Bank Mergers and the Dynamics of Deposit Interest Rates

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Summary: Despite extensive research interest in the last decade, the banking literature has not reached a consensus on the impact of bank mergers on deposit rates. In particular, results on the dynamics of deposit rates surrounding bank mergers vary substantially across different studies. In this paper, we aim for a comprehensive empirical analysis of a bank merger's impact on deposit rate dynamics. We base the analysis on a unique dataset comprising deposit rates of 624 US banks with a monthly frequency for the time period 1997-2006. These data are matched with individual bank and local market characteristics and the complete list of bank mergers in the US. The data allow us to track the dynamics of bank mergers while controlling for the rigidity of the deposit rates and for a range of merger, bank and local market features. An innovation of our work is the introduction of an econometric approach of estimating the change of the deposit rates given their rigidity.

Key words: deposit rate dynamics, bank mergers, deposit rate rigidity

JEL: G21, L11

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1. Introduction

Bank mergers affect bank competition by altering the market structure in affected local bank markets and the size and geographical scope of the merging banks. The wide-spread bank consolidation in the US has been met with a growing literature on the impact of bank mergers on bank competition. A substantial portion of this literature concentrates on the impact of bank mergers on bank loan and deposit rates.

The empirical research on the topic concentrates on two reciprocal hypotheses. The "efficiency hypothesis" states that the merged bank might reach economies of scale and other efficiency gains and transfer these to the customers in the form of more beneficial interest rates. The opposite, "structure-conduct-performance hypothesis", states that the merged bank may exploit its increased market power and impose disadvantageous interest rates. Berger and Hannan (1989) find empirical support for the "structure-conduct-performance hypothesis" by showing that high market concentration results in lower deposit rates. Hannan and Prager (1998) explicitly concentrate on bank mergers as a determinant of local bank market concentration and study the dynamics of deposit rates in the first year after bank mergers. They are able to document a negative impact of mergers on deposit rates. On the other hand, Focarelli and Panetta (2003) argue that the analysis of merger effects should embrace a longer time period after the merger since efficiency gains need more time to materialize. They are able to find support for the efficiency hypothesis by showing that in the long-run merging banks offer higher deposit rates than their rivals.

The contradicting results of these previous studies motivate us to revisit the topic. We present a comprehensive analysis of the impact of bank mergers on deposit rate dynamics. We base our analysis on a unique dataset comprising monthly deposit rates data of 624 banks in the

period 1997-2006. The deposit rate data are matched with bank and market characteristics and a complete list of bank mergers from 1988 to 2005.

Our detailed dataset allows us to address two important lacunae of the existing literature. First, the empirical literature on deposit rate dynamics around bank mergers has so far ignored the rigidity of deposit rates. As documented in earlier studies (Hannan and Berger, 1991; and Neumark and Sharpe, 1992) deposit rates adjust sluggishly to changes in the market interest rates. Deposit rate rigidity is relevant for the analysis of the changes of deposit rates around bank mergers because for a dominating number of observations no immediate change in the deposit rates is observed. In addition to a possibly slow adjustment to the change in market structure, which must be modelled with a dynamic model, the data present the additional problem of rigidity: that is for the vast majority of observations, the price is the same as for the period before. In econometric terms this censoring presents large potential problems. It has long been well known that in the presence of censoring, OLS regression results can be inconsistent and biased (see a standard text such as Wooldridge, 2002). We incorporate the rigidity of deposit rates in the empirical analysis by explicitly integrating the censoring process into the empirical estimation. Our focus is on modelling bank pricing behaviour by accounting for both the probability of a deposit rate change and the de facto change of the deposit rates in a joint framework. The design is to estimate bank merger's impact on the deposit rate setting mechanism.

Second, previous research on the impact of bank mergers has mostly concentrated on in-market mergers. We argue that the distinction between in- and out-of-market mergers is not clear cut since modern bank mergers might be classified as both in- and out-of-market depending on the perspective of the different local markets. We include all bank mergers (without ex ante imposing restrictions on the type of merger) together with a range of controls for the characteristics of the mergers. Thus, we are able to assess the impact of a wide range

of bank mergers and how this impact may be modified by various features of the merger (bank size growth, market share growth, or rise in the number of markets). In other words, we estimate whether bank mergers exert negative impacts on depositors and if that is the case, which particular features of the merger reinforce the negative impact.

The rest of the paper is organized as follows. Section 2 presents a review of the existing literature. Section 3 illustrates the data. Section 4 presents replications of earlier research approaches using our new dataset. Section 5 presents our empirical approach and its results. Section 6 draws the concluding remarks.

2. Literature

Our study aims to contribute to a broad empirical literature on the pricing effects of mergers. Whereas studies exist on the impact of company mergers in various industries[1], due to better data availability most of the research has concentrated on the banking industry.

As mentioned in the introduction, most of the literature on the impact of bank mergers has concentrated on testing the validity of two hypotheses, the "efficiency hypothesis" and its opposite, the "structure-conduct-performance hypothesis". The paper by Berger and Hannan (1989) which emphasizes the structure-conduct-performance hypothesis, is a static study of the relationship between local banking market concentration and deposit rates. Here, the authors find that more concentrated deposit markets are characterized by lower deposit rates[2]. The later work by Hannan and Prager (1998) focuses on bank mergers as a determinant of bank market concentration. The authors explore the dynamics of the deposit rate changes[3] and

[1] In a study that has inspired the early research on the effect of mergers in banking Kim and Singal (1993) find out that airline merger have resulted in higher airfares. On the contrary, Connor, Feldman, Dowd and Radcliff (1997) find out that hospital mergers have resulted in more beneficial consumer prices.

[2] Corvoisier and Gropp (2002) replicate Berger and Hannan's (1989) analysis on a sample of EU banks.

[3] Kahn et al (2004) study the dynamics of loan rates in a similar framework.

find that after a substantial in-market merger, the merging banks significantly decrease their deposit rates which they explain by an increase in market power.

The paper by Focarelli and Panetta (2003) which supports the efficiency view argues that previous studies have only examined the very short post-merger period[4]. They consider a longer time period. They posit that the effect of market power materializes instantaneously where efficiency gains need more time to materialize[5]. They present a more comprehensive study incorporating long-run post-merger dynamics and controlling for bank size and asset risk (bad loans/total asset) on the bank level and for market concentration on the local market level. In this study efficiency gains prevail. Whereas merging banks tend to decrease deposit rates in the transition period (up to three years after the merger) in the long-run deposit rates of merged banks go up and beyond those of rival banks.

The studies mentioned above focus mostly on in-market mergers, occasionally using out-of-market mergers as a control for mergers which do not increase market power. A newer strand of the literature suggests that although out-of-market mergers do not directly affect the distribution of market shares, they can significantly impact bank pricing behavior. The theoretical foundation, as given by the models of Barros (1999) and Park and Pennacchi (2005), is based on the assumption that multimarket banks (which are a result of out-of-market mergers) have access to more diverse sources of financing, whereas single-market banks depend largely on retail deposits[6]. As a result they argue that out-of-market mergers result in lower deposit rates. Park and Pennacchi (2005)[7] and Hannan and Prager (2006)

[4] Sapienza (2002) studies loan rate dynamics in a similar framework.

