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Borrower Risk under Alternative Mortgage Instruments

BRUCE G. WEBB*

ABSTRACT

This paper analyzes differences in borrower risk under alternative mortgage instruments and various borrower characteristics. The traditional approach of measuring borrower risk in terms of actual delinquency and foreclosure data is rejected in favor of a model based on potential delinquency—that is, changes in the mortgage payment to income ratio. The combinations of mortgage terms and borrower characteristics that are most likely to produce a potential delinquency are isolated based on the calculation of hypothetical payment to income ratios over an eight year period.

RECENT STUDIES HAVE ATTRIBUTED problems of instability in the housing market to a combination of inflation and the terms of the traditional mortgage instrument.¹ These studies have concluded that the standard mortgage instrument with a fixed nominal interest rate is incapable of meeting the needs of either borrowers or lenders during inflationary periods. Lenders may earn negative real rates of return while borrowers must face a time stream of real payments which is unlikely to match their real income. Alternative mortgage instruments (AMI's), with payments that are allowed to vary, have been proposed as a partial solution to these problems.²

The prospect of the widespread use of mortgages whose payments have the potential for variation has not met with universal enthusiasm, however. Particularly important is the assertion that such mortgage instruments would increase risk to borrowers. While under the standard fixed rate mortgage, the risk of unanticipated inflation is carried by the lender, the use of AMI's would shift this risk to the borrower. In addition, it is argued that lenders would be reluctant to grant such mortgages to borrowers felt to be more prone to income fluctuations such as young or minority families. If lending institutions offered only variable payment mortgages, these groups could be squeezed out of the mortgage market.³

While there seems to be a consensus that mortgages with variable payments will involve higher borrower risk, few studies have been undertaken to examine

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¹ See Kearn, Rosen, and Swan [6].

² For a description of these AMI's see Cohn and Fischer [1].

³ See the testimony of representatives of various consumer and labor groups before the U.S. Congress [10].

the nature and extent of this increased risk.⁴ Specifically, additional evidence is needed on two important issues: first, the extent to which borrower risk will vary among the alternative mortgage instruments and second, how this increased risk will affect various segments of the population.

This study will examine these issues by first defining an appropriate concept of borrower risk based on potential rather than actual delinquency and then applying this concept to a large number of hypothetical mortgage loans under alternative loan specifications. The use of actual income data allows for an analysis of differences in borrower risk based on borrower characteristics as well as the terms of the mortgage.

I. Potential Delinquency and Borrower Risk

Previous studies of mortgage risk have concentrated on predicting the likelihood of a loan ending in foreclosure or becoming delinquent.⁵ Differences in delinquency or foreclosure rates are estimated for loans granted to borrowers with a variety of personal and financial characteristics. In the case of foreclosure, the initial loan to value ratio is usually found to be the most important explanatory variable while for delinquency such variables as borrower income and occupation are found to be important.

This approach cannot be used in the present study for a number of reasons. First, the use of foreclosure statistics is inappropriate in a study of borrower risk, since the determinants of foreclosure are primarily related to property and loan characteristics and would have only a marginal relationship to borrower characteristics.⁶ In the present study we are concerned with determining whether differences in risk exist among various segments of the population, thus ruling out foreclosure as an indicator of mortgage risk.

Whether or not delinquency is an appropriate mortgage risk concept depends to a large extent on whether risk is viewed from the borrower or lender side. From the lender's point of view, statistics on delinquency may be an excellent gauge of risk for their entire mortgage lending operation. That is, the lender should be able to predict with considerable accuracy the percentage of his loans which will be slow, and the percentage which will ultimately end in foreclosure.

While these statistics may prove accurate in the aggregate, it is unlikely that an institution will be able to predict the likelihood that an individual loan will later become delinquent. This is because delinquency, in all but the most extreme cases, involves a certain degree of choice. Faced with a reduction in income, for example, a particular borrower may choose not to pay some other obligation or reduce nonmortgage expenditures rather than become delinquent on his mortgage loan. In making this decision, the borrower will compare the costs of delinquency (penalty charges, harm to the borrower's credit rating, reduced future nonmortgage expenditures) with the costs of staying current (reduction in present nonmortgage expenditures to allow the mortgage to be paid). Since all of these costs are not explicit and must be evaluated subjectively, it is inevitable that borrowers

⁴ Existing studies which have at least partially dealt with these issues include Swan [9], Stansell and Millar [8], and Vandell [12].

