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* Views expressed are those of the individual authors and do not necessarily reflect official positions of De Nederlandsche Bank.

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Asymmetric Price Adjustment in the Dutch Mortgage Market*

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Abstract

We analyze the mortgage interest rate setting behavior of the four largest banks in the Dutch mortgage market using advertised interest rates at a daily frequency from October 1997 to July 2003. We find that the pass-through of funding cost changes into mortgage interest rates on 5 and 10 year loans differs among these banks. Further, there is evidence of asymmetric price adjustment, in the sense that funding cost increases are more quickly passed on than decreases.
JEL-classification: G21, L13.
Key-words: Asymmetric Pricing, Mortgage Loans, Error Correction Model.

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1 Introduction

The merger wave in European banking during the last two decades has led to some concerns regarding the degree of banking competition. Especially in markets where entry is potentially blocked, either legally or economically (*e.g.* high entry costs), competition authorities face problems in guarding market performance and consumer interests. From an authorities' point-of-view it is essential to have insight into the degree of monopoly power in banking markets after this wave of consolidation. A few empirical studies compare bank competition in European countries. For instance Gual and Neven (1992) compare banking costs for consumers across countries. Mojon (2000) observes that the pass-through of monetary policy interest rate changes into money market rates varies across European countries. Corvoisier and Gropp (2001) report differences in retail interest rates across EU countries.

Dutch banking in particular faces concerns regarding financial competition, as is apparent in the recent initiative of the Dutch competition authority NMa to publish a Monitor of the Financial Industry (NMa, 2003). In the Netherlands four large banks (ABN-AMRO, RABObank, Fortis, and ING group) together control about 80 percent of the market for banking services. In the literature there is mixed evidence of imperfect competition in the Dutch banking markets. Bikker (1999) compares competition in 15 EU-countries and concludes that competition in the Dutch banking market is the weakest. Gual and Neven (1992) find that Dutch consumers face higher banking costs than Belgian, French, and German consumers. For some markets, such as the market for payments and the mortgage market, the market share of the top-four banks is even larger. As the provision of mortgages in the Netherlands is to a large extent still a local (or regional) activity the concerns with respect to the degree of competition apply *a fortiori* to this type of the banking market. As Degryse and Ongena (2005) show distance is an important element in the bank-client relation. Contrary to this argument one could say that all four banks have a national coverage and so compete in all local communities (as opposed to e.g. Germany). But some banks have a clear lead in urban and some in more rural areas. In a broad study De Haas *et al.* (2000) still conclude though that there is sufficient competition in the Dutch banking sector. But Mojon (2000) argues that the pass-through of official interest rate changes into bank mortgage rates in the Netherlands is about half the Euro-zone average. We note that this finding may reflect the fact that Dutch mortgage contracts have a rather large maturity as compared to other European countries. Toolsema and Jacobs (2005), using macro data, conclude that there is asymmetric pass-through of funding costs into mortgage interest rates in the sense that Dutch banks tend to increase interest rates instantly when costs rise, while waiting to lower the rates when costs drop. Our contribution also focuses on the Dutch mortgage market.

The contribution of our paper is that we analyze the interest rate setting behavior in the Dutch mortgage market using high-frequency micro data.[1] We test for two types of behavior. First, we test the pass-through of funding cost into mortgage rates. Our hypothesis is that a dominant market player is less cost sensitive and more able to shield

[1] We focus on interest rate setting and not on the quantities of mortgage loans supplied, because banks are likely to participate in a game of Bertrand price competition instead of Cournot quantity oligopoly (see also Freixas and Rochet, 1997).

profit margins. Next, we test for asymmetric price setting. Our prior is that a dominant market player adjusts prices more quickly upwards than downwards. Of course, the data also contains information on possible price leadership among the four banks concerned. This issue is elaborated in De Haan and Sterken (2005).

We use daily data on advertised mortgage interest rates set by the four large Dutch banks from October 1997 through July 2003 for 5 and 10 years loans. The interest rates used are the advertised rates, not the effective rates. Although most of the information used in this paper is public, some banks provided the time-series under the restriction that the name of the bank would be kept anonymous. We will do so hereafter and label the four Dutch banks concerned randomly Bank A, B, C and D, respectively.

Our main result is that there is evidence of asymmetric pricing. Especially one bank (Bank A) shows dominant pricing behavior.

The remainder of the paper is structured as follows. First, in section 2 we give a short description of the Dutch mortgage market. Section 3 reviews some of the theoretical and empirical literature on asymmetric pricing. Our econometric methodology is explained in Section 4, the results of which are presented in Section 5. We summarize and conclude in Section 6.