[5] Berger, Sounders, Scalise and Udell (1998) and Calomiris and Karceski (2000) argue that the "gestation" period needed to restructure a merged bank is three years.

[6] The structure of bank liabilities has been the subject also of a growing literature on market discipline. It has argued that banks may not refinance in the wholesale market because wholesale exposures are not insured and create incentives for the lenders to monitor. Therefore, banks which are perceived as riskier may prefer to refinance mostly with insured retail deposits (Billett, et el, 1998).

[7] Park and Pennacchi (2005) use bank size as a proxy for geographical scope.

present empirical tests of this hypothesis, and both find that multimarket banks offer lower deposit rates than their single-market rivals. Using a separate dataset and estimation approach Rosen (2003), however, finds different results. He argues that growing banks tend to offer higher interest rates on deposits, and moreover, a market with more and larger multimarket banks generally sees higher deposit rates at all banks.

The literature on multimarket banking is closely related to the strand in the banking literature which concentrates on the interaction between bank size and the way banks compete. In a seminal paper Stein (1992) argues that large and small banks process information differently and that is why they compete differently in the loan market. Park and Pennacchi (2005) extend this argument and argue that bank size is also important for deposit market competition.

The literature on multimarket banks is also related to an industrial organisation literature focusing on multiple contacts between firms as a factor facilitating collusion. Edwards (1955) points to the fact that when firms meet in numerous markets they may have higher incentives to collude because retaliation by the rivals may follow on numerous markets. This relation is known as the "linked oligopoly" hypothesis. Mester (1987) provides an empirical test of this hypothesis. She finds out that, contrary to expectations, multiple market contacts lead to more competitive pricing, especially in concentrated markets.

Obviously, these are contradictory results. One potential reason for the deviating results is that researchers have used different datasets. However, results might also be biased because of the fragmentary treatment of deposit rate dynamics (in particular the time series structure of the deposit rates has been ignored). Moreover, all existing studies include only a fraction of the past mergers in the analysis. We add to the literature by performing a comprehensive analysis which addresses both the dynamics of the deposit rates and the features of a broad range of

the mergers with a single dataset which controls for pre- and post-merger characteristics of the local markets.

3. Data

We base the empirical estimation on a unique dataset based on the full list of bank mergers in the US in the time period 1988-2005 from the *Supervisory Master File of Bank Mergers and Acquisitions*. For each bank we construct a list of its six most recent mergers. We match this data with *Bankrate Monitor's* deposit rates of 624 US banks operating in 164 local markets (a total of 1738 bank-market groups) for the period starting from September 19, 1997 and ending on July 21, 2006. Radecki (1998) presents evidence that multimarket banks tend to offer uniform rates across local markets. However, we observe banks which offer different rates in different local markets in our sample. Therefore, we prefer to keep the bank-market as observation unit. By doing this we can control for both bank and local market characteristics in the analysis.

Bankrate Monitor's deposit rate data have weekly frequency. Using the weekly deposit rate changes as a proxy for deposit rate setting after a merger however contains a lot of noise. Therefore, as in Kahn et al (2005) we base our tests on rate changes computed over 4-week intervals. Our sample encompasses a total of 461 weeks which allows us to construct a time series of 115 4-week intervals, which we refer to as "month" although they do no correspond to calendar months. This approach also allows the comparison of our results with those of Hannan and Prager (1998).

Bankrate Monitor reports cover a comprehensive set of deposit products (checking accounts, money market deposit accounts and certificates of deposits with a maturity of three months to up to five years). In this paper we concentrate on checking account and money market deposit account (MMDA) rates only. We exclude the rates on certificates of deposit because they are

investment products with a relatively high minimum denomination and we expect them to react less to changes in local deposit market conditions[8].

In addition, we enrich the dataset with a broad range of control variables on the individual bank level with quarterly frequency from the *Quarterly Reports of Conditions and Income* (*call reports*). We also include control variables on the local market level. The source of the local market controls is the *Summary of Deposits*. These data are only available at an annual frequency.

4. Mergers and deposit rate dynamics: a simple empirical framework

As pointed out in Section 2 previous studies have reached contradicting results on the impact of bank mergers on deposit rates. Results may differ because of different estimation approaches but also because researchers have employed different data sources. So, Hannan and Prager (1998), for example, employ data from US bank mergers, whereas Focarelli and Panetta (2003) base their analysis on Italian data. In order to illustrate how sensitive the empirical results are to the changes of the model specification we start the empirical analysis by replicating Hannan and Prager's and Focarelli and Panetta's estimation approaches with our dataset.

Our first exercise is to replicate Hannan and Prager's (1998) estimation approach. For the sake of comparability, we concentrate on substantial in-market mergers only[9]. As in Hannan and Prager (1998) we estimate the following empirical model:

$$\ln deprate_{ijt} - \ln deprate_{ijt-1} = \alpha_0 + \alpha_1 merger\_dummies_{i,t} + \xi_{i,j,t} \qquad (1)$$

[8] Hannan and Prager (1998) find no significant impact of bank mergers on certificate of deposit rates

[9] As in Hannan and Prager (1998) we concentrate on substantial in-market mergers defined as mergers which led to a rise in local market's HHI of at least 100 basis points.

The dependant variable, $\ln deprate_{ijt} - \ln deprate_{ijt-1}$, is the change in the log of the deposit rate (checking account rates and money market deposit account rates) between t-1 and t. The $merger\_dummies_{i,t}$ are a vector of dummy variables measuring the time to the latest merger of bank i. We adopt four time dummies here: 26 to 13 weeks pre-merger, 12 to 1 week pre-merger, 0 to 12 weeks post-merger and 13 to 52 weeks post-merger. The dummies take the value of 1 if a bank has experienced a merger within this time window and zero otherwise[10].

Table 1: Short-term effects of in-market bank mergers

	ckecking account rate	money market deposit account rate
26 to 13 weeks pre-merger	**-0.018**	**-0.020**
	0.012	0.013
12 to 1 week pre-merger	**0.026** **	**0.026** *
	0.013	0.014
0 to 12 weeks post-merger	**0.009**	**-0.017** **
	0.007	-0.008
13 to 52 weeks post-merger	**-0.012** ***	**-0.009** **
	0.003	0.004
constant	**0.000** ***	**0.007**
	0.001	0.002

Note: Coefficients in bold, standard errors below coefficients. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively

As illustrated in Table 1 for both the checking account and the MMDA rates we are able to qualitatively replicate the results of Hannan and Prager (1998). The time dummies for *0 to 12 weeks post-merger* and *13 to 52 weeks post-merger* enter the money market deposit account regressions with negative statistically significant coefficients. In the case of checking account rate only the *13 to 52 weeks post-merger* dummy is significant. These results confirm the negative short-term effect of in-market mergers[11] on deposit rates and can be interpreted is evidence for the structure-conduct-performance hypothesis.

[10] Our approach is slightly different for Hannan and Prager's here. They adopt a dummy variable for each of the -12/+12 months around the merger.

