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How do anticipated changes to short-term market rates influence banks' retail interest rates? Evidence from the four major euro area economies

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How do anticipated changes to short-term market rates influence banks' retail interest rates? Evidence from the four major euro area economies[§]

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Abstract

Much of the literature on interest rate pass through assumes banks set retail rates by observing current market rates. We argue instead that banks anticipate the direction of short-term market rates when setting interest rates on loans and deposits. Including anticipated rates - captured by forecasts of short-term market rates or futures rates - in an empirical model requires a detailed consideration of the information contained in the yield curve. In this paper we use two methods to extract anticipated changes to short-term market rates - a level, slope, curvature model and a principal components model - at many horizons, before including them in a model of retail rate adjustment for four retail rates in four major euro area economies. Using both aggregate data and data from individual French banks, we find a significant role for forecasts of market rates in determining interest rate pass through; alternative specifications with futures information yield comparable results.

Keywords: forecasting, factor models, interest rates, pass-through

JEL: C32, C53, E43, E44

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1 Introduction

One of the lessons learned in the recent financial crisis concerns the critical importance of the mechanisms banks use to finance their lending. Banks, which had become progressively more reliant on short-term market funding for their lending activities and less reliant on their deposit base, found their ability to lend was closely connected to the availability of funds in the money markets. Banks substantially changed their funding model a decade before the financial crisis emerged (Borio, 2008, Mizen, 2008, and Llewellyn, 2009) making them more dependent on short-term market-based finance up until the point that the financial crisis occurred. We might conclude that the consequence of this change would be a close correspondence between the rates that banks charged to lend to each other and the rates that they offered to households and firms, but this is not the case.

Figure 1 plots four retail rates for a representative euro area country (Germany) showing time deposits, short- and long-term loans to enterprises and mortgages from 1995-2007, while Figure 2 plots four market rates of interest, the 3-month and 12-month EURIBOR rates and 2-year and 10-year bond yields. As market rates rise and fall so it appears retail rates follow suit, but closer inspection reveals that retail rates do not follow market rates to the peaks and the troughs. While there is a reasonably close correspondence between rates at which banks can borrow in the interbank market and rates offered to retail borrowers, banks smooth the rates to some degree. This observation notwithstanding, most recent papers on interest

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rate pass through have argued the opposite and assumed that there is a close contemporaneous relationship between rates for retail customers and the current market rates at the same maturity.[1] According to these conventional models, the rates faced by new business should have fully reflected the current changes to costs of borrowing on the money markets even at the peaks and the troughs.

We argue otherwise. There are two reasons why banks smooth out variations in market rates in the interest rates offered to their customers. First, there is a cost of changing interest rates, which deters banks from making changes in one direction that may need to be reversed after a short duration; this also stops them from continuously changing rates. It is not the purpose of this paper to focus on this issue, but it is necessary to acknowledge that for a variety of reasons, adjustment to rates is not costless. Second, banks seek to anticipate the future direction of interest rates, particularly when they are setting rates for many periods, and even more so when they will have to refinance the loans that they make in the future, possibly several times. This is the primary focus of our paper because the current empirical literature does not discuss how projections of market rates might influence banks when they set retail rates. Expectations only feature in these papers to separate anticipated and unanticipated changes to *current* monetary policy. As we show, it is relatively straightforward to allow for the influence of *future* expected rates, and this is the contribution of our paper.[2]

[1]Examples of excellent papers in this tradition include Baugnet et al. (2007), de Bondt (2002, 2005), de Bondt et al. (2005), Borio and Fritz (1995), Cotarelli and Kourelis (1994), De Graeve et al. (2007), Ehrmann et al. (2001), Ehrmann and Worms (2001), Fuertes et al. (2008), Gambacorta (2008), Heffernan (1997), Hofmann and Mizen (2004), Kleimeier and Sander (2006) Kok-Sørensen and Werner (2006) and Sander and Kleiemeier (2004). These papers make two important contributions to the literature. First, they offer empirical evidence on the equilibrium relationship between retail and contemporary market rates, and second, they explore the dynamic adjustment around the equilibrium allowing for asymmetry, nonlinearity and the efficiency of markets across countries with a common source of shocks to market rates.

[2]The literature does not consider the impact of future money market rates on current retail rate setting, but in many respects it searches for evidence of market efficiency. Krueger and Kuttner (1996), Kuttner (2001), Bernoth and von Hagen (2004) consider efficient markets and Kleimeier and Sander (2006) have used futures prices to make allowance for anticipated and unanticipated monetary policy changes on the adjustment of retail rates. Kleimeier and Sander (2006) show there is a greater response to anticipated monetary policy changes measured by

Our paper differs in three distinctive respects from most empirical studies of interest rate setting that have largely concentrated on a contemporaneous relationship between retail and market rates with closely matched maturities, and no adjustment costs. First, we offer a forward-looking model in which banks form expectations about future rates when setting interest rates. Second, it assumes that banks cannot always perfectly match the maturity of loans to sources of funds. Third, the model allows for refinancing, and introduces costs of adjustment to retail rates.

We begin by offering a simple theoretical framework in which financial institutions look forward when setting interest rates. Financial institutions face incentives to anticipate the direction of future changes to market rates in order to avoid making costly changes to retail rates that may subsequently need to be reversed. Banks also anticipate future market rates because they cannot match maturities perfectly between loans and sources of funds, and therefore need to anticipate the costs of refinancing their loans at various points in the future. This offers a theoretical basis for the relationship between retail and future market rates of interest.

We then use this theoretical structure to motivate the inclusion of expected money market rates in our dynamic adjustment model of retail rates for data aggregated across banks within each country and for groups of individual banks in a representative country (France).[3] We do this using two methods described in Diebold and Li (2006). First, we generate forecasts of market rates using a dynamic Nelson-Siegel representation of the yield curve. Second, we forecast future rates using principal components extracted from the covariance matrix of market rates at various maturities. Using forecasts of changes to 1-month and 3-month maturities for EURIBOR market rates we then use the information on anticipated future changes to market rates to predict changes in four different retail rates in the four of the largest economies of the euro area (France, Germany, Italy and Spain) at

interest rate futures than to unanticipated changes.

[3]If the future level of market rates enters the empirical specification for interest rates this can either be included in the determination of the long-run relationship or it can be included as future expected *changes* in money market rates in the dynamic model.

various forecast horizons.

The data used in the estimation comes from two sources. The first comprises variables at a monthly frequency from January 1994 to July 2007 for France, Germany, Italy and Spain from the harmonized monetary and financial institutions' interest rate (MIR) dataset. This is what may be called the aggregate dataset. The second dataset consists of interest rates (also at a monthly frequency) taken from a sample of individual French banks. This disaggregation enables us to check whether the results derived from the first dataset are a consequence of the aggregation involved in constructing the MIR statistics using individual bank-level data. For France the disaggregate results confirm those from the aggregate dataset. Similar analysis could in principle be undertaken for the remaining countries but we are constrained by access to the relevant data which are available to us only for France.

We select the appropriate lag structure for the models using Bayesian information criteria and report the degree of interest rate pass through in each case. We are able to test the significance of coefficients on the forecasts of future changes to money market rates in our model at different maturities. When we compare our results from forecasting models with an alternative model using EURIBOR futures, we find that the results are very similar, both in terms of the pass through coefficients that we obtain, and the significance of the variables that anticipate future changes to money market rates. Our results provide evidence that previous modelling strategies, using only contemporary market rates to explain retail rates, neglected a large amount of relevant interest rate information in the yield curve about future short-term rates. Our approach acknowledges the uncertainty about future market rates which banks face when they set retail rates, and by forming forecasts of future market rates banks are able to take into account their expectation of future rates in the current retail rate setting decision.

The paper is organized as follows. The next section provides a brief literature review. Section 3 provides a theoretical basis for including forecasts of future market rates, Section 4 gives an outline of our econometric methodology, and Section 5 gives our data sources. Section 6 reports the results, with Sections 6.1 and 6.2 presenting the results for the aggregate data and Section 6.3 the results for bank-level data. Section 7 concludes. All tables and figures are given at the end of the paper and a brief data appendix lists the data sources used.

2 Literature on Rate Setting In Europe

The recent literature has addressed several contributions to the question of rate setting by banks which we discuss briefly below.

2.1 Equilibrium relationships between retail and market rates

Many of the studies cited in the introduction have used time series of weighted averaged interest rates by broad product category such as deposits, loans and mortgages; others have employed individual rates for identifiable banks, products, and product tiers within countries. Some of these papers have used the official refinancing rate as the benchmark, others have used a closely related short-term money market rate such as a EURIBOR rate. The equilibrium relationship between retail and money market rates modelled in these papers is assumed to be contemporaneous and does not include forecasts of future money market rates. This can be justified by appealing to a 'cost of funds' argument, which states that the marginal cost of funds is best captured by the market rate with the closest maturity to the retail product. A similar and related argument for this approach is that the monetary or financial institution will try to avoid mismatch in assets and liabilities by funding a loan with market finance at a similar maturity e.g. a money market instrument or bond issue, and therefore the rate or yield on that instrument gives the benchmark rate.

However, this approach is subject to several potential criticisms. First, it is not always possible to find a close match between retail and market rates for empirical analysis because the retail rate categories can be quite coarse - a problem that was particularly acute with the National Retail Interest Rate (NRIR) dataset, but is less serious for the Money and financial institutions Interest Rate (MIR) dataset. Besides, market rates exist only at certain maturities, and while interpolation is possible to infer rates at intermediate maturities, none of these interpolated rates is available on a single market instrument. A better definition of the rates on different bank deposits, loans and mortgages is made possible through the MIR statistics. Authors using recent data have been able to select the market rate to match more closely the maturity of the retail rate, but this is far from being a perfect solution. Kok-Sørensen and Werner (2006) overcame some of these problems by using higher definition MIR data, creating synthetic market rates from the existing actual market rates at given maturities and by selecting benchmark rates using correlations within pre-defined maturity bands appropriate for the retail rate in question. Their work represents one of the most sophisticated approaches to the issue of benchmark rate selection and is one that we follow in this paper, using their data series. But instead of matching maturities exactly, we are able to allow for the maturities to be mismatched, making refinancing necessary for interest rate adjustment. We explain this in more detail below.

Second, even when financial institutions seek to match maturities they may do so imperfectly, and may be exposed to movements in short-term market rates if they are forced to borrow to correct for illiquidity or attract additional funds to their deposit base, both of which are sensitive to short-term interest rates. Swap rates could not be expected to close maturity mismatches perfectly. Barbier de la Serre et al. (2008) recognize that hedging and securitization through the markets are not captured in this 'cost of funds' approach, even when it is done in a very sophisticated way. They use the median initial maturity on corporate loans, commercial loans and mortgages to match with bond yields rates at 2, 5 and 10 year maturities. They augment this approach with the use of common factors to explain omitted variables in the relationship between the retail rate and the market rate. Their data are drawn from banks in France from January 2003 to July 2007.

Third, the literature has tended to select the 'most appropriate' market rate by a pre-selection method using the correlation between the retail rate in question and alternative market rates, rather than by strict maturity matching, as noted by Sander and Kleimeier (2004) and Kok-Sørensen and Werner (2006). This method can overstate the extent of pass through since the highest correlation delivers the highest pass through coefficient among the options available.

2.2 Dynamic adjustment around equilibrium

The conventional basis for thinking about the interest rate setting behavior of banks has been the banking firm model based on the Monti-Klein framework (c.f. Monti, 1971, Klein, 1971).[4] It supposes that banks establish the markup (markdown) of loans (deposits) over a risk free rate, which is determined by a contemporaneous official or money market rate, and the extent of the markup (markdown) is then a function of market power. If in the Monti-Klein model it is assumed that markets are perfectly competitive then pass through should be full, symmetric and relatively swift in response to changes in official rates, but few studies have found this to be the case. The Monti-Klein model is able to allow for more realistic features of financial markets, including imperfect competition, asymmetric information, and switching costs, and with these features, it implies that full pass-through is a long-run phenomenon, with deviations from this 'equilibrium' occurring in the short-run.[5] For these deviations to persist there need to be frictions that impede adjustment.

[4]Although this model is forty years old, it is still the conventional wisdom in the graduate level textbooks on microeconomics of banking, and was used by Barbier de la Serre et al. (2008) to expain the relationship between retail and market rates in the long run. Extensions of this framework are provided by Elyasiani et al. (1995), and Kopecky and VanHoose (2012).

[5]de Bondt et al. (2005) provide a systematic summary of short-run and long-run pass through estimates from the literature (1994-2004) in Table 1 of their paper. In most cases the long run pass through, for the majority of countries and for the euroarea as a whole, is 100 percent, or very close to that figure.

Assessment of the dynamic adjustment of interest rates has reflected asymmetry and non-linear adjustment in response to official rate changes (c.f. Heffernan (1997), Hofmann and Mizen (2004), Sander and Kleimeier (2004), De Graeve et al. (2007), and Fuertes et al. (2008)). Studies of time series of weighted averaged interest rates and panel of data for individual financial institutions interest rates have found strong evidence in favor of nonlinearity and heterogeneity as financial institutions negotiate imperfections in financial markets, switching and menu costs.

Their models make adjustment around an equilibrium between retail and money market rates that is contemporaneous and does not include forecasts of future money market rates. We argue in this paper that the model ignores the realistic possibility that banks use their own expectations of future market rates to minimize the uncertainty they face when setting retail rates.

2.3 Market efficiency in the euro area

Many studies of interest rate setting in the euro area have looked at the efficiency of the transmission of information across countries at a point in time. For example, the comparison of retail rate setting behavior of banks in different euro area countries in response to a common monetary policy action includes Mojon (2000), Ehrmann et al. (2001), Ehrmann and Worms (2001), Worms (2001), Weth (2002), Kleimeier and Sander (2006) and Sander and Kleimeier (2004). These papers consider whether convergence in financial markets has occurred as economic reform has taken place through a common monetary policy and due to competition between banks across the euro area. The majority view is that pass through is strongly influenced by banks' financial characteristics and the banking industry structure in each country and this dominates the influence of monetary union or competitive forces across the euro area as a whole. de Bondt et al. (2002), de Bondt (2005), Kok-Sørensen and Werner (2006), Kleimeier and Sander (2006) and Sander and Kleimeier (2004) show that the degree of pass through continues to be substantially different across the euro area despite a common monetary policy. We therefore expect to find differences in the degree of pass through for countries in our sample, and differences in the extent to which expected future market rates affect retail rate setting.