⁵ See, for example, von Furstenberg [3, 4] and von Furstenberg and Green [5].

⁶ See Swan [9] and Webb [11] for an expanded discussion of this point.

will arrive at different decisions. Thus, the use of delinquency statistics as an indicator of mortgage risk is inadequate from the borrower's perspective since they fail to recognize the loss that results when a borrower reduces nonmortgage expenditures in order to avoid delinquency.

In addition to the problems cited above, there is a more fundamental difficulty which prevents the use of foreclosure or delinquency concepts in the present study. Previous studies of delinquency and foreclosure have used experience data which are not available for *AMI*'s which have only recently been introduced or in some cases have not yet been introduced at all. It is necessary, then, to introduce a new concept of mortgage risk which can be analyzed without the use of experience data.

As an alternative to actual delinquency data, we shall employ the concept of potential delinquency. We define a loan as being potentially delinquent if the borrower is forced to choose between delinquency on his mortgage loan and a reduction in nonmortgage expenditures, where nonmortgage expenditures are defined to include savings. The choice between mortgage delinquency and reduced nonmortgage expenditures will be required under each of the following conditions:

- (1) the mortgage payment increases while income remains constant or decreases;
- (2) income decreases while the mortgage payment remains constant or increases;
- (3) the mortgage payment increases more than income increases; and
- (4) the mortgage payment decreases less than income decreases.

Since income is exhausted by the sum of mortgage and nonmortgage expenditures (including saving), it is clear that each of these situations will require reduced nonmortgage expenditures in order to avoid delinquency. It should also be noted that each of the above situations involves an increase in the ratio of mortgage payments to income (M/Y). We thus alternatively define a potentially delinquent loan as a loan whose payment to income ratio increases.

Identification of a potentially delinquent loan by means of an increase in the payment to income ratio is useful in that it can be applied without the need for experience data and allows for a convenient categorization of the determinants of potential delinquency. Broadly speaking, we can consider these determinants under two categories: borrower characteristics, which will determine changes in income, and mortgage terms which will determine changes in the payment. Macroeconomic conditions are also important but can be considered in conjunction with these two categories.

Mortgage terms can affect the probability of potential delinquency by determining the timing and amount of changes in the mortgage payment. Such changes might be prearranged as with the graduated payment mortgage, based on changes in some reference interest rate as with the variable rate mortgage, or linked to movements in some price index as with the price level adjusted mortgage.⁷ The

⁷ It could be argued that the lower initial payments that accompany variable payment mortgages make these mortgages inherently less risky, particularly if the borrower invests the amount that is saved for the purpose of meeting higher future payments. It seems unlikely, however, that borrowers would exhibit such a degree of rationality. A far more reasonable assumption is that each borrower borrows up to his perceived limit, using any funds "saved" on account of lower initial payments to finance a larger principal or meet other nonmortgage expenditures.

extent to which payments will vary depends on the rate of inflation and changes in market interest rates as well as the choice of reference rate and specific limitations built into the mortgage contract. The mortgage terms to be used in this study are described below.

With respect to changes in income, we note that the M/Y ratio can increase as a result of a fall in income while the payment remains constant or increases, or an increase in income which is smaller than an increase in the mortgage payment. The first of these situations results largely from income variability around trend, while the second results from relatively slow income growth. Thus potential delinquency will result from borrower characteristics which tend to be associated with highly variable or slowly growing income.

In order to examine the sources of income variability and rate of growth, it will be convenient to break down total borrower income into its components:

$$TY = HLY + SLY + TRF + ASY$$

where TY is total income, HLY is the household head's labor income, SLY is a secondary labor income of husband or wife, TRF is transfer payments, and ASY is income from assets. We ignore income from children or other family members since income from these sources is unlikely to be used in support of household expenses.

Since in the majority of households the head's labor income will represent a high percentage of total income, we shall concentrate on this component. The growth rate of labor income will depend on such factors as occupation, age, sex, and race as well as general macroeconomic conditions. During inflationary periods these factors will determine the extent to which an individual's income keeps pace with the price level.

The major immediate cause of income variability is likely to be unemployment which is in turn determined by a combination of the factors given above. A given rate of aggregate unemployment will produce different unemployment rates for different demographic groups.

