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No 26

A Disequilibrium Model of Building Society Mortgage Lending

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S G Hall
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The object of this Technical Series of Discussion Papers is to give wider circulation to econometric research work predominantly in connection with revising and updating the various Bank models, and to invite comment upon it; any comments should abe sent to the authors at the address given below.

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1 Introduction

Over the last twenty years the behaviour of building societies generally has changed enormously. In simplistic terms the range and scope of services offered by the building societies has increased to the point at which they are now very close substitutes for the clearing banks in many areas. This change in behaviour has now become so important that recently a new monetary aggregate, M4, was introduced which treats building societies in the same way as clearing banks in the M3 aggregate. The numerical importance of building societies' behaviour in the monetary sector is enormous. In June 1988 the stock of M3 was £202 billion and the stock of M4 was £329 billion. Allmost all the difference of £127 billion being accounted for by building societies.

An understanding of the determinants of building society borrowing and lending therefore becomes crucial to a complete understanding of the UK monetary sector. However, despite a number of recent studies (PRATT (1980), NELLIS and THOM (1983), ANDERSON and HENDRY (1984) and WILCOX (1985)) the behaviour of building societies has received much less attention than one might expect. One reason for this may be that building societies' behaviour does not easily fit into the market clearing framework of much textbook economics and econometrics. Much of the work of the authors mentioned above has focussed on finding variables which proxy rationing effects in the mortgage market for example. Indeed there is not even a consensus as to the type of disequilibrium which operates in the market.

Anderson and Hendry (1984) model mortgage lending on the assumption that it is entirely supply determined. They model building society deposits and mortgages separately but both are supply determined. The societies are then seen as simple intermediaries passing on deposits to borrowers and so the supply of mortgages is mainly determined by the supply of deposits.

Wilcox approaches the problem differently, he uses a demand function for mortgages. The argument made here is that mortgages are often rationed and so variables which proxy the degree of rationing should enter the mortgage function. An earlier piece of work by O'Herlihy and Spencer (1972) followed a similar, if somewhat primitive, approach in that it estimated a demand function which included dummy variables to proxy various forms of rationing.

Perhaps the only common factor amongst the various approaches to modelling building society behaviour is the assumption that the market is a non-clearing one. It would seem therefore that a potentially useful approach, that has not so far been explained, would be to model the demand and supply for mortgages within an explicit disequilibrium framework. There are a number of advantages to this approach; first, and perhaps most important, no prior assumption needs to be made about the explicit structure of the market. Second, the possibility is opened up of the market structure changing over time, and finally a number of institutional changes which have occurred in the market can be modelled in a more structurally sound way.

In the light of these observations this paper will estimate a maximum likelihood, discrete switching, disequilibrium model of the Rosen and Quandt (1978) style. The paper will be organized as follows; Section 2 will present a description of the institutional changes which have affected building societies over the past fifteen years and describe some of the difficulties which this presents for modelling. Section 3 will discuss the various approaches to disequilibrium modelling and outline the maximum likelihood approach. Section 4 will develop a detailed model of the building societies sector and section 5 will estimate the model. Finally section 6 will present a set of conclusions.

2 Institutional Developments in the Mortgage Market

The growth in real mortgage lending has been far more rapid in the 1980s than in the preceding decade. Figure 1 shows the stock of such lending in 1980 prices, which rose by around 40% between 1970 and 1979, but by some 120% in the next six years or so. This period of rapid growth has coincided with major changes in the institutional structure of the UK mortgage market.

During the 1970s it was dominated by the building societies who were virtually the sole source of supply. Banks' behaviour over much of this period was restricted by the imposition of direct controls on their lending, which impinged most directly on the personal sector. Hence the mortgage and related markets at that time provide a good example of the segmentation of financial markets which characterized the UK financial system. Societies provided the bulk of such lending to persons as well as, increasingly, an outlet for personal sector savings while banks operated the payments mechanism. The area of direct competition between banks and building societies was, however, extremely limited.

As mutual institutions, societies were not profit maximizers. Rather they attempted to reconcile the conflicting demands between borrowers for low rates and savers for high rates by maintaining a relatively stable path for interest rates through time. This stability was made possible by the cartel arrangement under which the Building Society Association (BSA) recommended to its members the rate of interest they should charge on share accounts and mortgages. Such an institutional structure, which did not permit interest rates to play a major role in equilibriating the demand for and supply of funds, affected the behaviour of mortgage lending. When the general level of market interest rates rose building societies' rates to shareholders, which were relatively sticky, tended to lag behind, thereby diminishing societies' competitive position in the retail deposit market. Their inflows declined accordingly.

Although in this situation societies could run down their liquid assets to some extent in order to support lending, this could not happen indefinitely. In time, shortages of funds typically forced societies to reduce the rate of growth of their mortgage book. Since the societies would not raise interest rates by an amount sufficient to restrict mortgage demand they relied on a variety of non-market mechanisms to bring this about. These included queues and changes in lending arrangements - for example lowering the ratios of loans to the borrowers' income or to the price of the associated property. By contrast, at times when interest rates were falling societies' competitive position in retail deposit markets tended to strengthen, and the buoyancy of their inflows allowed rationing of mortgages to become less pervasive, lending to expand and liquidity to be rebuilt.

This market structure did not, however, survive much beyond the start of the current decade. The ending of the system of direct controls in mid-1980 gave the banks far greater freedom to develop areas of business in which the scale of their activity had become minimal. This they did immediately and vigorously, focussing in particular on the personal sector. As shown in Figure 2, the banks initial success in meeting new mortgage demand, as well as that which had been frustrated by the societies' rationing, was considerable; by 1982 they had attained a market share of net new lending which at one stage exceeded 40%. Following this initial assault, banks' mortgage lending subsequently grew more slowly for a period from 1983, in part because their initial targets had been met, while remaining significant. However, it began to accelerate once again in mid-1985 once the relative attraction of lending to the personal sector had been enhanced by the heightened risk associated with foreign exposure and the increasing use by large corporations of the securities markets. A number of foreign banks and also non-banks now compete with the UK clearers and building societies in offering mortgage funds.

The more intense competition in the mortgage market, which occurred at the same time as the retail market too was becoming increasingly competitive, induced a fundamental shift in building societies' behaviour. Increasingly, the societies attempted to meet in full the demand for mortgages at the prevailing level of interest rates and eschewed the array of rationing devices previously utilized. This involved a greater sensitivity to changes in market interest rates as well as, on occasions, the acceptance of higher interest rates than would otherwise have been the case. In these circumstances fewer societies implemented the rates recommended by the BSA which, recognizing its diminished influence, ceased to advise its members formally as to the appropriate level of rates from 1984.

