Bank Retail Rate Response to the Policy Rate: Time-variation, Regime-switching and Curvature

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Abstract

This paper explores several nonlinear aspects in the interest rate transmission mechanism on the basis of a large disaggregated sample of British monthly deposit and loan rates 1993-2005 for seven key products. The focus is on the adjustment speed towards the long run equilibrium rate. A sizeable proportion of UK deposits and credit products are found to have a time-varying adjustment speed, driven by the policy rate changes. Tests based on regime-switching models indicate that the adjustment speed has four states defined by the sign of the policy rate changes and the sign of the gap. The magnitude of the policy rate changes also influences the adjustment speed in a regime-switching manner, but this nonlinear aspect is less pervasive across products than the sign asymmetry. Furthermore, mainly for deposit products there is curvature in the catch-up effect towards equilibrium — the error correction is disproportionately large for big gaps. The wide variation in the nonlinearities uncovered across financial institutions and products raises important questions about the monetary transmission and the effectiveness of monetary policy.

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Keywords: Error Correction Model; Adjustment Speed; Time-variation; Regime-Switching; Curvature.

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1. Introduction

For well over two decades, the use of a 'policy' (or official) interest rate has been the main instrument of choice for central banks, whether they are focused on achieving specific inflation targets or not. In order to influence future spending and the inflation rate, official rate changes must prompt similar changes in short money market instruments and retail rates. Central banks rely on the assumption that financial institutions (FIs) tend to gravitate towards a long run equilibrium rate which changes with every rise or fall in the policy rate. This outcome will follow swiftly under certain conditions.

A profit maximizing financial intermediary would always seek to equate the policy rate to the expected marginal revenue for each asset and the expected marginal cost of each liability. Under perfect competition or contestability, with no uncertainty or adjustment costs, retail rate responses would be immediate, symmetric and one-for-one. If any of these conditions are not met, however, reactions may display lags due to menu costs, imperfect information and switching costs. Nonlinearity could arise because the relevant deposit supply or loan demand functions that the FI thinks it faces may not be isoelastic. Finally, uncertainty over rivals' responses, and/or menu costs could well prove to be a source of asymmetry in retail rate responses to official rate changes. If present, any of these nonlinearities could create challenging issues for monetary policy makers.

There exists a large empirical literature on nonlinear dynamics in macroeconomics and finance. For instance, unemployment has been found to display fast-up, slow-down dynamics (van Dijk et al. 2002; Coakley et al., 2001). There is also ample evidence that stock returns are affected by both the business cycle and behavioural asymmetries related to bull and bear markets (McMillan, 2003; Coakley and Fuertes, 2006). Moreover, transaction costs and other market frictions have been shown to induce a band of persistent deviations around the long run equilibrium or fundamental value of variables such as real exchange rates and the basis in stock index futures. The focus of the present study is the dynamics of retail interest rates. Detecting nonlinear behaviour in the way banks react to policy rate changes is important for several reasons. First, the insights it can provide about the practical operation of economic mechanisms may lead to modelling improvements. Second, if researchers focus on the class of models that are closer to the data generating process, significant policy implications may follow. Third, asymmetries in the propagation of shocks can pose special difficulties for forecasting time series using linear models.

Retail banks' reactions to official rate changes need be neither instantaneous nor symmetric to ensure an unimpaired transmission mechanism for monetary policy, as long as the authorities are cognizant of any lag structure and the character of the asymmetries. But are they, and equally importantly, do all banks and products behave in the same way following a change in policy rates? If the policy makers are unaware of any systematic differences that can be identified, the transmission mechanism may be much more difficult to predict than hitherto believed.

The main objective of this paper is to investigate nonlinearity in the adjustment of UK bank-specific retail rates to changes in policy rates, to better understand this aspect of the transmission mechanism. The paper differentiates itself from previous studies in several aspects. First, it explores a range of possible nonlinearities. Second, it is based on an extensive dataset both in the time and cross-section domain that represents a substantially large part of the UK banking market. Third, the ability of error correction models (ECMs) to explain retail rate behaviour is compared across a wide range of products.

Nonlinearity is defined as any departure from the conventional linear ECM typically used to characterize retail rate behaviour. The paper focuses on the following nonlinear aspects: conditional continuous variation, regime-switching and curvature. It investigates whether there is continuous time-variation in the adjustment speed which is exogenously driven by the actual change in the policy rate. It also tests for asymmetric adjustment to the sign (rises versus falls) and magnitude (large versus small) of policy rate changes, and of the gap itself. The notion of curvature refers to the error correction process and implies that, for a given adjustment speed, broad gaps entail an error correction which is disproportionately larger than that associated with narrow gaps.

A highly disaggregated dataset is used in the analysis in order to address the question of whether all (or most) banks and products behave in the same way following a change in the policy rate. Moreover, this dataset circumvents aggregation issues — heterogeneity in the speeds of adjustments of the individual banks may bias the aggregate estimate of the speed of adjustment. There are only two published papers in the literature that use disaggregated British retail rate data but they are confined to a small number of banks and products (Hoffman and Mizen, 2004) or to a linear econometric framework (Heffernan, 1997). The present study is based on a detailed sample of 92 FIs which offer one or more of business and household saving accounts, current accounts, personal loans and two types of credit cards, making it possible to compare the transmission process across products and banks.

The key finding is that different nonlinear elements are present in the retail rate adjustment process. For a notable proportion of sampled cases, a rise (fall) in the policy rate causes mortgage (deposit) rates to increase (decline) faster. Moreover, the sign of the disequilibrium or gap also matters in explaining the variation in retail adjustment speed across banks and over time. Although less marked, regime-switching behaviour dictated by the magnitude or size of the policy rate changes is also present for about half the deposits and a fifth of mortgages. In addition, there is evidence of curvature in the error correction process which is more pronounced for deposit than credit products. Neither the linear ECM nor any of the nonlinear variants considered can explain the dynamics of store card rates in response to official rate changes. For all but one of the big four/five banks and some smaller FIs, the same is true for personal loan and credit card rates. These insights could influence the way the Bank of England assesses the impact of the interest rate transmission mechanism and the conduct of monetary policy itself.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the dataset and Section 4 explains the econometric framework. Section 5 presents the models and empirical results. Section 6 discusses the policy implications before concluding in a final section.

2. Related Literature

Several theoretical contributions have motivated empirical investigations of nonlinearity in the interest rate transmission mechanism. Nonlinear behaviour can be modelled through a plethora of functional forms. A popular approach is the class of threshold error correction models (ECMs) that are inspired by Tong's (1983) threshold autoregressive (TAR) framework.[1] A threshold ECM can be cast as a piecewise-linear model and as such it nests the basic linear ECM. This approach

[1] There is a parallel literature that investigates nonlinearities in the dynamics of interest rates. For instance, Balke and Fomby (1996) showed that various short-term interest rates exhibit threshold cointegration. Enders and Granger (1998) adopt threshold autoregressive (TAR) models to show that there are asymmetries in the term structure of interest rates. Coakley and Fuertes (2002) explore the long run behaviour and short run dynamics of quarterly UK real interest rates 1950-1999 in a similar TAR framework and provide evidence of sign and size asymmetric mean reversion.

allows testing, for instance, whether a change in the policy rate triggers a different response when the disequilibrium level exceeds or lies below a threshold level. While most of the literature focuses on asymmetries in the short run speed of adjustment to the long run equilibrium rate, a few studies also test for asymmetries in short run pass-through. Due to space considerations, this review is confined to papers which employ nonlinear ECMs to analyse the interest rate transmission mechanism.[2]

Frost and Bowden (1999) were the first to employ nonlinear ECMs to capture asymmetries in the adjustment of mortgage rates to official rates. Taking the 90-day bank bill rate as an indicator of monetary policy, they find that the adjustment speed of New Zealand aggregate mortgage rates over 1985:9-1996:5 displays state-dependence and regime-switching. The former means that the adjustment speed varies over time in a 'continuous' manner, proportional to both the gap and the change in the bill rate. Regime-switching means that there are different 'regimes' of adjustment and the transition from one to another is dictated by the interaction of the signs of the gap and the bill rate changes — mortgage rate adjustment appears slower when the gap is negative (undercharging) and the bank bill rate rises. This asymmetry is more pronounced in periods of highly volatile rates.

Hoffman and Mizen's (2004) analysis of the UK banking market is limited to retail rates on two products, 90-day deposits and mortgages. Their monthly dataset 1985:1-2001:12 is confined to 7 financial institutions and a base rate is taken as proxy for the policy rate.[3] Using a similar methodology to that in Frost and Bowden (1999), they corroborate the importance of the interaction between the sign of the expected policy rate change and the sign of the gap — their findings suggest relatively faster adjustment when the gap is expected to widen. The perceived direction of change in the official rate is proxied by both the actual change (perfect foresight) and by yield spreads. However, neither the sign of the gap nor the direction of the official rate change matter significantly when their effects are tested separately.

De Graeve et al. (2006) investigate Belgian bank-specific retail rates 1993:1-2002:12 for 6 loan and 7 deposit products, with money market rates as the benchmark. They test whether the retail rate responses to changes in the money market rate are influenced by the sign or size of the gap. To formalize the size effect, they augment the linear ECM with error correction terms that are squared and cubic

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[2] Several studies (Hannan and Berger, 1991; Neumark and Sharpe, 1992; Mester and Saunders, 1995) have used alternative approaches (e.g. logit models) to investigate asymmetric retail rate behaviour.
[3] Defined as the average of the base rates quoted by the four major clearing banks.

in the gap. Little evidence of sign asymmetry is found for loans, only some deposit rates adjust significantly faster downward than upward. In contrast, the larger the deviation from equilibrium the faster the adjustment for both loans and deposits.

Two recent studies look at whether retail rate adjustment changed with the advent of the euro. De Bondt (2005) employs monthly average 'euro' retail deposit and loan rates over 1996:1 to 2001:5 and a number of money market rates to estimate linear ECMs and bivariate VARs over the whole sample and for a (post-1999) EMU sub-sample.[4] He reports faster adjustment and greater pass through post-euro. Chionis and Leon (2006) employ monthly data 1996:7 to 2004:9 on Greek 1-year deposit and loan rates. They find that stickiness is dramatically reduced post-EMU. These findings underline the importance of allowing for a time-varying adjustment speed in models used to analyze the interest rate transmission mechanism.

