INTRODUCTION

About 1967, 3 similar buildings, designed by the same architect in the same style, and built by the same developer, went up in northwest Washington D.C., at what is now the VanNess Metro station. In 1980-1981 2 of those buildings were converted from rental property to owner-occupancy. The VanNess East became a condo, and the VanNess North became a co-op. The North building obtained a 30 year master mortgage, at a then attractive 10% interest rate, with a 15 year prepayment lock-out, followed by a declining prepayment penalty. The VanNess East had no master mortgage.

Since purchasing a unit in the co-op requires assuming a share of the master mortgage, economically rational, fully informed buyers and sellers will capitalize the value of any unusual financing provisions in the sale price of the units. Previous economic research, examining below-market rate mortgage terms, calculated the value of the financing under the assumption that interest rates were not stochastic. This line of research usually found incomplete capitalization - sales prices were increased by the financing, but less than 100%. This paper suggests an alternative method for calculating the value of unusual financing arrangements attached to the purchase of owner-occupied housing. A dynamic stochastic simulation of the time path of interest rates is used to calculate an expected value for a co-op prepayment lockout. This estimated value is then used in a hedonic regression to predict the selling price of individual units in the co-op. By adding data from a similar condo building a sharper estimate of the value of the financing terms can be obtained, as well as an estimate of the effect of co-op status vs. condo status.
The remainder of the paper is laid out as follows. The first section reviews the previous literature on pricing mortgage features. The next section discusses the characteristics of the two VanNess buildings and describes the multiple listing service data used to test the market's value of the blanket mortgage. The next section discusses the model used to test for capitalization effects. Finally, the theoretical value of the mortgage option is defined and an empirical section tests the market's pricing of the co-op's financing.

I PREVIOUS RESEARCH

A series of papers written in the mid-1980's, many collected in a 1984 special issue of Housing Finance Review, found incomplete capitalization effects for below-market assumable mortgages. Most of these papers calculated the value of the below-market financing using the Cash Equivalence method, which assumes that the current difference between the mortgage rate and the market rate will continue for the remaining term of the mortgage. Papers by Smith, Sirmans, and Sirmans (1984) and Strathman, DeLacy and Dueker (1984) made some adjustments, such as assuming that the below market mortgage would refinance in 5 years, or by including an estimate of the tax consequences of the financing.

Cash Equivalence (or some variant) is then included in a hedonic regression with property descriptors, and the coefficient on the value of the financing terms is interpreted as a measure of capitalization. By and large, these papers find incomplete capitalization; the value of the property increases by some

percentage of the cash equivalence value of the financing, with "adjusted" values coming closer to 100% capitalization. An interesting alternative method is that of Schwartz and Kapplin (1984), who match sales of Florida condominiums with concessionary mortgage terms to similar units with market rate mortgages, in place of using a hedonic regression to 'standardize' the sales prices. In some ways this method yields an even cleaner estimate of capitalization than does the approach presented here, as the functional form of the hedonic regression is no longer an issue. However, their method breaks down if there is an unobserved systematic difference between units offered with and without concessionary financing.

Options theory suggests an alternative to Cash Equivalence for calculating the value of the financing in the face of volatile interest rates. The prepayment lock-out can be thought of as an option whose value is driven by a stochastic variable, the current rate of interest. Given the complexity of the declining prepayment penalty in the contract, a simulation strategy can be employed to "price the option". Similar techniques have been used by Berry and Gehr (1985), Hall (1985) and Leung and Sirmans (1990) to value simpler mortgage terms.

In a recent paper Goodman and Goodman (1994) use unpublished data from the American Housing Survey to estimate the price difference between condos and co-ops. Their estimate of the co-op discount, 22%, is much larger than the 9% in this paper. However, they do not separately estimate the value of co-op status from the value of the blanket financing, and the year that they chose for estimation, 1987, was a 10 year low in mortgage interest rates.

II The VanNess Buildings

VanNess is a complex of 3 apartment houses in the affluent upper Northwest area of Washington, D.C. They are bordered by Rock Creek Park on the north and east, and have an underground connection to the VanNess Metro station to the west. The 3 apartment houses were built by the same contractor at about the same time, and are similar in appearance and construction. All 3 share adjacent parking structures and 2 swimming pools. All 3 are in the same school district, police district, ZIPCode etc.