3 Theoretical basis for a forward-looking model

3.1 Monti-Klein model

The starting point for the analysis of interest rate pass through is the Monti-Klein model, first developed by Monti (1971) and Klein (1971). We use this framework to consider the microfoundations of the problem. Assume there are N banks, indexed $n = 1, ..., N$, using the same technology to hold deposits, D_n, for the households and supply loans, L_n, to borrowers, who are homogenous from the perspective of the bank. We can suppose that there is only one type of deposit and loan product for the present. The banks face a downward sloping demand for loans and an upward sloping supply of deposits. In the simplest case the bank could use deposits to fund loans, and generate profits by creating a differential between loan and deposit rates, but it could also lend (or borrow) on an interbank market. If we consider interbank loans, M_n, then in terms of quantities for each bank

$$D_n = L_n + M_n$$

Taking the supply of deposits as $D(r_D)$ and the demand for loans as $L(r_L)$, which can be more conveniently written inversely as $rr_D(D)$ and $rr_L(L)$, the profit of the n^{th}bank is

$$\pi_n = [rr_L(L_n + \sum_{o \neq n} L_o^*)L_n + mrM_n - rr_D(D_n + \sum_{o \neq n} D_o^*)D_n - C(D_n, L_n)],$$

where L_o^* is the optimal loan volume of all other banks, D_o^* is the optimal deposits of all other banks. mr is the market rate if interest on interbank loans and $C(D_n, L_n)$

is a cost of administration of banking services. The unique Cournot equilibrium has optimal bank loans and deposits for each bank of $L_n^* = L^*/N$ and $D_n^* = D^*/N$.

First order conditions show

$$\begin{aligned} rr_L^* &= -rr'_L(L^*)\frac{L^*}{N} + \ mr + C'_L(D, L), \\ rr_D^* &= -rr'_D(D^*)\frac{D^*}{N} + mr - \ C'_D(D, L), \end{aligned}$$

where $rr'_L(L^*)$ and $rr'_D(D^*)$ are the slopes of the loan and deposit functions, and $C'_L(D, L)$ and $C'_D(D, L)$ are the marginal administrative costs of an additional loan (deposit), which if we assume costs are linear $C(D_n, L_n) = \mu_D D_n + \mu_L L_n$ results in the addition (subtraction) of a markup (markdown), μ_L (μ_D).

Under perfect competition $N \to \infty$, we see $rr_L^* = mr + \ \mu_L$ and $rr_D^* = mr - \ \mu_D$. Banks have no market power and markups (markdowns) reflect only marginal administrative costs. Under monopolistic competition with small N we find that the markup (markdown) on retail rates rr_L and rr_D is larger than the marginal administrative cost since $rr'_L(L^*) < 0$ and $rr'_D(D^*) > 0$. Hutchison (1995) has a general equilibrium model in which the banking firm sets the retail rate of interest equal to the market rate of interest adjusting for the number of banking firms, the reserve requirements imposed by the monetary authorities, and parameters from the household preferences. Like the Monti-Klein model he finds the degree of competition, related to the number of banks, influences the degree that interest rate pass through deviates from one. In this framework, and that of Hutchison, there are no adjustment costs so we would expect any change in administration costs or the degree of competition to be reflected immediately in retail rates. Banks would keep retail rates and market rates in long run equilibrium at all times.

Elyasiani et al. (1995) and Kopecky and VanHoose (2012) have a similar model in which they maximize bank profits which are adjusted to allow for quadratic adjustment costs. Their model depends on the interest rates on loans, deposits and the money market (securities), and the quantities of deposits and loans received by the banks. They also make the point that the spreads between loan or deposit rates and money market rates depend on competition (market power).

3.2 Two-period model

To introduce dynamics we need to introduce a friction that would keep the financial intermediaries from making full adjustment to every market rate change. This could be the fixed cost of administration involved in providing loans, mortgages and deposits. When a market rate change occurs the financial institution incurs a cost of adjustment to the contracts of borrowers to reflect the change in market rates (see Mester and Saunders, 1995). It also incurs a cost for communicating the rate change to its customers.[6] Besides these actual costs of adjustment, there may be disincentives to make adjustments to rates if the deviation is small and insufficient to cause customers to switch to other lenders or deposit takers (Neumark and Sharpe, 1992). Hence rates can be 'sticky' so long as the deviation of the current retail rate from the optimal rate, given the movement in market rates, is small.

We take the model of the financial intermediary to be the same as the previous section, but now we have adjustment costs. We can consider a simple model based on the Ball and Mankiw (1994) to introduce fixed menu costs, c, of changing interest rates. For floating rate products such as deposits, short-term loans and variable rate mortgages the retail rate would change for new business and existing customers; for fixed rate products such as time deposits, fixed rate loans and fixed rate mortgages, the new rate would apply to new business only.[7] We suppose that there are two periods, and that there is no cost of adjustment in the even periods, but a menu cost, c, in the odd periods. Banks can observe current interbank market rates, which has a maturity h ($h = 1$ in this simple two period case, and

[6]In July 2010, the British Bankers' Association estimated this figure to be the cost of sending 13.5 million personal letters to banks' customers each time rates change. In 2008 there were five negative rate changes, involving 67.5 million letters, which would have incurred a cost of £33.75 million for the banking sector in the UK. Some banks have relied on full page advertisements in national newspapers to communicate rate changes on their products.

[7]In our empirical section both the MIR data and the data for the individual French banks refers to *new* business rates.

the maturity of the retail rate is $H = 2$). Banks must form an expectation about the second period market rate; market rates follow a random walk. Retail rates are set for a two period horizon, unless the bank incurs the fixed cost of changing rates. The bank minimizes the quadratic loss function in the deviation of actual retail rates from its desired level. For convenience we drop subscripts on retail rates, and allow the markup to be positive or negative according to the nature of the retail product i.e. loans have a positive markup, deposits have a negative markup.

Hofmann and Mizen (2004) showed that there would be an incentive for financial institutions not to adjust retail interest rates, rr_{t+i}, in response to observed or expected changes in market rates, mr_{t+j} in the two periods $j = 0, 1$. We reformulate the result in terms of s, which is an index counting the number of periods that retail rates must be refinanced: since $H = 2$ and $h = 1$, s counts two periods (periods 0 and 1). The desired retail rate would be

$$rr^*_{t+j}(H) = \frac{\sum_{s=0}^{1} E_{t+j} mr_{t+sh+j}(h)}{2} + \mu,$$

where $j = 0, 1$. The term μ is the markup. Using the result in Ball and Mankiw (1994) that rate adjustment should occur if the cost of the change is less than the cost of no adjustment. We can see that the financial intermediary minimizes a loss function that implies that adjustment will occur if

$$\begin{aligned} & E_{t+j} \sum_{s=0}^{1} \left[\left(rr^*_{t+j}(H) - mr_{t+sh+j}(h) \right)^2 - \left(rr^*_{t+j+1}(H) - mr_{t+sh+j}(h) \right)^2 \right] \\ = \; & 2[rr^*_{t+j+1}(H) - rr^*_{t+j+2}(H)]^2 > c. \end{aligned}$$

If the required adjustment to rates in the context of a two-period model were to lie within some interval $\left[-\sqrt{\frac{c}{2}} + \frac{E_t mr_{t+2}(h) - mr_{t+1}(h)}{2}, \sqrt{\frac{c}{2}} + \frac{E_t mr_{t+2}(h) - mr_{t+1}(h)}{2} \right]$, then banks would rather avoid the fixed cost of changing rates rather than make small adjustments to rates. Once we introduce an adjustment cost we can consider the dynamics of adjustment of rates around the long-run equilibrium relation, but the two-period horizon for rate setters is somewhat restrictive.

3.3 Multi-period model for retail interest rates

In this section we generalize the result above in order to emphasize the importance of forward-looking behavior and forecasts of future interest rates. In contrast with the model presented in the previous section, our model here has many periods. Instead of averaging the market rates with equal weights on current and future market rates, we use a discount factor γ to place a higher weight on recent market rates and a lower weight on market rates further into the future.

Second, if at *any point* in time the retail interest rate is changed, the financial intermediary incurs a small fixed cost, c, of making the change. In the simpler model above the financial intermediary can make changes to rates costlessly in even periods, but incurs a fixed cost c when making a price change in an odd period. Here there is a cost *whenever* any change is made to the retail rate irrespective of whether the period is odd or even. We make this alteration because it is realistic to assume that resetting the retail rate incurs a cost to the financial intermediary (the fixed cost of administration and communication) at any time that changes occur to market rates that had not been expected. This cost will be incurred for new business irrespective of whether the product has a fixed or floating rate.

A third change is introduced to allow for the possibility that the maturity of the market rate and the retail rate do not necessarily match. Many empirical models impose a matching maturity, but there is no reason for the maturity to match exactly. Banks may desire maturity matching, but markets may not offer funds at a maturity that actually matches the maturity of the mortgage or loan. We used this notation in the model above, but here it is explicitly recognized as $H > h$. This is of great importance in the empirical analysis, since the estimation methodologies have to be adapted to allow for possible mismatches. As before s counts the number of periods that it is necessary to refinance the loan.

Market rates represent the cost of additional funds for the financial intermediary, assuming that deposits have been fully used to provide existing loans, and at the point in time that the retail rate is posted it attempts to forecast future money market rates in order to set the retail rate at a level that represents the discounted cost of new funds for the period of the loan, H. Hence the optimal retail rate set at the beginning of the period for an H-period retail product, e.g. a 30-year mortgage, is then given by:

$$rr_{t+j}(H) = \mu + \frac{1-\gamma^h}{1-\gamma^{H/h}} E_{t+j} \sum_{s=0}^{H/h-1} \gamma^{sh} mr_{t+j+sh}(h), \tag{1}$$

where γ is the discount factor, E_{t+j} is the expectations operator, and $mr_{t+j+sh}(h)$ is the h-period future money market rate. This determines the ex-ante optimal retail rate, but ignores the effects of shocks to the interest rate. Once we allow for shocks to cause the actual future rate to deviate from the expected future rate, there will be conditions under which it is optimal to reset interest rates, even if there is a fixed cost of doing so.

At any point in time over the horizon of the retail product, the financial institution can reset the rate for an H-period retail product at a small cost, c. It is not our purpose in this paper to estimate the size of this cost, but we include it because its existence ensures that the bank does not remain permanently in equilibrium[8]. There is only an incentive for the bank to adjust its retail rates in any period if the loss of not adjusting is higher than the menu cost, but this depends how large is the difference between the retail rate and the newly preferred level for retail rates, based on its knowledge of shocks to market rates, its view about future market rates and the cost of adjustment. The loss function the financial intermediary minimizes in each period j is

[8]If the purpose of the paper were to explore the costs of adjustment it would be more appropriate empirically to estimate a threshold autoregressive model.

$$
\begin{aligned}
& \frac{1-\gamma^h}{1-\gamma^{H/h}} E_{t+j} \sum\nolimits_{s=0}^{H/h-1} \left[\begin{array}{c} \gamma^{sh} \left(rr^*_{t+j}(H) - mr_{t+sh+j+1}(h) \right)^2 \\ -\gamma^{sh} \left(rr^*_{t+j+1}(H) - mr_{t+sh+j+1}(h) \right)^2 \\ -\gamma^{sh} \left(rr^*_{t+j+2}(H) - mr_{t+sh+j+1}(h) \right)^2 - ... \end{array} \right] \\
= \ & \frac{H}{h} (rr^*_{t+j}(H) - \gamma^h rr^*_{t+j+1}(H) - \gamma^{2h} rr^*_{t+j+2}(H) - ...)^2 > c.
\end{aligned}
$$

This can be rearranged to yield:

$$
\left[\begin{array}{c} \left(rr^*_{t+j}(H) - \frac{1-\gamma^h}{1-\gamma^H} E_{t+j} \sum\nolimits_{s=0}^{H/h-1} \gamma^{sh} (mr_{t+sh+j}(h) - \mu) \right) \\ -\frac{1-\gamma^h}{1-\gamma^H} E_{t+j} \sum\nolimits_{s=0}^{H/h-1} \gamma^{sh} (mr_{t+sh+j+1}(h) - mr_{t+sh+j}(h)) \end{array} \right]^2 > \frac{ch}{H}.
$$

The first term is the deviation from long-run equilibrium, the second term represents the average expected change in the money market rates H periods into the future for each time period j. The firm will not adjust if:

$$
\left(rr^*_{t+j+1}(H) - \frac{1-\gamma^h}{1-\gamma^H} E_{t+j} \sum\nolimits_{s=0}^{H/h-1} \gamma^{sh} (mr_{t+sh+j}(h) - \mu) \right) \in \left[-\sqrt{\frac{ch}{H}} + Z, \sqrt{\frac{ch}{H}} + Z \right],
$$

where $Z = \frac{h}{H} \left[\frac{1-\gamma^h}{1-\gamma^H} E_{t+j} \sum\nolimits_{s=0}^{H/h-1} \gamma^{sh} (mr_{t+sh+j+1}(h) - mr_{t+sh+j}(h)) \right]$.

The point we wish to emphasize with this model is that the decision to make a change to retail rates on new business (and existing business where rates are variable) is determined by considering expected changes to future market rates but most models ignore the effects of anticipated changes in short-term market rates on retail interest rates.

Other authors have made a similar theoretical point. Elyasiani et al. (1995) and Kopecky and VanHoose (2012) argue that a theoretical model similar in structure to the Monti-Klein model but with quadratic adjustment costs justifies equations for deposit and loan rates that depend on current, past and future market rates of interest. Elyasiani et al. (1995) conclude that the correct specification for the deposit supply and loan demand equations should include forecasts of money market rates, and in empirical work they provide an ARIMA forecast of interest rates which are then found to be significant in these equations. The focus of the Elyasiani et al. paper is to establish whether deposit and liability decisions of banks are jointly (in)dependent, and the role of forecasts in the model is a by-product of this analysis. Kopecky and VanHoose (2012) extend this argument to interest rates to show that current retail rates on loans and deposits should depend on expected future market rates, as well as the extent of competition in the retail market. They then suggest that futures might provide an indication of the commonly held expectation of future market rates.

