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Source: *The Journal of Finance*, Vol. 37, No. 5 (Dec., 1982), pp. 1277-1293
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2327850
Accessed: 27/11/2009 08:21

THE JOURNAL OF FINANCE • VOL. XXXVII, NO. 5 • DECEMBER 1982

A Disequilibrium Model of Savings and Loan Associations

GARY SMITH and WILLIAM BRAINARD*

ABSTRACT

This paper discusses the consistent specification and estimation of asset demand equations in a disequilibrium model of financial markets. We estimate the effective asset demands of savings and loan associations, allowing for rationing in the mortgage market. These disequilibrium estimates are not very different from the estimates of notional demands with no rationing assumed. Savings and loans seem to be least affected by excess demand situations in that they are apparently not reluctant to raise mortgage rates and/or to ration borrowers.

WILLIAM BRAINARD AND JAMES Tobin [1] have set forth a general, consistent framework for modeling financial markets. However, the available data are not nearly rich enough to yield accurate estimates of the numerous parameters in these Brainard-Tobin "Pitfalls" models. Elsewhere ([7], [8], and [9]), we have argued that the explicit incorporation of a priori information is a sensible alternative to the common practice of simplifying financial models by deleting explanatory variables. To illustrate these arguments, our earlier papers included a variety of estimates of savings and loan association asset holdings, under the assumption that these institutions always realize their notional demands. In the present paper, these asset demands are modified to allow rationing in the mortgage market.

Recent analyses (e.g., [4] and [6]) of disequilibrium macromodels have focused on theoretical issues: exploration of rational consumer and firm behavior in a world of market disequilibria and investigation of the possibility of quantity equilibria at disequilibrium prices. These theoretical models pay little attention to econometric issues. Concurrently, there has been substantial work on the estimation of specific financial market disequilibria (e.g., [3] and [5]). These studies typically focus on a single market, and ignore disequilibrium spillovers across markets.

In this paper we discuss the consistent specification and estimation of asset demand equations in a disequilibrium model of financial markets. We estimate that portion of the model relating to savings and loan associations and compare these disequilibrium estimates with those for an equilibrium model. Our most important empirical finding is the strength of our original equilibrium estimates. The rate responses and adjustment parameters change very little and the rationing parameters are small. Savings and loans seem to be least affected by excess

* Pomona College and Yale University. The research described in this paper was supported by a grant from the National Science Foundation. Dwight M. Jaffee and Stuart I. Greenbaum provided very detailed and helpful suggestions.

demand situations in that they are apparently not reluctant to raise mortgage rates and/or ration borrowers. We do find some evidence that the mortgage rate is sticky downward and that savings and loans may be willing to absorb small mortgage market disequilibria. Overall, the striking similarity of the equilibrium and various disequilibrium estimates suggests that little may be lost by the simplifying assumption that savings and loans typically do realize their notional demands.

I. A Model of Market Disequilibria

Many of the disequilibrium specification issues are most clearly illustrated in a simple model with only two sectors and two traded goods. Let the sectors (a and b) have notional expenditure demands for the two goods (1 and 2) which depend on a variety of factors including P_1, the price of the first good in terms of the second:

$$N_1^a = N_1^a[\overset{-}{P}_1, \cdots] \qquad N_1^b = N_1^b[\overset{-}{P}_1, \cdots]$$
$$N_2^a = N_2^a[\overset{+}{P}_1, \cdots] \qquad N_2^b = N_2^b[\overset{+}{P}_1, \cdots]$$

If these demands are consistent with the budget constraints, $N_1^a + N_2^a = N_1^b + N_2^b = 0$ for all values of P_1, then the sectoral adding-up restrictions are

$$\frac{\partial N_1^a}{\partial P_1} + \frac{\partial N_2^a}{\partial P_1} = \frac{\partial N_1^b}{\partial P_1} + \frac{\partial N_2^b}{\partial P_1} = 0$$

The excess notional demands in the two markets are given by $SN_1 = N_1^a + N_1^b$ and $SN_2 = N_2^a + N_2^b$. The economy's budget constraint $(N_1^a + N_2^a) + (N_1^b + N_2^b) = 0$ ensures that the excess demands sum to zero, $SN_1 + SN_2 = 0$. Thus, if one market clears, the sectoral budget constraints ensure that the other market will also clear.

If the price is at a nonmarket clearing level, such as P_1^0 in Figure 1, what quantities will be traded? It seems plausible to rule out transactions that neither sector desires—i.e., quantities outside the gap between demand and supply. Subject to this restriction, we shall allow both sectors to be off their notional demand curves. Assume, for example, that Sector a absorbs a fraction α and Sector b absorbs $1 - \alpha$ of the excess demand for the first good. The actual transactions A are

$$A_1^a = N_1^a - \alpha SN_1 \qquad A_1^b = N_1^b - (1 - \alpha)SN_1$$

Given its "ration," each sector must adjust its demand for the second good in accordance with its budget constraint. The effective demands E for the second good are consequently

$$E_2^a = N_2^a + \alpha SN_1 \qquad E_2^b = N_2^b + (1 - \alpha)SN_1$$

The budget constraints ensure, in this two-good example, that the effective demands exactly clear the second market, $E_2^a + E_2^b = N_2^a + N_2^b + SN_1 = N_2^a + N_2^a + SN_2 = 0$.