2 The Dutch market for mortgage loans

2.1 The Market

In 2000 the new supply of mortgage loans by banks in the Dutch mortgage market accounted for roughly 45 to 50 percent of the total market volume (see Hassink and Van Leuvestein, 2003), but the market share of commercial banks in outstanding loans is much larger. In 2002 the total size of outstanding mortgage loans in the Netherlands was about 350 billion euros. Banks supplied 278 billion euros, institutional investors about 44 billion euros while the remaining 28 billion euros was supplied by e.g. foreign financial institutions.

The four largest banks had a total market share of the bank-mortgage market of about 83 percent on average over the sample period 1997-2003 (authors' calculations) and according to the NMa even 90 percent in 2000 (see NMa, 2003). The NMa reports that in that year ABN-AMRO had a market share of 20 percent, RABObank of 22 percent, Fortis 12 percent, and ING Group 25 percent.

Various types of mortgage loans are available in the Netherlands, ranging from simple annuity loans to security-financed products. Most contracts run for 30 years, with interest renewal negotiations mostly after 1, 2, 5 or 10 years (but also 15, 20, and even 30 years). About half a million new contracts were written in 2002. Two-third was meant to finance a new house, while one-third was a second mortgage. We focus in this paper on the most popular maturities for mortgage loans: 5- and 10-year loans.

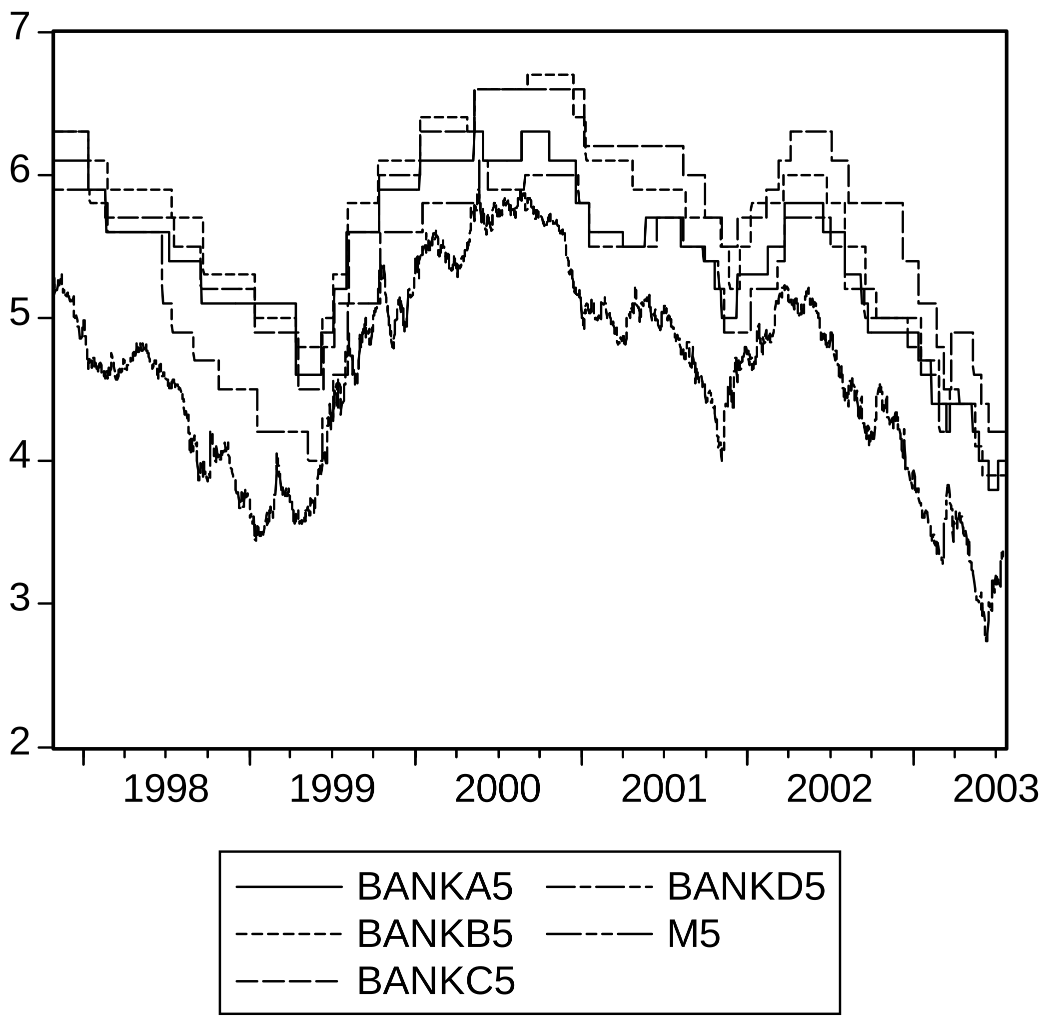

Figure 1: Interest rates on 5-year mortgage contracts (bank A to D) and the market rate

2.2 Price-setting behavior by banks

We track the price setting behavior of the four largest banks over the years 1997-2003 using daily observations. We present the data in two ways. First, Table 1 gives the dates of the changes of the interest rates on 5-year contracts. The datings clearly show clustering. The table does not show the size of the changes. Therefore we present in Figure 1 the time-series of the interest rates set by the four banks together with the capital market funding rate (the interest rate on 5-year government securities). This figure tells the same story as Table 1.