Similarly, Hofmann and Mizen (2004) consider a model similar to ours, but focused on two-period adjustment and with forward-looking terms defining the zone where no adjustment is worthwhile. The model considers the potential asymmetry and nonlinearity of the adjustment process in a backward-looking specification of the error correction model, where the error is the discrepancy between the actual retail rate and some desired retail rate, based on the market rate and a markup. Only when future anticipated rates are likely to result in a widening of the gap between the actual and desired retail rate do financial institutions incur the cost of adjusting rates.

The main contribution of our paper is to explore in detail the role of interest rate forecasts in pass through equations. As we explain in the section below, we provide a number of alternative forecast methodologies to evaluate the importance of future expected market rates on the current retail rate decision of banks. We demonstrate, using three different tests, that forecasts have a significant input into the current retail rate decision. We also provide empirical confirmation of the argument proposed by Kopecky and VanHoose (2012), that futures may be a useful measure of expectations of market rates.

4 Econometric Methodology

4.1 The Conventional View

The conventional model adopted by the literature (see inter alia de Bondt et al., 2002, de Bondt, 2005, Kok-Sørensen and Werner, 2006, Kleimeier and Sander, 2006 and Sander and Kleimeier 2004) makes use of the long run equation

$$rr_t^*(H) = \mu + \beta mr_t(H), \tag{2}$$

where the equilibrium retail rate $rr_t^*(H)$ of maturity H is determined by the contemporaneous money market rate $mr_t(H)$ of the corresponding maturity and a constant mark up μ. However, as retail rates are not aggregated using exact maturities, the matching of retail and market rates is only an approximation using the nearest available maturity in market rates.[9]

Given the equilibrium retail rate $rr_t^*(H)$, the error-correction model can be estimated for the actual retail rate, $rr_t(H)$

$$\begin{aligned} \Delta rr_t(H) &= \nu + \alpha(rr_{t-1}(H) - rr_{t-1}^*(H)) + \\ &+ \textstyle\sum_{k=0}^{K} \phi_k \Delta mr_{t-k}(H) + \sum_{l=1}^{L} \varphi_l \Delta rr_{t-l}(H) + \varepsilon_t. \end{aligned} \tag{3}$$

Substitution of (2) into (3) gives

$$\begin{aligned} \Delta rr_t(H) &= \nu + \alpha(rr_{t-1}(H) - \mu - \beta mr_{t-1}(H)) + \\ &+ \textstyle\sum_{k=0}^{K} \phi_k \Delta mr_{t-k}(H) + \sum_{l=1}^{L} \varphi_l \Delta rr_{t-l}(H) + \varepsilon_t. \end{aligned}$$

The coefficient β is interpreted as the long-run pass through determining the equilibrium relation, and the coefficient α determines the speed of adjustment to deviations from the equilibrium. The model does not have any forward-looking terms, since all the variables are lagged by one period or more. It therefore clearly diverges from the model we presented in section 3. In addition, because the model

[9] Some authors such as de Bondt (2002) depart from this process by using correlation analysis to match a retail rate with a market rate at a selected maturity and lag, and in this case the maturity of the retail and market rates are not necessarily the same.

(2) - (3) relies on the matching of retail and money market rates of the same maturity, where the money market rate is interpreted as the marginal cost of funds, it ignores the maturity mismatch faced by financial intermediaries. If there is maturity mismatch, then it becomes necessary for financial intermediaries to periodically refinance their loans, and to set the appropriate rate on these loan they then need to make projections of future market rates in setting current retail rates.

4.2 Our Approach

Based on our multi-period analysis in the previous section we modify the conventional model. Let us consider our multi-period model based on (1)[10]

$$rr_t^*(H) = \mu + \beta\frac{1-\gamma^h}{1-\gamma^H}\left(mr_t(h) + E_t\sum\nolimits_{s=1}^{H/h-1}\gamma^{sh}mr_{t+sh}(h)\right).$$

It is easy to see by rearrangement that

$$rr_t^*(H) = \mu + \beta mr_t(h) + \beta\frac{1-\gamma^h}{1-\gamma^H}\sum\nolimits_{s=1}^{H/h-1}\gamma^{sh}E_t\Delta^{sh}mr_{t+sh}(h),$$

where $E_t\Delta^{sh}mr_{t+sh}(h) = E_t mr_{t+sh}(h) - mr_t(h)$. If expectations $\{E_t\Delta^{sh}mr_{t+sh}(h)\}$ are stationary, they need not necessarily enter the error correction term in the dynamic specification of the model, which can be written as:

$$\begin{aligned}\Delta rr_t(H) &= \nu + \alpha_1(rr_{t-1} - \mu - \beta mr_{t-1}(h)) + \\ &+\alpha_2\beta\sum\nolimits_{s=1}^{H/h-1}\tfrac{(1-\gamma^h)\gamma^{sh}}{1-\gamma^H}E_t\Delta^{sh}mr_{t+sh}(h) \\ &+\sum\nolimits_{k=0}^{K}\phi_0\Delta mr_{t-k}(h) + \sum\nolimits_{l=1}^{L}\varphi_l\Delta rr_{t-l}(H) + \varepsilon_t.\end{aligned} \tag{4}$$

Moreover, if the restriction $\alpha_2 = -\alpha_1$ is not imposed, there can be different speeds of adjustment to changes of the market rates in the previous periods and expected future periods. If $\alpha_2 = 0$, it means that the expected changes of the money market rate do not affect the retail rate and the model (4) becomes a backward-looking error-correction model.

[10]If we impose the restriction $\beta = 1$, then we get equation (1) from the previous section.

In order to accommodate the uncertainty of financial intermediaries about the future path of the market rate, we substitute expectations with recursive out-of-sample forecasts of the money market rate:

$$\begin{aligned}\Delta rr_t(H) &= \nu + \alpha_1(rr_{t-1} - \mu - \beta mr_{t-1}(h)) + \\ &+\alpha_2\beta \textstyle\sum_{s=1}^{H/h-1} \frac{(1-\gamma^h)\gamma^{sh}}{1-\gamma^H} \Delta^{sh}\widehat{mr}_{t+sh|t}(h) + \\ &+ \textstyle\sum_{k=0}^{K} \phi_k \Delta mr_{t-k}(h) + \sum_{l=1}^{L} \varphi_l \Delta rr_{t-l}(H) + \eta_t,\end{aligned} \tag{5}$$

where $\Delta^{sh}\widehat{mr}_{t+sh|t}(h) = \widehat{mr}_{t+sh|t}(h) - mr_t$. The forecasts $\widehat{mr}_{t+sh|t}(h)$ are generated using two alternative models presented in Diebold and Li (2006): the dynamic Nelson-Siegel model and the direct regression onto three principal components.

4.2.1 Nelson-Siegel Forecasts

Following Diebold and Li (2006) we estimate the level, slope and curvature factors (L_t, S_t, C_t) using the multivariate regression

$$\begin{pmatrix} mr_t(\tau_1) \\ mr_t(\tau_2) \\ \vdots \\ mr_t(\tau_N) \end{pmatrix} = \begin{pmatrix} 1 & \frac{1-e^{-\lambda\tau_1}}{\lambda\tau_1} & \frac{1-e^{-\lambda\tau_1}}{\lambda\tau_1} - e^{-\lambda\tau_1} \\ 1 & \frac{1-e^{-\lambda\tau_2}}{\lambda\tau_2} & \frac{1-e^{-\lambda\tau_2}}{\lambda h_2} - e^{-\lambda\tau_2} \\ & \ddots & \\ 1 & \frac{1-e^{-\lambda\tau_N}}{\lambda\tau_N} & \frac{1-e^{-\lambda\tau_N}}{\lambda\tau_N} - e^{-\lambda\tau_N} \end{pmatrix} \begin{pmatrix} L_t \\ S_t \\ C_t \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ \vdots \\ u_{Nt} \end{pmatrix},$$

where the parameter $\lambda = 0.0609$ (as in Diebold and Li, 2006). The factors (L_t, S_t, C_t) are modeled and forecast as a VAR(1) process. The sh-period-ahead forecast of a market rate of maturity τ is

$$\widehat{mr}_{t+sh|t}(\tau) = \widehat{L}_{t+sh|t} + \widehat{S}_{t+sh|t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right) + \widehat{C}_{t+sh|t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right),$$

where

$$\begin{pmatrix} \widehat{L}_{t+sh|t} \\ \widehat{S}_{t+sh|t} \\ \widehat{C}_{t+sh|t} \end{pmatrix} = \widehat{\Pi}_0 + \widehat{\Pi}_1 \begin{pmatrix} \widehat{L}_t \\ \widehat{S}_t \\ \widehat{C}_t \end{pmatrix},$$

and matrices $\widehat{\Pi}_0$ and $\widehat{\Pi}_1$ are obtained by regressing $(\widehat{L}_t, \widehat{S}_t, \widehat{C}_t)'$ on an intercept and $(\widehat{L}_{t-sh}, \widehat{S}_{t-sh}, \widehat{C}_{t-sh})'$.

4.2.2 Direct Regression on Principal Components

For a comparison with the Nelson-Siegel model we consider an alternative forecasting model, which was also compared with the Nelson-Siegel model in Diebold and Li (2006).

First, we perform a principal component analysis on the full set of money market rates using the eigenvalue decomposition of the $(N \times N)$ covariance matrix $\widehat{S}_t = t^{-1}\sum_{s=1}^{t}(X_s - \widehat{X}_t)(X_s - \widehat{X}_t)'$, where $X_s = (mr_s(\tau_1), mr_s(\tau_2), ...mr_s(\tau_N))'$ and $\widehat{X}_t = t^{-1}\sum_{s=1}^{T} X_s$. Denote by $\widehat{Q}_t = (\widehat{Q}_{1t}, \widehat{Q}_{2t}, \widehat{Q}_{3t})$ three eigenvectors associated to three largest eigenvalues of the matrix $\widehat{S}_t$. The first three principal components, $\widehat{F}_t = (\widehat{F}_{1t}, \widehat{F}_{2t}, \widehat{F}_{3t})'$, are then defined by $\widehat{F}_t = \widehat{Q}_t' X_t$.

Second, the sh-period-ahead forecast of a market rate of maturity τ is computed as

$$\widehat{mr}_{t+sh|t}(\tau) = \widehat{a}_{0t}^h + \widehat{a}_{1t}^h \widehat{F}_{1t} + \widehat{a}_{2t}^h \widehat{F}_{2t} + \widehat{a}_{3t}^h \widehat{F}_{3t},$$

where coefficients $(\widehat{a}_{0t}^h, \widehat{a}_{1t}^h, \widehat{a}_{2t}^h, \widehat{a}_{3t}^h)$ are obtained by regressing $mr_t(\tau)$ onto an intercept and the principal components $(\widehat{F}_{1t-sh}, \widehat{F}_{2t-sh}, \widehat{F}_{3t-sh})'$.

4.2.3 Application of the Forecasting Methodology

In order to apply our methodology, we proceed in two stages. At the first stage we generate recursive out-of-sample forecasts of a selected money market rate. At the second stage we estimate the dynamic pass-through equation, where expectations of the money market rate are substituted by the forecasts generated at the first stage.

The two-stage procedure requires the division of the whole sample $\{1, 2, ..., T\}$ into sub-samples. We use observations $\{1, 2, ..., T_0\}$ to get initial estimates of the forecasting models and generate a first set of out-of-sample forecasts, $\{\Delta^{sh}\widehat{mr}_{T_0+h|T_0}(h),$

$\Delta^{sh}\widehat{mr}_{T_0+2h|T_0}(h)$,..., $\Delta^{sh}\widehat{mr}_{T_0+H-1|T_0}(h)\}$. Then we recursively augment the sample by one observation, re-estimate the forecasting models and generate a new set of forecasts $\{\Delta^{sh}\widehat{mr}_{t+h|t}(h)$, $\Delta^{sh}\widehat{mr}_{t+2h|t}(h)$,..., $\Delta^{sh}\widehat{mr}_{t+H-1|t}(h)\}$ for $t = T_0+1, ..., T$. At the second stage we estimate the error-correction model (5) using observations $\{T_0, ..., T\}$.

The error correction model makes use of anticipated changes to short-term money market rates, and it is important to make two statements about the inclusion of these terms. First, since retail rates are not aggregated using exact maturities, we cannot determine the precise forecast horizon based on the maturity H. This is less of a problem than it may first appear, since in practice, the performance of forecasting models deteriorates with the increase of the forecasting horizon, so in cases where H is distant there is little gain from the inclusion of forecasts as far ahead as H periods. We can demonstrate this by comparing our forecasts with a random walk model, which shows that forecasts beyond some horizon, $\bar{H}$, do not outperform a random walk and add little meaningful information on the direction of short term money market rates. Given these limitations, we include only forecasts up to this horizon $\bar{H}$, $\{\Delta^{sh}\widehat{mr}_{t+h|t}(h)$, $\Delta^{sh}\widehat{mr}_{t+2h|t}(h)$,..., $\Delta^{sh}\widehat{mr}_{t+\bar{H}|t}(h)\}$, for which the mean square forecast error is smaller than for a random walk.

Second, we note that forecasts of short-term market rates are generated using much the same information, and they overlap, which could result in multicollinearity problems in estimation. However, we use the innovations in the market rates $\{\Delta^{sh}\widehat{mr}_{t+h|t}(h)$, $\Delta^{sh}\widehat{mr}_{t+2h|t}(h)$,..., $\Delta^{sh}\widehat{mr}_{t+\bar{H}|t}(h)\}$ and we assign declining weights reflecting the discounting of the future implied by our theoretical model:

$$\frac{(1-\gamma^h)\gamma^h}{1-\gamma^{\bar{H}}}, \frac{(1-\gamma^h)\gamma^{2h}}{1-\gamma^{\bar{H}}}, ..., \frac{(1-\gamma^h)\gamma^{\bar{H}}}{1-\gamma^{\bar{H}}}$$

Therefore the inclusion of many forecasts of the innovations at horizons $\{h, 2h, ..., \bar{H}\}$ does not result in multicollinearity.