[11] In these regression specifications we follow Hannan and Prager (1998) and do not control for any features of the bank ort he local market

Here the change of deposit rates around a merger is studied without controlling for changes in the reference interest rates (T-Bill rate or Fed funds rate), which are important determinants of deposit rates. We control for the rates by adopting the more comprehensive approach suggested by Focarelli and Panetta (2003). Focarelli and Panetta (2003) examine the level of deposit rates relative to the reference rate around the merger rather than just the simple change of deposit rates. Focarelli and Panetta also expand the analyzed time period after the merger and include a few controls on the bank and local market level. The estimated model in this case is:

$$relative\_rate_{i,j,t} = \gamma_0 + \gamma_1 merger\_dummies_{i,t} + \gamma_2 Controls + \nu_{i,j,t} \qquad (2)$$

As in Focarelli and Panetta (2003) our dependant variable $relative\_rate_{i,j,t}$ in Table 2 is the difference between the deposit rate (checking account rate or MMDA rate) and the fed funds rate. The time distance to the merger is measured by a set of five dummies (for the first, second, third, fourth and fifth year after the merger). Controls for bank characteristics are bank size (log of total assets) and bank size squared. On the local market level we control for market concentration using the Herfindahl Index (HHI) and average per capita income in the local market (in log form).

Our results suggest that if we do not control for bank and market features, bank mergers have a positive short- and mid-term effect on deposit rates. The long-term effect (5 and more years after the merger) is, however, negative. Nevertheless, the magnitude of the coefficients suggests that the short-term positive impact outweighs the negative effect and the total impact is still positive.

Once we control for bank size, HHI and local market's average income the negative long-term effect disappears, and we are able to document that mergers are associated with a rise in deposit rates. The control variables enter the regression with coefficients of the expected sign,

given a Focarelli and Panetta world. So, larger banks offer lower deposit rates, but the negative effect of bank size is exhausted at a certain threshold. The Herfindahl Index (HHI) has a negative and statistically significant coefficient suggesting that banks offer lower deposit rates in more concentrated local markets.

Table 2: Short and long-term effect of bank mergers

	checking account rate		money market deposit account rate	
	(1)	(2)	(3)	(4)
1st year after the merger	**1.321** ***	**1.002** ***	**1.028** ***	**0.807** ***
	0.033	0.060	0.031	0.061
2nd year after the merger	**0.687** ***	**0.914** ***	**0.435** ***	**0.778** ***
	0.032	0.065	0.031	0.067
3rd year after the merger	**0.165** ***	**0.943** ***	**-0.004**	**0.863** ***
	0.037	0.079	0.035	0.081
4th year after the merger	**0.283** ***	**0.715** ***	**0.116** ***	**0.692** ***
	0.041	0.086	0.039	0.087
5th and more years after the merger	**-0.067** *	**0.123**	**-0.221** ***	**0.028**
	0.041	0.088	0.039	0.091
size		**-1.058** ***		**-0.746** **
		0.395		0.362
size squared		**0.037** ***		**0.026** **
		0.012		0.011
HHI		**-6.604** ***		**-4.212** ***
		0.542		0.528
income		**-0.176** **		**-0.128** **
		0.076		0.062
constant	**-3.882** ***	**7.854** **	**-3.275** ***	**5.202** *
	0.032	3.380	0.030	3.052

Note: Dependant variable is the difference between the deposit rate (money market rate or checking account rate) and the fed funds rate. Coefficients in bold, standard errors below coefficients. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

The results of this exercise substantially differ from those of the Hannan and Prager's (1998) approach. They can be interpreted as evidence on the efficiency hypothesis. Our results, however, differ from Focarrelli and Panetta's results, in that we do not document a negative short-term (that is in the first two years after the merger) impact on deposit rates. A comparison of the results illustrates that even when the same dataset is employed, empirical results change substantially when we expand the time window around the merger and the set of control variables. This conclusion leads us to track the dynamics of deposit rate changes in a more comprehensive framework.

5. Bank mergers and the dynamics of deposit interest rates: an extended empirical analysis

The empirical tests presented in Section 4 do not consider the censoring issue arising from the rigidity of the deposit rates. When we replicate Hannan and Prager's (1998) approach we estimate a regression where the dependent variable is the monthly change of deposit rates. In our sample this variable is equal to 0 in about 90% of the observations[12]. The observed values of the dependent variable are severely censored. As a result of the censoring OLS estimates can be biased and inconsistent[13].

In this section we present an estimation methodology which accounts for the censoring and thus incorporates deposit rate rigidity. We employ the following baseline empirical model:

$$\ln deprate_{ijt} - \ln deprate_{ijt-1} = \beta_0 + \beta_1 merger\_splines_{it} + \beta_2 Controls_{it} + \beta_3 Controls_{jt} + \beta_4 \Delta fedfund_t + \varepsilon_{ijt} \quad (3)$$

where $deprate_{ijt}$ is the deposit rate (checking account rate or money market deposit account rate) offered by bank i in market j in "month" t, $merger\_splines_{it}$ is a vector of splines for different time distances from the merger. $Controls_{it}$ and $Controls_{jt}$ are vectors of control variables on the individual bank level and the local market respectively. $\Delta fedfund$ is a vector of the change in the fed funds rate during the periods: (t-1,t), (t-2, t-1) and (t-3, t-2).

Our model, therefore, estimates how the process of adjustment—of bank deposit rates to changes in the reference rate during the current and previous periods—is modified by bank mergers and the characteristics of the bank and the local bank market. Thus, when we discuss

[12] We will present more detailed evidence on the rigidity of deposit rates in the next subsection.

[13] Although less obvious the censoring problem is also present in Focarelli and Pannetta's (2003) framework, where the difference between the deposit and the fed funds rate is used as a dependent variable. Again since deposit rates change very infrequently, the changes of the dependent variable are only driven by changes in the fed funds rate.

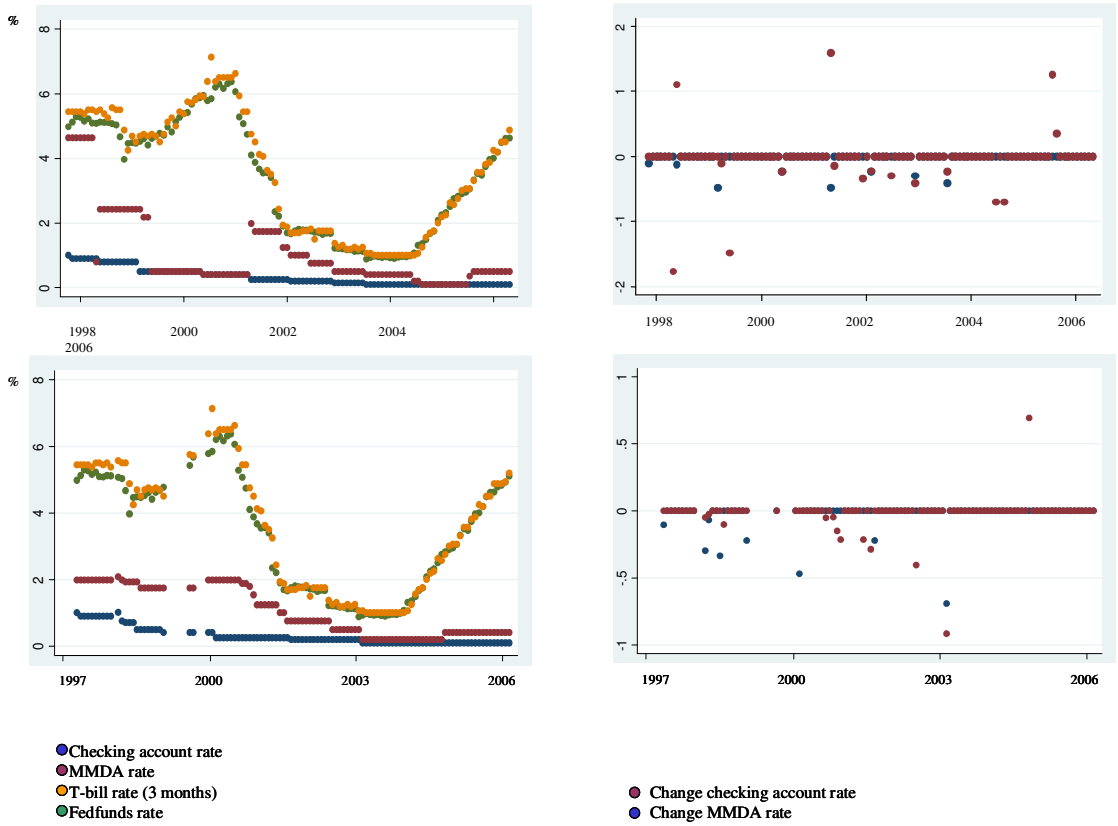
a negative/positive impact of a merger on the deposit rates, we mean the impact of the merger on this process.