Societies' ability to fund mortgage demand has been facilitated by their entry into the wholesale money and capital markets. In 1983 they began to issue time deposits and CDs as well as borrowing from banks on a significant scale, and their first issues in the eurosterling market were made at the end of 1985. Such receipts have become highly significant, accounting for about one third of all inflows in 1986. Access to these markets has also enabled societies to reduce their normal level of liquidity, allowing a further expansion of mortgage lending, though the decline in liquidity also reflects the imposition of corporation tax on societies' gilts in 1984, which lowered the post-tax rate of return. Prior to their use of wholesale markets, societies had typically been asset-managers, altering their mortgage lending in the light of the strength of their retail inflows and the level of liquidity; since that time they have increasingly managed their liabilities in order to fund fully the demand for mortgages. This change in behaviour, which has to some extent reversed the direction of causation between inflows and lending, was similar to that of the clearing banks following the introduction of 'Competition and Credit Control' in 1971, though there remain constraints on societies' wholesale borrowing which are not applicable to banks. Nevertheless, the wide range of share and deposit accounts currently offered by societies still allows them a limited degree of liability management using retail deposits.

Thus the mortgage market in the 1980s appears to have become one in which competitive forces have been allowed to play a far greater role. Potential borrowers who were frequently frustrated in the past now find that loans are more freely available provided that lenders' prudential criteria can be met - and there have been suggestions that these criteria have been made easier as a result of competitive pressures. There are, therefore, grounds for believing that the institutional structure of the mortgage market has been partly responsible for the more rapid growth in mortgage lending, and this hypothesis is examined at greater length in the following sections.

3 Modelling Disequilibrium Systems

The concept of equilibrium is obviously an important one in economics but it is not entirely unambiguous. Equilibrium is sometimes taken to mean that demand is equal to supply (in all markets if more than one market is being considered); an alternative definition is that the economic system is 'at rest' and so there are no forces tending to bring about change. These two definitions are not identical, we can for example consider the equilibrium position for a monopolist who fixes a market price subject to a known demand curve. The system has no tendency to move and is in equilibrium in the second sense but clearly demand does not equal supply and the first definition of equilibrium is inappropriate. This concept of an equilibrium which is defined by an absence of change is fundamental to much of the theoretical literature on disequilibrium or temporary equilibrium which has grown out of the work of Clower (1965) and Leijonhufvud (1968) (a recent survey of this work may be found in Benassy (1982)).

In its most fundamental form we can model a market with the following two equations:

$$D_t = \alpha_1 P_t + B_1 Z_t + U_{1t} \qquad (1)$$

$$S_t = \alpha_2 P_t + B_2 Z_t + U_{2t} \qquad (2)$$

Equation (1) is a demand curve, which relates demand for any good to its real price (P_t), a set of other factors Z_t, which may be a vector, and U_{1t} a stochastic error term. Equation (2) similarly relates supply to the price of the good, a set of other factors and an error term U_{2t}. The coefficient vectors B_1 and B_2 are such that the model is identified. These two equations are common to all forms of market analyses, the various approaches differing in their assumptions about what is observed and how the real price is determined. A full equilibrium approach, for example, would assume that $D_t = S_t = Q_t$ (where Q_t is the observed and traded quantity) and that the real price is determined simply where $D_t = S_t$, so $P_t=(B_1-B_2)Z_t/(\alpha_1-\alpha_2)$. An assumption of imperfect competition often amounts to assuming that the market is dominated by a monopolist (monopsonist) and that therefore we only observe points on the Demand (Supply) Curve, ie in the monopoly case $D_t = Q_t$ and the supply curve is unobservable. The distinguishing feature of the discrete disequilibrium approach is the assumption that the observed quantity actually being traded will always be on the short side of the market, that is:

$$Q_t = \mathrm{Min}(D_t, S_t) \qquad (3)$$

The justification for this approach is based on the notion of voluntary exchange, a demand or supply curve may be thought of as defining the maximum amount of a good which will be exchanged voluntarily at a given price. If someone is offered a smaller quantity than he demands at a given price, he will generally accept this trade as profitable, but an individual will not generally purchase a larger quantity than indicated by his demand curve.

In order to close the disequilibrium model it is necessary to make some assumption about the determination of prices. The usual assumption which is made is that -

$$P_t = P_{t-1} + \gamma(D_t - S_t) + U_{3t}, \ \gamma > 0 \qquad (4)$$

so that if demand is greater than supply the real price will rise and if it is less than supply the price will fall. Equations (1)-(4) then constitute a full statement of the single market disequilibrium model. Over time the real price will tend to adjust to the market clearing price and the speed at which it does this is governed by γ. If γ becomes very large the disequilibrium model will move very quickly towards equilibrium. If γ is small then disequilibrium will persist for a considerable time. One of the advantages of using an empirical model based on(1)-(4) therefore is that the estimate of γ will give us an indication of how closely the model approximates a market clearing model.

In this section we will be concerned with describing and estimating explicit disequilibrium models. For the single market, these, in essence, will convey two things. Firstly, they estimate the underlying demand and supply functions together with a price adjustment equation for the market. Secondly, they allow for discrete switches to take place in the regime - be it a demand or supply constraint in that market. The advantages of such an explicit recognition of disequilibrium to more informal notions of disequilibrium are obvious. One is that it is possible to place rival views about equilibrating/non-equilibrating models within a general disequilibrium model and test for the presence of discrete regime changes and the speed of adjustment. Furthermore, incorporating discrete switches in regime is an advance over the sort of modelling which simply introduces an activity variable into a behavioral equation, attributing to this the characteristics of a non-Walrasian function and spillover. The limitations of this latter, very widespread, practice is that it leaves unspecified the analytics of spillover effects between markets, and hence cannot be used as a test of them. It also assumes, by implication, that a particular regime is in force throughout the sample period, and again, does not test this key assumption. Thus the use of measured output as an additional variable in Walrasian labour-demand equation entails that a goods market constraint is in force throughout the sample. A two-market disequilibrium model in contrast could adjudicate on the realism of this assumption.

The paper which founded much of the literature on disequilibrium was Fair and Jaffee (1972), this paper considered a model like (1)-(4) except that the price adjustment equation was assumed to be non-stochastic. This unrealistic assumption allowed the model to be estimated by an instrumental variable technique. Maddala and Nelson (1974) derived the full likelihood function for a model with a stochastic price adjustment equation and much of the literature using this technique is surveyed in Quandt (1982). An alternative to this approach may be found in Muellbauer and Winter (1980) which derives continuous estimation equations by aggregating many markets each of which is in disequilibrium, an application of this approach is given in Andrews and Nickell (1986).