For 10-year contracts the table and figure look quite similar (and therefore are not reported here). In the analysis hereafter we proceed by describing the results for both products.[2]

[2]It should be noted that a precise comparison between the rates offered by the individual banks can be troubled by the diversity of the products involved.

Table 1: Dates of interest rate changes for 5-year contracts

Year	Bank A	Bank B	Bank C	Bank D
1998	13-Jan-98	13-Jan-98	13-Jan-98	13-Jan-98
				16-Jan-98
	20-Feb-98	19-Feb-98	23-Feb-98	24-Feb-98
				25-Jun-98
	10-Jul-98	20-Jul-98	14-Jul-98	16-Jul-98
	18-Sep-98	18-Sep-98	23-Sep-98	2-Sep 98
				26-Oct-98
1999		15-Jan-99	14-Jan-99	20-Jan-99
	14-Apr-99	20-Apr-99	16-Apr-99	
				12-May-99
	9-Jun-99	14-Jun-99	11-Jun-99	11-Jun-99
	7-Jul-99	9-Jul-99	6-Jul-99	6-Jul-99
	4-Aug-99	7-Aug-99	6-Aug-99	6-Aug-99
	14-Oct-99	15-Oct-99	13-Oct-99	19-Oct-99
2000	12-Jan-00	13-Jan-00	13-Jan-00	18-Jan-00
			26-Apr-00	
	10-May-00	12-May-00	12-May-00	
	31-May-00		23-May-00	
				9-Jun-00
	24-Aug-00		6-Sep-00	30-Aug-00
	23-Oct-00			
	20-Dec-00		15-Dec-00	27-Dec-00
2001	19-Jan-01	8-Jan-01	12-Jan-01	19-Jan-01
	4-Apr-01		24-Apr-01	
	23-May-01			
			18-Jun-01	
	10-Aug-01	15-Aug-01	20-Aug-01	17-Aug-01
	28-Sep-01		28-Sep-01	2-Oct-01
	24-Oct-01			2-Nov-01
	7-Nov-01	8-Nov-01	6-Nov-01	13-Nov-01
		26-Nov-01		
	12-Dec-01	14-Dec-01	19-Dec-01	
2002	18-Feb-02	15-Feb-02	12-Feb-02	11-Jan-02
		13-Mar-02		11-Mar-02
	26-Mar-02	8-Apr-02	25-Mar-02	28-Mar-02
	19-Jun-02	8-Jul-02	28-Jun-02	5-Jul-02
	7-Aug-02	15-Aug-02	8-Aug-02	7-Aug-02
	11-Sep-02		20-Sep-02	19-Sep-02
	26-Sep-02		14-Oct-02	
		13-Dec-02		23-Dec-02
2003	15-Jan-03	16-Jan-03	22-Jan-03	21-Jan-03
	12-Feb-03	24-Feb-03		
	17-Mar-03	13-Mar-03	3-Mar-03	3-Mar-03
	26-Mar-03	28-Mar-03		26-Mar-03

Table 2: Mean interest rate margins (percentage-points)

5-year rates	Margin	10-year rates	Margin
$r^5_A - r^5_M$	0.808	$r^{10}_A - r^{10}_M$	0.748
$r^5_B - r^5_M$	1.066	$r^{10}_B - r^{10}_M$	1.000
$r^5_C - r^5_M$	1.118	$r^{10}_C - r^{10}_M$	1.138
$r^5_D - r^5_M$	0.583	$r^{10}_D - r^{10}_M$	0.496

Sample period: 28 October 1997 - 21 July 2003. Number of observations: 2025.

