How do UK Banks React to Changing Central Bank Rates?

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Abstract This paper explores the interest rate transmission mechanism using a broad disaggregated sample of UK deposit and credit products. For a large proportion of rates the adjustment speed is time-varying, switching among four regimes according to the direction of the policy rate and its effect on the disequilibrium gap. In general, this sign asymmetry implies faster adjustment to the long run path when the policy rate revision widens the gap. There is evidence of curvature in the catch-up effect towards equilibrium, namely, large gaps entail a disproportionately faster correction although mainly for deposits. The size of the policy rate change also impacts the adjustment speed. The notable heterogeneity found across financial institutions/products regarding the presence of these nonlinear patterns raises important questions on how to assess the effectiveness of monetary policy. The cross-section heterogeneity uncovered can be explained to some extent by diversification, profit volatility, product range, market concentration and menu costs.

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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 main instrument for regulating the economy has been the central bank official (or policy) rate. In order to influence future spending and the inflation rate, official rate changes must prompt similar changes in retail rates. Central banks rely on the notion that the latter tend to gravitate towards a so-called '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 will always seek to equate the policy rate to the expected marginal revenue of each asset and the expected marginal cost of each liability. Under perfect competition with no uncertainty or adjustment costs, retail rate responses would be immediate, symmetric and one-for-one. However, in practice, lagged reactions and asymmetries are likely to be present due to menu costs, imperfect information and switching costs. Uncertainty over rivals' responses will induce asymmetries. Nonlinearities could also appear if the deposit supply or loan demand functions that the financial institutions (FIs) perceive are not isoelastic.

Nevertheless, 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 asymmetry pattern. But are they? Equally important, do all retail rates exhibit the same dynamic behavior, either linear or nonlinear, following a policy rate change? In the presence of marked heterogeneity among FIs and products, the transmission mechanism may be much more difficult to anticipate than hitherto believed. Identifying any patterns in the retail rate setting process of FIs could enhance the current understanding of the interest rate channel of the transmission mechanism.

The focus of the present study is the dynamics of retail interest rates in relation to the policy rate. Detecting nonlinear behavior in the way FIs react to policy rate revisions is important for several reasons. First, it can provide insights about the practical operation of economic mechanisms. Second, if researchers focus on the class of models that are closer to the true data generating process, significant policy implications may follow. Third, asymmetries in the propagation of policy shocks can pose special difficulties for forecasting economic variables using linear models.

More specifically, this paper sheds light on an important aspect of the UK interest rate transmission mechanism: the speed of adjustment of retail rates. Different types of nonlinear responses which may arise from switching costs, menu costs and uncertainty *inter alia* are formulated and tested against linearity. Nonlinearity is broadly defined as any departure from the conventional linear error correction model (ECM) typically used to characterize the dynamics of retail rates. Hence, nonlinear behavior can be modeled through a plethora of functional forms. This paper focuses on three aspects called conditional continuous time-variation, regime-switching and curvature. Conditional 'continuous' variation refers in this context to an adjustment speed which is proportional to the size of the policy rate change instead of being constant over time. Regime-switching is conceptualized as asymmetric adjustment to policy rate changes that widen or narrow the current disequilibrium gap (asymmetry driven by the sign of both the policy rate change and the gap), whilst controlling for the size effect. Curvature refers to nonlinearity in the 'catch up' mechanism towards the long run path and implies a size-of-gap effect.

The empirical analysis differentiates itself from previous studies in that it is based on an extensive dataset of 113 FIs representing a substantially large part of the UK banking market. In particular, not only does it cover virtually all FIs but also includes, alongside business/household saving and current accounts, credit products such as store and credit cards which, to the best of our knowledge, have not been considered in this context. It is well known that heterogeneities will induce estimation biases in models based on aggregated data. Only two published papers in the literature use disaggregated British retail rates but they are confined to a very small number of banks and products (Heffernan, 1997; Hoffman and Mizen, 2004). We use a disaggregated dataset in order to address the question of whether FIs and products exhibit similar (linear or nonlinear) patterns in their adjustment process. For each retail rate, the most appropriate model is selected using several criteria with a view to uncovering groups that systematically exhibit certain types of nonlinearities, or lack thereof. Finally, this is the first study that seeks to explain nonlinearities in retail rate adjustment on the basis of bank performance indicators, menu costs, market structure and product/ownership characteristics.

A key finding is the presence of substantial cross-section heterogeneity in the type of retail rate adjustment. Sign asymmetry is the dominant nonlinearity for household savings, current accounts and mortgages — the adjustment speed is proportional to the policy rate change but takes different values depending on whether the revision in the policy rate implies a widening or narrowing gap. There is less pervasive evidence across FIs of the adjustment being driven solely by the size of policy rate changes except for business savings. In addition, curvature in the error correction process is the dominant type of nonlinearity for business savings. Interestingly, neither the linear ECM nor any of the nonlinear variants considered can satisfactorily explain the behavior of personal loan, credit and store card rates. These insights could influence how the Bank of England (BoE) assesses the impact of the interest rate transmission mechanism and the conduct of monetary policy itself. Our results suggest that the size effect and curvature can be attributed to bank fundamentals such as diversification, profit variability, capital adequacy and menu costs, whereas sign asymmetry is mostly linked to market structure.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature. Sections 3 and 4 describe the dataset and methodology, respectively. Section 5 discusses the empirical results and Section 6 concludes.

2. Background literature

Several theoretical contributions have motivated empirical analyses of nonlinearity in the interest rate transmission mechanism.[1] To preserve space, this review is confined to studies that employ nonlinear ECMs.[2]

Baum and Karasulu (1998) use a threshold cointegration approach for characterizing the dynamic relation between US money market rates in a way that accounts for discrete and asymmetric behavior. They estimate Band-TAR models to capture the relationship between the US discount rate and the Federal funds rate using 1979:10-1996:01 weekly data. The adjustment of the former towards the latter displays regime-switching dictated by the lagged disequilibrium level.

Frost and Bowden (1999) utilize nonlinear ECMs to capture asymmetries in the adjustment of New Zealand mortgage rates. Taking the 90-day bank bill rate as an indicator of monetary policy, they find that the adjustment speed of an aggregate (weighted average of four major banks) mortgage rate over 1985:9-1996:5 displays state-dependence and regime-switching. The former means that the adjustment speed varies over time because it is proportional to the gap and the change in the bill rate. Regime-switching means that there are different types of adjustment, and the

[1] See Sheshinski and Weiss (1977), Rotemberg (1982), Calvo (1983) and Klemperer (1987), inter alios.

[2] A few studies such as Hannan and Berger (1991), Neumark and Sharpe (1992), and Mester and Saunders (1995) have used other approaches (e.g. logit models) to investigate retail rate behaviour.

transition from one to another is dictated by the interaction of the signs of the gap and the bill rate change — mortgage rate adjustment is slower when the gap is negative (undercharging) and the bill rate rises. This asymmetry is more pronounced in periods of highly volatile rates.

Hofmann and Mizen's (2004) analysis of the UK banking market is limited to data on two products, 90-day deposits and mortgages, over the 1985:1-2001:12 period. Their analysis is confined to 7 banks and an aggregate base rate, the average of the base rates quoted by the four major clearing banks, is taken as proxy for the policy rate. Using a similar methodology to that in Frost and Bowden (1999), they emphasize 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 tenet) and by yield spreads. However, neither the sign of the gap nor the direction of the official rate revision matter significantly when the two effects are tested separately.

Sander and Kleimeier's (2004a) analysis for 10 euro zone countries 1993:1-2002:10 is based on country-specific averages across FIs for 6 loan (mortgages, consumer and corporate loans of different maturities) and 4 deposit products alongside money market rates. They document that for about 23% of deposits and 40% of loans, the adjustment speed depends on whether the change (as opposed to the level) in the gap exceeds some threshold value. A similar approach is adopted in Sander and Kleimeier (2004b) for each of eight transition economies using average rates 1993:1-2003:12 on 4 loan and 3 deposit products. There is little evidence of asymmetry but the retail rate adjustment appears faster in transition markets than in the euro zone.

Kleimeier and Sander (2006) assess whether retail rates react differently to expected versus unexpected monetary policy shocks. Interest rate futures are used to represent expected future interest rates. Their analysis is based on Sander and Kleimeier's (2004a) sample with 1-month EURIBOR as a proxy for the monetary policy rate. They document a faster response of retail interest rates to anticipated changes in monetary policy, so a good communication policy by the ECB is crucial.

De Graeve et al. (2007) analyse disaggregate, bank-specific retail rates 1993:1-2002:12 on 6 loan (including mortgages, personal and corporate loans) and 7 deposit products for the majority of Belgian banks. They test whether the adjustment process is influenced by the sign and size of the gap. To formalize the size effect, they augment the linear ECM with error correction terms that are squared and cubic in the gap. Little evidence of sign asymmetry is found for loans, and only some deposit rates adjust significantly faster downward than upward. In contrast, larger gaps incur disproportionately faster adjustment for both loans and deposits.

3. Data

The study is based on 662 retail rate histories over the period 1993:01-2005:06 obtained from *Moneyfacts*.[3] These rates pertain to 113 firms for 8 deposit products (24 if division by tier is taken into account) and 4 credit products, defined as follows:

Business Saving (B-Sav) deposit rates quoted to small and medium sized businesses. Sub-products are created based on maturity (instant, 30-day and 90-day) and by deposit levels or tiers (low, £2,500; medium, £10,000; high, £250,000). To simplify the exposition, these three tiers are called LT, MT and HT, respectively.

Household Saving (H-Sav) deposit rates quoted to individuals on four maturities (instant, 30, 60, 90-day) and three tiers (LT, £500; MT, £5,000; HT, £10,000).

Current Account (CA) deposit rates for LT (£500), MT (£5000) and HT (£10,000).

Mortgage rates refer to home-purchase variable loan rates which are by far the most common in the UK.[4] 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 Loan (PL) 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 Card (CC) rates quoted on outstanding monthly balances.

Store Card (SC) rates for credit facilities offered by major department stores. Like with credit cards, any outstanding monthly balances are subject to interest charges.[5]

Appendix Table A1 provides a breakdown of the sample by type of firm and product. The appendix material is available at *http://www.cass.city.ac.uk/faculty/a.fuertes*. Moneyfacts covers 95% of the UK banking sector. Those FIs not listed are very small

[3] The data sources are *Moneyfacts* and *Business Moneyfacts*, two monthly publications of the Moneyfacts Group (*http://www.moneyfacts.co.uk*). The deposit 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.

