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AN ANALYTIC MODEL OF THE INTER-REGIONAL FLOW OF FUNDS

by

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Young P. Joun and Sylvia Lane*

I. Introduction

Factors which influence the inter-regional flow of funds, and especially mortgage funds, have, as a topic, become increasingly interesting in recent months with the increase in interest being especially noticeable in the capital importing states, such as California, during the present period of alleged monetary restraint.

Yet, despite the interest in this subject and its practical importance, very little significant empirical work has been done in this area, and a substantiated rationale for capital movement among regions, and especially for the movement of mortgage funds, has still to be developed. Succinctly, the dearth of research effort may be ascribed to the lack of revelant data on the regional level, and therefore, the recent studies by Grebler and Case,[1] although

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1. Leo Grebler, "California's Dependence on Capital Imports for Mortgage Investment", California Management Review. Spring 1963, pp. 47-54. Fred E. Case, "California's Continuing Needs for Mortgage Capital", California Management Review, Winter 1967, pp. 80-90.

confined to the construction of series, are an essential first step toward the exploration of this uncharted realm.

In the study of which we are reporting in this paper, we have formulated a nine equation econometric model which describes the inter-regional flow of mortgage funds and then proceeded to test our model empirically utilizing California data.

Interestingly, the popular but previously untested hypothesis to the effect that mortgage yield differences among regions are a prime determinant influencing the inter-regional flow of mortgage funds is not supported by our findings. The availability of loanable funds and the yields on bonds and other assets relative to mortgage yields seem to be the more important variables affecting the inter-regional flow of funds when their effects are compared with those of the differences in yields among regions. This accords with the results of our theoretical analysis which indicates the importance of bond markets and the liquidity status of financial institutions during business cycles as variables affecting the supply of mortgage funds.[2]

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2. For discussions of the importance of the bond market to the aggregate housing market, see William W. Alberts, "Business Cycles, Residential Construction Cycles, and the Mortgage Market", Journal of Political Economy, June 1962, pp. 263-281. J. M. Guttentag, "The Short Cycle in Residential Construction", American Economic Review, June 1961, pp. 275-298.

This finding, although tentative, suggests that policies aimed at widening the mortgage yield difference among regions in order to increase the flow of inter-regional mortgage funds have rather limited chances of success in accomplishing their objectives.[3]

The plan of this paper is as follows. In the next section, the theoretical aspect of the inter-regional flow of mortgage funds will be discussed. In Section 3, a nine equation model of the inter-regional flow of mortgage funds will be presented. Section 4 discusses the nature of the data used in this study. The results of the calculations made are shown in Section 5. Some concluding remarks are contained in Section 6. The data used in this study appear in the appendix.

II. Theoretical Considerations

According to the neo-classical theory of growth, the inter-regional flow of funds is analogous to the international flow of capital.[4]

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3. For instance, Case states: "As the interest rate differential on borrowed money increases between the capital importing and capital exporting states, the deficit tends to be smaller. Recent efforts to reduce interest rate differentials throughout the United States, therefore, threaten the ability of California to attract out-of-state funds since changes in the volume of the flow of these funds to the state apparently coincide with changes in interest rate differentials." op. cit. p. 80. However, he does not present any evidence to substantiate his observation.

4. George H. Borts, "Growth and Capital Movements Among U.S. Regions in the Postwar Period", American Economic Review, May 1968, pp. 155-162.

Capital will flow from a capital-surplus region to capital deficit region as a result of the interest rate differential between them, which is due to the relative strength of the demand for and the supply of capital in each region.[5] Excess demand in relation to the supply of capital in each region is a result of the differences in growth rates among them. Differences in growth rates, in turn, may have been caused by changes in exogenous variables such as technological change, population movement, and the accumulation of imported capital goods. The theory also implies that profit maximizing behavior by firms contributes to the efficient allocation of capital by moving them from a capital-surplus region, where the rate of return on their investment and the marginal efficiency of capital are both low, to the capital-deficit region where both are higher.

Interference with the inter-regional flow of funds by firms unwilling to allocate their loanable funds in accordance with the changing interest rates in different regions will, then, result in inefficiency.

Schaaf, however, contends that the differences in regional mortgage yields are the result of the differences in the investment quality of mortgages.[6] His cross-sectional study

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5. Bort's model does not explititly include the interest rate differentials among regions, but he implicitly assumes it. See, Ibid., p. 157.

6. A. H. Schaaf, "Regional Differences in Mortgage Financing Costs", Journal of Finance, March 1966, pp. 85-95.

shows that the three most important explanatory variables for the inter-regional variations in the mortgage yield are the loan-to-value ratio, the distance of the borrower from the Northeastern capital markets, and the pro-rated earnings for average dwelling units in the state.[7]

An empirical study based on a survey by Smith also finds that insurance companies operating in national markets do not place much importance on inter-regional yield differences in allocating their funds.[8]

Observation of the California data reveals that the mortgage yield in California has been higher than that in the rest of the nation for the period studied, and that California has been importing about 30 per cent of its mortgage funds from the rest of the nation. This seems to support the neo-classical theory of the inter-regional flow of capital.

But then, a more careful analysis of the data reveals that the increases in the mortgage yield differentials between California and the rest of the nation may not have caused the increases in the flow of mortgage funds into California, since the differences in mortgage yields have been decreasing in recent years while the out-of-state supply of mortgage funds exhibits generally increasing trend, as Fig. 1 illustrates.

