000	12587.999	1.408
BLD5	5297.479	2470.153	2.145
BLD8	-6126.574	3212.417	-1.907
FACTFAB	-4170.759	12798.065	-0.326
CENTLAIR	3285.775	1773.987	1.852
FIREPL	4381.879	1166.392	3.757
GOODCOND	4284.009	1095.951	3.909
GDRMSIZE	967.228	1109.896	0.871
BEDRMS	-2730.676	947.113	-2.883
BATHS	2024.361	1026.625	1.972
ROOMS	974.307	798.300	1.220
AGEHSE	-124.120	32.368	-3.835
LOTSIZE	-0.019	0.026	-0.724
LOTSZMIS	1201.311	1586.337	0.757
WASHDRY	3336.238	1374.286	2.428
RANGE	-3246.789	1647.669	-1.971
REFRIG	-2724.100	1103.151	-2.469
DISHW	459.763	1197.371	0.384
GARBDISP	1573.852	1101.890	1.428
FENCE	-3484.610	2279.612	-1.529
ALARM	5230.972	4418.394	1.184
PATIO	1527.785	1340.964	1.139
POOL	-5752.912	7734.956	-0.744
CARPORT1	4687.119	2554.208	1.835
GARAGE1	4912.581	1335.028	3.680
CARPORT2	-12912.000	8052.978	-1.603
GARAGE2	9166.518	1356.469	6.758
MICROWV	9468.959	3899.622	2.428
HRDWDFLR	4150.655	1168.857	3.551
CONC	-1053.253	1816.512	-0.580
SLAB	-4904.132	2377.889	-2.062

TABLE 11c
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
BRICK	2307.720	1040.028	2.219
MEDINT	540.382	421.752	1.281
INT0	-902.622	410.853	-2.197
NEW	1619.426	2146.906	0.754
URBAN	-979.916	1273.940	-0.769
RURAL	4418.174	3848.090	1.148
MISNEIGH	937.108	4081.767	0.230
UNKCNTY	-750.615	8373.151	-0.090
ADAMS	-6190.578	3461.294	-1.789
ARVANDA1	-8821.277	6721.484	-1.312
AURORA1	-1664.927	4422.267	-0.376
ARAPAHOE	-1133.451	3361.594	-0.337
AURORA2	250.166	4419.174	0.057
ENGLEWD	-4749.030	4910.836	-0.967
LTTLETON	3284.872	4951.654	0.663
LTTLTNSE	-2147.360	5046.714	-0.425
DENVERCO	-1661.761	3483.590	-0.477
DENVER	-392.444	3506.362	-0.112
DOUGLAS	1712.998	3697.821	0.463
JEFFERSN	-2053.806	3218.938	-0.638
ARVANDA2	-13428.000	10608.484	-1.266

Number of Observations: 466

R^2: 0.7075

Root MSE: 12240.17841

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11d

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

SAN ANTONIO 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	17198.000	8789.255	1.957
VBO	-0.007	0.474	-0.017
LAG1BUYP	2248.054	2931.350	0.767
DISCSELL	0.541	0.182	2.960
SQFT	26.593	2.096	12.683
SQFTMISS	35690.000	3833.685	9.310
BLD2	-5066.816	1744.137	-2.905
FACTFAB	-15002.000	6736.545	-2.227
CENTLAIR	4193.469	1163.801	3.603
FIREPL	2417.263	992.910	2.435
GOODCOND	1973.151	899.476	2.194
GDRMSIZE	695.593	802.039	0.867
BEDRMS	293.433	823.660	0.356
BATHS	-222.367	1149.807	-0.193
ROOMS	-1036.947	544.475	-1.904
AGEHSE	3.947	23.041	0.171
LOTSIZE	-0.014	0.071	-0.201
LOTSZMIS	134.860	2580.817	0.052
WASHDRY	296.271	1569.176	0.189
RANGE	2585.871	1039.889	2.487
REFRIG	1316.804	1288.360	1.022
DISHW	1875.566	1291.816	1.452
GARBDISP	1697.892	1351.265	1.257
FENCE	344.536	852.391	0.404
ALARM	-2286.251	3016.712	-0.758
SECSYS	10094.000	7279.863	1.387
PATIO	-54.113	921.113	-0.059
POOL	3927.651	4207.050	0.934
CARPORT1	1341.441	1599.384	0.839
GARAGE1	3116.248	1063.108	2.931
CARPORT2	3014.761	2115.649	1.425
GARAGE2	6414.838	1231.422	5.209
MICROWV	-33.464	2117.164	-0.016
HRDWDFLR	2226.900	993.314	2.242
CONC	-2175.595	3879.351	-0.561
SLAB	3902.902	1072.428	3.639

TABLE 11d
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
BRICK	4938.446	994.992	4.963
MEDINT	-51.030	578.525	-0.088
INT0	-1111.785	287.036	-3.873
NEW	5859.270	1545.406	3.791
URBAN	-37.568	713.517	-0.053
RURAL	4230.278	3474.218	1.218
MISNEIGH	-2215.206	2859.969	-0.775
UNKCNTY	1124.054	3947.318	0.285
BEXAR	-415.944	2271.799	-0.183
SANANTON	318.213	2390.776	0.133
COMAL	9183.680	3436.452	2.672

Number of Observations: 407

R^2: 0.9032

Root MSE: 6356.25582

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11e

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

SAN ANTONIO 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	8203.150	5463.130	1.502
VBO	0.446	0.295	1.508
LAG1BUYP	3880.519	4334.290	0.895
DISCSELL	0.342	0.199	1.715
SQFT	7.769	1.100	7.061
SQFTMISS	17170.000	5467.634	3.140
BLD2	-358.512	1902.779	-0.188
BLD3	-1996.546	2962.377	-0.674
BLD6	-994.197	2104.229	-0.472
BLD9	882.747	3751.294	0.235
FACTFAB	-8413.228	6373.291	-1.320
CENTLAIR	3502.722	1248.548	2.805
FIREPL	9275.225	1001.462	9.262
GOODCOND	1392.025	781.809	1.781
GDRMSIZE	428.930	857.968	0.500
BEDRMS	-1376.261	886.516	-1.552
BATHS	4041.557	1061.726	3.807
ROOMS	2450.632	490.251	4.999
AGEHSE	1.710	28.642	0.060
LOTSIZE	0.367	0.084	4.364
LOTSZMIS	3519.327	1498.928	2.348
WASHDRY	2454.338	1725.910	1.422
RANGE	3607.980	1135.365	3.178
REFRIG	-2102.585	1514.597	-1.388
DISHW	5968.728	1367.453	4.365
GARBDISP	-370.724	1285.479	-0.288
FENCE	-1394.361	798.966	-1.745
ALARM	-5264.367	1805.656	-2.915
SECSYS	658.666	1563.281	0.421
PATIO	-191.363	791.704	-0.242
POOL	9295.763	4048.683	2.296
CARPORT1	3034.608	1703.536	1.781
GARAGE1	2415.871	1173.729	2.058
CARPORT2	2308.817	2817.311	0.820
GARAGE2	9767.000	1327.112	7.359
MICROWV	-20.872	1540.154	-0.014