[4] 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.

[5] The interest rate quoted for deposits 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, outstanding store and credit card balances. All rates are variable.

players that opt out or do not meet their listing criteria, the most important being an agreement to inform Moneyfacts of any change in product characteristics.

Next there is the issue of choosing the exogenous interest rate. Since this paper focuses largely on monetary policy issues, it uses the BoE official rate[6] which is a direct measure of its monetary policy stance. Another method would be to proxy the latter by a short term money market rate (e.g. LIBOR or T-bills) but this approach raises issues because although money market rates change with the policy rate, they are largely driven by the demand and supply for global interbank funds. Moreover, anticipation of policy rate changes is typically reflected in money market rates a few weeks earlier which, if incorrect, merely adds noise to the retail rate-policy rate nexus. Otherwise it could speed up the transmission mechanism to the extent that money market rates influence retail rates. The official and LIBOR rates do occasionally diverge sharply as illustrated by the global market turbulence which began in the late summer of 2007. Banks scrambled to raise liquidity in global markets, causing the 3-month LIBOR to rise and peak at 6.9% in August - over 100 basis points (bp) above the BoE rate and, as of March 08, it remains above the latter.[7]

The BoE official rate is a crucial 'price' variable in the economy. Changes in the official rate affect other short and long-term interest rates and, through various channels, a host of important economic variables – investment, employment, output, and prices of goods and services. The issue of discreteness in the timing of official rate changes is dampened by using monthly average data, as plotted in Figure 1. Panel A represents the policy rate alongside 1-month LIBOR and the 3-month T-bill rate — all 3 series are monthly averages from the BoE.[8] The remaining plots (Panels B-F) are for the retail rates of one of the top 5 UK banks for five different products. [9]

Summary statistics for the BoE monthly average official rate series over the 1993:01-2005:06 period (y_t, t=1,…,T; T=150) are as follows. Average borrowing costs stood at 5.5% with a standard deviation of 1.07%, a maximum level of 7.5% during July 1998 to September 1998 and a minimum level of 3.5% during August 2003 to

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[6] Every month since May 1997, the BoE's Monetary Policy Committee has been revising the policy rate in order to achieve inflation targets. The name given to this rate has changed through the years (e.g. base rate, minimum lending rate, repo rate). Since July 2006, it has been called the *official bank rate* paid on commercial bank reserves, the name used before 1972. In this study, it is also called policy rate because the markets interpret an increase/decrease in it as a tightening/loosening of monetary policy.

[7] A similar phenomenon was observed in 1998 with the collapse of the hedge fund Long Term Capital Markets but it was confined largely to the US and quickly resolved.

[8] *http://www.bankofengland.co.uk/statistics*.

[9] The top 5 are HSBC, Royal Bank of Scotland, HBOS, Barclays and Lloyds TSB. Lloyds is much smaller than the others in the group, if measured by assets or tier 1 capital, but very active in the retail sector.

October 2003. There were 33 month-on-month rises ($\Delta y_t = y_t - y_{t-1} > 0$), 36 cuts and 80 instances with no change ($\Delta y_t = 0$). The monthly increase over the entire sample is 17bp on average and the average cut is 21bp. The absolute month-on-month official rate differential, given that there is a change ($|\Delta y_t| > 0$), is 19bp on average.

4. Methodology

The starting point for formalizing the short- and long-run relation between a retail rate (x_t) and the BoE official or policy rate (y_t) is the linear ECM equation:

$$\Delta x_t = \gamma u_{t-1} + \sum_{i=1}^{p} \lambda_i \Delta x_{t-i} + \sum_{j=0}^{q} \phi_j \Delta y_{t-j} + \varepsilon_t, \quad \varepsilon_t \sim iid(0, \sigma^2) \tag{1}$$

where $u_{t-1} = x_{t-1} - \underline{x}_{t-1}$ is the previous period error or gap, defined as the deviation of the retail rate from its long run equilibrium (or cointegration) path given by $\underline{x}_t = A + C\, y_t$.

The focus of the analysis is the short-run adjustment speed ($\gamma < 0$) toward the long-run equilibrium level. The linear ECM can be very restrictive because it forces γ to be time invariant, that is, identical under all circumstances. But the speed of retail rate adjustment could be time-varying and, in particular, proportional to the size of the policy rate change, which we call *size effect*. It is also plausible that a retail rate's speed of convergence to its long run path has *sign asymmetries* where sign refers to the direction of the policy rate and its effect on the disequilibrium gap. Third, the 'catch up' effect toward the long run path might display *curvature* in the sense that large gaps entail disproportionately faster adjustment than small gaps.

Menu costs can induce size effects or curvature while sign asymmetries typically stem from switching costs. Agency issues can explain sluggish loan rate adjustment following policy rate increases as compared to falls.[10] Sign asymmetry could also be consistent with forms of price discrimination because official rate increases (decreases) provide a temporary opportunity to exploit inert or poorly informed clients in the case of mortgages (deposits). Curvature and size effects are consistent with Sims' (2003) rational inattention hypothesis: relatively minor policy rate changes or deviations from equilibrium are linked to smaller changes in retail rates.

The inferences on a *size effect* in retail rate adjustment are based on the equation:

$$\Delta x_t = \gamma u_{t-1} + k u_{t-1} |\Delta y_{t-1}| + f_{\Delta y, \Delta x} + \varepsilon_t \tag{2}$$

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

where $f_{\Delta y,\Delta x}$ subsumes the regression terms with coefficients $(\lambda_1,\ldots,\lambda_p;\ \phi_0,\phi_1,\ldots,\phi_q)'$ in (1). In this nonlinear ECM, the adjustment speed is continuously time-varying and given by $\gamma_t=\gamma+k|\Delta y_{t-1}|$ which states that γ_t increases linearly with the size of the policy rate change.[11] Hence, the conditioning factor that induces the time-variation in γ_t is the extent of the policy rate revision, Δy_{t-1}. In line with the notion of an error correction mechanism, the adjustment speed γ_t should be negative irrespective of the magnitude of Δy_{t-1}. Hence, the plausible signs of the parameters are $\gamma<0$, $k<0$.

The *sign asymmetry* tests are based on the regime-switching equation:

$$\begin{aligned}\Delta x_t = \gamma u_{t-1} + \gamma_1 u_{t-1}|\Delta y_{t-1}|S_u S_{\Delta y} + \gamma_2 u_{t-1}|\Delta y_{t-1}|S_u(1-S_{\Delta y}) +\\ \gamma_3 u_{t-1}|\Delta y_{t-1}|(1-S_u)S_{\Delta y} + \gamma_4 u_{t-1}|\Delta y_{t-1}|(1-S_u)(1-S_{\Delta y}) + f_{\Delta y,\Delta x} + \varepsilon_t\end{aligned} \tag{3}$$

where S_u is a sign indicator for the gap defined as S_u=1 if $u_{t-1}>0$ and 0 else; $S_{\Delta y}$ is defined similarly as a sign indicator for the direction of the policy rate revision. By interacting the sign of the policy rate change and the gap, while controlling for size effects, model (3) allows for four regimes of adjustment: $\gamma_{1,t}=\gamma+\gamma_1|\Delta y_{t-1}|$ if $u_{t-1}>0$ and $\Delta y_{t-1}>0$, $\gamma_{2,t}=\gamma+\gamma_2|\Delta y_{t-1}|$ if $u_{t-1}>0$ and $\Delta y_{t-1}<0$, $\gamma_{3,t}=\gamma+\gamma_3|\Delta y_{t-1}|$ if $u_{t-1}<0$ and $\Delta y_{t-1}>0$, and $\gamma_{4,t}=\gamma+\gamma_4|\Delta y_{t-1}|$ if $u_{t-1}<0$ and $\Delta y_{t-1}<0$. The hypotheses of interest are either H_0: $(\gamma_1-\gamma_2)=0$ or H_0: $(\gamma_3-\gamma_4)=0$ and rejection implies sign asymmetry (regime-switching) for positive or negative gaps, respectively. As in (2), the parameter $\gamma<0$ in (3) is the adjustment speed for $\Delta y_{t-1}=0$ so, using the same argument, the plausible signs of the asymmetry coefficients are $\gamma_i<0$, i=1,…,4. In the absence of sign asymmetry ($\gamma_1=\ldots=\gamma_4=k$), this model still embodies a size-of-policy-rate-change effect ($\gamma_t=\gamma+k|\Delta y_{t-1}|$).

Most of the literature assumes that the error correction mechanism itself is linear in the gap, that is, the catch-up movement of retail rates towards their long run equilibrium is proportional to the gap (γu_{t-1}). To allow for curvature we introduce an additional error correction term which is nonlinear (cubic) in the gap, as in De Graeve et al. (2007). This amounts to an adjustment speed proportional to the lagged squared gap. Formally, the *curvature* tests are based on the equation:

$$\Delta x_t = \gamma_P u_{t-1}S_u + \gamma_N u_{t-1}(1-S_u) + k_P u_{t-1}^3 S_u + k_N u_{t-1}^3(1-S_u) + f_{\Delta y,\Delta x} + \varepsilon_t \tag{4}$$

which also allows for regime-switching with respect to the sign of the gap; S_u is the sign indicator function defined earlier. Thus the time-varying adjustment speed

[11] Time variation in the adjustment speed, as portrayed in (2), is not a nonlinearity *per se*. However, it can be cast as such in the sense that it represents a departure from the conventional linear ECM.

switches between $\gamma_{P,t} = \gamma_P + k_P(u_{t-1})^2$ for $u_{t-1}>0$, and $\gamma_{N,t} = \gamma_N + k_N(u_{t-1})^2$ for $u_{t-1}<0$. The plausible signs of the speed of adjustment coefficients are $\gamma_i<0$, $k_i<0$, $i=P, N$. Under the null hypothesis H_0:$k_P=k_N=0$ the error correction mechanism is (linear) proportional to the gap whereas under the alternative (curvature) hypothesis, large gaps matter disproportionately more than small gaps. A second test is designed to investigate the joint hypotheses of identical adjustment (no regime-switching) for positive and negative gaps, H_0: $\gamma_P=\gamma_N$, $k_P=k_N$. The retail rate adjustment portrayed in the linear, size effect, sign asymmetry and curvature ECMs through equations (1) to (4) is graphically illustrated in Figure 2, panels A to D, respectively.