Then we estimate the model

$$
\begin{aligned}
\Delta rr_t(H) &= \kappa + \alpha_1 rr_{t-1}(H) + \delta_1 mr_{t-1}(h) + \\
&+ \delta_2 \sum_{s=1}^{\bar{H}/h-1} \tfrac{(1-\gamma^h)\gamma^{sh}}{1-\gamma^{\bar{H}}} \Delta^{sh} \widehat{mr}_{t+sh|t}(h) + \\
&+ \sum_{k=0}^{K} \phi_k \Delta mr_{t-k}(h) + \sum_{l=1}^{L} \varphi_l \Delta rr_{t-l}(H) + \eta_t,
\end{aligned}
$$

where $\delta_1 = \alpha_1\beta$, $\delta_2 = \alpha_2\beta$, and $\kappa = \nu + \alpha_1\mu$. It implies that the estimate of the long run pass-through coefficient is $\widehat{\beta} = \widehat{\delta}_1/\widehat{\alpha}_1$ and the estimate of the adjustment coefficient for forecasts is $\widehat{\alpha}_2 = \widehat{\alpha}_1\widehat{\delta}_2/\widehat{\delta}_1$.

A general-to-specific procedure based on the Bayesian criterion is applied to select an optimal number of lags for given initial K and L and an optimal number of forecasts for a given initial $\bar{H}$. In order to avoid identification problems, the minimal number of forecasts equals two. The value of the discount factor γ is chosen from the interval $[0.9, 0.999)$.

4.2.4 Futures

For comparison with the models considered above, we explore the possibility that the financial intermediary does not produce its own forecast of future market rates but uses the market quoted futures rates. The futures based on 3-month EURIBOR deposits are quoted on the Euronext exchange, and assuming the expectations hypothesis is maintained as studies by Kuttner (2001), Krueger and Kuttner (1996), Rudebusch (2002), Bernoth and von Hagen (2004) and Bernanke and Kuttner (2005) suggest, then these should provide accurate predictions of actual market rates. The drawback with futures is that there is not a quoted rate for every maturity, and futures are available only up to 12-months ahead. There is also some evidence that using futures as predictors of short rates may breakdown in some circumstances. In our case we use the 3-month futures as these are the most heavily traded futures in the euro area, and we use futures up to 12 months ahead as we do with our forecasts. Our model in this case is

$$\begin{aligned} \Delta rr_t(H) &= \kappa + \alpha_1 rr_{t-1}(H) + \delta_1 mr_{t-1}(h) + \\ &+ \delta_2 \sum_{s=1}^{\bar{H}/h-1} \tfrac{(1-\gamma^h)\gamma^{sh}}{1-\gamma^{\bar{H}}} \Delta^{sh} mrf_{t+sh|t}(h) + \\ &+ \sum_{k=0}^{K} \phi_k \Delta mr_{t-k}(h) + \sum_{l=1}^{L} \varphi_l \Delta rr_{t-l}(H) + \eta_t, \end{aligned}$$

where the term $\Delta^{sh} mrf_{t+sh|t}(h) = mrf_{t+sh|t}(h) - mr_t$ is the sh-period change in the market rate inferred from the rate in the futures market minus the current market rate. The lag selection process and the discount rate using in the general-to-specific procedure are the same as for the forecasting models above. This analysis is undertaken only for the aggregate dataset.

5 Data

Our aggregate data comprise variables at a monthly frequency from January 1994 to July 2007 for France, Germany, Italy and Spain. We make use of monthly data on interest rates from the harmonized monetary and financial institutions' interest rate (MIR) dataset, January 2003 - July 2007, for euro area countries, which is then spliced to the non-harmonized national retail interest rate (NRIR) data to provide a sufficient sample for estimation back to January 1999.[11] Harmonized data from the MIR dataset offers 31 interest rates for euro area countries, but only extends backwards to January 2003. The NRIR dataset offers fewer interest rates but has a considerably longer time series for each rate in euro area countries. For the purpose of this study, the MIR series are aggregated into the more coarsely defined NRIR categories using new business volumes as weights, which is a modified approach to aggregation compared to the methods employed in Kok-Sørensen and

[11]It would also have been possible to extend the data forward beyond 2007. Initially we did not do this because the disruption in interbank lending associated with the financial crisis could have produced a period of instability that would have undermined the empirical exercise. In fact, as we discovered when we explored the results from the individual bank dataset reported below where we had no choice but to use a sample extending to 2011, our results would have been stable even in the period of disruption during the financial crisis.

Werner (2006).[12,13] There are six categories of retail interest rates generated by this method, including mortgage rates, short-term loans to enterprises, long-term loans to enterprises, time deposit and current account rates, and consumer loans to households, but not all these series are collected for all countries and years. We investigate the first four series in this paper.

The market rates used to indicate the cost of funds for these retail products include euro area overnight rates (EONIA), EURIBOR rates from 1 to 12 month maturity and bond yields from 2 to 10 years maturity. The Nelson-Siegel and principal components methods we adopt use this information to provide forecasts of 1-month and 3-month EURIBOR rates up to twelve months ahead. The Data Appendix at the end of the paper reports the definitions of the interest rates used.

Futures series are collected from Datastream. These are continuous series of futures prices calculated by Thomson Reuters using 3-month EURIBOR futures traded at Euronext (LIFFE before 2002). The average of all future prices is used to calculate the implied future rate.

The data for individual banks are provided by the Banque de France, giving bank-level time series for 297 banks and credit institutions over the period January 2003 to December 2011. These data comprise interest rates on a) loans to non

[12] We are grateful to Christopher Kok-Sørensen and Thomas Werner for providing their dataset. They explain in correspondence with the authors that '... the difference between the [former method] and the new data set is that in the former when deriving the weights (in order to aggregate the MIR categories to the less detailed NRIR categories) we used a combination of new business (NB) volumes and outstanding amounts (OA). The OA volumes we applied in order to create back series of the country-specific market rates, based on the notion that OA better reflected maturity structures of loans granted/deposits taken before January 2003 (a period for which we have no NB volume data).'

[13] Splicing MIR and NRIR retail rate categories may create a mixture of maturities in the retail rates that induces a role for forecasts of interest rates, but as far as possible we have kept short and long maturities apart. For example, mortgages are uniformly long, as are long-term loans (more than five year to maturity). Short-term loans and time deposits are more mixed, with maturities mostly between 1 and 5 years. Note however, that our market rates are very short (1-month or 3-month) and forecasts are up to 12 months ahead, beyond which they have little value. We believe we are being consistent with our theoretical argument in relating our retail rates of various maturities to short maturity current and future market rates, because we propose it is more realistic to model bank refinancing with successive short rates than to assume banks match maturities (which is not possible at all maturities).

financial corporations with initial rate fixation of up to 1 year; b) loans to non financial corporations with initial rate fixation over 1 year and up to 5 years; c) loans to non financial corporations with initial rate fixation over 5 years; d) deposits of households with agreed maturity (sole proprietorships excluded); e) deposits of non financial corporations with agreed maturity: and f) mortgage loans for house purchase to households (sole proprietorships excluded). All interest rates are for new business.

These six interest rates are available on a consistent basis for a fraction of the 297 banks in our dataset, but we have sufficient observations over individual banks to construct a volume weighted aggregate measure for each instrument, and measures for banks separated into different sizes by total assets. We can therefore compare the mean value of pass through for very large (deposits>euro 1bn), large (euro 999.9mn>deposits>euro 100mn), medium-sized (euro 99.9mn>deposits>euro 10mn) and small banks (deposits<euro 9.9mn).[14]

6 Results

We begin with results for all four major European countries, using the aggregate data compiled from the NRIR-MIR datasets described in the previous section. These provide evidence on the pass through, speed of adjustment and the importance of forecasts of future market rates. We then compare our findings with a model using futures rates in place of generated expectations of market rates, and confirm our conclusions. Finally, to investigate the potential aggregation bias, we take data for one of our countries (France) and re-estimate the models using individual bank data and compare the mean values of coefficients on pass through, speed of adjustment and forecasts of future market rates with results for aggregated data. We find no evidence that aggregated data offer biased results.

[14] We are prohibited from reporting individual bank pass through or adjustment coefficients for reasons of confidentiality, but the averages accurately summarise the responses of banks within size categories.

6.1 Nelson-Siegel and Principal Components Forecasts

As the data are monthly, we report results for 1-month EURIBOR ($h = 1$) and 3-month EURIBOR ($h = 3$) in our model. One reason for reporting the 3-month EURIBOR results alongside 1-month EURIBOR is that we can make comparisons with the results using 3-month EURIBOR futures in the next section. We use the data from January 1994 to January 1999 to obtain the first estimates of the forecasting models. The recursive out-of-sample forecasts are generated using the data from January 1999 to July 2007. The relative mean square forecast errors of the Nelson-Siegel and the principal component forecasts for up to 12 month horizon for each money market rate are reported in Table 1. The forecasting performance of these models for horizons beyond 12 months is worse than the forecasting performance of a random walk model. It determines the choice of the maximal horizon of forecasts used to estimate the pass-through equation, $\bar{H} = 12$.

Table 2 reports estimates of the pass-through coefficient, β. The results are reported for 1-month EURIBOR in Panel A and 3-month EURIBOR in Panel B for the model with Nelson-Siegel (NS) forecasts and for the model with principal components (PC) forecasts. Standard errors are reported in parentheses under the estimates of coefficients.

Our results show first of all that the choice of forecasting methodology does not make a great deal of difference to the estimates of the long-run pass through. The long run pass through coefficient gives an indication of the extent to which changes in the money market rates are transmitted to the retail rates offered to households and firms. If following changes to money market interest rates the adjustment to retail rates is lower, then monetary policy has less impact on household and firm behavior through the interest rate channel of monetary transmission through coefficients reported in Table 2. Pass through estimates from the Nelson-Siegel methods are very close to the estimates from principal components methods and the estimates are not greatly different from each other when we examine a common retail rate across countries.[15]

Second, we see very similar degrees of pass through for the same retail product across countries - time deposits and short-term loans to enterprises have pass through coefficients below one, while mortgages have coefficients mostly above one. These results are comparable to the results reported in de Bondt (2002) where the average responses across the entire euro area for the post-1999 period are comparable in magnitude to our estimates for individual countries, although our pass through coefficients are marginally higher.[16] His reported coefficients for pass through on time deposits was 0.720, short-term lending to firms 0.880, long-term lending to firms 0.804 and mortgages 1.041, all of which were significantly different from zero, and with the exception of the mortgage rate were significantly different from one. Standard errors show that our estimates of pass through rates are significantly different from one. Results reported for individual countries by Kok-Sørensen and Werner (2006) using panel data for the period from January 1999-June 2004 show estimates of pass through coefficients very similar to ours, and differ to a similar extent between countries, even though they do not include forward-looking terms.

The similarity of the results despite the omission of forward-looking terms can be explained in two ways. Previous studies matched maturities of retail and market rates which could implicitly allow for the future short-term rates in the longer maturity rate assuming there is complete arbitrage; but there is some doubt whether arbitrage is complete, and therefore these studies may have imperfectly allowed for future short rates by using matched maturities in their models. Also, previous models may have compensated for missing forward-looking terms by adding

[15] There are a few exceptions to this rule, namely short-term loans to enterprises in Germany, long-term loans to enterprises in France, and mortgages in Italy, which seem out of line with estimates in other countries for these retail rates.

[16] The same paper reports estimates in the literature for individual countries, but these use data mostly from the pre-1999 period, which are not comparable with our sample. Kok-Sorensen and Werner (2006) note that there is a structural break in the estimates of pass through in the euroarea before and after 1999. These authors note that pass through and adjustment speeds are generally higher after 1999 than before 1999.

longer lags of backward-looking dynamic terms in retail and market rates. This choice is not theory driven, and is largely a matter of empirical model selection, but while this might improve the fit of the dynamic model it significantly alters its interpretation. These compensating factors may account to some degree for the similarity in the pass through estimates even though the forecast is excluded. The dynamic, hence short-run, behavior of the models can also be dramatically different depending upon whether forecasts are included or not, even though the long run may be roughly the same.

Third, comparison between panels shows that estimates of pass through do not differ very much whether we use 1-month money market rates or 3-month money market rates. Therefore, despite an intense debate about how best to choose the appropriate maturity of market rates, the choice between these two short-maturity rates seems to be relatively unimportant as far as the estimate of the pass through coefficient is concerned.

Table 3 reports the estimated coefficient on the lagged retail rate in the dynamic equation. This is actually the estimated speed of adjustment of deviations of the retail rate from the equilibrium implied by the lagged market rate rate. Although we do not estimate the relationship between lagged retail and lagged money market rates as a separate cointegrating relationship, the negative and significant coefficient reported in Table 3 is consistent with the interpretation that the variables are cointegrated.[17]

We would expect the speed of adjustment coefficient to be negative and significant if the retail and market rates of interest are cointegrated, which it is in every case in Panel A reporting the results for 1-month EURIBOR and in Panel B reporting results for 3-month EURIBOR. Previous studies that have considered the pass through of money market rates to retail rates (without including expected changes to rates in the future) have typically reported regressions in which pass

[17]The reported estimates of the long run pass through coefficient in Table 2 were obtained by dividing the freely estimated coefficient, δ_1, on the lagged money market rate, by the estimate of the adjustment coefficient, α_1, reported in Table 3. It is therefore possible to impose a restriction that $\alpha_1 rr_{t-1}(H) + \delta_1 mr_{t-1}(h) = \alpha_1(rr_{t-1}(H) - \beta mr_{t-1}(h))$.

through is estimated using a cointegrating relationship between lagged retail and money market rates, and the adjustment coefficient is reported as the dynamic response to the lagged residuals from this relationship. Examining the results of Kok-Sørensen and Werner (2006) for example, their mortgage adjustment coefficients show Italy to have very fast adjustment speed relative to other countries, as we do; similarly they find the adjustment speeds for short- and long-term loans to enterprises to be fast for Italy and Spain compared to France and Germany. To an extent the similarity in the results is due to our common dataset, but our sample is longer, and our methods differ from those of Kok-Sørensen and Werner, and most importantly we have included expected changes to rates in the future, which we now show to be very important.[18]

The results in Table 4 give the estimated coefficients on the forecasts in our model. If these coefficients could be restricted to equal zero we would deduce that forecasts of future changes to market rates at that maturity were unimportant for the dynamic adjustment of retail rates, but the evidence in Table 4 says they are significantly different from zero. The findings for 1-month EURIBOR show the coefficients are very strongly significant in all cases and they are uniformly positive. This is what we would expect, since it tells us that as short-term money market rates are expected to rise, so retail rates are adjusted upwards, and vice versa. The results using 3-month EURIBOR are less consistent, but the majority of cases have a positive coefficient as expected, and in half of all cases (eight) the coefficient is positive and significant. The choice between NS and PC estimation methods does not alter the conclusion about sign and significance, and estimates of the coefficients are very similar.

