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The interest elasticity of consumers' expenditure

by

M J Dicks

December 1988

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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 be sent to the author at the address given below.

The author is grateful for comments from John Flemming, Phil Davis, Gary Dunn, Don Egginton, Brian Henry and Kerry Patterson. Any errors remain his own responsibility. The views expressed are those of the author and do not necessarily represent those of the Bank of England.

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Section 1: Introduction

This paper presents some new evidence on the subject of the interest elasticity of consumers' expenditure based on UK data. We find that, although the issue is by no means settled, the weight of evidence does seem to favour what Boskin (1987) calls a 'modest positive interest elasticity of private saving'. Moreover, interest rate effects appear to have increased (in both size and significance) during the 1980s, a period in which competition in the UK financial markets has increased as a result of the government's policy of deregulation. This liberalisation has led to a weakening of the liquidity constraints which previously restricted households' choice and, although this will have had the effect of permitting consumers to move closer to their desired (life-cycle) levels of expenditure (since they may now find it easier to borrow through periods when income is temporarily low so maintaining a smoother consumption profile over time), at the same time the proportion of households that are likely to react to changes in interest rates will have risen. Our findings suggest that the latter effect may dominate, at least in the short-run, implying that the leverage of monetary policy may have been strengthened as a result of deregulation of the financial markets.

The paper is organised as follows. Section 2 serves to motivate our work and introduce the subject by illustrating the results of previous research carried out both in the UK and the US. Next, in Section 3, we show how the old Bank model of consumers' expenditure on durables (as published in Patterson, Harnett, Robinson and Ryding (1987)) can be improved. Although the resulting specification outperforms those (of the same vintage) used in the other main macro-models it does still have problems regarding the stability of its parameters - particularly those pertaining to the interest rate and other financial variables. This is illustrated by running the model using recursive least squares. In Section 4 we consider how the old Bank model of consumers' expenditure on non-durables (again as published in Patterson et al (1987)) might be improved. Interestingly the resulting specification also suggests that interest rate effects have become more important during the 1980s. Finally, in Section 5, we present our conclusions.

Section 2: Previous Research in the US and the UK

Throughout much of the early 1970s the view both in the US and that in the UK was that the effects on consumption of interest rate changes were likely to be small, due to offsetting income and substitution effects (see, for example, Ferber's (1973) survey of the consumption literature). By the late 1970s, however, some research was beginning to hint at strong interest rate effects. Thus, Boskin (1978) reports an elasticity of -0.4. More recently the case for consumption being interest-elastic has been taken up forcefully by Summers (see Summers (1982 and 1984)). Although he admits that, at first glance, such a view appears to fly in the face of many previous empirical studies he claims that there are good reasons for his view. Apart from the standard problems of errors in variables[1] and mis-specification[2] most empirical work holds wealth constant when attempting to measure the effect of changes in interest rates on savings. Thus, for example, the fact that Boskin finds a wealth elasticity close to 3 for savings means that if the interest elasticity of wealth is 1/2 then the total interest elasticity of savings is close to 2, which is within the range suggested by Summers. One problem with estimating these interest rate effects, however, is deciding how one should treat expectations. Thus Summers (1982), for example, finds that a simple life-cyle model which fails to distinguish between transitory and permanent effects implies a short-run interest elasticity of just 10%.

Blinder and Deaton (1985) attempt to get round the problem of unobserved expectations by generating one-period-ahead forecasts from vector autoregressions for income, prices etc. They find a strong (but fragile, in the sense of depending upon the precise specification of the model) effect from nominal interest rates (a semi-elasticity of -2.3) in a "surprise" consumption function,[3] but a much weaker effect in their "no-surprise" model (a semi-elasticity of -0.8). Interestingly they also find that interest rate

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1 For example, the 'correct' interest rate term should include real expected after-tax returns on equities, housing, durable goods and financial saving.

2 For example, age and population variables are rarely included in empirical studies.

3 ie One in which only "surprises" in permanent income affect current consumption, once lagged consumption is controlled for.

effects cannot be detected using a sample period which excludes the 1980s. This, they suggest, is due to the relatively small variance in interest rates during the 1960s and early 1970s. They also report that it is nominal and not real interest rates which matter, a result they find hard to explain, although Hubbard suggests that it may simply be due to the fact that durable goods are excluded from the model. Sims suggests that the problem lies rather with the way inflation is predicted, which may lead to overly variable inflation forecasts. Blinder and Deaton's (1985) findings are, however, consistent with recent research carried out for the UK by Attfield, Demery and Duck (1988) who found that "preliminary investigations ... suggested that the real rate performed unsatisfactorily".

Muellbauer and Bover (1986) have recently extended previous research by Bean (1986) by considering not only the possibility that some households are liquidity constrained but also the implications of aggregation both over retired and non-retired households and over time. The importance of their work is that they find that aggregation may induce a negative correlation between interest rates and the constant in a consumption equation. This not only suggests that the evidence in favour of a 'big' interest rate elasticity needs to be treated with caution, but also provides some justification for the type of consumption function which has proved popular amongst British econometricians. These are the error-correction models first popularised by Sargan (1964) and used, with considerable success, by Davidson, Hendry, Srba and Yeo (1978) to model consumers' expenditure of non-durables. Although these models have been extended to permit a role for wealth (see, for example, Hendry and Von Ungern-Sternberg (1981) or Patterson (1984a)) they rarely permit the identification of any explicit (substitution) effect from interest rates. Recent research by Harnett (1988) shows that on those few occasions where significant effects have been claimed in this type of consumption function (see, for example, Davis (1982)) these results are very sensitive both to the chronology of the data (ie whether 1980-based or 1975-based data are used) and to the sample period used. Moreover, they generally have been applied only to non-durables expenditure and thus ignore what is likely to be the far more interest sensitive element. Both Cuthbertson (1980) and Davis (1984) have discovered significant interest rate effects on durables expenditure using UK data, as have Mankiw (1982 and 1985), Bernanke (1984) and Bar-Ilan and Blinder (1988) for the US. It would appear that the conclusion one must draw from existing research is that the interest elasticity of consumers' expenditure is negative, though perhaps of moderate size. One important caveat needs to be made, however, to these conclusions, concerning institutional factors. Bernheim and Shoven (1985) have pointed out that in the US there is virtually an automatic negative interest elasticity in the personal saving rate because defined benefit pension plans (eg final salary-based pension funds) will be able to meet their required rate of return with lower contributions when real interest rates rise. (Obviously the size of this effect will depend upon the extent to which the funds hold variable-rate deposits.) Thus, as Boskin (1987) mentions, there was a decrease in 1984 of almost $30 bn in contributions to private defined benefit pension plans in the US following the rise in interest rates. Since it is by no means clear that similar effects would pertain in this country the remainder of this paper is concerned with a re-examination of consumers' expenditure (both on durables and non-durables) in the UK.

Section 3: Modelling Consumers' Expenditure On Durable Goods Using UK Data

The role of interest rates in the main UK macroeconomic models has been surveyed by Easton (1985). Most of the models then included direct interest rate effects in their equations for consumers' expenditure on durable goods, but there was much less consensus as to whether or not there should be a similar term in the non-durables equations. In part these differences may have reflected alternative views of how the economy works, although they may also have been due to the fact that all the models are subject to periodic review so that any analysis is but a snapshot of one particular version of them. Several strands of analysis have been examined in recent research carried out in the Bank, each of which is pertinent to the question of how strong a role interest rates might have in determining consumers' expenditure. In the first Patterson (1988b) examines a generalisation of the Hendry and von Ungern-Sternberg (1981) framework, by allowing for the possibility that disaggregated (by asset) wealth-income ratios are a function of rates of return (instead of assuming that they are constant in the long-run). The second recognises that changes in interest rates affect consumers who are liquidity constrained and that these effects may well vary over time as, for example, competition in the mortgage and savings markets changes. The remainder of this and the next section consider the developments which have so far been made to the Banks' short-term model as a result of this research program.