5. Results

Model estimation is by OLS. Inferences are based on OLS or White heteroskedasticity robust standard errors, as appropriate. The Wald statistic is used for testing joint hypotheses and individual significance tests are based on t-statistics.[12]

5.1 How widespread are the nonlinearities?

The inferences made on the basis of the *size effect* model, equation (2), are set out in Table 1. The null hypothesis is constant adjustment speed (H_0: k=0) and rejection indicates that the adjustment speed is proportional to the policy rate change, i.e. driven by $|\Delta y_t|$. Hence, large official rate changes prompt a faster response of retail rates. This 'continuous' time variation is supported for a considerable proportion of deposit products (50%) and features most prominently among H-Sav rates. On the credit side, evidence that the adjustment speed is proportional to policy rate changes is found for 39% of mortgages, but just a minority of unsecured personal loans (22%), credit cards (17%) and store cards (7%).

The results of the nonlinearity tests based on the *sign asymmetry* model, equation (3), are set out in Table 2. Overall, sign asymmetry is more pervasive in savings accounts and mortgages. The first test (H_0: $\gamma_1=\ldots=\gamma_4=k$) suggests that, after controlling for size effects, 76% (340/445) of deposit rates display regime-switching adjustment dictated by the signs of the policy rate change and the gap. Of the 340 rates that exhibit sign asymmetry, 83% (281/340 in Table 2; col. 5) do so when overpaying

[12] The lag orders p and q are chosen so as to absorb all the residual autocorrelation. The interest rate series have non-stationary I(1) properties. A battery of tests in Fuertes and Heffernan (2008) confirm the existence of long run co-movement between each retail rate and the BoE policy rate.

while only 48% (164/340; col. 8) do so when underpaying. For mortgages, PLs and CCs, there is sign asymmetry in 80%, 28% and 30% rates, respectively (col. 5).

Intuitively, any policy rate change should exert a more powerful effect on retail rates when it widens the gap than vice versa. According to (3), in the context of overpaid (or overcharged) rates $u_{t-1}>0$, a policy rate cut $\Delta y_{t-1}<0$ implies a widening gap (γ_2) whereas a policy rate rise $\Delta y_{t-1}>0$ narrows the gap (γ_1). Hence, for overpaid rates it is expected that $\gamma_2<\gamma_1$ or equivalently, $\gamma_{2,t}$ is more negative than $\gamma_{1,t}$. Likewise, for undercharged (or underpaid) rates it is expected that $\gamma_3<\gamma_4$, that is, $\gamma_{3,t}$ is more negative than $\gamma_{4,t}$. The results suggest that for 89% (Table 2; col. 7) of the overpaid deposits that show asymmetric adjustment, the response is faster following a policy rate cut to close what would otherwise be an ever widening gap. Similarly, for 69% (col. 9) of the underpaid deposits with asymmetry, rates are revised upwards relatively faster after a policy rate rise. Hoffman and Mizen (2004) report a similar pattern for UK deposits although on the basis of a much smaller cross-section.

On the credit side, a comparison between γ_1 and γ_2 reveals that the evidence for overcharged rates ($u_{t-1}>0$) in the case of personal loans and credit cards is consistent with that for deposits. When the policy rate falls, adjustment is generally faster than when it rises in order to correct the widening gap. On the other hand, the comparison between γ_3 and γ_4 (for $u_{t-1}<0$), suggests that personal loans and credit cards show virtually no asymmetries when rates are undercharged, that is, policy rate rises and cuts incur the same speed of adjustment. The reluctance of FIs to raise personal loan rates faster when the policy rate increases is consistent with Stiglitz and Weiss' (1981, 1983) argument that if FIs 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 (see also Fried and Howitt, 1980). 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 FIs with a high proportion of new loan business, where information asymmetries are more widespread.

In principle, the results for mortgages are counterintuitive, albeit in line with Frost and Bowden (1999) for the New Zealand market. For the vast majority of overcharged mortgage rates with asymmetric adjustment, the response is faster for policy rate rises compared to falls ($\gamma_1<\gamma_2$), but if undercharged, the adjustment is faster for policy rate cuts ($\gamma_4<\gamma_3$). What partly explains this atypical result for mortgages is that, of all the products in the sample, they 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: the period average absolute gap for mortgages is 0.3%, compared to 2.5% for H-Sav instant (LT) and 2.98% for personal loans. 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 had more than halved, even though the official rate actually rose by about 60bp over the same period.[13] Also, interest rates began to drift downward from January 1999 onward.[14] Normally, undercharged mortgage rates would be expected to move relatively fast upward. But with a falling policy rate in a highly competitive mortgage market with thin margins, there might be little option but to quickly cut rates to keep or attract customers.

The inferences based on the *curvature model*, equation (4), are summarised in Table 3. For about half of the deposit rates (47%), there is significant curvature in the error correction mechanism, so the catch-up movement towards the long run equilibrium is disproportionately faster for larger gaps, especially for B-Sav rates. The presence of curvature in savings rates is consistent with De Graeve et al. (2007) for the Belgian market. On the credit side, the evidence is weaker – just over 20% of mortgages, personal loans, and credit cards reject the null of proportional error correction; the figure is even smaller for store cards (7%). Interestingly, for nearly all deposit and credit rates displaying curvature, the linear error correction terms ($\gamma_i u_{t-1}$; $i=P$, N) are insignificant. Regime-switching relating to the sign of the gap is present in a sizeable proportion of deposits (35%) and a minority of credit products (17%).

5.2 How is retail rate dynamics best captured?

The next exercise is model selection to ascertain which of the four ECMs under consideration ─ linear, size effect, sign asymmetry, and curvature ─ provides the best representation of the data. For this purpose, the AIC, SBC and adjusted R^2 are employed in a majority-rule approach. Appendix Table A2 reports a summary of the

[13] The cross-section average of the gap remains at around 0.25 for the rest of the sample period.
[14] 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.

adjusted R^2 for the different models product by product. For deposit and mortgage rates, the explanatory power of the models is quite reasonable (around 50%) and the nonlinear ECMs provide higher adjusted R^2 than the linear ECM. It is interesting to note, however, the relatively poor model fit with PL, CC and SC rates. This is a novel finding, partly because there are no other studies that use CC or SC data. In the few studies that do include PLs among their credit products (Sander and Kleimeier, 2004a; Kleimeier and Sander, 2006), model fit measures such as the R^2 are not reported. The worse fit occurs for SC rates: the average adjusted R^2 is about 4% for the nonlinear ECMs and even lower, at 2.8%, for the linear ECM.

The model selection results for banks, building societies and other FIs are summarised in Figure 3 — detailed statistics are provided in Appendix Table A3. With reference to the deposits offered by all FIs, sign asymmetry is the leading model (selected for 36% of rates) and the remaining three models follow with a similar share: linear (20%), size effects (20%) and curvature (23%). A breakdown by deposit type reveals similar results for H-Sav rates but marked differences for B-Sav rates and current accounts. The dominant model among current accounts is also the sign asymmetric (44%) but it is followed by the linear (34%). By contrast, for B-Sav rates, the curvature (36%) or size effects models (34%) are the top performers. On the credit side, the sign asymmetry model also dominates for mortgages (52%) followed by the linear model (28%). The linear model is, overwhelmingly, the top performer for PL, CC and SC rates, although as already noted, its explanatory power is relatively small. Banks and building societies (BS) display few sharp differences, with some exceptions. In the case of current accounts only two models are selected for BS, either the linear (54% of cases) or sign asymmetric (46%), whereas for banks all models are plausible with the sign asymmetric (44%) as top performer followed by the linear (30%). Turning to mortgages, the majority of BS rates are best explained by the sign asymmetry model (56%) but for banks, linear behavior is almost as common. CCs are similar; the dynamics of banks conform to linear (61%), sign asymmetry (26%) and curvature (13%), whereas for BS the linear model is by far the most notable (86%). So BS rates tend to display more homogeneous behavior than bank rates.

The analysis reveals no systematic differences with respect to maturities. Interestingly, the sign asymmetry model clearly dominates for products at both ends of the term structure (instant accounts and mortgages). This indicates that the presence of asymmetric adjustment does not relate to product maturity. For medium-term rates (30-, 60- and 90-day maturities), there is no clear winner among the nonlinear specifications since the percentage of cases where the size effect, sign asymmetry and curvature ECMs are selected as best-fit model is largely comparable.

5.3 Policy implications

The analysis thus far has suggested that the adjustment process of British retail rates exhibits nonlinear features (size effect, sign asymmetry and/or curvature) and that there is notable heterogeneity among both FIs and products.

Given that changes in official rates are based, to a large extent, on how retail rates are expected to react, these findings may have implications for the methods adopted by policymakers to simulate the effects of policy rate changes. Indeed, the BoE'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 the BoE's 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 nonlinearities in retail rate setting is relevant for (a) the central banks' choice of model to make predictions, and (b) the exercise of monetary policy.

The model used by the BoE to capture the transmission mechanism of policy rate decisions should recognise the possibility of several nonlinear aspects in the response of retail rates. But this is a challenging task, given the heterogeneity found across FIs and products. The breakdown of results across products reveals some interesting patterns. The adjustment of H-Sav, current account and mortgage rates conforms largely to sign-asymmetry, while that of B-Sav rates is best characterized by size and curvature effects. Building societies exhibit more homogeneous behavior than banks. But there is no clear distinctive pattern between small/large banks or maturities. Such diverse responses will slow down the interest rate transmission mechanism; had all the FIs been found to be equally responsive, the transmission mechanism would have been 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 may be at odds with what actually happens.

A 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"*[15] and suggests that monetary policy is more powerful in a restrictive environment than in an expansionary one. Mortgages play a key role in the British interest rate transmission mechanism. The sign asymmetry documented in the adjustment of overcharged mortgage rates is on balance consistent with the traditional view: policy rate rises trigger a faster reaction than cuts.

Changes in the disequilibrium gap, $u_t = x_t - \underline{x}_t$, are prompted by changes in the policy rate (y_t) since the long run equilibrium rate is linked to the latter ($\underline{x}_t$=A+Cy_t). Hence, another lesson for the execution of monetary policy relates to the finding, mainly for deposits, that there is curvature in the disequilibrium correction process. Curvature implies that, for a given policy rate change Δy_t, 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 and that the policy rate is raised under one of three different scenarios with no further change: (i) a one-off increase by 25bp (ii) three consecutive monthly rises of 25bp, or (iii) a one-off increase of 75bp rise. 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). Hence, a single large policy rate change will tend to prompt much swifter deposit rate responses than several gradual changes.