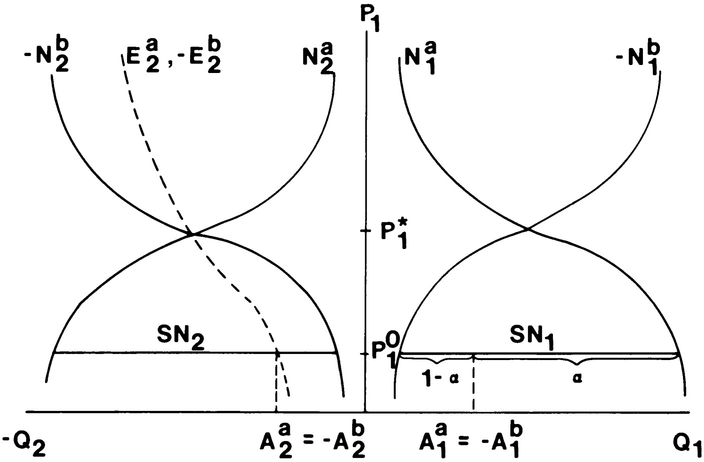

Figure 1.

Thus, in Figure 1, the effective demand curve $-E_2^b$ and the effective supply curve E_1^b coincide. The specific dotted line giving the effective demand and supply assumes that at any disequilibrium price the fraction α absorbed by Sector a is the same. It would be more realistic to have α depend on the sign, and perhaps the size, of the disequilibrium. For example, actual transactions may be close to the minimum of supply and demand.

A primary limitation of this two-market model is that it does not allow agents a choice in the way they respond to rationing in a particular model. Spillover demands are completely determined by budget constraints, and a disequilibrium in one market necessarily implies an equal and offsetting disequilibrium in the other market. Consequently, a rationing mechanism that "clears" one disequilibrium market automatically clears the other, and there is no room for a market cleared by price adjustment. In addition, there is no substantive distinction between effective demands and actual transactions. Nevertheless, the two-market example clarifies what is needed to completely specify a disequilibrium model. A disequilibrium model with n markets requires the following: (1) specification of the notional demands for the agents: (2) identification of the k markets which are rationed and the $n - k$ markets which are cleared by freely moving prices; (3) identification of the sectors which absorb the market disequilibria in the rationed markets; (4) specification of how these absorptions are financed (i.e., how effective demands for other items are influenced by quantity restrictions in rationed markets); and (5) identification of the $n - k - 1$ variables which adjust to clear the $n - k$ equilibrium markets.

Our framework is as follows, extending the previous notation, with the first k markets rationing excess effective demands $SE_j = \sum_h E_j^h$:

$$A_i^h = E_i^h + \alpha_{ii}^h SE_i = N_i^h + \sum_{j \leq k} \alpha_{ij}^h SE_j \tag{1}$$

where h indexes the agent, i the market, and $j \leq k$ the spillover. Although the effective demands and realized transactions could be specified as general functions of prices and market disequilibria, we assume a simple linear structure. Each agent's realized transaction differs from effective demands by a fixed share of the market excess effective demand. For example, Agent 2 is rationed by an amount $\alpha_{11}^{2} SE_1$ in Market 1. The effective demands in both rationed and unrationed markets reflect such rationing.

The sectoral budget constraints $\sum_i A_i^h = 0$ imply the following adding-up restrictions:

$$0 = \sum_i N_i^h = \sum_i \alpha_{ij}^h \tag{2}$$

The restrictions $\sum_i N_i^h = 0$ simply state that notional demands, which ignore disequilibria, must conform to budget constraints. If $SE_j = 0$, then $\sum_i A_i^h = 0$ if and only if $\sum_i N_i^h = 0$. The spillover restrictions $\sum_i \alpha_{ij}^h = 0$ state that an agent must make financial accommodation of whatever market frustrations are encountered. If an agent is unable to sell a planned amount $\alpha_{jj}^h SE_j$ of item j, then net purchases of other items must be reduced by this amount, $\sum_{i \neq j} \alpha_{ij}^h SE_j = -\alpha_{jj}^h SE_j$.

Since markets must actually clear ex post, a market disequilibrium is always absorbed by someone. Here, rationing clears the first k markets if and only if the market adding-up constraints are satisfied:

$$\sum_h \alpha_{jj}^h = -1, \qquad j \leq k \tag{3}$$

The effective demands in the equilibrium markets are not independent, since

$$\sum_{j>k} SE_j = \sum_{j>k} \sum_h E_j^h = \sum_h \sum_{j>k} E_j^h = \sum_h \sum_{i \leq k} -A_i^h = \sum_{i \leq k} \sum_h A_i^h = 0 \tag{4}$$

so that it only takes $n - k - 1$ freely moving variables to equilibrate the $n - k$ nonrationed markets. To complete this model, it is necessary to specify these equilibrating variables and how the other arguments of the demand equations are determined. In general, Walras' Law states that effective demand equilibrium in all but one nonrationed market ensures equilibrium in that final market. Since realized transactions differ from effective demands in the rationed markets, the summation of excess effective demands across all markets is not zero.