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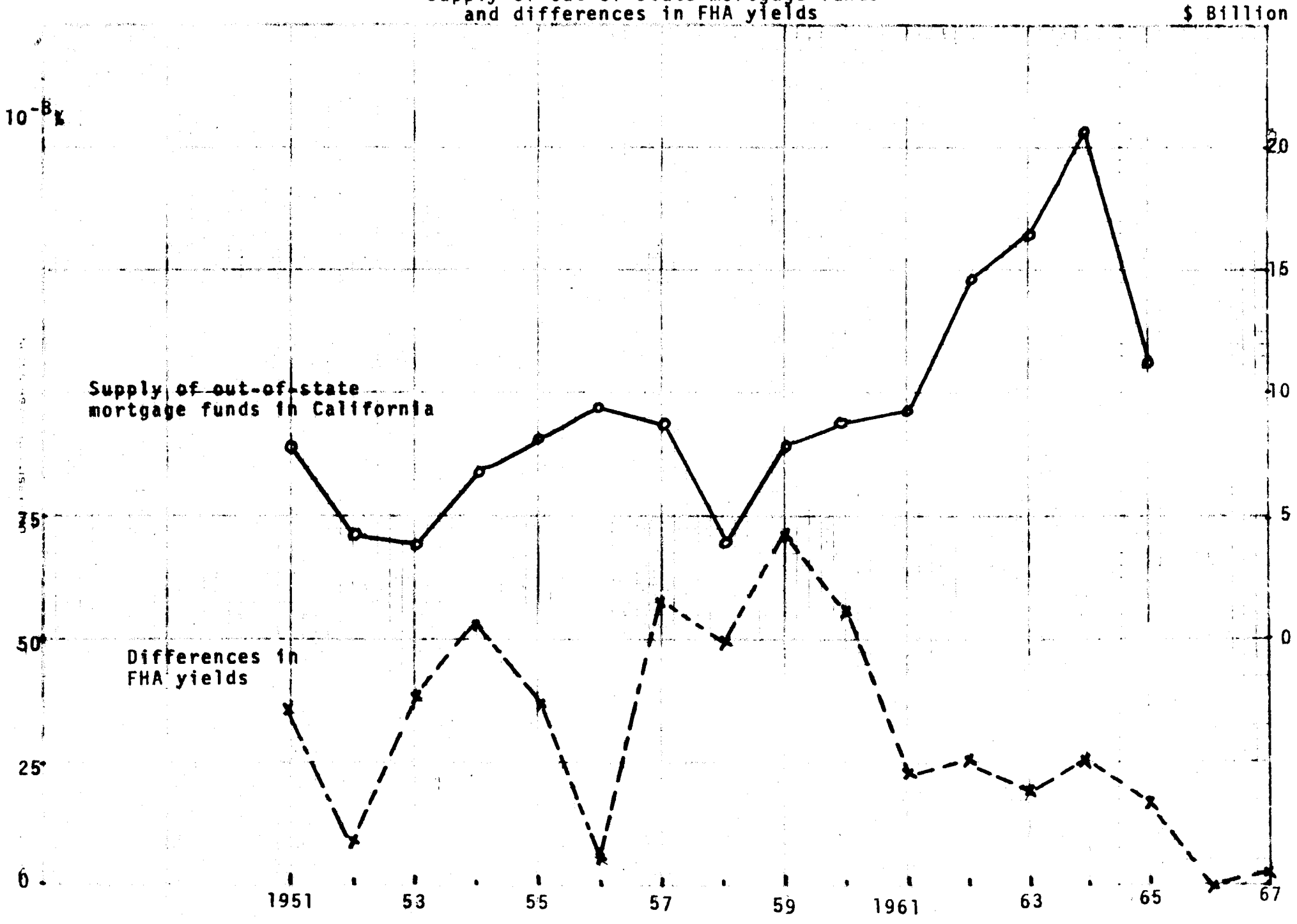
7. Ibid..

8. Halbert C. Smith, "Institutional Aspects of Inter-Regional Mortgage Lending," A paper presented at the 1967 Annual Meetings of Allied Social Science Association, Washington, D.C. December 29, 1967.

Figure 1

Supply of out-of-state mortgage funds
and differences in FHA yields



The explanation may be that the long-run capital flow differs from short-run capital flows. The simple neo-classical growth model apparently describes the long-run trend in the inter-regional flow of funds, but it is unable to explain short-run fluctuations in the inter-regional flows of funds during business cycles.

Short-run fluctuations in the supply of mortgage funds seem to be largely the result of cyclical portfolio adjustments by financial institutions. As Alberts notes, there is a high cross-elasticity with respect to yield between the demand for mortgages and the demand for competitive investments.[9] And, supplies of mortgage funds are very sensitive to changes in bond market yields relative to mortgage yields. The mortgage market and the bond market are closely related because of the portfolio selection process of financial institutions. As bond yields increase more than the mortgage yields during the period of an upswing in a business cycle, loanable funds in the capital-surplus region will flow into the national bond market rather than into the mortgage market in the capital-deficit region, although the mortgage yields between the regions usually widens during the period of an alleged "tight money policy". The opposite occurs during the downswing in a business cycle. This may explain the paradox of a decreasing inter-regional flow of mortgage funds in the face of increasing mortgage yield differences among regions,

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9. William W. Alberts, op. cit..

which was especially evident in California during the 1966-67 period of monetary restraint.

The flow of loanable funds from the mortgage market into the bond market is not only the result of the portfolio changes by financial institutions but also the result of the direct shift of consumer savings from deposit-type financial institutions to the bond market. The decrease in the flow of savings into deposit type institutions affects the ability of these institutions to make new mortgage loans, materially, as was illustrated when savings inflows into the three deposit type institutions in 1966, (savings and loan associations, commercial banks, and mutual savings banks) decreased 38.2% from the level of inflows in 1965.[10]

Furthermore, the response of depositors to the changing rate differentials seems to be stronger in the capital-deficit regions, such as the Western states, than in the capital-surplus region. This further aggravates the credit situation of the mortgage market in the capital-deficit regions.[11]

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10. Of these three, savings and loan associations experienced the largest reduction in net savings inflows in 1966, or a decrease of 56.6% from 1965. Net savings inflows at commercial banks and mutual savings banks in 1966 decreased 32.2% and 28.6% respectively from 1965. See, "Savings Flows and Mortgage Lendings, 1966-67," Economic Review, February 1968, Federal Reserve Bank of San Francisco, pp. 12-19.

11. "Time Deposit Scene," Monthly Review, Federal Reserve Bank of San Francisco, July 1966, pp. 132-133.

Still another factor influencing the inter-regional flow of funds, in the short-run, is credit rationing during the period of a "tight-money-policy".[12] When the money supply decreases, during the tight-money-policy period, the allocation of mortgage funds to another region may decrease so that the regular local demand may be satisfied.