Smith, Wiest, and Field [7] (*SWF*) used sample data from the Panel Study of Income Dynamics to look for differences in income variability and trend based on age, sex, race, education, marital status, and occupation of the household head, and total family size. In their study variability was measured by the R^2 and trend by the slope of a regression of income on time for the period 1967-75. Selected results are given in Table I.⁸ These results show higher income variability for female and nonwhite household heads and for those over 45 years of age. Occupational differences are also apparent with professional, technical, and managerial workers having the lowest variability while the self-employed, farmers, and laborers have the highest variability.

⁸ We choose to ignore the *SWF* results for education, marital status, and family size for several reasons. First, education is likely to be highly correlated with occupation and to a lesser extent with race, sex, and age. The most likely chain of causation would be from education to occupation and then from occupation to income variability and trend. In other words the immediate cause is occupation and not education. Second, *SWF* found that family size and marital status have only "limited importance" in determining trend and variability after first considering the other variables. Third, any possible effect of marital status should be accounted for by an examination of any secondary labor income (see below).

Table I
Mean R^2 and Slope by Selected Attributes of
Household Head from Smith, Wiest, and Field
Demographic Study^a

Selected Characteristics	R^2	Slope
Age:		
Under 25	.60	1111
25 to 34	.57	1066
35 to 44	.55	1095
45 to 54	.46	738
55 to 64	.38	269
65 to 74	.44	246
over 75	.50	247
Sex:		
Male	.52	969
Female	.45	381
Race:		
White	.53	927
Non-White	.46	593
Occupation:		
Not in labor force	.45	322
Professional, technical	.61	1418
Managers, officials	.61	1337
Self-employed	.39	1069
Clerical, sales	.55	890
Craftsmen, foremen	.52	841
Operatives	.50	785
Laborers	.45	563
Farmers	.41	929

^a Smith, Wiest and Field [7]

In general, those attributes of the household head associated with high income variability are also associated with lower rates of growth. Thus, those under 44 years of age, males, whites, and professionals/managers have the highest income trend. There are some exceptions to this in that farmers and the self-employed have both relatively high income trend and variability.

The effects of secondary labor income, transfer income, and asset income on total income trend will depend on whether any of these components represents a significant portion of total income. Since in most families these components are likely to be small, their effect on income trend will in most cases be minimal. Variability, on the other hand, might be greatly influenced by these components. A secondary income might be stabilizing if it is used to offset a fall in the labor income of the household head, or it might be destabilizing if it is used as a temporary supplement where the income will be voluntarily terminated after being used, for example, to finance a specific purchase.⁹ Transfer payments are presumably stabilizing insofar as they at least partially offset reductions in labor income due to unemployment. Asset income is likely to represent such a small percentage of total income for most families that it can be expected to contribute little to income variability except in rare cases.

⁹ See Smith, Wiest, and Field [7], p. 5.

In summary, we have shown in this section that potential delinquencies can result from differences in borrower characteristics which produce differences in income variability and trend. Specific characteristics which are likely to affect the path of borrower income include occupation, age, sex, and race of the household head and the existence of any secondary labor income, transfer income and the income from assets.

II. Estimation of Potential Delinquency Model

In this section we apply the potential delinquency concept to actual mortgage payment and income data to determine which borrower and loan characteristics are associated with high probability of potential delinquency and thus high borrower risk. The methodology to be employed involves the calculation of hypothetical payment to income ratios for a large number of families over a period of eight years (1968–75). Using realistic assumptions about mortgage terms and actual income data, the relationship between borrower characteristics, mortgage terms, and potential delinquency can then be observed.

The data for borrower income and characteristics are taken from the Panel Study of Income Dynamics developed by the Survey Research Center at the University of Michigan.¹⁰ The advantage of these data is that economic variables such as income can be followed from year to year for individual families. Thus the problem of aggregation which other researchers have encountered can be avoided.

For the purposes of the empirical portion of this study, we shall consider three alternatives to a simple increase in the payment to income ratio as measures of potential delinquency. First, a borrower's M/Y ratio might increase for a short period of time and then fall to (or below) its initial level. Such a temporary increase might represent only a minimal loss to the borrower since only a temporary reduction in nonmortgage expenditures would be required. A definition of potential delinquency which would eliminate loans with only short term losses would be to consider as potentially delinquent only those loans whose payment to income ratio rises above its initial level for two consecutive years.