Besides offering a test of the importance of the forecasts in our model, the test reported in Table 4 also evaluates whether the model without forecasts included

[18]Models that use selection algorithms similar to our own may attempt to compensate for the omission of forecasts of market rates by including additional lags of retail and market rates. To some extent this may enable them to match the properties of the data, but our later results show that when using an information criterion there is a preference for the model with forecasts to alternatives.

can be rejected in favor of a model that includes forecasts. This is a test that determines the preferred model specification, and the results suggest that a model without forecasts can be rejected compared to a model including forecasts.

In Table 5a we report this specification search as a likelihood ratio test of model in which the alternative to the model including forecasts is a nested version similar in all respects except that it excludes the forecasts. The reported p-values show that we reject the null that forecasts are insignificant in our model in all cases but one at the 5% level.

While this is a feasible alternative to the model with forecasts it is not the preferred alternative, since our selection algorithm chooses a different model when forecasts are excluded. In Table 5b we report the Bayesian Information Criterion (BIC) value for two alternative models selected by our algorithm - the first includes forecasts and the second does not, while lag structures for each model are different. On BIC criteria, taking 1-month EURIBOR as the market rate and Nelson-Siegel forecasts, we find that in 13 cases out of 16 the model with forecasts has a smaller BIC value than the model without forecasts therefore in the majority of cases we prefer the model with forecasts. We conclude that this test finds the additional information provided by adding the forecasts of market rates sufficiently great to favor this model over the alternative that excludes forecasts.

We interpret these results as an indication that banks do not look very far ahead when setting retail interest rates. The stronger evidence in favor of 1-month forecasts compared to 3-month forecasts suggests they use information in 1-month changes to rates rather 3-month changes, but in our model we allow for up to 12 leads of these 1-month changes, and four leads of the 3-month changes to short rates. This is consistent with the evidence that banks were funding their lending using short-term money market funding which was rolled over on a short-term basis. What matters for a bank that operates in this way is the expected cost of funding for the next period when refinancing will be required. To anticipate the results of the next section, we also find that changes to rates indicated by 3-month futures are not particularly influential over changes to retail rates, which confirms the results reported here.

Table 6 tests whether we can impose a restriction that adjustment to deviations of lagged retail rates from lagged money market rates is equal and opposite to the adjustment to expected future changes to market rates i.e. $\alpha_2 = -\alpha_1$. In half of the cases the reported p-value of the Likelihood Ratio test rejects the restriction, and in the other half the restriction is not rejected. In cases where the coefficient is significantly different from zero, the magnitude of the α_2 coefficient is much larger than the corresponding coefficient for α_1, which indicates that more weight is placed on future money market rates than on lagged cointegrating residuals. But it is not essential to our argument that the response to these terms should be the same, as indicated by the fact that these coefficients have equal and opposite signs. Our results from previous tables show that forecast changes in money market rates (especially at the 1-month maturity but also at the 3-month maturity) are important, and have the expected sign and significance.

Finally, we investigate the possibility of structural breaks in our model using the Cumulated Sum of Squares (CUSUM) test on model residuals for each retail rate in each of the four European countries in our study. The null hypothesis of the CUSUM test is the stability of the pass-through equation. The significance level is the probability of rejecting the null when it is true. We set the significance level at the conventional level of 5%. Our results are given in Figures 3-6 and show for each of the four panels - representing time deposits, short- and long-term loan rates, and mortgage rates - that none of the rates in France, Germany and Italy reject the null, while in Spain there are rejections for all four retail rates. These rejections do not occur at the same time, and the reason for the rejections is probably related to the quality of the data. Despite the poor results for Spain, the non-rejection for three other countries suggests that our models are reliable.

6.2 Use of Futures Rates

In this section we evaluate the results where we use 3-month futures in place of forecasts to determine the importance of anticipated changes to market rates. It has been common practice in the academic literature that supports the expectations hypothesis (see for example Krueger and Kuttner, 1996; Kuttner, 2001; Rudebusch, 2002; Bernanke and Kuttner, 2005) to argue that futures are good predictors of what actual short-term rates will be. Moreover, Kopecky and Van-Hoose (2012) have argued explicitly that futures may be a guide to expectations about market rates and these could be used to measure how expectations influence the retail rate setting by banks. To do this we consider 3-month EURIBOR futures compared to our findings with the two forecasting approaches using 3-month EURIBOR reported in the previous section. As before we discuss the pass through coefficients, the adjustment coefficients on the lagged retail rate, the coefficient on the future (used to determine the expected change in future market rates), and the test of coefficient restrictions within the model. The results for all retail rates and countries in our sample are very similar to the results for 3-month EURIBOR in the previous section, whether we compare with NS or PC forecasts.

The pass through coefficients reported in Table 7 are similar in magnitude for each retail rate and country and adjustment coefficients are estimated to be negative and significant in all cases. However, the expected changes to money market rates using futures information are insignificantly different from zero in eleven cases out of sixteen, which shows weaker evidence of forward looking behavior based on futures compared to our results from forecasts of the 3-month EURIBOR rates. There are several reasons why this might be the case. There has been an emerging literature that has cast doubt on the ability of futures to predict short term interest rates (see Cochrane and Piazzesi, 2005; Piazzesi and Swanson, 2008) since the mean errors and mean square prediction errors (MSPEs) when using futures can be large, with larger errors around turning points, and over-prediction of actual short-term future rates in recessions and under-prediction in booms. It is also possible that banks do not tend to use information from 3-month EURIBOR futures when setting retail rates, either because they use some other indicator of future short term market rates, or because they do not use changes in 3-month rates. Whatever the reason, we do not find that futures perform as well as forecasts in our models of retail rate adjustment.

6.3 Results for Individual French Banks

We report in this subsection the results of pass through estimates, speed of adjustment coefficients and coefficients on forecast terms computed using data for individual French banks. Neither the definitions of the variables, i.e. the aggregate measures constructed from volume-weighted individual rates, nor the sample period correspond exactly with the euro area data supplied by the NRIR-MIR datasets. With respect to the former, the categories of instruments are finer than those available in the MIR dataset. Reaggregation to correspond with the MIR categories is possible but was not recommended by the authorities at the Banque de France. Therefore we report in this section the similarities and differences between pass through and adjustment coefficients for banks of different sizes versus the aggregate measure as a means to determine the extent of any aggregation bias. With respect to the latter we need to use data spans typically running to 2010:05, in order to allow for a sufficient number of observations for estimation (given that the data start at 2003:01, in contrast to the MIR dataset).

Table 8 reports the mean values of pass through coefficient estimates by instrument computed for individual banks of different sizes and the pass through coefficient for a volume-weighted aggregate measure. The results are reported in two panels, the first is for the EURIBOR 1-month market rate and the second for the EURIBOR 3-month market rate. We consider the pass through for individual banks which are summarized for banks within four size categories ranging from very large (deposits>euro 1bn) to large (euro 999.9mn>deposits>euro 100mn), medium-sized (euro 99.9mn>deposits>euro 10mn) and small banks (deposits<euro

9.9mn).[19] Although the results are not directly comparable to the results for France reported in the previous sub-sections, the pass through coefficients for deposits are below unity, and for loans are above unity for almost all bank groups and in aggregate. The mean values of the coefficients are not generally significantly different from one. The table shows that there is heterogeneity in the pass through between bank size classes, and this is also true between banks within each size class. Figure 7 provides plots of the histograms of long-run pass through coefficients for the banks for the six different categories of retail rates for each of the two market rates (1 month and 3 month EURIBOR). The distributions in some cases appear approximately Normal and have a distinct mode value, but there are a few cases where the distribution is not Normal e.g. for time deposits of households.

It is evident that the pass through of the aggregate measure lies within the range of the mean values for banks of different sizes in almost every case (loans to non-financial companies is the only exception). The scale of the pass through coefficients are greater than unity but not significantly different from one, and given that the sample includes the financial crisis it is possible that pass through is greater than in 'normal' times. There is a similar correspondence between the mean values of adjustment coefficients for banks of different sizes and the adjustment coefficient for the aggregate measure. The conclusion to be drawn from these results is that responses of individual banks are very similar to responses in aggregate data, suggesting that there is no systematic aggregation bias in the data for France. The estimates over a different sample period and a different aggregation nevertheless point to a pass through coefficient not significantly different from unity, and an adjustment to deviations of retail rates from their implied equilibrium that is negative and significant. The response to forecasts of future market rates is positive and significant.

In Table 9 we report the mean estimates of the adjustment coefficient and the coefficient on the forecasts. As before the results are reported in two panels, Panel

[19] A reporting restriction within our confidentiality agreement with the Banque de France requires that we do not report individual bank results.

A provides results for the EURIBOR 1-month market rate and Panel B for the EURIBOR 3-month market rate. In all cases the adjustment coefficient is negative as expected, and the forecast coefficient is positive as expected. Table 10 tests whether these coefficients can be restricted to be equal and opposite in sign, and whether they can individually be restricted to equal zero. The results for different instruments in the various bank size classes shown in Panel A indicate that (at the 5% level of significance) for the majority of cases (86%) we reject the null that the adjustment coefficient equals zero, and we also reject the forecast coefficient is equal to zero in 60% of cases. For 3-month EURIBOR results reported in Panel B, these figures drop to 63% and 35% respectively. Once again our individual bank results uphold the findings we report for aggregate data in previous sub-sections, and most importantly confirm the importance of the forward looking terms.

7 Conclusions

A large number of empirical studies of the relationship between retail interest rates and market rates have assumed there is a contemporaneous relationship between these interest rates in levels. We argue that the literature has largely ignored forecasts of rates that might be undertaken by banks when setting interest rates. Since the inclusion of future rates would alter the equilibrium relationship and the dynamics of the models used to evaluate the degree of interest rate pass through, models that rely only on contemporary market rates to explain retail rates downplay the importance of expected market rates that could help a bank to deal with uncertainty surrounding the future market rate.

The paper offers a simple theoretical framework to examine forward-looking behavior by institutions, and introduces forecasts into models of interest rate setting for European countries. It then produces forecasts based on Nelson-Siegel and principal components methods to explain market rates, and these are then used to estimate dynamic models for four different retail rates in the four major euro area countries. We find a significant role for forecasts of future money market interest rates in pass through at 1-month and 3-month maturities. This seems to be consistent with the practice before the financial crisis of using short-term money market funding to regularly refinance lending of much longer maturities. Given the importance of future expected short-term money market rates we suggest this model provides a more realistic explanation of rate setting behavior by banks, that acknowledges their attempts to reduce uncertainty about future market rates. Our results for the four major euro area countries using aggregated data are corroborated using data for individual banks in France.

Our work can be extended in several directions. Following Diebold et al. (2006) it would be interesting to determine whether a wider range of data would improve forecasts from factors using principal components methods. This would allow us to consider the impact of monetary and macroeconomic variables as well as yield curve information on expected future short term changes to money market rates. It would also be interesting to explore the importance of the risk premium in our model. Piazzesi and Swanson (2008) claim that futures produce poor forecasts of market rates because they are correlated with, and uncorrected for, the risk premium. Piazzesi and Swanson (2008) show that the correction can be made using a vector of macro information known to market participants such as Non-Farm Payroll employment, but surely a wider range of monetary and macro factors might be expected to be better at capturing risk premium adjustments. These are detailed changes that we leave for future research.

8 References

Ball, L. and Mankiw, G.N. (1994) 'Asymmetric price adjustment and economic fluctuations', Economic Journal 104, 247-61.

Baugnet, V., Collin, M., Dhyne, E. (2007) 'Monetary policy and the adjustment of the Belgian private bank interest rates - an econometric analysis', National Bank of Belgium Research Department.

Barbier de la Serre, A., Frappa, S., Montornes, J., and Murez, M. (2008)

‘Bank interest rates pass-through: new evidence from French panel data’, Banque de France mimeo.

Bernanke, B.S. and Kuttner, K. N. (2005) ’What else explains the stock market’s reaction to federal reserve policy?, Journal of Finance, 60, 1221-1257.

Bernoth, K. and von Hagen, J. (2004) ‘The EURIBOR futures market efficiency and the impact of ECB policy announcements’, International Finance, 7, 1-24.

Bondt, G. de (2002) ‘Retail bank pass through : new evidence at the euro area level’, ECB Working Papers, No 136.

Bondt, G. de (2005) ‘Interest rate pass through in the euro area’, German Economic Review, 6, 37-78.

Bondt, G. de, Mojon, B. and Valla, N. (2005) ‘Term structure and the sluggishness of retail bank interest rates in the euro area countries’, ECB Working Papers, No 518.

Borio, C.E.V. (2008) ‘The financial turmoil of 2007-?: a preliminary assessment and some policy considerations’, BIS Working Papers, No. 251.

Borio, C.E.V. and Fritz, W. (1995) ‘The response of short-term bank lending rates to policy rates: a cross country perspective’, in BIS Financial Structure and Monetary Policy Transmission Mechanism, Basel, 106-53.

Cochrane, J. Y. and Piazzesi, M. (2005) ‘Bond risk premia’, Amercian Economic Review, 95, 138-160.

Cotarelli, C. and Kourelis, A. (1994) ‘Financial structure, bank lending rates and the transmission of monetary policy’, IMF Staff Papers 41, 587-623.

De Graeve, F., De Jonghe, O. and R. Vander Vennet (2007) ‘Competition, transmission and bank pricing policies: Evidence from Belgian loan and deposit markets’, Journal of Banking and Finance, 31, 259-278.