Sander and Kleimeier's (2004a) analysis is based on monthly averages of loan and deposit rates 1993:1-2002:10 in 10 euro zone countries. They consider four TAR models among which, using the AIC, a momentum TAR is selected most often as the best specification. This model implies that the adjustment speed depends on how fast the rates move away from or towards equilibrium, i.e. on whether the change (as opposed to the level) in the disequilibrium exceeds some threshold value. They corroborate that retail and official rates move together in the long run and document significant momentum-type asymmetries in short run adjustment for about 23 % of deposits and 40% of loans. A similar approach is adopted in Sander and Kleimeier (2004b) to explore pass-through in eight transition economies using monthly country average rates 1993:1-2003:12 on 4 loan and 3 deposit products. There is little evidence of asymmetry but pass-through is faster in transition markets than in the eurozone.

3. The Dataset

This study employs monthly data for 92 FIs on 8 deposit products (24 if division by tier is taken into account) and 4 credit products. The sources of data are *Moneyfacts* and *Business Moneyfacts*, two monthly publications produced by the Moneyfacts Group. The period of study is from January 1993 to June 2005. The two publications supply financial institutions' monthly rates on the following products:

Business Savings (B-Sav): Deposit rates quoted (mainly) to small and medium sized businesses. Sub-products are created based on maturity (instant, 30-day and 90-day)

[4] The rates are based on averages for each euro zone country.

and by deposit levels or tiers (low, £2,500; medium, £10,000; high, £250,000).[5] To simplify the exposition, these three tiers are called LT, MT and HT, respectively.

Household Savings (H-Sav): Deposit rates for four maturities (instant, 30, 60, 90 day) and three tiers (LT, £500; MT, £5,000; HT, £10,000).

Current Accounts (CA): Deposit rates for LT (£500), MT (£5000) and HT (£10,000).

Mortgages: Household repayment mortgages are by far the most common in the UK.[6] FIs have been criticised for offering more favourable rates to new clients. The sample includes rates for new and existing mortgages, but most FIs appear to quote the same rate for both, so just the existing rate is used.

Personal Loans: Rates quoted on unsecured loans made to individuals typically from £1,000 to £10,000, although a few banks offer up to £25,000.

Credit Cards: Rate quoted on outstanding monthly balances.

Store Cards: Credit facilities offered by major department stores. Like credit cards, any outstanding monthly balances are subject to interest charges.

The interest rate quoted for the deposit accounts is the gross annual equivalent rate or AER (compounded interest) with no tax deducted. For credit products, it is the annual percentage rate (APR) which includes the compounded interest paid on loans, including outstanding store and credit card balances. All rates are variable.

Each month since May 1997, the Bank of England's Monetary Policy Committee decides whether the interest rate should be increased, reduced or remain unchanged. The name given to this rate has changed through the years.[7] In this study, it is called the official or policy rate because the markets interpret any change as a tightening or loosening of monetary policy. Given this study's focus on the interest rate transmission mechanism, this rate is clearly the appropriate choice.

4. The Econometric Framework

The starting point for formalizing the short and long run relation between retail rates and a central bank's official rate is the linear error correction model (ECM):

[5] The tiers are chosen by the Moneyfacts group and do not change over the sample period. Banks report the deposit rate they pay at each tier.

[6] According to Miles (2003), 90% of mortgage lending in the UK is either variable rate or fixed for a term of up to 2 years, and 66% of all mortgages are variable rate. The interest rate volatility of the early 1990s prompted the growth of fixed rate mortgages but they continue to have a very small market share.

[7] In July 2006, its unofficial name became the bank rate, the name given to it before 1972.

$$\begin{aligned}\Delta x_t &= \gamma u_{t-j} + \beta \Delta y_t + \sum_{i=1}^{k} \lambda_i \Delta x_{t-i} + \sum_{i=1}^{k} \phi_i \Delta y_{t-i} + \varepsilon_t \\ &= \alpha + \gamma x_{t-j} + \delta y_{t-j} + \beta \Delta y_t + \sum_{i=1}^{k} \lambda_i \Delta x_{t-i} + \sum_{i=1}^{k} \phi_i \Delta y_{t-i} + \varepsilon_t\end{aligned} \tag{1}$$

where y_t is the official (policy) rate, x_t is a retail rate and $u_{t-j} = x_{t-j} - x^*_{t-j}$ is the lagged disequilibrium level or gap, defined as the deviation of the retail rate from its long run equilibrium path, $x^*_{t-j} = A + Cy_{t-j}$. The parameters $A = -\alpha/\gamma$ and $C = -\delta/\gamma$ represent the long run mark up (down) and pass-through, respectively.

An important component of the interest rate transmission mechanism is the short run adjustment speed toward equilibrium, measured by the parameter γ in equation (1). Several assumptions regarding the error or equilibrium correction term, γu_{t-j}, are implicit in the linear framework. First, the linear ECM restricts the adjustment speed to be time invariant, that is, identical under all circumstances; but it is plausible that γ is driven by some endogenous or exogenous factor, which would make it continuously *time-varying* instead. Second, the linear ECM assumes symmetry but it is likely, for instance, that a retail rate's speed of convergence to its long run equilibrium path is *asymmetric* with respect to the sign (or size) of the policy rate change and of the gap. Third, the error correction or 'catch up' effect toward the long run equilibrium rate could have *curvature* if, for a given adjustment speed, large gaps matter disproportionately more than small gaps. Menu costs may explain the presence of magnitude asymmetries or curvature in the error correction while sign asymmetries could be observed due to switching costs. Agency issues may explain sluggish loan rate adjustment following policy rate increases as compared to falls.[8]

Each of the above features — continuous time-variation in the adjustment speed, sign/magnitude asymmetry in the adjustment speed, and curvature in the error correction — represent a departure from the conventional linear ECM. The main goal of this paper is to investigate how pervasive these nonlinearities are in the UK banking market. For this purpose, a nonlinear framework is adopted.

A continuously time-varying adjustment speed can be generated as:

$$\gamma_t = \gamma + kd_t \tag{2}$$

[8] The underlying theoretical foundations for these arguments are found in, respectively, Sheshinski and Weiss (1977), Klemperer (1987) and Stiglitz and Weiss (1981, 1983).

where γ and k are constants and d_t is a *conditioning* factor which may be endogenous or exogenous.[9] It is possible to test the null hypothesis H_0: $k=0$, that the adjustment speed is identical under all circumstances as in (1), against the alternative, H_A: $k \neq 0$, that the adjustment speed varies over time because it is driven by d_t. These two settings are depicted in panels (a) and (b) of Figure 1.

Second, a regime-switching adjustment speed can be formalised as:

$$\gamma_t = \begin{cases} \gamma_1 & if\ z_t > \theta \\ \gamma_2 & if\ z_t \leq \theta \end{cases} \qquad (3)$$

where z_t is called switching or threshold variable and θ is the threshold parameter. The adjustment speed switches over time between the states $\gamma_a = \gamma_1$ and $\gamma_b = \gamma_2$. Hence, the degree of asymmetry is constant, $\Delta\gamma = \gamma_1 - \gamma_2$. The hypothesis H_0: $\gamma_1 = \gamma_2$ states that there is no regime-switching as it is assumed in the linear ECM.

Third, a non-constant asymmetry can be obtained by combining (2) and (3) as:

$$\gamma_t = \begin{cases} \gamma + \gamma_1 d_t & if\ z_t > \theta \\ \gamma + \gamma_2 d_t & if\ z_t \leq \theta \end{cases} \qquad (4)$$

so that the adjustment speed switches between two time-varying states, $\gamma_{a,t} = \gamma + \gamma_1 d_t$ and $\gamma_{b,t} = \gamma + \gamma_2 d_t$. Hence, the degree of asymmetry is time-dependent, $\Delta\gamma = (\gamma_1 - \gamma_2) d_t$. In this formulation, a two-stage testing approach is adopted. The stage I null hypothesis, H_0^I: $\gamma_1 = \gamma_2 = 0$, states that the adjustment speed is constant, as in the linear ECM, equation (1). Rejection of H_0^I motivates a test for the stage II null hypothesis of symmetry or no regime-switching in adjustment, H_0^{II}: $\gamma_1 = \gamma_2 = k$. Hence, three distinct outcomes are possible from this two-stage testing approach: i) non-rejection of H_0^I means that the linear ECM is supported by the data, ii) rejection of H_0^I and non-rejection of H_0^{II} implies that there is continuous time-variation in the adjustment speed driven by d_t, but not asymmetry, iii) rejection of both H_0^I and H_0^{II} suggests that there is both continuous conditional variation and asymmetry in the adjustment speed. Settings (3) - (4) are illustrated in panels (c) and (d) of Figure 1.

Most of the literature assumes that the error correction mechanism is linear in the gap, that is, adjustment towards the long run equilibrium is proportional to the gap. However, like De Graeve et al. (2006) this study allows for curvature in the error

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[9] Time variation in the parameter γ is not *per se* a nonlinearity. However, we refer to it as such in the sense that it represents a departure from the conventional linear ECM given by equation (1).

correction process by introducing an additional term that is nonlinear (cubic) in the gap. Thus the error correction term in equation (1) is generalized to:

$$\rho u_{t-j} + \delta u_{t-j}^3 \qquad (5)$$

and, in this setting, the restriction H_0: $\delta = 0$ implies that there is no curvature.

The analysis below involves tests of whether there is time-variation and/or regime-switching behaviour in the adjustment speed, and curvature. For this purpose different nonlinear models are formulated that relate to settings (2) to (5).

5. Empirical Analysis

This section outlines the models and presents the empirical results. Estimation is by OLS and inferences are based on either the OLS or White's heteroskedasticity-robust covariance matrix, as appropriate. The Wald statistic is used for testing joint hypotheses and individual significance tests are based on *t*-statistics.