(i) The old Bank Model of Consumers' Expenditure on Durable Goods (CD)

We begin by considering the model as reported in Patterson et al (1987) (which we refer to as the old Bank model). This was last re-estimated more than three years ago (see Edwards (1984) and Davis (1984)). Real consumers' expenditure on durable goods (CD) is measured relative to its average value over the previous four quarters (this we refer to as a "dagger" function for short-hand). This is modelled as a function of real household disposable income adjusted for inflation losses on net liquid asset holdings (YDLH), the flow of mortgage lending (ML) deflated by the price of consumer durables (PCD), real interest rates (RR) measured as the log of one plus the clearing banks' base rate minus the annual inflation rate of consumer prices, real net liquid assets (RNLAJ) measured relative to income and the effective minimum deposit rate on durables (RMD). Both the income and net liquid asset terms are measured using moving-average or "dagger" functions. Hence the durable consumption function is given by;

$$\begin{aligned} \ln CD = \ln CDD & \\ & + \beta_1 A(L)(\ln YDLH - \ln YDLD) \\ & + \beta_2 (\ln CDD - \ln YDLD) \\ & + \beta_3 \Delta(\ln RNLAJD - \ln YDLD) \\ & + \beta_4 B(L) \ln (ML/PCD) \\ & + \beta_5 B(L) RR \\ & + \beta_6 \Delta RMD \\ & + \beta_7 + \text{dummy variables} \end{aligned}$$

where $\ln CDD = 0.25 \sum_{i=1}^{4} \ln CD_{-i}$

$$\ln YDLD = 0.25 \sum_{i=1}^{4} \ln YDLH_{-i}$$

$$\ln RNLAJD = 0.25 \sum_{i=1}^{4} \ln (RNLAJ)_{-i}$$

$$A(L) = \sum_{i=0}^{2} (3-i)L^i$$

$$B(L) = \sum_{i=0}^{2} L^i$$

and L^i is the lag operator (i periods).

A number of problems exist with the model. First, if it is viewed in the Hendry and von Ungern Sternberg (1981) framework, then we might expect to see the level rather than the change in the ratio of real net liquid assets to income as an explanatory variable (ie there should be an integral control term).[4] Previous research has certainly found such a role for wealth in non-durable consumption functions. Patterson (1984a), for example, suggests that both liquid and illiquid assets have a role to play as integral control

4 Originally Davis (1984) included the level term. However, when the model was re-based (later the same year) it was found that only the change in the ratio turned out to be significant.

mechanisms[5] (although it should be emphasised that he finds it is necessary to adjust income for depreciation of the stock of durables in order to identify these effects) implying that any failure to meet desired long-run consumption to income ratios will have an impact on some part of the household sector's balance sheet. If it is also true that households try to maintain a ratio of durables expenditure to income constant in the long-run, then clearly the same result must hold in durable consumption functions (ie failure to meet desired expenditure can only lead to households either building up or running down other assets).

A related problem is that, since durables are long-lived, households may choose to vary expenditure without much affecting their consumption of durable services (which can be met largely from their existing stock of durables). This suggests that it might be better to try modelling the stock of consumer durables (rather than the flow) as the Treasury has recently chosen to do (see Allum (1986)). Nevertheless, it should be pointed out that even though such an approach might entail moving away from a flow-based equation past research suggests that the data does not firmly reject this sort of model. (Indeed, the logs of consumers' expenditure on durables and households' inflation-adjusted incomes are co-integrated suggesting that even though durables consumption and expenditure are unlikely to coincide, assuming that they do so may not be very harmful.) A second reason for not worrying too much is that the work carried out by the Treasury has resulted in an equation which explains changes in durable stocks using a lagged stock term as one of the explanatory variables - ie they run the regression;

$$\Delta S_t = aS_{t-1} + bZ_t \quad (1)$$

where S_t is the stock of durables at time t, and Z_t is a vector of additional explanatory variables. However, since stocks and flows are linked by the identity;

$$S_t = (1-d)\ S_{t-1} + E_t \quad (2)$$

5 Of course, one could appeal to liquidity constraints as another reason for including net liquid assets. See, for example, Cuthbertson (1980).

where E_t is expenditure on durables and d the fixed depreciation rate, then (1) can be rearranged to give;

$$E_t = (a + d) S_{t-1} + bZ_t \tag{3}$$

Clearly (3) implies that we can re-estimate the Treasury model using the flow of durables expenditure as the dependent variable provided we keep a lagged value of the stock of durables on the right hand side and we are willing to accept that the rate of depreciation is constant over time (probably a reasonable assumption as a first approximation). Such an approach can therefore be used to gauge the advantages of using a stock-based model.[6]

The term in mortgage lending in the 'old' equation is intended to capture the effects of credit rationing in the mortgage market, complementarity between expenditure on durables and housing (often households choose to buy furniture at the same time as they buy a house, for example) and perhaps also net cash or equity withdrawal. During the 1980s deregulation and financial innovation has led to large changes in the personal sector's financial behaviour (see Dicks (1987)), with the result that building societies now typically attempt to meet the demand for mortgage funds, taking the structure of interest rates as given, rather than try to protect exising borrowers from rises in the mortgage rate. This weakening of the liquidity constraints which previously restricted households' choice has led to a rise in both sides of the personal sector balance sheet. As regards liabilities, the growth of mortgage lending has been boosted in recent years by increased net cash withdrawal (defined as the amount by which the net increase in the stock of loans for house purchase exceeds the private sector's net expenditure on the sources of supply of housing). This excess lending must have, directly or indirectly, been used for purposes other than housing investment, such as consumption or increasing holdings of financial assets. Since, during the 1980s, it has occurred on such a large scale (being broadly equal to 3 1/2% of total consumers' expenditure over the period 1982-1984 according to Bank estimates - see Drayson (1985) and Appendix 1 below), then it is possible that part of the explanation behind the large coefficient on mortgage lending in the durables

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6 In fact, when we did try including a lagged stock term in our preferred specification we found that it was insignificant. This could, of course, simply imply that the assumption that d is constant is incorrect.

equation is increased cash withdrawal. It is important to note, however, that most net cash withdrawn is likely to have been used for purposes other than consumption. Holmans (1986) has considered in detail the gross flows of funds which lie behind the (net) estimates made by the Bank, concluding that equity withdrawal[7] comprises mainly payments to last-time sellers, and that money borrowed by moving owner-occupiers in excess of that needed to purchase their new homes was around one-third of the net cash withdrawal figures during the early 1980s (ie only £2 bn p.a. or thereabouts).[8] Nevertheless, it is likely that some cash extraction had occurred through owner-occupiers trading down or 'topping up' their mortgages. Moreover, the removal of mortgage lending guidance at the beginning of last year may also have stimulated this type of borrowing.

(ii) Attempts to Replicate the old Bank Equation

Table 1, Column A shows the old Bank model, as reported in Patterson et al (1987), together with a version of the same equation that has been estimated using the current databank (Column B). B is based on an identical sample period to that used by Edwards (1984) and has broadly similar coefficients.[9] An F-test to see if the old equation's coefficients can still be accepted by the new data takes the value of 1.0, compared with a 95% critical value of close to 1.9. A comparison of the coefficients for the two models suggests that the main problem still concerns the effects of changes in liquid assets on durables expenditure. However, as Table 1 shows, the old model forecasts fairly well. Indeed, when we compare it with the other main macro-models (see parameter stability tests in Table 2) it turns out that the Bank's model forecasts as well as does the National Institute's model although less well than that used by the London Business School.

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7 A slightly different concept from that used by the Bank, being defined as the sum of expenditure on house-purchase by first-time buyers plus lending to moving owner-occupiers net of loans redeemed on the houses sold plus new money put in by moving owner-occupiers less purchase of new houses.

8 Moreover, a fraction of this could have been used for home improvements.

9 Note, also, that it still contains one term (the change in the ratio of net liquid asset income) which is insignificant.

A problem arises in comparing the forecast errors for the years 1984 and 1985 with the average residuals over the sample period, since model A may provide a poor description of past data.[10] Hence, we have calculated the root mean squared percentage errors (RMS%Es) for both the old Bank model (A) and for a similar model which has been estimated using data up to the end of 1983 (model C). Model A overpredicts the growth of consumption in 7 out of the 8 quarters studied (both static and dynamic forecasts) but its dynamic forecast is hardly any worse than its static one (with RMS%Es of 0.49 and 0.48 respectively). Model C, however, performs slightly better, with RMS%Es around one-fifth smaller on the dynamic test (at 0.40) and one-tenth better on the static test (at 0.44), implying that even if we cannot improve on the functional form of the existing model it would at least be worthwhile re-estimating the coefficients using more recent data.[11] Since the same problems evident with the Bank's old model equation are still apparent in specifications based on more up-to-date data, however, (see Table 2) then such a fall-back should only be resorted to if new models forecast very inaccurately.