Second, a borrower's M/Y ratio might fall for one or more years and then

¹⁰ The Panel Study of Income dynamics is an ongoing survey of a wide range of economic and demographic characteristics of approximately 5000 families. At the time when this study was conducted, data were available for the interview periods 1968–76. Only data for interview periods 1969–76 (income data for 1968–75) are used in this study so that variable definitions can be consistently maintained.

The purposes of this study also suggested the elimination of certain observations from the sample. First, families were eliminated if the household head was in the armed services, not in the labor force during 1968, or if the household head reported his occupation as "unemployed" for the entire year (1968). It is unlikely that families with household heads in these groups would be seeking mortgages, and if they did their circumstances would be so unique as to be uninteresting in this study. Second, families where the household head was 58 years of age or older during 1968 were also eliminated. This was to avoid the possible problem of observing many large increases in payment to income ratios due to retirement. Third, families were eliminated if there was a change in the person given as head of the household at any time during the sample period. Changes in family income resulting from a change in the household head could well lead to potential delinquency but the cause would be uninteresting from the point of view of this study. After these eliminations, the size of the sample was 2181 families.

increase. Since the borrower actually benefited from the lower ratio, this gain might be taken into account when defining potential delinquency. In order to consider both gain and loss, we can define a loan as potentially delinquent when its *cumulative* M/Y ratio increases above the initial level. Thus, under this definition a loan would only be classified as potentially delinquent if any given rise in the ratio is sufficient to offset any previous decline.¹¹

Third, a trivial increase in the M/Y ratio would be unlikely to cause real hardship for the borrower. In order to eliminate such trivial increases we can consider a loan to be potentially delinquent only when the M/Y ratio increases by at least 10 percent over its initial value.

In summary, then, we have the following alternative definitions of potential delinquency:

PD1: If for any period t , $\frac{M_t}{Y_t} > \frac{M_0}{Y_0}$ then the loan is potentially delinquent.

PD2: If for any consecutive periods t and $t + 1$, $\frac{M_t}{Y_t} > \frac{M_0}{Y_0}$ and $\frac{M_{t+1}}{Y_{t+1}} > \frac{M_0}{Y_0}$ then the loan is potentially delinquent.

PD3: If $\frac{\sum_{t=0}^t M_t}{\sum_{t=0}^t Y_t} > \frac{M_0}{Y_0}$ then the loan is potentially delinquent.

PD4: If for any period t , $\frac{M_t}{Y_t} > (1.10) \frac{M_0}{Y_0}$ then the loan is potentially delinquent.

Given these definitions of potential delinquency, it is not necessary to use mortgage payment formulas to calculate payments for a particular loan and then compute M/Y ratios in order to identify a potential delinquency. A simpler approach is to calculate the change in payments relative to the initial payment for each year and mortgage type. These figures can then be compared with changes in each borrower's income¹² to determine if the loan is potentially delinquent. For example, in the case of the standard fixed rate mortgage, any fall in income below the initial level causes a potential delinquency. In the case of a price level adjusted mortgage, income must grow as fast as the rate of inflation in order to avoid potential delinquency (using PD1). This approach gives identical results to the more complicated method of computing actual M/Y ratios for each loan.

¹¹ We must emphasize the arbitrary nature of these definitions. In reality, the borrower might permanently adjust to the lower M/Y ratio and suffer extreme hardship as a result of any later increase. Our purpose is to experiment with these definitions to see if differences in the numbers of potential delinquencies can be noted.

¹² For the purposes of this study, borrower income is defined as the sum of the household head's labor income, any secondary labor income (defined as the wife's income), transfer payments, and income from assets. Labor income in the Panel Study of Income Dynamics data is defined to include wages, bonuses, overtime, commissions, professional practice, and the labor part of farm income, business income, and the income from roomers and boarders. Transfer income includes welfare other than ADC, Social Security, other retirement compensation, unemployment and workmen's compensation, alimony, child support, and gifts from relatives. Asset income includes the asset portion of income from farm, business, roomers, etc., plus income from rent, interest, and dividends. Income from children and other family members is ignored since it would not likely form an integral part of the household budget.