As the interest rate margin plays a role in the model to be defined in Section 4, we give the mean interest rate margins on the two types of contracts in Table 2. r^j_i is the interest rate on a j=(5,10)-year mortgage contract set by bank $i = A, B, C, D$. $r^j_{M,t}$ is the market funding rate with a maturity j at time t. For the market funding rate we use the capital market rate, i.e. the effective rate on government bonds with the same maturity j. So the margin is $r^j_i - r^j_M$. Table 2 shows that the interest rate margins differ between banks. We do not know whether these differences reflect relative market power or simply differences in products (note that the latter could also be considered as elements of market power), or even cross-subsidization. Bank D has the lowest interest margin on both 5 and 10 year mortgages. Below we will use a simple linear model to describe the long-run cost sensitivity of mortgage rates and the implied interest rate margin. Basically, we model the bank's mortgage interest rate as depending on the capital market rate (representing funding cost) plus an intercept, while taking short-run dynamics into account.

3 Literature review

Several theories of asymmetric price adjustments are presented in the literature. First, if concentration in a market is high, due to *e.g.* entry barriers, there is a scope for price coordination. Tacit collusion can occur with full or partial information on the input prices of all the players in the market. A second cause of asymmetric pricing may be the existence of consumer search costs. If searching for a lower price is costly, firms can exploit this. Also if consumers face a signal extraction problem and output prices are volatile, the expected gains from searching by the consumer are lower. Third, for physical products there may be short-run costs to unexpected changes in inventories. Because of finite inventories and production lags, positive demand shocks cannot be accommodated as quickly as negative shocks. Fourth, menu costs may cause asymmetries. Levy *et al.* (1997) find that 20 to 35 per cent of cost-based price changes in supermarkets are not implemented due to menu costs. Blinder (1994) argues that the presence of menu costs deters price increases more often than price decreases, implying upward rigidities. Fifth, vertical market linkages might play a role. Asymmetry tends to increase in the number of intermediaries. Sixth, markups might change over the business cycle. The difference between price and marginal costs tends to rise as the price level increases. And finally, banks incur a so-called offer cost. Mortgage interest rate offers by most banks remain valid until some expiration date, often a few weeks, also when the market interest rate rises in the meantime. On the other hand, the client is allowed to benefit from a lower interest rate if the market rate decreases. Hence, banks one-sidedly run the offer-rate risk, which may induce asymmetric pricing (see Toolsema, 2003).

There is an extensive empirical literature on asymmetric price responses to cost shocks. Peltzman (2000) presents microeconomic evidence on 77 consumer and 165 producer markets and finds that in two out of three markets output prices change faster to input price increases than decreases. The gasoline market is a well-known case. Borenstein *et al.* (1997) and Bettendorf *et al.* (2005) present results for that market. In the gasoline market both inventory/production problems and market power can explain asymmetric pricing. For mortgage markets the production process is quite irrelevant, so asymmetries might relate more to market power there. It is often suggested that banks in concentrated markets are likely to collude. Neumark and Sharpe (1992) present evidence for consumer deposit markets and link their empirical evidence of asymmetric pricing to market concentration. Frost and Bowden (1999) present evidence of asymmetric pricing for the New Zealand mortgage markets. Perhaps surprisingly, they find more upward than downward rigidity (which is beneficial to consumers). Allen *et al.* (1999), Haney (1988), and Toolsema and Jacobs (2005) find other evidence of asymmetric pricing in the mortgage market. The latter study is relevant to ours, since it analyzes the case of the Dutch mortgage market. Toolsema and Jacobs, using an macro-aggregate measure of the Dutch mortgage rate, indeed find downward rigidity. They conclude that the interest rate offer set by banks on new loans is valid for some time and is rigid downwards. Our contribution is that we use Dutch mortgage market data with a daily frequency and for individual banks. Micro-data evidence for the Dutch mortgage market is still lacking as far as we know. Arbatskaya and Baye (2004) present microeconomic evidence of an electronic market for mortgage loans for the US. They find that prices are much less sticky in electronic markets as compared to traditional retail outlets. But even in electronic markets cost increases are passed on to consumers about twice as quickly as cost decreases.

4 Econometric methodology

Prior to estimating the models, we will test for the time series properties of the interest rates used. Special interest should thereby not only go to testing stationarity but also to the presence of clustered volatility, which is a common characteristic of high-frequent data such as ours. The results of this pretesting information are then used when estimating the model. The model is a simple long-run mark-up model, which assumes that, in the long run, banks set mortgage rates as a simple mark-up on funding costs (Toolsema and Jacobs, 2005):

$$r^j_{i,t} = \alpha^j_i + \beta^j_i r^j_{M,t} + \epsilon_{i,t} \tag{1}$$

where $r^j_{i,t}$ is the interest rate on a j=(5,10)-year mortgage contract set by bank $i = A, B, C, D$ at time t, $r^j_{M,t}$ is the market funding rate with a maturity j at time t, and α^j_i, β^j_i are bank-specific and contract-maturity specific mark-up and pass-through parameters, respectively. $\epsilon_{i,t}$ is a residual, which may contain ARCH-effects as a result of the daily frequency of the data. Therefore we will estimate the long-run parameters correcting for possible ARCH-effects. Next, we specify an Error Correction Model (ECM) to catch the short-run dynamics. Following Geweke (2004) we allow for two types of asymmetric price adjustment in the short run. Suppose we capture the short-run dynamics including asymmetries in first differences by:

$$\begin{aligned}\Delta(r^j_{i,t}) &= \sum_{s=0}^{n} \lambda_i^+ \Delta r^{j,+}_{M,t-s} + \sum_{s=0}^{m} \lambda_j^- \Delta r^{j,-}_{M,t-s} + \\ &\quad \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t} \qquad (2)\end{aligned}$$

where $\omega^+, \omega^- < 0$ and RES are the residuals from Equation (1). The superscripts + and − refer to the positive part and negative part of the time series, so that

$$X_t^+ = \begin{cases} X_t & \text{if } X_t > 0 \\ 0 & \text{if } X_t < 0 \end{cases} \qquad (3)$$

and

$$X_t^- = \begin{cases} 0 & \text{if } X_t > 0 \\ X_t & \text{if } X_t < 0 \end{cases} \qquad (4)$$

The first two terms in Equation (2) are current and lagged capital market interest rate increases and decreases, respectively. We choose the number of lags for decreases m and increases n by minimizing the Akaike Information Criterion. First, it is possible that there is asymmetric adjustment to these capital market interest rate changes, so-called *amount asymmetry* in the short run. We define short-run amount asymmetry as the case where $\sum \lambda_i^+ \neq \sum \lambda_j^-$. Second, the adjustment process toward the long run can be asymmetrical. This so-called *adjustment* asymmetry is present if $\omega^+ \neq \omega^-$. [3]

Our hypothesis is that the amount and adjustment asymmetries will be more relevant for the market leader than for the Stackelberg followers. Since we have daily observations with irregular and discrete jumps (Figure 1) we will integrate positive and negative changes over the last twenty (and thirty) days using the Average Moving Sum (AMS) operator:

$$AMS(x,T) = \frac{\Sigma_{s=1}^{T} x_{-s}}{T} \qquad (5)$$

[3] Geweke (2004) also defines a third type of asymmetry, the so-called *timing* or *pattern* asymmetry, which refers to the differences in λ_j^+ and λ_j^- at identical lags j. Given our discrete nature of the data it is hard to test for timing asymmetry, so we focus on amount and adjustment asymmetry. In theory, the effects of volatility to shocks can be asymmetric as well (see Bettendorf *et al.*, 2005). One can for instance assume that the residuals in the short-run specification follow an EGARCH-process. Since our dependent variables do not demonstrate (G)ARCH-effects (we tested for ARCH-presence in the ECMs without finding it), we refrain from the latter type of asymmetry.

Table 3: Augmented Dickey-Fuller and Phillips-Perron unit root tests

	r^5_M	Δr^5_M	r^5_A	Δr^5_A
Augmented Dickey-Fuller test				
Exogenous	none	none	none	none
Lag length (SIC)	0	0	0	0
ADF test statistic	-1.094	-47.169	-1.428	-45.717
Critical values 5% level	-1.941	-1.941	-1.941	-1.941
p-value*	0.249	0.000	0.143	0.000
Observations	2091	2090	2092	2091
Null of unit root	not rejected	rejected	not rejected	rejected
Phillips-Perron test				
Exogenous	none	none	none	none
Bandwidth	6	4	1	0
P-P test statistic	-1.095	-47.145	-1.429	-45.717
Critical values 5% level	-1.941	-1.941	-1.941	-1.941
p-value*	0.248	0.000	0.143	0.000
Observations	2091	2090	2092	2091
Null of unit root	not rejected	rejected	not rejected	rejected

*MacKinnon (1996) one-sided p-values

Hence, we have the following model for each bank:

$$\begin{aligned}\Delta(r^j_{i,t}) &= \lambda^+_i AMS(\Delta r^{j,+}_{M,t-s}, T) + \lambda^-_j AMS(\Delta r^{j,-}_{M,t-s}, T) + \\ &\quad \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t} \qquad (6)\end{aligned}$$

For the final results we use $T = 30$ days (after experimenting with other lag lengths).

5 Results

5.1 Stationarity and clustered volatility of the series

First we test the interest rate time series on stationarity. Since the bank interest rates are constant in short intervals with discrete jumps (see Figure 1), the process is not typically standard. Table 3 presents results of Augmented-Dickey-Fuller and Phillips-Perron tests for stationarity for the 5-year capital market interest rate and the five-year mortgage rate of Bank A. Both series are of order $I(1)$ and the other interest rates exhibit the same property. Next we test for cointegration between bank A's mortgage interest rate and the capital market rate. Table 4 shows that we indeed find cointegration. Similar results apply to the interest rates of Bank B, C and D (therefore not reported here).