Table 1 shows that the Bank's equation suffers from a number of problems. First, the tests for normality of the residuals are not accepted - even the Shapiro-Wilk statistic is very close to the 95% significance level. Second, tests for autocorrelation are only just passed at 95% significance levels. These tests turn out to be particularly sensitive to the sample period used. For example, using the same coefficients as in Model A but with the sample ending in mid-1984, the relevant LM test takes a value of 9.2 compared to the 95% critical value of 9.5. Fourth order autocorrelation seems to be the main problem (see also Table 2 below).

These results suggest that there is a need to reconsider the dynamic structure of the old equation, despite the encouraging results from the forecast tests. A second problem we need to keep in mind is the role of mortgage lending in the equation. The long-run solution to the old model (ie the steady-state durable consumption function) is given by the expression;

$$\ln CD = \ln YDLH - 4.93 + 0.354 \ln (ML/PCD) - 0.737 \ln RR + 0.113 g_y - 0.782 g_m$$

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10 Implying that the forecast tests would be very easy to pass.

11 An added advantage of C is that its tendency to overpredict is weaker.

where g_y and g_m are the rates of growth of real household income and real mortgage lending respectively. The elasticity of close to one third for the flow of mortgage lending is too high to be explained by complementarity of housing and durables spending, and so tends to get attributed to net cash or equity withdrawal (see page 9 above). It would certainly be valuable to distinguish between the two effects if that were possible, especially given that we know that it has become easier to extract equity from the housing market recently. We also need to examine the income elasticity, which in the old model equation is constrained to equal one (through the use of the error correction term). Again it is important to see how high the income elasticity is when freely estimated; theory suggests that it ought to be somewhat higher for durable than non-durable goods. A third problem (probably connected with that of autocorrelation mentioned above) is the use of the moving-average 'dagger' functions (see page 7 above). These may have altered the dynamic properties of the model and are clearly worth examining more closely. Before attempting to examine these problems further, however, we first compare the current Bank model with those used in the other main macro-models.

(iii) Other Models of Durables Consumption

For ease of comparison we have re-estimated the models used by the Bank, the National Institute (NIESR), the London Business School(LBS) and the Treasury (HMT) on a common dataset.[12] These are shown in Table 2 (designated "ours"), together with the coefficients reported in the various model manuals (designated "model"). All of the models use much the same explanatory variables, the most important of which are incomes, the effective minimum deposit rate on durables spending, interest rates and a number of dummy variables to pick up the effects of Budget changes made in 1968, 1973 and 1979. The Bank model is the only one to contain terms in mortgage lending and the ratio of net liquid assets to income, although both the LBS and Treasury models contain financial terms. The former can perhaps be criticised for entering the equation with zero lag, because of possible simultaneity problems which this might entail. Moreover, lending is measured

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12 In practice, since this work was done new models will no doubt have been adopted for use in the other main macro models. Nevertheless, this section serves to illustrate the techniques used in Bank research.

relative to the price of durable goods (PCD), whereas the total consumers deflator (PC) is used to convert all other variables in the equation to real terms. Hence, it is not clear if relative price movements (between PCD and PCND - the price of non-durable goods and services) are not being picked up in the lending term. A second point to note is that households' inflation-adjusted income (YDLH) is used in the Bank model instead of the more conventional RPDI. This makes the durable and non-durable consumption functions easier to interpret, although the use of YDLH entails accepting that inflation has the same effect on durable as it has on non-durable expenditure, despite the fact that all of the tests as to whether the implied coefficient is acceptable or not would have been made on the non-durable equation. This may be part of the reason why we have found it so difficult to estimate a significant coefficient on the ratio of net liquid assets to income. Other problems evident with the Bank model (which are common with those found earlier using a shorter sample period) are that it fails to pass one of the relevant tests for autocorrelation (the Ljung-Box test), has errors which may not come from a normal distribution and forecasts less well than some of the other models we consider.

The NIESR model has a much simpler form than the Bank model, with no role for interest rates, lending or liquid assets in the equation. Despite the apparently simple dynamics there is little evidence of autocorrelation, heteroscedasticity, or problems of non-normal errors. However, although the parameters appear fairly stable, the equation predicts the 1984-85 period less accurately than any of the other models we consider. This suggests that use of a very simple dynamic structure impairs the dynamic predictive ability of the model (compare the RMS%E's of the dynamic and static forecast tests).

The LBS model uses a simple error correction structure, but without an integral control mechanism. Like the Bank model it does, however, include the change in a liquid assets term - in their case real building society shares and deposits is used. In addition, changes in real interest rates affect demand, as do a number of dummy variables. Rather surprisingly the LBS do not mention the need for dummy variables in 1979 Q2 and Q3 (despite their manual claiming to have used a sample period which included 1979 in estimating the equation). When we tried including the relevant dummies, we found coefficients on all the other variables very much closer to those reported in their manual (see LBS (Adjusted) in Table 2). However, such an equation suffers from autocorrelated errors. Despite this the two LBS equations perform better than the other models at predicting recent changes in expenditure, with RMS%E's around three quarters of those of the best alternative model.

The final model we consider is the HMT model. This is the oldest of the models, which may in part explain why we had great difficulty replicating the equation, although this is also likely to reflect the fact that the Treasury adjust their dependent variable for the effects of hire purchase controls and we have not been able to replicate their calculations (see HMT Model Manual). We have tried including a number of dummy variables in the equation, but still cannot find a similar relationship to that reported in the model manual. Our results indicate a model which performs very poorly, failing tests for normality, autocorrelation and heteroscedasticity. For these reasons this model seems best ignored.

(iv) Results

This section presents our results from estimating a new durables equation using broadly similar variables to those used in the previous Bank equation. Both the LBS and NIESR models suggest that use of the 'dagger' functions does not much help improve either the fit or the forecasting ability of the model. Moreover, they suggest that the income elasticity should not be constrained to equal one (see Table 4 for the relevant long-run elasticities) and that RPDI is probably as useful a measure of income as YDLH (although of course we have not tested this proposition directly).

In deriving the new model we have deliberately refrained from using current mortgage lending as an explanatory variable, because of problems of simultaneity. We have, however, tried including a number of wealth terms[13] but with little success. Only a term in real net liquid assets proved to be useful, together with the (lagged) flow of mortgage lending. We also attempted to split lending for house purchase between that used for housing investment and net cash withdrawal, but found that in such a model neither

13 Including gross and net liquid assets, gross illiquid assets, gross physical assets, net financial wealth, net wealth, plus ratios of these terms of income.

flow could be identified as significant (see Appendix 1). Finally we tried including relative price terms (unsuccessfully) and replaced YDLH with RPDI. Since the latter change increased the standard error of the equation very slightly, but otherwise made little difference to the specification, we decided to retain YDLH in our model.

The resulting specification (Table 3) does not suffer from as many problems as the old model specification, although it is still far from perfect. It does not suffer from autocorrelation, has errors which pass the tests for normality and has fairly stable parameters (passing the Hendry forecast tests for the period 1984 Q1 to 1985 Q4). To avoid putting too much weight on recent data, which is likely to be revised significantly, we have also estimated a similar model using data up to the end of 1980. The forecasts for the next five years indicate a better performance than for the period 1984-85. The relevant RMS%Es over the longer period forecast, of 0.38 and 0.41, are around one quarter less than for the shorter period (at 0.51 and 0.58). The main reason for this seems to be the fall in ("actual") consumption which occurred in the third quarter of 1984 and which is not well predicted by the model. All of this reduction is due to lower spending on vehicles, reflecting the fact that non-seasonally adjusted durables spending rose by just 4% in the third quarter of 1984, compared to the rise of close to 30% in the third quarters of 1982 and 1983. This suggests that either demand for cars may have been (temporarily) boosted with the introduction of the A and B number plates or that the 1984 "actual" may be revised up some time in the future.