Relative changes in mortgage payments were derived for each of six *AMTs* using the following assumptions:¹³

- FRM*: standard level payment, fixed rate mortgage.
- VRM1*: variable rate mortgage using the rate on new issues of 3 month U.S. Government bills as the reference rate; maximum allowable yearly adjustment in mortgage rate is $\frac{1}{2}$ of one percent; no adjustment is made unless the spread between the mortgage and the reference rate exceeds the initial spread by + or - .001; initial spread based on the average rate on conventional first mortgage loans in January 1968 less one half of one percent.
- VRM2*: same as *VRM1* except the rate on U.S. Government notes and bonds maturing in 3-5 years is used as the reference rate.
- PLAM*: price level adjusted mortgage indexed to the Consumer Price Index; payments are adjusted by the amount of the percent change in the *CPI* in the year prior to the start of the period for which the payment is being calculated.
- GPM*: graduated payment mortgage with a three percent per year rate of graduation over the entire period.
- CPF-VRM*: constant payment factor, variable rate mortgage; payment factor is fixed at three percent; variable debiting factor is tied to the three month bill rate, in the same way as the *VRM1* above.

Using the procedure outlined above, the number of potential delinquencies was determined for each mortgage instrument and *PD* definition combination. These results are summarized in Table II. The number of potential delinquencies ranged from 171 for the *FRM* and *PD4* combination to 1533 for the *PLAM* and *PD1* combination. It is interesting to note the large number of families that would experience some loss due to potential delinquency. Of the 2181 families, 1136 or 52.1% experienced a fall in family income below the 1968 level at some time during the sample period.

Looking at differences based on *PD* definition, *PD1* produced the largest number of potential delinquencies for all mortgage instruments. This, of course, was to be expected since a loan that is potentially delinquent according to any of the other definitions would also be potentially delinquent according to *PD1*. *PD2* (sustained 2 year increase in *M/Y*) produced the fewest potential delinquencies for all mortgages except the *FRM*, where *PD4* produced the smallest number. This suggests that a family is more likely to incur a large increase in its *M/Y* ratio (greater than 10%) than it is to experience an increase of any magnitude which lasts for two years or more.

Looking next at differences between the mortgage instruments, the smallest number of potential delinquencies was produced by the *FRM* for each *PD* definition. This reflects the fact that the *FRM* has constant payments and can only become potentially delinquent as a result of a fall in income. The *PLAM* produced the largest number of potential delinquencies for each *PD* definition.

¹³ For a more detailed discussion of these mortgage instruments including payment calculation formulas, see Cohn and Fischer [1]. It should be noted that no attempt was made to adjust payments for differences in taxes resulting from the deduction of interest payments from taxable income. Such an adjustment would have reduced the impact of higher interest rates on the *M/Y* ratios of the *VRM* and *CPF-VRM*.

Table II
Potential Delinquencies by Type of Mortgage and Definition of
Potential Delinquency
Total $N = 2181$

Type of Mortgage	Definition of Potential Delinquency				Mean
	PD1	PD2	PD3	PD4	
	Number (%)	Number (%)	Number (%)	Number (%)	
FRM	1136 (52.1)	604 (27.7)	852 (39.1)	171 (7.8)	691
VRM1	1362 (62.4)	814 (37.3)	1025 (47.0)	1031 (47.2)	1058
VRM2	1376 (63.1)	832 (38.1)	1025 (47.0)	1041 (47.7)	1069
PLAM	1533 (70.3)	1024 (47.0)	1055 (48.4)	1230 (56.4)	1211
GPM	1379 (63.2)	856 (39.2)	997 (45.7)	1055 (48.4)	1072
CPF-VRM	1425 (65.3)	914 (41.9)	1029 (47.2)	1099 (50.4)	1117

For the *PLAM* and *PD1* combination, 70 percent of the sample loans were potentially delinquent meaning that family income failed to keep pace with the rate of inflation for 70 percent of the sample families. In terms of the mean number of potential delinquencies over all *PD* definitions, the *CPF-VRM* placed second to the *PLAM* for most potential delinquencies with two *VRM*'s and the *GPM* all producing approximately the same number of potential delinquencies.

Potential Delinquency and Borrower Risk

Our general model of borrower risk is given by

$$P(PD_n)_I = F(\dots) \quad (1)$$

where $P(PD_n)_I$ is the probability of potential delinquency according to definition n for the I th mortgage instrument, and $F(\dots)$ represents a function of the variables described above in Section I. Specific variable definitions used in the estimation of Equation (1) are given in Appendix A. Equation (1) was estimated using the Tobit estimation technique in order to ensure that predicted values of the dependent variable fall in the interval 0 to 1 and can thus be interpreted as probabilities. Regression results are given in Table III. Rather than the regression coefficients and standard errors, we report instead the signs and significance levels¹⁴ for the coefficients of each variable by *PD* definition and type of mortgage. These results are summarized below.