Dependent Variable

Evidence on the rigidity of retail deposit rates

Our dependent variable $\ln deprate_{ijt} - \ln deprate_{ijt-1}$ represents the monthly change of the log of bank deposit rates[14].

Figure 1: Two examples of bank retail deposit rates



Source: Bankrate Monitor, Inc

Figure 1 shows cases illustrating the infrequent changes of bank deposit rates. The left hand panels of the figure present two examples of checking account rates and money market

[14] As robust checks we rerun the regressions using the difference of the deposit rate levels. Results do not change qualitatively. We report the change in log results in order to facilitate comparison with Hannan and Prager's results.

account rates together with the fed funds and the 3-month T-bill rate. The right hand panels present the changes of the log of the checking account rates and money market account rates for the same bank/market and time period. The graphs illustrate that deposit rates change very infrequently. As suggested by Berger and Hannan (1991) and Neumarke and Sharpe (1992) they react particularly sluggishly to upward changes in the wholesale interest rates. Table 3 presents a summary of the frequencies of interest rate changes in our sample. The two examples plotted in Figure 1 represent the usual pattern of infrequent deposit rate changes. On average checking account rates stay unchanged in 90% of the months, whereas money market account rates do not change in more than 84% of the months.

Table 3: Frequency of positive and negative monthly deposit rate changes

	fed funds rate	checking account rate	money market deposit account rate
positive change	45%	2%	5%
negative change	38%	8%	11%
no change	16%	90%	84%

Estimation technique

As a benchmark we first estimate the model by standard OLS. We then proceed with modelling the rigidity of the deposit rates to estimate the impact of bank mergers on deposit rates by a "trigger model" with fixed costs of the price (deposit rate) adjustment constructed in the tradition of the "Ss" literature. We assume that an underlying latent variable, itself a function of measured time series characteristics, must reach a positive or a negative trigger point before it can change the deposit rate in either direction.

The desired deposit rate, in the absence of a fixed cost of deposit rate adjustment is $P*$. The pooling model gives the following system

$$\Delta P_{i,t}^{*} = X_{i,t}\beta + u_{1i,t}, \qquad (4)$$

where $X_{i,t}$ denotes the vector of explanatory variables and $u_{1i,t}$ is the error term.

We then observe the following classic Ss model, where $\Delta P_{i,t}$ denotes the observed deposit rate change:

$$\Delta P_{i,t} = \Delta P^*_{i,t}, \text{ if } \Delta P^*_{i,t} + u_{2i,t} > c_u$$

$$\Delta P_{i,t} = \Delta P^*_{i,t}, \text{ if } \Delta P^*_{i,t} + u_{2i,t} < c_l \qquad (5)$$

$$\Delta P_{i,t} = 0, \text{ otherwise.}$$

Here the parameters, $c_l < 0 < c_u$, represent the trigger points of the Ss rule, and are estimated from the data. The term, $u_{2i,t}$ represents the error. It is straightforward to show that if $u_{1i,t}$ ~ $N(0,\sigma_1)$ and $u_{2i,t}$ ~ $N(0,\sigma_2)$, then

$$E(\Delta P_{i,t} \left| X_{i,t}, \Delta P_{i,t} \neq 0\right.) = A_l E(\Delta P_{i,t} \left| X_{i,t}, \Delta P_{i,t} < 0\right.) + A_l E(\Delta P_{i,t} \left| X_{i,t}, \Delta P_{i,t} > 0\right.) \qquad (6),$$

where

$$E(\Delta P_{i,t} / X_{i,t}, \Delta P_{i,t} < 0) = X_{i,t}\beta + \sigma \frac{\phi(v_l)}{\Phi(v_l)}$$

$$E(\Delta P_{i,t} / X_{i,t}, \Delta P_{i,t} > 0) = X_{i,t}\beta + \sigma \frac{\phi(v_u)}{\Phi(v_u)}$$

$$v_l = \frac{c_l - X_{i,t}\beta}{\sigma} \qquad (7)$$

$$v_u = \frac{-c_u + X_{i,t}\beta}{\sigma}$$

$$\sigma = \sqrt{\sigma_1^2 + \sigma_2^2}$$

$$A_l = \frac{\Phi(v_l)}{\Phi(v_u) + \Phi(v_l)}$$

$$A_u = 1 - A_l .$$

and where ϕ, Φ, are the standard normal density and cumulative normal density functions, respectively.

The likelihood functions for the system described above are well defined, but maximum likelihood estimation procedures rarely converged because of the large numbers of parameters combined with the huge number of observations. However, the form of the expectation above suggests a simple three stage procedure that we adopt when coding the estimator.

In the first step we estimate $v_l = \frac{c_l - X_{i,t}\beta}{\sigma}$ and $v_u = \frac{-c_u + X_{i,t}\beta}{\sigma}$ using two separate probits on whether or not we observe price increases or decreases and compute

$$\hat{\lambda}(v_l, v_u) = A_l(\hat{v}_l, \hat{v}_u)\frac{\phi(\hat{v}_l)}{\Phi(\hat{v}_l)} + A_u(\hat{v}_l, \hat{v}_u)\frac{\phi(\hat{v}_u)}{\Phi(\hat{v}_u)} \quad (8)$$

The intuition behind λ is that it represents the expectation due to the censoring process. By including an estimated value of λ as a right hand variable, we ensure that the unobserved error term has an expectation that approaches zero in large samples, giving us consistent estimates of our parameters of interest, β.

These parameters, β, are estimated in the second step, using simple GLS on

$$E(\Delta P_{i,t} / X_{i,t}, \Delta P_{i,t} \neq 0) = X_{i,t}\beta + \sigma\hat{\lambda}(v_l, v_u) \quad (9)$$

where, again, λ is included as a regressor in the estimation of $\Delta P_{i,t}$ to correct for the censoring bias.

Of course the standard errors for the estimated parameters must be estimated in a way that accounts for the fact that an included regressor, $\lambda(v_l, v_u)$, is estimated in the first stage. The methods we use are standard in the literature.