Diebold, F.X. and Li, C. (2006) ‘Forecasting the term structure of government bond yields’, Journal of Econometrics, 130, 337-364

Diebold, F.X., Rudebusch, G.D. and Aruoba, B. (2006) ‘The macroeconomy and the yield curve: A dynamic latent factor approach’, Journal of Econometrics, 131, 309-338.

Elyasiani, E., Kopecky, K.P. and VanHoose, D. (1995) ‘Costs of adjustment, portfolio selection, and the dynamic behavior of bank loans and deposits’, Journal of Money, Credit, and Banking, 27, 955-974.

Ehrmann, M., Gambacorta, L., Pagés J., Sevestre, P. and Worms,A. (2001) ‘Financial systems and the role of banks in monetary policy transmission in the euro area’, ECB Working Papers, No 105.

Ehrmann, M. and Worms, A. (2001), ‘Interbank lending and monetary policy transmission - evidence for Germany’, ECB Working Papers, No 73.

Fuertes, A-M., Heffernan, S. and Kalotychou, E. (2008) ‘How do UK banks react to changing central bank rates?’, CASS Business School mimeo.

Gambacorta, L. (2008) ‘How do banks set interest rates?’, European Economic Review, 52, 792-819.

Heffernan, S. (1997) ‘Modelling British interest rate adjustment: an error correction approach’, Economica, 64, 211-231.

Hofmann, B. and Mizen, P. D. (2004) ‘Interest rate pass through in the monetary transmission mechanism: UK banks’ and building societies’ retail rates’, Economica, 71, 99-125.

Hutchison, D.E. (1995) ’Retail bank deposit pricing: An intertremporal asset pricing approach’, Journal of Money, Credit, and Banking, 27, 217-231.

Kapetanios, G. and M. Marcellino (2009) ‘A parametric estimation method for dynamic factor models of large dimensions’, Journal of Time Series Analysis, 30, 208-238.

Kleimeier, S. and Sander, H. (2006) ‘Expected versus unexpected monetary policy impulses and interest rate pass through in euro-zone retail banking markets’, Journal of Banking and Finance, 30, 1839-70.

Klein, M.A. (1971) ‘A theory of the banking firm’, Journal of Money, Credit, and Banking, 3, 205-218.

Kok-Sørensen, C. and Werner, T. (2006) ‘Bank interest rate pass through in the euro area', ECB Working Papers, No 580.

Kopecky, K.P. and VanHoose, D. (2012) 'Imperfect competition in bank retail markets, deposit and loan rate dynamics, and incomplete pass through', Journal of Money, Credit, and Banking, forthcoming.

Krueger, J. T. and Kuttner, K.N. (1996) 'The Fed funds rate as a predictor of the federal reserve policy', Journal of Futures Markets, 16, 865-879.

Kuttner, K.N. (2001) 'Monetary policy surprises and interest rates: evidence from the Fed funds futures market', Journal of Monetary Economics, 47, 523-544.

Llewellyn, D. T. (2009) 'Financial innovation and the economics of banking and the financial system,in Anderloni, L., Llewellyn, D. T. and R. H. Schmidt (eds.), Financial Innovation and Retail and Corporate Banking, 1-40, Edward Elgar Publishing Limited.

Mester, L.J. and Saunders, A. (1995) 'When does the Prime rate change?', Journal of Banking and Finance, 19, 743-764.

Mizen, P.D. (2008) 'The Credit Crunch of 2007-2008: A Discussion of the Background, Market Reactions, and Policy Responses' FRB St Louis Economic Review, September 2008, 531-568.

Mojon, B. (2000), 'Financial structure and the interest rate channel of ECB monetary policy', ECB Working Papers, No 40.

Monti, M. (1971) 'A theoretical model of bank behaviour and its implications for monetary policy', L'Industria, 2, 165-191.

Neumark, D. and Sharpe, S.A. (1992) 'Market sructure and the nature of price rigidity: evidence from the market for consumer deposits', Quarterly Journal of Economics, 107, 657-80.

Piazzesi, M. and Swanson, E.T. (2008) 'Futures prices as risk-adjusted forecasts of monetary policy', Journal of Monetary Economics, 55, 677-91.

Rudebusch, G. (2002) 'Term structure evidence oninterest rate smoothing and monetary policy inertia', Journal of Monetary Economics, 49, 1161-1187.

Sander, H. and S. Kleimeier (2004) 'Convergence in euro-zone retail banking? What interest rate pass-through tells us about monetary policy transmission, competition and integration', Journal of International Money and Finance, 23, 461-492.

Weth, M. (2002) 'The pass-through from market interest rates to bank lending rates in Germany' Deutsche Bundesbank, Economic Research Centre Discussion Paper No. 11/02.

Worms, A. (2001) 'The reaction of bank lending to monetary policy measures in Germany', ECB Working Papers, No 96.

Table 1: Direct forecast comparison, relative mean square forecast error, random walk benchmark

Horizon	1-month EURIBOR Nelson-Siegel	1-month EURIBOR Principal Components	3-month EURIBOR Nelson-Siegel	3-month EURIBOR Principal Components
1	0.753	0.668	-	-
2	0.700	0.649	-	-
3	0.683	0.639	0.769	0.740
4	0.684	0.646	-	-
5	0.701	0.674	-	-
6	0.733	0.711	0.843	0.830
7	0.769	0.751	-	-
8	0.811	0.796	-	-
9	0.860	0.847	0.958	0.954
10	0.900	0.891	-	-
11	0.955	0.949	-	-
12	1.000	1.000	1.080	1.080

Note: The table provides a comparison of the mean square forecast errors of Nelson-Siegel and Principal Component forecasts at horizons 1-12 months versus a random walk benchmark. Vlues less than one indicate superior performance.

Table 2: Estimates of the pass-through coefficient, β

Panel A: 1-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	0.954 (0.017)	0.959 (0.014)	0.934 (0.004)	0.936 (0.005)	0.802 (0.012)	0.800 (0.014)	0.890 (0.010)	0.893 (0.009)
Short-term loans to enterprises	0.784 (0.092)	0.747 (0.082)	1.450 (0.235)	1.560 (0.254)	0.794 (0.020)	0.788 (0.019)	0.934 (0.026)	0.930 (0.027)
Long-term loans to enterprises	1.450 (0.054)	1.430 (0.054)	0.749 (0.053)	0.738 (0.054)	0.805 (0.032)	0.789 (0.031)	0.733 (0.048)	0.720 (0.046)
Mortgage loans	1.270 (0.077)	1.260 (0.086)	1.500 (0.065)	1.420 (0.093)	0.936 0.024	0.916 (0.027)	1.190 (0.046)	1.130 (0.054)

Panel B: 3-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	0.969 (0.010)	0.969 (0.010)	0.937 (0.005)	0.937 (0.005)	0.810 (0.016)	0.806 (0.016)	0.895 (0.009)	0.891 (0.009)
Short-term loans to enterprises	0.665 (0.061)	0.668 (0.060)	1.460 (0.212)	1.430 (0.199)	0.792 (0.021)	0.792 (0.020)	0.932 (0.024)	0.930 (0.024)
Long-term loans to enterprises	1.490 (0.060)	1.470 (0.057)	0.724 (0.049)	0.709 (0.050)	0.769 (0.031)	0.769 (0.031)	0.716 (0.046)	0.726 (0.048)
Mortgage loans	1.340 (0.073)	1.330 (0.070)	1.630 (0.084)	1.590 (0.072)	0.929 (0.023)	0.927 (0.024)	1.210 (0.047)	1.200 (0.048)

Note: The table provides estimates of the coefficient β from equation (5) for 1-month and 3-month EURIBOR rates, using results from two different forecasting methods (Nelson Siegel and Principal Components). Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors are provided in brackets.

Table 3: Estimated adjustment coefficient, α_1

Panel A: 1-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	-0.190 (0.093)	-0.180 (0.082)	-0.330 (0.076)	-0.250 (0.080)	-0.230 (0.086)	-0.200 (0.084)	-0.300 (0.064)	-0.340 (0.063)
Short-term loans to enterprises	-0.170 (0.070)	-0.180 (0.072)	-0.015 (0.010)	-0.014 (0.009)	-0.350 (0.033)	-0.350 (0.033)	-0.620 (0.091)	-0.610 (0.093)
Long-term loans to enterprises	-0.077 (0.017)	-0.076 (0.016)	-0.180 (0.031)	-0.190 (0.030)	-0.670 (0.060)	-0.660 (0.060)	-0.350 (0.100)	-0.330 (0.100)
Mortgage loans	-0.024 (0.007)	-0.022 (0.007)	-0.061 (0.010)	-0.045 (0.009)	-0.440 (0.044)	-0.400 (0.044)	-0.088 (0.019)	-0.077 (0.017)

Panel B: 3-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	-0.093 (0.043)	-0.093 (0.043)	-0.260 (0.065)	-0.240 (0.063)	-0.190 (0.093)	-0.180 (0.093)	-0.320 (0.059)	-0.330 (0.060)
Short-term loans to enterprises	-0.250 (0.062)	-0.250 (0.062)	-0.015 (0.009)	-0.015 (0.009)	-0.360 (0.031)	-0.360 (0.031)	-0.770 (0.120)	-0.770 (0.120)
Long-term loans to enterprises	-0.065 (0.018)	-0.066 (0.018)	-0.180 (0.035)	-0.180 (0.035)	-0.680 (0.060)	-0.680 (0.060)	-0.340 (0.100)	-0.340 (0.100)
Mortgage loans	-0.021 (0.007)	-0.021 (0.007)	-0.038 (0.008)	-0.044 (0.007)	-0.460 (0.056)	-0.450 (0.057)	-0.090 (0.022)	-0.088 (0.023)

Note: The table provides estimates of the coefficient α_1 from equation (5) for 1-month and 3-month EURIBOR rates, using results from two different forecasting methods (Nelson Siegel and Principal Components). Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors are provided in brackets.

Table 4: Estimated adjustment coefficient for forecasts, α_2

Panel A: 1-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	0.750 (0.250)	0.450 (0.150)	0.680 (0.180)	0.350 (0.110)	0.510 (0.110)	0.440 (0.110)	0.700 (0.110)	0.280 (0.040)
Short-term loans to enterprises	0.880 (0.280)	0.620 (0.180)	0.130 (0.110)	0.140 (0.087)	0.410 (0.110)	0.230 (0.073)	0.140 (0.052)	0.130 (0.052)
Long-term loans to enterprises	0.160 (0.040)	0.170 (0.040)	0.800 (0.110)	0.650 (0.089)	0.950 (0.210)	0.810 (0.200)	0.520 (0.190)	0.690 (0.160)
Mortgage loans	0.290 (0.068)	0.210 (0.047)	0.670 (0.081)	0.590 (0.081)	0.930 (0.110)	0.760 (0.100)	0.360 (0.053)	0.390 (0.048)

Panel B: 3-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	-0.013 (0.020)	-0.015 (0.019)	0.044 (0.040)	0.007 (0.016)	0.260 (0.088)	0.230 (0.083)	0.230 (0.055)	0.210 (0.051)
Short-term loans to enterprises	-0.120 (0.220)	-0.094 (0.210)	0.075 (0.041)	0.074 (0.040)	0.049 (0.036)	0.048 (0.035)	0.140 (0.078)	0.130 (0.079)
Long-term loans to enterprises	0.110 (0.048)	0.110 (0.050)	0.840 (0.150)	0.780 (0.140)	-0.051 (0.082)	-0.050 (0.082)	-0.120 (0.081)	-0.130 (0.097)
Mortgage loans	0.050 (0.033)	0.053 (0.033)	0.360 (0.078)	0.360 (0.080)	0.420 (0.093)	0.380 (0.084)	0.200 (0.032)	0.190 (0.031)

Note: The table provides estimates of the coefficient α_2 from equation (5) for 1-month and 3-month EURIBOR rates, using results from two different forecasting methods (Nelson Siegel and Principal Components). Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors are provided in brackets.

Table 5a: Likelihood ratio tests, $H_0 : \alpha_2 = 0$:, p-values 1-month EURIBOR, Nelson-Siegel forecasts

	France	Germany	Italy	Spain
Time deposits	0.000	0.000	0.000	0.000
Short-term loans to enterprises	0.000	0.095	0.010	0.020
Long-term loans to enterprises	0.000	0.000	0.001	0.025
Mortgage loans	0.003	0.000	0.000	0.000

Note: The table provides p-values for the Likelihood Ratio test that the unrestricted model (including forecasts) can be rejected in favor of the restricted model (excluding forecasts) for the estimate of equation (5) using 1-month EURIBOR and Nelson Siegel forecasts.

Table 5b: Bayesian information criterion, 1-month EURIBOR, Nelson-Siegel forecasts

	Model	France	Germany	Italy	Spain
Time deposits	without forecasts	-0.338	-1.117	-0.141	0.216
	with forecasts	-0.635	-1.606	-0.238	-0.029
Short-term loans to enterprises	without forecasts	1.290	-0.321	-0.460	0.823
	with forecasts	1.144	-0.294	-0.466	0.819
Long-term loans to enterprises	without forecasts	0.948	0.699	1.454	1.100
	with forecasts	0.801	0.295	1.390	1.129
Mortgage loans	without forecasts	-1.499	0.356	0.347	-1.101
	with forecasts	-1.250	-0.104	0.112	-1.454

Note: The table provides Bayesian Information Criteria values for the unrestricted model (including forecasts) versus the restricted model (excluding forecasts) for the estimate of equation (5) using 1-month EURIBOR and Nelson Siegel forecasts.

Table 6: Likelihood ratio test of $\alpha_2 = -\alpha_1$, p-values

Panel A: 1-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	0.000	0.009	0.000	0.177	0.030	0.056	0.002	0.140
Short-term loans to enterprises	0.016	0.058	0.182	0.103	0.834	0.080	0.000	0.000
Long-term loans to enterprises	0.002	0.001	0.000	0.000	0.690	0.923	0.879	0.358
Mortgage loans	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000

Panel B: 3-month EURIBOR

	France		Germany		Italy		Spain	
	NS	PC	NS	PC	NS	PC	NS	PC
Time deposits	0.064	0.055	0.000	0.000	0.802	0.968	0.068	0.019
Short-term loans to enterprises	0.054	0.058	0.180	0.183	0.000	0.000	0.000	0.000
Long-term loans to enterprises	0.138	0.118	0.000	0.000	0.000	0.000	0.000	0.004
Mortgage loans	0.182	0.141	0.000	0.000	0.442	0.291	0.000	0.000

Note: The table provides p-values for the Likelihood Ratio test of the restriction that $\alpha_2 = -\alpha_1$ in equation (5) for 1-month and 3-month EURIBOR rates, using results from two different forecasting methods (Nelson Siegel and Principal Components).