Bernanke et al. (2001) support the *financial accelerator* theory according to which, when monetary policy is restrictive, the economy cools off.[16] This negative pressure is further accelerated by the banks' reaction. Corporate default (loan) rates are expected or actually begin to rise. Banks raise margins on business loan rates to accommodate these defaults. What these authors refer to as the 'external finance' premium rises, squeezing investment still further. The financial accelerator mechanism will increase the loan rate reaction to official rate rises. This contrasts with Stiglitz and Weiss' (1981) model which is consistent with upward stickiness (ceilings) in loan rates. The sign asymmetry pattern documented for PL rates in Table 2 on balance supports the Stiglitz-Weiss model. Although the sample excludes corporate loan rates, our findings should extend at least to small start-up businesses for which bank loans are quite an important source of funds.

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[15] 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).
[16] See also Bernanke and Gertler (1995, 2001).

However, the applicability of the financial accelerator and Stiglitz-Weiss theories rests on whether ECMs capture well the retail rate dynamics which, as documented, is not the case for PL, CC and SC rates. The level of UK unsecured loans to consumers at the end of January 2008 was £226.3m or 16% of annual GDP (at market prices) which is more than twice the 1995 figure of 7.3%.[17] About two-fifths of this was credit card debt; separate figures on store cards are unavailable.[18] Given this rapid growth of unsecured consumer debt, any intended impact of policy rate changes on households may be considerably dampened if PL, CC and SC rates are relatively impervious to revisions in the official rate, as the present study suggests.

5.4 What lies behind the nonlinear retail rate behavior?

The analysis has revealed important nonlinear patterns in the way UK banks price their retail products. The next challenge is to try and explain these nonlinearities by identifying bank characteristics that could influence the extent of the size effect, sign asymmetry and curvature. Do differences in financial ratios, menu costs, market structure, product variability or type of ownership have a role to play?

For this purpose, three distinct measures of the degree of nonlinearity are used as dependent variable (y_i; i=1,…,N) in cross-section regressions. Two separate regression analyses are conducted for deposits and credit products. Mortgages are also analysed separately because, in view of the results in the previous sections, their behavior differs from that of the other three credit products. The extent of the size effect is defined as $y_i = |k|$, where for each retail rate i the estimates of k from model (2) represent the impact of policy rate changes on the short run speed of adjustment. For a particular rate, if k turned out to be insignificant in the tests of Section 5.1 (Table 1), then the size effect is set at zero, y_i=0. Turning to the sign asymmetry, according to model (3) two threshold effects are possible, $y_a=|\gamma_1-\gamma_2|$ and $y_b=|\gamma_3-\gamma_4|$, respectively, for positive and negative gaps. Hence, the dependent variable that represents the overall degree of sign asymmetry is defined as $y_i= y_a + y_b$, which is set at zero for retail rate i=1,…,N if the step-one test statistic (H_0: no regime-switching) in Table 2 was insignificant for that individual rate. Finally, model (4) allows for a degree of curvature given by $y_P=|k_P|$ and $y_N=|k_N|$ for positive and negative gaps,

[17] Source: Bank of England (2008), Online interactive Statistics (code LPMVZRD) and the Office for National Statistics (2008), *Economic Trends.*
[18] In some publications, store cards appear as subsets of unsecured loans.

respectively. Hence, the overall curvature (dependent) variable is $y_i = y_P + y_N$, which equals zero for rate *i* if the step-one test in Table 3 suggested insignificance.

The independent variables include financial ratios commonly used in the bank performance literature which affect rate setting decisions taken by management. Falling and fluctuating profits are measured by, respectively, the period-average fall in return on average assets (ROAE) and the variance of ROAE; either could induce asymmetries if managers respond more promptly to policy rate changes that shrink profits especially if they fear a shareholder revolt. Other financial ratios that could affect profits are cost-to-income, a measure of efficiency, and the asset growth rate.

The presence of curvature might be related to an agency phenomenon. A bank's capital adequacy (the ratio of equity plus disclosed reserves to total assets) is one plausible determinant of how it responds to monetary policy decisions. Regulators argue that well capitalised banks are less likely to fail — consequently, they may experience lower funding costs and could attract more customers. But setting aside more capital reduces their profit opportunities and managers may try to make up for it through nonlinear retail pricing. The degree of risk taken by banks (proxied by loan loss reserves to total loans) may also influence their retail rate assessment.

The degree of diversification (proxied by the non-interest income to average assets) is another possible candidate for explaining nonlinearities. Some authors argue that alternative sources of income might be used to cross-subsidise bank intermediation activities (Demirguc-Kunt et al., 2004). If so, more diversified banks may be less responsive to monetary policy changes. Alternatively, some changes may prompt more of a reaction than others, thus differentiating their responses to upward versus downward revisions in the policy rate.

Banks incur menu costs when they change rates, and so they will only respond to revisions in the policy rate if the cost is lower than what they would lose by not doing so. Size effects and curvature are consistent with the menu cost hypothesis because bigger policy rate changes or gaps are much more likely to trigger retail rate changes than small ones. They could also generate sign asymmetry since the cost of not adjusting retail rates will depend on the direction of the policy rate change. The number of bank branches adjusted for size is one proxy for menu costs. Since bigger UK banks have more branches,[19] scale and dispersion effects are separated out by using the ratio of branches to assets (in logarithms to allow for diminishing returns)

[19] The correlation between bank size and number of bank branches is high at 65%.

thereby providing a measure of dispersion/proximity, or customer convenience. Overhead expenses relative to total assets[20] contribute to menu costs, and a bank's size (measured by assets) may also be indicative of them.

According to Berger's (1995) hypothesis, banks with greater market power may price retail products less competitively incurring in tardier downward (upward) adjustment for loans (deposits). Such behavior represents a sign asymmetry. A bank's market share of the UK deposit market is used as a proxy for market power. Market structure is also captured through a concentration measure, defined as the number of FIs that offer a given deposit or loan product. The number of products (as percentage of the total available) a FI offers is used as a measure of product range. Finally, an ownership dummy variable equals 1 if the retail rate i=1,…,N pertains to a bank, 0 if a BS. Summary statistics for these variables are reported in Table 4 (top panel) alongside their description and the main effect measured (bottom panel).[21]

In view of the limited number of observations and to preserve degrees of freedom, the following sequential approach is adopted to find the 'best' cross-section regression, defined in terms of the highest adjusted R^2. The explanatory variables are first ranked according to their absolute correlation with the relevant dependent variable. We begin with a simple regression consisting of the explanatory variable with the highest correlation. The variable with the second highest correlation is then added and so forth. At each step, if the candidate regressor does not increase the adjusted R^2, it is discarded in favour of the next variable. The procedure continues until all variables have been considered. Table 5 reports the final 'best' regressions.

The best attested influence on the size effect and sign asymmetry is concentration which is clearly significant. For deposit rates, the negative coefficient implies that the more FIs there are in the relevant sub-market, the closer their behavior is to linear/symmetric adjustment. A more concentrated deposit market with fewer suppliers means FIs can exploit short-term profit opportunities by cutting deposit

[20] As noted in Table 4, the ratio of overhead expenses to assets has the practical advantage of being available for more FIs (66) as compared to the ratio of branches to assets (23).

[21] The cross-section analysis is based on the 66 FIs (out of a possible 113) for which data are available on all the independent variables. The correlation between ROAA and ROAE is high at 73% and both are highly correlated with other variables. For this reason, we only focus on the variance of the ROAE growth rate (VROAE) and its average fall (FROAE) over the period. The correlation between asset value (SIZE) and market share (MS) is high at 98%, and likewise for overhead costs (OH) and diversification (DIV) at 80%. To avoid multicollinearity, these variables are entered in separate regressions.

rates faster when the official rate is cut. Hence, for deposits, the impact of policy rate changes will be more symmetric when many firms offer the product.

However, the reverse is true for credit products; higher concentration implies a stronger size effect and sign asymmetry. Credit products are dominated by the UK mortgage market (CCs and PLs constitute a much smaller market share) with its many suppliers. The presence of mortgage switching costs creates scope for a more gradual (slower) pass-through of rate cuts than rises, at least in the 'overcharging' phases, as discussed in Section 5.1, when more FIs are likely to enter the market.

For deposit rates, the size effect is driven by risk and diversification. The significantly negative coefficient on the loan loss provisions ratio means that FIs that take on more risk, are less likely to display adjustment that is (non-constant) proportional to the policy rate change. In contrast, greater diversification amplifies the size effect probably because diversified firms incur higher communication costs which induce a more vigorous reaction to large policy rate changes and, slow or, effectively no reaction to small ones. The coefficient on profit volatility is significantly negative for deposits and mortgages: more variable profits accompany weaker size effects. Thus a firm that adjusts retail rates more uniformly over time (disregarding the size of the policy rate change) may experience more short-term volatility in profits than one that engages in possibly asymmetric smoothing.

For credit products, the capital-to-assets ratio triggers size effects. FIs financed by more equity funding may have less managerial discretion to trade off profits against other goals. Thus if regulatory changes prompt banks to hold more capital, monetary policy becomes less predictable because the loan rate adjustment speed is more likely to be non-constant over time. Conversely, responses to official rate changes could become more linear (weaker size effect) if FIs are highly leveraged.

In terms of the sign asymmetry, market concentration is the only attribute important for deposits, while profit volatility is the one financial ratio with a significant (negative) coefficient for loans. FIs with less managerial slack will make more variable profits because of their more symmetrical (linear) responses.[22]

Curvature in the disequilibrium correction is stronger for more diversified FIs, with a larger non-interest income ratio, and for those with a more variable rate of return on average equity, the latter especially for credit products. The positive impact

[22] In both the size and sign credit regressions, the rather high adjusted R^2 dropped substantially when mortgages were treated separately, indicating that the explanatory power was mostly arising from the type of product (whether it is mortgage or unsecured type of loan) as opposed to bank performance.

of diversification on curvature could be indicative of managerial slack or concerns about menu and higher communication costs: a bigger interest cushion would permit the neglect of small gaps, and pass-through from policy to retail rates would weaken for small policy rate changes. Less curvature is associated with FIs that offer a wider range of products which suggests that less specialised firms tend to adjust rates in an attempt to correct any prevailing discrepancy (gap), irrespective of its size.

