On competition and banking

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Chapter 7

Asymmetric mortgage rate adjustments

7.1 Introduction

In this chapter we consider the dynamic behavior of a bank lending rate (i.e. the Dutch mortgage rate), focusing in particular on the responses of this rate to changes in the cost of funding, i.e. the money market or capital market rate. Since the latter can be interpreted as the bank's marginal cost (see also chapters 4 and 6), we examine cost-change induced price adjustments by banks. According to empirical evidence, prices respond faster to cost increases than to cost decreases in many markets (Peltzman, 2000). That is, price rigidity is often asymmetric, and in many cases there is relatively more downward than upward price rigidity. We use the expression 'more downward rigidity' to refer to the case that prices respond faster and/or more to a cost change of given size when the change is an increase than when it is a decrease.

Peltzman (2000) analyzes price adjustments for 77 consumer goods and 165 producer goods and concludes that this type of asymmetry in price adjustments prevails in more than two of every three markets. The market for gasoline is a well-known example. Consumers closely observe retail gasoline prices and regularly complain that they rise faster than they fall. This suspicion is generally confirmed by observed time series of gasoline and crude oil prices. Borenstein et al. (1997) demonstrate that

[0]This chapter is based on joint work with Jan Jacobs. Section 7.2 draws on Jacobs and Toolsema (2001).

gasoline prices in the US indeed rise more quickly after an increase in crude oil prices than they fall after a decrease in this input price. Brown and Yücel (2000) discuss the evidence from several empirical studies. They list possible intuitive explanations for asymmetric pricing and argue whether or not they are relevant for gasoline prices. However, Godby et al. (2000) do not find evidence of asymmetries in price adjustments for retail gasoline in Canada.

Survey evidence by Blinder (1994) and a store-level analysis of supermarkets by Levy et al. (1998) suggest the existence of more *upward* rigidity, i.e. prices being more rigid upward than downward. However, in the remainder of this chapter, we focus on the case of more downward rigidity discussed above. Although this chapter concentrates on the response of an output price to an input price, we stress that the asymmetry phenomenon is not limited to some (or many as Peltzman, 2000, argues) specific consumer or producer good markets. For example, Shirvani and Wilbratte (1999) analyze the response of the domestic price level to import price changes in a macroeconomic context, focusing on price indices, and observe a similar asymmetry.

This chapter focuses on mortgage rates, a topic that did not attract a lot of attention in the literature on asymmetric price adjustments. We examine the dynamic behavior of the mortgage rate in The Netherlands, showing that there is relatively more downward rigidity. Using a related approach, Frost and Bowden (1999) find evidence of asymmetries for the case of the New Zealand mortgage rate. However, that rate is relatively more rigid upward and the authors interpret the asymmetry as being 'beneficial' to consumers. As an explanation they suggest that banks may smooth interest rates and therefore do not let them rise too much. Another empirical analysis of asymmetric interest rate adjustments is the study by Neumark and Sharpe (1992), who present evidence of asymmetric adjustments of consumer deposit interest rates in the US (which fall faster than they rise) and link this observation to market concentration. We also discuss the relevance of several explanations advanced in the literature of asymmetric price adjustments for the case of mortgage rates.

There is a wide variety of explanations of the observed asymmetry. Lay prejudice suggests that firms in concentrated markets collude. An alternative view believes that consumer search costs give firms some market power in the short run. At the firms' side there may be adjustment costs, causing firms to be reluctant to adjust prices. We will discuss these and other explanations below. Of course, any microeconomic explanation of the asymmetry has a strong New Keynesian flavor. New Keynesians try to underpin price rigidities by postulating that there are real costs to price changes.

The remainder of this chapter is structured as follows. Section 7.2 presents an empirical analysis of the Dutch mortgage interest rate. We show evidence of relatively more downward rigidity in the dynamic behavior of the mortgage rate. Section 7.3 summaries several possible explanations for the observed asymmetry between output price and input price changes as put forward in the (mainly empirical) literature. Furthermore, we discuss which of these may be relevant for mortgage rates. Section 7.4 concludes.