The remainder of this paper applies this approach to the estimation of savings and loan association asset demands with allowance for mortgage market disequilibria. Restricting ourselves to savings and loans will enable us to investigate the importance of spillover effects within this sector, but precludes study of the allocation of any market disequilibrium among other sectors. Other sectors may well be rationed even if savings and loans are always on their notional demand curves.

II. Specification of Savings and Loan Effective Demands

We sought to explain savings and loan association holdings of the following four assets:

CDD = currency and demand deposits

SHORT = short-term marketable securities

LONG = long-term bonds

MORT = mortgages

The sum of these four assets is disposable funds ("wealth") W:

$$W = \text{CDD} + \text{SHORT} + \text{LONG} + \text{MORT}.$$

Savings and loan disposable funds are essentially determined by deposit liabilities and borrowing from the Federal Home Loan Bank (FHLB) system.

The notional asset demands are the same as in our earlier paper [7] which assumed market equilibrium. This specification allows short-run portfolio adjustment towards long-run asset demands, but assumes that short-run notional demands are always realized. The long-run asset demands are of the form:

$$a_i^* / W^e = \alpha_{i0} + \sum_{j=1}^{n} \alpha_{ij}/r_j \tag{5}$$

where a_i^* is the long-run desired holding of the ith asset, r_j is the yield on the jth asset, and W^e is anticipated disposable funds. The "rational desires" assumption $\sum_{i=1}^{4} a_i^* = W^e$ implies the adding-up restrictions

$$\sum_{i=1}^{4} \alpha_{i0} = 1$$

$$\sum_{i=1}^{4} \alpha_{ij} = 0, \qquad j \neq 0$$

These restrictions state that an increase in disposable funds must be held somewhere and that a change in any portfolio proportion must be at the expense of the remaining proportions.

The short-run notional demands depend on the disequilibria in the portfolio and on the unexpected influx of new funds

$$\Delta a_i = \sum_{j=1}^{n} \varepsilon_{ij}(a_j^* - a_j(-1)) + f_i(S - S^e) + g_i \Delta FHLB \tag{6}$$

where Δa_i is the increase in holdings of the ith asset, $a_j^* - a_j(-1)$ is the discrepancy between desired and inherited holdings of the jth asset, ΔFHLB is the change in Federal Home Loan Bank borrowings, and $S - S^e$ is the unanticipated change in other disposable funds. The budget constraint $\sum_{i=1}^{4} \Delta a_i = W - W(-1) = \sum_{j=1}^{4} (a_j^* - a_j(-1)) + (W - W^e)$ implies the adding-up restrictions

$$\sum_{i=1}^{4} \varepsilon_{ij} = 1$$

$$\sum_{i=1}^{4} f_i = 1$$

$$\sum_{i=1}^{4} g_i = 1$$

The parameter ε_{ij} gives the partial effect on holdings of the ith asset of a unit increase in wealth and in desired holdings of the jth asset. The ε_{ij} consequently sum across equations to one. The parameters f_i and g_i give the partial effects on holdings of the ith asset of unanticipated inflows of funds. These parameters must also add up to one across equations.

Recognition of the possibility of market disequilibria requires the specification of effective as well as notional demands. One possible approach is to include the ration as part of anticipated disposable funds, W^e. There would then be $n - 1$ asset demands (5) subject to this modified budget constraint. If the rationing is not expected to be permanent, then it makes more sense to treat the shortfall analogously to $S - S^e$ and ΔFHLB in the short-run demand Equations (6). We have followed this latter procedure, in that the effective demand equations are simply short-run equations shifted in the additive way described in the previous section.

In the absence of direct information, proxies must be used to represent excess effective demands in the estimation of the model. Natural proxy candidates are variables such as prices that are thought to respond to disequilibrium pressures. There are, of course, markets where prices are administratively or legally set with little regard for market pressures and for which the use of price changes would be inappropriate. Suppose, however, that "prices" can be found for the rationed markets which do respond to excess demand, possibly with error v_j

$$\Delta P_j = \lambda_j SE_j + v_j \tag{7}$$

In principle, there could be a quite complex relationship between all market disequilibria and all prices. In practice, however, we have used only the own rate as the proxy for a particular excess demand.

Introducing disturbances terms ε_i in the demand Equations (1), and using (7),

$$A_i^h = N_i^h + \sum_{j \le k} \frac{\alpha_{ij}^h}{\lambda_j} \Delta P_j + \left(\varepsilon_i^h - \sum_{j \le k} \frac{\alpha_{ij}^h}{\lambda_j} v_j \right) \tag{8}$$

The use of endogenous variables as proxies creates simultaneity problems in the estimation of the model. Typically, the measurement errors in the proxies ΔP_j will bias their coefficients towards zero, while the positive correlation of ΔP_i and ε_i (through SE) will bias the coefficients away from zero. An instrumental variables procedure was consequently used for some of the estimates. The endogeneity of ΔP_j also creates problems about the division of the sample period into rationed and unrationed subperiods, and in the specification of priors, which we shall return to later in this section.

A simple extension of the analysis is to permit different rationing rules for periods of excess demand and excess supply, or depending on whether markets are "near" or "far" from equilibrium:

$$\alpha_{ij} = \alpha_{ij}^{+} D_j^{+} + \alpha_{ij}^{-} D_j^{-} \quad \text{where} \quad D_j^{+} = {}^{1}_{0} \; D_j^{-} = {}^{0}_{1} \quad \text{as } SE_j \gtrless 0 \tag{9}$$

In the empirical work reported in Section III, we distinguish between periods of mortgage market excess demand, excess supply, and "near equilibrium."