TABLE 11e
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
HRDWDFLR	5092.922	1297.223	3.926
SLAB	878.910	1260.813	0.697
BRICK	3185.606	890.534	3.577
MEDINT	-86.452	591.966	-0.146
INT0	-27.171	521.711	-0.052
NEW	606.704	2152.242	0.282
URBAN	-697.427	722.616	-0.965
RURAL	2437.102	3934.337	0.619
MISNEIGH	-4067.033	4401.803	-0.924
UNKCNTY	-4401.151	12291.667	-0.358
BEXAR	197.689	2569.640	0.077
SANANTON	3772.464	2973.724	1.269
COMAL	-6567.867	3659.292	-1.795

Number of Observations: 738

R^2: 0.8000

Root MSE: 20026.54721

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11f

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

PHOENIX

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	40787.000	6406.864	6.366
VBO	0.465	0.187	2.483
LAG1BUYP	-10300.000	5635.785	-1.828
DISCSELL	0.327	0.108	3.004
SQFT	29.437	1.375	21.408
SQFTMISS	60572.000	6593.976	9.186
BLD1	3452.325	1330.750	2.594
BLD4	-2939.076	2059.785	-1.427
BLD6	-2177.077	2418.295	-0.900
BLD7	-2573.142	1513.432	-1.700
BLD8	4212.214	2242.597	1.878
BLD9	5322.668	2519.004	2.113
FACTFAB	-12221.000	4423.572	-2.763
CENTLAIR	4180.172	1023.659	4.084
FIREPL	4095.040	562.336	7.282
GOODCOND	2776.345	739.197	3.756
GDRMSIZE	-195.375	756.682	-0.258
BEDRMS	-1148.290	626.471	-1.833
BATHS	3113.066	840.484	3.704
ROOMS	-365.673	425.635	-0.859
AGEHSE	-24.966	30.649	-0.815
LOTSIZE	0.117	0.055	2.105
LOTSZMIS	-327.214	784.227	-0.417
WASHDRY	36.042	1055.825	0.034
RANGE	-1272.389	1110.301	-1.146
REFRIG	1081.098	1228.009	0.880
DISHW	3178.346	878.342	3.619
GARBDISP	-2619.277	954.743	-2.743
FENCE	-1594.557	572.808	-2.784
ALARM	-3152.023	14726.264	-0.214
PATIO	685.756	599.061	1.145
POOL	3954.831	768.275	5.148
CARPORT1	2267.728	1038.908	2.183
GARAGE1	2901.413	1079.279	2.688
CARPORT2	4613.695	1097.074	4.205
GARAGE2	8303.238	1070.218	7.758

TABLE 11f
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
MICROWV	-1902.295	1573.234	-1.209
HRDWDFLR	30885.000	5483.396	5.632
CONC	599.384	5452.416	0.110
SLAB	-5801.305	4664.075	-1.244
BRICK	366.528	1661.741	0.221
MEDINT	-455.727	405.776	-1.123
INT0	-763.364	355.997	-2.144
NEW	9185.166	2025.180	4.535
TIME82	-2469.044	1661.697	-1.486
URBAN	-1494.527	691.270	-2.162
RURAL	-6589.732	4491.263	-1.467
MISNEIGH	-1513.615	4466.464	-0.339
UNKCNTY	-9935.000	3797.659	-2.616
GLENDALE	-6562.067	2650.508	-2.476
MESA	-3725.512	2663.594	-1.399
PHOENIX	-6137.250	2641.530	-2.323
SCOTTSDL	-11.263	2808.803	-0.004
TEMPE	-3964.993	2830.894	-1.401
AVONDALE	-6205.608	8792.248	-0.706
CHANDLER	-2946.528	2751.927	-1.071
GILBERT	-10198.000	3283.272	-3.106
GOODYEAR	-5243.573	4791.945	-1.094
KYRENE	-7546.714	15885.459	-0.475
LTCHFLD	-23450.000	6696.516	-3.502
PRDISCTY	3090.191	6383.150	0.484
PEORIA	-9761.000	2807.615	-3.477
TOLLESON	-4477.885	5936.221	-0.754
YNGSTWN	-8144.111	22080.326	-0.369

Number of Observations: 1,030
R^2: 0.8252
Root MSE: 27694.28215

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 11g

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Sales Price of Home

SAN ANTONIO

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	7500.811	4345.269	1.726
VBO	0.404	0.239	1.692
LAG1BUYP	2689.042	3117.002	0.863
DISCSELL	0.344	0.147	2.327
SQFT	8.482	0.898	9.436
SQFTMISS	15027.000	3805.457	3.949
BLD2	-707.542	1367.756	-0.517
BLD3	-2657.468	2414.661	-1.101
BLD6	-695.572	1711.600	-0.406
BLD9	1152.498	3090.748	0.373
FACTFAB	-8733.790	5006.212	-1.745
CENTLAIR	3774.953	974.616	3.873
FIREPL	8743.459	781.541	11.187
GOODCOND	1500.711	622.109	2.412
GDRMSIZE	605.672	663.294	0.913
BEDRMS	-1008.699	686.588	-1.469
BATHS	3811.307	838.695	4.544
ROOMS	2234.824	385.090	5.803
AGEHSE	9.872	21.824	0.452
LOTSIZE	0.296	0.064	4.592
LOTSZMIS	2810.354	1207.495	2.327
WASHDRY	2208.333	1331.110	1.659
RANGE	3503.603	885.027	3.959
REFRIG	-1879.004	1156.564	-1.625
DISHW	5764.783	1061.170	5.432
GARBDISP	-323.890	1009.636	-0.321
FENCE	-1078.874	627.498	-1.719
ALARM	-5257.596	1374.035	-3.826
SECSYS	469.270	1293.631	0.363
PATIO	-167.828	627.809	-0.267
POOL	7026.794	3184.770	2.206
CARPORT1	2754.538	1334.863	2.064
GARAGE1	2549.811	911.199	2.798
CARPORT2	2774.529	2113.646	1.313
GARAGE2	9530.610	1027.165	9.279
MICROWV	262.322	1242.084	0.211

TABLE 11g
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
HRDWDFLR	4564.877	985.249	4.633
CONC	-4705.877	9737.075	-0.483
SLAB	1237.503	968.407	1.278
BRICK	3748.103	701.978	5.339
MEDINT	164.837	425.869	0.387
INT0	-268.951	353.612	-0.761
NEW	1227.320	1523.328	0.806
TIME82	-8763.032	1365.784	-6.416
URBAN	-491.210	566.034	-0.868
RURAL	3244.163	3052.499	1.063
MISNEIGH	-3747.181	3242.196	-1.156
UNKCNTY	-1481.714	6709.312	-0.221
BEXAR	434.362	1997.445	0.217
SANANTON	2895.441	2248.586	1.288
COMAL	-3922.615	2844.066	-1.379