7.2 Empirical analysis of mortgage rate adjustments

At first sight, movements of the Dutch mortgage rate and long-run interest rates suggest that there is relatively more downward rigidity in mortgage rate adjustments. Figure 7.1 shows the mortgage rate r_m and the ten-year capital market rate r_l for the period April 1978 - December 2000 (for details on data and sources see the appendix to this chapter). The mortgage rate used here represents the rate charged for a period of five years. The long-run rate r_l refers to a ten-year term. Thus, a term structure effect may blur the comparison of the two series.[1] Dutch banks claim that they nowadays base the mortgage rate on an alternative capital market rate, the so-called swap rate, an interest rate that banks charge each other.[2] Figure 7.2 shows the movements of the mortgage rate and the five-year swap rate r_{sw} for the period June 1991 - December 2000. In both figure 7.1 and figure 7.2 the gap between the mortgage rate and the capital market rate widens in times of falling interest rates, suggesting that the mortgage rate rises faster than it falls.

[1]The possible term structure effect might be avoided when using mortgage rates with rate fixed for ten years. Unfortunately, The Netherlands Bank does not provide that series.

[2]De Volkskrant, 'Banken rekenen te veel voor hypotheek', January 21, 2001.

Figure 7.1: Mortgage rate (r_m) and ten-year capital market rate (r_l) for The Netherlands; April 1978 - December 2000.

Figure 7.2: Mortgage rate (r_m) and five-year swap rate (r_{sw}) for The Netherlands; June 1991 - December 2000.

Specification search

In order to analyze whether mortgage rate adjustments are indeed asymmetric, we consider three different samples. We examine the relationship between the mortgage rate r_m and the ten-year capital market rate r_l for the period April 1978 - December 2000. We also consider the five-year swap rate r_{sw} for the period June 1991 - December 2000. Since we know that the mortgage rate was based on the swap rate during the last years of these samples, we also consider the ten-year capital market rate r_l for the period April 1978 - May 1991. Thus, we have three samples: with r_l, long sample period; with r_l, short sample period; and with r_{sw}.

For each of the three samples we perform a similar specification search, using the 95% confidence level (unless stated otherwise). We start by checking for the order of integration of the variables. We perform Augmented Dickey-Fuller (ADF) tests with a maximum of four lags and with an intercept. We do not include a trend because it does not seem sensible to assume interest rates to follow a trend. To determine the optimal number of lags we use the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC). The results are presented in table 7.1.[3] Based on these results we cannot reject the null hypothesis that the variables r_m, r_l, and r_{sw}, for all relevant sample periods, are integrated of order one. Using this information on the order of integration, we examine how to model the relationship between the mortgage rate r_m and the underlying capital market rate r (which we use to refer to either r_l or r_{sw}).

For institutional reasons we do not believe the mortgage rate to drive the capital market rate. Mortgages only constitute a small fraction of total banking assets. Also, we would probably need higher frequency data in order to pick up the effects (if any) of r_m on r. Therefore, we expect the preferred specification to be a single equation with (the first difference of) r_m as the dependent variable. However, we perform a formal specification search and start off with a system of two equations.

We first determine the order of a bivariate VAR (Vector Auto Regression) system that includes both the mortgage rate r_m and the relevant capital market rate r, and as exogenous deterministic variables a constant and a trend. This model explains the two variables from their lagged values. Using a maximum of twelve possible lags, the outcome

[3] For completeness, we also performed the test with a maximum of twelve lags as well as with a trend, and found similar results (not shown).

		Levels			First differences		
		Lags		ADF test	Lags		ADF test
Sample	Series	AIC	SBC	statistic[a]	AIC	SBC	statistic[a]
1978:4-2000:12	r_l	1	1	-1.34	0	0	-11.46
	r_m	1	1	-1.33	0	0	-10.78
1978:4-1991:5	r_l	1	1	-1.59	0	0	-8.87
	r_m	1	1	-1.43	0	0	-8.15
1991:6-2000:12	r_{sw}	-	1	-2.17	-	0	-6.47
		3	-	-2.25	2	-	-4.02
	r_m	1	1	-1.90	0	0	-7.07

[a]The 95% critical values for the ADF test statistic are given by -2.87 for the first sample (1978:4-2000:12); -2.88 for the second sample (1978:4-1991:5); and -2.89 for the third sample (1991:6-2000:12).

Table 7.1: Augmented Dickey-Fuller (ADF) tests of the capital market rates r_l and r_{sw} and the mortgage rate r_m. The test was implemented using a constant, but no trend.

suggests that the order of the VAR is two for all of the samples; this outcome is backed by most of the test outcomes. In particular, the SBC always indicates order two; the AIC also indicates that the order is two, except for the case of r_l with the long sample period, where it suggests four lags. Below we include two lags for each sample.

