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An Analysis of the Impact of Interest Rate Ceilings

DANIEL J. VILLEGAS*

ABSTRACT

The first aim of this study is to estimate the interest rates paid for motor vehicle loans. The second aim is to identify those potential borrowers most likely to be rationed out of the market by the imposition of rate ceilings. Rate ceilings constrain the rates paid by successful loan applicants to be no greater than the applicable ceiling level. These constraints are dealt with by treating the interest rate paid as a variable truncated at the ceiling level. Assuming the dependent variable is truncated normal, consistent estimates are obtained by employing the maximum likelihood method of Hausman and Wise.

THE NOTION THAT HIGH risk borrowers are rationed out of the market for credit as a result of legally established ceilings on interest rates has been a prevailing conclusion of previous studies dealing with this subject. It is said that the lower the ceiling the greater is the number of rationed potential borrowers. For the most part, these previous studies have employed aggregated data for states or lending firms. At this level of observation these studies have attempted to explain the relationship between the ceiling level and the total volume of loans granted, the average rejection rate, the average interest rate paid, or the average level of risk assumed by lenders.[1] Little has been done, however, to analyze the economic impact of rate ceilings at the household level.[2]

This study is based on data reported by individual households financing the purchase of a motor vehicle, and it has a dual aim. The first aim is to uncover the determinants of the interest rates facing potential borrowers in the market for motor vehicle loans. This is accomplished using the model of hedonic prices as has been suggested by Baltensperger [3] and Barro [4]. Thus the interest rate paid is regressed on variables representing the attributes or characteristics of a loan. Having estimated how interest rates are determined, the second aim is to identify those potential borrowers most likely to be rationed out of the market by the imposition of rate ceilings for motor vehicle loans.

Stafford and Dunkelberg [25] ran an OLS regression with the interest rate paid for an auto loan as the dependent variable; they concluded that socioeconomic characteristics of the borrower as well as loan terms were important determinants

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[1] Nathan [18] has written a brief survey of previous studies.

[2] Household data have been used in studies by Dunkelberg [6], Eisenbeis and Murphy [8], and Long [17]. These studies and the present paper each offer a different approach to this subject.

of the rate paid. Yet, their analysis ignored the existence of rate ceilings, and quite arbitrarily they chose to truncate the rates paid at 36 percent per annum. In the present study the existence of rate ceilings is directly incorporated into the analysis. Rate ceilings constrain the rates paid by successful loan applicants to be no greater than the applicable ceiling level. These constraints are dealt with by treating the interest rate paid as a variable truncated at the ceiling level. Using the logarithm of the interest rate paid as the dependent variable, OLS estimation produces biased results if the ceilings are effective. Assuming the dependent variable is truncated normal, consistent estimates for the determinants of interest rates are obtained by employing the maximum likelihood method proposed by Hausman and Wise [14].

In contrast to the approach I adopt in this paper, Greer [9], Greer and Nagata [11], Peterson [20], Peterson and Ginsberg [19], Shay [23], Smith [24] and Wolken and Navratil [27] do not explicitly take into account the constraints on interest rates paid due to rate ceilings, when estimating the impact of rate ceilings on rates paid. Instead, they attempt to estimate the impact of ceilings by including a variable representing the level of ceilings in an OLS regression on average interet rates paid.[3] Aside from the fact that with effective ceilings OLS estimates are subject to truncation bias, the empirical results of these studies are undermined by the absence of a convincing explanation as to how rate ceilings affect rates paid. It is not clear what hypothesis about the behavior of credit markets is being tested by the inclusion of a ceiling variable in the regression equation. If the logarithm of the interest rate paid is a truncated normal dependent variable, then the approach in this paper leads to consistent estimates while at the same time offering a logical explanation for the relationship between rate ceilings and rates paid.

A brief discussion of the theory of credit markets underlying the analysis and its connection with the empirical methodology is reviewed in the first section of this paper. The second section describes the source of data and presents the variables used in the hedonic regression. In the third section, the results of the hedonic regression are examined. The fourth section illustrates the error in using OLS with ceiling variables to analyze the impact of effective rate ceilings. Finally, the impact of rate ceilings on the availability of credit and on the expected value of interest rates is simulated in the fifth section.

I. Theory and Methodology

A loan is considered here as multifaceted good with a set of attributes including the riskiness of the loan, the terms of the loan, and the origin of the loan. It is assumed that for each and every prospective loan to potential borrowers there is a specific equilibrium rate of interest arising from conditions of supply and demand.[4] The equilibrium rate of interest for a particular loan is presumed to be

[3] In order to explicitly account for the constraints on rates paid due to rate ceilings, it is necessary to make an assumption about the distribution of rates paid and how it is affected by rate ceilings. As stated, in this paper I assume that the log of the interest rate paid is a truncted normal dependent variable, with the log of the ceiling level as the truncation point.