In this study we will make use of the single market discrete switching model and we will estimate it using the maximum likelihood estimation. We prefer the single market approach to the aggregation approach of Muellbauer and Winter (1980) for two reasons; in this case the mortgage market is made up of very similar institutions and the idea of different regimes ruling in each society seems implausible. Also, the aggregation approach requires some knowledge of the proportion of markets in each regime at each point in time and we have no such information. An account of the exact form of the likelihood function we use is given in Hall, Henry, Markandya and Pemberton (1989).

4 A Model of the Market for Mortgages

This section will attempt to outline a model of the demand and supply for building society mortgages. It will also discuss the way in which some of the institutional changes described in section 2 may be incorporated into such a model.

Before describing the model in detail it is important to clarify the notion of disequilibrium which will be applied here. The discrete switching model, given in section 3, yields the equilibrium at any point as the point at which there is no pressure from within the market for a change in the real price, in this case interest rates. On average therefore the system is likely to be in equilibrium and we will observe fluctuations around this equilibrium. This view conflicts with the notion that mortgage demand is always rationed because people would always like to borrow more than a prudent lender will supply. Such a demand is based either on ignoring the possibility of default on the debt or, in a more sophisticated framework, it may even explicitly exploit the discontinuities which occur at bankruptcy to force the cost of default onto the lender. Such a notion of demand is not a useful one in this context and we will follow Stiglitz and Weiss (1981) and Wilcox (1985) as defining rationing of borrowers as meaning that some borrowers who can meet the prudency requirements of the lending societies are unable to find a mortgage in a given period ie that queuing exists. Similarly rationing on the supply side would imply that the lenders are not able to find as many borrowers who meet their prudency requirements as they would like, ie no queuing exists. Of course to some extent the building societies do not represent a perfectly homogeneous market and it would be possible for queues to exist with one society and not with another. The discrete switching model does not allow for this possibility and we would suggest that market imperfections are sufficiently small in this case for this not to be a serious problem.

The demand for mortgages

The demand for mortgages may be derived from a fairly simple utility maximization problem. Suppose a representative household has the utility function U (H, G) where H is housing services and G is an aggregate of other goods. Then the household will maximize this function subject to a total limit on disposable income of the following form.

$$g(r,P^H)H + GP = DY \tag{5}$$

where $g(r,P^H)$ is a cost function of servicing a mortgage which will provide housing services H, the cost is a function of r the rate of interest on mortgages and P^H the price of houses. DY is disposable income and P is the general price of goods. This will yield a general constrained demand function of the form:

$$H = f(r,P^H, DY, P) \tag{6}$$

This simple analysis says nothing about the decision of home ownership against renting, we could easily extend the analysis to cover some of the simple factors governing this decision, the relative costs of rents and mortgage repayments, for example. We have chosen not to do this however as we believe the main changes in owner occupation over the last 20 years have been largely influenced by institutional factors and are not well explained by purely economic ones. In particular the policies of various governments on the sale of council housing and the rate of release of building land for new houses will have largely controlled the growth of home ownership. We therefore prefer to scale equation (6) by the number of owner occupied houses to derive an aggregate demand for mortgage equation. So at any point in time the desired level of mortgage borrowing will be -

$$M = h(r, P^H, DY, P).\ NOH \qquad (7)$$

where NOH is the number of owner occupied houses.

There are two other factors which are important in the demand side of the model; the first is adjustment costs, clearly households are subject to enormous adjustment costs in changing the level of their mortgage borrowing. Under institutional arrangements in effect over most of the period this will generally involve either moving house or building a considerable extension to a house. We could therefore set the whole maximization problem within an intertemporal optimisation framework and derive the dynamic decision rule for the household. This would involve a number of lags on the level of mortgages and a stream of future expectations on the variables r, P^H, DY and P. If adjustment costs actually are high it would suggest a dynamic equation with a value close to one which would imply that households would need to look a long way into the future. We feel that, when dealing with expectations of variables such as interest rates prices and incomes over a long period agents will not use elaborate expectations schemes but will use simple robust adaptive expectations. So our model will include lagged dependent variables to capture the slow dynamic movement due to adjustment costs but we will use only current and lagged values of the forcing variables.

The second factor which we will give special treatment will be the move by the banks and other new lenders into the mortgage lending market. Once again this has occurred through largely institutional changes in the banking system, as discussed in section 2, and so we will not attempt to model the underlying behaviour of these institutions. Instead we will simply include mortgage lending other than by building societies in the demand equation on the basis of the following argument: There are two extreme possibilities; the new lender banks may be creating wholly new markets for lending, in which case they will have no effect on the building society sector at all, or they may be capturing a share of building society mortgage demand. If the first case is true then bank behaviour has no effect on the demand for building society mortgages; in the second case it causes a one for one reduction in demand. By including the non-building society borrowing figures explicitly we allow the data to decide to what extent building society demand is affected.

One technical point which needs to be made is that the model will be estimated in log-linear form so the treatment of this variable will be a little complex. Our hypothesis is that

$$M^D = D + \alpha BL \qquad (8)$$

where M^D is mortgage demand, D is demand without clearing bank activity, BL is clearing banks mortgage lending and α is hypothesized to be between 0 and -1. Clearly we cannot take the log of this function, so instead we define

$$M^D = D.ZBL$$

so that

$$ZBL = \frac{M^D}{D} = \left(\frac{M^D}{M-BL}\right) \qquad (9)$$

we may now take logs of the equation to give log (M^D) = log (D) + γ log (ZBL). Now $\alpha<0$ implies that the banks' activity is affecting building society mortgage demand.

Finally we will transform the model into real mortgage lending by deflating both sides of the equation by prices so that the data will be more homoscedastic. The final demand equation will therefore have the following form.

$$\log (M^D/p) = \gamma_0 + \gamma_1 \log(r) + \alpha_2 \log (PH/p) + \alpha_3 \log (DY/P) + \alpha_4 \log (P) + \alpha_5 \text{LOG (NOH)} + \alpha_6 \log (ZBL) + \alpha_7 \log (M/P_{t-1})$$

where $\alpha_1, \alpha_6, < 0$

$\alpha_2, \alpha_3, \alpha_7 > 0$

The supply of building society mortgage lending

We will break the supply of mortgages down into two parts, the supply of building society shares and deposits from the personal sector and the action of the building society when it carries out its role as an intermediary between depositors and lenders.