Second, we perform cointegration tests in order to determine the cointegration rank and the preferred deterministic trend assumptions. In the cointegration test we allow for different possible assumptions (models) for completeness. That is, we allow the data to have nonzero means and deterministic trends (either linear or quadratic), as well as stochastic trends. Similarly, the cointegrating relationships may have intercepts and deterministic trends. We perform three different tests. The first test is again based on the AIC (results not shown). The results indicate that for each sample the preferred model is that without a trend in the data (as we argued above), and with an intercept but no trend in the cointegrating relation. Also, the results indicate that we have one cointegrating relation for each sample. The other two tests are the cointegration likelihood ratio test based on the trace, and that based on the maximum eigenvalue. The results for these tests are presented in table 7.2, with the column referring to the preferred model in bold. Table 7.3 presents the results of the trace and maximum-eigenvalue tests in more

			Model				
		Data trend	No	**No**	Linear	Linear	Quadratic
		CR intercept	No	**Yes**	Yes	Yes	Yes
		CR trend	No	**No**	No	Yes	Yes
	Sample	Test			Number of CR's		
r_l	1978:4-	Trace	1	**1**	1	1	2
	2000:12	Max. Eig.	1	**1**	1	1	2
r_l	1978:4-	Trace	1	**1**	1	1	1
	1991:5	Max. Eig.	1	**1**	1	1	1
r_{sw}	1991:6-	Trace	0	**1**	2	0	1
	2000:12	Max. Eig.	0	**1**	2	1	1

Table 7.2: Cointegration test results: Number of cointegration relations (CR's) according to trace and maximum eigenvalue tests (using 95% critical values). The second model (in bold) is the preferred choice.

detail (for the preferred specification only). Summarizing, for each sample we find evidence of one cointegrating relation, with an intercept in the cointegrating equation, but no trend (neither in the cointegrating relationship, nor in the short run).

In the resulting cointegrating equation, we normalize the coefficient of r_m to one and we write the cointegrating relation as

$$r_m = a_2 r + a_3, \tag{7.1}$$

where a_2 and a_3 are parameters (we reserve a_1 for the speed of adjustment towards this long-run relationship; see below). The estimated cointegrating relationships are shown in table 7.4. For each of the three samples, we first show the estimation results for the cointegration relation (7.1). Then, we set $a_2 = 1$ in (7.1) and present the estimate of a_3 under this restriction. We will argue below that this is the relevant specification for the two samples with the ten-year rate r_l. We present standard errors instead of t-values in parenthesis in table 7.4, because this allows for an easy comparison of the estimated value not only to zero but to one as well.

Third, we perform a Wald test to see whether a_2, the parameter of r in the cointegrating equation indeed equals one. Note that this means that in the long run, changes in the capital market rate are fully transmitted to the mortgage rate. This does not necessarily mean that

Sample		Hypothesized no. of CR's	Trace statistic[a]	Max. Eig. statistic[b]
r_l	1978:4-	none	24.18	22.65
	2000:12	at most 1	1.53	1.53
r_l	1978:4-	none	28.68	26.41
	1991:5	at most 1	2.27	2.27
r_{sw}	1991:6-	none	25.36	18.93
	2000:12	at most 1	6.42	6.42

[a]The 95% critical value for the trace statistic is given by 19.96 for the null hypothesis of no CR's; for the null hypothesis of at most one CR it is 9.24.

[b]The 95% critical value for the maximum eigenvalue statistic is given by 15.67 for the null hypothesis of no CR's; for the null hypothesis of at most one CR it is 9.24.

Table 7.3: Trace and maximum-eigenvalue test results (for the preferred specification only, i.e.without a trend in the data, and with an intercept but no trend in the cointegrating relation).

	Sample		Without parameter restrictions		With parameter restrictions ($a_2 = 1$)	
r_l	1978:4-2000:12	a_2	1.0520	(0.0337)	1	-
		a_3	0.5116	(0.2558)	0.8979	(0.0632)
r_l	1978:4-1991:5	a_2	1.0496	(0.0307)	1	-
		a_3	0.5105	(0.2597)	0.9239	(0.0504)
r_{sw}	1991:6-2000:12	a_2	0.9108	(0.0283)	1	-
		a_3	1.5650	(0.1659)	1.0557	(0.0635)

Table 7.4: Estimation results for the cointegrating equation $r_m = a_2 r + a_3$, with and without imposing a unit coefficient for the capital market rate: $a_2 = 1$. Standard errors in parenthesis.