Number of Observations: 1,095
R^2: 0.8095
Root MSE: 16690.11874

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12a

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

PHOENIX 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.8983	0.4858	14.199
BRATIO	1.9420	0.5310	3.657
LAG1BUYP	-0.0439	0.2179	-0.202
DSRATIO	-0.1498	0.1853	-0.809
LSQFT	0.5541	0.0675	8.203
BLD4	-0.0561	0.1548	-0.363
BLD8	0.0154	0.0626	0.246
BLD9	0.0484	0.1564	0.310
FACTFAB	-0.2461	0.1531	-1.607
CENTLAIR	0.1017	0.0229	4.430
FIREPL	0.0501	0.0188	2.657
GOODCOND	0.0475	0.0165	2.871
GDRMSIZE	0.0383	0.0177	2.163
BEDRMS	-0.0213	0.0184	-1.161
BATHS	0.0344	0.0237	1.451
ROOMS	-0.0010	0.0151	-0.071
AGEHSE	-0.0007	0.0006	-1.143
LLOTSIZE	0.0462	0.0247	1.870
LOTSZMIS	0.3938	0.2219	1.775
WASHDRY	0.0167	0.0512	0.328
RANGE	0.0254	0.0228	1.113
REFRIG	-0.0188	0.0438	-0.429
DISHW	0.0206	0.0240	0.861
GARBDISP	0.0633	0.0260	2.433
FENCE	-0.0040	0.0147	-0.274
ALARM	-0.0970	0.0985	-0.984
PATIO	0.0245	0.0152	1.604
POOL	0.1010	0.0290	3.475
CARPORT1	0.0487	0.0280	1.741
GARAGE1	0.0858	0.0332	2.581
CARPORT2	0.0671	0.0326	2.055
GARAGE2	0.1051	0.0336	3.120
MICROWV	0.0539	0.0682	0.791
CONC	-0.2757	0.1954	-1.411
SLAB	-0.1852	0.1847	-1.003
BRICK	0.0954	0.0417	2.290

TABLE 12a
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
MEDINT	-0.0010	0.0127	-0.081
INT0	-0.0225	0.0063	-3.542
NEW	0.0365	0.0272	1.342
URBAN	-0.0201	0.0186	-1.084
RURAL	0.0017	0.0683	0.026
MISNEIGH	-0.0767	0.0840	-0.913
GLENDALE	-0.1154	0.0709	-1.628
MESA	-0.0900	0.0666	-1.350
PHOENIX	-0.0827	0.0675	-1.226
SCOTTSDL	0.0037	0.0758	0.050
TEMPE	-0.0312	0.0733	-0.426
AVONDALE	-0.1595	0.1161	-1.373
CHANDLER	-0.0964	0.0734	-1.313
GILBERT	-0.1326	0.0739	-1.793
KYRENE	-0.0974	0.1095	-0.890
PEORIA	-0.0443	0.0858	-0.516
YNGSTWN	-0.1371	0.1386	-0.990

Number of Observations: 370
R^2: 0.8599
Root MSE: 0.14787

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12b

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

PHOENIX 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.6459	0.2591	25.642
BRATIO	0.3732	0.2473	1.509
LAG1BUYP	-0.2644	0.1203	-2.198
DSRATIO	0.2054	0.1505	1.364
LSQFT	0.5668	0.0344	16.438
SQFTMISS	4.3339	0.2660	16.292
BLD1	0.0430	0.0223	1.923
BLD4	-0.0279	0.0349	-0.801
BLD6	-0.0252	0.0405	-0.623
BLD7	-0.0348	0.0254	-1.367
BLD8	0.0509	0.0386	1.320
BLD9	0.0905	0.0425	2.130
FACTFAB	-0.1676	0.0758	-2.210
CENTLAIR	0.1017	0.0177	5.744
FIREPL	0.0577	0.0095	6.041
GOODCOND	0.0445	0.0129	3.446
GDRMSIZE	-0.0099	0.0131	-0.759
BEDRMS	-0.0234	0.0107	-2.176
BATHS	0.0516	0.0150	3.424
ROOMS	-0.0073	0.0072	-1.010
AGEHSE	-0.0004	0.0005	-0.824
LLOTSIZE	0.0473	0.0170	2.771
LOTSZMIS	0.3939	0.1505	2.617
WASHDRY	0.0030	0.0178	0.170
RANGE	-0.0083	0.0195	-0.428
REFRIG	0.0170	0.0209	0.813
DISHW	0.0552	0.0151	3.648
GARBDISP	-0.0353	0.0164	-2.140
FENCE	-0.0218	0.0098	-2.210
PATIO	0.0119	0.0103	1.160
POOL	0.0604	0.0130	4.648
CARPORT1	0.0349	0.0178	1.950
GARAGE1	0.0447	0.0184	2.422
CARPORT2	0.0612	0.0188	3.251
GARAGE2	0.1117	0.0183	6.088
MICROWV	-0.0153	0.0267	-0.574

TABLE 12b
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
HRDWDFLR	0.3625	0.0923	3.926
CONC	0.0312	0.0959	0.326
SLAB	-0.0342	0.0825	-0.415
BRICK	0.0036	0.0286	0.127
MEDINT	-0.0003	0.0071	-0.050
INT0	-0.0104	0.0064	-1.636
NEW	0.1634	0.0452	3.612
URBAN	-0.0231	0.0118	-1.949
RURAL	-0.0480	0.0662	-0.726
MISNEIGH	0.0374	0.0796	0.470
UNKCNTY	-0.1273	0.0651	-1.955
GLENDALE	-0.0867	0.0464	-1.870
MESA	-0.0511	0.0464	-1.103
PHOENIX	-0.0835	0.0462	-1.807
SCOTTSDL	0.0050	0.0491	0.103
TEMPE	-0.0559	0.0495	-1.129
AVONDALE	-0.0418	0.1678	-0.249
CHANDLER	-0.0426	0.0479	-0.890
GILBERT	-0.1323	0.0575	-2.301
GOODYEAR	-0.0879	0.0804	-1.093
LTCHFLD	-0.3830	0.1136	-3.372
PRDISCTY	0.0385	0.1078	0.357
PEORIA	-0.1290	0.0483	-2.668
TOLLESON	-0.0726	0.0970	-0.749