The North is the tallest of the buildings at 16 stories, the East building is 12 stories high. The North building is closer to the subway than the East building, while the East building is closer to the main part of Rock Creek Park. When built, the North building consisted of 466 units, 241 2-bedroom units, 181 1-bedroom, 29 efficiencies and 15 3-bedrooms, while the East building consisted of 433 units, 60 2-bedroom, 272 1-bedroom, 90 efficiencies and 11 3-bedrooms. The South complex has 625 units, mostly efficiencies and 1-bedrooms. In 1980, the North building was converted to a co-op; a year later, the East building was converted to a condo. The co-op has slightly higher fees, and offers more services (5 free repair visits per year, and a valet service that will take delivery of refrigerators, for instance). The co-op also has more restrictive rules than the condo. Most importantly, the co-op has a master mortgage which new purchasers must assume.

Measured in nominal dollars, price per square foot rose slightly in the East building, and fell slightly in the North building, from

the end of 88 to the middle of 92. Prices fell in both buildings from mid 1992 late 1993, at which point the East building started to rise in price (Graph 1, 2). The fall in 1992-1993 is much steeper in the VN North than in VN East, and prices are not yet rising in the North. Washington was in a real estate downturn from early 1992 to late 1993.

The graphs tend to overstate the price trends in the buildings, as the more expensive units suffered the greatest decline in turn-over during the recession. In order to measure price trends more precisely, several variables were constructed from MLS data for a hedonic regression (TABLE 1).

III A MODEL OF UNIT PRICING

In order to test for capitalization effects, a hedonic model was estimated to predict the sale price of units in the VanNess North co-op and VanNess East condo. The dependent variable is sales price per square foot, measured in nominal dollars. Independent variables are entered in levels. The choice of functional form was dictated by the fact that most hedonic studies (for instance, Blomquist and Worley 1981) find that a log transformation fits best, but some of the independent variables in this study are clearly additive, not multiplicative, in effect. By focusing on price per square foot, some independent variables, such as quality of view or number of bedrooms, are allowed to have a roughly proportionate effect on price (as a log transform provides) while others, such as a parking space, can have an additive effect.

The relative value of the co-op master mortgage was calculated with a simulation described below. A value was created for each quarter from 1989 to 1994. This value was then linked to the unit by its contract date (date the offer was accepted) lagged one quarter.

TABLE 1
SUMMARY STATISTICS

VARIABLE	MEAN CO-OP	MEAN CONDO
$/SQ FT	119	121
SQUARE FEET	1218	777
FLOOR	7.7	5.3
PARKINGa	0.00084	0.00087
PARKVIEW	0.42	0.67
EFFICIENCY	0.04	0.25
1-BEDROOM	0.44	0.63
SUMMER	0.52	0.52
OPTION VALUEb	1.36	0

a These variable were calculated using square feet. For instance, a 1,200 sq. ft. unit that sold with 1 parking spaces had a PARKING value of (1/1,200).

The relative mortgage value was multiplied by the dollar amount owed on the mortgage by each unit. This value, CAPCOEF, should also be additive to the total price instead of the price per square foot. For that reason, this variable was also divided by square footage, and the coefficient can be interpreted as the impact on unit price of a $1 change in co-op mortgage value.

Most of the data comes from the Multiple Listing Service (MLS). List price, sales price, fees, contract date, square footage, number of bedrooms, whether 0, 1, or 2 parking spaces were sold with the unit, dollar value of the master mortgage assumed with unit purchase, and unit number were taken from the MLS sheets for units sold from January of 1989 to August of 1994. Sales with contract dates between January of 1989 and June of 1994 were kept. Sales which were clearly identified as foreclosure were eliminated, but a few may have slipped through. This provided 279 sales, 137 in the co-op (North), and 142 observations in the condo (East).

Prices were kept in nominal dollars, as prices at the Van Ness East were about the same at the end of the period as at the beginning, and average selling price (not quality adjusted) for condos in northwest Washington increased by less than 10% over the five and a half year period.