	Sample	χ^2	p
r_l	1978:4-2000:12	2.27	0.132
r_l	1978:4-1991:5	2.57	0.109
r_{sw}	1991:6-2000:12	5.48	0.019

Table 7.5: Tests of unit coefficient of the capital market rates r_l and r_{sw} in the cointegrating equation $r_m = a_2 r + a_3$. (Null hypothesis: $a_2 = 1$.)

they are equal in the long run (which would indicate that in the long run the price for mortgages equals marginal cost, i.e. there is perfect competition in the long run), because the intercept a_3 will differ from zero in general. Thus, in the long run the mortgage rate equals the capital market rate plus a constant markup. The results of these tests are listed in table 7.5. The χ^2-statistics and corresponding p-values indicate that we cannot reject the null hypothesis that the parameter equals one for the ten-year rate (both samples), but we can for the swap rate (at the 5% level). Therefore, we impose that in the model with the ten-year rate, a_2 equals 1. For the sample with the swap rate, we do not fix the long-run parameter a_2.

Fourth, we test perform weak exogeneity tests for r. That is, we estimate a Vector Error Correction Model (VECM) in two steps, first estimating the cointegrating equation and then substituting the estimated equation into the VECM, using Ordinary Least Squares (OLS; note that these OLS estimates may differ from the nonlinear estimates in the final specification below). If the coefficient of the error correction term in the equation for r is not significantly different from zero, r is said to be weakly exogenous for r_m. Table 7.6 shows the p-values for the weak exogeneity tests. In the first column of results, we did not impose the parameter restrictions on a_2 discussed above. These results indicate that r_{sw} is weakly exogenous for r_m, but r_l is not (in either sample, at the 5% level). The last column of table 7.6 shows the p-values when the parameter a_2 of the cointegrating relationship between r_m and r_l is set to 1 as we do in our estimations below (for the two samples with r_l only). In that case, for the long sample period r_l is weakly exogenous for r_m at the 5% level as well. For the short sample, r_l can only be interpreted as weakly exogenous at the 1% level based on the test results. However, as we argued above, for institutional reasons we do not believe the mortgage rate to drive the capital market rate. We treat the capital

	Sample	Without parameter restrictions	With parameter restrictions ($a_2 = 1$)
r_l	1978:4-2000:12	0.029	0.084
r_l	1978:4-1991:5	0.006	0.026
r_{sw}	1991:6-2000:12	0.494	-

Table 7.6: Tests of weak exogeneity of the capital market rates r_l and r_{sw} (p-values) in the Vector Error Correction Model (VECM), with and without imposing a unit coefficient $a_2 = 1$ for the capital market rate r_l in the cointegrating equation $r_m = a_2 r + a_3$.

market rates as exogenous in the analysis below.

Based on these steps of the specification search we end up with a single-equation Error Correction Model (ECM), where the cointegrating parameter a_2 is set equal to one for the samples using the ten-year rate. We are now ready to use this model in order to test for asymmetric mortgage rate adjustments.

Model and results

We test the hypothesis of asymmetric mortgage rate adjustments by estimating the following ECM using nonlinear least squares:

$$\begin{aligned} \Delta r_{m,t} &= a_1 \left(r_{m,t-1} - a_2 r_{t-1} - a_3 \right) \\ &\quad + a_4 \Delta r_t^+ + a_5 \Delta r_t^- + a_6 \Delta r_{t-1}^+ + a_7 \Delta r_{t-1}^- + \varepsilon_t, \end{aligned} \tag{7.2}$$

where $r_{m,t}$ denotes the mortgage rate in month t and r_t denotes the capital market rate in month t, and Δ is the first difference operator. Δr_t^+ and Δr_t^- refer to increases and decreases, respectively, of the capital market rate in month t. For the capital market rate we take the ten-year rate r_l (two samples) and the five-year swap rate r_{sw}. The a's are the parameters to be estimated and ε is an error term. The first term on the right-hand side expresses the deviation from the long-run equilibrium relationship between the mortgage rate and the capital market rate, which is represented by $r_{m,t} = a_2 r_t + a_3$. The parameter a_1 describes the speed of adjustment towards this long-run relationship. For each of the samples we find that the coefficient of the lagged change in the mortgage rate is not significantly different from zero if this variable is included in the ECM (7.2). Therefore we do not include this variable as an explanatory variable in the final specification. According to (7.2)