[4] Prospective loans are defined to be all loans that would be applied for in the absence of a ceiling.

a function of its specific attributes and the market-determined hedonic prices of those attributes.[5] Assuming a semilog hedonic equation with a normally distributed error term the basic model is:

$$\ln r_i = X_i'\beta + \epsilon_i \tag{1}$$

where i indexes the loans to potential borrowers, r is the equilibrium rate, X is the vector of loan attributes and a constant term, β is the vector of hedonic prices for loan attributes and an intercept, and ϵ is the error term distributed $N(0, \sigma^2)$ and $E[\epsilon_i\epsilon_j] = 0$ for $i \neq j$. It follows that, conditional on X_i, $\ln r_i$ is normally distributed, and r_i is lognormally distributed.[6]

So far this model presents no obstacle to OLS estimation of β using observed rates paid for r_i in Equation (1). However, a rate ceiling, say at level c, would prohibit loans to potential borrowers with an equilibrium rate greater than c. The only observed rates paid would be those of loans for which the equilibrium rate falls within the acceptable range: $r_i \leq c$. Whereas in the absence of a rate ceiling the conditional distribution of observed rates paid is identical to the conditional distribution of equilibrium rates, with a ceiling observed rates paid originate from the conditional distribution of equilibrium rates truncated at the ceiling level. OLS estimation of β using observed rates paid effectively constrained by a ceiling produces biased results, because $E[\epsilon_i | r_i < c] \neq 0$ and $\mathrm{Cov}[\epsilon_i, X_i \mid r_i < c] \neq 0$. Yet, following Hausman and Wise [14], a maximum likelihood estimate of β which is consistent and asymptotically normal may be obtained using observed rates paid, even if those rates are constrained by ceiling. This is achieved by treating the error term as coming from a truncated normal distribution, or equivalently by treating the logarithm of the observed rate paid as a truncated normal dependent variable. (Henceforth this procedure will be referred to as HW estimation.)

The probability that a prospective loan will be rejected (i.e. not qualify for acceptance) is assumed to be identical to the conditional probability that the equilibrium rate for the loan exceeds the ceiling and is given by:

$$\rho_i = P[r_i > c_i \mid X_i] = 1 - \Phi[(\ln c_i - X_i'\beta)/\sigma] \tag{2}$$

where Φ is the standard normal cumulative distribution function, and c_i is the applicable ceiling level for loan i. This relation captures the most interesting consequence of the truncation effect of rate ceilings. From this specification it is clear that the conditional probability of rejection is inversely related to the ceiling level.

The following two equations (3) and (4) give the expected value of the equilibrium rate conditional on X_i under two differing circumstances. Considering

[5] Rosen [21] provides an outline of the theory of hedonic prices. See also Triplett [26] for a description of the hedonic technique.

[6] The NCCF survey [22] found that the rates charged for unsecured personal loans and FHA home improvement loans were concentrated at the ceiling level, whereas a wide dispersion of rates was found for automobile loans, mobile home loans, non-FHA home improvement loans, and secured personal loans. This suggests that the normality assumption may be appropriate in an analysis of the latter types of loans but inappropriate in an analysis of unsecured personal loans and FHA home improvement loans.

the whole or untruncated distribution of the equilibrium rate, that is, without knowing whether the loan does or does not qualify for acceptance, the expected value is given by

$$\theta_i = E[r_i \mid X_i] = \exp(X_i'\beta + \sigma^2/2) \tag{3}$$

However, the expected value considering the truncated distribution of the equilibrium rate ($r_i < c_i$), that is, assuming the loan does qualify for acceptance, is given by the expression below:

$$\theta_i^* = E[r_i \mid X_i, r_i \leq c_i] = \exp(X_i'\beta + \sigma^2/2) \cdot \frac{\Phi[(\ln c_i - X_i'\beta - \sigma^2)/\sigma]}{\Phi[(\ln c_i - X_i'\beta)/\sigma]} \tag{4}$$

The last term in Equation (4) is due to the truncation effect, where $\ln c_i$ is the truncation point. In the absence of a rate ceiling ($c_i = \infty$) this term is equal to one, so in this case $\theta_i^* = \theta_i$. With an effective rate ceiling, this term is less than one, so $\theta_i^* < \theta_i$. Furthermore, this term is directly related to the truncation point, meaning that a reduction in the rate ceiling lowers θ_i^* although θ_i remains the same.

In sum, as a result of the truncation effect a reduction in the rate ceiling raises the probability of rejection (ρ_i), reduces the expected value of rates on loans that qualify (θ_i^*), but does not affect the mean of the underlying conditional distribution of equilibrium rates (θ_i).

II. The Data and Regression Variables

The source of the household data utilized in this study is the 1972–73 BLS Consumer Expenditure Survey.[7] This survey contains information about the purchase during the survey period of 8,230 automobiles, trucks, and campers for personal use. The data for the HW estimation of the hedonic regression include 1,039 purchases reported to have been financed at least in part by a loan. This data set excludes purchases financed by loans which were: (1) made between individuals; (2) not scheduled to be repaid on a regular monthly basis; (3) scheduled to be repaid in less than one year; (4) transacted for an amount less than $1,000; or (5) repaid in payments which also provided for motor vehicle insurance.[8]

Table I lists the regression variables and presents their definitions. The qualitative variables are set equal to 1 for observations that coincide with the definition and are set equal to 0 otherwise. Since the riskiness of a loan is not directly

[7] See Carlson [5] for a description of this survey.

