Heterogeneities in the Interest Rate Transmission Mechanism

Ana-Maria Fuertes, Shelagh A. Heffernan*

Cass Business School, City University London, 106 Bunhill Row, London EC1Y 8TZ

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Abstract

This paper differentiates itself from the existing literature by testing for the presence of intra and inter-bank heterogeneities in the UK interest rate transmission mechanism. Using a large disaggregated sample of monthly deposit and loan rates 1993-2004 for seven key products, an error correction model is adopted to measure long run pass-through, mark up and the short run speed of adjustment. Overall, the prediction that the official and retail rates move together in the long run is supported. However, financial institutions were found to adjust their rates in significantly different ways following changes in the official rate, which could hinder the achievement of policy objectives. Consumer responses to Bank of England official rate changes could therefore be phased and intricate. Heterogeneity in adjustment is found to be linked to menu costs and key financial ratios (e.g. ROE) under managerial control.

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* Corresponding author. T: 44(0) 207 040 8737; F: +44(0) 207 040 8881; E: s.a.heffernan@city.ac.uk

1. Introduction

Central banks in the industrialized countries use a number of channels to exercise monetary policy. An important conduit is changes in the central bank official rate to achieve inflation targets.[1] However, for this monetary policy tool effectively to influence future spending and the inflation rate, official rate changes must prompt similar changes in short money market instruments and retail rates.

In the UK, the impact of official rate changes on retail rates (particularly variable rate mortgages) is the most important vehicle influencing consumption, which makes up more than 60 per cent of aggregate demand. A number of theoretical arguments have been put forward to explain why retail rate responses might be sluggish. These include tacit collusion between financial institutions (FIs), sunk/menu costs and dynamic price discrimination that relies on consumer habit or inertia.

This study contributes to the literature in three ways. First, it exploits a large sample of disaggregated data to shed light on how published retail rates respond to changes in the Bank of England's official rate. The majority of available studies rely on aggregated data (averages of retail rates across FIs) which rules out the possibility of heterogeneities in retail rate behaviour, and hence could induce aggregation biases. The few papers that have used rates quoted by financial institutions are confined to one or two products and/or limited by short estimation periods.

Second, with its large panel dataset, this paper can analyse the short and long run dynamics of retail rates using the mean group approach of Pesaran and Smith (1995). Grouping the individual estimates by bank type (e.g. banks versus building societies) and by product type (e.g. current accounts versus mortgages), it is possible to test for inter-bank and intra-bank heterogeneity in the long run mark up and pass through and in the short run speed of adjustment. Significant heterogeneities in the retail rate responses to changes in the official rate will distort the impact of monetary policy if consumer reaction becomes relatively less predictable.

Third, this is the only study to date that investigates whether inter-bank heterogeneities in the speed of adjustment to the long run equilibrium rate are related to menu costs and managerial performance indicators. The empirical

[1] Other channels include wealth effects, impact on expectations, changes in the exchange rate and long term bond rates. See the Bank of England Monetary Policy Committee (2001) for a detailed review.

evidence finds links between the speed with which FIs adjust retail rates and key financial ratios such as profitability, costs and the number of branches.

The paper is organized as follows. The relevant literature is reviewed in Section 2. Section 3 describes the data and the econometric framework and Section 4 discusses the results of tests for long run co-movement. Section 5 presents tests for inter and intra-bank heterogeneities. This is followed by a regression analysis to investigate whether the cross-section variation in the adjustment speed is linked to variation in bank financial ratios. Section 6 summarises the conclusions.

2. Background Literature

Diebold and Sharpe (1990) probe the link between US monthly wholesale rates and retail deposit rates. Their retail rate series is created as an average from 25 commercial banks and 25 thrifts. They report strong evidence of causality from wholesale to retail rates and of sluggish retail rate responses. Hannan and Berger study over 12,000 price change decisions quoted by nearly 400 US banks over the period 1983-86. Their logit modelling framework reveals that the more concentrated the banking market, the more rigid the deposit rates. Also, they report greater rigidity following upward changes in the 3-month Treasury bill rate. Mester and Saunders (1995) study changes in the weekly prime lending rate.[2] Two periods are examined — one of 85 weeks with 20 rate rises and another of 87 weeks when rates decline 10 times. Using a logit model, they find that higher adjustment costs significantly reduce the probability of a rate change.

For the UK, using averages of building society mortgage and deposit rates, Paisley (1994) documents that market rates drive building society rates, although the relationship is not stable. Heffernan (1997) analyses UK monthly rates 1986-93 quoted by, at most, 8 banks/building societies on four products. Using linear error correction models (ECM), pass-through is shown to be complete for mortgages. Hofmann and Mizen (2004) analyze 17 years of monthly data on two products, mortgages and 90-day term deposits, in an ECM framework. A base rate is taken as proxy for the policy rate. Complete pass-through is found for mortgages but not deposits. They document asymmetries in adjustment linked to exogenous factors

[2] In the US the most creditworthy corporate borrowers can negotiate loans at near a bank's prime rate.

such as the actual or expected change in the official rate, and significant increases in the adjustment speed when the gap between the retail and official rate is growing**.**

Bredin et al. (2001) investigate the relationship between a money market rate (as a proxy for an official rate) and the average of the highest and lowest of four Irish loan rates. Pass-through is found to be incomplete and the speed of adjustment varies with the type of loan. Sander and Kleimeier (2004a) use monthly averages 1993:1-2002:10 on loan and deposit rates from 10 eurozone countries. Their analysis is based on a standard VAR model, a vector ECM or a first-difference VAR, depending on the stationarity properties of the data. They find evidence of short run price rigidity and report higher speed of adjustment measures when overnight money market rates are used to proxy changes in the policy rate. Their pass-through results suggest that eurozone retail banking markets remain highly fragmented.

Sander and Kleimeier (2004b) apply similar methods to test for interest rate pass-through 1993:1-2003:12 in eight transition economies: the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, the Slovak Republic and Slovenia. The central banks' policy rates are proxied by a one-month money market rate. The monthly rates (averaged across FIs in a given country) employed are for four loan and three deposit products. Most of the loan markets are characterised by complete pass-through, especially for corporate loan rates where the speed of adjustment is also high. For consumer loans and deposit products, pass-through is smaller. They conclude that the size and speed of pass-through increases by reducing concentration and loan risk and by increasing foreign bank participation.

De Bondt (2005) analyzes interest rate pass-through in the eurozone. He uses monthly average 'euro' deposit and loan rates 1996:1-2001:5 and several money market rates, including the overnight rate.[3] Short run adjustment is found to be, at most, about 50% monthly. Long term pass-through varied from nearly 40% for 90 day deposits, to close to 100% for bank lending rates. Higher adjustment speeds are found post-euro but with the exception of mortgages, pass-through is lower.

De Graeve et al. (2005) use monthly data 1993:1-2002:12 on six loan and seven deposit products of various maturities for 31 banks. Lending rates are fixed for the duration of a contract, except for mortgages, where they are semi fixed. The benchmark (or proxy for the policy rate) is a money market rate. Their ECM allows for asymmetries and for the adjustment speed to be driven by the disequilibrium level. They report evidence of heterogeneity in pricing between banks which is attributed to market power. The adjustment speed is highly variable across products. Pass-through is incomplete in the long run which is rationalized in terms of an imperfectly competitive banking market. There is less rigidity in corporate loan rate adjustment than in consumer credit. The larger the deviation from the long run mark up, the greater the adjustment speed in household deposit and loan rates. There is some evidence that deposit rates adjust relatively faster downward than upward.

Cottarelli and Kourelis (1994) focus on aggregated data (at country level) on monthly loan rates for 30 economies ranging from the US to Swaziland. They find that, following a change in money market rates, the loan rate adjusts on average by 67% after 3 months and 97% in the long run. This evidence is similar to that in Borio and Fritz (1995) for European countries.

Humala (2005) is one of the few studies to examine interest rate pass-through in a market characterised by periods of financial instability, Argentina from 1993:6 to 2000:12. He uses the local interbank rate as a proxy for the official rate and examines four types of loans (with different degrees of credit risk) which are weighted averages of bank rates. A Markov-switching VAR model is employed to allow for different financial crisis episodes. Credit risk is found to increase loan rate stickiness in normal periods and pass-through is more pronounced in volatile markets.

If the underlying goal is to shed light on the interest rate transmission mechanism, some of these studies suffer from one or more problems. First, virtually all of them use a money market/inter-bank rate as a proxy for the bank policy rate. These rates will be influenced by factors which may have nothing to do with a central bank's monetary policy goals. For example, changes in the demand or supply of deposits and loans on inter bank markets will affect overnight rates, even though there has been no change in a central bank's position. To examine the transmission mechanism, the appropriate rate is the central bank's official rate itself and its ready availability precludes the need for any proxy. Second, the meaning of pass-through varies across papers. As is explained in Section 3.2 below, pass-through is just one of several components of the interest rate transmission mechanism.