Finally, the trigger parameters, c_l and c_u, can be estimated in a third stage, using simple probits on $v_l = \frac{c_l - X_{i,t}\beta}{\sigma}$ and $v_u = \frac{-c_u + X_{i,t}\beta}{\sigma}$. Because each stage of the procedure represents an M-estimate, in the sense of Huber, standard errors can be estimated from the stacked system in fairly standard ways, described in Wooldridge (2002).

The empirical approach described above gives us a consistent estimate of the impact of mergers on deposit rates while accounting for interest rate rigidity. The estimates illustrate how mergers affect the bank pricing setting and in particular how the reaction of a bank to a change in the reference rate is modified by a merger.

Explanatory variables

Variables measuring merger's impact across time

When defining the bank merger impact on deposit rates we concentrate on two major issues, the evolution of the effect of a bank merger over time; and the question of the number mergers back in time that should be considered (numerous banks acquire multiple targets within a very short period). By concentrating exclusively on the last merger, we might omit important information about the evolution of bank merger effects.

To consider the evolution of a merger effect, we account for a period from a year before the merger date[15] to ten years after the merger. We approximate the development of deposit rates around the merger by linear spline interpolation, the simplest form of spline interpolation. It is equivalent to piecewise linear interpolation, where the function to be modeled is divided into a fixed number of subintervals, and within each of the subintervals the function is linearly approximated. Nonlinearity can, therefore, be modeled by different slopes of the linear

[15] The merger date is the date when the target bank loses its charter.

functions across the subintervals. The end points of the linearly approximated subintervals are known as "knots".

Algebraically, each spline is a linear function constructed as:

$$\frac{x_{i+1}-x}{x_{i+1}-x_i}\alpha_i + \frac{x-x_i}{x_{i+1}-x_i}\alpha_{i+1}, \qquad \text{when } x \in (x_i, x_{i+1}],$$

and 0, otherwise (10)

and where x is the value of the explanatory variable (the time distance to the merger, in our case). The values x_i denote the "knots" of the spline, and the coefficients, α_i, are estimated from the data. In our case we approximate the impact of a merger on the change of the deposit rates by dividing the time period around the merger into several subperiods. We fix the knots, x_i, at 6 months before the merger date, at the merger date, 6 months, one year, 1 1/2 year, 2 years, 3 years and 4 years after the merger. Through the splines we model the potential nonlinearity of the dependence between deposit rate changes and time after the merger.

To our knowledge previous research on the impact of mergers on bank rates has only used dummies for different time windows around the merger. A disadvantage of the dummies is that they are a step-wise and discontinuous approximation of the merger effect across time. Linear splines give a more precise approximation by modeling the effect of mergers as a set of continuous linear functions[16].

With regard to the history of a number of mergers experienced by the bank, we proceed as follows: to keep the model parsimonious, we define the splines for the time distance from the latest merger only. For previous mergers we define a set of dummy variables $merger_i$ which takes the value of one if the bank has had at least i mergers and zero, otherwise. Our dataset

[16] As a robustness check, we reran our regressions with dummies instead of splines; results did not change qualitatively; statistical significance of the splines results was, however, higher.

contains up to 6 mergers of a bank. The variables $merger_4$, $merger_5$, and $merger_6$ entered all regression specifications with statistically insignificant coefficients[17], we therefore, dropped them from the analysis. We interpret the insignificance of the dummies for earlier mergers as a result of the fact that banks which have merged three times during our sample horizon tend to have merged numerous times and so are all similar in this regard.

Variables controlling for the type of merger

In our study we include the full sample of bank mergers in the period 1988-2005. We do not divide mergers into in-market and out-of-market groups, because we think that this distinction is not clear cut. Most of the mergers in the US during the last few years are mergers between banks which are already operating in multiple markets. From one local market's point of view, a merger might appear as an in-market merger (if the local market is part of the overlapping geographical range of the two merging banks). In contrast, from the point of view of a local market, which has been operated by only one of the merging banks, the merger appears as a market extension (out-of-market) merger. Based on these considerations, we include all mergers in the analysis together with a range of merger characteristics as controls.

The existing literature has so far emphasized three important features of bank mergers, which might influence the pricing behavior of the merged bank. We include these three key merger features in the identification of the merger impact. The first one is the change in market share. When two banks operating in the same market merge, their joint market share allows them to exercise market power and offer lower deposit rates. We control for this effect by including in the regressions the change of market share (CMS) caused by the merger. We do not have precise data on the change of market share directly related to the merger for each of the affected local markets. We have instead to approximate this change by the change of market

[17] We interpret the insignificant impact of 4th to 6th latest mergers as a result of the fact that of the banks which have merged at least trice in our sample, most have merged up to 6 times.

share realized in the year of the merger. That is, if a bank has merged in a year T we approximate the change of market share caused by the merger as the difference between this bank's market share in T and T-1[18].

In order to estimate how the effect of the change of market share evolves in the time after the merger we also introduce a cross-product of CMS and the time after the merger (CMS**time after merger*=CMS*ln(1+ weeks after the merger)).

A second key aspect of mergers that has been emphasized in the literature is the change of bank size. By merging, banks grow in size. As a result, they might materialize efficiencies of scale. On the other hand, as pointed out by Park and Pennacchi (2005), larger banks have access to more diversified sources of refinancing and might therefore, keep deposit rates low. To estimate the impact of *target size* we include the volume of total assets of the target bank[19] (normalized to the acquirer's total assets) in the regression. The cross-product of the *target size* and the time after the merger (target size* ln(1+ weeks after the merger)) is also included in the regression.

Finally, as suggested by the linked oligopoly hypothesis, the number of markets where a bank is active might also significantly impact its pricing behavior. In order to estimate the effect of the market extension dimension of the mergers we include the *change of number of local markets* (CNM) divided by the number of markets prior to the merger as a regressor. We have again to approximate the CNM by the difference between a bank's number of markets in year T and year T-1. Again, we also include the cross-product of the CNM variable and the time after the merger (CNM* ln(1+ weeks after the merger)) as a regressor.

[18] The Summary of Deposits publish market shares as of June 30; therefore we define the year in this case as the period July, 1 to June, 30.

[19] The *Supervisory Master File of Bank Mergers and Acquisitions* provides data for the target banks' ID. Given these we match the acquirer banks' data with the target banks' data from the Call Report.

Control variables

In addition to the merger related variables and the variables measuring the change of the fed funds rate we include a number of control variables in the regression. On the individual bank level these are bank size (measured by the log of total assets), bank size squared and share of deposits to total assets (lagged with one year in order to avoid simultaneity). On the local market level we control for market concentration (as measured by the Herfindahl index) and per capita income (in log form).

Empirical results

The results of the baseline OLS estimations of the changes of the checking account rates and the money market deposit account rates are illustrated in Table 4 and 5, respectively. Those of the estimations of the "trigger" model are presented in Table 6 and 7.

A comparison of the OLS with the "trigger" model results indicates that both the economic and the statistical effect of mergers are stronger when we control for the rigidity of the deposit rates. The higher statistical significance can be explained by the fact that the "trigger" model ignores the noise introduced by the "no change" observations. The lower economic significance is a direct effect of the censoring bias which is present in the OLS estimation. In the following discussion we will concentrate on the unbiased "trigger" model results.