III. The Model

The model consists of nine structural equations; eight behavioral equations and one identity. In our model, the inter-regional flow of mortgage funds is seen as being determined by the interaction of 1) the demand and supply of mortgage funds within the region, 2) the supply of mortgage funds from outside the region, 3) the decision processes of "out-of-state" mortgage lenders, 4) and mortgage yields. The first behavioral equation describes the demand for mortgage funds within a region.[13] Since the demand for mortgage funds is a derived demand from the demand for housing, the same set of variables which influence the demand for housing will also determine the demand for mortgage funds.[14] The

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12. For credit rationing and the supply of mortgage funds, see Guttentag, op. cit., p. 283.

13. Since we have used the California data, we will use the region and California interchangeably.

14. The demand for housing has been extensively studied in recent years. See, R. F. Muth, "The Demand for Non-Farm Housing," A. C. Harberger (ed.), The Demand for Durable Goods, Chicago: University of Chicago Press, 1960, pp. 29-96, and Sherman Maisel, "Fluctuations in Residential Construction Starts," American Economic Review, June 1963, pp. 359-383.

demand for mortgage funds is therefore, hypothesized as being determined by the prevailing interest rate (or yield) at time "t" in the given region, e.g., i_{mt}; the money supply in the region, e.g., M_{et};[15] the ratio of the Boeckh construction cost index and the rent component of the Bureau of Labor Statistics consumer price index in the region, e.g., P_t/R_t; and income in the region, Y_t.

$$D_t = f_1 (i_{mt}, M_{ct}, P_t/R_t, Y_t) \qquad \ldots (1)$$

The importance of credit terms and the availability of credit on the demand for housing has been commented on elsewhere.[16]

The variable P_t/R_t is a price variable which measures the price elasticity of demand relative to rent.[17] We may expect that as the price of a house, P_t, relative to rent, R_t, increases, the demand for houses and mortgage funds will decrease, or

$$\frac{\partial (D_t)}{\partial (P_t/R_t)} \leq 0 ,$$

and when it decreases the opposite will occur. The relative

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15. The money supply is defined here in narrow sense, namely currency in circulation plus demand deposits.

16. Guttentag, op. cit. .

17. The Boeckh construction cost index has been used as a proxy variable for the price of house.

importance of current and permanent income on the demand for housing have been discussed in previous studies.[18] Muth concluded that permanent income had superior explanatory power when it was compared with current income. His study was primarily concerned with the demand for residential housing. In fact, very little had been written on the aggregate demand for housing which would include the demand for non-residential as well as residential buildings.[19] It appears that residential demand is more closely related to the permanent income but current income may be a more influential variable determining non-residential demand. For this reason, we have tried using both current and permanent income as explanatory variables. We have assumed in equation (1) that the effect of changes in the independent variables on the dependent variable will be apparent during the same time period, "t", and that the adjustment will be completed within this same time period. In actuality, the adjustment coefficient may be smaller than one and consequently the actual changes in demand may be smaller than the desired changes. However, we have avoided using the usual Koyck-Nerlove stock adjustment model for two reasons: First, recent studies seem to indicate that the lags in the demand for mortgage funds are shorter than was previously anticipated.[20]

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18. Muth, op. cit., pp. 54-58.

19. Non-residential demand includes commercial, industrial and other non-residential demand for mortgage funds.

20. See, Frank de Leeuw and Edward Granlich, "The Federal Reserve - MIT Econometric Model," Federal Reserve Bulletin, January 1968, pp. 11-40.

Secondly, methods for the identification and estimation of lag structures, statistically as well as theoretically, are not yet well established.[21]

The supply of mortgage funds within a region, e.g., S_{ct}, depends upon the institutional savings in the region, S_{at}, the difference between the mortgage yields and short term bond yields, $i_{mt} - i_{st}$, the difference between mortgage yields and long term bond yields, $i_{mt} - i_{bt}$, the money supply in the region, M_{ct}, and mortgage yields, i_{mt}, i.e.,

$$S_{ct} = f_2 [S_{at}, (i_m - i_s)_{t-1}, i_{mt} - i_{bt}, M_{ct}, i_{mt}] \quad . \; . \; . \; (2)$$

The flow of loanable funds, generated within the region, into the same regional mortgage market will depend upon the relative yields on investments in the regional mortgage market compared to the yields on other debt instruments. However, there is as yet no solid empirical evidence on the relative magnitude of the cross elasticities. It can be argued that the long-term bond market is the close competitive market to the mortgage funds market since both are long-term debts. On the other hand, it can be argued that the portfolios of financial institutions include both long and short-term debt instrutments and the reactions of these institutions, when selecting their portfolios, to changing monetary policy is not always predictable. For example, a sudden increase

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21. Zvi Griliches, "Distributed Lags: A Survey," Econometrica, January 1967, pp. 16-49.

in short-term interest rates relative to the long-term interest rates may result in an increase in more liquid short-term assets at the expense of mortgage assets in their portfolios while they await a new situation in the credit market. In our study, we have experimented with both the differences between the mortgage yields and short-term bond yields, and mortgage yields and long-term bond yields, in order to gather empirical evidence relative to this question.

The supply of out-of-state mortgage funds in the regional mortgage market, S_{ot}, which is the focus of our study, must be analyzed in connection with the investment behavior of the financial institutions which engage in the out-of-state mortgage lending activity. As previously discussed in the theoretical considerations, the aggregate supply of the mortgage funds will be determined by the relative yields of assets that compete with mortgages and the availability of investment funds.