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[3] The euro rates are average rates across eurozone countries.

Finally, a high level of aggregation in the data raises concerns. There is an extensive macroeconometrics literature which discusses aggregation bias problems (Imbs et al., 2005; Pesaran et al., 2006). The use of aggregated data rules out the possibility that the dynamic relationship between official and retail rates can significantly differ across FIs. For example, the deposit or loan retail rates used by Sander and Kleimeier (2004a) are monthly average rates per country, and De Bondt's (2005) rates are even more aggregated. Naturally, these authors are constrained by the data available. Only Hannan and Berger (1991), De Graeve et al. (2005), Heffernan (1997) and Hofmann and Mizen (2004) employ individual bank rates. However, with the exception of the De Graeve et al. (2005), the products and banks are limited in number and some of the estimation periods are quite short.

One major contribution of the present study is that it relies on disaggregate UK data for 92 financial institutions on 8 types of deposit account (24 if the separation by tier is taken into account) and 4 credit products over a relatively long time span. By using this dataset and the panel mean-group approach of Pesaran and Smith (1995), the present study avoids aggregation bias problems. Moreover, it makes possible formally to test for inter-bank and intra-bank heterogeneities, the presence of which may hinder the effectiveness of monetary policy. There are other interesting questions related to asymmetries associated, for instance, with the direction of policy rate changes. These issues are addressed in a companion paper.[4]

3. Data and Empirical Method

3.1. The Sample of Official, Deposit and Loan Rates

The data source is *Moneyfacts* and *Business Moneyfacts*, two monthly publications by the Moneyfacts Group. The time span is 1993:1- 2004:9. The products are as follows.

Business Savings (B-Sav): Deposit rates quoted mainly to small and medium size businesses. Sub-products are created by maturity (instant, 30-day and 90-day) and by deposit levels or tiers (low, £2,500; medium, £10,000; high, £250,000). To ease the exposition, the low, medium, and high tiers are called LT, MT, and HT, respectively.[5]

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

[4] Full reference to be supplied when the refereeing process has been completed.

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

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 data includes rates for new and existing repayment mortgages, but the majority of banks are found to quote the same rate for both and so only one (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: Interest rate quoted on outstanding monthly balances.

Store Credit Cards: Interest rate quoted on outstanding monthly balances for credit facilities offered by major department stores such as Selfridges and John Lewis.

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). All rates are variable.

Each month since May 1997, the Bank of England's Monetary Policy Committee announces their decision on whether the interest rate will be increased, reduced or remain unchanged. The name given to this rate has changed through the years. Here it is called the official or policy rate because the markets interpret any change as a tightening or loosening of monetary policy. Given the present objectives, this rate is more appropriate than a money market rate for the reasons discussed in Section 2.

3.2. Econometric Framework

Although nominal interest rates cannot fall below zero, there is ample consensus that they behave as (unit root) non-stationary processes. A given retail rate cannot deviate from the official rate over long periods, i.e. there should be a long run equilibrium relationship between them. Nonetheless, several reasons have been put forward to explain why financial institutions may stagger their adjustment to official rate changes — transaction (e.g. menu) and sunk costs, consumer habit or inertia, and implicit collusion among financial institutions. Hence a central policy concern is, following an official rate change, how quickly and by how much retail rates change. An important element is the *long run* equilibrium rate (LRER) which depends on the

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[5] The tiers, chosen by *Moneyfacts,* are constant over time. FIs report the deposit rate they pay at each tier.

[6] During the interest rate volatility of the early 1990s, fixed rate mortgages gained a foothold but they continue to have a very small market share.

long run mark up and long run pass-through. These issues are best analysed using error correction models (ECM) that capture both the short and long run behaviour.

Let x_t denote a retail rate and y_t the official bank rate. An ECM can be written as:

$$\Delta x_t = \beta\Delta y_t + \gamma(x_{t-j} - x^*_{t-j}) + \sum_{i=1}^{k}\lambda_i\Delta x_{t-i} + \sum_{i=1}^{k}\theta_i\Delta y_{t-i} + \varepsilon_t,\ \varepsilon_t \sim iid(0,\sigma^2) \quad (1)$$

where $x_{t-j} - x^*_{t-j}$ is the gap (error) or deviation of the retail rate from its LRER given by $x^*_{t-j} = A + Cy_{t-j}$. The short term lag j represents the delay in the error correction. This paper focuses on three components of the interest rate transmission mechanism. The long run *mark up*, given by A, represents how much a banking product rate is marked above or below the central bank's official rate over the long run.[7] The long run *pass-through*, given by the (positive) parameter C, is defined as the amount by which a retail rate moves relative to the official rate over the long run. Pass-though is the fraction or multiple of an official rate change that is eventually reflected in the deposit or loan rate. Figure 1 illustrates graphically the parameters A and C.

[Figure 1 around here]

The *adjustment speed*, or how much of the gap which is driven by policy rate changes is closed monthly, is measured by the absolute value of the (negative) parameter γ.

The ECM for the analysis is:

$$\Delta x_t = \alpha + \beta\Delta y_t + \gamma x_{t-j} + \delta y_{t-j} + \sum_{i=1}^{k}\lambda_i\Delta x_{t-i} + \sum_{i=1}^{k}\theta_i\Delta y_{t-i} + e_t,\ e_t \sim iid(0,\sigma^2), \quad (2)$$

the estimation of which permits the mark up and pass-through to be measured as $A = -\alpha/\gamma$ and $C = -\delta/\gamma$, respectively. Equation (3) can be parameterized in levels as:

$$x_t = \alpha + \pi_1 x_{t-1} + ... + \pi_p x_{t-p} + \phi_0 y_t + \phi_1 y_{t-1} + ... + \phi_q y_{t-q} + \varepsilon_t,\quad q = p = k-1$$

which is called autoregressive distributed lag (ARDL) model.

To identify the appropriate lag length j, the following equation is estimated:

$$\Delta x_t = \alpha + \beta\Delta y_t + \gamma x_{t-j} + \delta y_{t-j} + e_t \quad (3)$$

for j=1,2,…,J where J is a maximum plausible lag (J=6). All six specifications are estimated using the same number of observations (T-J) and the Akaike Information Criteria is used to compare them. Model (3), with the selected j, is improved upon by adding enough difference terms, $(\Delta x_{t-i}, \Delta y_{t-i})$, to absorb the residual autocorrelation.

4. Co-movement Tests and Error Correction Model Estimates

4.1. Long Run Co-movement Between Retail and Official Rates

On economic grounds it can be argued that a retail rate x_t cannot deviate from the official rate y_t over long periods and so the two rates move together in the long run. The relative strengths of the different unit root/cointegration tests available to detect this co-movement depend on unknown aspects of the true data generating process, making it difficult to identify an 'optimal' test. Some tests suffer from low power (i.e. they underreject the null hypothesis) but others exhibit size distortions (i.e. overreject). This underlines the need for researchers to deploy a range of tests.

The empirical analysis in this paper begins from the maintained economic assumption that a retail rate cannot drift too far apart from the policy rate in the long run. Seven different tests are deployed and the presence of long run co-movement is only considered refuted by the data if there is unequivocal empirical evidence against it. First, the null hypothesis of no long run effect (H_0: $\delta=\gamma=0$) in equation (2) is tested through the bounds Wald procedure developed by Pesaran, Shin and Smith (2001). In addition, the interest rate differential $z_t=x_t-y_t$ is subjected to six unit root tests which differ in the way they exploit the signal-to-noise ratio.[8,9] Investigating whether there is mean reversion in z_t instead of in the static regression residuals, $e_t=x_t-A-Cy_t$, is not unreasonable because: a) it amounts to a conservative approach, that is, a stronger hypothesis is being tested, b) critical values are not available for many of the unit root tests deployed when long-run coefficients are estimated, c) the

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[7] Credit products are marked above (A > 0) whereas deposit products are marked below (A < 0). In this paper, the expression 'large mark up' refers for either deposits or loans to a sizeable A in absolute value.