Table 4 shows the relevant elasticities for the new model,[14] indicating a more believable (higher) income elasticity of 1.4, a slightly larger (absolute) interest rate elasticity (-0.84) and a weaker effect from lending (0.16, as against 0.34 in the previous model specification). In the past we have justified the inclusion of mortgage lending because of complementarity (houses and durable goods) and net cash or equity withdrawal. Even with these two effects, however, a long-run elasticity of 1/3 seems high, given that we could not identify a strong effect from a model-based proxy for net cash withdrawal (when other lending for house purchase was included as a separate regressor). In an attempt to identify complementarity separately we have

14 Re-estimated up to the end of 1985.

tried including both levels and changes in the number of owner-occupied houses, and a proxy for the number of houses sold in the latest quarter[15] together with the net cash withdrawal term. Of all the terms used only the proxy for the number of houses sold in the last quarter was significant. However, once this variable was included it was not possible to find an effect from net cash withdrawal. These results suggest that simple proxies for equity or net cash withdrawal are not very useful indicators of how much lending is "leaking" into consumption. Clearly more work needs to be done if we are to model this sort of behaviour satisfactorily.

(v) Interest Rate Effects

In addition to checking that the coefficients relating to our preferred specification have not changed significantly in recent years (by re-estimating the equation using a sample period extended to the end of 1985) we have tried splitting the sample in 1974. In the first sub-period neither the interest rate or income terms are well identified, whilst lending plays a stronger role. In the second sub-period only the interest rate term is poorly identified, although the coefficient on lending has halved in value. The relevant F-test rejects stability, taking a value of 2.6 compared to the 95% significant value of 2.1; however, the 99% value is 2.8. To some extent instability of the equation might be expected when there have been a number of changes in the environment. In particular, one might expect that the effects of mortgage lending on consumption to have changed in recent years given the increased competition which has resulted from the banks entering the market.

In order to investigate the stability of the various parameters we have tried estimating the preferred model using a recursive least squares package. The main problems appear to lie with the interest rate coefficients. In particular that on ln(RR) is positive in a sample ending in the early 1970s, but negative on more recent samples. In addition, the coefficient on RMD appears to have risen (closer to zero) over time, whilst that on real net liquid assets has fallen. This suggests that interest rates are becoming a more important factor in determining when people buy durables and would explain why deposit requirements/liquid asset accumulation is becoming less relevant. Of course, this means that if we believe this process is going to

15 Defined as the flow of mortgage funding divided by average house prices.

continue we might expect the trends in the coefficients (which one finds using recursive OLS) to continue also. As an example, we have estimated a similar model to that of Table 3 but where RMD and RNLAJ are first multiplied/divided by a time trend suitably scaled so as to ensure a rate of increase/decrease broadly commensurate with trends identified in the recursive OLS regressions. In addition, a dummy variable taking the value 0 throughout the 1960s and 1 elsewhere was used to ensure that RR could only affect durables expenditure in the 1970s and 1980s. We found that these sorts of adjustments made identification of a net liquid assets affect very hard to find,[16] although otherwise the specifications were broadly similar to those found earlier. Obviously were this type of model used in a forecast somewhat different results would be obtained than from using a fixed-coefficients model (such as that presented in Table 3).

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16 Probably reflecting the fact that one cannot hope to have two time trends in the same equation!

Section 4: Modelling Consumers' Expenditure On Non-Durable Goods and Services Using UK Data

(i) The Old Bank Model of Consumers' Expenditure on Non-Durables (CND)

We begin by considering the properties of our old equation (as reported in Patterson et al (1987)). This modelled consumers' expenditure as a function of households' real disposable income (adjusted for the erosion of their net liquid assets by inflation) and real net financial wealth. The adjustment of the conventional measure of personal disposable income is, of course, just one of the adjustments needed if we are to approximate more closely the Hicksian concept of income. As yet no attempt has been made to allow for depreciation of the stock of durables (as suggested by Patterson (1984a)). Neither, as yet, have we tried disaggregating income in order to permit changes in the distribution of income to affect consumption (see, for example, Borooah and Sharpe (1984), although preliminary work indicates that it is possible to distinguish between the effects of labour and non-labour income. It is hoped that such extensions to the model will be the subject of future research.

The precise specification of the non-durable consumption function is given by;

$$\begin{aligned} \ln CND = \; & \ln CNDD \\ & + \beta_1 (\ln YDLH - \ln YDLD) \\ & + \beta_2 \Delta(\ln YDLH - \ln YDLD) \\ & + \beta_3 (\ln CNDD - \ln YDLD) \\ & + \beta_4 (\ln RNFWJD - \ln YDLD) \\ & + \text{dummy variables} \end{aligned}$$

$$\text{where } \ln CNDD = 0.25 \sum_{i=1}^{4} \ln CND_{-i}$$

$$\text{and } \ln RNFWJD = 0.25 \sum_{i=1}^{4} \ln RNFWJD_{-i}$$

The terms used in the specification suggest that consumers' expenditure on non-durables is influenced by changes in incomes (with a positive effect), the acceleration in income (with the consumption-income ratio falling when the rate of growth of income rises), lagged values of the consumption-income ratio (with a negative effect) and lagged values of the net financial wealth to income ratio (with a positive effect). Finally, allowance is made for the Budgets in 1968, 1973 and 1979 which were thought to have led to some expenditure being brought forward because of anticipated indirect tax changes. As in the old durables equation all of the variables used in the equation are measured relative to their one-year moving averages, as suggested (for some variables, at least) by Hendry and von Ungern-Sternberg (1981). One problem with the use of these 'dagger' functions, however, is that they imply implausible dynamic responses (see Dicks (1985)). As regards income the problem is not that consumption reacts slowly to a change in income (since the median lag is just one quarter thanks to the large impact response), but that it goes on reacting (slowly) for a very long time afterwards (with the next quarter of the total long-run response taking a further 36 quarters to work through). Given that the equation has an integral control mechanism, which is generally justified as ensuring that consumption-income and wealth-income ratios return to their long-run targets, it might be thought preferable to have an equation with shorter reponse times to changes in income. This means that, as regards wealth, one would expect the rational lags to indicate slower response times than to changes in income. Here again, however, the specification seems implausible since the median lag is 46 quarters, whilst the response function implies quarterly impacts which first rise then fall then rise again before, finally, beginning to decrease in the longer run.

The steady state solution of the equation, given constant growth in real incomes, is given by the expression;

$$\ln CND = \ln YDLH - 0.565 + 0.33 \ln (RNFWJ/YDLH) - 40.13\, g_y + 21.03\, (g_y - g_w) \quad (1)$$

where g_y and g_w are the rates of growth of real income and real wealth respectively.[17] Making the usual implicit assumption that the wealth to income ratio should be held constant, since this is what consumers plan to do in the long-run - see Patterson (1984b) - then we can ignore the last term in (1). One problem (highlighted by Patterson (1988a)) with our using an error correction term to ensure a unit income elasticity of consumers' expenditure on non-durables is that, when taken together with our new equation for

17 Note that the coefficient on g_y reported in the Patterson et al (1987) is slightly incorrect.

consumers' expenditure on durables (which has an elasticity above one)[18] implies an elasticity of total consumption to income of 1.045. In other words the aggregate consumption-income ratio (or the savings ratio) depends upon the level of income and hence is unbounded. It is impossible to avoid this problem since the only way of ensuring an aggregate elasticity of one is to constrain each of the two 'component' equations (ie for non-durables and durables) to have unit elasticities too. It is possible, however, to constrain the equations in such a way that if the ratio of durables spending to total consumers' expenditure remains at its average level (measured over some past interval) then an aggregate unit elasticity can be imposed. (Of course a local constraint of this nature does not imply a global one.) In this situation it might seem preferable to estimate our durables and non-durables expenditure equations jointly, although it is easy to show that it is possible to keep the current durables equation intact (with its income elasticity greater than one) by restricting the elasticity on the non-durables equation to ensure an elasticity of total consumers' expenditure to income of one (see Appendix 2 for details).[19] Such an approach implies that we would be treating spending on durables as consumption and not as savings (which many economists would find hard to accept) but at least it would be consistent, in the sense that the alternative (of treating durables expenditure as savings) would imply that it would also be necessary to adjust income for depreciation of the stock of durables.