Table 7: Results for models including future Rates

Panel A: Estimates of the pass-through coefficient, β

	France	Germany	Italy	Spain
Time Deposits	0.959 (0.014)	0.931 (0.008)	0.806 (0.059)	0.862 (0.017)
Short-Term Loans to Enterprises	0.619 (0.056)	1.680 (0.524)	0.787 (0.021)	0.925 (0.022)
Long-Term Loans to Enterprises	1.240 (0.055)	0.786 (0.022)	0.770 (0.033)	0.668 (0.036)
Mortgage Loans	1.150 (0.039)	1.240 (0.020)	0.944 (0.040)	1.24 (0.014)

Panel B: Estimated adjustment coefficient, α_1

	France	Germany	Italy	Spain
Time Deposits	-0.098 (0.040)	-0.260 (0.077)	-0.100 (0.093)	-0.300 (0.072)
Short-Term Loans to Enterprises	-0.320 (0.058)	-0.013 (0.010)	-0.360 (0.033)	-0.780 (0.120)
Long-Term Loans to Enterprises	-0.089 (0.027)	-0.450 (0.065)	-0.690 (0.068)	-0.450 (0.110)
Mortgage Loans	-0.064 (0.012)	-0.16 (0.028)	-0.320 (0.057)	-0.140 (0.034)

Panel C: Estimated adjustment coefficient for forecasts, α_2

	France	Germany	Italy	Spain
Time Deposits	0.005 (0.006)	0.007 (0.010)	0.006 (0.022)	0.053 (0.021)
Short-Term Loans to Enterprises	-0.150 (0.082)	-0.003 (0.007)	0.016 (0.022)	0.053 (0.040)
Long-Term Loans to Enterprises	0.077 (0.036)	0.450 (0.063)	-0.022 (0.054)	-0.180 (0.054)
Mortgage Loans	0.064 (0.016)	0.240 (0.045)	0.035 (0.032)	0.071 (0.015)

Panel D: Likelihood ratio test of $\alpha_2 = -\alpha_1$, p-values

	France	Germany	Italy	Spain
Time Deposits	0.079	0.000	0.131	0.000
Short-Term Loans to Enterprizes	0.000	0.227	0.000	0.000
Long-Term Loans to Enterprises	0.473	0.000	0.000	0.000
Mortgage Loans	1.000	0.000	0.000	0.000

Note: The table provides estimates of the pass through coefficient (Panel A), adjustment coefficient α_1 (Panel B); adjustment coefficient for forecasts α_2 (Panel C) and tests of the restriction$\alpha_2 = -\alpha_1$ in equation (5) for 1-month and 3-month EURIBOR rates, using 3-month EURIBOR futures in place of forecasts of market rates. Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors are provided in brackets.

Table 8: Mean of estimated pass through for individual banks

	Very Large Banks	Large Banks	Medium-sized Banks	Small Banks	Aggregate
1-month EURIBOR					
Time deposits of households	0.8952 (n.a.)	0.9224 (0.1099)	0.9699 (0.2147)	0.9916 (0.1548)	1.0380 (0.1587)
Time deposits of enterprises	0.9663 (n.a.)	0.9345 (0.0748)	0.9170 (0.2416)	0.8845 (0.0733)	0.9182 (0.2036)
Short term (< 1 yr) loans to enterprises	1.2292 (0.1473)	1.2903 (0.0927)	1.3527 (0.1648)	1.3466 (0.2228)	1.3298 (0.1591)
Medium term (1-5 yrs) loans to enterprises		1.3098 (n.a.)	1.4888 (0.4893)	1.2801 (0.7212)	1.3562 (0.6128)
Long term (>5 yrs) loans to enterprises		1.3601 (0.0841)	1.2686 (0.3162)	1.6905 (0.6123)	1.4191 (0.3758)
Mortgages		1.3313 (0.0669)	1.3083 (0.0995)	1.4152 (0.1963)	1.3319 (0.1211)
3-month EURIBOR					
Time deposits of households	0.8964 (n.a.)	1.0182 (0.2022)	1.2087 (0.2920)	1.0216 (0.2186)	1.0815 (0.2031)
Time deposits of enterprises	0.9391 (n.a.)	0.9044 (0.0590)	0.9176 (0.0816)	0.9043 (0.1280)	0.9175 (0.0880)
Short term (<1 yr) loans to enterprises	1.2465 (0.1009)	1.2778 (0.1031)	1.3617 (0.1630)	1.441 (0.1759)	1.3494 (0.1568)
Medium term (1-5 yrs) loans to enterprises		1.3810 (n.a.)	1.5519 (0.6002)	1.5191 (0.3921)	1.5015 (0.4666)
Long term (>5 yrs) loans to enterprises		1.3989 (0.0677)	1.3633 (0.3112)	1.7076 (0.5406)	1.2964 (1.3011)
Mortgages		1.4042 (0.0843)	1.3463 (0.0668)	1.3935 (0.1112)	1.3778 (0.0800)

Note:The table provides mean estimates of the coefficient β from equation (5) for 1-month and 3-month EURIBOR rates, using results from Nelson Siegel forecasting methods, for groups of individual banks in France. Empirical standard errors, computed from the estimated coefficients for each group of banks are provided in brackets.

Table 9: Mean of adjustment speed (α_1) and forecast coefficient (α_2) for individual banks

1-month EURIBOR

		Very Large Banks	Large Banks	Medium-sized Banks	Small Banks	Aggregate
Time deposits of households	α_1	-0.1989	-0.1572	-0.2803	-0.3106	-0.2920
	α_2	0.2268	0.3179	1.0206	0.4598	0.5948
Time deposits of enterprises	α_1	-0.5924	-0.3807	-0.4282	0.2796	-0.4083
	α_2	0.3171	0.2140	1.1042	0.4696	0.8621
Short term (<1 yr) loans to enterprises	α_1	-0.2576	-0.3277	-.3231	-0.3292	-0.3213
	α_2	0.4406	0.3043	0.4408	0.8107	0.4731
Medium term (1-5 yrs) loans to enterprises	α_1		-0.2098	-0.1686	-0.1436	-0.1566
	α_2		0.4411	0.2897	0.3491	0.3241
Long term (>5 yrs) loans to enterprises	α_1		-0.1520	-0.1128	-0.0903	-0.1011
	α_2		0.2579	0.3134	0.2168	0.2715
Mortgages	α_1		-0.0541	-0.0599	-0.1010	-0.0659
	α_2		0.1287	0.1349	0.1135	0.1299

3-month EURIBOR

		Very Large Banks	Large Banks	Medium-sized Banks	Small Banks	Aggregate
Time deposits of households	α_1	-0.1941	-0.1539	-0.2382	-0.3255	-0.2799
	α_2	0.2299	0.5182	0.5182	0.7047	0.5746
Time deposits of enterprises	α_1	-0.7080	-0.2679	-0.3963	-0.3820	-0.3699
	α_2	3.2706	0.6477	0.6052	0.2913	0.7279
Short term (<1 yr) loans to enterprises	α_1	-0.2476	-0.2967	-0.3179	-0.3213	-0.3099
	α_2	0.4731	1.2473	0.5533	0.4325	0.6797
Medium term (1-5 yrs) loans to enterprises	α_1		-0.2442	-0.1861	-0.1809	-0.1864
	α_2		0.5713	0.4721	0.5556	0.5063
Long term (>5 yrs) loans to enterprises	α_1		-0.1586	-0.1283	-0.0935	-0.1114
	α_2		0.2853	0.3254	0.2578	0.2511
Mortgages	α_1		-0.0554	-0.0593	-0.1159	-0.0684
	α_2		0.1263	0.0852	0.3925	0.1477

Note: The table provides mean estimates of the coefficients $\alpha_1$and α_2 from equation (5) for 1-month and 3-month EURIBOR rates, using results from Nelson Siegel forecasting methods, for groups of individual banks in France.

Table 10: Median of p-values for
$H_0 : \alpha_1 = -\alpha_2$, $H_0' : \alpha_1 = 0$, $H_0'' : \alpha_2 = 0$, individual banks

1-month EURIBOR

		Very Large Banks	Large Banks	Medium-sized Banks	Small Banks	Aggregate
Time deposits of households	H_0	0.9170	0.0581	0.0330	0.1864	0.0917
	H_0'	0.0000	0.0174	0.0252	0.0346	0.0000
	H_0''	0.0246	0.0652	0.0465	0.1044	0.0617
Time deposits of enterprises	H_0	0.0154	0.0473	0.0202	0.0243	0.0206
	H_0'	0.0000	0.0000	0.0000	0.0160	0.0000
	H_0''	0.0018	0.1900	0.0068	0.0000	0.0008
Short term (< 1 yr) to enterprises	H_0	0.2270	0.4772	0.1573	0.0492	0.1573
	H_0'	0.0368	0.0048	0.0000	0.0000	0.0000
	H_0''	0.0252	0.0369	0.0296	0.0195	0.0297
Medium term (1-5 yrs) to enterprises	H_0		0.0019	0.1771	0.1180	0.1436
	H_0'		0.0000	0.0000	0.2198	0.2198
	H_0''		0.0004	0.0646	0.0409	0.0468
Long term (>5 yrs) to enterprises	H_0		0.1284	0.1048	0.3196	0.1636
	H_0'		0.0000	0.0008	0.0467	0.0680
	H_0''		0.0493	0.0630	0.1992	0.0900
Mortgages	H_0		0.1366	0.2177	0.3087	0.2238
	H_0'		0.0000	0.0013	0.1254	0.0014
	H_0''		0.0378	0.0999	0.1448	0.1041

Table 10 continued

3-month EURIBOR

		Very Large Banks	Large Banks	Medium-sized Banks	Small Banks	Aggregate
Time deposits of households	H_0	0.7993	0.1156	0.1124	0.0910	0.1182
	H_0'	0.0004	0.0099	0.0296	0.0065	0.0004
	H_0''	0.0476	0.0450	0.0943	0.0761	0.0768
Time deposits of enterprises	H_0	0.0013	0.5255	0.0910	0.0905	0.1956
	H_0'	0.0000	0.0005	0.0008	0.0000	0.0008
	H_0''	0.0000	0.2752	0.0358	0.1888	0.0691
Short term (< 1 yr) loans to enterprises	H_0	0.1296	0.4136	0.2371	0.2188	0.2753
	H_0'	0.1080	0.0135	0.0088	0.0023	0.0088
	H_0''	0.0278	0.0699	0.0359	0.0449	0.0443
Medium term (1-5 yrs) loans to enterprises	H_0		0.0004	0.1075	0.0495	0.0521
	H_0'		0.0000	0.0003	0.0371	0.0371
	H_0''		0.0001	0.0666	0.0538	0.0609
Long term (> 5 yrs) loans to enterprises	H_0		0.1898	0.1049	0.3196	0.1626
	H_0'		0.0000	0.0000	0.1014	0.1083
	H_0''		0.0994	0.0724	0.2329	0.1054
Mortgages	H_0		0.1640	0.2844	0.2936	0.2755
	H_0'		0.0000	0.0006	0.1342	0.0006
	H_0''			0.2382	0.2071	0.2268

Note: The table provides median p-values in tests of the hypotheses that $H_0 : \alpha_1 = -\alpha_2$, $H_0' : \alpha_1 = 0$, $H_0'' : \alpha_2 = 0$ from equation (5) for 1-month and 3-month EURIBOR rates, using results from Nelson Siegel forecasting methods, for groups of individual banks in France.

Data Appendix

Retail interest rates*

Type of product	Source
Time deposits	European Central Bank
Short-term loans to enterprises	European Central Bank
Long-term loans to enterprises	European Central Bank
Mortgage loans	European Central Bank

*The rates a calculated using the same methodology for Germany, France, Italy, and Spain (see Sorensen and Werner (2006))

Money market interest rates

Type of product	Source
1-month Euribor	European Central Bank
3-month Euribor	European Central Bank
6-month Euribor	European Central Bank
12-month Euribor	European Central Bank
2-year government benchmark bond	European Central Bank
3-year government benchmark bond	European Central Bank
5-year government benchmark bond	European Central Bank
7-year government benchmark bond	European Central Bank
10-year government benchmark bond	European Central Bank

Banque de France data

Data at a monthly frequency at the level of individual banks were made available to us for 297 banks and credit institutions for France for the products given below. The time span of the data is in general January 2003 until December 2011 although complete runs of data are in large part not available. For each type of product, in order to avoid potential complications arising from interpolation, in the estimation we have used banks for which complete runs of data exist from January 2003 until the early part of 2010 (January or May 2010). This allows us to work with a sufficient number of banks in each category of product and since the banks are drawn from across the size spectrum (defined according to volumes of loans) we do not expect any distortion of the results from this selection process. The span of data is kept as long as possible in order to ensure precision in estimation.