Number of Observations: 660

R^2: 0.8391

Root MSE: 0.46433

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12c

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

DENVER 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	9.3427	0.3209	29.110
BRATIO	-0.1712	0.4494	-0.381
LAG1BUYP	-0.0478	0.0648	-0.737
DSRATIO	-0.7796	0.2061	-3.781
LSQFT	0.2670	0.0415	6.421
SQFTMISS	1.8334	0.3360	5.456
BLD5	0.0607	0.0353	1.722
BLD8	-0.0673	0.0462	-1.455
FACTFAB	-0.0727	0.1849	-0.393
CENTLAIR	0.0476	0.0253	1.875
FIREPL	0.0667	0.0167	3.982
GOODCOND	0.0671	0.0157	4.275
GDRMSIZE	0.0034	0.0159	0.219
BEDRMS	-0.0282	0.0137	-2.055
BATHS	0.0299	0.0146	2.043
ROOMS	0.0117	0.0112	1.045
AGEHSE	-0.0019	0.0004	-4.197
LLOTSIZE	-0.0204	0.0220	-0.924
LOTSZMIS	-0.1780	0.1996	-0.892
WASHDRY	0.0592	0.0197	2.992
RANGE	-0.0420	0.0236	-1.780
REFRIG	-0.0495	0.0157	-3.149
DISHW	-0.0000	0.0172	-0.003
GARBDISP	0.0362	0.0158	2.288
FENCE	-0.0364	0.0327	-1.111
ALARM	0.0557	0.0636	0.876
PATIO	0.0260	0.0192	1.351
POOL	-0.0736	0.1111	-0.662
CARPORT1	0.0850	0.0366	2.319
GARAGE1	0.0929	0.0192	4.831
CARPORT2	-0.1573	0.1157	-1.360
GARAGE2	0.1435	0.0194	7.382
MICROWV	0.1460	0.0560	2.605
HRDWDFLR	0.0683	0.0167	4.084
CONC	0.0058	0.0261	0.223
SLAB	-0.0445	0.0342	-1.301

TABLE 12c
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
BRICK	0.0334	0.0149	2.237
MEDINT	0.0120	0.0060	1.988
INT0	-0.0163	0.0059	-2.764
NEW	0.0334	0.0304	1.100
URBAN	-0.0168	0.0183	-0.919
RURAL	0.0795	0.0572	1.389
MISNEIGH	-0.0556	0.0589	-0.945
UNKCNTY	0.0157	0.1202	0.131
ADAMS	-0.0630	0.0497	-1.267
ARVANDA1	-0.1373	0.0965	-1.422
AURORA1	-0.0034	0.0635	-0.055
ARAPAHOE	0.0045	0.0482	0.095
AURORA2	0.0069	0.0634	0.110
ENGLEWD	-0.0780	0.0706	-1.105
LTTLETON	0.0624	0.0709	0.881
LTTLTNSE	-0.0085	0.0721	-0.118
DENVERCO	-0.0203	0.0502	-0.406
DENVER	0.0113	0.0503	0.225
DOUGLAS	0.0395	0.0529	0.746
JEFFERSN	0.0019	0.0462	0.042
ARVANDA2	-0.1644	0.1523	-1.080

Number of Observations: 466

R^2: 0.7114

Root MSE: 0.17579

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12d

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.2551	0.4511	13.864
BRATIO	0.3073	0.6298	0.488
LAG1BUYP	0.0371	0.0696	0.533
DSRATIO	-0.2912	0.2921	-0.997
LSQFT	0.6036	0.0633	9.522
SQFTMISS	4.3515	0.4571	9.519
BLD2	-0.0203	0.0420	-0.484
FACTFAB	-0.2836	0.1600	-1.773
CENTLAIR	0.0887	0.0275	3.222
FIREPL	0.0631	0.0233	2.700
GOODCOND	0.0784	0.0213	3.667
GDRMSIZE	0.0085	0.0189	0.450
BEDRMS	-0.0029	0.0194	-0.149
BATHS	-0.0012	0.0272	-0.046
ROOMS	0.0002	0.0128	0.021
AGEHSE	0.0000	0.0005	0.110
LLOTSIZE	0.0270	0.0248	1.088
LOTSZMIS	0.2554	0.2311	1.106
WASHDRY	-0.0428	0.0371	-1.154
RANGE	0.0879	0.0246	3.562
REFRIG	0.0467	0.0304	1.535
DISHW	0.0463	0.0307	1.509
GARBDISP	0.0584	0.0320	1.822
FENCE	0.0036	0.0201	0.184
ALARM	-0.0085	0.0714	-0.119
SECSYS	0.1305	0.1720	0.759
PATIO	0.0108	0.0216	0.500
POOL	0.0512	0.0996	0.515
CARPORT1	0.0289	0.0379	0.762
GARAGE1	0.0790	0.0252	3.136
CARPORT2	0.0902	0.0509	1.772
GARAGE2	0.1440	0.0291	4.943
MICROWV	0.0130	0.0498	0.262
HRDWDFLR	0.0830	0.0235	3.527
CONC	-0.2679	0.0922	-2.906
SLAB	0.1424	0.0254	5.601

TABLE 12d
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
BRICK	0.0761	0.0231	3.288
MEDINT	-0.0050	0.0136	-0.370
INT0	-0.0299	0.0067	-4.451
NEW	0.1000	0.0363	2.748
URBAN	-0.0084	0.0169	-0.500
RURAL	0.0171	0.0820	0.208
MISNEIGH	-0.0577	0.0678	-0.851
UNKCNTY	-0.0092	0.0936	-0.099
BEXAR	-0.0778	0.0541	-1.438
SANANTON	-0.0714	0.0567	-1.259
COMAL	0.1586	0.0813	1.950

Number of Observations: 407

R^2: 0.8908

Root MSE: 0.15052

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12e

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO 1985/86

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	7.5430	0.2551	29.558
BRATIO	0.2257	0.3418	0.660
LAG1BUYP	0.0655	0.0696	0.942
DSRATIO	-0.1297	0.2240	-0.579
LSQFT	0.3065	0.0338	9.061
SQFTMISS	2.2938	0.2526	9.079
BLD2	-0.0150	0.0306	-0.493
BLD3	-0.0284	0.0476	-0.596
BLD6	-0.0086	0.0339	-0.256
BLD9	0.0187	0.0603	0.310
FACTFAB	-0.0754	0.1025	-0.736
CENTLAIR	0.0969	0.0200	4.834
FIREPL	0.1374	0.0164	8.336
GOODCOND	0.0218	0.0125	1.739
GDRMSIZE	0.0063	0.0137	0.462
BEDRMS	-0.0290	0.0142	-2.037
BATHS	0.0565	0.0174	3.250
ROOMS	0.0251	0.0082	3.057
AGEHSE	-0.0000	0.0004	-0.054
LLOTSIZE	0.0723	0.0178	4.048
LOTSZMIS	0.6462	0.1600	4.037
WASHDRY	0.0397	0.0277	1.432
RANGE	0.0638	0.0182	3.491
REFRIG	-0.0265	0.0243	-1.089
DISHW	0.1083	0.0220	4.926
GARBDISP	-0.0027	0.0206	-0.135
FENCE	-0.0221	0.0128	-1.727
ALARM	-0.0610	0.0290	-2.102
SECSYS	0.0013	0.0251	0.054
PATIO	0.0097	0.0127	0.766
POOL	0.1463	0.0651	2.247
CARPORT1	0.0613	0.0273	2.241
GARAGE1	0.0781	0.0189	4.135
CARPORT2	0.0825	0.0453	1.819
GARAGE2	0.1832	0.0213	8.565
MICROWV	-0.0068	0.0248	-0.276