[8] The tests include: 1) the Augmented Dickey Fuller (1979; ADF) test, 2) the semiparametric Phillips-Perron (1988; PP) test, 3) the Kwiatkowski, Phillips, Schmidt, and Shin (1992; KPSS) test that differs from the first two tests in that the data are assumed to be (trend) stationary under the null to mitigate the lack of power of the conventional ADF and PP tests in near-stationary cases, 4) the Dickey-Fuller test with GLS detrending (DFGLS) proposed by Elliot, Rothenberg, and Stock (1996) as a simple modification of the ADF tests in which the data are detrended so that explanatory variables are 'taken out' of the data prior to running the test regression, 5) the Elliot, Rothenberg, and Stock point optimal (ERS) test based on a regression for the quasi-difference of z_t that builds on the residual spectrum at frequency zero, 6) the Ng and Perron (2001; NG) modified form of Phillips-Perron statistic based on GLS detrended data and the residual spectrum at frequency zero. The regression lag length in the ADF, DFGLS, ERS and NG tests is selected automatically through the Schwarz Information Criterion from k=1,2,…,12. The spectral estimation method employed is the Barlett kernel in the PP and KPSS tests, the AR spectral-OLS in the ERS test and the AR GLS-detrended in the ERS and NP tests.

[9] For details and an extensive discussion, see Maddala and Kim (1998).

problem of testing for cointegration between retail rates and the policy rate with freely estimated coefficients is already tackled through the bounds Wald procedure.

To conserve space, the discussion focuses on the top 15 banks, offering 24 deposit and credit products.[10] For all but 5.4% of these retail rates, at least one of the seven tests produces strong evidence of a long run co-movement with the official rate.[11] As Table 1 shows, the few cases where there is no evidence of co-movement are:

- Household Savings Instant (LT, MT, HT) in 4, 2, and 1 bank, respectively.
- Current Account (Mid, High tier) in 1 and 2 banks, respectively.
- Unsecured Personal Loans in 1 bank.
- Credit Cards in 1 bank.

[Table 1 around here]

Reported also are the adjustment speed measures for these 'no co-movement' cases. It turns out that, for all but one of them, the speed of adjustment is well below average. For example, for the H-Sav Instant LT offered by BK1 and BK11, none of the seven tests is able to detect co-movement; at the same time, their respective speeds of adjustment (0.016, 0.046) are considerably low compared to the the top 15 average (0.113) and the all FIs average (0.111). The speed of adjustment for BK11's credit card is 0.013, well below the top 15 average at 0.054 and the overall average at 0.083.

Thus, although each retail rate is expected to co-move with the official rate in the long run, it is not surprising to find persistent deviations for a small minority of cases because of their low adjustment speeds. The more sluggish the adjustment, the tougher it is for a test to produce evidence of co-movement. This observation is backed up by t tests for differences in γ between two groups: banks for which the Wald test suggested co-movement and those for which it did not.[12] For every product tested, the latter group of banks had a significantly lower adjustment speed.

[10] The top 15 are defined as those with the highest tier 1 capital. Detailed test results can be found in the website appendix Table A1 at *www.cass.city.ac.uk/faculty/a.fuertes*.

[11] For under 5% of the overall sample (comprising 600 retail rates) the Wald test provided no evidence of a long run co-movement. For details, see Table A2 in the website appendix for this paper.

[12] Detailed results are available from the authors upon request.

4.2. Short Run Adjustment and the Long Run Equilibrium Rate

The ECM captures the dynamics of retail rates quite well. The adjusted R^2 reaches a high of 69% for mortgages and 87% for savings. However, there is notable variation in the fit of the model across products. Among assets, the adjusted R^2 is much higher for mortgages (49% on average) than for personal loans or credit cards (5%). For liabilities, B-Sav has the highest adjusted R^2 (50% on average) and the lowest are for current accounts (25%). There is a slight tendency for the adjusted R^2 to increase with the tier — for example, for the B-Sav LT and HT products it averages, respectively, 46% and 53%. The superiority of the ECM for both mortgages and high tier deposit products may be linked to some commonalities: they are relatively low risk and the direct marginal management costs are small; banks may also think clients are relatively well informed of prices set by their rivals and, in the presence of a large number of suppliers, prepared to switch if the difference is marked.

Personal loans and credits cards involve relatively high direct costs for managers which are not constant — for example, default rates vary widely over time. Current accounts and lower tier savings also carry relatively high management costs and their holders may be perceived as less knowledgeable about alternative suppliers' rates or are more inert because the sums involved are quite low. Thus the supply elasticity for these products may well have changed over time and across banks.

Least squares estimation of equation (2) yields unbiased measures of the long run mark up (*A*) and pass-through (*C*) together with the short run speed of adjustment (γ), and the adjustment delay (*j*). The long run equilibrium level (LRER) of each individual retail rate, x_{it}, is a target level given by $x_{it}^* = A_i + C_i y_t$. Hence, the amount of change in the LRER per unit change in the official rate y_t is given by the long run pass through, $C_i = \Delta x_{it}^* / \Delta y_t$.

Table 2 presents the ECM estimates.[13] The short run behaviour is set out in columns 4-5, which report the mean-group estimates and ranges for the percentage of error closed monthly (given by $100 \cdot |\gamma|$) and the adjustment delay or lag (*j*), respectively. Long run behaviour is summed up in Columns 5-7, which show the mean-group estimates and ranges that correspond to the long run mark up (*A*), long run pass through (*C*) and the time-average LRER, hereafter referred to as the LRER for ease of exposition.

[Table 2 around here]

For savings, the individual LRERs range from a low of 0.73% (B-Sav Instant LT) to a high of 10.53% (H-Sav Instant HT). The range for current accounts is from 0.03% (LT) to 4.38% (HT). With the exception of mortgages, the LRER is notably higher for credit products, ranging from 6.28% to 17.98% for unsecured personal loans to between 13.34% and 29.12% for store cards.[14] For 90 day B-Sav, the adjustment lag is one month at all tiers but there is substantial variation in the percentage of error closed each month, ranging from 7% for one bank to about 70% for another. The other deposit products display a similar variation in the adju

stment speed but the lag is more variable – from one to six months. The maximum degree of error correction is at its lowest for credit products.

Turning to household saving accounts, on average about 16% of the error is closed monthly. Again, these averages hide differences in the way banks react to a change in the policy rate. For example, the percentage of error closed monthly lies between 0.5% and 5% for banks with an adjustment lag of one month. Among the banks with an adjustment lag of 4-6 months, the amount of the gap closed each month can be as much as 54% to 72%

For current accounts, some banks close between 0.8% and 3% of the gap after a month whereas others close 40% but with a 6 month delay. Finally, on average, about 7% of the error is closed per month for credit products with the range varying from as little as 1.3% for one bank, rising to 22% for another.

In general, when the adjustment delay ranges from 4 to 6 months, between 82% and 91% of the error is closed each month. For those with a delay of one month, the monthly error correction ranges between 43% and 62%. The key message from this discussion is that the retail rate responses to official rate changes vary substantially across FIs.

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[13] Detailed results for each FI and product can be found in the website appendix Tables A2 and A3.

[14] Due to non-stationarity issues, the comparison of individual time-average LRERs in an unbalanced panel should be treated with caution. Nevertheless, this is not a serious problem because the individual products being compared in the discussion are sampled over roughly similar periods.

5. Heterogeneities in Retail Rate Responses to Policy Rate Changes

5.1 Group-Mean Difference Tests by Type of Financial Institution

Financial institutions with different objectives, costs or market characteristics could differ in their responses to a policy rate change. For example, in the UK, it is frequently argued that unlike quoted banks answering to shareholders, building societies, as mutual organisations with substantial reserves, can opt to protect their depositor/borrower 'shareholders' by smoothing their responses or delaying passing on changes in the central bank rate.[15] Alternatively, smaller FIs may offer customers keener prices or alter their prices more quickly than larger ones.

The empirical analysis in Section 4 provided prima facie evidence of heterogeneities among FIs with respect to their short and long run responses to policy rate changes. Formally to address the heterogeneity problem, difference-in-mean t statistics are employed to test for discrepancies in the way different types of FIs react to changes in the official rate in terms of the short-term adjustment speed (γ), and the long run mark up (A) and pass through (C).[16] For each product, institutions that offer it are assigned to one of the following groups: the top 5 and/or top 15 banks (defined by tier one capital), small banks, building societies and other firms. For products that are offered by a sufficiently large number of building societies, a pairwise comparison is made between banks and building societies.

For example, consider the comparison of mortgages offered by banks (the reference or control group) versus building societies. The test interpretation is:

- If the t statistic for γ is significantly positive, it indicates that the adjustment process to long run equilibrium or 'closing the gap' mechanism is slower for banks than for building societies.
- If the t statistic for A is significantly positive, the long run mark up on mortgages ($A > 0$) by banks is smaller than that by building societies.[17]

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[15] Building societies are mutual organizations where every borrower and depositor has a share in the organization but only one vote, independent of the size of the deposit or loan.