The following explanatory variables are assumed to influence price per square foot. Square footage, FEET, is entered on the right hand side, allowing price to vary systematically with unit size. Two dummy variables, EFFIC and 1BR, also allow variability by size, allowing efficiencies and 1 bedrooms to have different prices. The omitted category is 2 or more bedrooms. Number of baths is not used as all efficiencies and 1 bedrooms had 1 bath, all 2 bedrooms had 2 baths. Another dummy variable, PARKVIEW, equalled 1 if the unit had a view of Rock Creek Park. FLOOR was an integer variable measuring number of floors above ground. Seasonality was captured with a dummy variable, SUMMER, which equaled 1 for contracts signed from April to September. The variable CO-OP equals 1 for the VN North and 0 for the VN East to absorb any inherent differences in the two buildings, or co-op vs. condo status. Time was first entered flexibly as a set of time splines, one variable per calendar year, measured in months. A second specification leaves out the time trend, and a third redefines the time splines in an attempt to more closely approximate the cycle in the D.C. housing market.

Other variables should have an additive effect on the price of the unit, instead of influencing price per foot. There are "secondary markets" in parking spaces, both for ownership and rental. It makes more sense to assume that a parking space adds a constant

$/FEET = à + á1 FEET + á2 FLOOR + á3 (PARKING/FEET) + (1)
á4 PARKVIEW + á5 EFFIC + á6 1BR + á7 CAPCOEF (MORTVAL/FEET) +
á8 CO-OP + á9 SUMMER + át,j TIMEj + î

amount to the total price of the unit. Thus, the variable PARKING is the number of parking spaces (usually 1), divided by the square footage of the unit. In this way, the coefficient on PARKING measures the price of a parking space.

IV MORTGAGE VALUATION

The master mortgage that was signed in April, 1980, when the VanNess North was converted to a co-op, carries a fixed interest rate of 10%, and a 30 year amortization schedule. There is a prepayment lockout for 15 years. Starting in April of 95 the mortgage can be prepaid with a 5% penalty. The penalty declines by 1 percentage point annually, until April 2000, when the mortgage can be prepaid without penalty. At the time of conversion, new purchasers could chose their LTV, up to 90%. Most buyers chose the maximum, but some did not. By 1993, amortization and property appreciation had lowered the master mortgage to about 45% of the value of the typical unit sold. However, a few units had much lower master mortgages, and one unit sold had no master mortgage obligation at all.

A simple method was needed to value this rather complex option. The valuation was done with a spreadsheet simulation. Quarterly mortgage interest rates from 1984 to 1994 were obtained in order to measure volatility. Volatility was defined as the root mean square of the first differences of the log of the quarterly rates for the previous 5 years. Interest rates had a pronounced downward drift for most of this period; this specification assumes that the true process is a driftless random walk. The measured volatility, å, ranged from 0.04 to 0.13.

å2 = ä(ln(r)t - ln(r)t-1)2/n (2)

A spreadsheet model was built that started with the log of the mortgage rate prevailing in the quarter of purchase. The next quarter added to the log of the previous quarter's rate a draw from a normal distribution with mean 0, and å as calculated in EQ 1 with data from the preceding 20 quarters.

rt+1 = exp(ln(rt) + N(0,å)) (3)

A decision rule was inspected, and either the previous mortgage rate was kept, or the prevailing mortgage rate for that quarter was assigned (a refinancing), and the refinancing cost (including prepayment penalties) was recorded. This was done for each quarter remaining in the mortgage's term. The after-tax present value of each stream was calculated, assuming a marginal tax rate of 34.8%

$$MORTVAL = \sum_{t=0}^{T} ((R_{condo,t} - R_{co\text{-}op,t}) + (POINTS_{condo,t} - (POINTS+PENALTIES)_{co\text{-}op,t})) * (BALANCE_t * (1-TAXRATE)/(1+R0)^t) \quad (4)$$

(the combination of 28% Federal and 9.5% D.C.). This process was repeated 100 times and the value of the mortgage terms was taken to be the mean of the present values of the streams of after-tax mortgage interest payments.

In order to model the value of the master mortgage's terms, several assumptions were needed. First, it was necessary to assume a counterfactual financing method. The model assumes that the alternative for a co-op buyer was a condo purchased with a standard, 30 year fixed rate mortgage, non-assumable, with a 5% termination probability in each year, to reflect mobility. If the mortgage terminated, the buyer got a new mortgage at the new prevailing rate. If mortgage rates in a future year were low enough, relative to the condo buyers mortgage rate, the mortgage was assumed to refinance at the new rate, with the payment of 2 points. If penalties were paid, this was added to the present value of the mortgage's stream of payments.