The supply of deposits is given by a fairly simple analysis of portfolio allocation among a number of assets which vary in their risks and rates of return. Deposits will therefore vary with income and relative returns between building society deposits and other assets. The simple hypothesis for deposits is -

$$D = g\ (r^D/r^1,\ DY)$$

where r^D is the average share rate and r^1 is a representative competing interest rate, in the empirical work a number of alternatives were tried and the best performance was obtained using the yield on three month treasury bills.

Modelling the behaviour of the building societies is a little more difficult mainly because the underlying objective function of societies is not obvious particularly during the 1970s. They can not be assumed to maximize profits over our sample period in the sense in which a conventional commercial company does. The 1962 Building Societies Act stated that 'The purpose for which a society may be established under this Act is that of raising, by the subscription of the members, a stock or fund for making advances to members out of the funds of the society upon security by way of mortgage of freehold or leasehold estate'. The society is therefore required to act in the best interest of its members who include both the borrowers and depositors of its funds. It is not however clear what its overall strategy should be determined by, one plausible assumption might well be one of maximizing growth. This would certainly explain the long-term growth trend which has occurred in the real size of building society activities. It does not provide a very useful framework for the present exercise. We have therefore chosen to use a fairly simple and agnostic formulation of bulding society behaviour of the following form

$$M^S = \phi D$$

where ϕ is a factor determined by the societies with a view to a number of considerations which include the basic liquid asset reserve ratio of 7 1/2% (which up until 1987 was a legal requirement, though this was always exceeded by a substantial amount), overall lending conditions, the security of loans and the availability of funds from sources other than depositors, in particular the growth of borrowing from the wholesale money markets by the building societies. We will measure the willingness of societies to supply mortgages relative to deposits by the loan to value ratio and the loan to income ratio of first time buyers. So a higher loan to value or loan to income ratio will indicate that the societies are currently keen to expand lending relative to deposits. We will also explicitly include the societies' borrowing on wholesale markets using a similar transformation as given above for clearing bank mortgages. That is if

$$M^S = D + WB$$

where WB is borrowing on wholesale markets, then we may write

$$M^S = D.ZWB$$

where

$$ZWB = \frac{M}{D} = \frac{M}{M-WB}$$

and this variable may be added to the model in a multiplicative fashion.

So $\phi = h(LV, LY, ZWB)$ when $h_1, h_2, h_3 > 0$

where LV and LY are the loan to value and loan to income rate for first time buyers.

Finally we would again expect there to be long lags in the adjustment of building society deposits as most households view this as a reasonably long-term form of asset. As a result we will again allow the possibility of simple dynamics in the model in the form of lagged mortgage lending. The final model will then be -

$$\log (M^S/P) = B_0 + B_1 \log (r_D/r^1) + B_2 \log (DY/P) + B_3 \Delta\log (P) + B_4 \log (LV) + B_5 \log (LY) + B_6 \log (ZWB) + B_7 \log (M/P)_{t-1}$$

where $B_1, B_2, B_5, B_6, B_7 > 0$

The interest rate adjustment equation

Finally in order to close the model we need to specify the interest rate adjustment equation. The formulation of the model gives the change in ln (r_D/r^1) as a function of excess demand or supply plus a range of other factors. This part of the model is of only minor interest and so we adopt a simple 'ad hoc' equation involving the change in the long-term consul rate, the change in the treasury bill yield and a lagged dependent variable. This gives the following formulation

$$\Delta\log (r^D/r^1) = \gamma_0 + \gamma_1 \Delta\log (20YC) + \gamma_2 \Delta\log r^1) + \gamma_3 \Delta\log (r^D/r^1)_{t-1} + \gamma_4 \log (M^D/M^S)$$

where 20YC is the 20 year consul yield. This completes the general formulation of the model.

5 Estimation of the Model

This section will discuss the practical problems of maximum likelihood estimation of disequilibrium models and then present the numerical estimates of our mortgage lending model.

As pointed out in section 3, the likelihood function for the discrete switching disequilibrium model is an extremely complex one. It is not available as part of any of the standard econometric computer programs and it is sufficiently ill-conditioned to present serious problems for any of the standard numerical maximization procedures. The numerical work reported in this section will draw heavily on the work of Hall, Henry, Markandya and Pemberton (1989) in that their estimation program will be used here. Numerical optimisation of the likelihood function was achieved by the combined use of a non-linear Simplex algorithm and a conventional Quasi Newton algorithm using analytical first derivations. The non-linear Simplex algorithm is used first as it is relatively robust to the presence of local maxima and discontinuities, its final convergence on the maximum point is however slow. The Quasi Newton algorithm takes over the optimisation problem from the Simplex procedure and is usually then successful in finding a true maximum. Verifying that a true maximum has actually been located is of course difficult, the programme provides a graphical search around the final solution, presenting a set of line searches across the likelihood space, which may indicate a failure to find a true maximum if this is the case.

Section 4 outlined the general form of the model to be estimated, there is of course scope within this general framework for a wide range of dynamic specifications. In a normal modelling exercise we would start from a general model and nest down on the dynamics until a parsimonious form of the model was achieved. This is not a practical procedure for this type of system estimation as the general form would involve far too many parameters for successful optimisation. Even in the final form to be reported here the model involved maximizing the likelihood function with respect to 26 parameters. The estimation procedure has therefore had to be less systematic than we might like, it has involved a search over the models dynamics which has proceeded from the specific to the general. Before proceeding on the numerical estimates it is worth pointing out that the standard battery of diagnostic test procedures on the error process are not applicable to this model. The reason for this is that the observed error, $Q-\hat{Q}$, can not be uniquely associated with any of the error terms in the model. The observed error will be a mixture of the structural model errors and as such it provides no formal evidence about the properties of the structural errors. We do not make the assumption that $Q-\hat{Q}$ is white noise and uncorrelated and so there is no point testing this assumption.

The final model had the following form.