[16] The significance of differences in a parameter Z for groups a (reference) and b with sample means and variances z_i and σ_i^2, $i=a,b$ is tested using the t-statistic $(z_a - z_b)/\{\sigma_a^2/N_a + \sigma_b^2/N_b\}^{1/2}$ which follows a limit $N(0,1)$ distribution. Since the number of observations per group (N_i) can be small, the critical values of the Student-t distribution with N_a+N_b-2 degrees of freedom are used instead. The Jarque-Bera test confirmed that the samples are approximately normally distributed in all cases.

[17] The opposite holds for deposit products because they are marked down ($A < 0$).

- If the t statistic for C is significantly positive, banks exhibit more long run pass through than building societies. Referring to Figure 1, for products with a steeper long run pass through (larger C) the marginal effect of a given policy rate change on their LRER is relatively stronger.

The main findings of the tests for intra-bank differences are reported in Table 3.

[Table 3 around here]

Columns 3 through 5 report the mean-difference t statistics for the adjustment speed (γ), mark up (A) and pass-through (C), respectively. Notable differences between FIs are found in both γ and A for about half the deposit and loan products.

The test results for B-Sav Instant, current accounts, mortgages and credit cards imply that bigger banks tend to adjust their rates significantly more slowly in response to policy rate changes. This sluggish response could stem from a combination of high transactions costs and market dominance because of, say, an extensive branch network and/or product range. More research, beyond the scope of this paper, is needed to adjudicate between these explanations. However, in the case of 90 day B-Sav and H-Sav, banks are quicker than building societies to adjust their rates in response to policy rate changes. The contrast may be explained by the different ownership structures. Profit maximising banks adjust their saving rates significantly faster, but mutual building societies could have different priorities, making them, compared to banks, less sensitive to the presence of other types of investment at this maturity, especially at the higher tiers.

The long run mark up on mortgages and on most deposit products is significantly larger for the top 5/15 banks and, in some cases, for all banks relative to building societies — the exceptions are 30 day B-Sav (HT), instant H-Sav (LT) and current accounts. For credit cards, the mark up is smaller for the top 5/15 banks.

The long run pass-through on deposits is largely homogeneous among FIs. Exceptions include H-Sav-Instant (MT) and current accounts (LT, HT) where the pass through of the top 5-15 banks is significantly smaller than that of other financial firms. The opposite is found for personal loans and credit cards. For current accounts (HT), pass-through is also more muted for banks compared to building societies.

A popular view is that building societies offer their customers-shareholders better value than banks. Mortgages were the traditional domain of building societies until the mid 1980s when most of the major banks entered the market. Interestingly, no significant differences between banks and building societies are found in γ, A or C for mortgages. However, once the smaller banks and other suppliers (e.g. firms that specialise in selling mortgages) join the building societies to form the 'other' group in the tests, significantly differences among FIs are uncovered for both γ and A — it is the smaller FIs, including building societies, that have a lower mark up and adjust their mortgage rates faster compared to the top 5-15.[18]

There is a widely held suspicion that store cards have, on average, a larger mark up than credit cards; the empirical findings support it — the positive t statistic in the 'SC/CC' comparison for A is strongly significant. Over the sample period, the mark up on store cards exceeds that on credit cards by 8% on average.

5.2. *Group-Mean Difference Tests by Type of Product*

Another heterogeneity issue is whether, for a given change in the official rate, individual banks exhibit different pricing behaviour across products. In particular, is the speed of adjustment lower for personal loans than for mortgages? Is the long run pass-through identical for all deposit products? To answer these and related questions, the banking products are grouped by key characteristics such as tier, maturity of deposits, type of client, collateral and type of loan agreement.

For each FI, a t statistic for differences in the speed of adjustment (γ) is computed for several pairwise combinations of the products available. Likewise, for the long run mark up and pass through.[19] For the test results to be more informative, the focus is on FIs that offer (nearly) all of the products in the sample.[20] A significantly positive t statistic indicates that the first product of the pair shows:

- A slower adjustment speed (γ) to the LRER.
- A larger long run mark up (A) for loans; a smaller mark down for deposits.
- A more pronounced pass-through (C), that is, a steeper long run equilibrium line, implying greater long run sensitivity to official rate changes.

[18] In 2004, the average assets of the top 5 building societies was £75,734 million compared to the top 5 banks which had average assets of £586, 431 million.

[19] Let γ_a and γ_b denote the estimates of the adjustment speed γ for two products, with standard errors SE_a and SE_b. For each FI in the sample, the difference t statistic is computed as γ_a-γ_b/$\{SE_a^2 + SE_b^2\}^{1/2}$ which follows asymptotically a $N(0,1)$ distribution. The SEs are based on White's covariance matrix where appropriate. Since the mark up and pass-through measures are nonlinear functions of estimated parameters, A=-α/γ and C=-δ/γ, their SEs are obtained by means of the delta method.

Table 4 summarises the results. Columns 3 and 4 report for γ the proportion of banks for which the difference *t* statistic is significantly positive and negative, respectively. Likewise, columns 5 through 8 set out the test results for *A* and *C.*

[Table 4 around here]

In contrast to the previous analysis (c.f. Table 3) which established some notable inter-bank differences, Table 4 illustrates broad intra-bank similarity, that is, the response by a bank to a change in the official rate is largely homogeneous among the products that it offers. Differences in the term of deposit, type of client, and the presence or absence of collateral/formal loan agreement do not appear to influence the way a bank reacts to a policy rate change. In particular, significant differences in the speed of adjustment are rare. This is consistent with the observation that a given bank will tend to change all its rates at once, possibly due to menu costs.[21]

However, a test for 'balance sheet' effects through a comparison of 90 day H-Sav with mortgages reveals that nearly half of the FIs tested (all major market players in retail banking) have a significantly negative *t* statistic for γ suggesting that they react to a policy rate change by adjusting their three month household savings rates significantly faster than their mortgage rates. The *t* statistic for *C* is positive for all but two banks, indicating that the long run sensitivity of savings rates to the policy rate is greater than that of mortgage rates.[22] Table 4 also shows that for all FIs tested, the mark up on credit cards is significantly higher than that on mortgages, reflecting that credit card debt is unsecured. This may also explain why in the long run, credit card rates are more sensitive than mortgage rates (significantly larger *C*) to policy rate changes.

5.3 Managerial Discretion, Menu Costs and Bank Heterogeneities

The foregoing analysis has established significant evidence of heterogeneity across banks in the speed of retail rate adjustment to policy rate changes. Hence, it seems natural to ask: what lies behind the inter-bank heterogeneity? One possible answer is the presence of menu costs and differences in managerial behaviour. The term

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[20] There are ten such FIs which include 7 of the top 15 banks, 1 smaller bank and 2 (one large and another quite small) building societies.

[21] In cases where one or two banks display significant differences, it probably means very little because significant *t*-tests would be expected in 5% of the sample cases on average.

[22] The mark up for deposits ($A < 0$) and loans ($A > 0$) is not comparable due to the different sign.

'managerial behaviour' is used here to emphasise the link between pricing and key financial ratios — managers are responsible for both. There is an extensive literature on, respectively, menu costs and sticky prices, and the managerial/shareholder relationship.[23] The latter is linked to agency theory: managers maximise their own utility subject to a minimum profit and/or shareholder remuneration constraint.[24] This section investigates whether the inter-bank heterogeneity uncovered is linked to an agency problem in the shareholder/managerial relationship and to menu costs.

For each product, the adjustment speed ($100|\gamma|$) is regressed on a set of managerial/menu cost indicators for a cross-section of FIs. The following variables are chosen as proxies for managerial behaviour: return on average equity (ROAE), return on average assets (ROAA), assets, the asset growth rate, the Basel risk asset ratio and the ratio of cost to income.[25] Largely under the control of managers, shareholders use these indicators to monitor bank performance. The number of branches per bank is a useful proxy for menu costs. The question being addressed is whether the variability in the adjustment speed is related to bank variation in those performance indicators. No inference on causality is drawn from the regressions.[26]

The correlation coefficient between bank size (by assets) and number of bank branches is high at 0.65. This finding is not surprising because the scale and dispersion effects are linked — in the UK, the larger banks (by assets) tend to have more branches. For this reason, the ratio of branches to assets (in logarithms to allow for diminishing returns) is used as regressor because it adjusts for bank size, giving a measure of dispersion/proximity, or customer convenience. The correlation between the two performance measures ROAA and ROAE is positive but low at 0.16.[27] Table 5 summarises the potential explanatory variables for the cross-section regressions.