The empirical results in regard with the change of the checking account rate point to a negative impact of mergers. Whereas the pre-merger effect is insignificant in all checking account rate regression specifications, the immediate effect of the merger is negative and statistically significant. Moreover, the merger continues to exert a negative impact on the deposit rates up until the beginning of the third year after the merger. Only during the third year we can identify a positive impact of the merger on deposit rates changes, but this positive impact is offset by the negative effect during the following years.

Table 4: Mergers and checking account rate dynamics: OLS estimates

	(1)	(2)	(3)	(4)	(5)
spline-.5	**-0.001**	**0.000**	**-0.001**	**-0.001**	**0.000**
	0.006	0.006	0.006	0.006	0.006
spline0	**0.023** ***	**0.023**	**0.023**	**0.023** ***	**0.023** ***
	0.004	0.004	0.004	0.004	0.004
spline+.5	**0.003**	**0.001**	**0.003**	**0.003**	**0.002**
	0.004	0.004	0.004	0.004	0.004
spline+1	**0.006**	**0.004**	**0.006**	**0.006**	**0.004**
	0.004	0.004	0.004	0.004	0.004
spline+1 1/2	**-0.011** ***	**-0.014** ***	**-0.011** ***	**-0.011** **	**-0.013** ***
	0.004	0.005	0.004	0.005	0.005
spline+2	**-0.007** *	**-0.011** ***	**-0.007** *	**-0.007** *	**-0.010** **
	0.004	0.004	0.004	0.004	0.004
spline+3	**0.002**	**-0.002**	**0.002**	**0.002**	**-0.001**
	0.004	0.004	0.004	0.004	0.004
spline+4	**-0.012** ***	**-0.018** ***	**-0.013** ***	**-0.012** ***	**-0.017** ***
	0.003	0.003	0.003	0.003	0.004
target' size		**-0.006**			**-0.005**
		0.005			0.005
TS*time after merger		**0.005**			**0.006**
		0.002			0.002
change market share (CMS)			**-0.023**		**-0.013**
			0.031		0.031
CMS*time after merger			**0.005**		**-0.001**
			0.009		0.009
change number of markets (CNM)				**-0.002**	**-0.001**
				0.002	0.002
CNM*time after merger				**0.000**	**-0.001**
				0.001	0.001
merger2	**0.000**	**0.000**	**0.000**	**0.001**	**0.000**
	0.003	0.003	0.003	0.003	0.003
merger3	**-0.003**	**-0.002**	**-0.003**	**-0.004**	**-0.002**
	0.003	0.003	0.003	0.003	0.003
change fed fundsrate (t;t-1)	**0.022** ***	**0.022** ***	**0.022** ***	**0.022** ***	**0.022** ***
	0.002	0.002	0.002	0.002	0.002
change fed fundsrate (t-1;t-2)	**0.052** ***	**0.052** ***	**0.052** ***	**0.052** ***	**0.052** ***
	0.002	0.002	0.002	0.002	0.002
change fed fundsrate (t-2;t-3)	**0.031** ***	**0.032** ***	**0.031** ***	**0.031** ***	**0.032** ***
	0.002	0.002	0.002	0.002	0.002
bank size	**-0.016** ***	**-0.013** **	**-0.017** ***	**-0.018** ***	**-0.014** **
	0.005	0.005	0.005	0.005	0.005
bank size squared	**0.001** ***	**0.000** ***	**0.001** ***	**0.001** ***	**0.000** ***
	0.000	0.000	0.000	0.000	0.000
deposits to assets	**0.001**	**-0.001**	**0.000**	**0.000**	**-0.001**
	0.014	0.014	0.014	0.014	0.014
market share	**-0.006**	**-0.008**	**-0.006**	**-0.006**	**-0.008**
	0.007	0.007	0.008	0.007	0.008
HHI	**-0.005**	**-0.005**	**-0.006**	**-0.006**	**-0.005**
	0.011	0.011	0.011	0.011	0.011
income	**0.004** **	**0.004** **	**0.004** **	**0.004** **	**0.004** **
	0.002	0.002	0.002	0.002	0.002
constant	**0.096** **	**0.074** *	**0.099** **	**0.106** **	**0.075** *
	0.044	0.046	0.044	0.045	0.047
number of observations	41440	41440	41440	41440	41440
R-squared	0.0194	0.0195	0.0194	0.0197	0.0198

Note: Dependant variable is the money market account rate with weekly frequency. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively

Table 5: Mergers and money market deposit account rate dynamics: OLS estimates

	(1)	(2)	(3)	(4)	(5)
spline-.5	**-0.005**	**-0.005**	**-0.005**	**-0.005**	**-0.005**
	0.007	0.007	0.007	0.007	0.007
spline0	**-0.003**	**-0.002**	**-0.003**	**-0.003**	**-0.002**
	0.005	0.005	0.005	0.005	0.005
spline+.5	**-0.007**	**-0.008**	**-0.007**	**-0.007**	**-0.007**
	0.005	0.005	0.005	0.005	0.005
spline+1	**0.027** ***	**0.026** ***	**0.027** ***	**0.027** ***	**0.027** ***
	0.005	0.005	0.005	0.005	0.005
spline+1 1/2	**-0.002**	**-0.003**	**-0.002**	**-0.002**	**-0.003**
	0.005	0.005	0.005	0.005	0.005
spline+2	**-0.017** ***	**-0.018** ***	**-0.017** ***	**-0.017** ***	**-0.018** ***
	0.004	0.005	0.004	0.005	0.005
spline+3	**0.007**	**0.006**	**0.007**	**0.007**	**0.006**
	0.004	0.004	0.004	0.004	0.004
spline+4	**-0.023** ***	**-0.025** ***	**-0.023** ***	**-0.023** ***	**-0.025** ***
	0.003	0.004	0.003	0.004	0.004
target' size		**0.006**			**0.007**
		0.005			0.006
TS*time after merger		**0.001**			**0.002**
		0.002			0.002
change market share (CMS)			**-0.001**		**-0.006**
			0.034		0.035
CMS*time after merger			**-0.002**		**-0.003**
			0.010		0.010
change number of markets (CNM)				**0.000**	**-0.001**
				0.002	0.002
CNM*time after merger				**0.000**	**0.000**
				0.001	0.001
merger2	**0.000**	**-0.002**	**0.000**	**0.000**	**-0.001**
	0.003	0.003	0.003	0.003	0.003
merger3	**-0.001**	**0.001**	**-0.001**	**-0.001**	**0.000**
	0.003	0.003	0.003	0.003	0.003
change fed fundsrate (t;t-1)	**0.021** ***	**0.021** ***	**0.021** ***	**0.021** ***	**0.021** ***
	0.003	0.003	0.003	0.003	0.003
change fed fundsrate (t-1;t-2)	**0.073** ***	**0.073** ***	**0.073** ***	**0.073** ***	**0.073** ***
	0.003	0.003	0.003	0.003	0.003
change fed fundsrate (t-2;t-3)	**0.035** ***	**0.035** ***	**0.035** ***	**0.035** ***	**0.035** ***
	0.003	0.003	0.003	0.003	0.003
bank size	**-0.001**	**0.002**	**-0.001**	**-0.001**	**0.003**
	0.006	0.006	0.006	0.006	0.006
bank size squared	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
	0.000	0.000	0.000	0.000	0.000
deposits to assets	**0.070** ***	**0.070** ***	**0.070** ***	**0.070** ***	**0.071** ***
	0.016	0.016	0.016	0.016	0.016
market share	**0.014** *	**0.012**	**0.014** *	**0.014** *	**0.012**
	0.008	0.008	0.008	0.008	0.008
HHI	**0.000**	**0.001**	**0.000**	**0.000**	**0.001**
	0.012	0.012	0.012	0.012	0.012
income	**0.004** **	**0.004** **	**0.004** **	**0.004** **	**0.004** **
	0.002	0.002	0.002	0.002	0.002
constant	**-0.026**	**-0.054**	**-0.027**	**-0.024**	**-0.056**
	0.050	0.052	0.050	0.050	0.053
number of observations	39861	39861	39861	39861	39861
R-squared	0.0261	0.0262	0.0261	0.0261	0.0262