The mortgage interest rates set by banks do not demonstrate clustered volatility (by definition). Therefore we show tests for ARCH-effects in the capital market interest rates

Table 4: Johansen cointegration test

Series	r_A^5, r_M^5			
Trend assumption	no deterministic trend			
Lags	2			
Observations	2089			
Unrestricted cointegration rank test (trace)				
Hypothesized no. of CE(s)	eigenvalue	trace statistic	5% critical value	p-value**
None *	0.042	91.107	25.872	0.000
At most 1	0.001	1.835	12.518	0.978
Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesized no. of CE(s)	eigenvalue	max-eigen statistic	5% critical value	p-value**
None *	0.042	89.272	19.387	0.000
At most 1	0.001	1.835	12.528	0.978
* Denotes rejection of the hypothesis at the 0.05 level				
** MacKinnon-Haug-Michelis (1999) p-values				

only. Table 5 shows some significant autocorrelations of $\Delta(r_M^j)$ and $(\Delta(r_M^j))^2$ indicating clustered volatility of the 5- and 10-year capital market interest rates ($i = 5, 10$).

From the results of the stationarity and ARCH tests we conclude that we can use the unit-root properties of the time series to estimate Error Correction Models and that we have to deal with clustered volatility of the market interest rates.

5.2 Pass-through of costs

We estimate the long-run parameters α^j and β^j for each bank by estimating a simple pairwise ARCH(1) model of r_i^j on r_M^j (see equation (1)). We start by simply estimating the OLS-version of this model (see Table 6). Table 6 shows that there is incomplete pass-through and a significant mark-up for 5-year contract pricing by bank A (note that β^j differs significantly from unity). The reported ARCH-LM test indicates that there are ARCH-effects present in the residuals. Therefore we reestimate the model using an ARCH(1)-specification (see Table 7). Table 7 illustrates that the magnitude of the parameters is not significantly affected by the ARCH-correction (as compared to the OLS-results). Table 8 gives the parameter estimates of all the cointegrating vectors, corrected for (G)ARCH for all cases (this is a summary table that presents condensed information on the results of the models for all four banks in line with Table 7). From this table we can conclude the following:

1. All banks set their prices competitively, as β^j is significantly positive;
2. Bank A typically follows the market rate less closely than the others (lower β^j). A similar argument holds for bank D;
3. Bank B has β-parameters closer to unity and thus follows the market more closely;

Table 5: Autocorrelations of first differences and squared first differences of r_M^5 and r_M^{10}

lag	$\Delta(r_M^5)$	$(\Delta(r_M^5))^2$	$\Delta(r_M^{10})$	$(\Delta(r_M^{10}))^2$
1	-0.031	0.117	-0.039	0.135
2	0.044	-0.005	0.035	-0.001
3	-0.007	0.007	-0.023	0.002
4	0.008	0.004	-0.007	0.021
5	-0.029	-0.007	-0.032	-0.008
6	0.016	0.054	0.011	0.071
7	-0.023	0.115	-0.034	0.097
8	0.026	0.068	0.025	0.070
9	-0.001	0.020	-0.007	-0.001
10	-0.012	0.016	0.025	0.028

Two standard error bounds are computed as $\pm 2/\sqrt{T} = \pm 0.044$, with T=2091

4. Mark-up parameter α is highest for Bank C. However, since we have heterogeneous products, the estimated mark-ups are uninformative with respect to assessing market power;

5. The ARCH(1)-model seems to be able to describe the stochastic volatility.

We use the estimated residuals from the corresponding models in the ECM-models hereafter.

5.3 Asymmetric passthrough

The next step is the analysis of the asymmetric cost adjustment model. We repeat the specification of the model here:

$$\begin{aligned}\Delta(r_{i,t}^j) &= \lambda_i^+ AMS(\Delta r_{M,t-s}^{j,+}, T) + \lambda_j^- AMS(\Delta r_{M,t-s}^{j,-}, T) + \\ &\quad \omega^+ RES_{i,t-1}^{j,+} + \omega^- RES_{i,t-1}^{j,-} + \epsilon_{i,t} \end{aligned} \tag{7}$$

The λ-parameters indicate amount asymmetry, while the ω-parameters denote adjustment asymmetry. As explained above, we use $T = 30$ after experimenting with other lags. Tables 9 to 12 give the estimation results for the models of the four banks for the two maturities. The tables lead to the following general conclusions:

1. The amount parameters are largest for bank A for both maturities. So, while bank A follows the market rate less closely in the long-run (see Table 8), it does respond more strongly in the short run. Concerning amount asymmetry we do not find strong evidence that banks pass on interest increases more rapidly than decreases. For 5-year maturities we find that bank A and bank D respond more strongly to decreases of the market interest rate than to increases.