5.1 Regime-Switching in the Adjustment Speed: Sign Asymmetry

Three nonlinear specifications are formulated to assess the degree to which the sign of policy rate changes influences bank behaviour. **Model I** introduces the simplest form of sign asymmetry to test whether the direction of the policy rate affects a bank's adjustment speed. For example, do banks take longer to adjust loan rates downward than upward? The model equation is:

$$\Delta x_t = \gamma_1 u_{t-j} S_{\Delta y} + \gamma_2 u_{t-j}(1 - S_{\Delta y}) + f_{\Delta y,\Delta x} + \varepsilon_t \qquad (6)$$

where $f_{\Delta y,\Delta x}$ represents the terms $\beta\Delta y_t + \sum\lambda_i \Delta x_{t-i} + \sum\phi_i \Delta y_{t-i}$ in (1) to simplify the notation; $S_{\Delta y}$ is a sign indicator function for policy rate changes defined as $S_{\Delta y} = 1$ if $\Delta y_{t-j} > 0$ and 0 otherwise. This model exemplifies setting (3) with the threshold or switching variable $z_t = \Delta y_{t-j}$ and the threshold parameter $\theta = 0$, thereby characterizing sign asymmetry that is constant through time.[10] Hence, the adjustment speed switches between two constant states, $\gamma_a = \gamma_1$ and $\gamma_b = \gamma_2$. Rejection of the null hypothesis of constant adjustment H_0: $\gamma_1 = \gamma_2$ is suggestive of sign asymmetry and, in

[10] The error correction lag *j* is selected from a set of plausible values (*j*=1,..,6) to maximise the AIC. The augmentation lag *k* is chosen so as to absorb the residual autocorrelation. A two-stage estimation approach is adopted. First, the dynamic model $x_t = a_0 + a_1 x_{t-1} + \ldots + a_p x_{t-p} + c_0 + c_1 y_{t-1} + \ldots + c_q y_{t-q} + e_t$ is estimated by OLS to obtain the long run parameters $A = a_0/(1-a_1-\ldots-a_p)$ and $C = (c_0 + \ldots + c_q)/(1-a_1-\ldots-a_p)$. The estimates of the gap $u_t = x_t - A - Cy_t$ are incorporated in the ECM to obtain information on the speed of adjustment.

particular, $\gamma_1 < \gamma_2$ implies that for a given gap u_t, the retail rate is more responsive to policy rate rises than to policy rate cuts ceteris paribus.[11]

The estimation and inference results from Model I are set out in Table 1. The constant-adjustment null cannot be rejected for over 90% of all deposit cases. Nor is there much evidence of sign asymmetry for personal loans, credit cards and store cards. However, sign regime-switching is present in a minority (21%) of mortgages, and with one exception, all suggest downward rigidity — the mortgage rate adjustment is faster when the official rate rises than when it falls. But overall, Model I produces little evidence to suggest that the direction of the policy rate affects the speed with which banks adjust their deposit and loan rates.

Model II generalizes equation (6) to allow for a time-varying adjustment speed that is conditional on an exogenous factor, the policy rate changes. The equation is:

$$\Delta x_t = \gamma u_{t-j} + \gamma_1 u_{t-j} \Delta y_{t-j} S_{\Delta y} + \gamma_2 u_{t-j} \Delta y_{t-j} (1 - S_{\Delta y}) + f_{\Delta y, \Delta x} + \varepsilon_t \quad (7)$$

where Δy_{t-j} denotes the policy rate change at time t-j. In both Models I and II, the speed of adjustment switches between two regimes associated with positive and negative policy rate changes. The novel feature of Model II is that the two regimes are dynamic or time-varying, $\gamma_{a,t} = \gamma + \gamma_1 \Delta y_{t-j}$ and $\gamma_{b,t} = \gamma + \gamma_2 \Delta y_{t-j}$, conditional on the policy rate fluctuations. In both regimes (policy rate rises or cuts) this conditional behaviour implies that large policy rate changes are followed by faster adjustment speeds than small policy rate changes. Hence, this model corresponds to setting (4), with threshold variable $z_t = \Delta y_{t-j}$ and threshold parameter $\theta = 0$.

Table 2 summarises the estimation and inference results for Model II. The stage I null hypothesis that the adjustment speed is time-invariant (H_0: $\gamma_1 = \gamma_2 = 0$) is rejected for 51% of deposit rates. Those rates are subjected to the stage II (H_0: $\gamma_1 = \gamma_2 = k$) test with the result that sign asymmetry is uncovered in 44% of them and, for the overwhelming majority of these, responses are faster when the policy rate falls. The stage I null is rejected for 65% of mortgages, and the majority of these (about 70%) exhibit regime-switching in the form of faster adjustment to policy rate increases. Overall, for about 20% (76/415) of all deposit products in the UK banking market,

[11] During the period under study 1993:01-2005:06, there are 148 policy rate changes, 32 of which represent policy rate rises $\Delta y > 0$ and the remaining 116 are (no change or) policy rate cuts $\Delta y \leq 0$.

adjustment is faster following a policy rate cut. For nearly 40% (20/51) of mortgage products, the rates are adjusted more rapidly following policy rate rises.[12]

The previous two models implicitly assume that the way banks adjust their retail rates does not depend on whether the gap is positive or negative at the time of a policy rate change. **Model III** addresses the question: does the sign of the disequilibrium level prompt different speeds of retail rate adjustment in response to a given policy rate change? The model equation is:

$$\begin{aligned}\Delta x_t = \gamma u_{t-j} + \kappa_1 u_{t-j}\Delta y_{t-j} S_u S_{\Delta y} + \kappa_2 u_{t-j}\Delta y_{t-j} S_u (1-S_{\Delta y}) + \\ \kappa_3 u_{t-j}\Delta y_{t-j}(1-S_u)S_{\Delta y} + \kappa_4 u_{t-j}\Delta y_{t-j}(1-S_u)(1-S_{\Delta y}) + f_{\Delta y,\Delta x} + \varepsilon_t\end{aligned} \quad (8)$$

where S_u is a sign indicator function for the gap defined as S_u=1 if $u_{t-j} > 0$ and 0 otherwise. The interaction of the sign of the gap and the policy rate change gives four regimes of adjustment: $\gamma_{a,t} = \gamma + \kappa_1 \Delta y_{t-j}$ if $u_{t-j} > 0$ and $\Delta y_{t-j}>0$, $\gamma_{b,t} = \gamma + \kappa_2 \Delta y_{t-j}$ if $u_{t-j} > 0$ and $\Delta y_{t-j}<0$, $\gamma_{c,t} = \gamma + \kappa_3 \Delta y_{t-j}$ if $u_{t-j} \leq 0$ and $\Delta y_{t-j}>0$, and $\gamma_{d,t} = \gamma + \kappa_4 \Delta y_{t-j}$ if $u_{t-j} \leq 0$ and $\Delta y_{t-j}<0$.

Hence, Model III pertains to setting (4) with two threshold variables, $z_{1t}=u_{t-j}$ and $z_{2t}=\Delta y_{t-j}$, and threshold parameter $\theta = 0$. Given that the gap varies not only over time but across FIs too, evidence of asymmetric adjustment with respect to its sign would be in line with the inter-bank heterogeneity in adjustment speeds documented in De Graeve et al. (2006) and Fuertes and Heffernan (2006).

The estimation and inference results for Model III are summarised in Table 3. The stage I test (H_0: $\kappa_1=\kappa_2=\kappa_3=\kappa_4=0$) suggests that for about 80% of deposit rates the adjustment speed is non-constant but instead driven by the policy rate changes, which provides strong evidence against the linear ECM. Furthermore, for all of these deposits, the stage II null (H_0: $\kappa_1=\kappa_2=\kappa_3=\kappa_4=\kappa$) is also rejected suggesting sign-asymmetric adjustment. For mortgages, credit cards and personal loans, there is evidence of non-constant adjustment in 80%, 50%, and 33% cases, respectively. The one exception is store cards for which there is no evidence against the linear ECM.

The plausible signs for the asymmetry coefficients are $\kappa_1>0$, $\kappa_2>0$, $\kappa_3<0$ and $\kappa_4<0$. The rationale for this is based on the notion that γ captures the overall or 'average' adjustment speed for the four regimes. For example, the combination of $u_{t-j} \leq 0$ and $\Delta y_{t-j}>0$ implies a widening-gap regime where the adjustment is expected to be faster than the overall adjustment ($\gamma_{c,t} < \gamma$), suggesting that $\kappa_3<0$. Reassuringly, the vast

[12] The stage I test provides evidence against the linear ECM (i.e. non-constant adjustment) for 41% of credit cards and 23% of personal loans. The stage II test reveals sign asymmetry for just 4 out of 22 credit cards and 1 out of 13 personal loans. Given the weak evidence of sign asymmetry and the low explanatory power of the models for these credit products, the discussion is confined to mortgages.

majority of the estimates are correctly signed.[13] But the really interesting questions relate to the relative sizes of the κ_j, j=1,…,4. It is anticipated that for both deposit and credit products $\kappa_1 > \kappa_3$ and $\kappa_2 > \kappa_4$ since any interaction between the gap and the policy rate change should exert a more powerful effect on retail rate adjustment if they have opposite signs, that is, if the gap is widening. The evidence suggests that for 80% of the deposit rates with asymmetry (Table 3; col. 6), banks that are underpaying increase their rates relatively fast following a policy rate rise to close what would otherwise be an ever widening gap. Likewise, for about 75% of deposits exhibiting asymmetry, banks that are overpaying (col. 7) cut their rates relatively fast.

A notable result for personal loans is the tardiness of banks to raise rates, irrespective of the sign of the gap — only $\kappa_2 > 0$ is significant and hence, a relatively fast reaction is observed for policy cuts when the bank is overcharging. This finding is consistent with the Stiglitz and Weiss (1981, 1983) argument that if banks raise loan rates, not only is there an increase in moral hazard among existing borrowers but better risks drop out, reducing the average quality of the loan book.[14] Both factors tend to limit the size of any additional revenue, which could even turn negative. This "double whammy" may have a greater impact on banks with a high proportion of new loan business, where information asymmetries are more widespread.

The evidence for credit cards is consistent with that for deposits. When the policy rate increases, adjustment is generally faster for undercharged rates. When the policy rate decreases, adjustment is faster for overcharged rates. But the results for mortgages are counterintuitive. For the vast majority of mortgages with asymmetric adjustment, when the policy rate rises, the response is faster in the case of FIs that are overcharging relative to those that are undercharging ($\kappa_1 < \kappa_3$); likewise, when the policy rate falls, adjustment is faster for the undercharged mortgage rates ($\kappa_2 < \kappa_4$).