Further problems with the previous model specification have emerged in recent years through its use as part of the main short-term model in the Bank's bi-annual forecasts. The equation has generally underpredicted consumption of non-durables over the past few years, with 9 out of the last 10 static residuals (up to 1987 Q2) being positive. No doubt much of the problem is due to the poorer quality of recent estimates of personal incomes and/or consumption, since the discrepancies between the traditional savings ratio and one based on the financial accounts has widened in recent years. As a result, the balancing item required to bring the two savings measures in line

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18 See Section 3 above.

19 Of course this is only a short-term solution to the problem. But then we ought also to examine the long-run properties of a change in wealth on total consumption. To do this we would need to estimate a more complex system of equations than one containing simply two consumption functions.

has risen from close to £5 1/2 bn in both 1983 and 1984 to £11 bn in 1985 and £16 1/2 bn in 1986. The latter figure accounts for some 85% of total savings as indicated by the traditional measure, highlighting the enormousness of the problem. Our recent research suggests that the main problem with the real-side estimates could lie with the income rather than the consumption figures since there are discrepancies between the growth rates of average earnings (as measured by the Department of Employment) and the CSO's (National Accounts) estimates of income from wages and salaries. If it is the income estimates which are wrong then this would also help explain the 'unexpectedly' high income-tax receipts of recent years, although it would, in addition, lead to a bigger gap between the income and expenditure measures of GDP.

Before turning to a consideration of how the old model specification might be improved, we first re-estimated the current equation using more up-to-date data.[20] We have deliberately chosen not to use the last two years' figures because of the problems with recent years' estimates described above. Nevertheless our results, shown in Table 5, do provide a useful benchmark against which we can test other specifications. The first column of the table shows the current specification (as first reported by Edwards (1985)).[21] Although the error correction term was then found to be insignificant it was not felt necessary to test the implied unit elasticity of CND to income, presumably since the then current CD equation also (mistakenly) had a unit elasticity. According to Bollerslev and Hylleberg (1985) the unit elasticity condition of the error correction form of the non-durables consumption function is refuted by the data. This may, of course, still be consistent with Hendry's notion of equilibrium being that of "all change ceasing" (see Hendry (1983)), this not being an assertion about behaviour in the long-run.[22] A second problem with the specification was its evidence of serial correlation, with the model just failing the relevant LM test at the 95% significance level. This result is all the more surprising since one of the original justifications for using the 'dagger' functions was that it might help remove the problem of autocorrelated errors, a problem which had been found to be evident in most of the macro-models (see Davis (1982)).

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20 We do not compare our model with those used by the HMT, LBS etc since this was the subject of Davis (1982).

21 Although it is fairly similar to that suggested by Davis (1982).

22 For a fuller discussion of these issues see Harnett (1988).

Although there have been significant revisions to much of the data since 1985 our attempt at replicating the equation has been fairly successful (see column 2 of Table 5). The most noticeable development is the change in the size and significance of the error correction term (which has halved in size). Interestingly if the equation is re-estimated using a sample period ending in 1987 Q2 the error correction term does become significant again, although its coefficient is now very close to zero. Harnett (1988) reports the results of running recursive least squares programmes to gauge the variability of error correction terms in similar consumption functions, although in his work those recursive estimates reported are firstly for a simple error-correction model (which does not include a role for liquid assets or other forms of wealth) and secondly for a more complex model (including wealth, unemployment and interest rates). Using seasonally unadjusted data the coefficient on the error correction term in the first model varies from -0.075 to -0.13 and, in the second model, from -0.135 to -0.245. For some samples the coefficient is not significantly different from zero.

Another problem evident from Table 5 is the equation's poor performance in the forecast test. Note that although the sample period used originally to estimate the current specification ended in 1984 Q2, all the testing down carried out to find this final equation used a sample period six quarters shorter. Hence the original Hendry forecast test (which was passed comfortably) was a true test of the equation's forecasting capabilities, even though in more recent years the equation appears (at first blush) to have broken down (although, as we mentioned above, this could be due to poor "data" in recent quarters). We examine this question again later (see Section 4 (iii) below).

(ii) The Theoretical Model Underlying the Consumption Function

The Bank's CND equation can be interpreted as part of an extended error correction system, with consumption changing to eradicate disequilibrium in the target net financial assets to income ratio and derived target consumption to income ratio (as outlined in Hendry and von Ungern-Sternberg (1981)). The main theoretical advance of this work on that by Davidson, Hendry, Srba and Yeo (1978) had been to recognise that if consumers wish to maintain their consumption to income ratios constant in the long-run then the integral of past discrepancies between consumption and income would influence their wealth holdings and hence, possibly, their behaviour. For this reason a term in real net liquid assets was included in their regression work.[23] The recognition that cumulated savings might play an important role in expenditure equations was not a new development (see, for example, Townend (1976)), but the theoretical underpinnings had not been clearly set out in applied work until Hendry and von Ungern-Sternberg's work. More recent research (see, for example, Patterson (1984a)) has suggested that both liquid and illiquid financial wealth may play a role in explaining consumers' expenditure, although when just the former is contained in the equation we have found that the simulation properties of the short-term model are less plausible than when net financial wealth is included (see Jenkinson (1985)). In recent research we have not re-opened the question of which wealth term(s) to use, although again it is an important question which we hope to address again some time in the future.

This brings us to a further important consideration, the role of interest rates in determining consumption. Patterson (1988b) has generalised the Hendry and von Ungern-Sternberg framework to allow for the possibility that disaggregated wealth-income ratios are a function of rates of return. Changes in interest rates will, anyhow, clearly affect consumers who are liquidity-constrained (for the theoretical underpinnings of this type of approach see Jackman and Sutton (1982) and Stiglitz and Weiss (1981) and (1987)).[24] For these reasons it would seem reasonable to expect some role for interest rates, although for non-durables expenditure the empirical evidence is somewhat mixed. Easton (1985) reports, for example, that of the five main macro-models only the Treasury and the Liverpool Models then included an explicit role for interest rates in their non-durables equation.[25] The LBS, however, considered only total and durable consumption (with non-durables given by identity) implying an interest rate effect on non-durables, since each of their

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23 Of course other justification for including such a variable, such as the existence of liquidity constraints, are possible. See for example Flemming (1973) or Pissarides (1978).

24 Surveys of the literature are contained in Hubbard and Judd (1986) and Zeldes (1985).

25 Of course, the situation will have changed since then.

consumption functions included interest rate effects (which are not offsetting). The models were generally driven primarily by real personal disposable income (and in some cases this is adjusted for inflation), although the Liverpool model is something of an exception given its equilibrium approach (see Easton (1985), pages 46-48). In addition all of the models use one or more wealth variables, usually either net liquid assets or net financial wealth.

Our own previous research (see for example, Dicks (1985)) had suggested that it was easy to improve on the current model specification by using Δ_4 ln(CND) as the dependent variable and keeping the error correction framework. Harnett (1988) also reports a number of similar equations, although his preferred model equation is based on current price, seasonally unadjusted data. Both lines of research find a role for interest rates (and for unemployment too in the case of Harnett (1988)). One problem with the use of Δ_4 equations, however, is that if consumers' expenditure estimates are poorly seasonally adjusted (which they are!) they will tend to keep their (incorrect) quarterly pattern in the future. If we are using these models simply to forecast what the CSO estimates will look like next year (and not what the estimates will look like in ten years time) then of course this will not be a problem. Nevertheless, to avoid problems of this nature, we have kept to a levels equation.[26] In testing down we have allowed for the possibility of long lags on income and wealth (of up to 8 quarters) but assumed shorter lags on the dependent variable and interest rates (of up to 4 quarters).