Table 6: Long-run OLS results

$r_A^5 = \alpha_A^5 + \beta_A^5 r_M^5 + \eta_t$		
	Coefficient	(t-value)
α_A^5	2.055	(110.09)
β_A^5	0.732	(65.929)
Observations	2092	
Adjusted R^2	0.853	
S.E. of regression	0.213	
F-statistic (p-value)	12120.6	(0.000)
Durbin-Watson	0.042	
ARCH-LM-test (p-value)	7493.98	(0.000)
Wald test	F-statistic	(p-value)
$H_0 : \beta_A^5 = 1$ (df=2090)	1627.55	(0.000)
$H_0 : \alpha_A^5 = 0, \beta_A^5 = 1$ (df=2090)	15.945	(0.000)

Table 7: Long-run ARCH(1) results

$r_A^5 = \alpha_A^5 + \beta_A^5 r_M^5 + \eta_t$		
	Coefficient	(z-value)
α_A^5	2.104	(352.58)
β_A^5	0.723	(552.03)
Observations	2092	
Adjusted R^2	0.852	
S.E. of regression	0.214	
F-statistic (p-value)	4024.28	(0.000)
Durbin-Watson	0.042	
ARCH-LM-test (p-value)	0.138	(0.968)
Wald test	F-statistic	(p-value)
$H_0 : \beta_A^5 = 1$ (df=2085)	44630.59	(0.000)
$H_0 : \alpha_A^5 = 0, \beta_A^5 = 1$ (df=2085)	453878.0	(0.000)

Table 8: Long-run ARCH(1) parameters

5-year	α^5	β^5	10-year	α^{10}	β^{10}
r^5_A	2.104	0.723	r^{10}_A	2.315	0.682
r^5_B	1.744	0.829	r^{10}_B	1.945	0.818
r^5_C	2.223	0.758	r^{10}_C	2.538	0.738
r^5_D	1.939	0.710	r^{10}_D	1.717	0.760

Table 9: ECM estimation results for Bank A and B (5-year)

$$\Delta(r^j_{i,t}) = \lambda^+_i AMS(\Delta r^{j,+}_{M,t-s}, T) + \lambda^-_j AMS(\Delta r^{j,-}_{M,t-s}, T) + \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t}$$

	Coefficient$_A$	(t-value)	Coefficient$_B$	(t-value)
λ^+_i	0.411	(3.579)	0.249	(2.032)
λ^-_i	0.562	(5.024)	0.355	(2.881)
ω^+	-0.007	(1.091)	-0.014	(2.254)
ω^-	-0.023	(3.337)	-0.019	(2.836)
Observations	2062		2062	
Adjusted R^2	0.028		0.023	
S.E. of regression	0.033		0.033	
Durbin-Watson	2.029		2.017	
ARCH LM-test (p-value)	0.262	(0.608)	0.228	(0.633)
Wald tests	F-statistic	(p-value)	F-statistic	(p-value)
$H_0 : \lambda^+_i = \lambda^-_i$ v $H_1 : \lambda^+_i \neq \lambda^-_i$	2.915	(0.088)	1.409	(0.235)
$H_0 : \omega^+ = \omega^-$ v $H_1 : \omega^+ \neq \omega^-$	2.073	(0.150)	0.263	(0.608)

2. For adjustment asymmetry we do find that banks in general respond more strongly to situations where the previous day's capital market interest rate is above the long-run predicted rate than *vice versa*. In fact this finding appeals strongly to the hypothesis of asymmetric pricing. For 5-year contracts we moreover find evidence that bank A responds to market rate increases and not to decreases. For 10-year contracts we find that bank C behaves in an opposite way.