As proxies for menu costs, neither asset value nor overheads explain the presence of a size effect, sign asymmetry or curvature in the adjustment of retail rates. But the logarithm of branches to assets ratio has a significantly positive effect on both the size effect and curvature for deposits. Thus, firms with a relatively large number of branches will take into consideration the size of the policy rate change and of the prevailing gap in their deposit rate adjustment decisions. Furthermore, like diversified banks, those with an extensive branch network have higher communication costs than similarly sized banks with fewer branches. More branches induce more nonlinearity (asymmetry) in retail rate setting so any policy rate change is likely to have a more predictable impact on less widely dispersed banks. Overall, these results are fully consistent with the implications of menu cost theory.

6. 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 662 disaggregated, bank-specific monthly rates for several types of savings and current accounts, unsecured personal loans, mortgages, credit cards and store cards. The 113 FIs sampled range from the top 5 banks to the smallest building society. Three generalizations of the linear ECM are formulated with a view to testing for a size effect and regime-switching sign asymmetry in the adjustment speed, and curvature in the disequilibrium correction.

Overall, for at least half of the deposit and over a quarter of loan rates in the sample, the adjustment speed varies over time proportionally to the size of the policy rate change — large changes trigger faster retail rate responses than small changes. For deposit rates, the adjustment tends to be faster when the official rate is cut (monetary expansion) than when it is raised whereas for mortgage rates the adjustment is typically more rapid when the official rate is increased. There is strong evidence that, for a given policy rate change (rise or fall), the responsiveness of banks depends on the sign of the prevailing 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 FIs but also inter-bank heterogeneities. For many deposit and some loan rates, there is curvature in the catch up movement towards the long run equilibrium path.

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 and personal loans make up a large part of consumer debt, their apparent insensitivity 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 behavior of retail rates across FIs and products. These findings raise questions about the simulation models and representative retail rate histories utilized by the central bank to anticipate the effects of policy rate changes on the interest rate transmission mechanism, and about the exercise of monetary policy.

Cross-section regressions are estimated to assess whether a selection of financial ratios and product/market attributes could help explain the presence of a size effect, sign asymmetry and curvature in retail rate setting. The results are complex, but the key findings are as follows. Menu costs proxied by the log of branches to assets tend to amplify the size effect and curvature. The significantly positive influence of diversification on the size effect and curvature is also suggestive of menu costs and/or managerial slack. Market concentration and profit volatility emerge as significant determinants of all three types of nonlinearity. The size effect and sign asymmetry are more prominent in more concentrated deposit markets whereas profit volatility tends to dampen these two nonlinear features. The range of products offered is relevant for the degree of curvature: the disproportionately faster response to a given policy rate change in the presence of a large gap is more prominent for more specialised FIs. Taken together, these findings mean that under a variety of conditions, the effect of a change in official rates on pass-through will tend to be muted or accentuated, making monetary policy less predictable.

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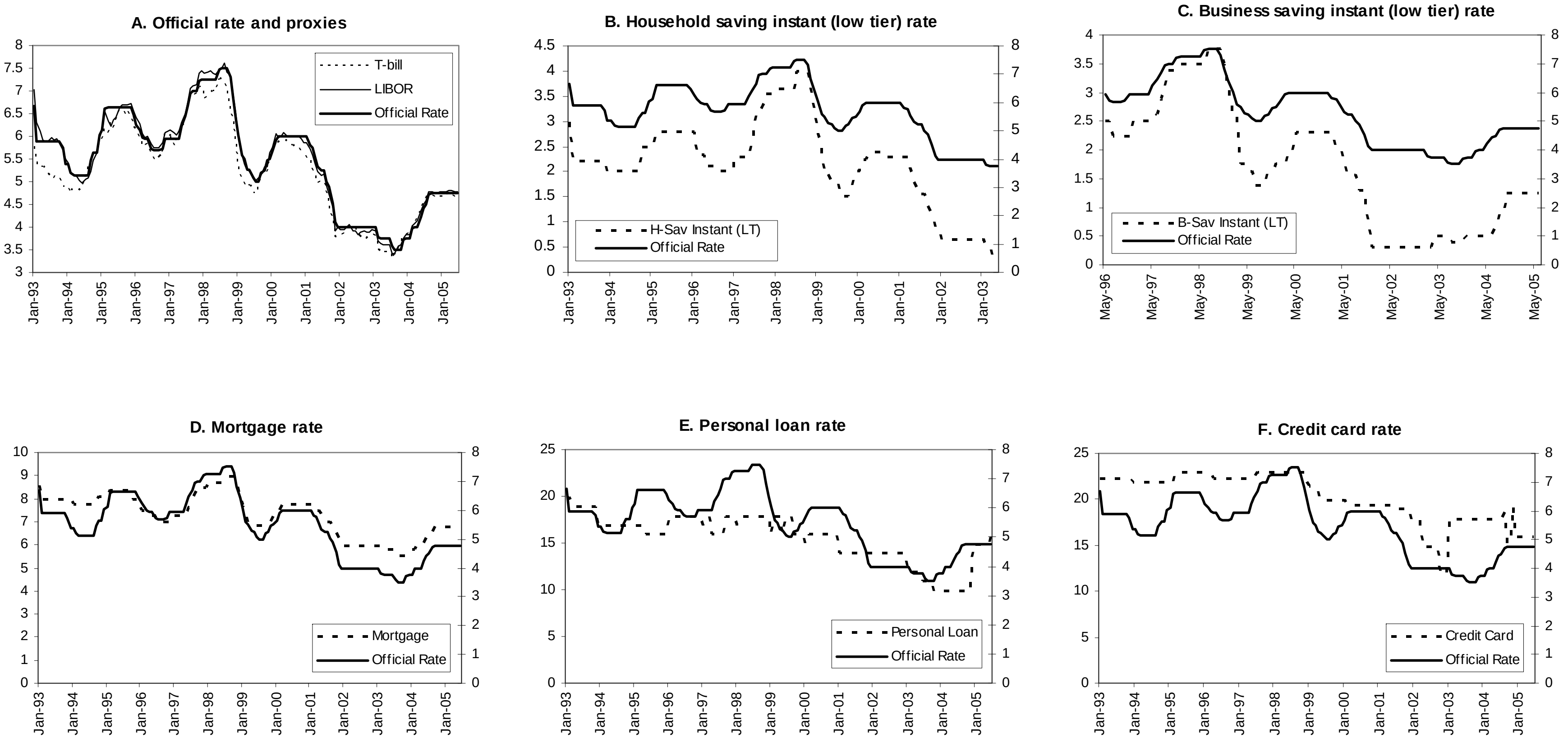
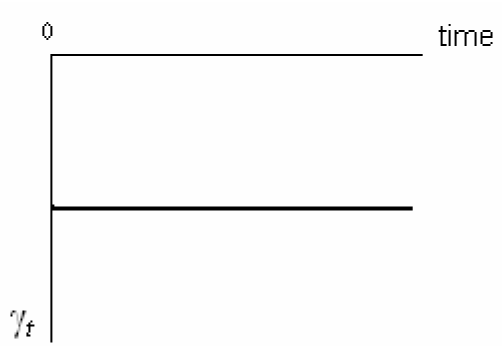
Figure 1. Official rate, short-term money market rates and retail rates for one of ‘top 5’ British banks



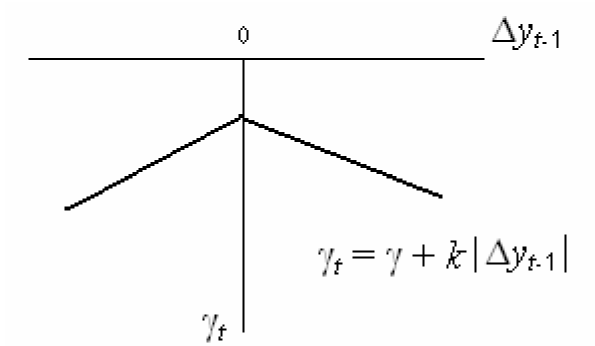
All three rates in Panel A refer to the left-hand-side axis. Due to the different order of magnitude (mark up/down) of the retail rates and official rate for some products (e.g. the period mean rate for personal loans is 15.53% whereas for the official rate it stands at 5.5%), to avoid scale-distortions in the time variation of the rates Panels B to F plot the retail rate relative to the left-hand-side axis and the official rate relative to the right-hand-side axis.

Figure 2. Alternative settings for the adjustment of retail rates to policy rates

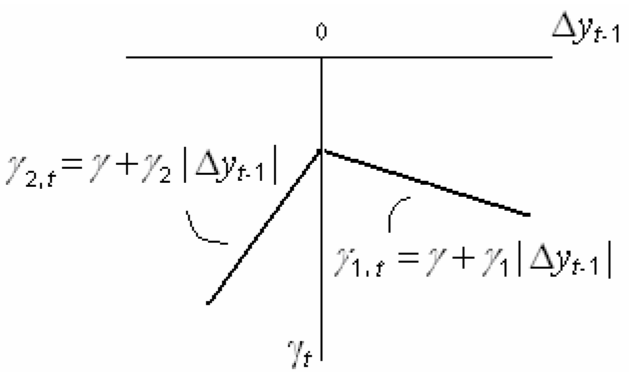
A. Constant Adjustment Speed
(*Linearity*)