[8] Loans with rates either above the truncation point or below 6% APR were also dropped from the regression data. In many states the ceiling level depends upon the age of a vehicle, but the age of used vehicles was not included in the data. Therefore, the truncation point for all used vehicles in each of these states has been set at the state's lowest ceiling level for used vehicles. For this reason, used vehicle loans with rates above this ceiling have been dropped from the regression data. A majority of the loans with rates below 6 percent are suspected to include reporting errors. Thus, all loans with an APR below 6 percent have been dropped from the data, and ln 6 is used as a lower truncation point in the HW estimation. Nevertheless, the lower truncation by itself caused no significant change from the OLS results.

observable, variables representing the socioeconomic characteristics of the borrowing household are included as possible proxies for the level of risk associated with a loan.[9] Note that total household expenditure is used instead of household income; it is felt that total expenditure is a better measure of permanent income. Besides the borrower characteristics, variables representing the terms of a loan and the origin of a loan are also included in the hedonic regression examined in the next section.

The state interest rate ceilings pertaining to motor vehicle loans have been obtained from the *Cost of Personal Borrowing in the United States, 1972 Edition* [12]. For each loan the applicable ceiling level has been ascertained and is used as the truncation point in the HW estimation. Additionally, the fifty states and the District of Columbia have been divided into four categories according to their policies on rate ceilings. The first category is composed of those states which had no ceilings on interest rates for motor vehicle loans. In the other categories, some states established ceilings depending upon the class or age of a vehicle, other states established ceilings depending upon the loan amount, and still other states established a single ceiling for all vehicle loans. Within these last three categories, states have been classified as having high, moderate, or low ceiling levels.[10] In the fourth section of this paper this classification scheme is used to define the ceiling variables: HICEIL, MODCEIL, and LOCEIL. In that section these ceiling variables are included in the hedonic regression in order to illustrate the error in the OLS approach.

III. The Regression Results

The results of the HW estimation of the hedonic regression are presented in Table I; the OLS estimates based on the same data set are also shown for comparison. If rate ceilings are so high as to be ineffective, the OLS and HW estimates will be approximately equal; otherwise we expect the OLS and HW estimates to differ. Hausman's specification test [13] indicates a significant overall difference between the OLS and HW estimates of Table I, suggesting that the rate ceilings are effective and the truncation effect should be accounted for.[11]

[9] Similarly, lending institutions measure the level of risk by including borrower characteristics in their credit scoring models. EQUITY is also included in the regression equation as a possible proxy for risk.

[10] Across the 8,230 vehicles surveyed a "typical" new vehicle loan was a 36-month loan for $2,900, and a "typical" used vehicle loan was a 24-month loan for $1,500. The average of the rate ceilings for these two "typical" loans has been computed for each state. States with an average below 15 percent are classified as low-ceiling states; states with an average between 15–19 percent are classified as moderate-ceiling states; and states with an average above 19 percent are classified as high-ceiling states.

[11] The Hausman specification test allows us to test the null hypothesis of normal errors with no truncation against the alternative hypothesis specifying the existence of truncation. Under the null hypothesis, both the OLS and the HW estimates are consistent. Under the alternative hypothesis, the OLS estimates are biased and inconsistent, whereas the HW estimates remain consistent. The Hausman "m" test statistic was computed jointly for the 33 regression estimates. Using the HW estimate for the variance of the error ($\sigma^2 = 0.20$), "m" equals 50.04, which is above the critical value of 47.40 for a χ^2 (d.f. = 33, $\alpha = .05$) variable. So the null hypothesis is rejected.

Table I

Results of the OLS and HW Hedonic Regressions
Dependent Variable = Ln (annual percentage interest rate paid)

Variable Names and Definitions[a]		OLS Estimates[b]	HW Estimates[c]
A. Borrower Characteristics			
EXPEND	total household expenditure	−0.0245[d]	−0.0562[d]
		(0.0075)	(0.0201)
$EXPEND^2$	squared household expenditure	0.0007[d]	0.0014[d]
		(0.0002)	(0.0005)
ASSETS	total financial assets (000's)	−0.0028[e]	−0.0077
		(0.0017)	(0.0056)
DEBT	total installment debt (000's)	−0.0028	−0.0082
		(0.0057)	(0.0167)
HDLE25	1 = household head 25 or younger	−0.0373	−0.0802
		(0.0320)	(0.0921)
HDGE60	1 = household head 60 or older	0.0060	0.0102
		(0.0351)	(0.0963)
HDHSGD	1 = household head high school grad	−0.0123	−0.0123
		(0.0205)	(0.0589)
HDCGGD	1 = household head college grad	−0.0493[e]	−0.1606[e]
		(0.0293)	(0.0905)
HDBLK	1 = black household head	−0.0749[d]	−0.2377[d]
		(0.0351)	(0.0961)
SGLMALE	1 = single male	−0.0011	0.1025
		(0.0490)	(0.1443)
SGLFEM	1 = single female	−0.1196[d]	−0.2633
		(0.0541)	(0.1614)
HWWOC	1 = couple without children	−0.0336	−0.0892
		(0.0269)	(0.0830)
SGLWC	1 = single with children	0.1158[d]	0.2715[e]
		(0.0449)	(0.1429)
OTHHLD	1 = other household types excluding couples with children	−0.0297	−0.0379
		(0.0294)	(0.0815)
MOVESY	1 = household moved into its home during survey year	0.0345	0.0845
		(0.0290)	(0.0825)
RENTHM	1 = household rents its home	0.0234	0.0264
		(0.0235)	(0.0660)
RURAL	1 = rural household location	0.0065	−0.0424
		(0.0195)	(0.0575)
B. Terms of the Loan			
LOAN	amount of the loan (000's)	−0.1484[d]	−0.3407[d]
		(0.0419)	(0.1282)
$LOAN^2$	squared amount of loan	0.0160[d]	0.0361[e]
		(0.0066)	(0.0211)
LENGTH	length of the loan (years.)	0.2785[d]	0.9487[d]

[a] Excluded loan attributes are: household head between 25 and 60, household head not a graduate, white household head, couple with children, household moved into home before survey year, household owns its home, urban household location, loan for a new vehicle, loan for an automobile, bank loan, period of low prime rates (1/72–6/73) and eastern U.S.