Once the decision is made as to the amount to be allocated to mortgage investment relative to other investments, the actual allocation of mortgage funds to any particular region will be determined by the magnitude of aggregate mortgage investment, M_{et}, the mortgage yield differential between the region under consideration and the rest of the nation, $i_{mt} - \bar{i}_{mt}$.

$$S_{ot} = f_3 (M_{et}, i_{mt} - \bar{i}_{mt}) \qquad \ldots (3)$$

The aggregate supply of mortgage funds in a region will then be the sum of the supply of mortgage funds within the region and the supply of "out-of-region" funds, or

$$S_t = S_{ct} + S_{ot} .$$

In equilibrium, the aggregate supply of mortgage funds should equal the aggregate demand for mortgage funds.

$$D_t = S_{ct} + S_{ot} \qquad \ldots (4)$$

Aggregate mortgage investment, M_{et}, is a function of total investment k_t, the ratio of investment in corporate securities to total investment, B_t/k_t,[22] and aggregate construction expenditure at time t-1, C_{t-1}, as previously noted. That is,

$$M_{et} = f_4 (k_t, B_t/k_t, C_{t-1}) \qquad \ldots (5)$$

The total investment, K_t, is determined by the net savings inflows and gross investment in the economy, GE_t.

$$K_t = f_5 (D_{ot}, GE_t) \qquad \ldots (6)$$

Net savings inflows into these financial institutions,

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22. Theoretically, investments to all competitive assets should be considered instead of just investment on corporate securities. However, the observation of data shows that investments to other assets are small per cent of total portfolio of the financial institution under consideration in post-war period.

which is measured by the net changes in savings deposits and life insurance reserves, affects the investment ability of the institutions. Gross investment, e.g., GE_t, on the other hand, indicates the general investment trend in the economy.

Net savings inflows into the selected financial institutions are determined by the yields on other assets such as long-term bonds, i_{bt}, relative to the average deposit rate, i_{dt}, or i_{bt}/i_{dt}, and money supply, M_{ust}.

$$D_{ot} = f_7 (i_{bt}/i_{dt}, M_{ust}) \qquad \ldots (7)$$

The ratio of investment in bonds to total investment, B_t/k_t, is determined by the relative yield of bond investments to mortgage investments, $i_{bt}/\bar{i}_{mt}$, industrial production, PI_t.

$$B_t/k_t = f_8 (i_{bt}/\bar{i}_{mt}, PI_t) \qquad \ldots (8)$$

The last behavioral equation describes the mortgage yield adjustment process within the region.

The changes in the mortgage yield, Δi_m will result when there is excess supply relative to the demand for mortgage loans, $S_t^* - D_t$ or $D_t^* - S_t$. Therefore, a measure of excess supply is a determinant of the change in mortgage yield, where S_t^* is the desired supply.

$$\Delta i_m = f_9 (S_t^* - D_t) \qquad \ldots (9a)$$

Since the "desired supply" reflects the amount of supply desired given the changes in the independent variables, one may substitute the independent variables from the supply equations, i.e. (2) and (3), for S_t^* in equation (9a). Then

$$\Delta i = f_9 [S_{at}, i_{st-1}, M_{ct}, M_{et}, D_t] \quad \ldots (9b)$$

Rewriting (9b), knowing that $\Delta i_m = i_{mt} - i_{mt-1}$, we obtain[23]

$$i_{mt} = f_9(S_{act}, i_{st-1}, M_{cat}, M_{et}, D_t) \quad \ldots (9c)$$

The system (1) - (9c) is complete with eight jointly determined variables (D, S_c, S_o, M_e, K, D_o, B/K, i_m) and fourteen predetermined variables (M_c, P/R, Y, c_{t-1}, $\bar{i}_m$, GE, M_{us}, PI, i_b, i_{s-1}, $i_b/\bar{i}_m$, i_b/i_d, S_{ac}, i_s).

IV. Data

Post-war California data (1950-1965) were utilized in estimating the parameters of the model because of the importance of the inter-regional flows of funds to California and because these data were available.

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23. See, David S. Huang, "The Short-Run Flows of Nonfarm Residential Mortgage Credit," Econometrica, April 1966, pp. 433-459.

The holdings of California mortgages by out-of-state lenders accounted for about 30-40% of total mortgage holdings in California during the post-war years.[24]

Furthermore, the California mortgage market accounts for a significant portion of the inter-regional flow of mortgage funds in the United States. For example, mortgage holdings by mutual savings banks in California represent 23.2% of total out-of-state mortgage holdings in the nation and 31.4% of the mortgage holdings on properties located in non-mutual-savings-bank states in 1966.[25]

For life insurance companies, California mortgage holdings accounted for 15.2% of total mortgage holdings in the United States in 1965.[26] The precise percentage of California mortgage holdings in the total of out-of-state mortgage investment by life insurance companies is not known, but the California mortgage market is a significant portion of out-of-state mortgage investment.

Savings and loan associations are restricted by the law from actively engaging in out-of-state mortgage lending, but

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24. Holdings by institutional lenders (Life Insurance Companies, Mutual Savings Banks, and Savings and Loan Associations) account for about 30%. Holdings by all lenders including FNMA and "Cal-Vet" were approximately 40%. See, Case, op. cit. Table II, pp. 84-85.

25. National Fact Book, Annual Report of the National Association of Mutual Savings Banks, May 1968, Tables 69 and 71, p. 45.

26. Life Insurance Fact Book, 1967, Institute of Life Insurance, 1967.

the extension of their allowable lending area from 50 to 100 miles in the 1964 "Housing Act" and the sale of home mortgage participation loans by Associations since 1957 has increased the out-of-state mortgage lending activities of savings and loan associations.[27]

The above mentioned three financial institutions, i.e., Life Insurance Companies, Mutual Savings Banks, and Savings and Loan Associations, account for more than 80% of the total estimated out-of-state mortgage funds placed in California during the 1950-1965 period.

The annual data available for the 1950-1965 period and the methods of estimation they utilized are discussed in detail by Grebler and Case.[28] Their estimates indicate that life insurance companies are the most important source of out-of-state mortgage funds accounting for about 50% of the total. They are followed by mutual savings banks and savings and loan associations which each account for 25%. We have not

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27. From 1957 to 1965, $6 billion in participation has been sold, and more than 62% of the sales were accounted for by associations in the San Francisco Federal Home Loan Bank district, Savings and Loan Fact Book, United States Savings and Loan League, 1966, Table 74, p. 90. Also, California Associations responding to the 1960 survey by the Stanford Research Institute reported $430 million in "broker" savings and $950 million of direct accounts obtained from savers located more than 50 miles from the reporting offices (most of them are out-of-state accounts), for a total of $1,380 million. See, Southern California Laboratories of Stanford Research Institute, The Savings and Loan Industry in California, South Pasadena, November 1960. Also, Grebler, op. cit. p. 48.