6 Summary and conclusions

In this paper we present evidence on asymmetric pricing in the Dutch market for mortgage loans using high-frequent micro data on interest rate settings by the four largest banks. Our hypotheses are, first, that a dominant market player is less cost sensitive in the long

Table 10: ECM estimation results for Bank C and D (5-year)

$\Delta(r^j_{i,t}) = \lambda^+_i AMS(\Delta r^{j,+}_{M,t-s}, T) + \lambda^-_j AMS(\Delta r^{j,-}_{M,t-s}, T) + \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t}$				
	Coefficient$_C$	(t-value)	Coefficient$_D$	(t-value)
λ^+_i	0.204	(1.364)	0.201	(1.374)
λ^-_i	0.259	(1.735)	0.367	(2.722)
ω^+	-0.021	(2.951)	-0.010	(1.809)
ω^-	-0.022	(3.414)	-0.023	(3.726)
Observations	2062		1995	
Adjusted R^2	0.031		0.026	
S.E. of regression	0.036		0.035	
Durbin-Watson	2.023		2.022	
ARCH LM-test (p-value)	0.210	(0.647)	0.168	(0.682)
Wald tests	F-statistic	(p-value)	F-statistic	(p-value)
$H_0 : \lambda^+_i = \lambda^-_i$ v $H_1 : \lambda^+_i \neq \lambda^-_i$	0.322	(0.570)	3.050	(0.081)
$H_0 : \omega^+ = \omega^-$ v $H_1 : \omega^+ \neq \omega^-$	0.035	(0.852)	1.943	(0.164)

Table 11: ECM estimation results for Bank A and B (10-year)

$\Delta(r^j_{i,t}) = \lambda^+_i AMS(\Delta r^{j,+}_{M,t-s}, T) + \lambda^-_j AMS(\Delta r^{j,-}_{M,t-s}, T) + \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t}$				
	Coefficient$_A$	(t-value)	Coefficient$_B$	(t-value)
λ^+_i	0.377	(3.062)	0.038	(0.302)
λ^-_i	0.420	(3.387)	0.165	(1.379)
ω^+	-0.012	(2.948)	-0.018	(3.360)
ω^-	-0.024	(2.614)	-0.025	(3.512)
Observations	2062		2062	
Adjusted R^2	0.024		0.024	
S.E. of regression	0.032		0.029	
Durbin-Watson	2.023		2.007	
ARCH LM-test (p-value)	0.072	(0.790)	0.182	(0.670)
Wald tests	F-statistic	(p-value)	F-statistic	(p-value)
$H_0 : \lambda^+_i = \lambda^-_i$ v $H_1 : \lambda^+_i \neq \lambda^-_i$	0.289	(0.591)	2.408	(0.121)
$H_0 : \omega^+ = \omega^-$ v $H_1 : \omega^+ \neq \omega^-$	1.288	(0.256)	0.376	(0.540)

Table 12: ECM estimation results for Bank C and D (10-year)

$\Delta(r^j_{i,t}) = \lambda^+_i AMS(\Delta r^{j,+}_{M,t-s}, T) + \lambda^-_j AMS(\Delta r^{j,-}_{M,t-s}, T) + \omega^+ RES^{j,+}_{i,t-1} + \omega^- RES^{j,-}_{i,t-1} + \epsilon_{i,t}$				
	Coefficient$_C$	(t-value)	Coefficient$_D$	(t-value)
λ^+_i	0.118	(0.801)	0.028	(0.181)
λ^-_i	0.190	(1.451)	0.121	(0.826)
ω^+	-0.039	(5.119)	-0.015	(2.972)
ω^-	-0.020	(3.120)	-0.028	(3.860)
Observations	2062		1995	
Adjusted R^2	0.033		0.022	
S.E. of regression	0.032		0.033	
Durbin-Watson	2.011		2.004	
ARCH LM-test (p-value)	0.082	(0.775)	0.036	(0.850)
Wald tests	F-statistic	(p-value)	F-statistic	(p-value)
$H_0 : \lambda^+_i = \lambda^-_i$ v $H_1 : \lambda^+_i \neq \lambda^-_i$	0.856	(0.355)	1.144	(0.285)
$H_0 : \omega^+ = \omega^-$ v $H_1 : \omega^+ \neq \omega^-$	3.445	(0.064)	2.071	(0.150)

run and more able to increase and maintain margins and, second, that such players may show more asymmetric pricing behavior in the sense that they pass-on cost increases more rapidly into their mortgage rates than that they pass on cost decreases. Our results show that, in the long run, Bank A follows the market rate less closely than the other banks but in the short run shows a more rapid pass-through of cost changes into mortgage rates than the other banks. Overall, we find evidence of asymmetric pricing for all banks, and more specifically of the so-called adjustment asymmetry-type.

From a competition authority's perspective the results do not give rise to alarm about imperfect competition on the Dutch mortgage market. In the long run bank supply of mortgages appears to be competitive as interest rates are set on the basis of funding costs. In the short run, however, there seems to be evidence of some asymmetric pricing which seems at first sight not beneficial to consumers. Especially Bank A shows some elements of dominant pricing behavior. The issue needs further investigation, however. In a sister paper (see De Haan and Sterken, 2005) we exploit the data further when we take up the question of dominance in the sense of price leadership.

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