[b] The figures in parentheses are standard errors.

[c] The figures in parentheses are asymptotic standard errors.

[d] Significant at the $\alpha = .05$ level.

[e] Significant at the $\alpha = .10$ level.

Table I—*Continued*

	Variable Names and Definitions[a]	OLS Estimates[b]	HW Estimates[c]
		(0.1111)	(0.3135)
LENGTH^2	squared length of loan	−0.0453[d]	−0.1675[d]
		(0.0222)	(0.0623)
EQUITY	borrower equity (000's)	0.0205[e]	0.0479
		(0.0117)	(0.0370)
USED	1 = loan for a used vehicle	0.0691[d]	−0.0605
		(0.0218)	(0.0640)
TRUCK	1 = loan for a truck or camper	0.0466	0.1338[e]
		(0.0291)	(0.0762)
C. Origin of the Loan			
DEALER	1 = loan from a vehicle dealer	0.0302	0.0704
		(0.0343)	(0.1068)
FINCO	1 = finance company loan	0.0654[e]	0.1291
		(0.0339)	(0.0884)
CREDITU	1 = credit union loan	−0.1652[d]	0.0256
		(0.0258)	(0.1024)
OTHLEND	1 = loans from other lending institutions excluding bank loans	0.0034	−0.0539
		(0.0395)	(0.1049)
HIPRIME	1 = period of high prime rates (7/73–3/74)	0.0103	0.0465
		(0.0196)	(0.0586)
NCENT	1 = north central U.S.	0.1156[d]	0.2360[d]
		(0.0260)	(0.0854)
SOUTH	1 = southern U.S.	0.1599[d]	0.0970
		(0.0257)	(0.0797)
WEST	1 = western U.S.	0.1322[d]	0.0126
		(0.0288)	(0.0899)
INTERCEPT		2.3258[d]	2.3720[d]
		(0.1495)	(0.3792)

Therefore, I conclude that the OLS estimates are biased and inconsistent because OLS ignores the truncation effect.

Based on the HW estimates of the hedonic prices, it appears that several of the borrower characteristics are statistically significant determinants of the equilibrium rate. The predicted equilibrium rate (θ_i) declines as total household expenditure increases up to an expenditure level of \$20,000.[12] Single males are estimated to have equilibrium rates 44 percent higher than those for single females, whereas single parent households, which are predominantly households with female heads, have the highest estimated coefficient among household types. Households with heads who are college graduates are estimated to have equilibrium rates 15 percent lower than those for households with less educated heads; black households are estimated to have equilibrium rates 21 percent lower than those for white households.

All but two of the loan term variables seem to be significant determinants of

[12] Here, as in the following statements about the predicted equilibrium rate, all but the relevant regression variables are assumed to remain constant.

the equilibrium rate.[13] For the most part, the predicted equilibrium rate declines with an increase in the loan amount but rises with an increase in the contract length of the loan. These results reflect the conditions of the supply side of the credit market; the average cost per dollar loaned declines with an increase in the loan amount but rises with an increase in the contract length. The type of vehicle seems to be an important factor as well. Equilibrium rates of loans for trucks and campers are estimated to be 14 percent higher than those for auto loans.

Among the variables specifying the origin of a loan, one appears to be significant. It is estimated that equilibrium rates in the north central region are higher in comparison with those in other regions of the country.

IV. Error in the OLS Approach

From Table I it is apparent that almost all of the OLS estimates are biased toward zero.[14] Note however, that the OLS estimates of the coefficients of USED and CREDITU are significant and larger in absolute value than the HW estimates of these coefficients. In a majority of states, rate ceilings have been higher for used vehicles than for new vehicles and lower for credit union loans than for loans from the remaining lending institutions. Accounting for the truncation effect of these diverse ceiling levels, the HW estimates reveal that USED and CREDITU are not significant determinants of the equilibrium rate. On the other hand, OLS does not separate out the differences in observed rates paid due to the truncation of equilibrium rates from the differences due to loan attributes. Therefore, the OLS estimate for USED is positive and significant because ceilings for used cars were relatively high, whereas the OLS estimate for CREDITU is negative and significant because ceilings for credit union loans were relatively low.[15]

Similarly, if the ceiling variables (HICEIL, MODCEIL, and LOCEIL) are included in the regression the OLS estimates of the coefficients of these variables are large and significant unlike the HW estimates. These results are presented below with the standard errors in parentheses.[16]

[13] USED and EQUITY are the two loan term variables that are not significant. Douglas Greer has suggested that perhaps separate regressions should be made for new vehicles and used vehicles. These separate regressions have been computed, but the likelihood ratio tests does not reject the null hypothesis that the slope parameters and the variance of the error are identical for new and used vehicles. The test statistic is equal to 43.65, which is below the critical value of 46.19 for a χ^2 (d.f. = 32, $\alpha = .05$) variable.