¹⁴ Significance levels were determined by employing a two-tail "*t*" test. These should be interpreted with caution, however, since the test statistics were not exact "*t*" statistics but rather asymptotically normal variables. Thus the test statistic approaches the normal distribution as the sample size approaches infinity. The test remains useful for our purposes, however, since we are more concerned with the relative importance of the variables than with exact significance levels. Nevertheless, given the relatively large sample size, we can assume that the significance levels shown are useful approximations.

Table III
Signs and Significance Levels for Estimated Coefficients of Equation (1)

	PD1				PD2				PD3				PD4					
	FRM	VR1	VR2	GPM	PL M	CPF	FRM	VR1	VR2	GPM	PL M	CPF	FRM	VR1	VR2	GPM	PL M	CPF
DSEX	-	-	-	-	+	-	- ¹	-	-	-	-	-	-	-	-	-	- ²	-
DRAC	- ¹	-	-	-	-	-	+	+	+	+	+	-	+	- ¹	- ²	- ¹	+	-
EXJB	+	+ ²	+ ²	+	+ ²	+ ²	+	+	+	+	+	+	+	+	+	+	+	+
AGE	-	+	+	+	+	+	-	+	+	+	+	+	+ ¹	-	-	-	+	-
AGSQ	+	-	-	-	-	-	+	-	-	-	- ²	-	-	+	+	-	-	+
HVYO	+ ³	+ ¹	+ ¹	+ ²	+	+	+ ¹	+	+	+	+	+	-	+	+ ³	+ ³	+ ²	+
LTYO	+	+ ²	+ ³	+ ²	+ ²	+ ²	+ ³	+	+	+	+	+	-	+ ²	+ ²	+ ¹	+ ²	+
ASY/TY	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+ ³	+	+ ³	+ ³	+ ³	+ ³	+
TRF/TY	+	+	+	+	-	-	+ ²	+	+	+	+	+	+	+	+	+	+	+
DWWS	+ ³	+ ³	+ ³	+ ³	+ ²	+ ³	+ ³	+	+	+	+	+ ¹	-	+ ³	+ ³	+ ³	+ ³	+

¹ significant at the 10 percent level.

² significant at the 5 percent level.

³ significant at the 1 percent level.

All significance levels are for two tail tests; see footnote 14 for interpretation.

Personal Characteristics of Household Head

Personal characteristics of the household head (sex, race, and age) did not prove to be highly significant in predicting the probability of potential delinquency. It is likely that the failure of these variables to add significantly to the regressions is due to their relationship to other variables in the model, particularly those related to occupation. It should also be noted that since families with unemployed household heads at the start of the period were deleted, it is likely that a disproportionate percentage of families headed by nonwhites and females were also eliminated.

It was expected that the coefficient of the dummy variable indicating the sex of the household head ($DSEX = 1$ for male and 0 for female) would be negative, indicating a higher probability of potential delinquency for female household heads. $DSEX$ consistently had the expected sign but was only significant for the $PD2$ and FRM combination. The significance of the coefficient for this combination could reflect a higher likelihood of prolonged reductions in income for female household heads.

The expected sign of $DRAC$ was also negative which would indicate a higher probability of potential delinquency for nonwhite households heads. The estimated coefficients for $DRAC$ were generally negative for $PD1$, $PD3$, and $PD4$ combinations while positive for $PD2$. All of the significant coefficients, however, appeared in $PD1$ or $PD4$ combinations. Of particular interest are the significant negative coefficients for $PD4$ in combination with $VRM1$, $VRM2$, $PLAM$, GPM , and $CPF-VRM$. Apparently there is no difference between white and nonwhite borrowers in terms of the probability of potential delinquency for the various mortgage instruments. Race does appear to play a role, however, in the severity of a potential delinquency. Since $PD4$ represents a "severe" increase in the M/Y ratio (greater than 10%) we conclude that families headed by nonwhite household heads are more likely to experience a "severe" increase in M/Y (operating through a reduction in Y) without regard to the terms of the mortgage instrument. This is no doubt the result of a higher probability of unemployment for nonwhites which would result in large reductions in income and thus severe increases in M/Y .