28. See, Grebler, op. cit.. Case, op. cit..

included in our data the California holdings by FNMA (the Federal National Mortgage Association) and the "Cal-Vet" bonds held Outside the state because of their irregularity which would distort rather than explain the market mechanism of the inter-regional flow of funds. They accounted for approximately 18% of the total estimated out-of-state mortgage funds flow in 1960.[29]

The regional mortgage yield time series data covering the 1950-1965 period has been a difficult commodity to obtain. Fortunately, we have received a recently released FHA (Federal Housing Administration) average market yield series and an unpublished National Bureau of Economid Research-Urban Land Institute manuscript containing time series for the non-residential interest rate.[30]

Both sets of data are classified by regions rather than by states. We have used the Western regional data in approximating the California mortgage yields.[31] Because of the relative homogeneity of the region and the importance of

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29. Grebler, op. cit., Table I, p. 48.

30. The FHA data give estimates of the average yields of FHA-insured home mortgage loans under section 203 for immediate delivery in secondary market. See, "FHA Secondary Market Prices," HUD News, HUD No. 68-1844, May 15, 1968, U.S. Department of Housing and Urban Development, Washington, D.C. The NBER-LIAA time series data are average contract interest rates of loan commitments for 15 life insurance companies.

31. The interest rate series compiled by the Federal Home Loan Bank on the conventional loan rates contains more detailed information. However, they do not go back beyond 1954 for California data.

California in the Western region, the error introduced by this approximation should be small.

The other basic data utilized in the analysis and the definitions of the variables are shown in the appendix.

V. Empirical Results

The parameters of the equations (1) - (9c) described in the previous section have been estimated by ordinary least squares (OLS), two-stage least squares (2SLS), and three-stage least squares methods (3SLS). The results of the computations are as follows:

a. Ordinary Least Squares Estimates:

$$(1)\quad D_t = 24672 - \underset{(.526)}{.938}\, i_{mt} + \underset{(.302)}{1.030}\, M_{cat} - \underset{(9.849)}{30.047}\, P_t/R_t + \underset{(.359)}{.119}\, Y_{pt}$$

$$R^2 = .826 \qquad S_e = 752.9 \qquad \delta = 1.412$$

$$(2)\quad S_{ct} = -3941 + \underset{(.215)}{.620}\, S_{act} + \underset{(2.610)}{7.732}\, (i_m - i_s)_{t-1} + \underset{(.713)}{.099}\, (i_m - i_b)_t + \underset{(.267)}{.212}\, M_{cat} - \underset{(.417)}{.053}\, i_{mt}$$

$$R^2 = .907 \qquad S_e = 424.0 \qquad \delta = 2.383$$

(3) $S_{ot} = -745 + 1.923\ M_{et} + 2.014\ (i_m - \bar{i}_m)_t$
$\qquad\qquad\qquad\qquad\quad (.360) \qquad (4.014)$

$R^2 = .732 \qquad S_e = 264.6 \qquad \delta = 1.619$

(4) $M_{et} = -280 + .210\ K_t - 1.041\ B_t/K_t + 2.882\ C_{t-1}$
$\qquad\qquad\quad (.037) \qquad (.451) \qquad (1.225)$

$R^2 = .892 \qquad S_e = 81.2 \qquad \delta = .783$

(5) $K_t = -1932 + 2.443\ D_{ot} + 3.359\ GE_t$
$\qquad\qquad\quad (.338) \qquad (1.051)$

$R^2 = .941 \qquad S_e = 295.3 \qquad \delta = 1.624$

(6) $D_{ot} = -1.064 - 1.326\ i_{bt}/i_{dt} + 2.103\ M_{ust}$
$\qquad\qquad\quad (.464) \qquad (.310)$

$R^2 = .898 \qquad S_e = 11.4 \qquad \delta = 1.256$

(7) $B_t/K_t = -457 + .646\ i_{bt}/\bar{i}_{mt} + .255\ PI_t$
$\qquad\qquad\quad (.436) \qquad (.134)$

$R^2 = .849 \qquad S_e = 36.7 \qquad \delta = 2.375$

(8) $i_{mt} = 1013 - .197\ S_{act} + .213\ i_{st-1} + .231\ M_{cat}$
$\qquad\qquad\quad (.110) \qquad (.117) \qquad (.114)$

$- 1.447\ M_{et} + .130\ D_t + 5.860\ i_{bt}$
$\quad (.446) \qquad (.085) \qquad (1.802)$

$R^2 = .945 \qquad S_e = 138.1$

b. Two-Stage Least Squares Estimates:

(1) $D_t = 25730 - .760\ i_{mt} + .707\ M_{cat} - 30.138\ P_t/R_t$
$\qquad\qquad\qquad\quad (.630) \qquad (.663) \qquad\quad (11.514)$

$+ .705\ Y_{pt}$
(1.139)

$R^2 = .798 \qquad\qquad S_e = 811.2$

(2) $S_{ct} = -4694 + .682\ S_{act} + 7.598\ (i_m - i_s)_{t-1}$
$\qquad\qquad\quad (.207) \qquad\quad (2.259)$

$+ .620\ (i_m - i_b)_t + .421\ M_{cat} - .057\ i_{mt}$
$\quad (.744) \qquad\qquad (.275) \qquad\quad (.051)$

$R^2 = .918 \qquad\qquad S_e = 398.1$

(3) $S_{ot} = -749 + 1.926\ M_{et} + 2.053\ (i_m - \bar{i}_m)_t$
$\qquad\qquad\quad (.322) \qquad\quad (3.601)$

$R^2 = .734 \qquad\qquad S_e = 236.7$

(4) $M_{et} = 9.2 + .224\ K_t - 1.063\ B_t/K_t + .727\ C_{t-1}$
$\qquad\qquad\quad (.040) \qquad\quad (.485) \qquad\quad (1.116)$

$R^2 = .844 \qquad\qquad S_e = 83.5$

(5) $K_t = -1935 + 2.455\ D_{ot} + 3.342\ GE_t$
$\qquad\qquad\quad (.299) \qquad\quad (.927)$