TABLE 12e
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
HRDWDFLR	0.1007	0.0208	4.833
SLAB	0.0350	0.0202	1.731
BRICK	0.0410	0.0143	2.859
MEDINT	0.0121	0.0095	1.275
INT0	-0.0147	0.0083	-1.761
NEW	0.0249	0.0345	0.720
URBAN	-0.0076	0.0116	-0.657
RURAL	0.0596	0.0626	0.952
MISNEIGH	-0.0420	0.0709	-0.592
UNKCNTY	-0.0115	0.1981	-0.058
BEXAR	-0.0043	0.0414	-0.104
SANANTON	0.0337	0.0478	0.705
COMAL	-0.0944	0.0567	-1.664

Number of Observations: 738

R^2: 0.8358

Root MSE: 0.32203

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12f

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

PHOENIX

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	6.7100	0.2061	32.545
BRATIO	0.4440	0.1980	2.242
LAG1BUYP	-0.1358	0.0773	-1.756
DSRATIO	0.1576	0.1164	1.353
LSQFT	0.5653	0.0276	20.410
SQFTMISS	4.3414	0.2139	20.293
BLD1	0.0385	0.0182	2.117
BLD4	-0.0302	0.0283	-1.065
BLD6	-0.0239	0.0331	-0.722
BLD7	-0.0358	0.0207	-1.728
BLD8	0.0437	0.0307	1.423
BLD9	0.0892	0.0345	2.581
FACTFAB	-0.1640	0.0607	-2.698
CENTLAIR	0.1009	0.0139	7.236
FIREPL	0.0571	0.0076	7.431
GOODCOND	0.0446	0.0101	4.398
GDRMSIZE	-0.0069	0.0103	-0.671
BEDRMS	-0.0227	0.0086	-2.646
BATHS	0.0517	0.0120	4.315
ROOMS	-0.0068	0.0058	-1.173
AGEHSE	-0.0004	0.0004	-1.043
LLOTSIZE	0.0464	0.0135	3.431
LOTSZMIS	0.3892	0.1193	3.260
WASHDRY	0.0041	0.0144	0.287
RANGE	-0.0053	0.0152	-0.348
REFRIG	0.0150	0.0168	0.892
DISHW	0.0553	0.0120	4.597
GARBDISP	-0.0299	0.0130	-2.287
FENCE	-0.0219	0.0078	-2.796
ALARM	-0.0570	0.2019	-0.282
PATIO	0.0122	0.0082	1.495
POOL	0.0591	0.0104	5.647
CARPORT1	0.0339	0.0142	2.386
GARAGE1	0.0466	0.0148	3.151
CARPORT2	0.0617	0.0150	4.109
GARAGE2	0.1121	0.0146	7.661

TABLE 12f
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
MICROWV	-0.0166	0.0216	-0.770
HRDWDFLR	0.3685	0.0752	4.899
CONC	-0.0002	0.0747	-0.003
SLAB	-0.0586	0.0639	-0.918
BRICK	0.0090	0.0227	0.398
MEDINT	0.0000	0.0055	0.008
INT0	-0.0142	0.0048	-2.928
NEW	0.1127	0.0277	4.059
TIME82	-0.0653	0.0228	-2.863
URBAN	-0.0224	0.0094	-2.372
RURAL	-0.0423	0.0511	-0.828
MISNEIGH	0.0215	0.0612	0.351
UNKCNTY	-0.1283	0.0525	-2.442
GLENDALE	-0.0871	0.0369	-2.361
MESA	-0.0531	0.0368	-1.441
PHOENIX	-0.0824	0.0367	-2.243
SCOTTSDL	0.0067	0.0391	0.172
TEMPE	-0.0551	0.0393	-1.401
AVONDALE	-0.0878	0.1208	-0.728
CHANDLER	-0.0432	0.0381	-1.135
GILBERT	-0.1356	0.0453	-2.988
GOODYEAR	-0.0815	0.0648	-1.259
KYRENE	-0.0874	0.2168	-0.403
LTCHFLD	-0.3688	0.0920	-4.007
PRDISCTY	0.0328	0.0877	0.374
PEORIA	-0.1254	0.0385	-3.254
TOLLESON	-0.0689	0.0780	-0.883
YNGSTWN	-0.1374	0.3028	-0.454

Number of Observations: 1,030
R^2: 0.8413
Root MSE: 0.37974

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

TABLE 12g

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Log of Sales Price of Home

SAN ANTONIO

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	7.4183	0.2094	35.414
BRATIO	0.1647	0.2831	0.582
LAG1BUYP	0.0161	0.0520	0.310
DSRATIO	-0.1576	0.1705	-0.924
LSQFT	0.3367	0.0280	11.989
SQFTMISS	2.4678	0.2075	11.893
BLD2	0.0015	0.0228	0.069
BLD3	-0.0562	0.0402	-1.396
BLD6	-0.0160	0.0286	-0.560
BLD9	0.0070	0.0516	0.136
FACTFAB	-0.0932	0.0835	-1.115
CENTLAIR	0.0989	0.0162	6.087
FIREPL	0.1302	0.0133	9.770
GOODCOND	0.0284	0.0103	2.741
GDRMSIZE	0.0080	0.0110	0.724
BEDRMS	-0.0236	0.0114	-2.061
BATHS	0.0509	0.0142	3.569
ROOMS	0.0220	0.0067	3.295
AGEHSE	0.0002	0.0003	0.567
LLOTSIZE	0.0619	0.0144	4.290
LOTSZMIS	0.5540	0.1294	4.281
WASHDRY	0.0290	0.0222	1.308
RANGE	0.0657	0.0147	4.447
REFRIG	-0.0188	0.0193	-0.975
DISHW	0.1032	0.0177	5.825
GARBDISP	0.0026	0.0168	0.158
FENCE	-0.0134	0.0104	-1.286
ALARM	-0.0800	0.0229	-3.491
SECSYS	-0.0030	0.0215	-0.142
PATIO	0.0077	0.0104	0.745
POOL	0.1203	0.0531	2.264
CARPORT1	0.0559	0.0222	2.510
GARAGE1	0.0805	0.0152	5.290
CARPORT2	0.0960	0.0353	2.721
GARAGE2	0.1806	0.0171	10.514
MICROWV	-0.0034	0.0207	-0.164

TABLE 12g
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic *
HRDWDFLR	0.0939	0.0164	5.716
CONC	-0.4155	0.1625	-2.556
SLAB	0.0507	0.0161	3.140
BRICK	0.0485	0.0117	4.133
MEDINT	0.0144	0.0070	2.040
INT0	-0.0180	0.0058	-3.093
NEW	0.0602	0.0253	2.373
TIME82	-0.1921	0.0228	-8.401
URBAN	-0.0059	0.0094	-0.630
RURAL	0.0561	0.0505	1.111
MISNEIGH	-0.0419	0.0542	-0.773
UNKCNTY	-0.0004	0.1120	-0.004
BEXAR	-0.0035	0.0334	-0.107
SANANTON	0.0253	0.0375	0.674
COMAL	-0.0568	0.0460	-1.234

Number of Observations: 1,145
R^2: 0.8427
Root MSE: 0.27857

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

coefficient on ROOMS measures the effect on house price of adding a room other than a bedroom or bathroom. Note also that these effects are conditioned on house size (SQFT), thus assuming that square footage remains fixed.