B. Adjustment Speed Proportional to Policy Rate Change
(*Size Effect*)



C. Regime-switching Adjustment Speed
(*Sign Asymmetry*)



D. Adjustment Speed Proportional to Squared Gap
(*Curvature in Error Correction*)

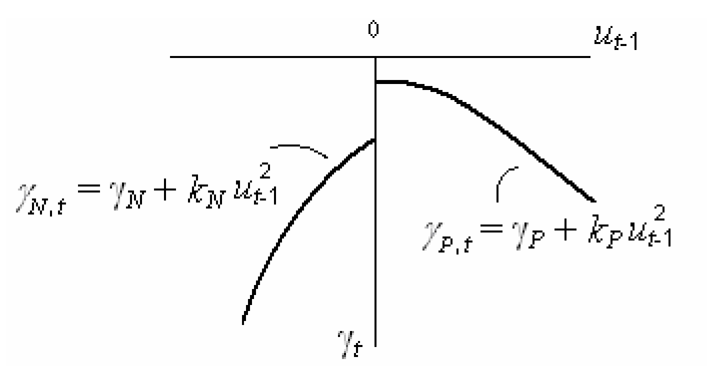
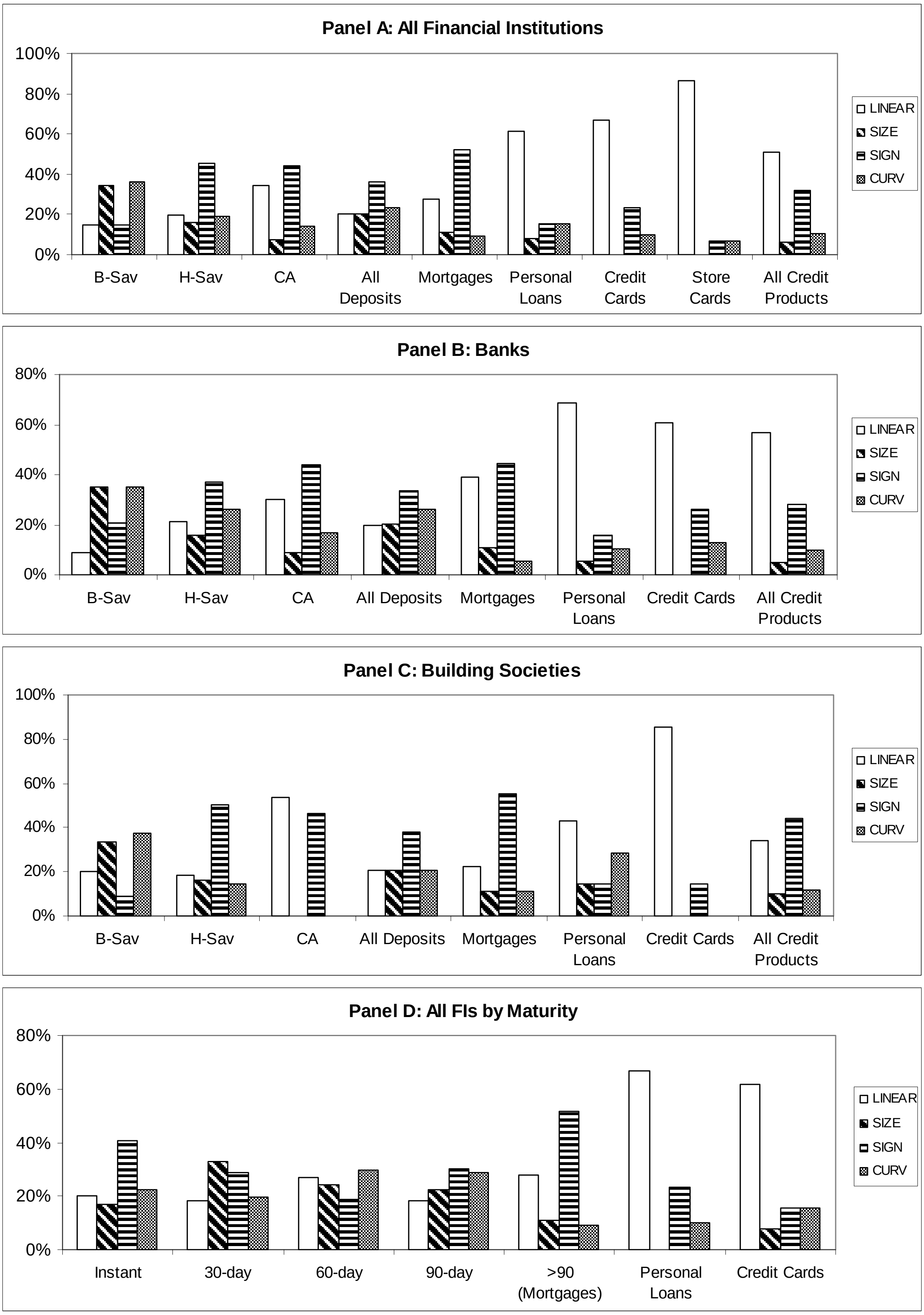


Figure 3. Model Selection



The figure shows for a given product or maturity the percentage of UK financial institutions for which retail rate dynamics is best characterized by a linear, size effect, sign asymmetry or curvature ECM. Store cards are not reported because they are issued by department stores, not financial institutions. Detailed statistics are given in Appendix A3.

Table 1. Inferences from size effect model

Product	Firms (N)	H_0: $k = 0$ (*Linear ECM*) H$_0$ Rejected	H_1: $k < 0$ Size effect
B-Sav-Instant			
LT (£2.5K)	36	15	42%
MT (£10K)	38	14	37%
HT (£250K)	34	19	56%
B-Sav-30 day			
LT (£2.5K)	9	6	67%
MT (£10K)	12	8	67%
HT (£250K)	10	5	50%
B-Sav-90 day			
LT (£2.5K)	5	1	20%
MT (£10K)	5	2	40%
HT (£250K)	5	3	60%
H-Sav-Inst			
LT (£500)	42	26	62%
MT (£5K)	47	27	57%
HT (£10K)	47	21	45%
H-Sav-30 day			
LT (£500)	8	3	38%
MT (£5K)	18	9	50%
HT (£10K)	19	10	53%
H-Sav-60 day			
LT (£500)	5	3	60%
MT (£5K)	16	10	63%
HT (£10K)	17	10	59%
H-Sav-90 day			
LT (£500)	10	5	50%
MT (£5K)	22	14	64%
HT (£10K)	27	13	48%
Current Accounts			
LT (£500)	24	9	38%
MT (£5K)	28	12	43%
HT (£10K)	27	9	33%
DEPOSIT TOTAL	*511*	*254*	*50%*
Mortgages	54	21	39%
Personal Loans	23	5	22%
Credit Cards	30	5	17%
Store cards	14	1	7%
CREDIT TOTAL	*121*	*32*	*26%*

Column 2 reports the number of FIs in the sample, excluding the few cases where coefficients are implausibly signed. Columns 3 and 4 give the number and % of cases where the null hypothesis of constant adjustment speed (γ) is rejected. The size effect $k < 0$ means that the adjustment is proportional to the size of the policy rate change ($\gamma_t = \gamma + k\,|\,\Delta y_{t-1}\,|$).

Table 2. Inferences from sign asymmetry model

Product	Firms (N)	$H_0: \gamma_1=\gamma_2=\gamma_3=\gamma_4=k$ (*No Regime-Switching*) / $H_1: \gamma_i \neq \gamma_j$ for $i \neq j$ (*Sign Asymmetry*): H₀ Rejected	Sign effects	$H_0: \gamma_1=\gamma_2$ (*No Regime-Switching for Overpay*) / $H_1: \gamma_1 \neq \gamma_2$: H_0 Rejected	OVERPAY Faster Response: $\gamma_1 < \gamma_2$ Policy Rate Rise	OVERPAY Faster Response: $\gamma_2 < \gamma_1$ Policy Rate Cut	$H_0: \gamma_3=\gamma_4$ (*No Regime-Switching for Underpay*) / $H_1: \gamma_3 \neq \gamma_4$: H_0 Rejected	UNDERPAY Faster Response: $\gamma_3 < \gamma_4$ Policy Rate Rise	UNDERPAY Faster Response: $\gamma_4 < \gamma_3$ Policy Rate Cut
B-Sav-Instant									
LT (£2.5K)	36	23	64%	20	5%	95%	7	43%	57%
MT (£10K)	35	24	69%	17	12%	88%	9	22%	78%
HT (£250K)	29	23	79%	16	0%	100%	5	80%	20%
B-Sav-30 day									
LT (£2.5K)	8	7	88%	6	0%	100%	2	0%	100%
MT (£10K)	11	10	91%	7	0%	100%	5	60%	40%
HT (£250K)	6	5	83%	4	0%	100%	1	100%	0%
B-Sav-90 day									
LT (£2.5K)	5	3	60%	2	0%	100%	1	0%	100%
MT (£10K)	5	4	80%	4	0%	100%	2	50%	50%
HT (£250K)	5	5	100%	4	0%	100%	2	50%	50%
H-Sav-Inst									
LT (£500)	31	26	84%	24	21%	79%	14	79%	21%
MT (£5K)	34	29	85%	24	13%	88%	15	80%	20%
HT (£10K)	38	31	82%	25	12%	88%	17	88%	12%
H-Sav-30 day									
LT (£500)	7	4	57%	4	25%	75%	2	100%	0%
MT (£5K)	15	11	73%	10	10%	90%	7	86%	14%
HT (£10K)	19	14	74%	13	8%	92%	10	90%	10%
H-Sav-60 day									
LT (£500)	5	5	100%	4	25%	75%	4	50%	50%
MT (£5K)	15	12	80%	10	0%	100%	9	56%	44%
HT (£10K)	15	13	87%	12	8%	92%	10	70%	30%
H-Sav-90 day									
LT (£500)	9	8	89%	6	33%	67%	5	80%	20%
MT (£5K)	21	15	71%	13	23%	77%	9	100%	0%
HT (£10K)	26	21	81%	17	12%	88%	9	56%	44%
Current Accounts									
LT (£500)	20	15	75%	15	7%	93%	6	50%	50%
MT (£5K)	25	15	60%	11	18%	82%	6	33%	67%
HT (£10K)	25	17	68%	13	8%	92%	7	86%	14%
DEPOSIT TOTAL	*445*	*340*	*76%*	*281*	*11%*	***89%***	*164*	***69%***	*31%*
Mortgages	45	36	80%	25	80%	20%	29	31%	69%
Personal Loans	25	7	28%	7	29%	71%	1	0%	100%
Credit Cards	30	9	30%	6	17%	83%	2	100%	0%
Store cards	14	1	7%	1	100%	0%	0	0%	0%
CREDIT TOTAL	*114*	*53*	*46%*	*39*	***62%***	*38%*	*32*	*34%*	***66%***

The information reported in each column is as follows. Column 2: number of FIs in the sample, excluding the few cases where coefficients are implausibly signed. Columns 3 and 4: number and % of cases where the null hypothesis of no regime-switching adjustment speed is rejected. Columns 5 and 8: cases that reject the null of no regime-switching for overpaid rates ($x_{t-1} > \underline{x}_{t-1}$) and underpaid rates ($x_{t-1} < \underline{x}_{t-1}$), respectively. Columns 6-7 and 9-10: breakdown by type of asymmetry, that is, whether retail rate adjustment is faster for policy rate rises or cuts for overpaid and underpaid rates, respectively. For example, for B-Sav Instant (LT), 23 or 64% of FIs reveal regime-switching adjustment (Col. 3 and 4); 20 out of these 23 display sign asymmetry when overpaying (Col. 5) and 5/23 when underpaying (Col. 6); for overpaid rates, 95% of FIs raise their rates faster when policy rate is cut (Col. 7); for underpaid rates, 57% of FIs raise rates faster when policy rate rises (Col. 9). Bold indicates the prominent type of asymmetry over all deposits and credit products.