[14] This result is not surprising. In the case of a regression with a truncated normal dependent variable Hausman and Wise state [14, p. 935]: "... the bias of individual [OLS] parameter estimates cannot be determined a priori; but in general one should expect least squares estimates to be biased toward zero."

[15] The OLS estimates for SOUTH and WEST are significant and have a larger positive value than the HW estimates of these coefficients. An examination of state ceilings reveals that southern states and western states generally have higher rate ceilings than eastern states, which is the reference region in the regression equation. Here again it seems, OLS has confused the truncation effect of rate ceilings with the effect of loan attributes.

[16] The OLS and HW parameters have been reestimated after including the ceiling variables in the regression equation (a state with no ceiling now becomes an excluded attribute). With respect to the HW results, the likelihood ratio test statistic for the three ceiling variables is 2.19, well below the

	Variable Names and Definitions	OLS Estimates	HW Estimates
HICEIL	1 = high-ceiling state	−0.1426	−0.0746
		(0.0449)	(0.1316)
MODCEIL	1 = moderate-ceiling state	−0.2338	0.0487
		(0.0340)	(0.1015)
LOCEIL	1 = low-ceiling state	−0.3432	−0.0302
		(0.0404)	(0.1338)

OLS treats differences in observed rates paid as stemming from differences in the conditional distribution of equilibrium rates, when in fact they should be attributed to the truncation of equilibrium rates. The HW estimates of the coefficients of the ceiling variables are not significant. Thus, the HW results do not support the hypothesis that equilibrium rates vary across states according to the level of state ceilings. For motor vehicle loans, the impact of rate ceilings on the availability of credit and on the expected value of interest rates paid seems to arise exclusively from the truncation effect of these ceilings.

V. The Impact of Rate Ceilings

Estimates of the probability of rejection ($\hat{\rho}_i$), as well as estimates of the expected value of interest rates considering the untruncated ($\hat{\theta}_i$) or truncated ($\hat{\theta}_i^*$) conditional distribution of equilibrium rates can be calculated using the HW results in Equations (2), (3), and (4) respectively. Calculating these estimates for various ceiling levels makes it possible to simulate the impact of interest rate ceilings.

Four cases have been selected to exemplify state policies on rate ceilings. In the first case it is assumed that there is no ceiling, as was true for West Virginia and still is true for Tennessee and Virginia. A uniform ceiling level of 21 percent has been the policy of Rhode Island and closely approximates the policy of California and Nevada; this ceiling level has been selected as the second case. The third case is a ceiling level of 16% APR which has been the predominant rate ceiling in North Carolina since the time of the survey. The fourth and final case is a ceiling level of 12% APR which has been the uniform ceiling level of the state of Washington. Using these four cases, we can proceed to simulate the impact of rate ceilings by calculating $\hat{\rho}_i$ and $\hat{\theta}_i^*$ for each of the 1,039 loans in the data set; a distinct set of estimates is calculated under each of these four cases.

In summarizing these estimates, the first objective is to average $\hat{\rho}_i$ across the loans in the data set to obtain an estimate of the average probability of rejection.

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critical value of a χ^2 variable with 3 d.f. The inclusion of the ceiling variables caused very little change in the estimated parameters for the 33 original variables from the figures reported in Table I.

Furthermore, the likelihood ratio test does not reject the hypothesis of identical regression parameters for loans in LOCEIL and MODCEIL states as opposed to loans in HICEIL and in states with no ceiling. After computing separate regressions for each of these two groups and comparing those results with the results of the pooled regression of Table I, the test statistic is found to be equal to 41.71. The critical value for a χ^2 (d.f. = 34, α = .05) variable is equal to 48.60; so the null hypothesis specifying identical coefficients and an identical error variance is not rejected. Therefore, I feel justified in treating all rates paid as originating from the same conditional distribution of equilibrium rates independent of the level of state ceilings.

However, an unweighted average of $\hat{\rho}_i$ will not do because the data set is a sample of loans that qualified for acceptance only. In order to represent all prospective loans—including those that would be rejected as well as those that would qualify—each estimate of ρ_i is weighted by the inverse of one minus the estimated probability of rejection under the actual ceiling applicable to the loan.[17] For example, included in the data set is a loan with a ceiling of 12.83 percent resulting in an estimated probability of rejection of 75 percent a priori. In averaging $\hat{\rho}_i$, this loan is given a weight of $1/(1 - .75) = 4$, because for each loan of this type that qualifies for acceptance, it is predicted that there are three other prospective loans of the same type that do not qualify. This weighted average of $\hat{\rho}_i$ is calculated individually for the four selected cases.

The second objective is to average $\hat{\theta}_i^*$ across the loans in the data set to obtain an estimate of the average equilibrium rate on loans that qualify for acceptance. For a given ceiling, each estimate of $\hat{\theta}_i^*$ is weighted by the ratio of the probability of qualifying with that ceiling to the probability of qualifying with the actual ceiling level. For example, included in the data set is a loan subject to a ceiling of 12 percent resulting in an estimated probability of rejection of 77 percent a priori; if, instead, the ceiling is set at 16 percent APR the probability of rejection is estimated to be 54 percent. Therefore, in averaging $\hat{\theta}_i^*$ given a 16 percent ceiling this loan is weighted by $(1 - .54)/(1 - .77) = 2$, because it is predicted that a loan of this type is twice as likely to qualify with the ceiling at 16 percent than with the ceiling at 12 percent APR. This weighted average of $\hat{\theta}_i^*$ is also calculated individually for the four selected cases.