In sum, the asymmetry pattern uncovered for deposits, personal loans and credit cards is consistent with the way banks are expected to behave — faster adjustment when the change in the policy rate exacerbates the disequilibrium level ceteris paribus — and with the evidence in Hoffman and Mizen (2004) for a much smaller UK sample. Mortgages are an exception in that adjustment is faster when the policy rate movement has the effect of narrowing the gap. This finding is, however, consistent with the results in Frost and Bowden (1999) for New Zealand mortgages.

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[13] The very few cases where any of the estimates for κ_j yields $\gamma_t > 0$ are excluded from the discussion.
[14] See also Fried and Howitt (1980).

The likely explanation for what appears to be a counter-intuitive result for mortgages is that, of all the products in the sample, mortgages come closest to the perfectly competitive ideal, with many suppliers, highly elastic demand and transport costs barely relevant. The period average cross-section variances for mortgages, H-Sav Instant (LT), and personal loans are, respectively, 0.05, 0.75 and 3.8, an illustration of how strongly clustered mortgage rates are, with little inter-bank heterogeneity. They also move closely with policy rates, producing small gaps u=x-x^*. The period average gap for mortgages is 0.3%, whereas it stands at 2.5% for H-Sav (LT) and 2.98% for personal loans. These statistics help to explain the perverse direction of the sign asymmetry for mortgages. From 1993 onward, risk premia began to fall, caused by fading memories of negative equity and repossessions which occurred in the early 1990s. The cross-section average of the gap for mortgages in January 1993 is 0.6%, but 5 years later, it has more than halved, even though the official rate actually rose by about 60 basis points over the same period.[15] Also, interest rates began to drift downward from January 1999 onward.[16] Banks that are undercharging mortgages would be expected to raise rates but in a competitive market with a falling policy rate, there might be little option but to quickly cut rates.

5.2 Regime-Switching in the Adjustment Speed: Magnitude Asymmetry

This section investigates whether the magnitude of an official rate change influences a bank's rate of adjustment in a regime-switching way: do above-average (large) changes in the official rate trigger a relatively fast adjustment of retail rates?

The simplest size asymmetry representation is **Model IV** where the speed of adjustment switches between two constant values, γ_a=μ_1 and γ_b=μ_2, is as follows:

$$\Delta x_t = \mu_1 u_{t-j} M_{\Delta y} + \mu_2 u_{t-j}(1 - M_{\Delta y}) + f_{\Delta y,\Delta x} + \varepsilon_t \tag{9}$$

where $M_{\Delta y}$ is a magnitude indicator for the policy rate changes defined as $M_{\Delta y}$ = 1 if $|\Delta y_{t-j}| > \tau$ and 0 otherwise. The average of the (absolute) policy rate changes over the sample period is used to define 'large' versus 'small', i.e. τ=$T^{-1}\sum_t|\Delta y_t|$; changes above τ are large and those below are small. This model is a special case of setting (3) with threshold variable z_t=$|\Delta y_t|$ and threshold parameter θ=$T^{-1}\sum|\Delta y_t|$. Rejection

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15 It remained at around 0.25 for the rest of the sample period.

16 From January 1999 to May 2004 the official rate fell by 2%, with the exception of 12 months from January 2000, when it rose by approximately 50 basis points.

of the null hypothesis H_0: $\mu_1=\mu_2$ is suggestive of size-asymmetry. For instance, $\mu_1 < \mu_2$, implies that the retail rate is more responsive to large policy rate changes.

Table 4 summarises the evidence from Model IV. For most of the personal loans, store cards and credit cards the null hypothesis of symmetry (linear ECM) cannot be rejected. However, there is evidence of size asymmetry for a third of deposit products, and of these, the overwhelming majority react relatively faster to above average changes in the official rate. Size asymmetry is present for just under a fifth of mortgages and again, for all of them, μ_1 is significantly smaller than μ_2. Thus, overall for about 30% of the deposit and mortgage rates in the sample, large changes in the official rate trigger faster adjustment than small changes.

Model V maintains the two regimes of adjustment associated with large and small policy rate changes but, in addition, it allows for dynamics in each regime which is dictated by the absolute policy rate change. The model equation is:

$$\Delta x_t = \gamma u_{t-j} + \mu_1 u_{t-j}\left|\Delta y_{t-j}\right| M_{\Delta y} + \mu_2 u_{t-j}\left|\Delta y_{t-j}\right|(1-M_{\Delta y}) + f_{\Delta y,\Delta x} + \varepsilon_t \qquad (10)$$

which is a special case of setting (4) with exogenous driver is $d_t=|\Delta y_t|$, threshold variable $z_t=|\Delta y_t|$ and threshold parameter $\theta=T^{-1}\sum|\Delta y_t|$. Hence, the adjustment speed switches between regimes $\gamma_{a,t}=\gamma+\mu_1|\Delta y_{t-j}|$ and $\gamma_{b,t}=\gamma+\mu_2|\Delta y_{t-j}|$.

Table 5 reports the results for Model V. The stage I null hypothesis that the adjustment speed is constant (H_0: $\mu_1=\mu_2=0$) is rejected for half of the deposit rates, suggesting that retail rate behaviour does not conform to a linear ECM. For a sizeable 42% of these cases, the stage II test (H_0: $\mu_1=\mu_2=\mu$) provides evidence of regime-switching adjustment. These findings indicate that there is both conditional time-variation and size asymmetry in retail rate adjustment, meaning that large official rate changes amplify the adjustment speed of deposit rates.

About one third of credit products (32%) reject the constant-adjustment hypothesis. This low proportion is largely driven by credit and store cards. A non-constant speed of adjustment is evident in 38% and 50% of mortgages and personal loans, respectively. Columns 6-8 show that for over half of these products (55% and 57%,) there is also evidence of size asymmetry — the adjustment speed to narrow the gap (x-x^*) is larger for above than below-average official rate changes.

Up to this point, two nonlinear aspects of retail rate adjustment have been investigated. First, whether the adjustment speed is time-varying as opposed to constant because it is dictated by the policy rate changes. Second, whether there is regime-switching in the adjustment speed triggered by the sign/magnitude of the policy rate changes and the sign of the gap. Irrespective of the model used to test for the first aspect (Models II, III or V), there is evidence of non-constant adjustment for at least half of the products. Moreover, in a sizeable proportion of these cases, sign asymmetries are also evident whereas magnitude asymmetries are less pronounced.

5.3 Curvature in the Error Correction Process

This section addresses the issue of curvature or whether large gaps matter disproportionately more than small gaps. Curvature in the equilibrium correction is introduced through a cubic gap term in **Model VI** below. The model equation is:

$$\Delta x_t = \rho_1 u_{t-j} S_u + \rho_2 u_{t-j}(1-S_u) + \delta_1 u_{t-j}^3 S_u + \delta_2 u_{t-j}^3 (1-S_u) + f_{\Delta y, \Delta x} + \varepsilon_t \quad (11)$$

where S_u is the sign indicator function defined earlier. The novel aspect of Model VI is that the catch-up effect towards the long run equilibrium is allowed to depend on the disequilibrium in two ways: proportionally through a linear term (u) and nonlinearly through a cubic term (u^3). In addition, there is the possibility of sign asymmetry also. Hence, this model can be seen as a special case of setting (4) with speed of adjustment $\gamma_{a,t} = \rho_1 + \delta_1 u_{t-j}^2$ for positive gaps ($u_{t-j} > 0$), and $\gamma_{b,t} = \rho_2 + \delta_2 u_{t-j}^2$ for negative gaps ($u_{t-j} < 0$). The driver of the continuous time-variation in the adjustment speed is the size of the disequilibrium given by $d_t = u_{t-j}^2$. The threshold variable is $z_t = u_{t-j}$ with threshold parameter $\theta = 0$.

Several questions can be addressed with Model VI. First, under the stage I null hypothesis (H_0: $\delta_1 = \delta_2 = 0$) retail rates are adjusted proportionately to the gap whereas under the alternative (curvature) hypothesis, large gaps matter disproportionately more than small gaps. Second, under the stage II null hypothesis (H_0: $\rho_1 = \rho_2$, $\delta_1 = \delta_2$), there is no regime-switching, that is, the adjustment speed is identical for positive and negative gaps. It is important to note that regime-switching can occur either in the linear error correction ($\rho_1 u_{t-j}$ versus $\rho_2 u_{t-j}$) or in the cubic one ($\delta_1 u_{t-j}^3$ versus $\delta_2 u_{t-j}^3$). Hence, the stage II test is applied to all the retail rates in the sample, irrespective of the stage I test outcome.

The key results are reported in Table 6. It turns out that for about half (48%) of all deposit products there is significant curvature in the error correction mechanism — adjustment is disproportionately faster for large gaps relative to small gaps. The evidence is strongest for business savings accounts with nearly 70% of retail rates with curvature. These findings are consistent with De Grauve et al. (2006) who also report a 'size of the gap' effect in the Belgian banking market.

On the credit side the evidence of curvature is weaker with 18% (mortgages), 15% (personal loans) and 19% (credit cards) sample cases rejecting the stage I null hypothesis. Interestingly, with reference to columns 4-5 and 6-7, for nearly 70% of the deposit cases displaying curvature, the standard linear error correction term appears insignificant. The same is true for the minority of cases in which curvature is detected for mortgages, credit cards and unsecured personal loans.

Regime-switching asymmetry with respect to the sign of the gap is present in a sizeable proportion of deposits (column 8). This asymmetry is quite pervasive in the cubic error correction term (77%), compared to the linear term (35%). It is important to note at this point that, in line with the empirical analysis in Hoffman and Mizen (2004), the evidence on sign asymmetry with respect to the gap and the policy rate changes is stronger when both effects are permitted to interact (Model III) than when they are investigated separately (Model II and Model VI, respectively).

6. Policy Implications

This paper investigated several questions regarding the complexities of the UK retail rate adjustment process following a change in the official rate. Different statistical tests suggested that the response of retail rates has nonlinear elements (time-variation, asymmetry and curvature in the disequilibrium correction) and there are notable differences among both FIs and products. The ensuing discussion regarding sign/magnitude asymmetry to policy rate changes focuses on Models II and V, respectively, because they are the most informative in this respect.[17] The evidence on the gap sign effect pertains to Model III. Finally, Model VI is addressed with reference to curvature in the error correction mechanism or the gap size effect.