[Table 5 around here]

In view of the limited number of observations and to preserve degrees of freedom, a sequential approach is adopted to find the 'best' cross-section regression, defined in

[23] There are a large number of published studies on menu costs. Those most closely linked to banking include Ball and Mankiw (1994), Caplin and Spulber (1987), Dutta et al. (1999), and Wynne (1995).
[24] The emphasis on maximising managerial utility subject to these constraints has its roots in the classics such as Baumol (1958), Marris (1966), Mirrlees (1976), and Williamson (1963). These ideas are applied to the banking sector by Adams and Santos (2006), Edwards (1977) and Fama and Jensen (1983) inter alios.
[25] The focus is on the adjustment speed because, unlike mark up and pass-through, it is a short run parameter and therefore, more easily linked to managerial issues such as performance and efficiency.
[26] A Granger causality analysis would require a time sequence of adjustment speeds (γ_t) for each bank.

terms of the highest adjusted R^2. The seven managerial/menu cost indicators are ranked according to their absolute correlation with the regressand. The variable which is most highly correlated is included first in a simple regression. The variable with the second highest correlation is considered as an additional regressor 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 6 reports the estimates for the selected variables.

[Table 6 around here]

The adjustment speed is positively related with the cost to income ratio for 6 different deposit products, significantly so in 5 of them. For 11 products, the coefficient on ROAE is negative and the effect is significant in 9 cases. Thus, a higher cost to income ratio and a lower return on equity are associated with a faster speed of adjustment. Both findings are consistent with the hypothesis that managers at less efficient banks will attempt to pacify shareholders by reacting quickly to official rate changes. If the policy rate falls and hence, the benchmark marginal revenue, banks are more likely to reduce loan rates to attract more business, and correspondingly, lower their deposit rates. This behaviour is consistent with any profit maximising bank operating in an oligopolistic market, but especially inefficient banks if profits are falling to a level that is likely to prompt shareholder action.

The coefficient on ROAA is positively signed for 7 different products (significant in 6 of them) which suggests that banks with a lower ROAA tend to adjust rates more slowly. This finding may reflect indirect reverse feedback: a lower ROAE results in a relatively faster adjustment speed to a new equilibrium rate, which could result in the bank taking more business from its rivals, thereby raising ROAA.

The branches ratio is significantly related to retail rate adjustment for 4 different products, 3 of which have negative coefficients suggesting that the reaction to an official rate change tends to slow down as the branch network expands. This supports the presence of 'internal' menu costs which deter rapid adjustment. Large banks with multiple branches may take longer to reach/communicate decisions about rate changes and so they are slower to adjust their rates after a change in the

[27] This is likely caused by the loan component of a bank's assets, which is one of its major products too. In other sectors, assets consist of property, plant and machinery, all of which determine output.

official rate, no matter what its direction. If rates fell, this would boost income but if raised, revenues would fall, depending on the reaction of their competitors.

There is no clear pattern for assets, asset growth rate and the Basel ratio. The lack of an obvious role for asset variables in explaining heterogeneities in rate adjustment is consistent with the observation that banks no longer focus on expanding the balance sheet unless it improves profitability. Furthermore, the risk asset ratio for most UK banks has averaged around 11%, fluctuating little since 1987 when banks were first obliged to meet a minimum requirement of 8%.[28]

To sum up, while managerial accountability to shareholders is linked to rapid rate adjustment, the presence of menu costs (proxied by the scale of the branch network) has the opposite effect. Once these factors are controlled for, the size effect (assets) appears less relevant in explaining heterogeneity in speed of rate adjustment.

5.4 Implications for Monetary Policy

The present analysis has revealed marked inter-bank heterogeneities in the speed of retail rate adjustment to policy rate changes whereas, in contrast, at an individual bank level the degree of heterogeneity in responses across products is less pervasive. It is found that the variation in adjustment speed across banks is to some extent linked with variability in bank performance. The behaviour of the major banks differs significantly from that of other FIs in terms of both the short run speed of adjustment and long term mark up. Differences were also found between building societies and banks. Hence, the Bank of England faces disparate reactions to policy rate changes. Suppose policy-makers raise official rates. The major banks, with their high market share, are significantly slower in adjusting some of their rates. Deposit and loan rates, including the all important mortgage rates, tend to rise more slowly for major banks than for building societies, other minor banks and some non-banks. Additionally, for mortgages and several deposit products, the major banks' long term mark up is greater than that of other FIs.

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[28] The lack of evidence on a bank size effect may appear to contradict the findings of Section 5.1, but the two sets of results are not strictly comparable, for two reasons. First, the analysis in this section controls for a number of other variables in addition to bank size, which may reduce the importance of a size effect. Second, the cross-section regressions are based on a smaller sample (N) than the mean-difference tests in Section 5.1 because only the FIs for which financial ratios are available can be included. Average risk asset ratios have been higher than the minimum largely due to pressures from the regulators and markets.

The Bank of England's policy rate either fell or did not change during 110 of the 128 months in the sample. These episodes lasted between 15 and 42 months. Periods with rising rates were brief (5 months or less), except for the final 10 months of the sample, when they were increased by 25 basis points three times. Though evidence for intra-bank heterogeneities was weak, two findings are worth noting. First, for a given change in policy rates, the long run sensitivity (pass through) of savings rates tends to be greater than that of mortgages. Second, among the major banks, the adjustment of savings rates towards their new LRER after a policy rate shock is significantly faster than that of mortgage rates.[29] Though the relatively slow adjustment speed for mortgages is not ideal, a central bank should not be unduly concerned provided this product heterogeneity is predictable. But is it? Further research is needed to answer this question. The clear message from this study is that banks react to policy rate changes in very mixed ways making it more difficult for the central bank accurately to predict the course of the transmission mechanism.

6. Conclusions

The principal objective of this paper is to test for significant inter-bank and intra-bank heterogeneities in the responses of retail rates to changes in the Bank of England's policy rate. By using aggregate retail rates, many published studies on interest rate pass through implicitly assume that all financial institutions are identical in they way they react to policy rate changes. The data for this study is highly disaggregated, consisting of monthly rates 1993:1-2004:9 set by individual financial institutions for a wide range of products: business and household savings deposits with different maturities and tiers, current accounts at three deposit levels, unsecured personal loans, mortgages, credit cards and store cards. This extensive dataset both in the time and cross-section domain differentiates the present paper from previous studies — the analysis provides a better understanding of bank pricing by analyzing a substantially large part of the UK banking market.

The sample consists of six hundred retail rates and for each of these an error correction model is estimated to identify three components of the interest rate

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[29] This finding is consistent with the general view that banks adjust savings rates more quickly than mortgage rates if the policy rate is falling. This and other asymmetries are the subject of a sequel paper (full reference to be supplied when the refereeing process has been completed).

transmission mechanism: the long term mark up and pass-through which, alongside the official rate, determine the long run equilibrium rate, and the short run speed of adjustment towards equilibrium. Statistical tests reveal significant heterogeneity across banks in their responses to a change in the policy rate. By contrast, for a given bank, the responses across products are largely homogeneous with one exception: there is some evidence to suggest that mortgage rates are less responsive than savings rates among the major players.

Cross-section regressions suggest that, to some extent, the inter-bank heterogeneity in the adjustment speed of retail rates is linked to heterogeneity in managerial discretion and menu cost factors. Managerial accountability to shareholders appears to be linked with a speedy rate adjustment following a change in the official rate. But the scale of the branch network implies slower adjustment.

Overall, this study has shown that banks' short term adjustment speeds and long run responses to official rate movements are not all identical. This means that the interest rate transmission mechanism is more intricate than is conventionally thought which could make policy goals more difficult to achieve.

References

Adams, R.B. and J.A.C. Santos, 2006. Identifying the Effect of Managerial Control on Firm Performance. Journal of Accounting & Economics 41, 1/2, 55-85.

Bank of England, 2001. The Transmission Mechanism of Monetary Policy. Monetary Policy Committee, London: Bank of England.

Ball, L. and G. Mankiw, 1994. A Sticky Price Manifesto. Carnegie Rochester Conference Series on Public Policy, 127-152.

Baumol, W., 1958. On the Theory of Oligopoly. Economica 25, 187-98.

Bredin, D., T. Fitzpatrick and G. O'Reilly, 2001. Retail Interest Rate Pass-Through: The Irish Experience, Central Bank of Ireland, Technical Paper 06/01.

Diebold, F.X. and S. A. Sharpe, 1990. Post-Regulation Bank-Deposit-Rate Pricing: The Multivariate Dynamics. Journal of Business and Economic Statistics 8, 281-291.

Borio, C. and W. Fritz, 1995. The Response of Short-term Bank Lending Rates to Policy Rates: A Cross-Country Perspective. Financial Structure and the Monetary Policy Transmission Mechanism , Basel: BIS.

Cottarelli, C and A. Kourelis, 1994. Financial Structure, Bank Lending Rates and the Transmission Mechanism of Monetary Policy. IMF Staff Papers 41, 4, 587-623.

Caplin, A. and D. Spulber, 1987. Menu Costs and the Neutrality of Money**.** Quarterly Journal of Economics 102, 703-725.