Note: Dependant variable is the money market account rate with weekly frequency. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively

Table 6: Mergers and checking account rate dynamics: results of the "trigger" model

	(1)	(2)	(3)	(4)	(5)
spline-.5	**-0.058**	**-0.054**	**-0.059**	**-0.056**	**-0.056**
	0.057	0.056	0.057	0.057	0.057
spline0	**-0.102** **	**-0.110** **	**-0.095** **	**-0.104** **	**-0.102** **
	0.046	0.046	0.047	0.046	0.046
spline+.5	**-0.090** **	**-0.109** **	**-0.090** **	**-0.096** **	**-0.107** **
	0.044	0.045	0.044	0.045	0.045
spline+1	**-0.021**	**-0.030**	**-0.022**	**-0.027**	**-0.033**
	0.039	0.039	0.039	0.039	0.039
spline+1 1/2	**-0.102** **	**-0.128** ***	**-0.106** **	**-0.098** **	**-0.121** ***
	0.044	0.044	0.044	0.045	0.045
spline+2	**-0.092** **	**-0.115** ***	**-0.098** **	**-0.093** **	**-0.115** ***
	0.041	0.042	0.041	0.042	0.043
spline+3	**0.096** ***	**0.072** **	**0.088** **	**0.095** ***	**0.068** *
	0.035	0.035	0.035	0.035	0.035
spline+4	**-0.056** **	**-0.096** ***	**-0.064** **	**-0.057** *	**-0.096** ***
	0.028	0.031	0.029	0.030	0.032
target' size		**-0.034**			**-0.016**
		0.030			0.032
TS*time after merger		**0.043** ***			**0.040** ***
		0.013			0.014
change market share (CMS)			**-0.408** **		**-0.378** *
			0.195		0.193
CMS*time after merger			**0.143** **		**0.103** *
			0.061		0.060
change number of markets (CNM)				**-0.021** *	**-0.017**
				0.012	0.013
CNM*time after merger				**0.002**	**0.000**
				0.005	0.005
merger2	**-0.028**	**-0.026**	**-0.023**	**-0.022**	**-0.019**
	0.021	0.022	0.021	0.021	0.022
merger3	**-0.017**	**-0.014**	**-0.019**	**-0.021**	**-0.018**
	0.019	0.020	0.019	0.020	0.020
change fed fundsrate (t;t-1)	**-0.015**	**-0.013**	**-0.014**	**-0.017**	**-0.014**
	0.016	0.015	0.016	0.016	0.015
change fed fundsrate (t-1;t-2)	**0.103** ***	**0.104** ***	**0.103** ***	**0.101** ***	**0.103** ***
	0.013	0.013	0.013	0.013	0.013
change fed fundsrate (t-2;t-3)	**0.059** ***	**0.061** ***	**0.059** ***	**0.056** ***	**0.058** ***
	0.015	0.015	0.015	0.015	0.015
bank size	**-0.096** **	**-0.087** **	**-0.105** **	**-0.114** ***	**-0.103** **
	0.043	0.043	0.044	0.045	0.044
bank size squared	**0.003** **	**0.003** **	**0.003** **	**0.003** ***	**0.003** **
	0.001	0.001	0.001	0.001	0.001
deposits to assets	**0.354** ***	**0.350** ***	**0.341** ***	**0.351** ***	**0.338** ***
	0.112	0.112	0.112	0.112	0.113
market share	**0.057**	**0.053**	**0.039**	**0.064**	**0.043**
	0.061	0.061	0.062	0.061	0.062
HHI	**-0.226** **	**-0.229** **	**-0.222** **	**-0.241** ***	**-0.235** ***
	0.091	0.091	0.091	0.091	0.091
income	**0.020**	**0.020**	**0.021**	**0.019**	**0.019**
	0.014	0.014	0.014	0.014	0.014
lambda	**-0.374** ***	**-0.379** ***	**-0.367** ***	**-0.380** ***	**-0.377** ***
	0.034	0.034	0.034	0.034	0.034
constant	**0.949** **	**0.886** **	**1.013** ***	**1.111** ***	**1.015** ***
	0.384	0.384	0.390	0.396	0.392
number of observations	41440	41440	41440	41440	41440
censored regression observations	4360	4360	4360	4360	4360
R-squared	0.09	0.09	0.09	0.09	0.09

Note: Dependant variable is the money market account rate with weekly frequency. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively

Table 7: Mergers and money market deposit account rate dynamics: results of the "trigger" model