The empirical results document several nonlinearities in retail rate adjustment for a non-negligible number of products and FIs. First, for more than half of the deposit and loan rates in the sample the speed of adjustment is not constant over time but instead, it is 'continuously' driven by the policy rate movements. Second, regime-switching asymmetries are also present in a sizeable number of retail rates implying

[17] For example, both Model I and Model II seek to characterize the asymmetric effect of policy rate rises versus cuts. But for virtually all the sampled retail rates Model II is superior to Model I as borne out by the AIC and the adj-R^2 statistics. See Appendix A for details.

that the adjustment speed switches between distinct states according to the direction (rises versus falls) and magnitude (large versus small) of policy rate changes. Third, for about half of deposit rates there is curvature in the catch-up effect towards the long run equilibrium: large gaps matter disproportionately more than small ones.

Given that changes in official rates are based, to a large extent, on how retail rates are expected to react, the findings provide important implications for the methods adopted by policy makers to simulate the effects of policy rate changes. Indeed, the Bank of England's quarterly model, which forms the basis for simulations states: "*A further simplification is that we have not attempted to model a layer of financial intermediation*" (Bank of England, 2005, p.43). Therefore, implicit in this model is the assumption that a policy rate change is transmitted to households and firms fully, immediately, and symmetrically through the financial sector, with no nonlinearities. The presence of diverse, nonlinear elements in the way retail rates respond to policy rate changes has important implications for: a) the model used by central banks to generate forecasts conditional on a retail rate history, b) how historical retail rates are chosen by central banks to predict the effects of such changes on the monetary transmission mechanism, c) the exercise of monetary policy.

Many central banks use a multi-equation model to capture the transmission mechanism of monetary policy rate decisions. The upshot of this study's findings is that such model should recognise the possibility of a number of nonlinear aspects in the response of retail rates to policy rate changes. This is a challenging task, given the marked heterogeneities across FIs and products. There are at least three ways in which key retail rates can be defined and measured for this purpose. First, drawing from a narrow sample, possibly the biggest retail bank, or some average of the largest banks. Second, averaging for each product the retail rates offered by all banks. Finally, current market shares could be used to obtain a weighted average of retail rates across all banks. Central banks tend to adopt one of the former two methods, which is sensible provided the behaviour of each product rate is similar across banks and building societies and other types of FIs, independently of size.

One lesson from this analysis is that some FIs match the policy rate quickly for certain products whereas others let the gaps build up before changing their deposit or loan rates. Unfortunately, the breakdown of the summary results (reported in the tables) reveals no clear distinctive pattern between small/large banks or banks/building societies. But there is one exception. For current account and household instant rates (which represent 35% of the deposits in the sample or 30% of the total sample), the individual test results for Model VI suggest that the 'big five' banks[18] tend to react disproportionately faster to larger gaps and to adjust rates at different speeds (regime-switching) when overpaying or underpaying. In contrast, a majority of smaller FIs display symmetric retail rate adjustment. Such diversity in responses will slow down the interest rate transmission mechanism — had all the banks been found to be synchronised and equally rapid, the transmission mechanism would be faster and more predictable. Moreover, if the central bank is using the same model to simulate the effects of changes in official rates for all FIs and retail products, the predictions will be at odds with what actually happens.

In the UK, the Office for National Statistics (*Financial Statistics*) is more advanced than that for most countries because it publishes a weighted average of rates for variable rate mortgages, instant access accounts and time deposits. However, the method of weighting used by the statisticians is not publicly available. The IMF *International Financial Statistics* series relies on data supplied by the central banks of member countries. It quotes "representative" deposit and loan rates. The lending rate is for short to medium sector private credit. Disaggregated rates are not reported. Though some central banks possess more detailed (unpublished) rates, the extent to which they are used to assess the effects of the transmission mechanism is unknown. The issue of weighting does not arise in the disaggregated data used in this paper which also explicitly differentiates instant access and time deposits by tier and size.

The present findings have also implications for the exercise of monetary policy. A long-standing traditional view is that the effects of monetary expansion may be weaker than those of contraction. It dates back to the famous quote "*you mean you cannot push a piece of string*"[19] and suggests that monetary policy changes are more powerful in a restrictive environment than in an expansionary one. Mortgage rates play a key role in the transmission mechanism of British monetary policy. Some of the results in the previous section are suggestive of a relatively competitive mortgage market. But there is also evidence (Model II) of asymmetry in mortgage adjustment which is consistent with the traditional view: policy rate rises trigger a faster reaction than cuts. On the other hand, some of the findings on deposit products do not

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[18] The 'big five' are HSBC, Royal Bank of Scotland, HBOS, Barclays Bank (the'big four') and Lloyds TSB. The latter is much smaller, if measured by assets or tier one capital, but very active in the retail sector.

[19] Made by representative Goldborough to Governor Eccles (latter Chairman of the Fed) on 4 March, 1935 during the hearing into the Banking Act. The statement is recently recalled by Orphanides (2006).

support this view. For example, the evidence from Model II strongly suggests that the vast majority of deposit rates react faster to policy rate cuts than to increases.

Another lesson for the execution of monetary policy relates to the finding, mainly for deposits, that there is curvature in the equilibrium correction process. Changes in the disequilibrium or gap, $u=x-x^*$, are prompted by changes in the policy rate (y) since the long run equilibrium rate $x^*=A+Cy$ changes with y. Curvature means that, for a given policy rate change, deposit rates tend to react disproportionately more when the existing gap is large (in absolute value) than when it is small. This could mean that the policy rate has increasing returns in its impact on deposit rates, as illustrated by the following example. Assume all rates begin in long run equilibrium. Then the policy rate is raised under three different scenarios: (i) a one-off increase by 25 basis points (ii) three consecutive rises of 25 basis points (i.e. over 3 months), or (iii) by a 75 basis points rise all at once, followed by no further change in each case. The deposit rate reactions in the short to medium term will be more than three times larger in case (iii) than in (i) but not so in case (ii). This observation about curvature applies to about half the deposit products but only one quarter of the loans. It also means that a single large change could prompt much swifter deposit rate responses than several gradual changes. This gap size effect is most clearly attested in Model VI through tests for curvature. But other results point also in this direction: the evidence on 'continuous' variation conditional on the policy rate changes (Models II, III) and the magnitude asymmetry findings from Model V.

Bernanke et al. (2001) are proponents of the *financial accelerator* theory according to which, when monetary policy is restrictive, the economy cools off.[20] This negative pressure is further accelerated by the banks' reaction. Corporate default rates are expected (or actually begin) to rise. Banks raise margins on business loan rates to accommodate these defaults. Thus, the 'external finance' premium (or additional cost of raising external finance) rises which squeezes investment still further. Assuming policy rates are the main influence on loan rates, the financial accelerator mechanism will increase the loan rate reaction to any changes in the official rate. This is in sharp contrast to the Stiglitz and Weiss (1981) model, which is consistent with upward stickiness or ceilings in loan rates. In this study, the evidence on personal loan rates firmly supports the Stiglitz and Weiss model. Although the sample excludes

[20] See also Bernanke and Gertler (1995, 2001) .

corporate loan rates, the findings of this study should extend at least to small businesses start-ups for which bank loans are quite an important source of funds.

However, the applicability of the financial accelerator and Stiglitz-Weiss theories rests on whether ECMs are a good representation of the dynamics of retail rates. It turns out that the adjusted R^2 of the linear ECM is quite reasonable for all deposit and mortgage products.[21] Interestingly, for all the 600 retail rates in the sample any of the nonlinear ECMs is superior (in terms of both the AIC and the adjusted R^2 statistic) to the linear ECM. But personal loans, store and credit cards display a different pattern. For store cards, continuously time-varying adjustment speeds, regime-switching asymmetry and curvature in the error correction are rarely, if ever, observed. In fact, none of the ECMs employed can explain the dynamics of store card rates well: the average adjusted R^2 varies between 5% and 9% for the nonlinear ECMs and it is even lower, at 2.6%, for the baseline linear ECM. There is reasonable evidence of time-varying adjustment, regime-switching and curvature in credit card and personal loan rates. But the adjusted R^2 is low on average for all the nonlinear ECMs, ranging from 6.5% to 9.9% with personal loans and from 8.4% to 13.8% with credit cards. Figure 2 illustrates this point by plotting the personal loan and credit card rates for one of the major banks (coded BK17) — they do not appear to follow the official rate closely, a pattern which is repeated for most of the minor FIs.

According to the Bank of England's official statistics (September, 2006) the level of UK unsecured consumer debt at the end of the second quarter (2006) was £211,678 million, of which some 42% was credit card debt. The other 58% includes unsecured personal loans.[22] The findings suggest that for many FIs, credit card and personal loan rates appear to be largely immune to changes in the Bank of England official rate. Hence, any intended impact on consumer behaviour may be considerably dampened if credit card and personal loan rates are apt to wander up and down, largely impervious to changes in the official rates, as the present analysis suggests.

7. Conclusions

This paper investigates the presence of nonlinearity in the dynamics of British retail rates over the period 1993:1-2005:6. The focus is on their responsiveness to official rate changes. The dataset consists of disaggregated, bank-specific monthly rates for

[21] See Appendix A for details.
[22] Office for National Statistics (2006), *Financial Statistics*, September.

several types of savings and current accounts, unsecured personal loans, mortgages, credit cards and store cards. Virtually all the FIs that offered a product were included, ranging from the 'big five' banks to the smallest building society. Several generalizations of the conventional, linear error correction model are formulated with a view to testing different departures from the linear equilibrium correction: continuous time-variation in the adjustment speed driven by the policy rate changes, regime-switching asymmetries in adjustment and curvature in the error correction.