De Bondt, G., 2005. Retail Bank Interest Rate Pass-Through: New Evidence at the Euro Area Level. German Economic Review 6, 1, 37-78.

De Graeve, F., O. De Jonge and R. Vander Vennet, 2005. Competition, Transmission and Bank Pricing Policies: Evidence from the Belgian Loan and Deposit Markets. Mimeo, Ghent University.

Dickey, D.A. and W. A. Fuller, 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association 74, 427-431.

Dutta, S., M. Bergen, D. Levy and R. Venable, 1999. Menu Costs, Posted Prices and Multiproduct Retailers. Journal of Money Credit and Banking 31, 683-703.

Edwards F.R., 1977. Managerial Objectives in Regulated Industries: Expense Preference Behaviour in Banking. Journal of Political Economy 85, 147-162

Elliot G., T.J. Rottenberg and J. H. Stock, 1996. Efficient Tests for an Autoregressive Unit Root. Econometrica 64, 813-830.

Fama, E. and M. Jensen, 1983. Separation of Ownership and Control, and Agency Problems and Residual Claims. Journal of Law and Economics 26, 301-325 and 327-349.

Hannan, T. and A. Berger, 1991. The Rigidity of Prices: Evidence from the Banking Industry. American Economic Review 81, 4, 938-945.

Heffernan, S. A., 1997. Modelling British Interest Rate Adjustment: An Error Correction Approach. Economica 64, 211-231.

Hofmann, B. and P. Mizen, 2004. Interest Rate Pass-through and Money Transmission: Evidence from Individual Financial Institutions' Retail Rates. Economica 71, 281, 99-124.

Humala, A., 2005. Interest rate Pass-Through and Financial Crises: Do Switching Regimes Matter? The Case of Argentina. Applied Financial Economics 15, 2, 77-94.

Imbs, J., H. Mumtaz, M.O. Ravn and H. Rey, 2005. PPP Strikes Back: Aggregation and the Real Exchange Rate. Quarterly Journal of Economics, 120, 1-43.

Kwiatkowski, D., P.C.B. Phillips, P. Schmidt and Y. Shin, 1992. Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root, Journal of Econometrics, 54, 159-178.

Maddala, G.S. and Kim, I., 1998. Unit roots, Cointegration and Structural Change. Cambridge University Press: Cambridge.

Marris (1966), The Economic Theory of Managerial Capitalism, London: Macmillan.

Mester, L. J. and A. Saunders, 1995. When does the Prime Rate Change? Journal of Banking and Finance 19, 5, 743-764.

Mirrlees, J.A., 1976. The Optimal Structure of Incentives and Authority Within an Organisation. Bell Journal of Economics 7, 105-31.

Ng, S. and P. Perron, 2001. Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. Econometrica 69, 1519-1554.

Paisley, J., 1994. A Model of Building Society Interest Rate Setting. Bank of England Working Paper, Series 22, June.

Pesaran, M. H. and R. P. Smith, 1995. Estimating Long Run Relationships from Dynamic Heterogeneous Panels. Journal of Econometrics 68, 79-113.

Pesaran, M. H., R.P. Smith and T. Yamagata, 2006. Pairwise Tests of Purchasing Power Parity Using Aggregate and Disaggregate Price Data, University of Cambridge, mimeo.

Pesaran, M.H., Y. Shin and R.J. Smith (2001). Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics* 16, p289-326.

Phillips, P.C.B. and P. Perron, 1988. Testing for a Unit Root in Time Series Regression. Biometrika 75, 335-346.

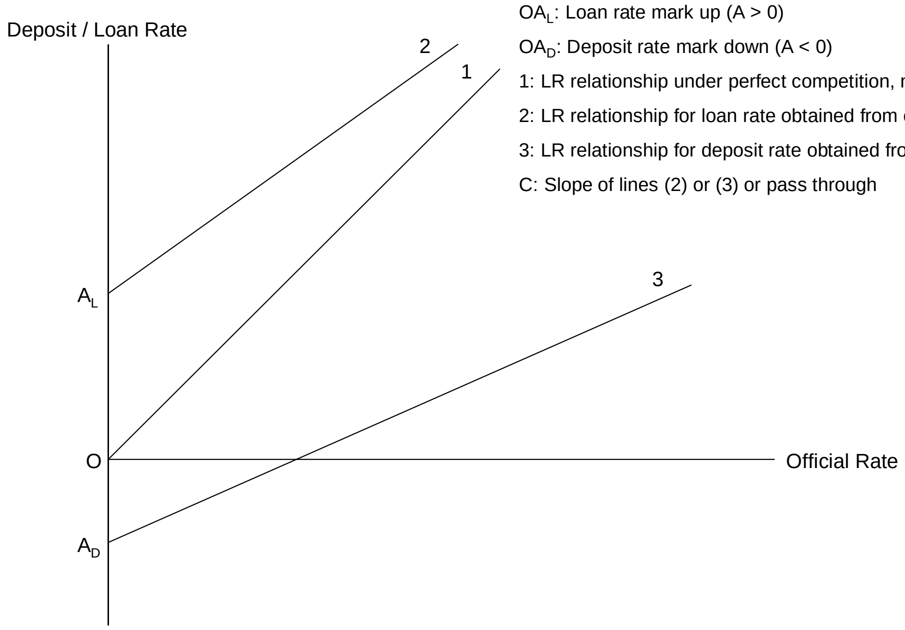
Sander, H. and S. Kleimeier, 2004a. Convergence in Eurozone Retail Banking: What Interest rate Pass-Through Tells us about Monetary Policy Transmission. Journal of International Money and Finance 23, 461-492.

Sander, H. and S. Kleimeier, 2004b. Interest Rate Pass-through in an Enlarged Europe: The Role of Banking Market Structure for Monetary Policy Transmission in Transition Countries. METEOR, Maastricht Research School of Economics of Technology and Organization, Working Paper 05.

Williamson, O.E., 1963. Managerial Discretion and Business Behaviour. American Economic Review 53, 1032-1057.

Wynne, M., 1995. Sticky Prices: What is the Evidence? Federal Reserve Bank of Dallas, Economic Review, First Quarter 1-12.

Figure 1. Long Run (LR) Relationship between Deposit/Loan Rates and the Official Rate



OA_L: Loan rate mark up (A > 0)

OA_D: Deposit rate mark down (A < 0)

1: LR relationship under perfect competition, no banking costs

2: LR relationship for loan rate obtained from equation (3)

3: LR relationship for deposit rate obtained from equation (3)

C: Slope of lines (2) or (3) or pass through

Table 1. Long Run Equilibrium Tests

Product Type	Top 15 Banks Failing all Tests		Average Adjustment Speed	
	Bank	Adjustment Speed	Top 15	All FIs (*N*)
H-Sav Instant LT (£500)	BK1	0.016	0.113	0.111 (42)
	BK8	0.103		
	BK11	0.043		
	BK13	0.034		
H-Sav Instant MT (£5K)	BK11	0.028	0.103	0.089 (48)
	BK13	0.005		
H-Sav Instant HT (£10K)	BK11	0.019	0.107	0.089 (48)
Current Accounts MT (£5K)	BK3	0.014	0.053	0.077 (29)
Current Accounts HT (£10K)	BK3	0.008	0.055	0.105 (32)
	BK11	0.024		
Personal Loans	BK24	0.023	0.057	0.059 (32)
Credit Cards	BK11	0.013	0.054	0.083 (36)

Notes: The adjustment speed reported is the absolute value of the negative parameter γ. A 'failing test' refers to a unit root or cointegration test that was unable to produce evidence of long run co-movement between a given retail rate and the official rate. For each product, the last two columns report the mean adjustment speed for the top 15 banks and for the total number of FIs in the sample (*N*) that offer the specified product.