$R^2 = .944 \qquad\qquad S_e = 260.7$

$$(6)\quad D_{ot} = -1.064 - \underset{(.464)}{1.326}\, i_{bt}/i_{dt} + \underset{(.310)}{2.103}\, M_{ust}$$

$$R^2 = .898 \qquad S_e = 11.4$$

$$(7)\quad B_t/K_t = -457 + \underset{(.436)}{.646}\, i_{bt}/\bar{i}_{mt} + \underset{(.134)}{.255}\, PI_t$$

$$R^2 = .849 \qquad S_e = 36.7$$

$$(8)\quad i_{mt} = 1002 - \underset{(.113)}{.205}\, S_{act} + \underset{(.119)}{.220}\, i_{st-1} + \underset{(.113)}{.231}\, M_{cat}$$

$$- \underset{(.466)}{1.453}\, M_{et} + \underset{(.088)}{.138}\, D_t + \underset{(1.810)}{5.804}\, i_{bt}$$

$$R^2 = .945 \qquad S_e = 138.1$$

The three-stage least squares estimates (3SLS) are not shown here, but they are similar to the two stage least squares estimates. The standard errors of regression coefficients obtained by 3SLS are, however, generally smaller than that obtained by 2SLS. This may reveal that contemporaneous disturbance terms in different structural equations are highly correlated and the gain of efficiency when 3SLS is applied.

32a. See, Arnold Zellner, "Estimators for Seemingly Unrelated Regression Equations: Some Exact Finite Sample Results," Journal of American Statistical Association, December, 1963, pp. 977-992.

The results of the estimates by the different simultaneous estimators are presented here to test the sensitivity of the parameter estimates from the different estimation methods.[32]

The numbers inside the paraentheses are the standard errors of the regression coefficients. S_e and δ designate the standard error of the estimates and the "Durbin-Watson" statistic, respectively.

The results show that some of the structure equations in the model, i.e., the demand equation (D_t), are sensitive to the alternative simultaneous equation estimators. However, the results of the estimations, in general, are encouraging. All of the regression coefficients have the right signs in accordance with the theoretical expectations and the analysis of variance shows that the "F" ratios of all the equations are significant, indicating that significant relationships exist between the independent and the dependent variables.

The results of the estimations support our hypothesis that the inter-regional flow of mortgage funds is determined by the availability of loanable funds and the yields of bonds and other assets relative to mortgage yields, as can be seen from equations (3) - (7). Equation (3), e.g. the out-of-state supply equation (S_{ot}) also shows that the differences

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32. As is well known, the ordinary least-squares estimators are biased, but the small sample properties of the different estimators are as yet unknown. See, A. L. Najar, "A Monte Carlo Study of Alternative Simultaneous Equation Estimators," Econometrica, July 1960, pp. 573-590.

in the mortgage yield variable, e.g. $(i_m - \bar{i}_m)_t$, is statistically insignificant in explaining the out-of-state supply of mortgage funds.[33] This refutes the popular but previously untested hypothesis to the effect that mortgage yield differences are a prime determinant influencing the inter-regional flow of mortgage funds.[34]

Equation (1), e.g. the demand for mortgage funds, i.e., equation (D_t), and equation (2) e.g. the supply of mortgage funds within California (S_{ct}), reveal that factors influencing the supply and demand of mortgage funds are quite different.

The money supply in California (M_{cat}) and the price of housing relative to rent (P_t/R_t) are most important in explaining the demand for mortgage funds while savings in California (S_{act}) and the difference between the mortgage yield and the short-term bond yield of the previous period $[(i_m - i_s)_{t-1}]$ are most important in explaining the supply of mortgage funds within California.

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33. Also the simple correlation coefficient between S_{ot} and $(i_m - \bar{i}_m)_t$ is low (-.390) and statistically insignificant at the 1% level.

34. We have also recomputed equation (3) using non-residential and conventional interest rate series, but in all cases, the differences between mortgage yields and bond yields, e.g. $(i_m - \bar{i}_m)_t$, is statistically insignificant.

The income variable (Y_{pt}) is statistically insignificant in explaining the demand for mortgage funds. This may reflect the fact that the housing cycle runs counter to the business cycle.

The permanent income variable appearing in the equation (1) is obtained from the equation

$$Y_{pt} = (1 - e^{-\beta}) \sum_{i=0}^{T} Y_{ct-i} e^{-\beta i}$$

and assuming $\beta = .7$. This means that computing the permanent income the weight for current income is 50% and the weight for previous income is also about 50%.

This particular weighted average income, e.g. permanent income with $\beta = .7$, was used instead of current income or another weighted average income with a different "β" value because the strong multi-colinearilty between the money supply in California (M_{cat}) and current income (Y_{ct}) disappears when this particular weighted average income is used.[35] However, the regression coefficients for all weighted average income variables with different "β" values are statistically insignificant, as Table I shows.[36]

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35. This can be seen from the decrease of the zero-order correlation coefficient between Y_{ct} and M_{cat} ($r_{2.4} = .97$) when weighted average income with "β" = .7 is used ($r_{2.4} = .85$) See Table I.

36. These are the ordinary least squares estimates.

TABLE I

Weighted Average Income

With Different Values of "β"

Variables / Weights		(1) i_{mt}	(2) M_{cat}	(3) P_t/R_t	(4) Y_{pt}
$\beta = \infty$ * (Current Income)	reg. coeff.	-.95	.65	-28.87	.79
		(.50)	(.60)	(9.72)	(.98)
	$r_{2.4} = .97$			$R^2 = .83$	
$\beta = 2.3$	reg. coeff.	-.94	.68	-28.99	.73
		(.50)	(.60)	(9.76)	(.98)
	$r_{2.4} = .97$			$R^2 = .83$	
$\beta = .7$	reg. coeff.	-.94	1.03	-30.05	.12
		(.53)	(.30)	(9.85)	(.36)
	$r_{2.4} = .85$			$R^2 = .83$	
$\beta = .2$	reg. coeff.	-.93	1.04	-30.07	.13
		(.52)	(.28)	(9.84)	(.38)
	$r_{2.4} = .81$			$R^2 = .83$	

* The weights of current income (Y_t) and previous income (Y_{t-i}) are: 1.00 and 0 when $\beta = \infty$, .90 and .10; when $\beta = 2.3$, .50 and .50 when $\beta = .7$; and .18 and .82 when $\beta = .2$, respectively.

Equation (4) shows that the aggregate mortgage investment (M_{et}) is determined by the total amount of investment at time "t" (K_t) and the ratio of the investment in bonds to total investment (B_t/K_t) by the financial institutions which engage in out-of-state mortgage investment.