Demand

$$\log (M^D/P) = A_0 + A_1 \log (r) + A_2 \log (P^H/P) + A_3 \log (NOH) + A_4 \log (DY/P) + A_5 \log (P) + A_6 \Delta\log(P) + A_7 \log (ZBL) + A_8 \log (M/P)_{t-1}$$

Supply

$$\log (M^S/P) = B_0 + B_1 \log (r_D/r^1) + B_2 \log (DY/P) + B_3\Delta \log (P) + B_4 \log (LV) + B_5 \log (LY/LY_{-3}) + B_6 \log (ZWB) + B_7 \log (M/P)_{t-1}$$

Interest rate adjustment

$$\Delta \log (r^D/r^1) = Co + C_1 \Delta \log (20YC) + C_2\Delta\log(r^1) + C_3 \Delta \log (r^D/r^1)_{t-1} + C_4 \log (M^D/M^S)$$

Table 1

Parameter Estimates for the Model[a]

	Model 1		Model 2		Model 3	
A_0	-6.86	(5.1)	-6.92	(5.8)	-1.13	(5.5)
A_1	-0.045	(8.1)	-0.046	(8.8)	-0.08	(8.3)
A_2	0.03	(2.4)	0.03	(2.9)	0.005	(0.34)
A_3	0.75	(5.2)	0.78	(6.1)	----	
A_4	0.06	(1.8)	0.04	(1.7)	0.11	(3.4)
A_5	-0.12	(5.2)	-0.12	(6.0)	0.005	(0.6)
A_6	-0.79	(8.1)	-0.82	(10.6)	-0.73	(5.6)
A_7	-0.087	(3.7)	-0.09	(3.9)	-0.07	(1.6)
A_8	0.94	(23.1)	0.95	(27.7)	1.01	(85.9)
B_0	-1.03	(4.0)	-1.08	(5.2)	-0.99	(5.1)
B_1	0.003	(0.7)	0.002	(0.4)	0.003	(1.2)
B_2	0.10	(3.9)	0.13	(4.4)	0.11	(2.0)
B_3	-1.1	(16.7)	-1.1	(18.6)	-1.1	(19.6)
B_4	0.11	(3.6)	0.10	(4.2)	0.09	(1.9)
B_5	0.06	(3.2)	0.06	(3.5)	0.06	(2.9)
B_6	0.38	(2.3)	0.54	(2.2)	0.82	(1.9)
B_7	0.91	(44.1)	0.88	(35.0)	0.91	(16.9)
C_0	0.007	(0.9)	0.007	(0.8)	0.007	(0.9)
C_1	0.35	(2.2)	0.42	(3.0)	0.36	(2.2)
C_2	-0.95	(14.3)	-0.97	(15.4)	-0.955	(15.1)
C_3	-0.13	(2.1)	-0.06	(1.11)	-0.13	(2.2)
C_4	0.0004	(0.00002)	0.00004	(0.0)	0.00003	(0.0)
σ (Q-Q)	0.0031		0.0026		0.0034	
LIKELIHOOD F	510.006		462.03		505.04	
DATA	1969Q2 - 86Q1		1969Q2 - 84Q1		1969Q2-86Q1	

(a) asymptotic t statistics in parenthesis.

Table 1 contains the parameter estimates of the preferred model (Model 1), this model estimated without the last 8 data points as a structural stability test (Model 2) and a variant which restricts the terms in the stock of housing and the price of housing to be a value of owner occupied housing (Model 3). The term $\sigma(Q-\hat{Q})$ is the standard error of the observed forecast of the model this may be compared standard error of the Anderson and Hendry model of 0.0029 and the Wilcox model of 0.0029.

The preferred model conforms with the prior expectations about the signs of the parameters given in section 4. It produces a model which tracks the data reasonably well even in comparison to the conventional OLS models, this is demonstrated by the standard deviation of the observed error which is of a very similar size to the other mortgage lending models (although the data period is quite different). The tendency of the model to move towards equilibrium is measured by the size of C_4, ($C_4 = 0$ implies equilibrium is never reached, $C_4 = \infty$ implies continuous market clearing) this parameter estimate suggests that there is only a very slow adjustment and that for practical purposes disequilibrium may persist indefinitely. This conforms well with the conventional view of building society behaviour over the 1970s. Nevertheless the market for mortgages is not characterized by a very large degree of disequilibrium. Figure 3 (page 28) shows the model's forecast for the stock of mortgage demand and supply in contrast with the actual level of lending. It is quite clear from this figure that, by and large, the building societies were able to equate the demand and supply of mortgages fairly effectively. This is not however to suggest that disequilibrium is insignificant in this market. Figure 4 (page 29) shows the deterministic model estimates of excess demand over the period 1969Q2 - 1986Q1. The degree of disequilibrium peaks in 1974 at around 4% of the mortgage stock. This represents a sizable constraint on households borrowing, for example in 1985 this would have implied a level of constraint in excess of £l,000 million. The overall pattern of excess demand corresponds remarkably closely with that estimated by Wilcox prior to 1981, although this model does not detect such strong excess demand in the period 1979-1980. Unfortunately there is no time series of actual mortgage queuing length available to contrast with figure 4.

Figure 4 also suggests that the incursions into the mortgage market of non-building society lenders, particularly the banks, has had a very significant impact on the degree of excess, supply or demand. The three periods (the start of the 1970s 1981/3 and 1986/7) in which the banks' market share rose very rapidly were estimated to have been those in which the extent of rationing fell substantially, or even that conditions of excess supply prevailed. It is perhaps surprising that the degree of rationing was estimated to have been greater in 1984/5 than in the second half of the 1970s, since in the later period building societies were thought to have adopted a more flexible interest rate policy. While this finding may not be consistent with general perceptions of the way of the mortgage market operated at that time, the results do indicate that over the period as a whole, societies' propensity to use interest rates to equilibriate the demand for and supply of mortgage was greater when competitive pressures were more intense.

The long-run properties of the demand and supply equation are fairly reasonable. The long-run solution to the demand equation is -

$$\log(M^D/P) = -0.75\log(r) + 0.5\log(P^H/P) + 12.5\log(NOH) + 1.0\log(DY/P) - 2.0\log(P) - 1.4\log(ZBL)$$

These parameter estimates are all quite reasonable with the possible exception of the elasticity on the number of owner occupied housing, which will be discussed further below.

The long-run solution for the supply equation is

$$\log(M^S/P) = 0.03\log(r^D/r^1) + 1.11\log(DY/P) + 1.2\log(LV) + 4.2\log(ZWB)$$

Rather surprisingly, the level of liquidity was not found to be a significant variable in the supply equation. Because of the non-linear transformation used for both ZBL and ZWB neither of these coefficients may be interpreted as a simple elasticity.

There is an interesting asymmetry between the long-run effect of prices in these two equations with real mortgage demand showing a strong permanent price effect while the supply equation has no such long-run effect. This may be explained in terms of the fact that all existing mortgages are reduced, in real terms, by a rise in the price level leading to a permanent fall in mortgage demand. No such effect would be expected in the supply equation.