Second, the non-interest terms of the mortgage that the co-op would get if it refinanced had to be specified. The model assumes that the co-op will refinance into a fixed-rate mortgage with no lockouts or penalties, for the remaining term of the mortgage. This was made for convenience, but any other combination of terms and rate will have roughly the same expected value. The Freddie Mac 30 year fixed rate commitment rate was used. When/if the mortgage refinances, it will probably be into a 15 year commercial mortgage. 15 year mortgages have lower rates than do 30 year mortgages, but commercial mortgages have higher rates than do single family. Thus, the Freddie Mac rate contains 2 offsetting errors, and represented the best rate available.

Finally, a refinancing rule had to be specified. Initially, the model assumed that the co-op would refinance the master mortgage if prevailing rates were at least 200 basis points below the contract rate, if a declining penalty were in effect, and would refinance for a 100 basis point difference if no penalty were incurred. Refinancing was assumed to cost 2 points, plus the penalty if appropriate. The two thresholds were modified, and the model re-estimated, until optimal values were found. The final valuation model assumes a refinancing threshold of 150 basis points if a prepayment penalty exists, and 100 basis points if there is no penalty. The present value of the refinancing strategy didn't change much in the range of 50 to 200 basis point thresholds.

The primary determinants of the (negative) value of the co-op mortgage are, of course, the spread between the currently prevailing mortgage and the co-op's 10% rate, and the length of time remaining on the prepayment lock-out.

From 1989 to 1991 the value is near zero as the prevailing rate is about 10%. The value isn't precisely zero even when the prevailing rate is 10%, because a "standard" mortgage at 10% has a prepayment option that the co-op lacks. Of course, the co-op mortgage is assumed upon sale, but with a 5% (or even a 10%) mobility rate the

lack of prepayment dominates when interest rates are equal.

The value of the option falls continuously through the 3rd quarter of 93 as interest rates fall (Graph 3). In the last quarter of 93 the value turns slightly upward as the time to lockout expiration decreases. In 1994 the value turns sharply upward as rates rise and the first potential refinancing date approaches.

IV REGRESSION RESULTS

The value of the co-op mortgage is highly collinear with the negative time trend of 92-93. However, the use of data from both the buildings allows the separation of the mortgage effect from the general trend in prices. Regressions were run by stacking data from both buildings, with a dummy variable, CO-OP, absorbing any inherent differences in price between the 2 buildings.

TABLE 2
REGRESSION COEFFICIENTS

	- SPECIFICATION 1-		-SPECIFICATION 2-		-SPECIFICATION 3-	
VARIABLE	BETA	T	BETA	T	BETA	T
INTERCEPT	116.415		117.097		119.703	
SQ. FEET	0.0008	1.68	0.0008	1.65	0.0007	1.54
FLOOR	0.7507	3.22	0.7540	3.17	0.7273	3.14
PARKING	8839.3	6.11	8718.2	5.90	8769.1	6.11
PARKVIEW	0.6609	0.38	0.6788	0.38	0.7428	0.43
EFFIC	-21.4853	-4.76	-21.4748	-4.71	-21.8464	-4.88
1BR	-15.5799	-5.24	-15.4434	-5.09	-16.0392	-5.42
SUMMER	0.9042	0.58	1.0631	0.68	1.1321	0.74
CO-OP	-10.8482	-4.59	-8.9865	-3.83	-10.5109	-4.47
CAPCOEF	-1.7557	-2.01	-3.6934	-5.38	-1.8250	-2.12
Y1989	0.3963	1.06				
Y1990	-0.2103	-0.73				
Y1991	0.0543	0.16				
Y1992	-0.5331	-1.43				
Y1993	-0.5800	-1.37				
Y1994	0.96322	0.89				
Y89-92Q1					-0.0071	-0.09
Y92Q2-93Q2					-0.6502	-2.75
Y93Q3-94					-0.0723	-0.18
R2		0.534		0.497		0.530
DF		263		269		266

The primary specification fit remarkably well (see Table 2). The Efficiency, 1 Bedroom, and Square Footage variables all indicated that price per square foot rises with size. This is consistent with the opinion of realtors in the area, and with Stigler's survivor principle (Stigler 1958), as a few small units have been combined over time, but no large units have been split. PARKVIEW and FLOOR are both positive, consistent with previous work by Blomquist (1988) and Pollard (1977) indicating the value of a good view as an amenity. The effect of going up 1 floor is only about a 0.6% increase in price. When shares were originally allocated at the time of the co-op's conversion, the number of shares increased by about 1% per floor. PARKING adds almost $9,000 to the price of a unit, which agrees with the handful of parking spaces which sold "naked" over the time period for prices between $5,000 and $11,000.