These two variables are, in turn, determined by the net savings receipts (D_{ot}) in equation (5), and by the ratio of the average bond yield of long-term bonds to the average mortgage yield ($i_{bt}/\bar{i}_{mt}$) among other variables [equation (7)].

In our analysis we have used the FHA yield series since most of the out-of-state lenders prefer federally guaranteed loans in order to reduce risk.[37] However, we have also recomputed the parameters of the model using non-residential and conventional interest rate series and found no significant differences.

VI. Conclusion

In this project, an econometric model has been developed to explain the mechanism of the inter-regional flow of mortgage funds and to indicate the structural relationships among the variables influencing such flows in the post-war

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37. See, E. A. Brady, "Regional Cycles of Residential Construction and the Interregional Mortgage Market: 1954-1959," Land Economics, February 1963, pp. 15-30.

period. The results of the analysis show that the more important variables affecting the inter-regional flow of mortgage funds appear to be the liquidity status of the financial institutions and the yields on bonds and other long-term assets relative to mortgage yields rather than the differences in mortgage yields among regions. This intimates that any attempt to increase the yield difference between capital-deficit and capital-surplus regions during periods of monetary restraint in order to attract more out-of-state mortgage funds may be futile unless the increases in the mortgage yield differentials between regions are greater than the increases in long-term bond yields. The model can also be useful in predicting the conditions in future mortgage markets. Simulation of the mortgage market using our model may assist in revealing the effect of different monetary-fiscal policies on the supply and demand for mortgage funds. More work, however, should be done in refining the model and in obtaining better data.

We have knowingly omitted many important variables such as loan-to-value ratios on mortgages, length of amortization periods, and acquisitions of federally underwritten mortgages by the Federal National Mortgage Association (FNMA), because of a lack of data. As more new data become available, it will be interesting to examine the effect of including these variables in the model. The dynamic

properties of the model should also be investigated in order to gain more information on the time path of the endogenous variables generated by the model. We are encouraged, however, by the results of our initial study, and we hope that this study will provide a useful framework for future studies.

APPENDIX

In this appendix, we present the definition of the variables and the basic data utilized in the analysis. All data are in constant dollars unless otherwise specified, and subscripts refer to time, e.g., "t". The sources of the data are given at the end of this appendix.

Definition of Variables

1. Endogenous variables

D_t: Net portfolio increase in total non-farm mortgages in California (mortgage holdings recorded during the year less repayments), in millions of dollars.

S_{ct}: Net increase in total non-farm mortgages by California financial institutions (which include savings and loan associations, commercial banks, and life insurance companies), in millions of dollars.

S_{ot}: Net increase in total California non-farm mortgage holdings by out-of-stae lenders (which include life insurance companies, mutual savings banks, and savings and loan associations; FNMA and Cal-Vet are excluded), in millions of dollars.

M_{et}: The aggregate mortgage investments in the United States by life insurance companies and mutual savings banks, in billions of dollars.

K_t: The total investment by life insurance companies, mutual savings banks, and savings and loan associations, in billions of dollars.

D_{ot}: The net savings inflows into the above three financial institutions (net savings receipts of mutual savings banks and savings and loan associaitions plus life insurance reserves), in billions of dollars.

i_{mt}: Average market yield of FHA insured home mortgage loans in California (estimated by the average yields of FHA insured home mortgage loans under Section 203 for immediate delivery in the secondary market).

B_t/K_t: The ratio of investment in bonds to total investment by life insurance companies and mutual savings banks, as a percentage.

2. Exogenous variables

M_{cat}: Money supply in California (currency plus demand deposits), in millions of dollars.

P_t/R_t: The ratio of the Boeckh construction cost index to the rent component of the BLS consumer price index for California. (The latter is obtained by averaging the Los Angeles and San Francisco indices.)

Y_{pt}: The weighted average of disposable income (or so called permanent income), in billions of dollars. It is obtained from the following equation;

$$Y_{pt} = (1 - e^{-\beta}) \sum_{i=0}^{T} Y_{ct-i} e^{-\beta i}$$

where Y_{ct-i} is disposable income at time "t minus i."

In our analysis, $\beta = .7$ is used, which implies that about 50% of the disposable income at time "t" and 50% of the income at time "t-1" will be included in the computation of the permanent income.[38]

$i_{bt}/\bar{i}_{mt}$: The ratio of the average annual yield on long-term corporate bonds to the FHA mortgage yield at time "t".

i_{bt}/i_{dt}: The ratio of the average annual yield on long-term corporate bonds to the average annual yield on savings deposits (the average of the yields of savings accounts in savings and loan associations and savings deposits in mutual savings banks).

C_{t-1}: Total private non-farm construction expenditures in United States at time "t-1", in billions of dollars.

GE_t: Gross private domestic investment in the United States, in billions of dollars.

M_{ust}: Money supply in the United States (seasonally adjusted currency plus demand deposits), in billions of dollars.

PI_t: The index of industrial production; 1957-59 = 100.

i_{bt}: Average market yield of corporate bonds (Moody's Aaa); per cent per annum.

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38. See, Philip Cagan, "The Monetary Dynamics of Hyperinflation," Studies in the Quantity Theory of Money by Milton Friedman (ed.) The University of Chicago Press, 1958. pp. 37-47. Also, Muth, op. cit., p. 56.