One plausible though extreme assumption about the α_{ij} is that agents may be frustrated in attempts to make purchases or sales, but that they are never compelled to make unwanted transactions. By this reasoning, the actual quantities transacted will equal the lesser (in absolute value) of effective supply or demand. Demanders will fully absorb the market disequilibrium in an excess demand environment, while suppliers will fully absorb any excess supply. The seminal Fair-Jaffee [2] paper emphasizes this approach and most subsequent work has been concerned with the maximum likelihood identification of excess demand and supply regimes.

While this "minimum quantity" scheme has considerable appeal, it is sometimes argued that, in the interests of long standing "customer relationships," financial intermediaries do not charge all that the market will bear nor completely cease lending when money is tight. Instead, they try to accommodate their clients' needs. Indeed, a "maximum quantity" model might be used to depict the willingness of commercial banks to find funds for customers who would otherwise be caught short.[1]

Because thrift institutions have had relatively little flexibility in attracting funds, our priors on the α_{ij} for the mortgage market are actually not far from the "minimum quantity assumption." Our prior means are that savings and loan associations absorbed .4 of an excess demand for mortgages, but only .04 of an excess supply. In the periods when the mortgage market was near equilibrium, our prior means are that savings and loans absorbed .2 of whatever disequilibrium existed. The differences between these factors and 1 are absorbed by other financial institutions and borrowers.

We also expect the price adjustment speed, λ_j, to depend on whether there is excess demand or supply in the mortgage market. There is, however, an ambiguity here that may have already worried the reader. Should a large change in mortgage rates be interpreted as evidence of a large disequilibrium, or as evidence that a potential disequilibrium has been eliminated by rapid rate adjustment? It could be argued that rapidly moving interest rates are associated with periods of market clearing and sticky rates with persistent disequilibrium. An extreme example is the case where an interest rate is against a legal barrier. In addition to the simultaneity and measurement problems discussed above, this ambiguity makes it difficult to use price adjustments to identify disequilibria.

Because of this difficulty, we sought nonrate information to partition the sample into periods of excess demand, excess supply, and near equilibrium for mortgages. Specifically, we used characterizations of mortgage market conditions generously provided by the Economics and Research Department of the Mortgage Bankers Association of America. This information, reproduced in Table I, is referred to in our empirical work as the MBA classification. We have used the convention of labeling as "excess demand" a situation in which there is an excess demand for mortgage notes and an excess supply of mortgage money.

For comparison, we also used changes in the mortgage rate Δr_M as a classification criterion. Quarters in which the percentage-point changes in the mortgage rate were within the range

$$-.05\% \leq \Delta r_M \leq .10\% \tag{10}$$

[1] Similarly, in slack labor markets some firms retain long-time employees who would otherwise be unemployed. People will be hesitant to accept jobs at firms with reputations for firing employees whenever there is an excess labor supply. Sometimes, these restraints are formalized. For example, academic tenure may commit departments to employ more people than they wish even in excess-supply labor markets.

Table I

Classification of Mortgage Market Disequilibria[a]

	Δr_M (%)	$r_M - r_L$ (%)	Market Condition +: Excess Demand −: Excess Supply		Mortgage Bankers Association Description of Market
			$-.05\% \leq \Delta r_M \leq .10\%$	MBA	
1952.I		1.93			
II	.00	1.96			Mortgage yields steady / recordings steady /
III	.01	1.95			percentage of institutional inflows invested
IV	.01	1.92			in mortgages remains steady
1953.I	.03	1.87			
II	.21	1.83	−		
III	.22	2.10	−	+	
IV	.05	2.29		+	
1954.I	−.14	2.32	+	+	Spreads between mortgage and corporate
II	−.08	2.32	+	+	bond rates high / life insurance commit-
III	.00	2.32		+	ments at high levels / percentage of insti-
IV	−.05	2.26		+	tutional inflows in home mortgages high
1955.I	.00	2.19		+	
II	.00	2.12		+	
III	.02	2.07		+	
IV	.03	2.08		+	
1956.I	.02	2.12			Saving inflows to mortgages level off / FHA
II	.06	2.02			falls off from peak levels / mortgage yields
III	.12	1.98	−		increase somewhat but yield spreads fall
IV	.20	1.92	−		
1957.I	.15	2.05	−	−	Mortgage yield jumps / yield spread falls off
II	.02	2.00		−	before large increase in 1958 / downpay-
III	.13	1.83	−	−	ments stay high / housing sales plummet
IV	.10	2.00		−	
1958.I	−.15	2.24	+	−	Mortgage yield and yield spread begin to
II	−.23	2.04	+		move up / life insurance commitments and
III	−.04	1.71			saving inflows to mortgage market begin to
IV	.19	1.68	−		pick up / downpayments fall
1959.I	.03	1.67		+	