Capital market rate	r_l		r_l		r_{sw}	
Sample period	1978:4-2000:12		1978:4-1991:5		1991:6-2000:12	
Coefficients[a]						
a_1	-0.12	(0.029)	-0.21	(0.049)	-0.23	(0.052)
a_2	1^b	-	1^b	-	0.90	(0.025)
a_3	0.64	(0.129)	0.73	(0.108)	1.51	(0.166)
a_4	0.42	(0.061)	0.48	(0.076)	0.25	(0.075)
a_5	0.34	(0.065)	0.38	(0.083)	0.24	(0.075)
a_6	0.53	(0.063)	0.48	(0.080)	0.45	(0.083)
a_7	0.28	(0.068)	0.18	(0.089)	0.19	(0.087)
Wald tests	χ^2	p	χ^2	p	χ^2	p
$a_4 = a_5$	0.58	0.446	0.55	0.456	0.02	0.894
$a_6 = a_7$	5.51	0.019	4.98	0.026	4.13	0.042
$a_4 = a_5$, $a_6 = a_7$	8.57	0.014	7.66	0.022	4.61	0.100
$a_4 + a_6 = a_5 + a_7$	7.69	0.006	6.93	0.008	3.20	0.074

[a]The estimated model is the ECM in equation (7.2), which reads $\Delta r_{m,t} = a_1 (r_{m,t-1} - a_2 r_{t-1} - a_3) + a_4 \Delta r_t^+ + a_5 \Delta r_t^- + a_6 \Delta r_{t-1}^+ + a_7 \Delta r_{t-1}^- + \varepsilon_t$.

[b]Because test results indicated that a_2 is not significantly different from 1 for the samples with r_l, we impose $a_2 = 1$ there.

Table 7.7: Estimation results for the ECM. Standard errors in parenthesis.

the change in the mortgage rate is explained by the deviation from the long-run equilibrium in the previous month and (current and lagged) increases and decreases in the capital market rate. Using a Wald test, we can test for equality of the coefficients of the variables referring to increases and decreases, respectively, of r in order to determine whether or not there is evidence of asymmetries in mortgage rate adjustments.

Table 7.7 summarizes the main estimation results for the model (7.2). The table presents estimates for the coefficients (and corresponding standard errors), all significant at the 5% level, and the χ^2-statistics and corresponding p-values for the Wald tests. From the results we conclude that the sum of the direct and lagged effects of an increase in the capital market rate r_l is significantly larger than the sum of the effects of a decrease in that rate. This means that in the short run, the (total) effect of a positive change in r_l exceeds the effect of a negative change in r_l (in absolute value), for both sample periods under consideration. For the

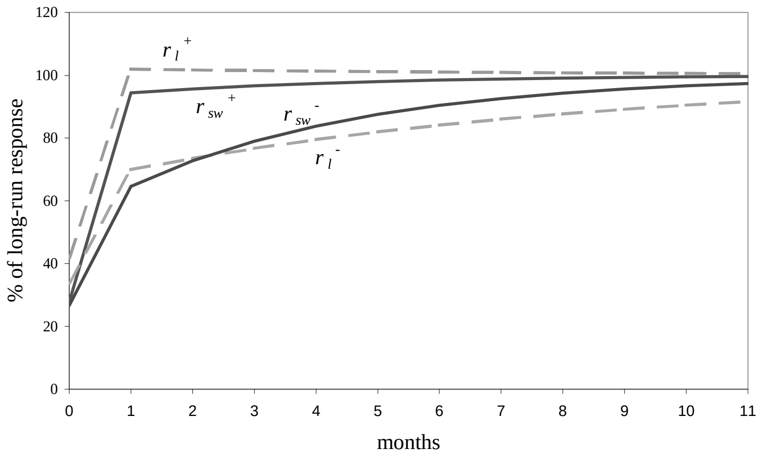

Figure 7.3: Dynamic cumulative multipliers (responses of the mortgage rate to a shock to the capital market rates, as a percentage of the long-run response).

swap rate, where the term structure does not blur the relationship, the result is less convincing, but still we can reject equality of the effects at the 10% significance level.