The outcome of these calculations for $\hat{\rho}$ and $\hat{\theta}^*$ are presented below.[18]

No Ceiling		Ceiling = 21%		Ceiling = 16%		Ceiling = 12%	
$\hat{\rho}$	$\hat{\theta} = \hat{\theta}^*$	$\hat{\rho}$	$\hat{\theta}^*$	$\hat{\rho}$	$\hat{\theta}^*$	$\hat{\rho}$	$\hat{\theta}^*$
0	18.5	30.7	13.2	50.6	11.1	71.5	9.0

In the absence of a ceiling, it is presumed that no one is denied credit, so the estimate of the average probability of rejection ($\hat{\rho}$) is set to equal 0. Since no one is denied credit, the estimate of the average equilibrium rate on loans that qualify ($\hat{\theta}^*$) must be identical to the estimate of the average rate on all prospective loans ($\hat{\theta}$); this estimate is equal to 18.5 percent. A reduction in the ceiling level raises the average probability of rejection. Also, a reduction in the ceiling level reduces the average equilibrium rate on loans that qualify. For instance, if the ceiling is at 21 percent, the estimate of the average probability of rejection is 30.7 percent, and the estimate of the average equilibrium rate on loans that qualify is 13.2 percent.[19] With the ceiling at 12 percent the estimate of the average probability

[17] Of course, this weighting scheme cannot account for those potential borrowers who would qualify for a loan but were discouraged by a rate ceiling and decided not to apply. To the extent that the characteristics of this group of borrowers differs from the characteristics of successful applicants the proposed weighting scheme is not truly representative of all prospective loans.

[18] Note, $\hat{\rho}_i$, $\hat{\theta}_i$, and $\hat{\theta}_i^*$ refer to estimates for individual loans. Dropping the subscript, we shall now use $\hat{\rho}$, $\hat{\theta}$, and $\hat{\theta}^*$ to signify average estimates across loans.

[19] With a 21 percent ceiling it is predicted that on average 30.7 percent of all prospective loans would be turned down by lenders. Prospective loans include all loans applied for in the absence of a

of rejection rises to 71.5 percent, and the estimate of the average equilibrium rate on loans that qualify falls to 9.0 percent APR.

Next the data set is divided into groups of loans according to the values of a specific loan attribute, and the weighted average of $\hat{\rho}_i$ and $\hat{\theta}_i^*$ is calculated separately for each group. The results are reported in Table II for values of the eight loan attributes found to be significant in the HW regression.

The inverse relationship between the ceiling level and $\hat{\rho}$ together with the direct relationship between the ceiling and $\hat{\theta}^*$ are quite conspicuous in the figures of Table II. It is also evident that as the ceiling level declines, $\hat{\theta}^*$ tends to equalize across attribute groups, but this occurs in conjunction with higher probabilities of rejection.

Low-expenditure households, single male and single parent households, households financing a small loan, and households residing in the north central region of the country have the highest estimated probabilities of rejection as well as the highest estimated equilibrium rates. For these households the average of $\hat{\rho}_i$ with a 21 percent ceiling is greater than 40 percent; with a 16 percent ceiling it is greater than 60 percent, and with a 12 percent ceiling it is greater than 80 percent.

Higher probabilities of rejection for small loan borrowers are attenuated somewhat by the fact that more often than not rate ceilings for small loans are less restrictive than those for larger loans. Some states have explicitly established higher ceilings for small loans; furthermore, many states have established higher ceilings for used vehicle loans which encompasses a majority of small loans. Higher ceilings for small loans broadens the acceptable range of rates for these loans, thereby expanding the availability of credit to small loan borrowers, although some of these borrowers will be facing relatively high rates.

VI. Conclusion

The central conclusion derived from the results of this paper is that rate ceilings on motor vehicle loans curtail the availability of credit without appreciably changing the underlying conditional distribution of equilibrium rates. There is no significant difference in the equilibrium rates of interest for comparable loans between states with ceilings and states with no ceiling or between states with low ceilings and states with higher ceilings. Some high-risk borrowers with equilibrium rates which would be on the margin of acceptance in low-ceiling states are able to obtain credit in states with higher ceilings but at relatively high rates. Consequently, the average interest rate paid is observed to be greater in states with higher ceilings and in states with no ceiling because in those states more high-risk borrowers are able to obtain credit paying high rates; the explanation that lending institutions in those states charge higher rates for comparable loans is not supported here.[20]

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ceiling. However, with the establishment of a ceiling some potential borrowers may become discouraged about their chances of qualifying for a loan and decide not to apply. If the probability of applying is related to the probability of rejection, then the ratio of actual turndowns to the number of loan applications will differ from the average probability of rejection across all prospective loans.

[20] Across the 1,039 loans used in the hedonic regression the average interest paid was 15.9 percent for loans in states with no ceiling, 12.3 percent for loans in high-ceiling states, 11.3 percent for loans in moderate-ceiling states, and 9.9 percent for loans in low ceiling states.