II	.03	1.48		+	Mortgage yields fall / activity up / life insur-
III	.19	1.55	−	+	ance and institutional activity remains high
IV	.23	1.68	−	+	
1960.I	.05	1.75		+	
II	−.02	1.83			
III	−.02	1.95			
IV	−.08	1.86	+		
1961.I	−.07	1.84	+		
II	−.12	1.71	+		
III	−.01	1.54			
IV	.00	1.57			
1962.I	.00	1.57			
II	.00	1.68			
II	−.01	1.63			
IV	−.04	1.67			
1963.I	−.04	1.69			All types of money market rates stable
II	−.05	1.62			
III	−.01	1.54			
IV	.00	1.50			
1964.I	.00	1.46			
II	.01	1.43			
III	−.01	1.42			
IV	.00	1.40			
1965.I	.00	1.41			
II	.00	1.39			
III	.03	1.36			Mortgage yields climb / yield spread between
IV	.09	1.34			FHA secondary market rate and Aaa bonds
1966.I	.15	1.29	−	−	falls below 100 basis points for first time /
II	.26	1.36	−	−	massive outflows of savings–first major
III	.25	1.29	−	−	bout of disintermediation / housing starts
IV	.11	1.34	−	−	to fall off
1967.I	−.17	1.43	+	+	Sharp turnaround in savings flow / mortgage
II	−.08	1.21	+	+	rates dip / starts to jump
III	.09	.96		+	Widely fluctuating month to month changes
IV	.10	.62			in money market rates / housing starts to
1968.I	.13	.66	−		move up consistently but not nearly as rap-

Table I—continued

	Δr_M (%)	$r_M - r_L$ (%)	Market Condition +: Excess Demand −: Excess Supply: $-.05\% \le \Delta r_M \le .10\%$	MBA	Mortgage Bankers Association Description of Market
II	.34	.88	−		idly as in the early quarters of 1967
III	.20	1.25	−		Savings flows fall off / housing starts to drop
IV	.02	1.11			sharply / yield spread between mortgages
1969.I	.26	.91	−		and corporate bonds vanishes / average
II	.25	.97	−	−	downpayments on conventional loans rise
III	.36	1.16	−	−	A period of transition from shortage to surplus
IV	.16	.91	−	−	of funds
1970.I	.20	.69		−	
II	.01	.45	−	−	
II	.01	.38	+		
IV	−.16	.53			
1971.I	−.63	.59	+	+	
II	−.12	.22	+	+	
III	.15	.28	−	+	Savings flows build up through most of period
IV	−.02	.52		+	/ starts sales rise consistently / average
1972.I	−.20	.39	+	+	downpayment on conventional homes fall
II	.04	.38		+	while prices rise
III	.04	.49		+	
IV	.03	.59		+	
1973.I	.05	.56	0	+	
II	.21	.68	−	+	
III	.74	1.14	−	−	
IV	.05	1.13	0	−	
1974.I	−.17	.71	+	−	
II	.49	.74	−	−	
III	.50	.61	−	−	
IV	−.04	.54	0	−	

[a] r_M: mortgage rate
r_L: corporate bond rate

were classified as market balance; quarters for which Δr_M was below (above) this range were classified as excess demand (supply). The asymmetry in (10) reflects our belief that mortgage rates, like wages and many prices, are more resistant to decreases than increases. Our results which use the change in the mortgage rate to classify disequilibrium periods are labeled Δr.

Table I shows that there is not a close correspondence between the MBA and Δr classifications. Unlike the MBA classification, the Δr classification depicts the mortgage market as erratically swinging in and out of disequilibrium. However, these two classification systems are not statistically independent. Table II provides a contingency table comparison for the sample period 1952.III through 1974.IV used in this paper. The probability of observing the Pearson chi-squared statistic here of 18.71 as a result of chance alone is less than .005.

The MBA classification rationale makes frequent reference to the spread between mortgage and corporate bond rates. These yields might move roughly together in the long run but diverge in the short run because of institutional stickiness in changing the mortgage rate. The third column of Table I displays the time path of this yield spread. Clearly, the MBA classification is a complex judgemental procedure which bears no simple relationship to the yield spread.

If the minimum of supply and demand were assumed to prevail and there were no spillovers from other markets, notional mortgage note demand equations could be estimated using only the periods here classified as equilibrium or excess supply. However, to use data from excess demand periods or to allow the possibility that more than the minimum of supply and demand is traded requires a quantitative measure of market disequilibrium.

One measure that we used was provided by explicitly assuming a mortgage rate adjustment based upon the amount of excess effective demand

$$\Delta\left(\frac{1}{r_M}\right) = \lambda SE \tag{11}$$

As indicated above, we allow the speed of rate adjustment λ to depend on market conditions. Unfortunately, it is not obvious how these speeds vary. It might plausibly be argued, for example, that the responsiveness of rates will depend either upon the pressures which impinge directly on the "price setter" or,

Table II

Contingency Table for Disequilibrium Classification Methods[a]

		MBA Classification			
		−	0	+	
Δr Classification	−	13 (5.78)	8 (12.13)	5 (8.09)	26
	0	5 (11.11)	29 (23.33)	16 (15.56)	50
	+	2 (3.11)	5 (6.53)	7 (4.36)	14
		20	42	28	90

[a] Numbers in parentheses: Expected number with independence

alternatively, upon how much the "price setter" expects to benefit from a rate change. Using Figure 2, if borrowers absorb most of the disequilibrium when $SE < 0$ and lenders absorb most of it when $SE > 0$, then the direct pressure argument suggests that lenders will lower rates faster than they raise them. The prospective benefits argument suggests the opposite, since when $SE > 0$ more mortgages can be made at higher rates. Although we are far from certain (as revealed by the relatively large variances on our prior means), we lean towards the prospective benefits view. Our prior means for $1/\lambda$ are 500 when $SE < 0$, 1000 when SE is near zero, and 2000 when $SE > 0$. These figures imply that, for a 5% mortgage rate, an excess demand of $4 billion will lower the mortgage rate 5 basis points while a $1 billion excess supply will raise it 5 basis points.

