WALTER WASSERFALLEN*

Interest Rate Differentials and the Structure of Banks' Balance Sheets

1. Introduction

In many countries, large differentials between interest rates on various fixed-income assets with short-term maturity can be observed over extended periods of time.[1] The typical example is the spread between interest rates on savings deposits and short-term deposits held with commercial banks. Customers apparently react sluggishly to such differentials by shifting their wealth to alternatives with higher yields. Moreover, banks do not seem to exploit the resulting profit opportunities to a large extent. The reasons given for these findings include additional services associated with specific investments, search and switching costs, informational asymmetries between banks and different groups of customers, lack of competition between financial intermediaries, legal restrictions and inefficient markets. However, the speed of adjustment should become higher over time as people learn from past experience, competition increases, restrictions are weakened and new instruments become available.

With a few exceptions, the existing literature concentrates on the United States. Most authors deal exclusively with the adjustment of interest rates on specific short-term deposits to a competitive market rate such as the Treasury bill rate. Associated changes in the structure of banks' balance sheets due to the response of customers to yield differentials have not been investigated in any detail. The same is true for the consequences with respect to the profitability and riskiness of financial institutions.

This paper offers evidence on all these issues. The dependencies between the amounts of various short-term assets and liabilities of banks and their rates of return are examined using Swiss data over the period 1960–1993. These relationships are chosen for this study because they exhibit the most interesting and puzzling characteristics. The Swiss banking system moreover offers a testing environment which is characterized by very little regulatory interference. The sample ends in 1993 because afterwards a large number of mergers and acquisitions among banks took place. The results should however still be relevant.

* The comments by Philippe Bacchetta, Mark Flannery, Urs Graf, Anthony Saunders, Hansruedi Scherer, Thomas Stucki, Daniel Wydler and Heinz Zimmermann as well as by seminar participants at the University of Virginia, the University of Rochester, the Ohio State University and the Hochschule St. Gallen are gratefully acknowledged. Excellent research assistance has been provided by Philipp Aegerter. Part of this research was done while the author was visiting the University of Washington, Seattle. Walter Wasserfallen, Studienzentrum Gerzensee, 3115 Gerzensee, Switzerland, Phone 41 - 31 - 780 31 31, Fax 41 - 31 - 781 31 00.

The paper is organized as follows. The data and some institutional features are described in section 2. The empirical regularities to be explained are documented in section 3, followed by a description of relevant hypotheses available in the literature in section 4. A variety of estimates concerning the speed of adjustment to a new equilibrium are contained in sections 5 to 7. In section 8, the implications for the asset and liability management of banks are discussed based on the evidence. A summary and some conclusions complete the paper.

2. Data and Institutional Setting

Monthly observations on various interest rates and balance sheet positions of banks over the period 1960–1993 are used in the empirical work. All banks with total assets in excess of 100 million Swiss francs have to submit their balance sheets to the Swiss National Bank on a monthly basis. The figures for various categories of banks are published in the monthly report of the Swiss National Bank. Table 1 provides definitions and additional explanations for all variables used in this study.