Retail interest rates for French banks

Type of product	Source
Time deposits with agreed maturity of households (sole proprietorships excluded): new business	Banque de France
Time deposits with agreed maturity of non financial corporations: new business	Banque de France
Loans to non financial corporations, up to 1 year initial rate fixation: new business	Banque de France
Loans to non financial corporations, over 1 year and up to 5 years initial rate fixation: new business	Banque de France
Loans to non financial corporations, over 5 years initial rate fixation: new business	Banque de France
Lending for house purchase to households (Mortgages) (sole proprietorships excluded): new business	Banque de France

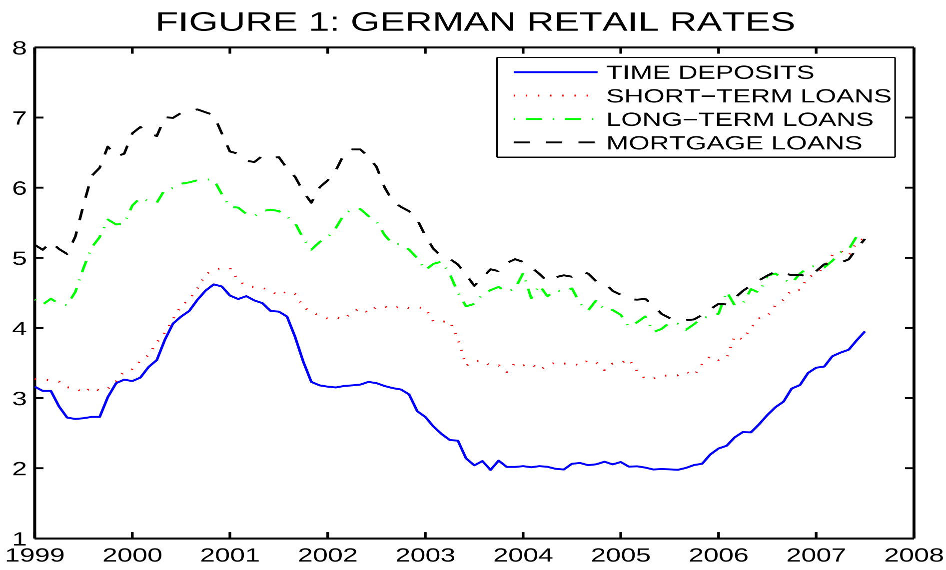
FIGURE 1: GERMAN RETAIL RATES
TIME DEPOSITS
SHORT−TERM LOANS
LONG−TERM LOANS
MORTGAGE LOANS
1
2
3
4
5
6
7
8
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

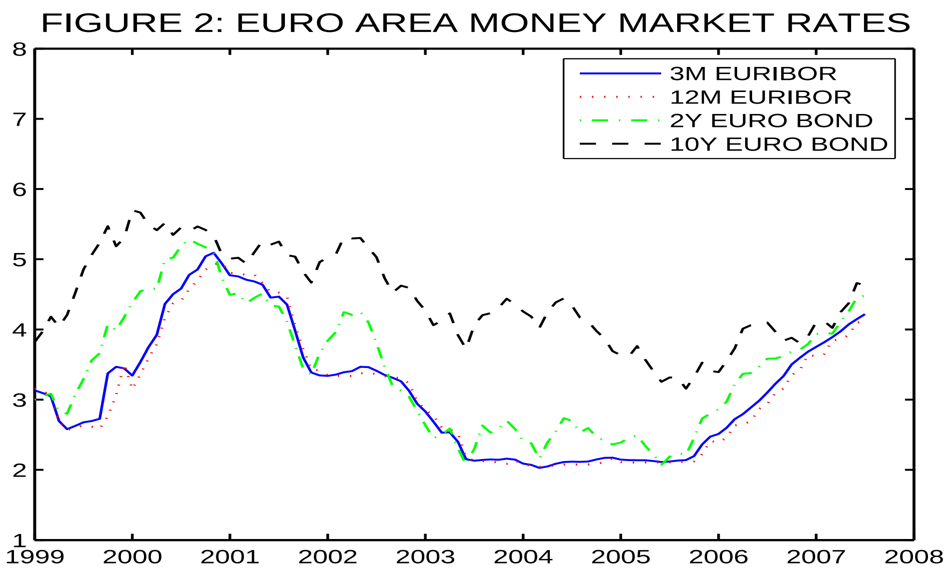
FIGURE 2: EURO AREA MONEY MARKET RATES
3M EURIBOR
12M EURIBOR
2Y EURO BOND
10Y EURO BOND
1
2
3
4
5
6
7
8
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008

Figure 3: Results of CUSUM tests, France

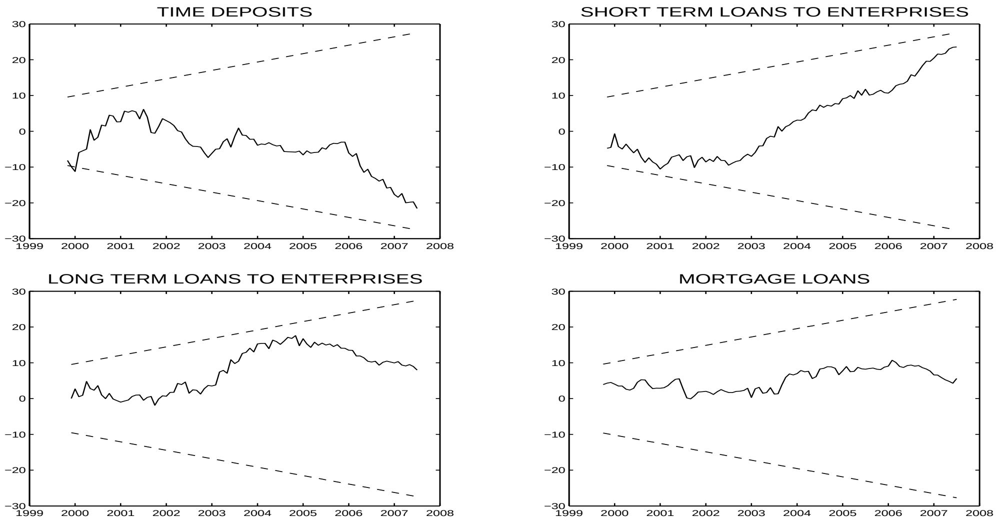

Figure 4: Results of CUSUM tests, Germany

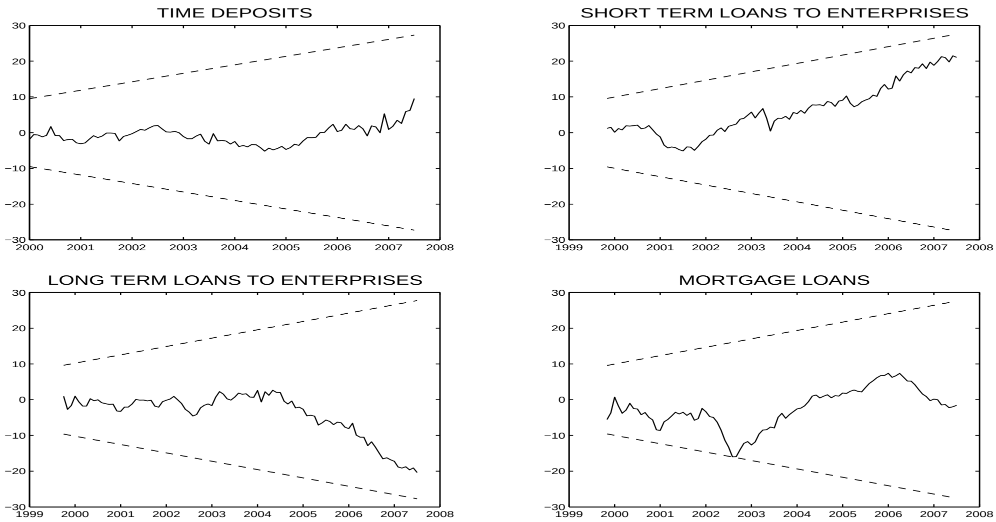

Figure 5: Results of CUSUM tests, Italy

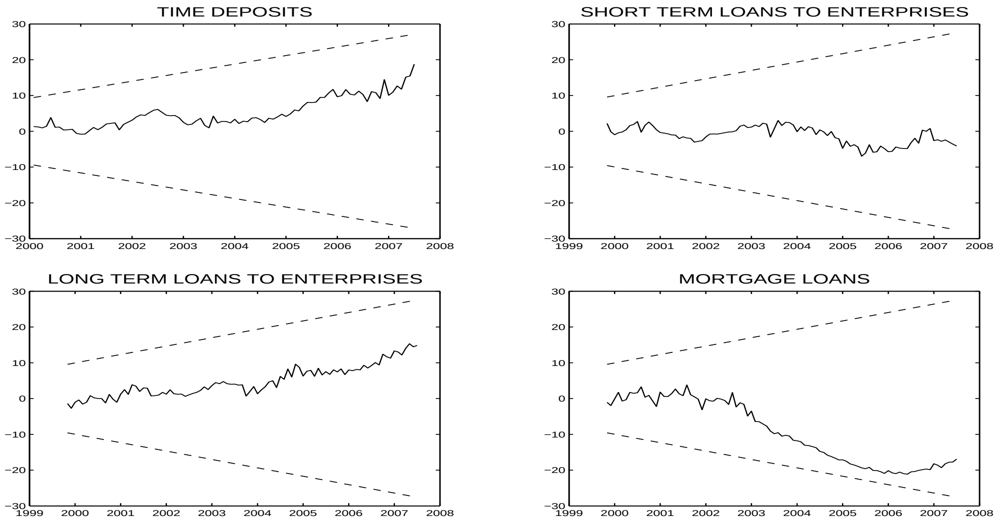

Figure 6: Results of CUSUM tests, Spain

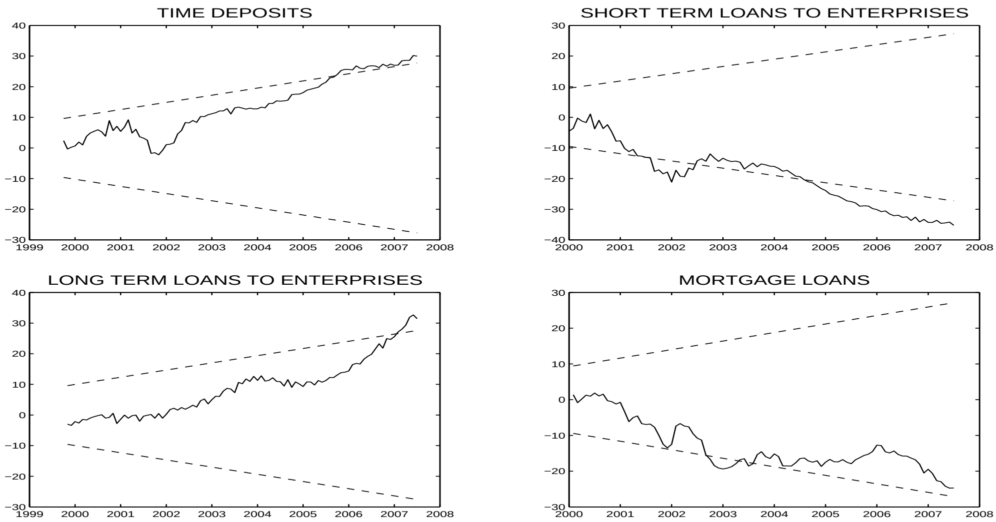

Figure 7: Histograms of pass-through coefficients based on French bank-level data

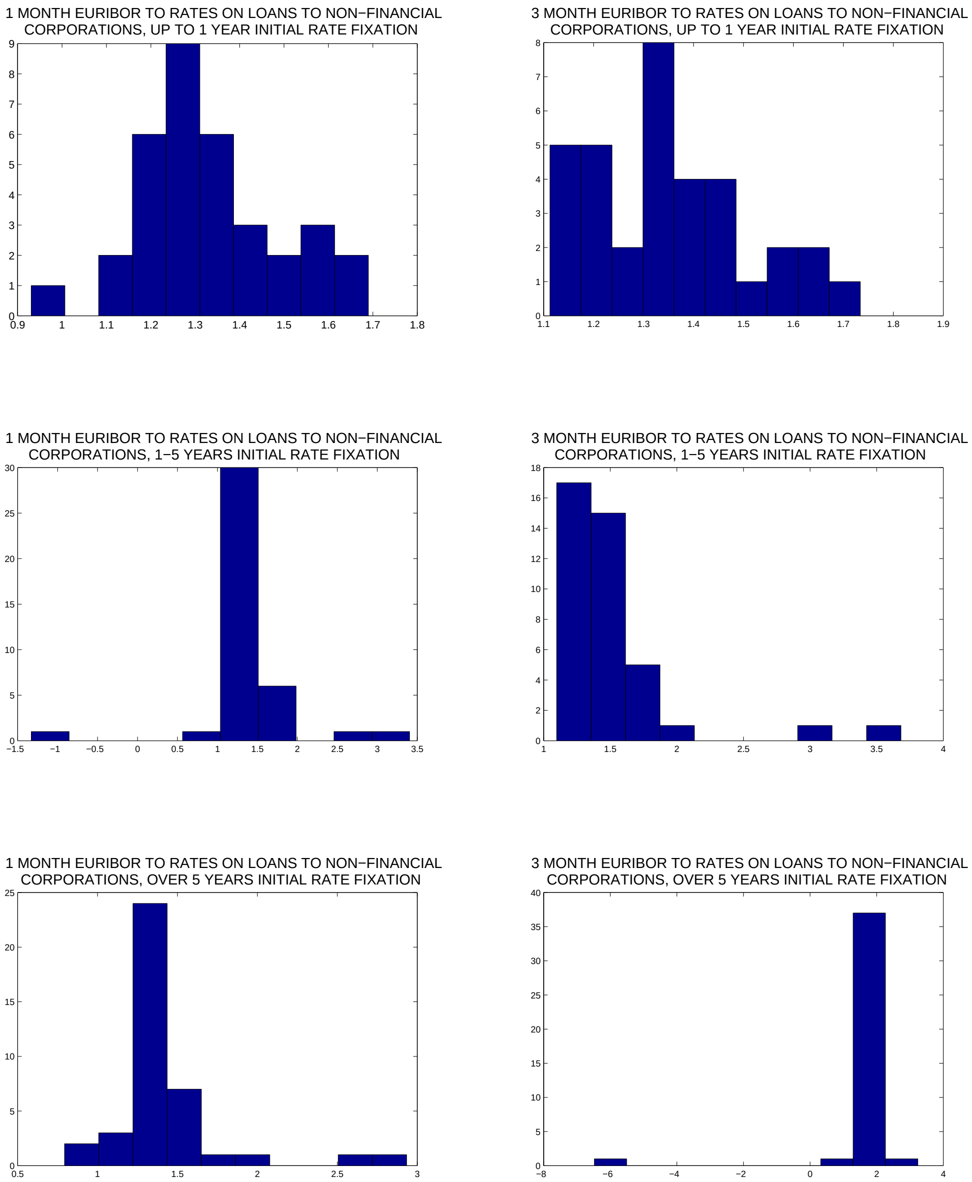

Figure 7 continued: Histograms of pass-through coefficients based on French bank-level data