Figure 7.3 presents some of the estimation results in another way. It shows the responses of the mortgage rate to permanent positive and negative shocks to the capital market rates r_l (presenting the results for the long sample period only for expositional convenience) and r_{sw}. That is, it presents dynamic (cumulative) multipliers, which describe the effect on the endogenous variable (r_m) over time of a unit shock to the exogenous variable (r_l or r_{sw}). In the literature, these multipliers are also referred to as impulse responses. The dynamic multipliers are expressed in terms of the percentage of the long-run responses as measured by the parameter a_2 in (7.2). We computed the figure with permanent 1%-point impulses. However, because the model is linear, the size of the impulses does not affect the percentage results. We observe that positive impulses in both capital market rates are (more or less) completely passed on to the mortgage rate within one month. Negative shocks are transmitted with longer lags.

This econometric analysis allows us to conclude that Dutch banks adjust the mortgage rate asymmetrically after changes in their cost structure. Our results show that the mortgage rate responds stronger to an increase in the capital market rate than to a decrease. We now turn to a discussion of possible explanations for this observation.

7.3 Explanations for the asymmetry

Several explanations for asymmetries in price adjustments have been advanced in the literature. Most of them are merely intuitive, but a few theoretical models do exist. This section starts with an overview of these explanations, and proceeds with a discussion of their relevance for the case of mortgage rates.

Explanations for asymmetric price adjustments

If concentration in a market is high—for example due to entry barriers or because the market is geographically limited—there may be scope for coordination on prices. Even if firms cannot explicitly coordinate on a certain price level (which is commonly forbidden by law) there may be room for tacit collusion. Suppose there is asymmetric information, say about input prices, and that firms are engaged in an unspoken collusive agreement. If a firm's input price rises—which is not observed by the other firms—it will be quick to increase its output price to signal that it adheres to the agreement. However, if the firm's input price falls, it will be reluctant to decrease output price, since the other firms may interpret this as a deviation from the collusive agreement and punish the presumed deviator by competing more aggressively. Damania and Yang (1998) present a theoretical model in which this kind of behavior indeed emerges in equilibrium, focusing on the case with asymmetric information about a rival's demand.

But even if input prices and demand are common knowledge, there is a possibility for tacit collusion after a decrease in input prices. In this situation, the old price serves as a 'focal' or trigger price. As long as no firm decreases its price, all firms can earn supernormal profits. However, as soon as one firm reduces its price, the others will follow in order not to lose their market share. Thus, a firm hurts itself by being the first to decrease its output price. Therefore, every firm has an incentive not to adjust the output price after a decrease in the input price. With respect to empirical evidence, in Peltzman's (2000) analysis the effect of more competition on the asymmetry of price adjustments is statistically indistinguishable from zero. Nevertheless, in their analysis of consumer deposit interest rates, Neumark and Sharpe (1992) conclude that their empirical results with respect to US deposit rates indicate that the observed asymmetry is a consequence of market concentration (which acts as a proxy for market power).

A second explanation based on market power builds on consumer search costs. It is assumed that searching for a low(er) price is costly, for example because it is time-consuming. In the case of local monopolies (think of a gasoline station at a specific location) firms have some market power in the short run, since they are only forced to lower prices to the competitive level after their customers engage in the search process. This implies that they can pass on input price decreases to the output price slowly, and temporarily have high profit margins. This is particularly relevant in markets in which demand is relatively inelastic, such as the market for retail gasoline. Note that a similar reasoning applies if switching itself is costly or time-consuming. Also, a similar argument holds when consumers believe input prices to be volatile. In this situation, consumers face a signal-extraction problem: it is not clear whether a higher output price reflects a higher input price, or a higher relative output price. The expected gain from search to the consumer is therefore decreased. Consumers will search less, and firms' market power is temporarily higher (see Peltzman, 2000).

Third, even for competitive firms, there may be short-run costs to unexpected changes in firms' inventories. Because of finite inventories and production lags, positive demand shocks cannot be accommodated to as quickly as negative demand shocks (see Reagan and Weitzman, 1982). According to Borenstein et al. (1997), this partly explains the asymmetries in gasoline price adjustments. However, Peltzman's (2000) empirical analysis does not suggest that this effect is very important in other markets.

Fourth, adjustment or menu costs that a firm incurs when adjusting its price or output may cause asymmetries. Levy et al. (1997) show that for their sample of supermarkets, adjustment costs may indeed form a barrier to price changes. They find that approximately 20 to 35% of cost-based price adjustments are not implemented because the costs of these adjustments are higher than the corresponding benefits. However, both Blinder (1994) and Levy et al. (1998) suggest that the presence of asymmetric adjustment costs deters price increases more often than price decreases, implying more upward rigidity in prices. An explanation for this type of asymmetric costs to adjusting prices may be the fear of loss of sales in competitive markets if rivals do not match the price increase (see Blinder, 1994).