Table II

Weighted Average of $\hat{\rho}_i$, and $\hat{\theta}_i^*$ across Loans with a Specific Loan Attribute

Loan Attribute	Number of Loans	No Ceiling[a] $\hat{\rho}$	No Ceiling[a] $\hat{\theta}^* = \hat{\theta}$	Ceiling = 21 $\hat{\rho}$	Ceiling = 21 $\hat{\theta}^*$	Ceiling = 16 $\hat{\rho}$	Ceiling = 16 $\hat{\theta}^*$	Ceiling = 12 $\hat{\rho}$	Ceiling = 12 $\hat{\theta}^*$
A. Total Household Expenditure ($)									
0–10,000	242	0	22.1	44.0	14.2	64.7	11.7	82.6	9.3
10,000–18,000	570	0	17.2	25.8	13.0	45.8	11.0	68.2	9.0
18,000 or more	227	0	16.2	22.0	12.3	39.9	10.6	61.7	8.7
B. Education of Household Head									
Not Graduated	327	0	19.9	35.7	13.5	55.9	11.3	75.8	9.1
High School Grad	554	0	18.5	30.5	13.3	50.9	11.2	72.2	9.0
College Grad	158	0	14.5	16.3	11.9	32.9	10.3	54.9	8.5
C. Race of Household Head									
Non-Black	963	0	18.8	31.6	13.3	51.7	11.2	72.6	9.0
Black Head	76	0	13.3	11.9	11.4	26.5	10.0	48.3	8.4
D. Household Type									
Single Male	42	0	24.2	51.7	14.6	71.6	11.9	86.8	9.4
Single Female	33	0	15.8	20.6	12.5	39.3	10.7	62.1	8.8
Couple	171	0	17.5	27.2	13.0	47.3	11.0	69.2	8.9
Couple w/children	640	0	17.3	26.2	13.0	46.2	11.0	68.4	8.9
Single w/children	43	0	26.1	57.7	15.2	77.1	12.3	90.7	9.7
Other Households	110	0	16.5	23.0	12.8	42.5	10.9	65.3	8.9
E. Loan Amount ($)									
1,000–2,000	380	0	21.3	41.1	13.9	61.7	11.6	80.3	9.2
2,000–3,000	376	0	17.1	25.1	13.0	45.5	11.1	68.3	9.0
3,000–4,000	217	0	15.7	20.4	12.4	38.6	10.6	61.2	8.8
over 4,000	66	0	13.5	12.7	11.5	28.0	10.1	50.2	8.5
F. Length of the Loan (month)									
12–21	55	0	15.1	18.7	12.0	35.8	10.4	57.7	8.5
21–27	200	0	19.1	33.1	13.4	53.7	11.2	74.3	9.1
27–33	85	0	19.0	32.5	13.5	53.3	11.3	74.3	9.1
over 33	699	0	18.5	30.5	13.1	50.2	11.1	71.1	9.0
G. Type of Vehicle									
Automobile	931	0	18.3	29.8	13.1	49.4	11.0	70.5	8.9
Truck or Camper	108	0	20.3	37.5	13.9	58.7	11.6	78.7	9.3
H. Region									
East	196	0	15.6	19.9	12.5	38.5	10.7	61.6	8.8
North Central	299	0	21.6	42.2	14.1	63.0	11.6	81.4	9.3
South	336	0	17.2	25.8	13.0	45.9	11.0	68.2	9.0
West	208	0	15.6	19.9	12.4	38.4	10.6	61.0	8.7

[a] $\hat{\theta}_i = \hat{\theta}_i^*$ in the no ceiling case, and $\hat{\theta}$ remains the same with a change in the ceiling level.

Rate ceilings are commonly said to be necessary to ensure access to "fair" interest rates. The assumption underlying this view is that the interest rate for a particular loan would be greater in states without effective ceilings. Supporting this assumption, Peterson [20] and Peterson and Ginsberg [19] concluded that loan rates range from 0.5 percent to about 2.0 percent higher for 36-month auto loans in states without effective ceilings. However, their estimates are based on an OLS regression which does not account for the truncation effect of rate ceilings.[21] I have attempted to account for the truncation effect by using HW estimation, and the HW results do not support the conclusion that the equilibrium rate for a loan is higher in high ceiling states or in states with no ceiling. So it would seem that legislating rate ceilings for the purpose of ensuring access to "fair" interest rates for motor vehicle loans is misguided.

Avio [1] argues that it is the impact on the availability of credit which produces the actual rationale of legislators for the establishment of rate ceilings. The cost to society of maintaining the standard of living of needy households is kept down, so the argument goes, by imposing rate ceilings and thereby preventing high-risk needy borrowers from obtaining loans and going into debt. Whether or not this is the real purpose behind the establishment of rate ceilings, and whether or not society benefits from such a policy has been the subject of some debate [see 2, 7, 15, 16] and cannot be answered here. This paper does provide an analytical framework supporting an inverse relationship between the ceiling level and the probability of rejection and aids in identifying which households tend to have the highest probabilities of rejection.