The only unrealistic elasticity is the effect of the number of houses on the demand for mortgages. A long-run elasticity of 12 is clearly unreasonable. It would be quite plausible to have an elasticity greater than one and we would certainly expect the elasticity on the number of houses to be larger than house prices, as almost all houses which are additions to the owner-occupied stock are associated with mortgages. None the less a long-run figure of 12 is clearly implausible. There would seem to be two possible explanations. First, we may have failed to pick up the full dynamic effect and so we may have a plausible short-run effect from housing but a very poorly defined long-run. Second, there may be a trend factor in mortgage demand which we have failed to model but which is highly collinear with the housing stock, in which case part of the long-run effect may be due to this unidentified component. In an attempt to investigate these possibilities we performed a number of experiments. First, lags in the housing stock were introduced to allow for the possibility of complex dynamics. This did not change the long-run elasticity to any great extent, but it is still possible that this is the correct explanation and that less than 20 years of data are simply not enough to analyse a market fully where the average term of loans is about 7 years. Second, Model 3 in table 1 considers the effect of restricting the housing terms to be the value of the owner occupied housing stock. This restriction is heavily rejected by the data with a likelihood ratio test statistic of 9.9 and in addition the model has a number of undesirable features. In particular, the demand equation is dynamically unstable and so the long-run solution is no longer defined.

Finally, while conventional tests of structural stability are not practical within this framework it is worth noting how little change occurs in the parameter estimates of

Model 1 when the last 8 observations are dropped from the estimation procedure (Model 2 in table 1). No parameters change sign and indeed the stability of the model seems remarkable, the standard error falls quite substantially suggesting that the last 8 observations are subject to unusually large errors. There is however no sign of parameter instability at all.

The model has been estimated and tested using data which ends in the first quarter of 1986. It is however, useful to know how the model would have performed over recent quarters, partly as a test of the model itself, and partly to use the model to throw light on recent events. To this end we have updated the housing stock figure, assuming 1% annual growth rate, and solved the model up to the first quarters of 1987. The models forecast for demand and supply of mortgage lending are shown in the following table.

Table 2

The Models Forecast 1986 Q1 - 1987 Q1[(a)]

Year		Actual mortgage lending	Demand	Supply	Excess demand
86	Q1	6.55698	6.58398	6.56234	0.0216
86	Q2	6.60122	6.62500	6.60270	0.0223
86	Q3	6.63850	6.66404	6.63821	0.0258
86	Q4	6.67445	6.70165	6.68931	0.0123
87	Q1	6.69752	6.73359	6.72375	0.0098

(a) All variables are measured in LOGS.

During 1986 the banks moved to increase their share of the mortgage market and as a result the size of the excess demand for mortgages fell quite sharply towards the end of 1986. The model seems to perform quite satisfactorily in this out of sample exercise, its forecast for demand and supply are reasonable and the movement in excess demand seems to accord well with anecdotal evidence about the housing market.

6 Conclusion

In this paper we have attempted to formulate and estimate an explicit disequilibrium model of the supply and demand for mortgage lending. This approach yielded an interesting and credible set of results. It was found that a significant degree either of excess supply or excess demand, had characterized the mortgage market over much of the period between 1970 and 1985, and that the nature and extent of the disequilibrium was related quite sharply to the institutional structure of the market. In those periods when building societies faced little competition typically they did not meet in full the demand for mortgages, or alter the level of interest rates in order to eliminate excess demand. By contrast, it was found that when competition from other institutions, notably banks, was very strong, those wishing to borrow and who could meet the requisite criteria were not frustrated. The results also indicate that on occasions lending institutions have found the level of demand insufficient to match their willingness to offer loans but have not altered lending criteria substantially in order to attract new business.