The presence of additional controls in Tables 11 and 12 also changes the reference group against which some effects are measured. For example, in moving from Tables 7 and 8 to Tables 11 and 12, variables for one- and two-car garages (GARAGE1 and GARAGE2) are supplemented with variables that distinguish one- and two-car carports (CARPORT1 and CARPORT2), and thus the reference group now excludes carports but includes uncovered parking, on-street parking, or unspecified parking facilities.

The regression results in Tables 11 and 12 are in some respects less satisfactory than those in Tables 7 and 8. Many of the estimates seem more highly variable across samples and more sensitive to the level of aggregation. In addition, many of the newly measured coefficients are often implausible, especially those that measure features that are not intrinsic to the structure of the home, such as the presence of clothes washers/dryers, dishwashers, garbage disposals, etc. One possibility is that these features are spuriously correlated with other unobserved house characteristics that are of substantial importance, perhaps in part because particular builders that are not separately identified in our regressions consistently offer packages that either include or exclude some of these features.

Although it is difficult to interpret some of these estimated parameters as true structural effects, similar hedonic regressions offer a potentially useful basis for estimating house values or for checking house price appraisals. The results here suggest that additional controls may be necessary, or larger samples may be required to improve estimates of house characteristics that have already been singled out. It may also be useful to estimate regressions over smaller geographic areas, thus possibly providing added homogeneity of unmeasured features of homes. It is encouraging that even the relatively brief list of variables contained in the earlier tables (Tables 7 and 8) explained a fairly substantial fraction of variation in house prices—on the order of three-quarters of the variation around the mean—and most of the estimates in these regressions appeared to be plausible.

One potentially useful way in which to exploit regression estimates like these is to form predictions of house prices against which appraised values may be judged. Appraised values that are found to be too distant from the regression prediction of sales price would then be subjected to additional scrutiny—perhaps reappraisal. This procedure would aid in identifying suspect appraisals, thus helping to preclude inadvisable loans.

This application presumes, of course, that the regression predictions of house prices are reasonably close to appraised values. Although it would be shocking if this were not true, it is worth establishing this property. Figure 4 uses scatterplots to illustrate graphically the similarity between regression house price predictions and the corresponding appraised values for the samples of homes used here.[24] The regression predictions are computed from the parameter estimates presented in Tables 11a-11e.

Table 13 supplements the graphical evidence by using weighted regressions to summarize the relationship between appraised values and regression predictions of sales prices, where the latter are denoted by the variable PRICEHAT. The values of the R-squared statistics indicate that in the samples used here the regression sales price predictions explain between 64 and 91 percent of the variation in appraised values. As with the scatter diagrams, these regressions show a reasonable degree of concordance between the two measures of home value.

It is worth emphasizing that the samples used to conduct these exercises consist exclusively of sales transactions that are actually consummated. In contrast, the use of regression predictions as a check on appraised values is likely to occur at a much earlier point in the lending process, and as a result, the sample of prospective sales transactions at issue in practice may include many that are never completed. The differences between the samples used here and those likely to arise in practice may be both systematic and important. In

[24]The estimates utilized to predict house prices are from weighted regressions, but the scatterplots themselves are unweighted in the sense that each observation is represented by a single point.

Figure 4
Appraised Values versus Regression Predictions of Sales Prices

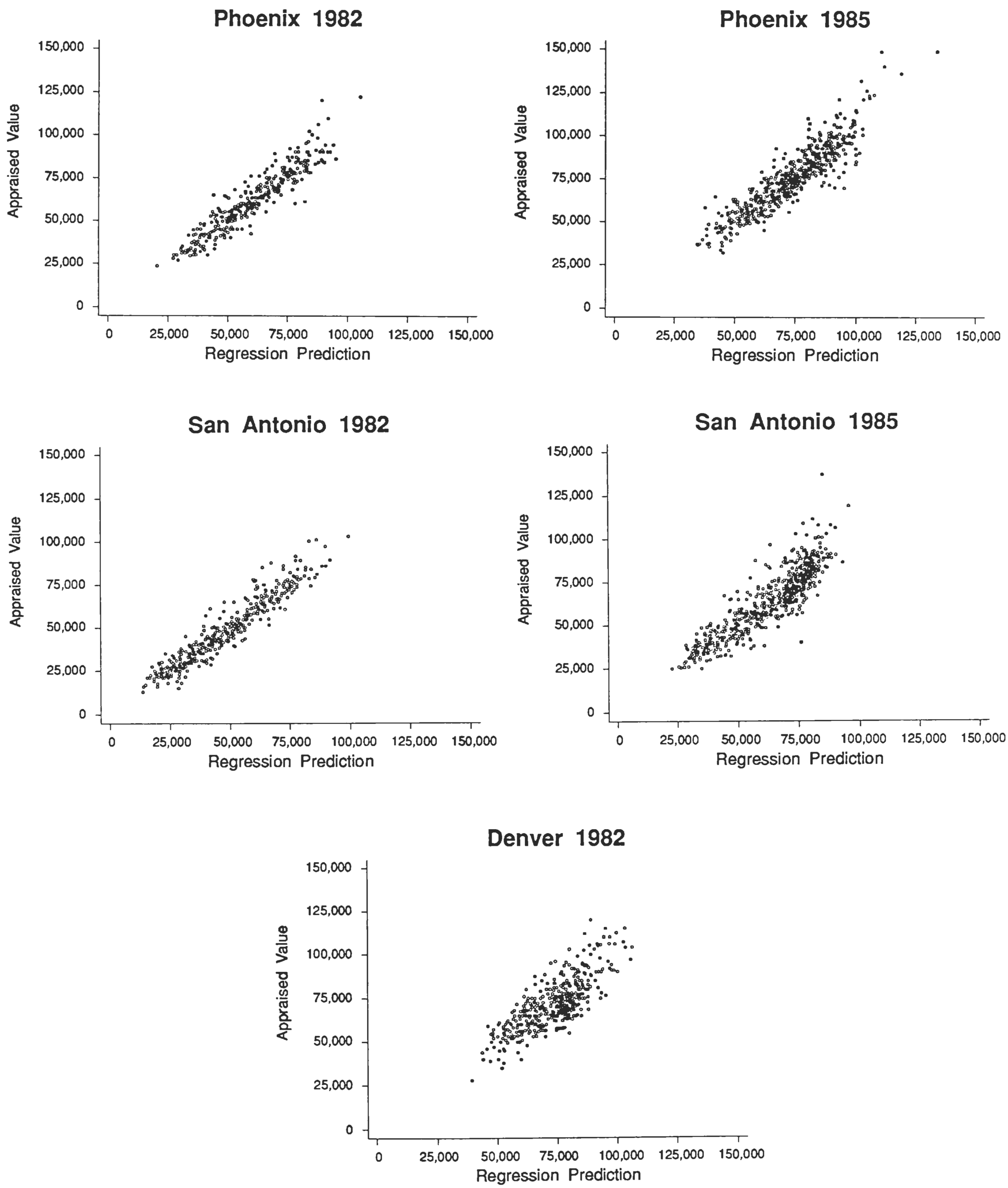


TABLE 13

Weighted Least Squares Regression Estimates
Dependent Variable: Appraised Value of Home