(iii) Results

In Table 6 we report the results obtained by testing down from a general specification. We found that the data preferred a negative coefficient on $\ln(YDLH)_{-2}$ and, therefore, used $\Delta\ln(YDLH)_{-1}$ instead. We also found a $\Delta\ln(YDLH)$ term was significant. The first column of Table 6 shows a specification in which the long-run income elasticity has been constrained equal to one, so that it can be compared to the previous model equation. The

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26 We have also tried estimating a Δ_1 equation in which the income elasticity is restricted to be less than one. This turned out to fit the data slightly less well than our levels model, although it too included both interest rates and net financial wealth (which were both found to be significant).

second column reports our preferred specification, in which the elasticity has been constrained to equal 0.946, thus giving us an overall (local) unit elasticity (ie of total consumption to income). This restriction is easily accepted by the data.[27]

In addition we have constrained the coefficients on the dummy variables to ensure that they have no long-lasting effect. Again the tests for these restrictions are easily passed. However, this second group of restrictions do make some difference to the model, for they ensure that the t-value on the constant rises above 2 (ie without these restrictions, but with the elasticity constrained to be below one, the constant in the new equation is insignificant). Patterson (1985) has shown that the original research by Davidson, Hendry, Srba and Yeo (1978) was wrong to exclude the constant from their work, since the imposition of a unit long-run elasticity on a non-durables consumption equation in which income has not been adjusted for depreciation of the stock of durables implies that either there are no durables, or that if they do exist then they have infinite lives. One way of making an allowance for depreciation in the steady state is to include an intercept, even if it is collinear with the error correction term. The first column of Table 6 indicates a significant negative constant, as one would expect if depreciation of the durables stock had not been taken into account. Once we recognise that the constrained elasticity is too high, however, by taking account of durables expenditure too and ensuring that the total consumption to income elasticity is unity (locally), then we find that the constant is insignificant (and could be dropped). Since we have not adjusted incomes for depreciation, so our results hint that it is the fact that the elasticity of durables expenditure is above one, and not the failure to adjust incomes for depreciation, which is the real reason why we need to keep a constant in a non-durables consumption function when its elasticity is constrained to unity (as in the Davidson, Hendry, Srba and Yeo (1978) model).

The new equation clearly fits the data better than the old model does, even if the latter is re-estimated to take account of revisions to the data (compare the standard errors in Tables 5 and 6). In part, this is simply because of the new explanatory variable (interest rates) included in my model. Previous research (by Harnett (1988)) had shown that including an interest rate term as

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27 Although, interestingly, the freely estimated elasticity is above one.

a regressor when using a sample which covers the 1960s and 1970s would not have given similar results (with the interest rate term then being positive). We have tried checking this result for our preferred equation by splitting the sample at the end of 1977 and re-estimating the model for each of the sub-periods. The interest rate term was found to be small and insignificantly different from zero in the first period (t-value 1.4) although it was correctly signed. By way of contrast not only was the t-value during the second sub-period well above 2 but the coefficient was broadly twice the magnitude of that estimated for the sample as a whole. Clearly this result implies that further work is needed if we are to understand why interest rate effects appear to be becoming more important, particularly given that we found much the same story was true of durables expenditure. One possible reason, suggested in Dicks (1987), is that greater competition in the markets for personal sector saving and borrowing has resulted in reductions in liquidity constraints, which may be correlated with changes in interest rates. For this reason it might be better to try including in the equation new proxies for credit rationing. To this end we have tried using measures of mortgage rationing in the non-durables equation (based on the same approach as Wilcox (1985)) and net cash withdrawal. Neither variable turned out to be significant.[28]

Other points to note from Table 6 are the new equation's performance regarding the diagnostic tests that have been tried on it. There is no evidence of non-normality, of autocorrelation or of heteroscedasticity. When it comes to the out-of-sample stability tests, however, the new model fails the Hendry forecast test. Like the old model the new specification underpredicts consumption in each of the last eight quarters. The questions raised earlier, regarding the quality of recent estimates, seem to have been borne out in the sense that the new equation, when confronted with the 'data' for the first time, finds that consumption appears consistently too high given the income figures. In a sense this is comforting, for we have in testing down allowed for the possibility of a faster response from changes in income than

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28 We have also tried adding other housing market variables to the model but without success - neither the house price earnings ratio nor the flow of (real) mortgage lending were significant.

does the old specification[29] and found some change (see below). It does mean that, if we do disbelieve the National Accounts, then we need to spend more time examining the question of what the 'true' levels of consumption and income are.

The rational lags for the new model have changed significantly from those of the old model. Clearly the $\Delta \ln (YDLH)_{-1}$ term implies a small impact effect (in the third quarter) which is negative, although otherwise the response function is close to triangular in shape. The stronger effects in the first and second quarters do, however, ensure that the cumulative effects are much faster. Hence, whilst in the old model half of the full long-run effect of a change in income takes under six months to work through and the next quarter of the total effect a further eight and a half years, in the new model half of the total effect works through slightly more slowly (in close to one year) but the next quarter takes a mere eighteen months longer. As for the rational lags regarding wealth the median lag for the new model is only 10 quarters, compared with 11 years for the old model - again a significant change.

Next we consider the steady-state solution to the new equation. This is given by the expression;

$$\ln CND = 0.946 \ln YDLH + 0.331 + 0.061 \ln (RNFWJ/YDLH) - 0.488 \ln RR$$
$$- 6.645\, g_y + 7.296\, (g_y - g_w)$$

Although the income elasticity is only slightly less than in the old model, the growth coefficient is very much closer to zero. The wealth (to income) elasticity looks very small on the new equation, although it is clear that rather more work needs to be done if we are understand what 'sensible' long-run properties should be imposed in this respect. Finally, the interest elasticity (at close to one half) is, though smaller than for the durables equation, much higher than most previous studies had suggested. Moreover, running the equation through recursive least squares suggests (as it did for the durables equation) that these effects vary over time both in size and significance.

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29 The usual reason given in the past for the old equation's apparent breakdown.

Section 5: Conclusions

In this paper we have presented some results which suggest that interest rates do play a significant role in helping to explain changes in consumers' expenditure, both of durable and non-durable goods. Moreover, our research suggests that interest effects vary over time in both size and significance, hinting that changes in liquidity constraints may be playing an important role. Such a conclusion implies that the leverage of monetary policy is also likely to vary over time.

TABLE 1

THE BANK MODEL

Dependent Variable; ln (CD)

Explanatory Variables;	A Coef (t-value)		B	
ln (CDD)	1*		1*	
ln (CDD/YDLD)	-0.674	(5.1)	-0.709	(5.4)
A(L) ln (YDLH/YDLD)	0.240	(4.4)	0.252	(4.4)
B(L) ln (ML/PCD)	0.077	(5.1)	0.079	(4.6)
B(L) ln (RR)	-0.166	(2.3)	-0.182	(2.4)
$\dot{l}$n (RNLAJD/YDLD)	1.019	(1.1)	0.997	(1.0)
Δln (RMD)	-0.176	(3.4)	-0.164	(3.0)
D681	0.166	(3.3)	0.158	(3.0)
D731	0.109	(2.2)	0.110	(2.1)
D792	0.228	(4.6)	0.280	(5.5)
Constant	-3.329	(4.8)	-3.459	(5.1)
R^2	0.738		0.734	
SEE	0.047		0.049	
DW	1.6		1.7	
Sample Period	1966 Q3 - 1981 Q4		1966 Q3 - 1981 Q4	

* = Constrained

Definitions of terms used are given in Appendix 3.

Table 1 cont

Test Statistics	Comparison Values	Model B
<u>(1) Normality of Errors</u>		
Shapiro-Wilk W Statistic	Reject if below 0.9546	0.95
Skewness	Reject if outside ($\pm$ 0.62)	-0.99
Kurtosis	Reject if outside (1.76, 4.24)	5.41
<u>(2) Autocorrelation</u>		
Residual Correlogram	Correlation;	
	lag 1	0.13
	lag 2	-0.19
	lag 3	-0.12
	lag 4	-0.21
Ljung Box (4)	Chi Sq(4) = 9.49 at 95% level	7.34
LM test for autocorrelation	"	8.35
Modified Test	F(4, 48) = 2.57 at 95% level	1.87
<u>(3) Heteroscedasticity</u>		
Peak Test	Cumulative Probability that the linear model is wrong;	0.85
<u>(4) Parameter Stability*</u>		
Static forecast test (1984 Q1-1985 Q4)	Chi Sq (8) = 15.5 at 95% level	5.4
Dynamic forecast test (1984 Q1-1985 Q4)	"	6.5

* For an equation estimated up to the end of 1983.