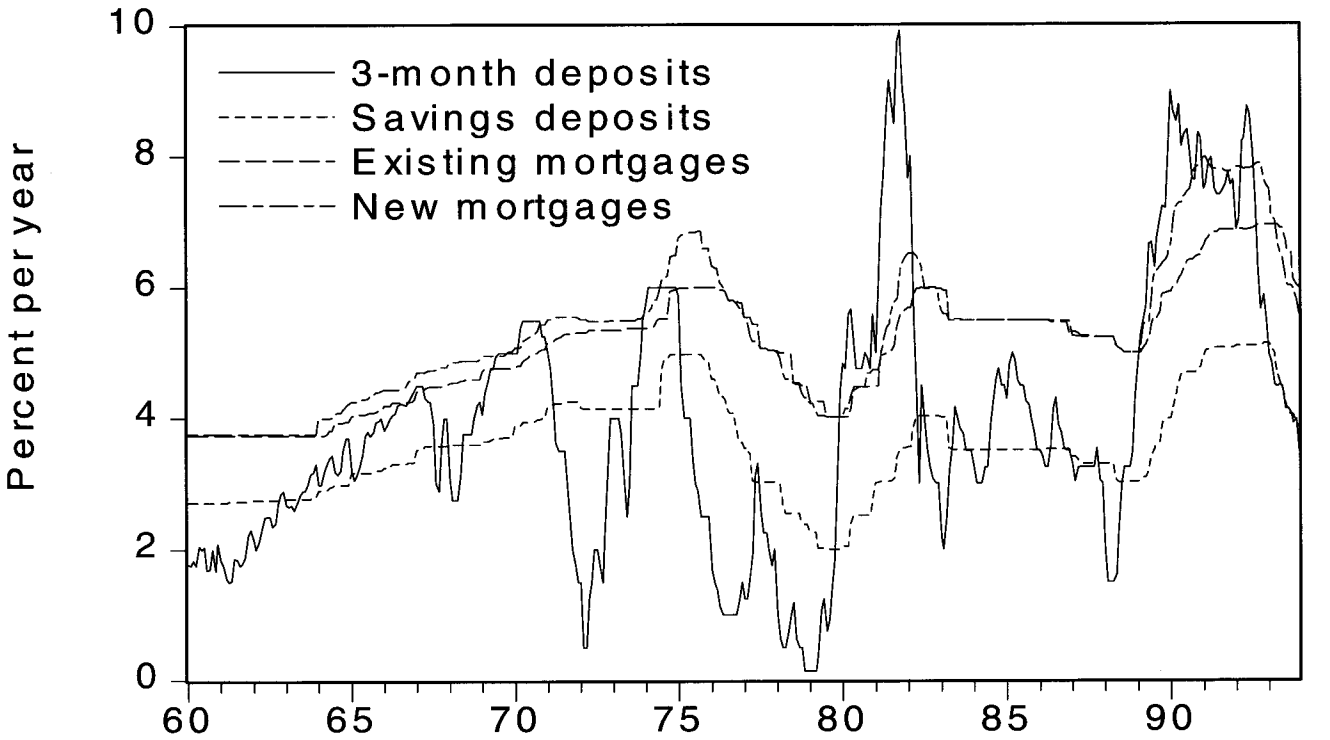
Three categories of banks are distinguished in the empirical work. The class of "big banks" includes Union Bank of Switzerland, Swiss Bank Corporation, Credit Suisse, Swiss Volksbank and, until 1989, Bank Leu. The almost 30 "Cantonal banks" are owned by the member states of the Swiss confederation. The class of "regional banks" (including savings banks) contains about 200 smaller institutions.[2] In 1990, big banks

Table 1: Data

Variable	Definition
Positions of banks' balance sheets	
All items from the banking statistic are listed that are included in the respective positions for each category of banks. Short-term deposits, savings deposits, savings bonds and bonds are liabilities of banks. Mortgages are assets of banks. The banking statistic is compiled by the Swiss National Bank.	
Short-term deposits	"Kreditoren auf Sicht" (sight deposits) + "Kreditoren auf Zeit" (time deposits). Maturities extend up to 1 year. For big banks, a considerable part is in foreign currencies. A time series for Swiss Franc deposits alone is available starting in 1975.
Savings deposits	Spareinlagen" + "Depositen- und Einlagenhefte".
Savings bonds	"Kassenobligationen" + "Kassenscheine".
Bonds	"Obligationenanleihen".
Mortgages	"Hypothekaranlagen" + "Feste Vorschüsse und Darlehen mit hypothekarischer Deckung".
Total assets	Total of balance sheet.
Interest rates	
Rates for a specific category of banks are representative for other banks as well.	
Euromarket	Rate on 3-month deposits in Swiss francs on the Euromarket.
Short-term deposits	Rate on 3-month deposits with big banks.
Savings deposits	Rate on savings deposits with cantonal banks. Banks offer various types of savings deposits with different interest rates. Spreads across these deposits are quite stable over time.
Mortgages	Rates on existing and new mortgages with cantonal banks for residential buildings.