	(1)	(2)	(3)	(4)	(5)
spline-.5	**-0.017**	**-0.017**	**-0.017**	**-0.015**	**-0.016**
	0.023	0.023	0.023	0.023	0.023
spline0	**0.032**	**0.031**	**0.032**	**0.031**	**0.033**
	0.021	0.021	0.021	0.021	0.021
spline+.5	**-0.113** ***	**-0.113** ***	**-0.113** ***	**-0.117** ***	**-0.116** ***
	0.034	0.034	0.034	0.034	0.034
spline+1	**0.108** ***	**0.101** ***	**0.108** ***	**0.105** ***	**0.099** ***
	0.037	0.037	0.037	0.037	0.038
spline+1 1/2	**0.022**	**0.023**	**0.022**	**0.018**	**0.021**
	0.029	0.030	0.029	0.029	0.030
spline+2	**-0.102** ***	**-0.102** ***	**-0.101** ***	**-0.105** ***	**-0.105** ***
	0.025	0.028	0.025	0.026	0.029
spline+3	**0.092** ***	**0.087** ***	**0.093** ***	**0.089** **	**0.086** **
	0.035	0.033	0.035	0.035	0.033
spline+4	**-0.076** ***	**-0.082** ***	**-0.075** ***	**-0.081** ***	**-0.084** ***
	0.020	0.023	0.020	0.021	0.024
target' size		**0.007**			**0.018**
		0.021			0.024
TS*time after merger		**0.006**			**0.004**
		0.010			0.010
change market share (CMS)			**0.100**		**0.085**
			0.157		0.157
CMS*time after merger			**-0.029**		**-0.029**
			0.047		0.047
change number of markets (CNM)				**-0.011** *	**-0.015** *
				0.007	0.008
CNM*time after merger				**0.002**	**0.003**
				0.003	0.003
merger2	**-0.017**	**-0.019**	**-0.018**	**-0.014**	**-0.018**
	0.015	0.015	0.014	0.015	0.015
merger3	**-0.022** *	**-0.020**	**-0.022** *	**-0.023** *	**-0.020**
	0.013	0.013	0.013	0.013	0.013
change fed fundsrate (t;t-1)	**-0.027** **	**-0.026** **	**-0.027** **	**-0.027** **	**-0.027** **
	0.012	0.012	0.012	0.012	0.012
change fed fundsrate (t-1;t-2)	**0.080** ***	**0.081** ***	**0.080** ***	**0.080** ***	**0.080** ***
	0.010	0.010	0.010	0.010	0.010
change fed fundsrate (t-2;t-3)	**0.016**	**0.017**	**0.016**	**0.015**	**0.016**
	0.010	0.010	0.010	0.010	0.010
bank size	**0.082** ***	**0.088** ***	**0.084** ***	**0.074** **	**0.082** ***
	0.028	0.029	0.028	0.029	0.030
bank size squared	**-0.002** ***	**-0.003** ***	**-0.002** ***	**-0.002** **	**-0.002** ***
	0.001	0.001	0.001	0.001	0.001
deposits to assets	**0.375** ***	**0.375** ***	**0.378** ***	**0.365** ***	**0.370** ***
	0.069	0.069	0.069	0.069	0.070
market share	**0.045**	**0.045**	**0.048**	**0.047**	**0.047**
	0.043	0.043	0.044	0.043	0.044
HHI	**-0.061**	**-0.059**	**-0.060**	**-0.065**	**-0.062**
	0.070	0.070	0.071	0.070	0.071
income	**0.013**	**0.013**	**0.013**	**0.012**	**0.013**
	0.010	0.010	0.010	0.010	0.010
lambda	**-0.221** ***	**-0.218** ***	**-0.221** ***	**-0.223** ***	**-0.220** ***
	0.019	0.019	0.019	0.018	0.019
constant	**-0.717** ***	**-0.774** ***	**-0.738** ***	**-0.653** ***	**-0.727** ***
	0.238	0.246	0.239	0.247	0.249
number of observations	39861	39861	39861	39861	39861
censored regression observations	6893	6893	6893	6893	6893
R-squared	0.07	0.07	0.07	0.07	0.07

Note: Dependant variable is the checking account rate with weekly frequency. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively

Among the merger features only the change of market share (CMS) has both statistically and economically significant impact. Substantial in-market mergers have stronger negative effect on checking account rates in the affected market. This negative effect is, as expected, decreasing with the time after the merger. This result is consistent with Hannan and Prager's (1998) results, which also document a negative impact of substantial in-market mergers on deposit rates. The effect of target size is statistically insignificant. The effect of the change of the number of markets (CNM) is negative but statistically only marginally significant. We, therefore, find limited support of the hypothesis that the expansion of the geographical scope negatively affects checking account rates (once bank size has been controlled for), especially mergers that increase in market share significantly.

The statistically insignificant coefficients of the *merger2* and *merger3* variables indicate that earlier mergers do not have a significant impact on checking account rates. The change of the fed funds rate during the current month also has no significant impact on the change of the checking account rates. The change of checking account rates is determined instead by the changes of the fed funds rate in the previous two months. These results show that checking account rates adjust to fed fund rate changes only with a substantial delay. The coefficients of the change of fed funds rate variables also suggest that the pass-through is incomplete[20].

Bank size enters the checking account rate regressions with negative significant coefficients indicating that larger banks tend to offer lower deposit rates. This result is consistent with results of previous studies (Park and Pennacchi, 2005). The ratio of deposits to total assets has a significant positive impact on checking account rates: if retail deposits are the primary source of financing of a bank, it will be more likely to increase the deposit rates. Market share and local market average population income are not significant, but the local market

[20] Grop et al (2007) find evidence on incomplete and delayed adjustment of deposit rates offered by European banks.

concentration (measured by the Hyrfindahl index HHI) enters the regression with the expected negative significant coefficient.

When we turn from checking account rates to money market deposit account rates we cannot document a persistent positive or negative impact of mergers. MMDA rates significantly decrease about six months after the merger but recover again in about a year after the merger, they drop again about two years after the merger and significantly increase during the third year. In the following years the effect is negative. We interpret this dynamic path of the MMDA rate changes as a result of the post-merger integration of the pricing policies of the merging banks. It is unlikely that this pattern is caused by a systematic abuse of market power.

Among the merger features only the change in the number of markets enters the regression with a statistically significant coefficient. The sign of this coefficient is negative and points to a negative impact of geographical expansion on MMDA rates. Target's size and the change in the market share have no significant impact on MMDA rates.

A comparison between the checking account and MMDA rate results shows that mergers mainly affect the checking account rates. Our interpretation of this result is that because of the high switching costs monopoly rents can more easily be extracted from checking account customers. Instead of this, MMDAs are an investment product with low switching costs, so that MMDA customers can easily switch to a competitor, if their current bank offers relatively low MMDA rates.

Moreover, the coefficients of the control variables suggest that local market characteristics are irrelevant for MMDA rates. These results suggest that competition on the MMDA market is not geographically limited to the metropolitan statistical area (MSA). Previous research has already argued that the traditional definition of the bank local market limited to the MSA may

not be valid nowadays, because telecommunication allows customers to access more distantly located banks (Edelstein and Morgan, 2006). Our results show indeed that MMDA rates are generally decoupled from local market conditions. Checking account rates, on the contrary, still strongly depend on local market concentration and on the changes in the distribution of market shares.

Another interesting difference between MMDA and checking account rates is their dependence on bank size. Whereas larger bank tend to keep checking account rates low they are more likely to increase their money market account rates. It may be that larger banks are associated with more sophisticated customers, who can take advantage of the increased competition offered in the larger geographical markets.

6. Conclusion

This research project is motivated by the contradicting results of previous studies examining the impact of mergers on deposit rates. By replicating previous studies on our new comprehensive deposit rate dataset we are able to show that empirical results are very sensitive to the treatment of the time span around a merger and the choice of control variables. This observation encourages us to revisit the topic of the deposit rate dynamics around bank mergers. For this purpose we employ deposit rate data with monthly frequency. The high frequency data allows a better treatment of the deposit rate dynamics. However, it makes necessary an estimation methodology accounting for the rigidity of deposit rates.

When accounting for deposit rate rigidity we are able to document a significant negative impact of mergers on checking account rates. In particular, in-market merger which substantially increase the market share of the merging bank tend to cause a substantial drop their checking account rates. On the other hand, MMDA rates are not consistently aggravated after bank mergers. Moreover, once we control for bank size, we cannot document a negative

impact of out-of-market mergers on deposit rates. Our results are not inconsistent with results of earlier studies which find support for the structure-conduct-performance hypothesis (Berger and Hannan, 1989 and Hannan and Prager, 1998). They do, however, contradict with Focarelli and Panetta (2003) results since we are not able to find any positive long-term effects of the mergers on both types of deposit rates.

A major contribution of our analysis is the uncovered importance of the deposit rate dynamics. A more comprehensive analysis of the time series structure of the deposit rate and its reaction to wholesale rate changes is a scheduled extension of this research project.

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