The assumed relationship between SE and $\Delta(1/r_M)$ seems appropriate for the sample classification based upon the observed changes in the mortgage rate. For the MBA classification, this quantitative measure does not always agree with the qualitative label. For example, in 16 of the 28 periods labeled excess demand by the MBA, the quantitative measure $\Delta(1/r_m)$ is negative. We consequently constructed two simple alternative excess demand proxies. One assumes a constant level of excess demand or supply in each period so classified by the MBA. The second assumes that the excess demand or supply grows at a constant rate until the middle of each classified interval and then declines at a constant rate, giving a triangular pattern.

III. Estimation Results

The Federal Reserve Board's quarterly flow of funds data were used for all financial quantities. All interest rate data were taken from the MPS data bank. We used a Theil-Goldberger mixed estimation procedure to combine the time series data with explicit a priori information about the model's parameters. The prior means and covariances for the notional demands are identical to those used in our previous equilibrium study [7]. Our earlier paper explains some of the rationale for our prior information. In practice, we have found the specification of prior means to be fairly straightforward, while the prior covariance matrix

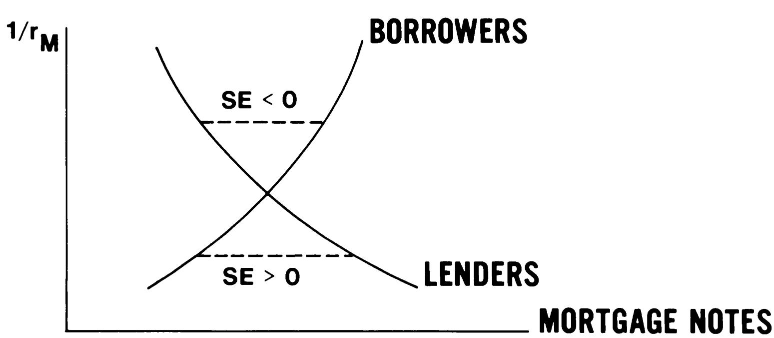

Figure 2

requires considerable effort. Smith [9] describes a formal framework for systematically eliciting prior covariances for asset demand equations.

The only specification searches undertaken here involve the specific qualitative and quantitative descriptions of mortgage market disequilibria discussed above. These are catalogued below:

1. Minimum of demand and supply (Δr, MBA)
2. $\Delta(1/r_M) = \lambda SE(\Delta r, MBA)$
3. $\Delta(1/r_M) = \lambda SE$ with instruments (Δr, MBA)
4. Constant and triangular proxies for $SE(MBA)$

To reduce some of the clutter of results, only the estimates for Methods 3 and 4 are displayed in Table III. The nature of the results for Methods 1 and 2 are summarized below, and the actual estimates are available from the authors. For comparative purposes, Table III also contains the estimates for the equilibrium model, labeled with an "e" superscript.

Our first disequilibrium method assumes that savings and loans realize their notional demands except in excess demand situations. Using the MBA classification of markets, 26 of the 90 quarters from 1953.III–1974.IV were omitted; with the Δr rule, 13 quarters were deleted. The least squares estimates, and particularly the adjustment parameters, are fairly sensitive to these reductions of the sample period. One interpretation is that rationing is in fact important in explaining savings and loan portfolios, and that our earlier estimates are contaminated by the inclusion of the "disequilibrium" observations. However, this sensitivity is also consistent with Smith's finding [8] that the least squares estimates are significantly altered by minor changes in the data base. This latter interpretation is supported by the general implausibility of the least squares "disequilibrium" parameter estimates. In contrast, the Δr mixed estimates are little affected by the exclusion of "excess demand" periods. There are some modest changes in the MBA estimates. One change is a reduction in the fractions of an unexpected increase in wealth allocated to long-term bonds and mortgages and an increase in the amount put into short-term bonds. These shifts put the disequilibrium mixed estimates closer to our priors.