All series are monthly from 1960 to 1993. Quarterly averages of monthly observations are used in the regression analysis. The source is the monthly report of the Swiss National Bank.

Figure 1: Short Term Interest Rates



accounted for about 48% of total assets, cantonal banks for 20% and regional banks for 9%. The remaining 23% are held by foreign owned banks and other institutions.

The size and structure of the balance sheet is different for the three categories of banks. In 1990, total assets of big banks amounted to 525 billion Swiss francs. The respective numbers for cantonal and regional banks are 215 billion and 95 billion Swiss francs respectively. The ratio of savings deposits to total assets is between 30% and 40% for cantonal and regional banks compared to about 13% for big banks. The opposite is observed for short-term deposits with close to 40% of total assets for big banks and 15–20% for cantonal and regional banks. Mortgages account for about 15–20% of total assets at big banks and for almost 60% at cantonal and regional banks. A considerable part of short-term deposits at big banks are denominated in foreign currencies, especially in US-dollars and in Deutschmarks. Data on Swiss Franc deposits alone are only available starting in 1975. This problem is absent for cantonal and regional banks because they have virtually no such accounts.

Compared to other countries, the Swiss banking system has a long history of little regulatory interference. Most importantly, no legal restrictions on the setting of interest rates, on transactions with foreigners and on the composition of banks' balance sheets existed over the whole sample period. The only legal

arrangements deal with reserve and capital requirements designed to protect depositors from illiquidity and insolvency of banks. These rules were changed only once during the sample period, namely at the beginning of 1988 when reserve requirements were drastically lowered. However, a variety of agreements on interest rates for various deposit and loan categories existed among banks in the same region or city until about the middle of the eighties.

As mentioned in the introduction, the adjustment to a new equilibrium should become faster over time. Consequently, all relationships are evaluated for three subperiods. The first subperiod, covering the years of fixed exchange rates from 1960 to 1972, exhibits slowly increasing interest rates. Figure 1 shows that the second subperiod, extending from 1973 to 1987, is characterized by both upward and downward movements in short-term interest rates as well as by a relatively large volatility in rates.[3] At the beginning of the third subperiod, covering the years 1988 to 1993, reserve requirements were drastically lowered and cartel arrangements were no longer effective. Access to more competitively priced investments, such as Euromarket deposits, became much easier also for customers with small amounts of wealth. During this last subperiod, interest rates first increased considerably, followed by a rapid decline.

Quarterly averages of monthly observations are used to estimate the regressions presented in sections 5 to 7. This smoothing procedure allows a more reliable estimation of the hypothesized relationships because it eliminates a substantial amount of noise in the data. Enough degrees of freedom are preserved to allow a meaningful analysis. Moreover, regressions with monthly data or over longer periods yield similar results.

3. Empirical Regularities

Figures 1 to 3 show the relevant empirical regularities to be explained. Figure 1 contains monthly observations for various short-term interest rates from 1960–1993. The rates on 3-month deposits held with commercial banks and on savings deposits are for short-term liabilities of banks with very similar characteristics. However, the 3-month rate, which is determined on a highly competitive market, fluctuates much more than the savings rate.[4] The differential has been especially large over the periods of high interest rates in the early 1980's and 1990's. It can be seen from Figure 1 that at least a partial adjustment of savings rates takes place over time.

Figure 1 also includes two time series for mortgage rates offered by banks, one for existing and the other for new mortgages. In Switzerland, almost all mortgages are on a flexible rate basis, meaning that the rate on already existing contracts can be adjusted with little delay to current market conditions. No maturity date is fixed at which the mortgage has to be repaid.[5] Typically, banks refinance mortgages to a large extent by savings deposits. A relatively constant spread of about 1.3 percentage points between the interest rates on savings deposits and on existing mortgages is observed from 1960 to 1976. Afterwards, the spread increases to about 2.0 percentage points. Usually, the rate on new mortgages is slightly higher than on existing ones. Rather suprisingly, the differential between 3-month rates and mortgage rates is negative during periods of high interest rates. The consequence is that banks would suffer a loss even before covering any operating expenses if they had to refinance mortgages with short-term deposits.