Table 2. Short-Run and Long-run Behaviour of Retail Rates

Product Type	Cross-Section Units (N)	Short run		Long run		
				Equilibrium Path (LRER) $x_t^* = A + Cy_t$		Average LRER $\bar{x}^* = A + C\bar{y}$
		% error closed ($100\|\gamma\|$)	adjustment delay (j)	Mark Up (A)	Pass-Through(C)	
B-Sav Instant						
LT (£2.5K)	37	22.5	1.3	-2.37	0.84	2.06
		[3.9, 91.3]	[1, 6]	[-0.20, -6.34]	[0.31, 1.75]	[0.73, 4.65]
MT (£10K)	40	24.9	1.1	-2.47	0.96	2.62
		[3.1, 81.7]	[1, 4]	[-0.12, -6.45]	[0.35, 1.75]	[0.87, 4.83]
HT (£250K)	32	23.3	1.1	-1.75	0.98	3.40
		[2.6, 56.3]	[1, 2]	[-0.04, -3.67]	[0.64, 1.25]	[1.28, 4.99]
B-Sav 30 day						
LT (£2.5K)	9	24.0	1.4	-2.62	0.91	2.17
		[4.1, 53.8]	[1, 5]	[-1.08, -5.25]	[0.37, 1.66]	[0.85, 3.42]
MT (£10K)	12	29.0	1.1	-2.34	1.06	3.21
		[7.1, 61.2]	[1, 2]	[-0.92, -4.30]	[0.83, 1.51]	[1.31, 4.30]
HT (£250K)	10	32.5	1.2	-1.32	1.09	4.11
		[20.1, 52.2]	[1, 3]	[-0.33, -2.51]	[0.96, 1.40]	[3.25, 4.82]
B-Sav 90 day						
LT (£2.5K)	5	28.8	1.0	-2.01	0.86	2.41
		[6.9, 61.9]	[1, 1]	[-1.10, -2.69]	[0.58, 1.04]	[1.23, 3.27]
MT (£10K)	4	31.9	1.0	-1.67	1.01	3.49
		[13.2, 43.5]	[1, 1]	[-0.92, -2.33]	[0.82, 1.61]	[3.14, 4.13]
HT (£250K)	5	25.1	1.0	-2.24	1.21	4.00
		[1.4, 42.9]	[1, 1]	[-0.38, -6.48]	[0.86, 1.74]	[2.78, 4.62]
H-Sav Instant						
LT (£500)	38	10.9	1.5	-1.78	0.83	2.83
		[1.6, 53.9]	[1, 6]	[-0.002, -5.10]	[0.03, 1.27]	[0.06, 7.68]
MT (£5K)	41	9.9	1.4	-2.30	9.88	3.13
		[0.5, 53.9]	[1, 5]	[-0.000, -6.11]	[0.14, 1.50]	[0.07, 7.75]
HT (£10K)	42	9.6	1.4	-2.44	1.04	3.29
		[1.4, 53.9]	[1, 5]	[-0.000, -6.28]	[0.16, 1.74]	[0.83, 10.53]
H-Sav 30 day						
LT (£500)	9	17.7	1.2	-1.34	0.88	3.13
		[4.3, 34.9]	[1, 3]	[-0.01, -3.45]	[0.46, 1.17]	[1.58, 5.24]
MT (£5K)	18	19.1	1.5	-1.84	1.02	3.53
		[0.6, 61.3]	[1, 5]	[-0.011, -6.71]	[0.37, 1.51]	[2.21, 6.79]
HT (£10K)	20	22.4	1.3	-1.79	1.14	4.15
		[3.0, 71.5]	[1, 4]	[-0.007, -5.55]	[0.87, 1.44]	[2.64, 7.44]
H-Sav 60 day						
LT (£500)	5	24.2	1.6	-1.73	0.92	3.10
		[4.9, 43.2]	[1, 4]	[-0.44, -3.17]	[0.71, 1.14]	[2.07, 4.07]
MT (£5K)	16	22.1	1.3	-2.30	1.09	3.64
		[4.7, 47.1]	[1, 4]	[-0.19, -8.03]	[0.63, 1.79]	[2.47, 5.10]
HT (£10K)	15	28.7	1.1	-2.23	1.16	4.12
		[4.6, 60.8]	[1, 2]	[-0.47, -7.54]	[0.96, 1.84]	[3.20, 5.57]
H-Sav 90 day						
LT (£500)	10	15.8	1.2	-2.51	1.06	3.42
		[4.1, 47]	[1, 3]	[-1.11, -4.17]	[0.87, 1.37]	[2.32, 4.84]
MT (£5K)	23	13.2	1.3	-2.75	1.17	3.81
		[3.6, 31.7]	[1, 4]	[-0.22, -7.26]	[0.77, 1.86]	[2.58, 5.23]
HT (£10K)	28	12.3	1.1	-2.15	1.15	4.28
		[2.3, 38.8]	[1, 4]	[-0.08, -5.63]	[0.62, 1.61]	[2.79, 6.42]
Current Accounts						
LT (£500)	20	8.7	1.6	-0.89	0.27	0.65
		[3.00, 27.8]	[1, 6]	[-0.001, -6.29]	[0.03, 1.49]	[0.14, 2.55]
MT (£5K)	25	8.0	1.7	-2.02	0.61	1.42
		[1.4, 37.4]	[1, 5]	[-0.02, -7.09]	[0.02, 1.77]	[0.11, 4.38]
HT (£10K)	26	11.0	1.5	-2.10	0.66	1.65
		[0.8, 39.8]	[1, 6]	[-0.09, -6.44]	[0.07, 1.39]	[0.03, 4.38]
Credit Products						
Mortgages	54	6.0	1.2	3.06	0.73	4.13
		[1.6, 11.8]	[1, 6]	[1, 4.9]	[0.34, 1.00]	[1.95, 5.98]
Personal Loans	16	7.0	1.4	4.43	1.38	11.95
		[1.7, 15.2]	[1, 3]	[0.10, 17.54]	[0.06, 2.56]	[6.28, 17.98]
Credit Cards	26	7.2	1.3	11.76	1.02	17.36
		[1.3, 21.6]	[1, 4]	[2.40, 18.86]	[0.00, 2.43]	[11.89, 21.07]
Store Cards	14	6.9	1.1	20.25	0.94	25.44
		[1.3, 16.6]	[1, 2]	[7.19, 27.49]	[0.04, 3.39]	[13.34, 29.12]

Notes: LRER is the long run equilibrium rate. y_t is the official rate at time t and $\bar{y}$ is its average over the sample period. For each product the mean group estimates together with the range (in squared brackets) are reported.

Table 3. Tests for Inter-Bank Heterogeneities

Product Type	Bank Groups	Adjustment Speed *t*-statistic (γ)	Mark Up *t*-statistic (A)	Pass Through *t*-statistic (C)
B-Sav Instant				
LT (£2.5K)	Top 5 / Other	**2.970**	0.360	-0.335
	BK / BS	**3.221**	0.348	-0.935
MT (£10K)	Top 5 / Other	**3.268**	-0.076	-1.039
	Top 15 / Other	1.254	**-2.358**	-0.110
HT (£250K)	Top 5 / Other	1.553	**-1.828***	0.153
	Top 15 / Other	1.168	**-2.069**	-0.352
B-Sav 30 day				
LT (£2.5K)	BK / BS	1.268	1.027	-1.151
MT (£10K)	BK / BS	1.066	0.860	**1.825***
HT (£250K)	BK / BS	-0.196	**1.801***	-0.136
B-Sav 90 day				
LT (£2.5K)	Top 5-15 / Other	**-2.323**	1.298	-1.432
MT (£10K)	Top 5-15 / Other	**-1.687***	-0.470	-0.662
HT (£250K)	BK / BS	**-1.742***	-0.897	1.180
H-Sav Instant				
LT (£500)	Top 15 / Other	-0.142	**1.923***	-0.011
	BK / BS	-0.163	-1.553	-1.270
MT (£5K)	Top 15 / Other	1.169	0.053	**-1.824***
	BK / BS	-1.128	-1.274	-1.187
HT (£10K)	Top 15 / Other	0.146	**-1.751***	0.111
	BK / BS	-0.935	**-1.836***	0.371
H-Sav 30 day				
LT (£500)	BK / BS	0.843	**-2.766**	-0.023
MT (£5K)	Top 5-15 / Other	-0.082	**-2.937**	0.477
	BK / BS	0.144	**-3.380**	0.383
HT (£10K)	Top 15 / Other	1.452	**-4.894**	0.937
	BK / BS	**1.705***	**-4.619**	0.514
H-Sav 60 day				
MT (£5K)	Top 15 / Other	0.283	0.902	-0.777
	BK / BS	0.368	1.211	-0.812
HT (£10K)	Top 5-15 / Other	-1.500	0.922	-0.336
	BK / BS	-1.541	0.418	-0.202
H-Sav 90 day				
LT (£500)	BK / BS	**-1.932***	0.395	-0.819
MT (£5K)	BK / BS	**-2.150**	-0.380	0.643
HT (£10K)	Top 5-15 / Other	**-1.790***	-1.217	0.314
	BK / BS	**-1.988**	-0.608	0.418
Current Accounts				
LT (£500)	Top 5-15 / Other	**3.766**	**2.360**	**-2.421**
	BK / BS	**2.102**	-0.447	-0.554
MT (£5K)	Top 5 / Other	**3.628**	1.355	-1.306
	BK / BS	-0.023	-1.323	0.273
HT (£10K)	Top 15 / Other	**2.504**	**3.320**	**-4.510**
	BK / BS	0.010	1.115	**-1.617***
Credit Products				
Mortgages	Top 5 / Other	**1.749***	**2.140**	-0.762
	Top 15 / Other	0.019	**1.830**	-0.690
	BK / BS	0.697	0.287	-0.141
Personal Loans	Top 5 / Other	1.320	-1.240	**1.856***
Credit Cards	Top 5-15 / Other	**1.962**	**-1.725***	**1.629***
Store Cards	SC / CC	0.260	**3.398**	0.075

Notes: The *t*-statistics reported are for two-sided tests on pairwise comparisons (e.g. Ho:A_1=A_2). 'Top 5/Other' refers to the top 5 banks versus all other banks and building societies. If there are not enough of the top 5 banks for reliable inference, the 'Top15/Other' test is conducted instead. 'Top 5-15' means that the top 5 and the top 15 groups differ by just 2 or 3 banks. BK/BS' refers to the test that compares banks and building societies; this test was only conducted for products with enough FIs per group for reliable inference. 'SC/CC' means store cards versus credit cards. Bold indicates statistically significant at the 10% level using Student t critical values. H-Sav 60 day (LT) is not reported due to insufficient data.