Variable	Coefficient Estimate	Standard Error	T-statistic*
	PHOENIX 1982		
INTERCEPT	− 536.516	1252.944	− 0.428
PRICEHAT	1.036	0.020	51.608
Number of Observations: 369			
R^2: 0.8789			
Root MSE: 7353.99778			
	PHOENIX 1985/86		
INTERCEPT	− 1996.261	1432.290	− 1.394
PRICEHAT	1.059	0.019	55.708
Number of Observations: 653			
R^2: 0.8266			
Root MSE: 34400.37445			
	DENVER 1982		
INTERCEPT	2400.407	2443.218	0.982
PRICEHAT	0.958	0.033	28.831
Number of Observations: 466			
R^2: 0.6418			
Root MSE: 12801.94323			
	SAN ANTONIO 1982		
INTERCEPT	561.576	801.754	0.700
PRICEHAT	0.997	0.015	63.187
Number of Observations: 407			
R^2: 0.9079			
Root MSE: 5813.91365			
	SAN ANTONIO 1985/86		
INTERCEPT	234.678	1183.199	0.198
PRICEHAT	1.017	0.018	54.404
Number of Observations: 738			
R^2: 0.8009			
Root MSE: 19661.52488			

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

particular, because appraised values that fall short of buyers' offer prices may induce some buyers to back out of sales transactions, such appraisals are likely to be rarer in the samples used here than in the broader set of appraisals that would arise in practice. If, in fact, the samples used here are censored versions of the broader samples, the quantitative relationships explored here may not hold up in actual application. In particular, the relationship between regression predictions of sales prices and appraised values, as well as various characteristics of the distributions of appraised values and regression price predictions, may be very different from those found here. For this reason, the explorations in this section should be taken as only illustrative of what could be done. At a minimum, some attention should be given to the possible consequences of broadening the samples to a larger set of potential transactions.

The latter caveat aside, it is of interest to note that the differences between appraised values and regression predictions do not appear to be strongly related to the observed home characteristics that form the basis of the regression predictions. To demonstrate this point, we used weighted regressions to explain the difference between the appraised value and the regression prediction of house price in terms of the house features measured by the regressors in Tables 11a-11e. Table 14 presents the results from the regression on one sample, but is typical of the findings for all of the samples. In particular, only occasionally is a coefficient statistically significantly different from zero.[25] One interpretation of these findings is that appraisers attach values to home features in a way that does not generally differ systematically from the way in which values are assigned statistically by the regression procedure.

Having established that regression predictions of house prices are reasonably good estimates of appraised values, we now ask more precisely how the former may be used to check on the latter. One possibility is to use the strength of the general relationship between appraised values and regression predictions to isolate appraisals that appear to be wide

[25]For the results in Table 14 we do find, however, that the appraised value responds more strongly to square footage than does the regression prediction of price.

TABLE 14

Weighted Least Squares Regression Estimates with Extended Variable List
Dependent Variable: Appraised Value Minus Predicted Price

PHOENIX 1982

Variable	Coefficient Estimate	Standard Error	T-statistic*
INTERCEPT	-5550.442	14684.193	-0.378
VBO	-0.558	0.393	-1.419
LAG1BUYP	6276.039	10973.797	0.572
DISCSELL	-0.127	0.136	-0.931
SQFT	5.424	2.573	2.108
BLD4	3633.424	7864.467	0.462
BLD8	2835.854	3201.413	0.886
BLD9	524.930	8012.909	0.066
FACTFAB	2714.187	7825.065	0.347
CENTLAIR	-5.261	1170.801	-0.004
FIREPL	558.881	973.977	0.574
GOODCOND	545.881	847.783	0.644
GDRMSIZE	-1177.615	910.695	-1.293
BEDRMS	256.936	944.582	0.272
BATHS	-706.033	1165.854	-0.606
ROOMS	-933.392	774.314	-1.205
AGEHSE	-3.088	31.910	-0.097
LOTSIZE	0.103	0.079	1.305
LOTSZMIS	1369.618	1400.489	0.978
WASHDRY	-1944.186	2625.061	-0.741
RANGE	456.378	1174.476	0.389
REFRIG	397.364	2258.519	0.176
DISHW	-900.836	1230.687	-0.732
GARBDISP	811.505	1345.491	0.603
FENCE	-129.432	756.728	-0.171
ALARM	-3036.574	5032.199	-0.603
PATIO	-146.820	782.006	-0.188
POOL	-698.886	1481.950	-0.472
CARPORT1	609.406	1434.163	0.425
GARAGE1	27.119	1697.624	0.016
CARPORT2	-106.381	1668.640	-0.064
GARAGE2	154.991	1726.582	0.090
MICROWV	732.857	3516.173	0.208
CONC	-2503.969	9973.617	-0.251
SLAB	-3602.839	9427.083	-0.382
BRICK	-303.087	2130.722	-0.142

TABLE 14
(Continued)

Variable	Coefficient Estimate	Standard Error	T-statistic*
MEDINT	247.632	651.612	0.380
INT0	81.874	329.274	0.249
NEW	-2571.152	1389.765	-1.850
URBAN	242.065	951.060	0.255
RURAL	-3138.632	3711.999	-0.846
MISNEIGH	59.352	4298.876	0.014
GLENDALE	3436.429	3738.170	0.919
MESA	4704.389	3553.194	1.324
PHOENIX	2571.481	3584.025	0.717
SCOTTSDL	3876.355	3981.827	0.974
TEMPE	3767.465	3876.907	0.972
AVONDALE	-248.391	6011.578	-0.041
CHANDLER	5488.934	3851.667	1.425
GILBERT	7592.553	3816.235	1.990
KYRENE	-3724.456	5717.959	-0.651
PEORIA	983.163	4402.155	0.223
YNGSTWN	342.861	7146.637	0.048

Number of Observations: 369

R^2: 0.0983

Root MSE: 7559.55714

* For reference, the critical absolute value of the t-statistic for a two-tailed test at the five percent significance level is 1.960, and at the one percent significance level the critical value is 2.576.

of the mark. For example, the regression relationships in Table 13 could be used to form confidence intervals for appraised values conditional on a particular value of the regression prediction of house price. Appraised values falling outside the confidence interval would be singled out as suspect. The disadvantage of this procedure is that it fails to recognize that the regression predictions of house prices are themselves subject to varying degrees of error. When the regression prediction of house price is very imprecise, there is little statistical surprise in finding a large deviation between the latter prediction and the appraised value. On the other hand, when the data indicate that the regression prediction of house price is very precise, even a fairly small difference between the latter and the appraised value may be surprising and thus worthy of attention.