Overall, for a majority of deposits and half of credit products the adjustment speed varies over time in a continuous manner, conditional on the policy rate fluctuations. For a sizeable minority of deposits, the adjustment is faster when the official rate is cut (monetary expansion) than when it is raised. In contrast, for nearly half of UK mortgage rates, adjustment is more rapid when the official rate is increased. There is magnitude asymmetry in the form of regime-switching for many deposits and mortgages — large changes in the policy rate are associated with faster adjustment than small changes, but this effect is generally less marked than the sign asymmetry. There is strong evidence that, for a given policy rate change (rise or fall), the responsiveness of banks depends on the sign of the gap at the time of the monetary policy action. Since the gap varies over time and across FIs, this finding can explain not only temporal variation in the adjustment speed of individual banks but also inter-bank heterogeneities. For many deposits and some loans, there is a gap size effect or curvature in the error correction.

Mortgage and deposit rates are reasonably well described by nonlinear ECMs. However, neither the linear nor nonlinear ECMs explain much of the dynamics of store, credit card or personal loans. Since credit cards make up a large part of consumer debt, the apparent insensitivity of these rates to official rate changes raises questions about the effectiveness of monetary policy through the lending channel.

By using disaggregated data, the present analysis reveals non-trivial differences in the behaviour of retail rates across FIs and products. These findings raise questions about the models and retail rate histories constructed by the central bank to simulate the effects of policy rate changes on the interest rate transmission mechanism and the exercise of monetary policy itself.

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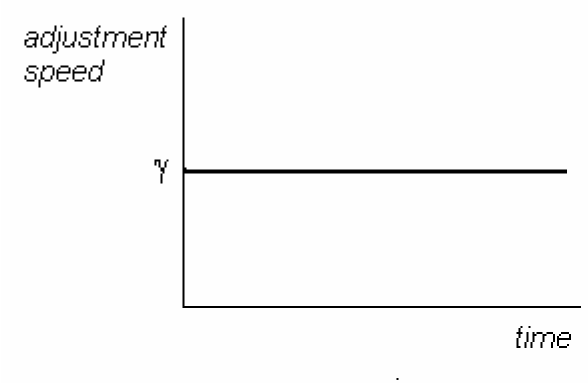
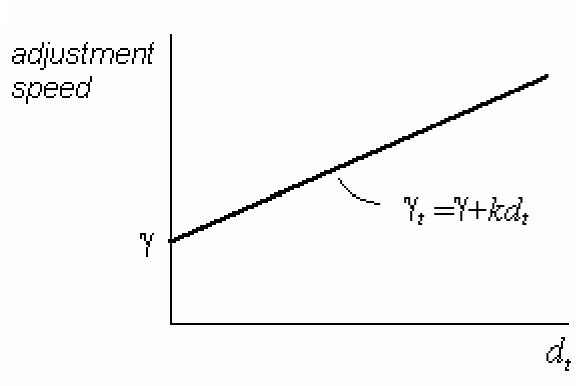
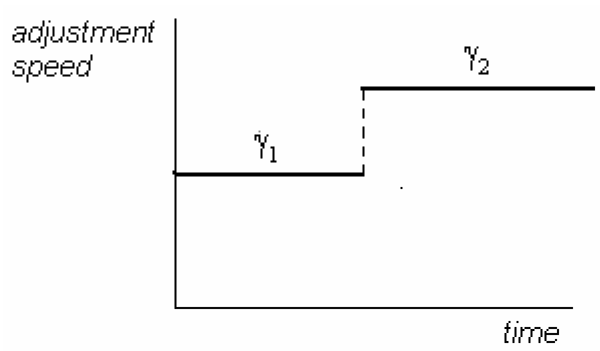


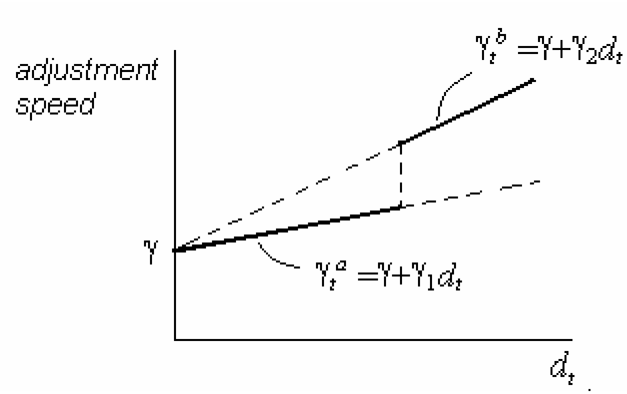
a) Constant adjustment (Linear ECM)



b) Time-varying (conditional) adjustment



c) Regime-switching adjustment



d) Time-Varying and regime-switching adjustment

Figure 1. Alternative settings for the adjustment of retail rates to policy rates

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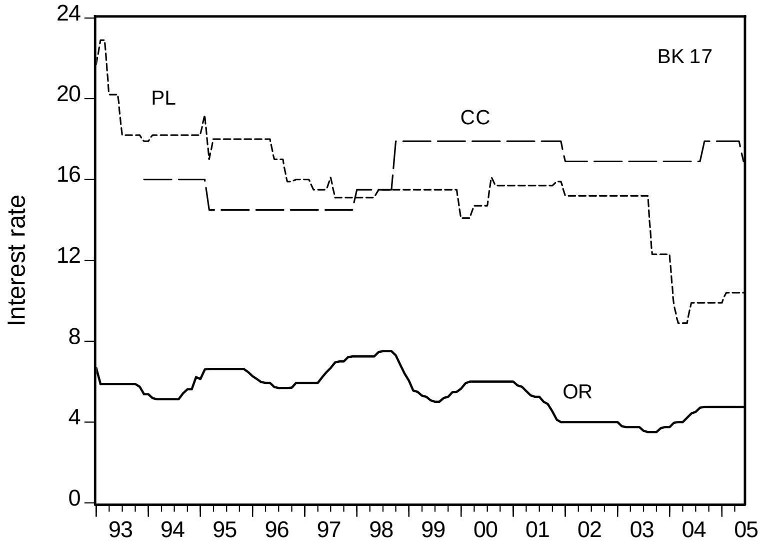

CC and PL are the annual percentage rates (APR) charged on respectively, personal unsecured loans and outstanding credit card balances. OR is the official rate set by the Bank of England.

Figure 2. Credit Card and Personal Loan Rate Behaviour, 1993-2005

Table 1. Summary Results from Model I

		Symmetric Adjustment $H_0: \gamma_1 - \gamma_2 = 0$ (*Linear ECM)*)		
			Faster Response	
Product	**Sampled FIs**	**H_0 Rejected**	**Increase**	**Decrease**
B-Sav-Instant				
LT (£2.5K)	32	3%	0%	100%
MT (£10K)	33	0%	—	—
HT (£250K)	27	0%	—	—
B-Sav-30 day				
LT (£2.5K)	9	0%	—	—
MT (£10K)	12	0%	—	—
HT (£250K)	11	9%	100%	0%
B-Sav-90 day				
LT (£2.5K)	5	20%	100%	0%
MT (£10K)	4	0%	—	—
HT (£250K)	5	0%	—	—
H-Sav-Inst				
LT (£500)	23	17%	100%	0%
MT (£5K)	27	11%	67%	33%
HT (£10K)	30	17%	100%	0%
H-Sav-30 day				
LT (£500)	7	0%	—	—
MT (£5K)	16	13%	50%	50%
HT (£10K)	14	7%	0%	100%
H-Sav-60 day				
LT (£500)	4	25%	100%	0%
MT (£5K)	16	0%	—	—
HT (£10K)	15	0%	—	—
H-Sav-90 day				
LT (£500)	10	20%	100%	0%
MT (£5K)	21	10%	100%	0%
HT (£10K)	22	18%	75%	25%
Current Accounts				
LT (£500)	12	8%	0%	100%
MT (£5K)	21	10%	50%	50%
HT (£10K)	21	14%	100%	0%
DEPOSIT TOTAL	*397*	*8%*	***79%***	*21%*
Mortgages	53	21%	91%	9%
Personal Loans	14	0%	—	—
Credit Cards	21	5%	100%	0%
Store cards	12	8%	0%	100%
CREDIT TOTAL	*100*	*13%*	***85%***	*15%*

Column 2 reports the number of FIs in the sample. Column 3 reports the percentage of FIs for which the stage I null hypothesis of a constant adjustment speed (γ) is rejected. For example, for total deposits, it is rejected in 8% (33/397) of cases. The breakdown by type of asymmetry is reported in columns 4 (faster adjustment for policy rate increases, or $\gamma_1<\gamma_2$) and 5 (faster adjustment for decreases or $\gamma_1>\gamma_2$), expressed as a percentage of the total number of asymmetric cases. For example, the final row indicates that, of the 13 credit products that reject the stage II null (symmetry), 11 loan rates (85%) rise faster if the policy rate rises than they decline when it is cut. Inferences are based on the 90% confidence level in this and subsequent tables. Bold indicates the dominant type of asymmetry.

Table 2. Summary Results from Model II

Product	Sampled FIs	Stage I: Constant Adjustment $H_0: \gamma_1 = 0, \gamma_2 = 0$ (*Linear ECM*) H₀ Rejected	Individual significance $\gamma_1 < 0$	$\gamma_2 > 0$	Stage II: Symmetric Adjustment $H_0: \gamma_1 + \gamma_2 = 0$ (*No Regime-Switching*) H_0 Rejected	Faster Response Increase	Decrease
B-Sav-Instant							
LT (£2.5K)	31	35%	55%	82%	27%	0%	100%
MT (£10K)	37	43%	38%	81%	25%	25%	75%
HT (£250K)	29	66%	21%	84%	42%	25%	75%
B-Sav-30 day							
LT (£2.5K)	8	75%	17%	67%	67%	0%	100%
MT (£10K)	10	60%	17%	83%	50%	0%	100%
HT (£250K)	11	55%	17%	83%	67%	25%	75%
B-Sav-90 day							
LT (£2.5K)	5	60%	33%	33%	67%	50%	50%
MT (£10K)	4	25%	0%	100%	100%	0%	100%
HT (£250K)	5	40%	0%	100%	100%	0%	100%
H-Sav-Inst							
LT (£500)	28	61%	24%	76%	53%	22%	78%
MT (£5K)	33	52%	18%	82%	53%	11%	89%
HT (£10K)	34	56%	26%	68%	68%	23%	77%
H-Sav-30 day							
LT (£500)	6	33%	50%	100%	0%	0%	0%
MT (£5K)	15	53%	13%	75%	50%	25%	75%
HT (£10K)	16	63%	30%	100%	50%	0%	100%
H-Sav-60 day							
LT (£500)	5	80%	75%	75%	50%	100%	0%
MT (£5K)	14	57%	38%	88%	38%	33%	67%
HT (£10K)	15	47%	14%	100%	29%	0%	100%
H-Sav-90 day							
LT (£500)	10	50%	40%	40%	0%	0%	0%
MT (£5K)	20	55%	45%	82%	18%	50%	50%
HT (£10K)	23	52%	50%	83%	25%	0%	100%
Current Accounts							
LT (£500)	13	46%	50%	83%	50%	0%	100%
MT (£5K)	22	18%	25%	50%	50%	0%	100%
HT (£10K)	21	48%	50%	80%	50%	20%	80%
DEPOSIT TOTAL	*415*	*51%*	*31%*	*80%*	*44%*	*18%*	***82%***
Mortgages	51	65%	73%	30%	67%	91%	9%
Personal Loans	13	23%	0%	100%	33%	0%	100%
Credit Cards	22	41%	33%	22%	44%	75%	25%
Store cards	13	0%	—	—	—	—	—
CREDIT TOTAL	*99*	*45%*	*60%*	*33%*	*60%*	***85%***	*15%*