The expected sign of the coefficient for the age of household head variable was not clear. The SWF data cited in Section I suggested the possibility of a positive relationship, with higher ages being associated with higher probability of potential delinquency. Aggregate unemployment data, on the other hand, suggest the possibility of a negative relationship since the rate of unemployment tends to decline with age. The significant estimated coefficients were in fact positive, which may be largely the result of using essentially the same data as in the SWF study. The significance of the $PD2$ and $PLAM$ combination would appear to indicate that the incomes of older household heads had a more difficult time keeping pace with the rate of inflation than did the incomes of their younger counterparts. This was confirmed by the significance of the $AGSQ$ coefficient for the same combination, thus indicating a change in the sign of the age-potential delinquency relationship from negative to positive.¹⁵

¹⁵ Apparently, the growth rate of income actually increased in the early stages of the earnings life-cycle but then declined for older workers. This led to a change (from negative to positive) in the relationship between age and PD via the $AGSQ$ variable.

Occupational Differences in Income Trend and Variability

The coefficients of *HVYO* and *LTYO* both proved to be significant in a large number of the regressions. All of the significant coefficients had positive signs as expected, indicating that occupations with higher than average income variability or lower than average income growth are positively related to a higher probability of potential delinquency. The biggest difference in these two variables was in the *PD2* and *PD3* potential delinquency definitions. The coefficient of *LTYO* was significant in all *PD2* combinations but not in any *PD3* combinations, while the coefficient for *HVYO* was significant in two *PD3* combinations but only one *PD2* combination (with *FRM*).

This is not surprising since *PD2* represents a sustained two year increase in *M/Y* which could be expected to result from a low trend rate of growth rather than high income variability. On the other hand, a highly variable income might be more likely to lead to a higher cumulative *M/Y* than would a low trend rate of growth. It is interesting that differences based on *PD* definition appear to be more important than differences in the mortgage instruments. Apparently low income trend and high income variability are sufficient causes of potential delinquency irrespective of the existence or extent of changes in mortgage payments.

Source of Income

Coefficients of variables relating to the source of family income (*EXJB*, *DWWS*, *TRF/TY*, *ASY/TY*) were significant in a large number of cases with coefficients for *DWWS* and *ASY/TY* producing consistently high significance levels.

The signs of the *EXJB* coefficients were all positive, indicating that household heads with extra jobs had a higher probability of potential delinquency. With one exception, however, the only significant coefficients were in combinations involving *PD1*. Since *PD1* is the least restrictive definition, it would seem that an extra job for the household head can lead to short and minor changes in *M/Y*, but is generally not related to sustained or major changes in *M/Y*.

A change in the wife's work status (*DWWS*) was also positively related to potential delinquency. This supports the hypothesis that a secondary income tends to destabilize rather than stabilize total family income. No clear differences between mortgage instruments were observed, however.

The coefficients of *TRF/TY* were generally positive suggesting that the higher the ratio of transfer income to total income, the higher the probability of potential delinquency. A significant difference between mortgage instruments was apparent for this variable. Coefficients were significant only for *FRM* and *GPM* combinations suggesting that high variability or low trend of transfer income is sufficient to produce potential delinquency without accompanying variation in payments. It would appear that transfer income variability is the major problem since low trend should have produced more potential delinquencies in *PLAM* or *CPF-VRM* combinations.

Finally, the most surprising results were obtained for *ASY/TY*. The coefficients of this variable had the most consistently high levels of significance, with the

signs being uniformly positive. It is the positive sign, implying a positive relationship between the ratio of asset income to total income and potential delinquency that is difficult to explain. It is possible that asset income is more variable or tends to have a lower trend rate of growth than does labor income. The results here tend to support both of these contentions, since the sign and significance does not vary with either mortgage type or *PD* definition.

III. Conclusions

The purpose of this study was to analyze differences in borrower risk under alternative mortgage instruments and various borrower characteristics. For this purpose a model of potential rather than actual delinquency was developed which made it possible to consider differences in risk without the use of experience data.