The coefficient of 1.76 on CAPCOEF in the first specification provides evidence for overcapitalization of the above-market terms of the co-op mortgage. Each $1.00 change in mortgage value produces a $1.76 change in the selling price of a co-op unit. This is in contrast to the conclusions of studies of below-market financing, where incomplete capitalization is usually found. In the second specification, which has no time splines to absorb the effect of the real estate downturn, CAPCOEF is more than doubled, to 3.7, indicating an implausibly large effect for the mortgage terms. The third specification, in which time splines are created to track the D.C. real estate market, provides estimates almost identical to the first regression.

Before offering explanations of overcapitalization it is important to note that the capitalization coefficient is significantly greater than zero, but only about 1 standard deviation above one. The D.C. real estate recession hit at the same time that falling interest rates reduced the value of the Co-op units, reducing the ability of the regression to separate the effects of the recession from the effects of the financing. Indeed, without data from the adjacent Condo building it may have been impossible to separate the effect of interest rates from the effect of the recession.

There are several plausible explanations for the measured overcapitalization. The first is simple, the 'marginal transactors' in the co-op may have had marginal tax rates lower than that assumed in the model. The average selling price is over $120,000. Following the rule of thumb that price is 3 times income implies an average income of over $40,000, certainly high enough to justify the assumption of a high marginal tax bracket. But, the building has several owners who may be more or less tax exempt, either because they are foreign nationals working for the World Bank, etc., or because they are retirees living on assets. If they represented marginal buyers, the mortgage terms should be calculated gross of tax deductability.

The second explanation is that overcapitalization reflects risk aversion. If buyers and sellers treat the 'price' attached to financing terms as more volatile than the prices of the real property, and/or they treat their estimates of the mortgage value as more prone to error, they may demand a premium when accepting unfavorable terms. This would also explain undercapitalization of favorable financing, as buyers would also demand a discount when purchasing below market financing.

A third possibility stems from the steep yield curve which prevailed in 1993, and the popularity of ARM's and teaser rates. Purchasing a unit in the co-op forced a borrower to accept an FRM for almost half the purchase price, but many borrowers obviously preferred ARM's in 1993. This could also explain some of the undercapitalization found in studies of favorable financing, as much of the 'creative finance' of the early 1980's involved assuming FRM's at a time when ARM's were increasingly popular.

The estimate of an 9% 'fixed effect' for the difference between condo and co-op status is probably an underestimate, for one of two reasons. There is substantial negative correlation between the coefficients on CO-OP and on CAPCOEF. If CAPCOEF is overestimated, then CO-OP is underestimated. If the point estimate on CAPCOEF is correct, and the undercapitalization found in studies of favorable financing is also correct, then interest rate volatility has asymmetric effects on the values of co-op with blanket mortgages, which would have the effect of lowering co-op prices, on average, relative to condo prices.

V CONCLUSION

The regressions indicate that co-op units are worth at least 9% less than comparable condo units. It is interesting to note that the board of this co-op considered conversion to condo status, and at least two co-ops in the Virginia suburbs are in the process of converting to a condo. However, to date no co-op in the District of Columbia has ever converted to condo status (Richards, 1994).

Unlike previous research, which indicates incomplete capitalization of unusual financing terms, this paper finds more than 100% capitalization of the terms of the co-op mortgage. Risk aversion and preferences for ARM's over FRM's are consistent with both under-capitalization of below-market terms and over-capitalization of above-market terms. Lower tax rates for marginal buyers could also contribute to the findings of this paper.

The research does indicate that co-op prices are determined by the value of the underlying financing. A straightforward stochastic estimate of the value of complicated financing terms is shown to be systematically related to co-op prices.

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