To correct for this apparent defect, we consider an alternative procedure that recognizes that both the appraised value and the regression price prediction are subject to error. Under this method we view both the appraisal and the regression prediction as error-ridden predictors of an unknown "true" value that is represented by the sales price of the home.[26] When the two predictors of value differ substantially, after due allowance for the precision with which they are measured, we reject the notion that they are measuring the same true value.

More specifically, we assume, as in the text, that observed sales prices P obey the hedonic regression relationship $P = X\beta + \epsilon$, where X is a matrix of observed house characteristics, β is a vector of unknown parameters, and ϵ is a vector of random disturbances. The out-of-sample regression prediction $\hat{P}$ for a home with characteristics X_o may be written as $X_o\hat{\beta}$, where $\hat{\beta}$ is the (weighted) regression estimate of the parameter vector. Under standard assumptions, this prediction is unbiased in the sense that its expectation is the same as that of the unknown true value, conditional on the observed house characteristics: $E(\hat{P}) = E(P)$. The prediction error may be expressed as

$$\hat{P} - P = X_o(\hat{\beta} - \beta) - \epsilon_o.$$

[26]That is, we use the sales price as the "true" value, rather than as another indicator of some unmeasured abstract "true" value that could differ from sales price.

The first term on the right-hand side represents error arising from misestimating the parameter vector β. The second term reflects randomness that would be present even if the full parameter vector β were known with certainty. That is, unobservable factors would generally cause the predicted sales price to differ from the realized value even if the influence of all observable house characteristics were known. Again under standard assumptions, the mean square prediction error may be written as

$$E(\hat{P} - P)^2 = X_o V(\hat{\beta}) X_o' + \sigma_o^2$$

where σ_o^2 is the variance of ϵ_o.

The appraised value $\tilde{P}$ may be taken as a second predictor of the true value P. Although less is known about its structure, we treat the relationship as one in which $P = \tilde{P} + \epsilon_1$, where the random error ϵ_1 has zero mean, has constant variance σ_1^2, and is uncorrelated across homes. (The assumption that ϵ_1 has zero mean can easily be relaxed to allow for appraised values that are biased on average.) The appraised value is thus an unbiased predictor of true value in the sense that $E(\tilde{P}) = E(P)$, and its mean square prediction error is

$$E(\tilde{P} - P)^2 = \sigma_1^2.$$

Next consider the difference D between the appraised value and the regression prediction of price: $D = \tilde{P} - \hat{P}$. Under the assumptions made thus far, this difference should have an expected value of zero and a variance of

$$E(\tilde{P} - \hat{P})^2 = X_o V(\hat{\beta}) X_o' + \sigma_o^2 + \sigma_1^2 - 2\sigma_{o1}$$

where σ_{o1} is the covariance between errors in appraised values and the disturbances in the hedonic regression. Notice that this expression for the variance in D recognizes that both the regression prediction of price and the appraised value are subject to error, and that the forecast errors may be correlated. Notice, moreover, that all terms on the right hand side can be estimated. Estimates of the first two terms on the right-hand side of the above equation can be obtained from the hedonic regression. Estimates of the final two terms can be obtained as well: σ_1^2 can be obtained as the variance of the prediction errors $\tilde{P} - P$, while σ_{o1} can be obtained from a regression of $\tilde{\bar{P}} - \bar{P}$ on $\hat{\bar{P}} - P$.[27]

Utilizing the observed difference D between appraised value and the regression prediction of price, together with the estimated variance of D, should form a useful basis upon which to identify suspect appraisals. Although there are several ways to implement the search for suspect appraisals, all methods rely on the idea that the extent of statistical surprise can be measured by the size of D relative to its estimated standard error (the square root of the estimated variance of D). For example, one could examine all cases in which D is larger than some predetermined number of standard errors. Alternatively, one could array all cases in terms of standardized differences (*i.e.*, D divided by its standard error) and examine some fixed percentage of the highest standardized differences. Under either of these methods, it may also be desirable to key on the raw difference as well: even a statistically surprising difference between appraised value and the regression prediction of price may not be worth investigating if the raw dollar difference is not large enough to justify the expense of reappraisal. Similarly, a large raw difference may justify a reappraisal even if it is imprecisely measured because the potential losses from lending on the basis of such an incorrect appraisal are correspondingly large.

In implementing such procedures, it would be useful to know more about the distribution of the standardized differences. In particular, the usual assumption of normality may not be appropriate. To give some indication of how the distribution of standardized differences in our samples would compare to the normal distribution, we computed the values of the standardized differences at various percentiles of the distribution.[28] These values are

[27]Values of σ_1^2 and σ_{o1} are estimated, respectively, as 25914258 and 15810712 for Phoenix 1982; 359284693 and 18156856 for Phoenix 1985/86; 71977069 and 19898613 for Denver 1982; 7211173 and 4657175 for San Antonio 1982; 56185759 and 22496510 for San Antonio 1985/86.

[28]These standardized differences contain a mean correction as well. We found that, on average, appraised values differed from sales prices in the samples used here. The standardized differences first normalize appraisals by deducting the mean difference between appraised values and sales prices. These mean differences are as follows: 1663 for Phoenix 1982; 2403 for Phoenix 1985/86; -588 for Denver 1982; 421 for San Antonio 1982; and 1294 for San Antonio 1985/86.

presented in Table 15. Values that would occur under normality are presented in the final column.

TABLE 15

Standardized Values of D at Various Percentiles of the Distribution

Percentile	Phoenix 1982	Phoenix 1985/86	Denver 1982	San Antonio 1982	San Antonio 1985/86	Normal Dist.
99	2.23	1.76	2.52	2.59	3.03	2.33
95	1.77	0.96	1.57	1.73	1.80	1.65
90	1.22	0.71	1.27	1.06	1.25	1.28
75	0.47	0.29	0.62	0.45	0.48	0.67
50	– 0.12	– 0.05	– 0.07	– 0.10	– 0.06	0.00
25	– 0.50	– 0.34	– 0.58	– 0.51	– 0.52	– 0.67
10	– 0.97	– 0.63	– 1.02	– 1.01	– 1.17	– 1.28
5	– 1.22	– 0.79	– 1.21	– 1.43	– 1.49	– 1.65
1	– 2.08	– 1.33	– 1.54	– 2.03	– 2.24	– 2.33

Although it is difficult to generalize about the shapes of these empirical distributions relative to the normal, a few salient features are worth mentioning. First, the left-hand tails (corresponding to negative values of D) of the empirical distributions seem generally to be less thick than for the normal, perhaps a reflection of a tendency for sales transactions not to occur when appraised values fall far short of prospective sales prices. The shapes of the distributions above the median are less consistent. For example, the distribution for San Antonio 1985/86 seems to have a somewhat longer right-hand tail than the normal, while the opposite seems to hold for the distribution for Phoenix 1985/86.

It is worth reemphasizing the point that even these qualitative findings may well be inapplicable if the set of appraisals to be examined is broadened by conducting the investigation at an earlier stage of the loan qualification process. Actual experience in applying the methods outlined above, however, will permit the empirical determination of the distribution of standardized differences.