Table 4. Tests for Intra-Bank Heterogeneities

		Number of FIs with significant intra-bank heterogeneities					
		Adjustment Speed (γ)		Mark Up (A)		Pass Through (C)	
Product Groups	Effect	*t* -stat (+)	*t* -stat (-)	*t* -stat (+)	*t* -stat (-)	*t* -stat (+)	*t* -stat (-)
B-Sav Instant at £2.5K and £250K	B-Sav Tier	1/8	0	1/8	1/8	0	4/8
H-Sav Instant at £500 and £10K	H-Sav Tier	1/9	0	0	0	2/9	0
Current Accounts at £500 and £10K	CA Tier	0	0	2/9	0	0	3/9
B-Sav Instant at £10K and H-Sav Instant £10K	Client - 1	0	0	1/8	1/8	1/8	3/8
B-Sav Instant at £10K and Current Accounts £10K	Client - 2	0	0	0	1/7	2/7	0
H-Sav Instant at £10K and Current Accounts £10K	Cheque book	0	1/7	0	2/7	2/7	0
H-Sav Instant at £10K and Term Deposits £10K	Term	3/10	0	1/10	2/10	1/10	2/10
Personal Loans and Mortgages	Collateral 1	0	0	1/7	0	3/7	1/7
Credit Cards and Mortgages	Collateral 2	0	1/8	8/8	0	7/8	0
Personal Loans and Credit Cards	Loan Agreement	0	0	1/6	0	0	0
H-Sav 90-day £10K and Mortgages	Balance Sheet	0	4/9			7/9	0

Notes : The first column specifies the pairwise comparisons. For example, the first row reports the results of comparing the low and high tiers of B-Sav Instant. The second column indicates the effect being tested. Columns 3 to 8 report the proportion of FIs for which the two-sided *t* -statistic is significantly positive or negative, meaning that the effect is present. For example, 4/8 in the first row under t-stat(-) on C means that in 4 out of 8 cases (FIs available), the long run pass-through is less pronounced for the B-Sav Instant at £2.5K than at the £250K tier. In the test for term effects, deposits with the longest maturity are used, i.e. H-Sav at 60 or 90 days. The sample consists of 10 Fis that offer all (or most) of the products. The total FIs vary between 8 and 9 because one or two did not offer a particular product. For example, 1 of the 10 did not offer a 90 day H-Sav account so 9 Fis were tested for a 'balance sheet' effect.

Table 5. Summary Statistics of Manageria/Menu Cost Indicators

Statistics	ROAE	ROAA	Assets	Asset Growth	Basel 1	C:I	B:A
Mean	12.692	0.845	0.0934	12.903	11.937	59.346	8.831
Median	10.498	0.609	0.0118	11.603	12.110	60.110	8.963
Maximum	30.270	4.079	0.637	36.934	16.800	81.520	10.762
Minimum	1.795	0.274	0.000	2.587	6.350	36.150	6.617
Std. Dev.	6.683	0.746	0.155	6.927	2.309	10.490	0.944
Skewness	0.610	2.853	1.897	1.495	-0.506	0.013	-0.202
Kurtosis	2.784	11.745	6.066	6.251	3.333	2.522	2.515
Observations	36	36	36	36	35	36	36

The bank-specific data described in this table are averages of annual data 1997-2004 for 36 financial institutions, except for Basel1 which is available in 35 cases. ROAE is the return on average equity. ROAA is the return on average assets. Asset Growth is asset growth rate. Basel1 is (Tier1+Tier2) capital over risk weighted assets. C:I is cost over income. B:A is the logarithm of the number of branches over assets. Assets in trillions of pounds

Table 6. Cross-Section Regression Analysis for Speed of Adjustment

		Managerial / Menu Cost Indicators								
Product Type	a	ROAE	ROAA	Assets	Asset Growth	Basel 1	C:I	B:A	N	adj-R^2
B-Sav Instant (LT)	9.761	**-0.799**				1.391			22	22.4
	(0.533)	(0.051)				(0.209)				
B-Sav Instant (MT)	6.229	**-1.415**	**11.930**			-1.086	**0.496**	0.481	23	65.6
	(0.825)	(0.002)	(0.001)			(0.331)	(0.074)	(0.854)		
B-Sav Instant (HT)	**38.179**	**-1.648**	**10.024**			-0.469			23	61.9
	(0.032)	(0.000)	(0.003)			(0.669)				
B-Sav (LT)	**28.076**	**-0.873**							28	23.1
	(0.000)	(0.006)								
B-Sav (MT)	-9.384	**-1.525**	**11.653**	**25.599**		**-1.949**	**0.711**	1.942	29	61.5
	(0.726)	(0.000)	(0.001)	(0.081)		(0.079)	(0.014)	(0.479)		
B-Sav (HT)	-35.115	-0.622	**7.111**	22.849	0.434			**5.734**	27	13.6
	(0.323)	(0.281)	(0.062)	(0.241)	(0.255)			(0.091)		
H-Sav Instant (LT)	**12.240**					1.314			25	3.1
	(0.000)					(0.199)				
H-Sav Instant (MT)	**11.303**					1.199			27	1.4
	(0.000)					(0.253)				
H-Sav Instant (HT)	**70.456**	**-0.868**	**10.681**	-15.910	-0.402			**-5.623**	28	15.6
	(0.041)	(0.082)	(0.058)	(0.371)	(0.285)			(0.099)		
H-Sav 30 day (MT)	**20.026**		-10.616						14	2.7
	(0.003)		(0.265)							
H-Sav 30 day (HT)	**25.162**	**-0.870**				1.824	**0.927**		16	27.8
	(0.000)	(0.091)				(0.299)	(0.094)			
H-Sav 90 day (MT)	**68.598**							**-5.941**	13	46.7
	(0.001)							(0.006)		
H-Sav 90 day (HT)	**98.472**					-1.839	0.263	**-8.843**	15	46.4
	(0.003)					(0.177)	(0.272)	(0.004)		
H-Sav (LT)	**20.389**				-0.302				41	1.2
	(0.000)				(0.232)					
H-Sav (MT)	**41.903**	**-0.567**	3.625					-2.451	62	2.6
	(0.017)	(0.063)	(0.336)					(0.185)		
H-Sav (HT)	**22.232**	-0.332							67	0.4
	(0.000)	(0.273)								
Current Accounts (LT)	**13.108**	**-0.207**	-1.187	-6.968					13	22.5
	(0.001)	(0.097)	(0.221)	(0.147)						
Current Accounts (MT)	8.102			-4.625	-0.115*	-0.667	**0.148**		17	45.6
	(0.268)			(0.196)	(0.104)	(0.205)	(0.037)			
Current Accounts (HT)	-26.948			-6.574	-0.0416		**0.322**	2.139	16	43.4
	(0.123)			(0.257)	(0.714)		(0.009)	(0.166)		
Mortgages	2.612		**1.514**	**-4.376**	0.0514	0.147			26	8.4
	(0.225)		(0.078)	(0.089)	(0.244)	(0.349)				

Notes: For each product, the OLS parameter estimates and *p*-values (in parentheses) are reported for a regression of the adjustment speed ($100|\gamma|$) on a set of financial indicators. a is the intercept. See Table 5 for a description of the regressors. Adj-R^2 is the adjusted coefficient of determination. Bold indicates statistical significance at the 1%, 5% or 10% level. * denotes marginally significant with a *p*-value slightly above 10%. N is the number of observations. Some products (e.g. personal loans) are excluded because there are not enough observations for reliable inference. For the savings accounts where no maturity is specified, e.g. B-Sav (LT), the regression estimates are based on pooled data across all available maturities.