FIGURE 1. THE MORTGAGE MARKET

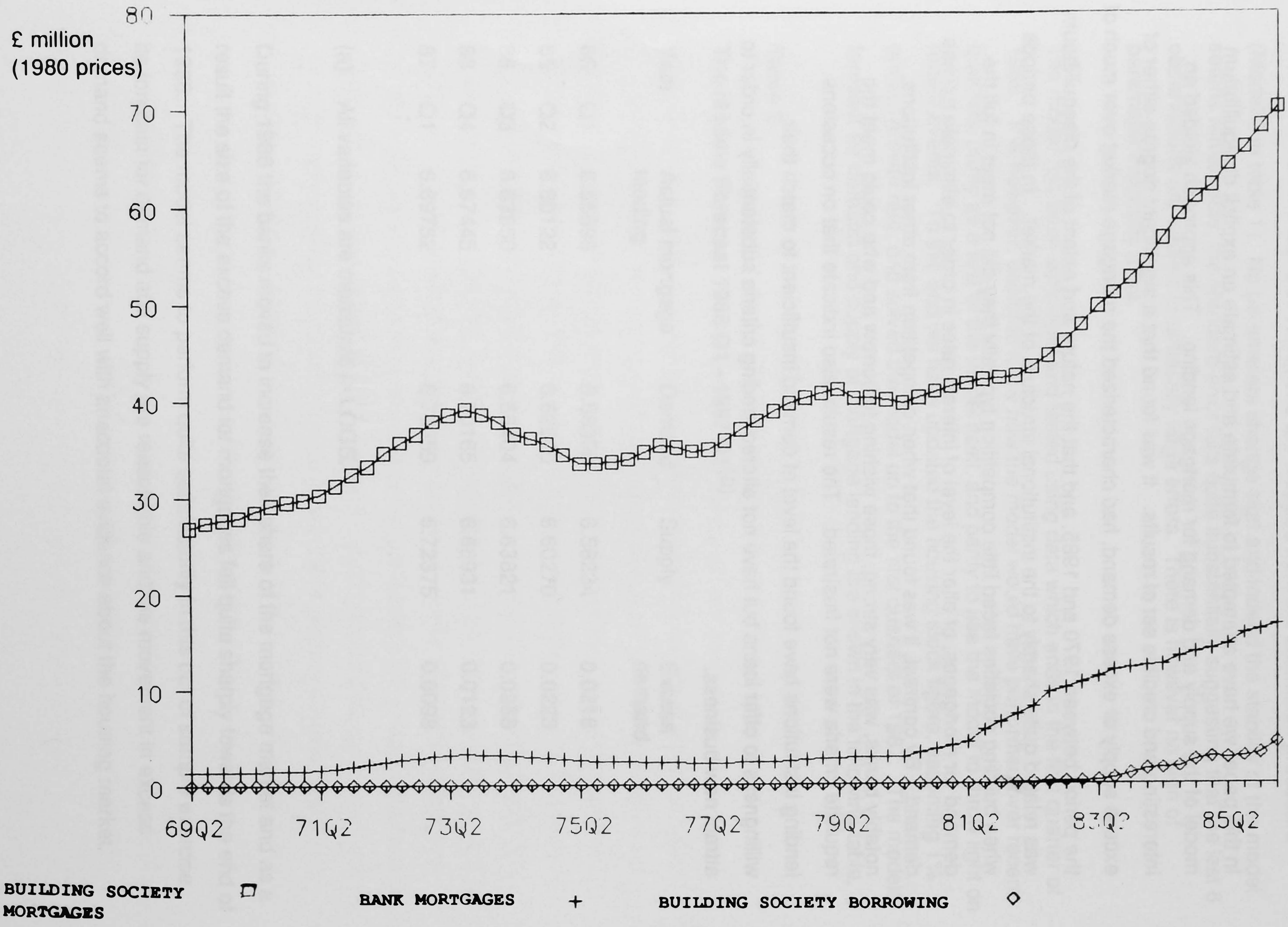


FIGURE 2. THE MORTGAGE MARKET (rates of growth)