Table 3. **Inferences from curvature model**

		H_0: k_P=0, k_N=0 (*Correction Proportional to Gap*) H_1: $k_P \neq 0$ or $k_N \neq 0$		H_0: γ_P-γ_N=0, k_P-k_N=0 (*No Regime-Switching*) H_1: γ_P-$\gamma_N \neq 0$, k_P-$k_N \neq 0$
Product	**Firms (*N*)**	**H_0 Rejected**	**Curvature**	**H_0 Rejected**
B-Sav-Instant				
LT (£2.5K)	38	22	58%	29%
MT (£10K)	39	20	51%	33%
HT (£250K)	32	16	50%	34%
B-Sav-30 day				
LT (£2.5K)	8	4	50%	13%
MT (£10K)	11	8	73%	27%
HT (£250K)	10	6	60%	30%
B-Sav-90 day				
LT (£2.5K)	5	4	80%	20%
MT (£10K)	5	3	60%	20%
HT (£250K)	5	4	80%	20%
H-Sav-Inst				
LT (£500)	41	21	51%	29%
MT (£5K)	46	24	52%	48%
HT (£10K)	43	17	40%	47%
H-Sav-30 day				
LT (£500)	9	6	67%	33%
MT (£5K)	18	6	33%	22%
HT (£10K)	20	7	35%	15%
H-Sav-60 day				
LT (£500)	5	2	40%	60%
MT (£5K)	16	7	44%	31%
HT (£10K)	17	10	59%	41%
H-Sav-90 day				
LT (£500)	11	5	45%	45%
MT (£5K)	22	7	32%	36%
HT (£10K)	26	15	58%	50%
Current Accounts				
LT (£500)	21	3	14%	10%
MT (£5K)	26	9	35%	42%
HT (£10K)	24	10	42%	42%
DEPOSIT TOTAL	*498*	*236*	*47%*	*35%*
Mortgages	54	12	22%	20%
Personal Loans	24	5	21%	33%
Credit Cards	29	6	21%	7%
Store cards	14	1	7%	0%
CREDIT TOTAL	*121*	*24*	*20%*	*17%*

The information reported in each column is as follows. Column 2: number of FIs in the sample excluding the few cases where coefficients are implausibly signed. Column 3: number and % of cases where the null hypothesis of linear error correction is rejected; significant k_P or k_N means that the speed of adjustment is driven by the square of the disequilibrium gap (u^2) or, equivalently, the error correction term is cubic in the gap. Column 5: % cases with regime-switching according to the sign of the gap in either the linear (u) or the nonlinear (u^3) error correction terms.

Table 4. Summary of explanatory variables

	SIZE	ASSETGR	VROAE	FROAE	KA	LLR	DIV	CI	MS	OH	LBA	FIN	PROD
Mean	0.236	0.091	0.244	-0.195	6.782	0.991	0.679	61.352	0.021	1.802	1.022	24	0.320
Median	0.020	0.075	0.047	-0.155	5.866	0.426	0.383	63.333	0.002	1.463	1.024	24	0.300
Maximum	2.663	0.549	6.698	-0.054	36.171	19.347	2.613	84.113	0.219	5.171	1.616	54	0.810
Minimum	3.50E-04	-3.54E-04	0.005	-1.119	3.826	0.037	-0.014	33.409	2.90E-05	0.454	0.518	5	0.040
Std. Dev.	0.519	0.076	0.850	0.166	4.186	2.433	0.702	10.251	0.046	0.970	0.295	14.879	0.185
Skewness	2.742	3.875	6.864	-3.657	5.462	6.692	1.207	-0.526	2.580	1.372	0.114	0.360	0.501
Kurtosis	10.365	22.367	52.129	18.668	38.206	50.671	3.164	3.164	9.055	4.663	2.485	1.997	2.428
Sample Size	66	66	66	66	66	66	66	66	66	66	23	27	66

Explanatory Variable	Acronym/Name	What it Measures
Assets in £trillions for each financial institution	SIZE	Bank size
Annual growth rate of assets (£trillions)	ASSETGR	Growth of the loan book
Variance of return on average assets	VROAE	Profit volatility
Period average fall in return on average assets	FROAE	Decline in performance
Capital (equity + disclosed reserves) to total assets	KA	Capital adequacy
Loan loss reserves to total loans	LLR	Risk
Non-interest income to average assets	DIV	Diversification
Cost to income ratio	CI	Efficiency
A FI's market share of the UK deposit market	MS	Market structure/power
Overheads expenses relative to total assets	OH	Menu costs
Logarithm of branches to total assets	LBA	Menu costs
Number of FIs offering a product	FIN	Market structure/concentration
Percentage of products offered by a financial institution	PROD	Product range
Type of ownership dummy: 1 if a bank, 0 otherwise	DUMMYB	Ownership

The top table reports summary statistics for the explanatory variables used in the cross-section analysis of nonlinearity. All variables are bank-specific, therefore Sample Size gives the number of FIs for which data is available (66 or 23 for LBA), except for FIN which is product-specific so 27 is the number of products in the sample; the latter excludes store cards since they are not issued by FIs. For every variable, each of the 66 data points summarised in the top table represents the annual observations (for each bank) averaged over the sample period under study or over a subsample if full-period data was not available (see Appendix A1).

Table 5. Cross-section regression analysis of nonlinearity in retail rate adjustment

Dependent variable	SIZE	ASSETGR	VROAE	KA	LLR	DIV	CI	OH	LBA	FIN	DUMMYB	PROD	N	Adj-R2
Size effect														
Deposits	-0.014	-0.168	**-0.010**	-0.001	**-0.011**	**0.083**		-0.027	*0.104*	**-0.001**	-0.015		461	5.63%
	(-0.90)	(-1.88)	**(-4.60)**	(-1.39)	**(-3.95)**	**(3.31)**		(-1.92)	*(2.78)*	**(-3.26)**	(-0.78)			
Credit Products				**0.007**						**0.002**			83	12.87%
				(2.16)						**(2.65)**				
Mortgages		-0.230	**-0.011**	**0.010**						N/A			49	7.13%
		(-1.62)	**(-3.20)**	**(2.66)**										
Sign asymmetry														
Deposits		7.04								**-0.05**			406	3.97%
		(1.58)								**(-2.81)**				
Credit Products			**-0.347**				0.016			**0.062**		-0.984	77	35.57%
			(-2.18)				(1.27)			**(5.01)**		(-1.34)		
Mortgages			**-0.381**				0.021	0.279		N/A		**-2.163**	42	7.32%
			(-6.47)				(0.88)	(0.84)				**(-1.97)**		
Curvature														
Deposits			0.222	-0.033		**0.422**			*1.883*	-0.010	**-0.651**	**-1.134**	457	2.68%
			(1.73)	(-1.68)		**(2.26)**			*(3.30)*	(-1.32)	**(-2.36)**	**(-2.06)**		
Credit Products			**0.171**			**0.153**	-0.010				**-0.272**	**-0.582**	84	30.51%
			(11.37)			**(2.26)**	(-1.80)				**(-2.11)**	**(-2.71)**		
Mortgages			**0.181**		0.173	0.210	**-0.018**				**-0.495**	**-0.761**	49	34.58%
			(3.61)		(1.25)	(1.77)	**(-3.37)**				**(-3.27)**	**(-2.58)**		

The table reports OLS estimates and White heteroskedasticity robust *t*-ratios for the final regressions in the sequential specific-to-general approach outlined in Section 5.4. Bold denotes significant at the 5% level. For LBA, observations for only 23 FIs are available so the variable is added to the final regression; italics indicate the estimates and *t*-ratios in this additional (reduced sample) regression. For the market concentration (FIN) variable, N/A means that for a given product, such as mortgage rates, the explanatory variable FIN has constant value so it cannot be included in the regressions.

APPENDIX

Table A1. Firms and products in the sample

	PRODUCTS																											
	Deposit																								Credit			
Num.	B-Sav-Inst			B-Sav-30			B-Sav-90			H-Sav-Inst			H-Sav-30			H-Sav-60			H-Sav-90			Current Acct			Mortg	PL	CC	SC
products	LT	MT	HT	LT	MT	HT	LT	MT	HT	LT	MT	HT	LT	MT	HT	LT	MT	HT	LT	MT	HT	LT	MT	HT				
17	1	1	1							1	1	1		1	1				1	1	1	1	1	1	1	1	1	
14	1	1	1							1	1	1		1	1							1	1	1	1	1	1	
3																						1	1	1				
1																											1	
6				1	1	1	1	1	1																			
1																											1	
8	1	1	1																			1	1	1	1		1	
18	1	1	1			1				1	1	1	1	1	1					1	1	1	1	1	1	1	1	
15	1	1	1							1	1	1		1	1		1	1					1	1	1	1	1	
6										1	1	1					1	1							1			
4	1	1	1						1																			
2																										1	1	
1																											1	
5		1	1															1							1	1		
2	1	1																										
4			1																				1	1	1			
6										1	1	1		1	1										1			
2	1	1																										
1																											1	
6										1	1	1								1	1				1			
2																							1	1				
7										1	1	1							1	1	1				1			
3											1	1													1			
7	1	1	1							1	1	1													1			
3																						1	1	1				
15	1	1	1											1	1		1	1		1	1	1	1	1	1	1	1	
8	1	1	1	1	1	1																				1	1	
1																												1
9		1	1								1	1									1		1	1	1		1	
10	1	1	1							1	1	1							1	1	1				1			
10	1	1	1							1	1	1							1	1	1				1			
8	1	1								1	1	1								1	1				1			
3	1	1	1																									
10	1	1	1							1	1	1	1	1	1										1			
2	1	1																										
2				1	1																							
2																										1	1	
8										1	1	1					1	1							1	1	1	
4																						1	1	1	1			
1																												1
3																						1	1	1				
22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1				1	1		
1																											1	
1																											1	
14	1	1	1							1	1	1					1	1				1	1	1	1	1	1	
3				1	1	1																						
2				1	1																							
1																												1
1																												1
3																						1	1	1				
13	1	1	1							1	1	1					1	1				1	1	1		1	1	
1																												1
1																											1	
4										1	1	1													1			
1																												1
1																												1
10	1	1	1	1	1	1					1	1								1	1							
1																									1			
4																	1	1			1				1			
1																												1
6											1	1										1	1	1	1			
6										1	1	1								1	1				1			
2																							1	1				
2																										1	1	
15	1	1	1	1	1	1				1	1	1									1	1	1	1		1	1	
3	1	1	1																									
13	1	1	1	1	1	1				1	1	1		1	1										1	1		
11	1	1					1	1		1	1	1							1	1	1					1		
2																										1	1	
8										1	1	1			1				1	1	1				1			
6										1	1	1					1	1							1			
10	1	1	1							1	1	1				1	1	1							1			
11	1	1								1	1	1					1	1		1	1				1	1		
1																												1
1																									1			
2																										1		1
3																				1	1				1			
15										1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	
18	1	1	1		1	1				1	1	1		1	1					1	1	1	1	1	1	1	1	
9	1	1	1							1	1	1								1	1				1			
7										1	1	1	1	1	1										1			
1																												1
5	1	1	1																			1	1					
8										1	1	1										1	1	1	1	1		
13	1	1	1							1	1	1	1	1	1							1	1	1	1			
13	1	1	1							1	1	1		1	1		1	1		1	1				1			
3																						1	1	1				
18	1	1	1							1	1	1	1	1	1	1	1	1				1	1	1	1	1	1	
1																												1
1																											1	
12					1	1				1	1	1				1	1	1	1	1	1				1			
2																										1	1	
4										1	1	1													1			
9	1	1								1	1	1							1	1	1				1			
4	1	1	1																								1	
1																												1
1																											1	
7	1	1	1								1	1			1										1			
6										1	1	1		1	1										1			
1																											1	
1																											1	
13	1	1	1				1	1	1	1	1	1							1	1	1				1			
1																									1			
8	1	1	1		1	1																1	1	1				
3							1	1	1																			
6										1	1	1					1	1							1			
1																												1
14										1	1	1	1	1	1					1	1	1	1	1	1	1	1	
8										1	1	1	1	1	1						1				1			
15										1	1	1	1	1	1				1	1	1	1	1	1	1	1	1	
662	38	40	34	9	12	11	5	5	5	43	48	48	9	18	20	5	16	17	11	24	28	24	29	28	54	31	36	14