The information reported in each column is as follows. Column 2: number of FIs in the sample. Column 3: cases where the stage I null of a constant adjustment speed (γ) is rejected. Columns 4 and 5: cases of time-varying adjustment speed for which γ_1 and γ_2 are statistically significant, respectively. Column 6: cases that reject the stage II null conditional on rejecting the stage I null. Columns 7 and 8: a breakdown by type of asymmetry. For example, 51% for Deposit Total means that for 209 of the 413 deposit rates sampled, the speed of adjustment is time-varying. Of these 209 deposit rates, switching behaviour is present in 93, or 44% of them. Column 7, labelled 'Increase', gives the percentage of regime-switching rates for which adjustment is faster following positive policy rate changes; vice versa for column 8, labelled 'Decrease'. For example, 82% for total deposits means that in 76 of the 93 cases with regime-switching behaviour, a decrease in the official rate induces faster adjustment than an increase.

Table 3.Summary Results from Model III

		Test I: Constant Adjustment $H_0: \kappa_1=\kappa_2=\kappa_3=\kappa_4=0$ (*Linear ECM*)	Test II: Symmetric Adjustment $H_0: \kappa_1=\kappa_2=\kappa_3=\kappa_4=k$ (*No Regime-Switching*)				
				Policy Rate Increase Faster Response		Policy Rate Decrease Faster Response	
Product	**Sampled FIs**	**H_0 Rejected**	**H_0 Rejected**	**Overpay**	**Underpay**	**Overpay**	**Underpay**
B-Sav-Instant							
LT (£2.5K)	31	68%	100%	33%	67%	81%	19%
MT (£10K)	29	86%	100%	33%	67%	86%	14%
HT (£250K)	21	95%	100%	27%	73%	67%	33%
B-Sav-30 day							
LT (£2.5K)	8	88%	100%	50%	50%	100%	0%
MT (£10K)	10	100%	100%	0%	100%	67%	33%
HT (£250K)	7	86%	100%	0%	100%	75%	25%
B-Sav-90 day							
LT (£2.5K)	4	75%	100%	0%	100%	100%	0%
MT (£10K)	4	75%	100%	0%	100%	100%	0%
HT (£250K)	5	100%	100%	0%	100%	67%	33%
H-Sav-Inst							
LT (£500)	26	88%	100%	18%	82%	81%	19%
MT (£5K)	26	92%	100%	12%	88%	53%	47%
HT (£10K)	27	93%	100%	14%	86%	63%	38%
H-Sav-30 day							
LT (£500)	6	67%	100%	50%	50%	50%	50%
MT (£5K)	12	67%	100%	40%	60%	100%	0%
HT (£10K)	11	82%	100%	14%	86%	100%	0%
H-Sav-60 day							
LT (£500)	3	100%	100%	0%	100%	50%	50%
MT (£5K)	9	67%	100%	0%	100%	40%	60%
HT (£10K)	12	83%	100%	17%	83%	86%	14%
H-Sav-90 day							
LT (£500)	9	78%	100%	20%	80%	75%	25%
MT (£5K)	18	78%	100%	20%	80%	100%	0%
HT (£10K)	22	77%	100%	9%	91%	60%	40%
Current Accounts							
LT (£500)	14	64%	100%	0%	100%	100%	0%
MT (£5K)	19	53%	100%	50%	50%	43%	57%
HT (£10K)	18	72%	100%	22%	78%	78%	22%
DEPOSIT TOTAL	*351*	*80%*	*100%*	*20%*	***80%***	***75%***	*25%*
Mortgages	41	80%	100%	78%	22%	8%	92%
Personal Loans	12	33%	100%	0%	0%	50%	50%
Credit Cards	24	50%	100%	17%	83%	71%	29%
Store cards	13	0%	0%	0%	0%	0%	0%
CREDIT TOTAL	*90*	*54%*	*100%*	***66%***	*34%*	*25%*	***75%***

Column 2 reports the number of FIs in the sample. Column 3: cases where the stage I null is rejected . Column 4: cases that reject the stage II null conditional on rejecting the stage I null. Columns 5-8: breakdown by asymmetry, that is, whether retail rate adjustment is faster when FIs are either overpaying ($x_t>x_t$*) or underpaying ($x_t<x_t$*) for a policy rate change increase or decrease. For example, for B-Sav Instant (LT), 68% of FIs reveal both a time-varying adjustment speed (col. 3) and asymmetry (col. 4); for policy rate increases, 67% of FIs raise their rates faster if they are underpaying (col. 6); for policy rate cuts, 81% of banks cut their rates faster if they are overpaying (col. 7).

Table 4.Summary Results from Model IV

		Symmetric Adjustment H_0: $\mu_1 - \mu_2 = 0$ (*Linear ECM*)		
			Faster Response	
Product	**Sampled FIs**	**H_0 Rejected**	**Large**	**Small**
B-Sav-Instant				
LT (£2.5K)	33	21%	86%	14%
MT (£10K)	35	31%	82%	18%
HT (£250K)	29	28%	75%	25%
B-Sav-30 day				
LT (£2.5K)	7	43%	100%	0%
MT (£10K)	10	20%	100%	0%
HT (£250K)	11	18%	100%	0%
B-Sav-90 day				
LT (£2.5K)	4	25%	100%	0%
MT (£10K)	4	25%	100%	0%
HT (£250K)	5	60%	100%	0%
H-Sav-Inst				
LT (£500)	31	26%	88%	13%
MT (£5K)	33	24%	100%	0%
HT (£10K)	35	40%	100%	0%
H-Sav-30 day				
LT (£500)	7	14%	100%	0%
MT (£5K)	14	29%	100%	0%
HT (£10K)	16	38%	100%	0%
H-Sav-60 day				
LT (£500)	5	80%	100%	0%
MT (£5K)	16	44%	86%	14%
HT (£10K)	16	50%	100%	0%
H-Sav-90 day				
LT (£500)	10	40%	100%	0%
MT (£5K)	21	48%	100%	0%
HT (£10K)	23	35%	100%	0%
Current Accounts				
LT (£500)	15	33%	100%	0%
MT (£5K)	23	35%	100%	0%
HT (£10K)	20	45%	100%	0%
DEPOSIT TOTAL	*423*	*34%*	***95%***	*5%*
Mortgages	53	17%	100%	0%
Personal Loans	14	7%	100%	0%
Credit Cards	17	12%	100%	0%
Store cards	11	0%	—	—
CREDIT TOTAL	*95*	*13%*	***100%***	*0%*

This table is interpreted the same way as Table 1, but the focus is on the magnitude of the policy rate change. Column 3 reports the percentage of retail rates for which the constant-adjustment null hypothesis is rejected. Columns 4 and 5 show the breakdown by type of asymmetry. Column 4 reports the cases (as a percentage of total asymmetric cases) with faster adjustment for large policy rate changes, ($\mu_1<\mu_2$), and column 5 gives the percentage of asymmetric cases for which adjustment is faster when the policy rate change is small ($\mu_1>\mu_2$).

Table 5.Summary Results from Model V

Product	Sampled FIs	Stage I: Constant Adjustment H_0: μ_1=0, μ_2=0 (*Linear ECM*)			Stage II: Symmetric Adjustment H_0: $\mu_1 - \mu_2 = 0$ (*No Regime-Switching*)		
			Individual significance			Faster Response	
		H_0 Rejected	$\mu_1 < 0$	$\mu_2 < 0$	H_0 Rejected	Large	Small
B-Sav-Instant							
LT (£2.5K)	29	41%	75%	58%	50%	100%	0%
MT (£10K)	36	56%	70%	55%	45%	89%	11%
HT (£250K)	26	58%	80%	60%	47%	86%	14%
B-Sav-30 day							
LT (£2.5K)	7	100%	57%	71%	71%	80%	20%
MT (£10K)	7	57%	75%	75%	75%	100%	0%
HT (£250K)	11	55%	67%	100%	83%	100%	0%
B-Sav-90 day							
LT (£2.5K)	5	20%	100%	100%	100%	100%	0%
MT (£10K)	4	50%	50%	100%	100%	100%	0%
HT (£250K)	5	80%	75%	75%	75%	100%	0%
H-Sav-Inst							
LT (£500)	26	54%	93%	43%	43%	83%	17%
MT (£5K)	32	50%	100%	25%	25%	100%	0%
HT (£10K)	34	44%	100%	13%	20%	100%	0%
H-Sav-30 day							
LT (£500)	7	43%	67%	33%	67%	50%	50%
MT (£5K)	14	50%	86%	29%	43%	100%	0%
HT (£10K)	16	50%	88%	25%	38%	100%	0%
H-Sav-60 day							
LT (£500)	5	80%	75%	0%	25%	0%	0%
MT (£5K)	16	56%	78%	22%	22%	100%	0%
HT (£10K)	15	53%	88%	25%	50%	100%	0%
H-Sav-90 day							
LT (£500)	10	70%	57%	29%	71%	100%	0%
MT (£5K)	21	62%	100%	15%	31%	100%	0%
HT (£10K)	23	48%	100%	18%	18%	100%	0%
Current Accounts							
LT (£500)	11	36%	100%	0%	25%	100%	0%
MT (£5K)	25	40%	60%	10%	40%	100%	0%
HT (£10K)	22	41%	78%	11%	33%	100%	0%
DEPOSIT TOTAL	*407*	*51%*	*82%*	*36%*	*42%*	***94%***	*6%*
Mortgages	53	38%	90%	0%	55%	100%	0%
Personal Loans	14	50%	71%	29%	57%	100%	0%
Credit Cards	25	20%	40%	40%	60%	67%	33%
Store cards	12	8%	0%	0%	100%	100%	0%
CREDIT TOTAL	*104*	*32%*	*76%*	*12%*	*58%*	***95%***	*5%*