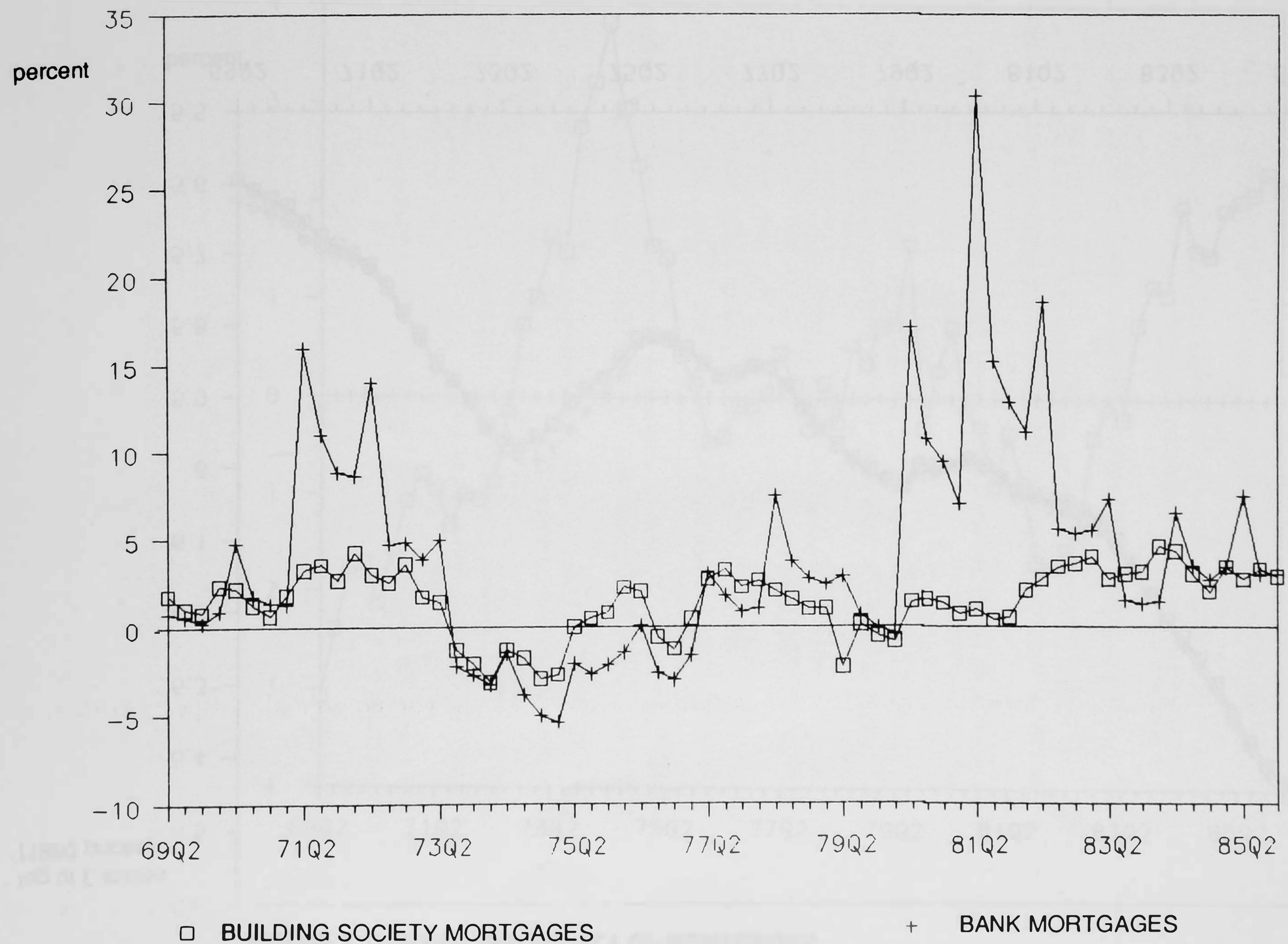


FIGURE 3. DEMAND AND SUPPLY OF MORTGAGES

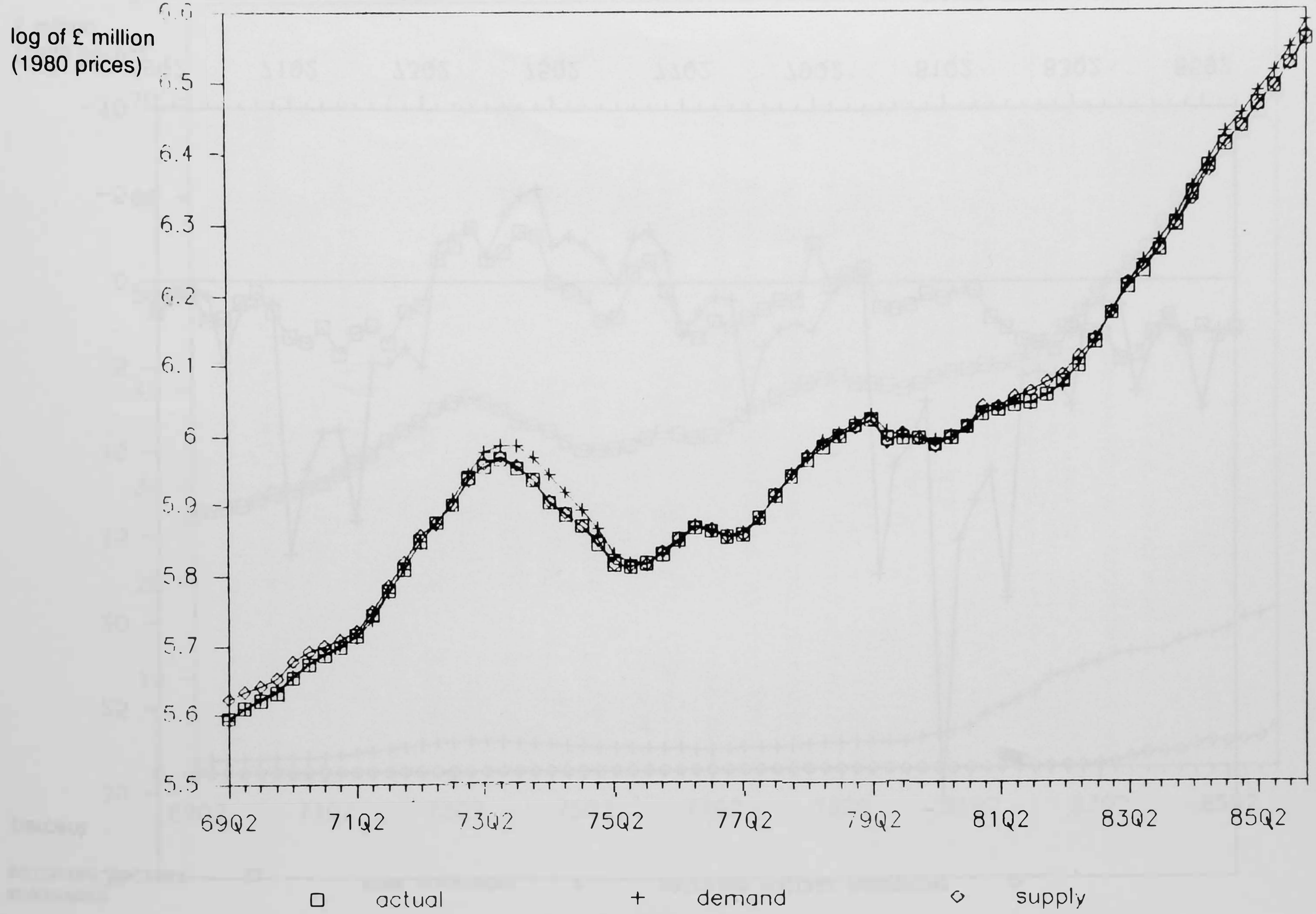
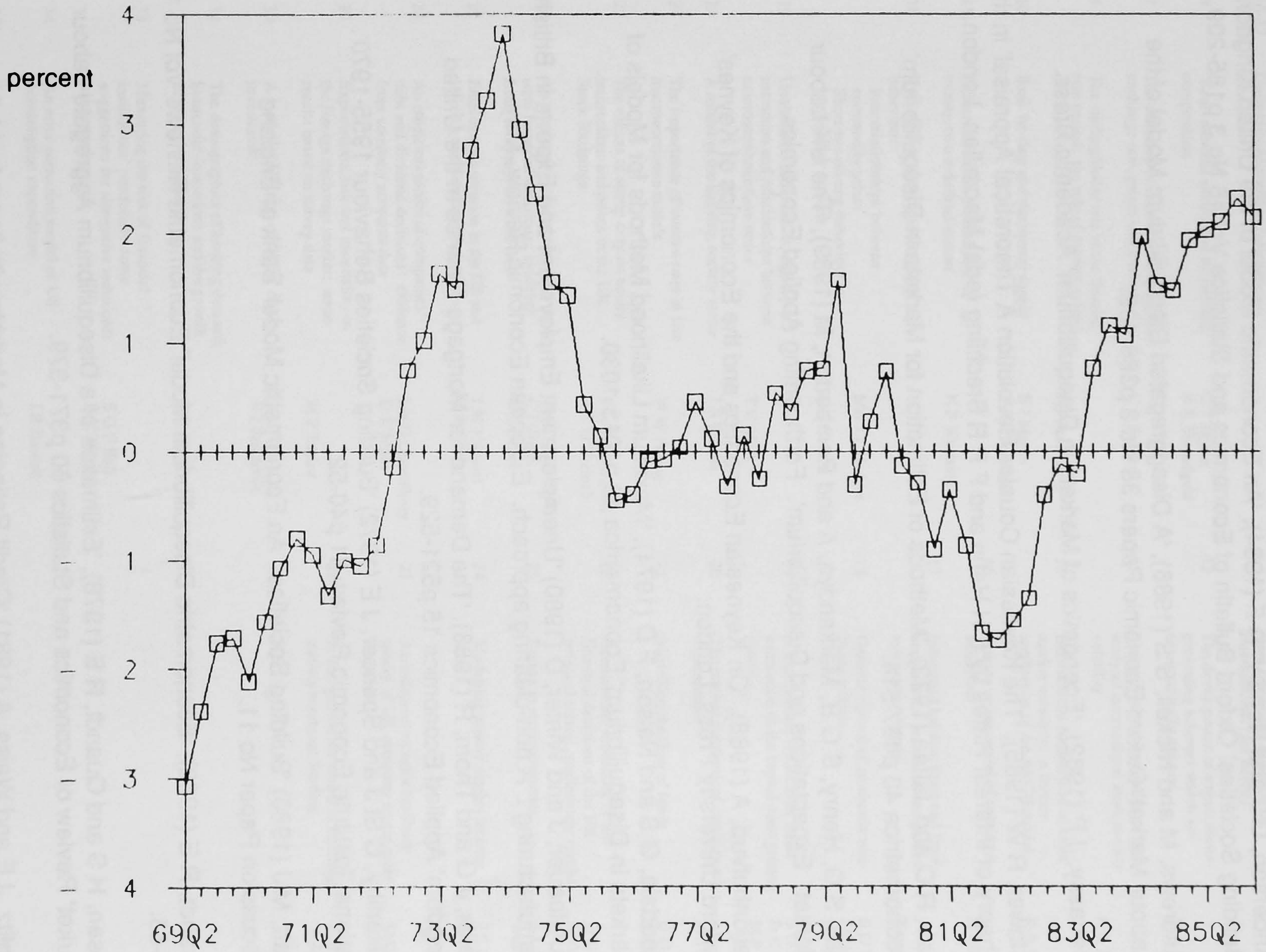


FIGURE 4. EXCESS DEMAND FOR MORTGAGES



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