In Method 2, $\Delta(1/r_M)$ is used as a proxy for the amount of excess effective demand. This time, both the least squares and mixed estimates of the rate responses and adjustment coefficients are little affected by the allowance for disequilibria. The "rationing" coefficients are of particular interest. The least squares estimates of α/λ have the wrong sign as often as not. The mixed estimates, on the other hand, are quite well-behaved. Relative to our priors, the absolute values of α/λ tend to be very low, indicating that either savings and loans do not absorb much of any disequilibrium in mortgage markets, or that the speed of mortgage rate adjustment is quite rapid. Given the small differences in the other coefficients from those of the equilibrium model, this would seem to suggest that the mortgage market adjusts more rapidly than we had thought. As expected, in every case the mixed estimates for $|\alpha/\lambda|$ are smallest for $SE < 0$. Although the

Table III[a]

Short-Run Parameters $\frac{\Delta a_i}{W^e} = (\sum_{j=1}^{n} \epsilon_{ij}\alpha_{j0}) + \sum_{k=2}^{n} (\sum_{j=1}^{n} \epsilon_{ij}\alpha_{jk})(1/r_k) - \sum_{j=1}^{n} \epsilon_{ij}a_j(-1)/W^e + f_i(S - S^e)/W^e + g_i\Delta\text{FHLB}/W^e + \alpha_i SE$

		Rate Response ($\sum_j \epsilon_{ij}\alpha_{jk}$)				Adjustment Coefficients (ϵ_{ij})						Disequilibrium Measures (α_i)				
		1	$\frac{1}{r_S}$	$\frac{1}{r_L}$	$\frac{1}{r_M}$	$\frac{\phi\text{CDD}}{W^e}$	$\frac{\phi\text{SHORT}}{W^e}$	$\frac{\phi\text{LONG}}{W^e}$	$\frac{\phi\text{MORT}}{W^e}$	$\frac{S - S^e}{W^e}$	$\frac{\Delta\text{FHLB}}{W^e}$	$\frac{(\Delta 1/r)^+}{W^e}$	$\frac{(\Delta 1/r)^0}{W^e}$	$\frac{(\Delta 1/r)^-}{W^e}$	$\frac{SE^+}{W^e}$	$\frac{SE^-}{W^e}$
$\frac{\Delta\text{CDD}}{W^e}$	Prior Means	none	.021	.064	−.072	1.0	.0	.1	.2	.3	.1	100	20	2	none	none
	OLS[e]	−.228	−.004	.090	.089	.447	−.177	−.453	−.199	.166	.258					
	OLS − 3 (MBA)	−.186	−.003	.094	.071	.536	.536	−.149	−.341	−.162	.174	−68.9	−91.7	−50.1		
	OLS − 3 (Δr)	−.183	−.007	.096	.070	.459	−.141	−.344	−.159	.180	.311	38.5	−75.7	−1.3		
	OLS − 4 (Con)	−.194	−.002	.097	.083	.507	−.177	−.371	−.166	.178	.265				−.048	−.046
	OLS − 4 (Tri)	−.194	−.000	.102	.066	.512	−.160	−.358	−.169	.174	.265				−.025	−.012
	Mixed[e]	.028	−.005	.127	.095	.976	−.014	.083	.050	.177	.210					
	Mixed − 3 (MBA)	.037	−.005	.132	.086	.977	−.014	.083	.059	.180	.215	90.3	15.9	1.7		
	Mixed − 3 (Δr)	.031	−.010	.135	.096	.977	−.013	.084	.054	.187	.251	38.9	15.9	1.7		
	Mixed − 4 (Con)	.035	−.001	.125	.091	.980	−.014	.086	.058	.199	.228				−.104	141
	Mixed − 4 (Tri)	.019	.003	.129	.077	.979	−.015	.085	.039	.199	.224				−.049	−.064
$\frac{\Delta\text{SHORT}}{W^e}$	Prior Means	none	−.028	.058	−.074	.0	1.0	.2	.3	.4	.1	100	30	3	none	none
	OLS[e]	.033	.001	−.064	.096	−.130	.198	.068	.035	.020	−.084					
	OLS − 3 (MBA)	.018	.000	−.059	.085	−.154	.192	.034	.020	.010	−.086	13.1	8.0	20.3		
	OLS − 3 (Δr)	.025	.002	−.070	.105	−.088	.205	.086	.025	.006	−.115	6.6	−.195.2	−.14.6		
	OLS − 4 (Con)	.025	.000	−.055	.073	−.149	.200	.041	.026	.012	−.089				−.009	.047
	OLS − 4 (Tri)	.018	−.000	−.057	.076	−.161	.197	.021	.019	.011	−.087				.001	.031
	Mixed[e]	.221	−.008	−.043	−.001	−.005	.980	.203	.209	.060	.023					
	Mixed − 3 (MBA)	.223	−.008	−.045	.008	−.005	.980	.203	.213	.062	.027	20.4	24.6	2.7		
	Mixed − 3 (Δr)	.224	−.009	−.041	−.002	−.005	.980	.203	.212	.061	.030	4.2	24.8	2.6		
	Mixed − 4 (Con)	.223	−.009	−.030	−.031	−.006	.980	.203	.209	.049	.015				−.017	.090
	Mixed − 4 (Tri)	.223	−.008	−.031	−.028	−.006	.980	.203	.209	.050	.022				−.007	.048
	Prior Means	none	.007	−.322	.546	.0	.0	.7	.0	.0	.0	600	150	15	none	none
	OLS[e]	.149	−.001	.012	−.103	−.073	−.030	.328	.131	.251	−.012					
	OLS − 3 (MBA)	.177	.001	−.000	−.069	−.052	−.038	.375	.163	.284	.008	47.1	34.6	−.33.2		
	OLS − 3 (Δr)	.157	−.002	.014	−.098	−.023	−.019	.347	.139	.265	.009	4.1	87.3	.6		