PL denotes unsecured personal loan, CC is credit card and SC is store card. Blank means that the product is not being offered by the firm. For confidentiality reasons, the firm names are coded. BK=domestic bank. BKS=subsidiary owned by British bank. BS=building society. FB=foreign bank. FC=finance company (non-bank). INS=insurance company. PBK=private domestic bank. CS data refers to the availability of annual firm-specific financial ratios for the CS regression analysis; 1=available over full sample period; blank=not available; else, available years.

Table A2. Explanatory power of competing models

	Error Correction Models			
Products	**Linear**	**Size effect**	**Sign asymmetry**	**Curvature**
B-Sav-Instant				
LT (£2.5K)	50.1	**55.3**	53.5	54.3
	[9.4, 98.1]	[8.7, 98.2]	[11.0, 98.2]	[11.0, 98.6]
MT (£10K)	50.2	54.6	54.7	**54.9**
	[9.4, 96.8]	[12.2, 87.0]	[12.1, 97.0]	[12.2, 97.0]
HT (£250K)	55.7	**60.3**	57.2	58.8
	[11.8, 95.2]	[16.2, 95.6]	[15.2, 95.6]	[12.9, 95.5]
B-Sav-30 day				
LT (£2.5K)	42.9	**53.1**	46.3	48.1
	[26.0, 74.4]	[33.3, 76.3]	[26.8, 67.6]	[25.1, 76.7]
MT (£10K)	44.1	54.7	48.6	**55.9**
	[11.1, 87.9]	[33.6, 90.3]	[20.3, 89.4]	[29.6, 89.9]
HT (£250K)	52.9	61.2	46.0	**63.5**
	[12.1, 93.8]	[36.0, 94.5]	[19.8, 72.3]	[29.8, 93.9]
B-Sav-90 day				
LT (£2.5K)	45.1	49.9	51.1	**55.0**
	[17.4, 65.9]	[14.9, 67.2]	[22.6, 67.6]	[18.6, 76.8]
MT (£10K)	51.9	**61.7**	60.2	61.5
	[43.3, 60.7]	[47.5, 79.4]	[44.7, 79.4]	[46.2, 76.7]
HT (£250K)	57.9	65.7	67.9	**68.0**
	[44.8, 91.7]	[52.5, 92.6]	[50.8, 93.0]	[49.0, 93.6]
H-Sav-Instant				
LT (£500)	24.9	30.8	**35.9**	30.0
	[2.9, 55.2]	[9.9, 57.7]	[11.1, 81.6]	[4.1, 61.3]
MT (£5K)	26.5	32.4	**37.8**	28.7
	[7.3, 71.9]	[12.0, 77.7]	[16.4, 81.6]	[7.9, 77.4]
HT (£10K)	27.0	32.5	**37.6**	29.9
	[3.8, 71.0]	[6.9, 77.7]	[11.4, 81.6]	[3.0, 77.1]
H-Sav-30 day				
LT (£500)	48.7	**54.8**	54.4	51.2
	[26.0, 73.2]	[27.3, 73.5]	[20.5, 73.4]	[28.3, 76.7]
MT (£5K)	41.3	**46.2**	45.3	42.1
	[15.7, 65.2]	[14.2, 67.3]	[13.6, 69.2]	[13.0, 66.0]
HT (£10K)	42.3	48.5	**50.8**	42.4
	[23.0, 75.4]	[19.8, 75.4]	[20.3, 74.5]	[22.0, 66.2]
H-Sav-60 day				
LT (£500)	47.7	56.15	**57.21**	54.47
	[22.5, 59.9]	[42.1, 68.3]	[42.8, 66.9]	[24.2, 79.1]
MT (£5K)	43.0	49.7	**51.2**	46.1
	[14.8, 60.2]	[20.8, 69.7]	[28.0, 70.5]	[15.6, 79.1]
HT (£10K)	41.4	49.9	**52.9**	45.8
	[14.1, 66.5]	[23.5, 69.0]	[26.1, 71.7]	[15.5, 72.4]
H-Sav-90 day				
LT (£500)	26.1	34.6	**39.4**	33.4
	[8.3, 54.2]	[9.2, 66.9]	[20.7, 58.9]	[9.9, 63.1]
MT (£5K)	32.6	39.8	**40.8**	34.9
	[5.9, 62.5]	[8.0, 66.9]	[9.8, 61.2]	[9.7, 63.1]
HT (£10K)	32.8	**38.9**	38.8	35.2
	[0.0, 62.8]	[4.5, 67.8]	[10.2, 69.5]	[1.1, 63.7]
Current Accounts				
LT (£500)	23.6	28.6	**39.2**	27.0
	[0.0, 58.8]	[4.4, 70.4]	[0.9, 71.0]	[0.3, 76.6]
MT (£5K)	26.6	29.7	**34.8**	31.5
	[2.3, 63.5]	[0.5, 63.7]	[3.3, 64.5]	[6.3, 76.6]
HT (£10K)	29.5	28.3	**38.6**	34.1
	[0.0, 84.4]	[0.0, 63.7]	[9.6, 84.9]	[0.7, 84.7]
Credit Products				
Mortgages	48.3	51.1	**53.8**	49.5
	[17.9, 68.4]	[24.3, 69.7]	[29.5, 73.1]	[19.8, 68.7]
Personal Loans	4.8	6.4	7.8	**9.5**
	[0.0, 19.1]	[0.0, 24.7]	[0.0, 37.3]	[0.0, 49.3]
Credit Cards	5.7	10.5	**11.4**	8.5
	[0.0, 68.6]	[0.0, 68.5]	[0.0, 80.4]	[0.0, 65.7]
Store Cards	2.8	3.9	**4.7**	4.6
	[0.0, 14.6]	[0.0, 8.6]	[0.0, 17.0]	[0.0, 27.9]

The table reports the mean and the range (in square brackets) of the adjusted R^2 for the models associated with all the FIs that offer a given product. Linear is equation (1), Size effect is equation (2), Sign asymmetry is equation (3) and Curvature is equation (4). Bold denotes for each product the best model according to the largest mean adjusted R^2.

Table A3. Model selection

Products	Error Correction Models			
	Linear	Size Effect	Sign Asymmetry	Curvature
Panel A: All Financial Institutions				
B-Sav	15%	*34%*	15%	**36%**
H-Sav	*19%*	16%	**46%**	*19%*
Current accounts	*34%*	8%	**44%**	14%
DEPOSIT TOTAL	20%	20%	**36%**	23%
Mortgages	*28%*	11%	**52%**	9%
Personal Loans	**62%**	8%	*15%*	*15%*
Credit Cards	**67%**	0%	*23%*	10%
Store Cards	**87%**	0%	*7%*	*7%*
CREDIT TOTAL	**51%**	6%	*32%*	10%
Panel B: Banks				
B-Sav	9%	**35%**	*21%*	**35%**
H-Sav	21%	16%	**37%**	*26%*
Current accounts	*30%*	9%	**44%**	17%
DEPOSIT TOTAL	20%	20%	**34%**	*26%*
Mortgages	*39%*	11%	**44%**	6%
Personal Loans	**68%**	5%	*16%*	11%
Credit Cards	**61%**	0%	*26%*	13%
CREDIT TOTAL	**57%**	5%	*28%*	10%
Panel C: Building Societies				
B-Sav	20%	*34%*	9%	**38%**
H-Sav	*19%*	16%	**50%**	15%
Current accounts	**54%**	0%	*46%*	0%
DEPOSIT TOTAL	*21%*	*21%*	**38%**	*21%*
Mortgages	*22%*	11%	**56%**	11%
Personal Loans	**43%**	14%	14%	*29%*
Credit Cards	**86%**	0%	*14%*	0%
CREDIT TOTAL	*34%*	10%	**44%**	12%
Panel D: All FIs by Maturity				
Instant	20%	17%	**41%**	22%
30-day	18%	**33%**	29%	20%
60-day	27%	24%	19%	**30%**
90-day	18%	22%	**30%**	29%
>90 (Mortgages)	28%	11%	**52%**	9%
Personal Loans	**67%**	0%	23%	10%
Credit Cards	**62%**	8%	15%	15%

The table shows for each product or maturity the percentage of FIs whose retail rate dynamics is best captured by a linear, size effect, sign asymmetry, or curvature error correction model. Bold indicates the best model and italics the second-best model.