REFERENCES

1. K. L. Avio. "An Economic Rationale for Statutory Interest Rate Ceiling." *The Quarterly Review of Economics and Business* 13 (Autumn 1973), 61–72.
2. ———. "Economic Rationale for Statutory Interest Rate Ceiling: Reply." *The Quarterly Review of Economics and Business* 15 (Summer 1975), 111–13.
3. E. Baltensperger. "Credit Rationing: Issues and Questions." *Journal of Money Credit and Banking* 10 (May 1978), 170–83.
4. R. J. Barro. "The Loan Market, Collateral, and Rates of Interest." *Journal of Money Credit and Banking* 8 (November 1976), 439–56.
5. M. Carlson. "The 1972–73 Consumer Expenditure Survey." *Monthly Labor Review* 97 (December 1974), 16–23.
6. W. C. Dunkelberg. "A Lower Rate Maximum for Retail Credit: The Impact on Consumers." *The National Commission on Consumer Finance*, Technical Studies, 6, 1–29.
7. T. A. Durkin. "More on an Economic Rationale for Statutory Interest Rate Ceilings." *The Quarterly Review of Economics and Business* 14 (Autumn 1974), 95–104.
8. R. A. Eisenbeis and N. B. Murphy. "Interest Rate Ceilings and Consumer Credit Rationing: A Multivariate Analysis of a Survey of Borrowers." *Southern Economic Journal* 41 (July 1974), 115–23.

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[21] Peterson and Ginsberg are aware of the truncation effect of rate ceilings but do not attempt to account for it in their empirical analysis. This is apparent from their statements in footnote 5 of their paper. They write: 'Restrictive rate ceilings might also have reduced work credit availability to riskier customers or caused other terms of credit transactions (such as sales prices or downpayments) to be modified to increase creditors' expected yields. Such effects possibly could reduce the observed rate effect. However, because they are difficult to quantify, they were not investigated in this study.' [19, p. 15].

In the present paper I have proposed a method of estimation which takes into account the truncation effect (i.e. the effect of reduced bank credit due to restrictive rate ceilings). In putting this method into practice, I have shown in Section IV that accounting for the truncation effect does indeed reduce "the observed rate effect" as measured by the coefficients of the ceiling variables. In fact, the HW estimates of the coefficients of the ceiling variables are not significantly different from zero.

9. D. F. Greer. "An Econometric Analysis of the Personal Loan Credit Market." *The National Commission on Consumer Finance*, Technical Studies, 4, 37–126.
10. ———. "Rate Ceilings and Loan Turndowns." *Journal of Finance* 30 (December 1975), 1376–83.
11. ——— and E. A. Negata. "An Econometric Analysis of the New Automobile Credit Market." *The National Commission on Consumer Finance*, Technical Studies, 4, 151–238.
12. C. H. Gushee (ed.). *The Cost of Personal Borrowing in the United States, 1972 Edition.* Boston, Mass: Financial Publishing Company, 1972.
13. J. A. Hausman. "Specification Tests in Econometrics." *Econometrica* 46 (November 1978), 1251–71.
14. ——— and D. A. Wise. "Social Experimentation, Truncated Distributions, and Efficient Estimation." *Econometrica* 45 (May 1977), 919–38.
15. J. M. Jadlow. "Economic Rationale for Statutory Interest Rate Ceilings: Comment." *The Quarterly Review of Economics and Business* 15 (Summer 1975), 104–11.
16. ———. "Adam Smith on Usury Laws." *Journal of Finance* 32 (September 1977), 1195–1200.
17. M. S. Long. "Effect of Lending Rate Ceilings and Money Costs on Extensions of Consumer Credit." *Journal of Bank Research* 7 (Autumn 1976), 206–12.
18. H. C. Nathan. "Economic Analysis of Usury Laws." *Journal of Bank Research* 10 (Winter 1980), 200–11.
19. R. L. Peterson and M. D. Ginsberg. "Determinants of Commercial Bank Automobile Loan Rates," Working Paper No. 6, Credit Research Center, Purdue University, 1976. Also, a revised version has been published in the *Journal of Bank Research* (Spring 1981), 46–55.
20. R. L. Peterson. "Effects of Creditor Remedies and Rate Restrictions." *The Regulation of Financial Institutions*, Conference Series No. 21, Federal Reserve Bank of Boston, 1979.
21. S. Rosen. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy* 82 (January/February 1974), 34–55.
22. M. W. Schober and R. P. Shay. "State and Regional Estimates of the Price and Volume of the Major Types of Consumer Installment Credit in Mid-1971." *The National Commission of Consumer Finance*, Technical Studies, 3.
23. R. P. Shay. "The Impact of State Legal Rate Ceilings upon the Availability and Price of Credit." *The National Commission on Consumer Finance*, Technical Studies, 4, 387–424.
24. P. F. Smith. "Pricing on Consumer Loans at Commerical Banks." *Journal of Finance* 25 (May 1970), 517–25.
25. F. Stafford and W. Dunkelberg. "The Cost of Financing Automobile Purchases." *The Review of Economics and Statistics* 51 (November 1969), 459–64.
26. J. E. Triplett. "Consumer Demand and Characteristics of Consumption Goods." In *Household Production and Consumption*, ed. N. E. Terleckyj. New York: National Bureau of Economic Research, 1975.
27. J. D. Wolken and F. J. Navratil. "The Economic Impact of the Federal Credit Union Usury Ceiling." *The Journal of Finance* 36 (December 1981), 1157–68.