The results indicated that all of the *AMI*'s studied (*VRM*, *GPM*, *PLAM*, *CPF-VRM*) were riskier than the fixed rate mortgage, based on the number of potential delinquencies. Defining risk as the mean number of potential delinquencies over the various *PD* definitions, the most risky mortgages were found to be the *PLAM* and the *CPF-VRM*. Evidently the risk associated with small, steady, and in the case of the *GPM*, certain increases in payments can be smaller than the risk associated with payments which have the *potential* for larger and more uneven increases. Of course, this conclusion might be different if the terms of the *GPM* allowed higher rates of graduation than the 3% assumed in this paper. In addition, it is apparent that mortgages whose payments show a higher degree of fluctuation with a relatively slow rate of growth (*VRM*) or a steady but slow rate of growth (*GPM*) are less risky than mortgages whose payments increase steadily but at a relatively high rate of growth (*PLAM* and *CPF-VRM*). These conclusions may, of course, be sensitive to the time period studied.

Personal characteristics of the household head were generally not significant in determining the probability of potential delinquency. Some evidence was found to indicate that nonwhite household heads were somewhat more likely to experience a *severe* potential delinquency. This no doubt results from higher unemployment rates among nonwhites. In addition, some evidence was found to suggest that older household heads were more likely to experience potential delinquency, particularly under *PLAM* or *CPF-VRM* loans. Other loans showed no significant differences in the number of potential delinquencies based on age.

Thus in terms of personal characteristics of the household head, we conclude that at least some *AMI*'s are appropriate for all borrowers without regard to race, sex, or age. Older borrowers would be wise to avoid the *PLAM* or *CPF-VRM* unless they have reason to be confident that their income can keep pace with the rate of inflation. While nonwhites are more likely to experience *severe* potential delinquency, this is no more likely to occur with *AMI*'s than under the standard fixed rate mortgage.

Occupational differences in income trend and variability were found to be very important in determining the probability of potential delinquency, and the strength of these relationships did not vary with the terms of the mortgage instrument. Finally, the results indicated that the sources of income were very important determinants of potential delinquency. Again, the strength of these

relationships did not vary among different mortgage instruments.

Though the relationship between most of the variables discussed above and the probability of potential delinquency did not vary with the type of mortgage instrument, we are still left with the fact that some *AMI*'s produced considerably more potential delinquencies than others. The reason for this would seem to be twofold. First, any of the variables which were significantly related to the probability of potential delinquency were apparently able to produce potential delinquency without being reinforced by changes in mortgages payments. A borrower with high risk characteristics will be likely to have a potentially delinquent loan whether or not the mortgage has highly variable payments. It should be noted, however, that the significance of borrower characteristics *was* related to the definition of potential delinquency. In other words, borrower characteristics are important determinants of the severity or duration of an increase in the mortgage payment to income ratio.

Second, the *AMI*'s with the widest variation in payments are fully able to produce potential delinquencies without regard to the characteristics of the borrower. Again it is the severity and duration of the potential delinquency that is most closely related to borrower characteristics.

APPENDIX A

Definition of Variables

DSEX: dummy variable for indicating the sex of the household head; male = 1; female = 0. 1785 of the 2181 families in the sample were headed by males.

DRAC: dummy variable for indicating the race of the household head; white = 1; nonwhite = 0. 1367 families had a white household head while 814 were headed by nonwhites.

EXJB: dummy variable indicating whether or not the household head held a second job in the year the hypothetical mortgage was begun; extra job = 1; no extra job = 0. 419 of the 2181 household heads held an extra job in 1968.

AGE: age of household head in 1968 in years

AGSQ: age of household head in 1968 squared.

HVYO: dummy variable indicating that the household head held an occupation with relatively high income variability, based on the results of the SWF study cited above. Out of 8 occupational groups, those with the highest income variability were: self-employed, farmers, laborers, and operatives. *HVYO* = 1 if household head held a job with high income variability (one of the four groups listed above); *HVYO* = 0 otherwise. 1054 of the 2181 household heads held a job with high income variability in 1968.

LTYO: dummy variable indicating that the occupation of the head had relatively low income trend, again using the SWF results to classify occupations. Low income trend occupations were: laborers, operatives, craftsmen and foremen, clerical and sales. *LTYO* = 1 if household

head held a job with low income trend; $LTYO = 0$ otherwise. 1546 of 2181 household heads held a job with low income trend in 1968.

ASY/TY: ratio of asset income to total family income.

TRF/TY: ratio of transfer income to total family income.

DWWS: dummy variable to indicate a change in the wife's work status, whether from work to no-work or no-work to work, at any time during the sample period. $DWWS = 1$ indicates a change; $DWWS = 0$ if no change. 973 of the 2181 families experienced such a change.

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