TABLE II*

Basic Data

	D_t	S_{ct}	S_{ot}	M_{et}	K_t	D_{ot}	i_{mt}	B_t/K_t	M_{cat}	P_t/R_t	Y_{pt}
1951	1,236	457	779	7.35	28.44	7.94	4.248	16.8	9,951	1.035	22.29
52	1,217	749	468	5.71	26.11	10.51	4.299	25.2	10,343	1.006	23.36
53	1,214	770	444	6.07	26.10	11.21	4.646	22.6	10,274	.972	24.61
54	1,552	895	657	7.80	32.08	12.28	4.673	17.8	10,889	.987	25.60
55	2,084	1,310	774	9.26	34.31	12.87	4.674	15.5	11,836	1.010	27.33
56	2,352	1,491	861	8.90	31.82	12.66	4.793	21.4	11,994	1.016	29.21
57	1,409	628	782	6.36	29.27	11.28	5.474	30.8	11,994	1.007	30.71
58	1,785	1,358	427	5.98	35.56	13.20	5.540	25.5	11,610	.990	31.98
59	2,865	2,105	760	7.03	35.76	12.50	5.781	24.4	11,986	1.003	33.98
1960	2,198	1,403	795	7.26	34.82	13.36	6.233	30.3	12,658	.995	35.38
61	3,040	2,225	815	8.08	42.84	15.01	5.833	30.5	12,419	.975	37.14
62	4,821	3,337	1,484	9.44	49.49	17.20	5.653	35.3	13,477	.969	39.15
63	5,990	4,312	1,679	11.25	55.75	19.12	5.488	37.6	13,494	.966	41.54
64	5,125	3,044	2,081	12.29	56.45	19.65	5.478	38.1	13,780	.975	44.31
65	3,011	1,892	1,119	12.20	58.41	17.40	5.470	45.9	14,218	.1031	46.76

* In the actual computation of parameters, the decimal points appearing in this table were ignored to simplify computation.

	$i_{bt}/\bar{i}_{mt}$	i_{bt}/i_{dt}	C_{t-1}	GE_t	M_{ust}	PI_t	i_{bt}	i_{st-1}	$(i_m-i_s)_{-1}$	S_{act}	$i_m - \bar{i}_{mt}$
1951	.679	1.24	33.3	69.3	121	81.3	2.86	1.218	2.95	768	36
52	.689	1.18	30.3	58.5	126	84.3	2.96	1.552	2.30	1,022	9
53	.694	1.23	29.3	59.6	127	91.3	3.20	1.776	2.21	954	40
54	.627	1.07	30.9	57.7	130	85.8	2.90	1.931	2.30	1,258	53
55	.659	1.09	33.1	74.1	133	96.6	3.06	953	3.26	1,010	39
56	.701	1.16	37.1	74.9	135	99.9	3.36	1.753	2.60	1,109	3
57	.718	1.25	36.1	69.5	134	100.7	3.89	2.658	1.66	1,943	58
58	.690	1.17	35.7	60.9	139	93.7	3.79	3.267	1.83	2,336	49
59	.767	1.30	35.0	74.1	140	105.6	4.38	1.839	3.23	1,376	71
1960	.715	1.20	38.3	72.8	138	108.7	4.41	3.405	1.93	1,987	56
61	.749	1.17	36.5	68.6	143	109.7	4.35	2.928	2.38	3,191	23
62	.769	1.09	36.7	78.5	145	118.3	4.33	2.378	3.03	4,033	25
63	.779	1.05	39.3	81.4	150	124.3	4.26	2.778	2.61	4,297	20
64	.807	1.07	40.2	85.4	157	132.3	4.40	3.157	2.20	4,262	28
65	.824	1.08	39.9	96.1	164	143.4	4.49	3.549	1.78	3,436	17

i_{st-1}: Average market yield of 3-month treasury bills at time "t-1"; percent per annum.

$(i_m - i_s)_{t-1}$: The difference between the mortgage yield and the short-term bond yield at time "t-1".

S_{act}: Net changes in institutional savings in California (savings in savings and loan associations, commercial banks, and life insurance companies), in millions of dollars.

D_{t-1}: D at time "t-1".

$i_{mt} - \bar{i}_{mt}$: Mortgage yield differential between California and the rest of the nation; in thousandths of a percent.

Sources of Data

D_t, S_{ct}, S_{ot}, S_{act}: Fred E. Case, "California's Continuing Need for Mortgage Capital," California Management Review, Winter 1967, pp. 80-90.

M_{et}, K_t, D_{ot}, B_t/K_t: Life Insurance Fact Book, 1967, Institute of Life Insurance; Savings and Loan Fact Book, 1966, United States Savings and Loan League; "National Fact Book," Annual Report of National Association of Mutual Savings Banks, May 1968.

i_{mt}, $\bar{i}_{mt}$: Federal Housing Administration.

M_{cat}, Y_t: California Statistical Abstract, 1967, State of California; Economic Report of the Governor, 1967, May 1967.

R_t: Bureau of Labor Statistics.

C_{t-1}, GE_t, PI_t, i_{bt}, B_t, i_{st-1}: Survey of Current Business, 1967; Economic Report of the President, 1967; Federal Reserve Bulletin, Various issues.

i_{dt}: Savings and Loan Fact Book, 1967, Table 6, p. 17.

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ERRATA

Page 8, footnote 10, line 7:
"Federal Reserve Bank of San Francisco" should read "Federal Reserve Bank of Cleveland."

Page 14, line 9-10:
"...the ratio of investment in corporate securities" should read "the ratio of investment in corporate bonds..."

_____, footnote 22:
"...investment on corporate securities." should read "investment on corporate bonds."

Page 15, line 11, 12:
"The ratio of investment in bonds to total investment, B_t/K_t, is determined by the relative yield of bond investment to ..." should read "The ratio of investment in corporate bonds to total investment, B_t/K_t, is determined by the relative yield of corporate bond investment to ..."

Page 16, equations (9b) and (9c):
The variable, i_{bt}, should be added to both equations (9b) and (9c).

_____, line 11-12:
"...and fourteen predetermined variables (M_c,...,i_c)." should read "...and fifteen predetermined variables (M_{ca}, ..., $i_m - T_m$, i_{mt-1})."

Page 18, footnote 27:
"...participation has been..." should read "participation loan has been..."

Page 24, line 2-3, line 2-3:
"...to test the sensitivity of the parameter estimates from the different estimation methods." should read "...to test the sensitivity of the parameter estimates when different estimators are compared."

Page 25, footnote 34:
"...the differences between mortgage yields and bond yields..." should read "the differences in mortgage yields..."

Page 26, line 8:
"This means that computing the permanent income..." should read "This means that in computing the permanent income..."

Page 29, line 6-7:
"This intimates that ..." should read "This indicates that..."

_____, line 21-23:
"...and acquisitions of federally underwritten mortgages by the Federal National Mortgage Association (FNMA)" should be deleted.

Page 32, line 12:
"The ratio of investment in bonds..." should read "The ratio of investment in corporate bonds..."