But adjustment or menu costs need not be asymmetric themselves to explain asymmetries in price adjustments. Alternatively, consider input supply shocks and symmetric adjustment costs, and assume that there are no stocks. In that case, a negative input supply shock must imply a decrease in output, despite the adjustment costs. A positive supply shock however does not necessarily imply an increase in output precisely because of the adjustment costs, which may outweigh the benefits of increasing output. This suggests that price rises following a negative input supply shock, but it does not necessarily fall following a positive shock.[4] Nevertheless, Peltzman's (2000) empirical results indicate that inflation-related asymmetric adjustment costs[5] are irrelevant in explaining asymmetric price dynamics.

Finally, there are some more sketchy explanations. Peltzman (2000) suggests vertical market linkages, since the number of independent intermediaries between the factory and the consumer tends to be positively correlated with the asymmetry in his empirical results. Brown and Yücel (2000) mention varying markups over the business cycle. The difference between price and marginal cost could rise as the price level rises (see also Reagan and Weitzman, 1982).

Explanations for asymmetric mortgage rate adjustments

With respect to relatively more downward stickiness of mortgage (or other lending) rates, some of the above explanations can be skipped. For example, tacit collusion due to asymmetric information with respect to input prices does not seem very relevant, since the main 'input price' for mortgages is the capital market (or swap) rate which is common knowledge to all banks. Theories based on inventories or in-

[4]Note that this argument is related to that on demand shocks presented above. It is not the same, though. There, we argued that firms may not be able to accommodate their output to a positive demand shock, leading to an (additional) increase in price. Here, we argue that a positive supply shock may not be accommodated to because doing so is too expensive. This prevents the price from falling.

[5]In the presence of inflation, a firm can avoid the menu costs of responding to a cost decrease. Thus, inflation may imply asymmetric adjustment costs.

put supply shocks do not seem very important for mortgages either, since banks can turn to the capital market where they face an 'infinite' supply of funds at the current interest rate. In some cases, however, a premium may be involved if banks require additional funds and the explanation based on inventories might be relevant. Further, the explanations based on adjustment costs and vertical market linkages do not seem particularly relevant for mortgage rates, or bank lending rates in general. Thus, asymmetric mortgage rate adjustments might be due to tacit collusion with symmetric information;[6] consumer search or switching costs, possibly in combination with input price volatility; perhaps inventory arguments as we just discussed; or varying markups over the business cycle.

An additional explanation for asymmetries in the dynamic behavior of mortgage rates in particular is related to the prepayment risk. This refers to the risk that current clients renew their mortgage if the bank decides to charge a lower mortgage rate. That is, a lower rate attracts additional new clients, but it may also lead to lower interest revenues from outstanding mortgages. If the latter effect is relatively large (e.g. if it is easy for clients to renew their mortgage), banks may hesitate to lower the mortgage rate after a decrease in the capital market rate. This would imply more downward rigidity in mortgage rates.

In order to explain asymmetries in mortgage rate changes, we could also exploit the mortgage offer practice. In The Netherlands, most mortgages are fixed rate contracts. Fixed rate mortgages are also offered in other countries, for example in the UK, Germany, Sweden, Belgium, Italy, Spain, Portugal and Greece. If a person wants to buy a house with a fixed rate mortgage, he can invite mortgage offers from one or more banks.[7] The bank makes an offer to the client, stating that he can borrow at most this or that amount at some fixed rate. In general, this rate depends on the number of years for which the rate is fixed (in The Netherlands, say, 2, 5, 10, 15 or 20 years for a 30-year mortgage). For simplicity, we assume below that an offer consists of a single interest rate that corresponds to some given term (say, five years, as in the data

[6] Swank (1995) argues that the Dutch mortgage market was characterized by significantly less competitive behavior than in Cournot equilibrium during the period 1957-1990. However, he also argues that the market has become more competitive during that period, and this trend may have continued after 1990.

[7] The procedure for mortgage offers described here is based on the Dutch case. For at least some of the other countries mentioned, the procedure is similar.

used in section 7.2). The offer is valid for a fixed period of, say, two weeks. The client can accept it at any time during this period and get a mortgage at the given rate; if the client wants a mortgage after the offer has expired, he has to solicit for a new offer.