$\frac{\Delta LONG}{W^e}$	OLS − 4 (Con)	.176	.001	−.001	−.063	−.017	−.034	.407	.160	.270	.001				−.003	−.103
	OLS − 4 (Tri)	.183	.002	.005	−.077	−.004	−.024	.432	.165	.269	−.006				−.008	−.053
	Mixed[e]	.239	.007	−.081	.118	.013	.015	.706	.224	.156	−.033					
	Mixed − 3 (MBA)	.264	.008	−.081	.145	.014	.015	.707	.256	.171	−.007	231.5	133.2	13.9		
	Mixed − 3 (Δr)	.253	.003	−.072	.116	.014	.016	.707	.240	.159	−.001	17.9	120.1	13.0		
	Mixed − 4 (Con)	.232	.008	−.115	.193	.014	.013	.707	.222	.184	−.012				.043	−.229
	Mixed − 4 (Tri)	.233	.009	−.102	.163	.014	.013	.707	.221	.180	−.027				−.000	−.104
	Prior Means	none	.0	.200	−.400	.0	.0	.0	.5	.3	.8	−.800	−.200	−.20	none	none
	OLS[e]	1.046	.004	−.039	−.082	.757	1.009	1.056	1.033	.564	.839					
	OLS − 3 (MBA)	.991	.002	−.035	−.087	.671	.995	.932	.980	.532	.834	8.8	49.1	63.0		
	OLS − 3 (Δr)	1.001	.007	−.041	−.076	.703	.955	.911	.994	.549	.796	−.49.3	183.6	15.2		
$\frac{\Delta MORT}{W^e}$	OLS − 4 (Con)	.993	.001	−.041	−.092	.659	1.011	.922	.981	.540	.823				.060	.101
	OLS − 4 (Tri)	.993	−.001	−.050	−.065	.653	.986	.905	.985	.546	.827				.033	.034
	Mixed[e]	.514	.007	−.004	−.211	.017	.020	.009	.520	.607	.800					
	Mixed − 3 (MBA)	.477	.004	−.008	−.239	.016	.019	.008	.474	.586	.765	−.341.8	−.173.7	−.18.3		
	Mixed − 3 (Δr)	.494	.015	−.024	−.211	.016	.018	.006	.496	.593	.717	−.60.9	−.160.8	−.17.3		
	Mixed − 4 (Con)	.510	.002	.018	−.252	.013	.021	.005	.512	.568	.769				.079	.279
	Mixed − 4 (Tri)	.527	−.004	.002	−.211	.013	.022	.005	.532	.571	.781				.057	.120

[a] r_S: Treasury bill rate
r_L: Corporate bond rate
r_M: Mortgage rate

CDD: Currency and demand deposits
SHORT: Short-term marketable securities
LONG: U.S. government securities other than short-term marketable, state and local government securities, corporate bonds and foreign bonds
MORT: Mortgages
FHLB: Borrowing from Federal Home Loan Banks

Estimation Method 3: $\Delta(1/r_M) = \lambda SE$ with instrumental variables
Estimation Method 4: constant and triangular proxies for MBA *SE*

estimates of $|\alpha/\lambda|$ are generally low, they are unexpectedly largest for $SE = 0$. Savings and loans are apparently willing to absorb small disequilibria.

As indicated above, the use of the mortgage rate change as a proxy for mortgage market disequilibria creates a simultaneity problem in that the error in the mortgage demand equation is correlated with the change in mortgage rate. In Method 3, we estimated the demand equations using per capita disposable income and the change in the number of households as instrumental variables for each rationing proxy $[\Delta(1/r)/W^e]$ in the appropriate periods. These particular instruments were selected because they will influence the change in the mortgage rate through the supply of mortgage notes but have little direct effect on savings and loan association portfolio management.

Again, the disequilibrium estimates of the rate responses and adjustment coefficients are close to the equilibrium estimates. In fact, the slight changes found with Methods 1 and 2 are no longer apparent. However, as compared with Method 2, the use of instrumental variables greatly increases the absolute values of the rationing coefficients. Again the least squares rationing estimates are as often as not implausibly signed. While the magnitudes of the mixed estimates are now not as far from our priors, their relative sizes conform to the pattern noted earlier. The excess supply parameters are the smallest in every case, indicating that savings and loans are willing to raise mortgage rates and/or ration customers. The large near-equilibrium parameters suggest some rate stickiness close to equilibrium and a savings and loan willingness to absorb small disequilibria. The excess demand rationing parameters are also large, though not as large as our priors. Apparently, mortgage rates are a bit sticky downward and/or borrowers absorb little, if any, of this type of disequilibrium.

Table III, also contains the estimates with the constant ("Con") and triangular ("Tri") proxies for market disequilibrium using the MBA classification of market conditions. Once again, the rate and adjustment parameters are strikingly similar to those for the equilibrium model. The rationing coefficients are unfortunately ambiguous because the proxies are consistent with any scale for the market disequilibrium. Due to a reluctance to assign a dollar figure to the amount of disequilibrium, we did not use priors here for the rationing coefficients. One consequence is that the disequilibrium estimates show considerable variation. Another is that the interpretations of the magnitudes depend upon the reader's assessment of the average market disequilibrium. The reported estimates correspond to an average one billion dollar level or change in market disequilibrium. A doubling of this figure would halve these estimates. The rationing coefficients consequently appear quite small.

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