TABLE 2

Dependent Variable: ln(CD)

BANK

	Model Coef	t-value	Ours Coef	t-value
ln (CDD)	1	-	1	-
ln (CDD/YDLD)	-0.674	5.1	-0.635	5.3
A(L) ln (ML/PCD)	0.077	5.1	0.064	5.1
A(L) ln (RR)	-0.166	2.3	-0.220	3.5
B(L) ln (YDLH/YDLD)	0.240	4.4	0.261	4.9
Δ ln (RNLAJD/YDLD)	1.019	1.1	1.373	1.5
Δ ln (RMD)	-0.176	3.4	-0.146	2.7
D681	0.166	3.3		
D731	0.109	2.2	0.127	2.5
D791	0.228	4.6	0.288	5.8
Constant	-3.329	4.8	-3.026	5.6

NIESR

	Model		Ours	
ln $(CD)_{-1}$	0.501	5.1	0.442	4.1
Δ ln (RPDI)	0.778	2.9	0.887	3.2
Δ ln $(RPDI)_{-1}$	0.367	1.4	0.599	2.2
Δ ln $(RPDI)_{-1}$	0.717	4.1	0.792	4.4
DHP	-0.005	5.3	-0.004	5.0
D681	0.110	2.6		
D682	-0.271	6.0	-0.264	5.7
D683	0.014	0.3	0.003	0.1
D731	0.094	2.2	0.101	2.2
D732	-0.151	3.3	-0.124	2.6
D792	0.222	5.3	0.261	6.2
D793	-0.133	2.9	-0.189	3.7
Constant	-3.42	3.2	-3.75	3.4

Definitions of terms used are given in Appendix 3.

LBS	Model		Ours		Adjusted (Ours)	
$\ln(CD)_{-3}$	0.181	3.9	0.304	4.9	0.215	4.7
ln (RPDI)	1	-	1	-	1	-
$\ln(CD/RPDI)_{-1}$	0.605	7.7	0.382	3.8	0.569	7.3
RMD	-0.997	4.1	-0.007	2.8	-0.007	4.1
RMD_{-1}	-0.002	1.1	-0.003	1.2	-0.002	1.1
$\ln(KZJ/PC)_{-1}$	1.22	3.0	1.544	2.5	1.405	3.3
RRL	-0.386	2.9	-0.339	1.8	-0.399	3.0
D681	0.110	2.6				
D682	-0.263	6.0	-0.206	3.2	-0.243	5.2
D731	0.105	3.7	0.111	2.6	0.115	3.8
Constant	-2.45	6.2	-3.98	5.6	-2.804	5.3
D792					0.235	5.4
D793					-0.248	5.1

HMT	Model		Ours		Adjusted (Ours)	
$\ln(CD)_{-1}$	0.608	7.0	0.907	10.7	0.978	13.6
$\Delta_4 \ln(RPDI)$	1.361	6.9	0.555	1.7	0.400	1.4
$\ln(CD/RPDI)_{-4}$	-0.854	7.8	0.096	0.6	0.022	0.2
$\Delta_4 \ln(NFIN_{-4}/PC_{-3})$	0.292	4.1	0.719	2.3	0.617	2.5
$\Delta_4 \ln(NFIN_{-1}/PC)$	0.225	1.9	0.533	2.5	0.167	0.9
Δ4 (PEXP-RBLPE)	0.004	-	0.004	-	0.004	-
Constant	-5.260	8	0.98	1.0	0.234	0.3
D731					-0.172	0.8
D732					0.267	2.2
D792					-0.312	3.6
D793					0.234	4.0

Definitions of terms used are given in Appendix 3.

TABLE 2 Cont

	Bank Model	Bank Ours	NIESR Model	NIESR Ours	LBS Model	LBS Ours	HMT Model	HMT Ours	LBS (Adjusted) Ours	HMT (Adjusted) Ours
Sample Period	1966Q2 1981Q4	1968Q2 1983Q4	1967Q1 1984Q1	1968Q2 1983Q4	1967Q3 1981Q4	1968Q2 1983Q4	1968Q2 1978Q4	1966Q3 1983Q4	1968Q2 1983Q4	1968Q2 1983Q4
R^2	-	0.951	-	0.965	-	0.924	0.862	0.836	0.962	0.908
SEE	0.047	0.048	0.041	0.042	0.040	0.060	0.049	0.088	0.043	0.072
DW	1.6	1.52	-	2.00	2.08	2.36	1.72	0.24	2.18	1.87
Tests for Normality of errors										
Shapiro - Wilk W Statistic (value less than 0.9550 rejects normality)		0.9531		0.9694		0.9100		0.9150	0.8966	0.8654
Skewness, (Range of Comparison: ± 0.62)		-0.98		-0.52		0.32		-0.86	0.15	-1.86
Kurtosis, (Range of Comparison: 1.8 to 4.2)		5.5		3.9		8.3		7.0	3.80	12.14
Autocorrelation										
Ljung Box, (95% significance level = 9.5)		6.5		3.4		7.7		9.9	11.8	8.3
Modified F-test, (95% significance level = 2.6)		1.5		0.7		1.8		2.4	2.7	1.8
Parameter Stability (1984 Q1 to 1985 Q4)										
Static Test; (95% significance level = 15.5)		3.1		5.0		1.4		1.2	3.2	1.7
Dynamic Test; (95% significance level = 15.5)		3.9		6.9		1.3		?	3.8	?
RMS%E; Static Test		0.40		0.43		0.40		0.40	0.32	0.4
Dynamic Test		0.41		0.51		0.32		?	0.43	?
Heteroscedasticity										
Peak Test; (95% significance level = 3.8)		0.70		0.85		0.69		0.25	0.69	0.09
F test for Linear Restriction; (95% Significance level =4.0)		1.09		-		0.0		5.1	0.0	3.0

TABLE 3 The New CD Specification

Dependent Variable: ln(CD)

	Coef	t value
ln (CD)	0.219	2.9
A(L) ln (YDLH)	1.074	6.8
ln (RR)	-0.656	5.0
ln $(RMD)_{-1}$	-0.005	5.3
ln $(ML/PC)_{-1}$	0.125	3.7
ln $(NLAJ/PC)_{-1}$	0.206	2.4
D681	0.147	3.9
D682	-0.210	5.4
D731	0.108	2.9
D732	-0.132	3.5
D764*	0.117	3.2
D792	0.264	7.2
D793	-0.113	2.7
Constant	-8.032	6.1
R^2	0.988	
SEE	0.036	
DW	1.8	
Sample Period	1963 Q3 - 1985 Q4	

Definitions of terms used are given in Appendix 3.

* We found this dummy was necessary, despite it not having been adopted in the past. It may be associated with the Mini-Budget of December 1976, and/or the sharp rise in car prices (by Ford and Chrysler).

Table 4 Long-Run Elasticities

Model	Elasticity with respect to; Income	Interest Rates	Mortgage Lending
Current Bank Model	1.00	-0.74	0.34
NIESR	1.44	-	-
LBS	1.85	-	-
HMT	1.85	-	-
New Specification	1.38	-0.84	0.16

Table 5: The Previous CND Specification

Dependent Variable; ln (CND)

Explanatory Variable	Original Estimates		New Estimates	
	Coef	t-value	Coef	t-value
ln (CNDD)	1	-	1	-
ln (YDLH/YDLD)	0.37522	12.4	0.37399	14.3
Δ ln (YDLH/YDLD)	-0.13492	3.8	-0.15571	5.4
ln (CNDD/YDLD)	-0.03889	1.0	-0.01782	0.6
ln (RNFWJD/YDLD)	0.01272	3.9	0.01353	4.5
Constant	-0.02196	3.1	-0.02154	3.7
D681A	0.01270	2.2	0.01399	3.9
D731A	0.02128	3.7	0.01998	3.9
D79A	0.01655	3.9	0.01887	3.7
R^2	0.786		0.818	
SEE	0.006		0.0056	
DW	1.6		1.62	
Sample Period	1967Q4 - 1984Q2		1967 Q4 - 1985 Q2	

Definitions of terms used are given in Appendix 3.