The crucial idea here is that whenever the mortgage rate moves up, clients with an outstanding offer can still get the mortgage at the low rate specified in the offer. If clients accept their offer after the increase, they pay the low rate of the offer even though the current mortgage rate is higher. When the mortgage rate falls, the bank cannot charge the old, high rate to clients that have a non-expired offer (they would simply ask for a new offer at the current, lower rate if the bank would do so). So, a mortgage rate increase does not affect outstanding offers, whereas a decrease does. Note the analogy of this offer policy with an option. The offer is a contract that gives the owner the right to obtain a mortgage at a fixed, specified rate at any time on or before a given date. The mortgage offer policy implies a loss to the bank because increases in the mortgage rate are not immediately passed on to all clients. This is referred to as the offer risk. An increase in the mortgage rate stated by the bank does not immediately imply an equal increase in the mortgage rate charged because of outstanding offers whereas decreases are passed on to all clients immediately. The banks may choose to 'compensate' for this loss by adjusting the mortgage rate upward faster than downward, implying that mortgage rates are more rigid downward.

This type of offer is related to the most-favored-customer (mfc) clause (see Cooper, 1986; Tirole, 1988, pp. 330-332). With such a clause, a firm guarantees its current customers that if it charges a lower price in the future (up to some specified date), they will be reimbursed the difference. Note that for those clients who accept their offer at some time, say t, during the two-week term, it is as if they obtained the mortgage immediately (at time zero, when they received the offer), combined with an mfc clause. This clause guarantees them the lowest mortgage rate offered by the bank in the 'future', i.e. between time zero and t. As Cooper (1986) argues, the mfc clause allows firms (banks) to commit to a higher price (mortgage rate) by penalizing price cuts, which softens price competition. Therefore, banks may precisely engage in mortgage offers because this facilitates tacit collusion.

Despite these similarities, the mortgage offer policy is not exactly the same thing as the mfc policy. For example, clients may accept their mortgage offer immediately, at time zero (so $t = 0$). In that case, they do not have an mfc clause. Also, the term t of the mortgage-mfc clause is endogenous, and will differ across clients. Further, with the offer policy clients may decide to adjust the quantity demanded (i.e. the size of the mortgage) after a mortgage rate change. With a standard mfc policy, the consumers actually buy a certain quantity at time zero which cannot be adjusted later (although they could buy more of the product later, at the prevailing price). Nevertheless, it would be interesting to study cost-induced price changes in the presence of the mfc clause. We consider this issue in the next chapter, and show that the mfc clause leads to asymmetric price adjustments, where there may either be more downward or more upward price rigidity.

7.4 Conclusion

Our empirical analysis of the dynamic behavior of the Dutch mortgage rate has shown that this interest rate follows an increase in capital market rates faster than a decrease. This result of asymmetric price adjustments is not unique to the mortgage market. We discussed empirical studies that present evidence for prices responding asymmetrically to cost changes, rising faster than falling in many markets.

We summarized possible explanations for such asymmetric price adjustments as advanced in the literature. Also, we discussed their relevance for the mortgage market, concluding that several of the explanations suggested in the literature do not apply to the case of mortgages rates or interest rates in general. The explanations that remain are related to the presence of tacit collusion with symmetric information; consumer search or switching costs, possibly in combination with input price volatility; perhaps inventory-related arguments; and varying markups over the business cycle.

Additional explanations that may be particularly relevant for the mortgage market are the prepayment risk (the risk that if a bank lowers the mortgage rate, current clients renew their mortgage and will pay a lower rate in the future), and the offer risk (if a bank increases the mortgage rate, this increase is not fully passed on to all future clients, because those clients with a non-expired offer may still obtain the mortgage at the old, low rate specified in the offer). We also referred to the most-favored-customer clause as a possible explanation for asymmetries in cost-change induced price adjustments. This topic will be analyzed in detail in the next chapter.

Appendix: Data and sources

For the mortgage rate r_m we use the nominal mortgage rate with rate fixed for five years (monthly average), published in Statistisch Bulletin, The Netherlands Bank. For the long-run (ten-year) rate r_l we use NL-BRYLD: NL benchmark bond 10 yrs (DS) (monthly average) as published in Thomson Financial Datastream. Finally, for the swap rate r_{sw} we use ICNLG5Y: Netherlands (NLG) IR Swap 5 year - middle rate from Thomson Financial Datastream. The sample period is 1978:4-2000:12 for the long-run rate r_l (as well as for r_m), and 1991:6-2000:12 for the swap rate r_{sw}.