The information reported in each column is as follows. Column 2: number of FIs in the sample. Column 3: sample cases where the stage I null hypothesis of a constant adjustment speed (γ) is rejected. Columns 4 and 5: cases of varying adjustment speed for which μ_1 and μ_2 are statistically significant, respectively. Column 6: cases that reject the stage II null conditional on rejecting the stage I null. Columns 7 and 8: a breakdown by type of asymmetry. For example, in the row showing the Deposit Total, 51% means that for 209 of the 407 deposit rates, the speed of adjustment is time-varying. Of these 209 deposit rates, switching behaviour is present in 88, or 42% of them. Column 7, labelled 'Large', gives the percentage of regime-switching FIs for which adjustment is faster following above average policy rate changes; vice versa for column 8, labelled 'Small'. For example, 94% for total deposits means that in 83 of the 88 deposit rates with switching behaviour, a large policy rate change induces faster adjustment. Bold indicates the dominant type of asymmetry.

Table 6.Summary Results from Model VI

		Stage I: Linear Error Correction $H_0: \delta_1=0,\delta_2=0$ (*Correction Proportional to Error*)					Stage II: Symmetric Adjustment $H_0: \rho_1\text{-}\rho_2=0, \delta_1\text{-}\delta_2=0$ (*No Regime-Switching*)				
			Individual Significance					Individual Significance		Faster Response	
Product	Sampled FIs	H_0 Rejected	$\delta_1<0$ ($\rho_1<0$)	$\delta_1<0$ ($\rho_1=0$)	$\delta_2<0$ ($\rho_2<0$)	$\delta_2<0$ ($\rho_2=0$)	H_0 Rejected	$\rho_1\text{-}\rho_2\neq0$	$\delta_1\text{-}\delta_2\neq0$	Overpay	Underpay
B-Sav-Instant											
LT (£2.5K)	**33**	61%	10%	*75%*	10%	*55%*	27%	22%	89%	44%	56%
MT (£10K)	**37**	59%	14%	*64%*	9%	*41%*	32%	42%	67%	83%	17%
HT (£250K)	**30**	53%	25%	*56%*	6%	*69%*	30%	44%	89%	78%	22%
B-Sav-30 day											
LT (£2.5K)	**7**	71%	40%	*40%*	20%	*60%*	14%	100%	100%	100%	0%
MT (£10K)	**10**	70%	29%	*57%*	43%	*57%*	30%	33%	67%	67%	33%
HT (£250K)	**10**	40%	25%	*75%*	25%	*50%*	30%	67%	33%	67%	33%
B-Sav-90 day											
LT (£2.5K)	**4**	100%	0%	*75%*	0%	*100%*	25%	0%	100%	100%	0%
MT (£10K)	**4**	50%	50%	*50%*	50%	*50%*	0%	0%	0%	0%	0%
HT (£250K)	**5**	80%	50%	*50%*	0%	*50%*	20%	0%	100%	100%	0%
H-Sav-Inst											
LT (£500)	**29**	55%	0%	*75%*	0%	*75%*	28%	13%	88%	0%	100%
MT (£5K)	**31**	52%	0%	*81%*	0%	*94%*	48%	27%	73%	7%	93%
HT (£10K)	**29**	41%	0%	*75%*	0%	*92%*	45%	38%	69%	0%	100%
H-Sav-30 day											
LT (£500)	**7**	29%	0%	*50%*	0%	*50%*	29%	0%	100%	0%	100%
MT (£5K)	**15**	27%	0%	*25%*	0%	*75%*	20%	33%	100%	67%	33%
HT (£10K)	**17**	41%	0%	*71%*	0%	*71%*	12%	50%	100%	50%	50%
H-Sav-60 day											
LT (£500)	**5**	40%	50%	*50%*	0%	*50%*	60%	33%	67%	0%	100%
MT (£5K)	**15**	40%	0%	*83%*	0%	*100%*	20%	33%	100%	100%	0%
HT (£10K)	**16**	56%	0%	*67%*	0%	*89%*	38%	33%	83%	83%	17%
H-Sav-90 day											
LT (£500)	**9**	44%	25%	*50%*	0%	*100%*	44%	50%	75%	75%	25%
MT (£5K)	**20**	30%	0%	*33%*	0%	*83%*	35%	57%	57%	43%	57%
HT (£10K)	**21**	67%	0%	*64%*	0%	*79%*	57%	17%	83%	8%	92%
Current Accounts											
LT (£500)	**16**	13%	0%	*100%*	0%	*50%*	6%	100%	0%	100%	0%
MT (£5K)	**20**	20%	0%	*25%*	0%	*50%*	25%	40%	60%	40%	60%
HT (£10K)	**17**	35%	0%	*83%*	0%	*50%*	24%	50%	100%	50%	50%
DEPOSIT TOTAL	*407*	48%	10%	*65%*	6%	*70%*	31%	35%	77%	41%	**59%**
Mortgages	**50**	18%	0%	*44%*	0%	*67%*	16%	50%	50%	0%	100%
Personal Loans	**13**	15%	0%	*50%*	0%	*50%*	8%	0%	100%	0%	100%
Credit Cards	**21**	19%	0%	*100%*	0%	*0%*	5%	100%	0%	100%	0%
Store cards	**13**	8%	0%	*100%*	0%	*100%*	0%	0%	0%	0%	0%
CREDIT TOTAL	*97*	16%	0%	*63%*	0%	*50%*	10%	50%	50%	10%	**90%**

The information reported in each column is as follows. Column 2: number of FIs in the sample. Column 3: cases where the stage I null is rejected. Columns 4-7: the significance of the coefficients on u^3 and u for cases where $u>0$ (col. 4-5), and $u\leq 0$ (col. 6-7), as a percentage of the total number of cases that reject the stage I null. Column 8: cases where the stage II null is rejected. Columns 9 and 10: cases with regime-switching in the linear (u) and nonlinear (u^3) terms, respectively. Columns 11-12: the direction of asymmetry. For example, for B-Sav Instant (LT) there is curvature in the error correction in 61% of FIs (col. 3); for overpaid rates, once u^3 is included, u becomes insignificant in a majority, 75%, of cases (col. 5); ditto for underpaid rates, 55% of cases (col. 7); there is regime switching for 27% of banks but there is less evidence of it for u (22%; col. 9) than u^3 (89%; col. 10); 44% of banks adjust their deposit rates faster if they are overpaying ($u>0$) and 56% respond more quickly when underpaying ($u<0$).

Appendix A. Model Adequacy of the Linear and Nonlinear ECMs

Product Type	Linear	Model I	Model II	Model III	Model IV	Model V	Model VI
B-Sav Instant							
LT (£2.5K)	53.1	55.2	57.1	57.1	54.5	**59.2**	58.0
MT (£10K)	52.3	55.6	57.5	58.7	55.5	**59.6**	58.7
HT (£250K)	52.9	56.6	58.1	58.3	57.9	**59.8**	58.6
B-Sav 30 day							
LT (£2.5K)	39.4	40.8	51.0	44.8	44.6	**54.2**	50.3
MT (£10K)	44.1	48.1	51.5	47.4	47.9	**53.5**	52.6
HT (£250K)	46.3	51.7	55.4	53.4	52.2	55.2	**57.2**
B-Sav 90 day							
LT (£2.5K)	45.1	46.0	52.9	50.0	55.0	50.4	**64.1**
MT (£10K)	58.0	50.8	56.9	56.3	52.7	57.8	**59.6**
HT (£250K)	57.9	58.7	63.1	67.9	60.6	65.7	**68.0**
H-Sav Instant							
LT (£500)	26.0	32.6	33.8	**37.0**	29.8	30.4	31.1
MT (£5K)	27.3	33.1	34.7	**35.7**	31.7	34.2	30.0
HT (£10K)	27.6	32.8	36.3	**38.6**	32.2	34.3	29.5
H-Sav 30 day							
LT (£500)	49.4	50.1	50.7	**54.8**	50.4	53.8	51.2
MT (£5K)	40.9	40.8	46.5	**49.5**	46.4	49.2	42.9
HT (£10K)	40.8	40.7	49.7	**53.9**	46.2	51.1	44.5
H-Sav 60 day							
LT (£500)	46.2	49.8	56.7	**57.7**	52.7	57.0	53.0
MT (£5K)	44.2	44.9	50.2	**52.1**	47.6	51.0	48.7
HT (£10K)	41.5	42.9	48.5	**53.2**	46.6	48.6	46.0
H-Sav 90 day							
LT (£500)	31.1	33.6	35.9	35.5	35.4	35.8	**36.4**
MT (£5K)	33.1	35.6	39.1	**41.4**	38.1	39.9	36.3
HT (£10K)	33.9	38.3	**42.5**	42.1	40.1	41.6	37.3
Current Accounts							
LT (£500)	21.7	27.3	30.9	**33.9**	27.4	30.6	26.2
MT (£5K)	23.8	27.0	25.4	**30.3**	29.4	27.9	25.9
HT (£10K)	28.9	31.0	30.4	34.4	32.4	33.1	**35.0**
Credit Products							
Mortgages	48.7	50.7	53.2	**55.4**	50.6	51.6	49.9
Personal Loans	4.8	6.5	7.9	7.8	6.9	**9.9**	7.9
Credit Cards	4.9	8.4	10.8	10.2	11.6	**13.8**	9.2
Store Cards	2.6	7.9	5.4	5.0	**9.0**	5.1	5.6

The table reports for each product, the average adjusted R^2 for the FIs in the sample. Bold denotes the best model.