Table 5 contd

	Original Estimates	New Estimates
Diagnostic Statistics		
(i) For Normality;		
Shapiro-Wilk	-	0.9870
Skewness	-	-0.0005
Kurtosis	-	3.0298
(2) For Autocorrelation;		
Ljung Box, Chi Sq (2)	-	6.01
LM test, Chi Sq (4)	9.9	6.27
Modifed LM test, F (4, 59)	-	1.43
(3) For Heteroscedasticity;		
LM test, Chi Sq (2)	-	1.96
(4) For Parameter Stability;		
Static "Hendry" Forecast test;		
Chi Squ ( )	3.8 (6)	30.60 (8)
RMS%E	-	36.86

Table 6: Some New CND Specifications

Dependent Variable; ln (CND)

Explanatory Variable	Unit Elasticity wrt income		Preferred Spec 0.946 Elasticity wrt income	
$\ln(CND)_{-1}$	0.58655	(7.4)	0.53402	(6.7)
$\ln(CND)_{-2}$	0.31808	(4.4)	0.34013	(4.7)
$\Delta \ln(YDLH)$	0.11337	(3.1)	0.11587	(3.0)
$\Delta \ln(YDLH)_{-1}$	0.19634	(6.7)	0.19570	(6.4)
ln (YDLH)	0.09537	(2.5)	0.11905	(-)
$\ln(RNFWJ/YDLH)_{-1}$	0.01072	(4.0)	0.00770	(2.8)
$\ln(RR)_{-1}$	-0.05749	(2.5)	-0.06142	(2.7)
Constant	-0.02448	(4.0)	0.04969	(2.1)
D681	0.01473	(3.0)	0.01661	(4.8)
$D681_{-1}$	-0.01914	(3.9)	-0.01661	(-)
D731	0.01821	(3.7)	0.01519	(4.4)
$D731_{-2}$	-0.01198	(2.5)	-0.01519	(-)
D792	0.02500	(5.1)	0.01823	(5.1)
$D792_{-2}$	-0.00987	(1.9)	-0.01823	(-)
R^2	0.997500		0.996614	
SEE	0.004768		0.004805	
DW	2.1352		2.0645	
Sample Period	1967 Q4 - 1985 Q2		1967 Q4 - 1985 Q2	

Definitions of terms used are given in Appendix 3.

Table 6 cont

Diagnostic Statistics

(i) For Normality;

Shapiro-Wilk	0.973	0.982
Skewness	0.358	0.252
Kurtosis	3.484	3.022
(2) For Autocorrelation;		
Ljung Box, Chi Sq (4)	3.3830	3.7145
LM test, Chi Sq (4)	3.5637	3.6261
Modifed LM test, F (4, 53)	0.7002	0.7131
(3) For Heteroscedasticity;		
LM test, Chi Sq (2)	3.5176	1.8020
(4) For Parameter Stability;		
Static "Hendry" Forecast test, Chi Squ (8)	16.96	18.82
RMS%E	0.07	0.07
(5) Tests for Restrictions;		
Elasticity restricted, F(1,57)	0.5708	0.5360
Dummies restricted, F(3,60)	(-)	1.669

Appendix 1: Estimates of Net Cash Withdrawal

This appendix gives details of how one can obtain estimates of net cash withdrawal (NCW) using published data. NCW is defined as;

NCW = ML - HI - CHS + SC + CG

where ML is net new loans for house purchase, HI is private sector housing investment (both new dwellings and improvements), CHS is dwellings purchased from the public sector (ie council house sales), SC is private sector slum clearance and CG is government capital grants to the private sector for housing improvements. The sources of data are;

ML	:	Financial Statistics (Table 9.3)
HI	:	Economic Trends (National Accounts, Table 14)
CHS	:	Housing and Contruction Statistics (Part 2, Tables 2.12 and 2.13)
SC	:	Housing Construction Statistics (Part 2, Tables 2.2 and 2.25)
CG	:	United Kingdom National Accounts, Table 9.4

Appendix 2: The Aggregate Consumers' Expenditure Long-Run Elasticity with Respect to Income

We can write consumption functions for non-durables (CND) and durables (CD) respectively as;

$$CND = K_1 Y^{\alpha} \qquad (1)$$

$$CD = K_2 Y^{\beta} \qquad (2)$$

where Y is income and we would expect $\alpha < 1$ and $\beta > 1$. We next define total consumption (C) as the sum of its components;

$$C = CND + CD \qquad (3)$$

Clearly we can write the aggregate income elasticity as the sum of the individual elasticities;

$$E_{cy} = \frac{Y}{C}\frac{dC}{dY}$$

$$= \frac{Y}{C}\left(\frac{dCND}{dY} + \frac{dCD}{dY}\right)$$

$$= \frac{Y}{C}\left(K_1 \alpha Y^{(\alpha-1)} + K_2 \beta Y^{(\beta-1)}\right) \qquad (4)$$

which, using (1) and (2), gives;

$$E_{cy} = (\alpha CND + \beta CD)/C \qquad (5)$$

Our current CD equation implies that $\beta = 1.59$ (evaluated assuming the wealth income ratio is held constant) and our CND equation implies that $\alpha = 1$. Given that CD/C has averaged 8.32% between 1955 and 1986 then, on average over this period, the aggregate elasticity of C to Y implied by our model has been 1.049.

In order to ensure that the aggregate elasticity averaged one over this period we can substitute the current model estimate for β in (5) and calculate a 'target' value of α using the mean durables to total consumption ratio. This gives a figure of 0.946 for α which would need to be imposed on our non-durables equation.

Appendix 3: Notation

CD = Consumers' expenditure on durables, (real)

CDD = $(CD_{-1} * CD_{-2} * CD_{-3} * CD_{-4})**0.25$

CND = Consumers' expenditure on non-durable goods and services, (real)

CNDD = $(CND_{-1} * CND_{-2} * CND_{-3} * CND_{-4})**0.25$

Dxxy = Dummy variable for 19xx, quarter y

DHP = Hire purchase dummy used in NIESR model (similar to RMD)

KHBB = Stock of mortgage loans from banks (nominal)

KHPG = Stock of mortgage loans from public sector (nominal)

KHPV = Stock of mortgage loans from other OFI's (nominal)

KZJ = Stock of personal sector deposits with building societies (nominal)

KZNA = Stock of mortgage loans from building societies (nominal)

LHBB = Flow of KHBB

LHPG = Flow of KHPG

KHPV = Flow of KHPV

LZNA = Flow of KZNA

ML = (LHBB + LHPG + LZNA + LHPV)

NFIN = (NFWJ + KZNA + KHBB + KHPG + KHPV)

NFWJ = Personal Sector net financial wealth (nominal)

NLAJ = Personal Sector net liquid assets (nominal)

PC	=	Consumers' expenditure deflator: all items (1980=1)
PCD	=	Consumers' expenditure deflator: durables (1980=1)
PCND	=	Consumers' expenditure deflator: non-durables (1980=1)
PEXP	=	Proxy for expected rate of inflation (%)
RBLPE	=	(RCBR + 5)
RCBR	=	Clearing banks' base rate (%)
RLA	=	Local authority 3-month rate (%)
RMD	=	Effective minimum deposit rate on durables (%)
RNFWJ	=	(NFWJ/PC)
RNFWJD	=	$(RNFWJ_{-1} \times RNFWJ_{-2} \times RNFWJ_{-3} \times RNFWJ_{-4})**0.25$
RNLAJ	=	(NLAJ/PC)
RNLAJD	=	$(RNLAJ_{-1} * RNLAJ_{-2} * RNLAJ_{-3} * RNLAJ_{-4})**0.25$
RPDI	=	Real Personal Disposable Income (1980 £million)
RR	=	$(1 + (RCBR/100) - (\ln PC_{-1} - \ln PC_{-5}))$
RRL	=	$\Delta_2 \ln ((RLA - ((PC/PC_{-2})**2-1)*100)/100) + 1)$
YDLH	=	Real Household Disposable Income (adjusted for the effects of inflation eroding the value of persons' net liquid assets stock), (1980 £million)
YDLD	=	$(YDLH_{-1} \times YDLH_{-2} \times YDLH_{-3} \times YDLH_{-4})**0.25$

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