The relationships between the various interest rates create some obvious incentives for investors as well as financial intermediaries. For investors, it would be highly advantageous to shift funds between savings deposits and short-term deposits depending on the sign of the interest differential. In periods of high interest rates it has sometimes even been profitable to get a mortgage, if possible, and invest the funds in the Euromarket. Furthermore, banks themselves could have earned substantial arbitrage profits over many years by investing funds deposited on savings accounts in

Figure 2: Savings Deposits/Short Term Deposits

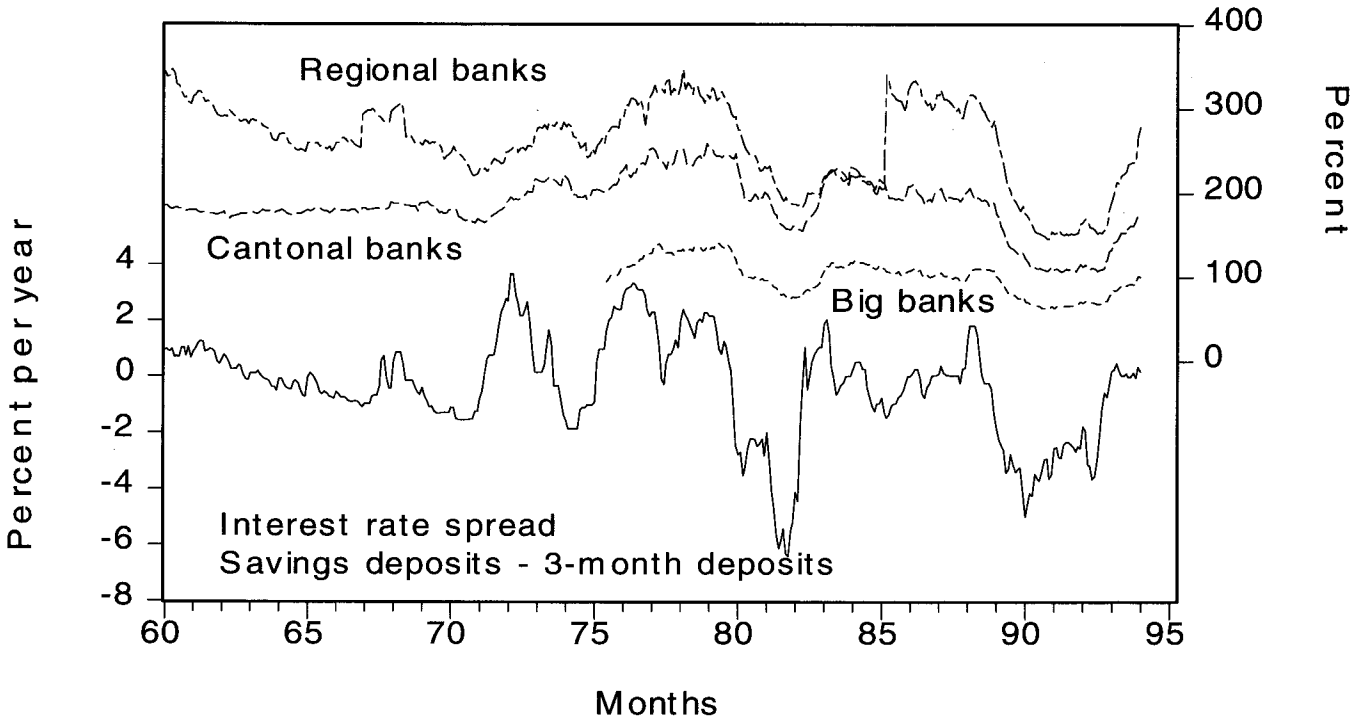
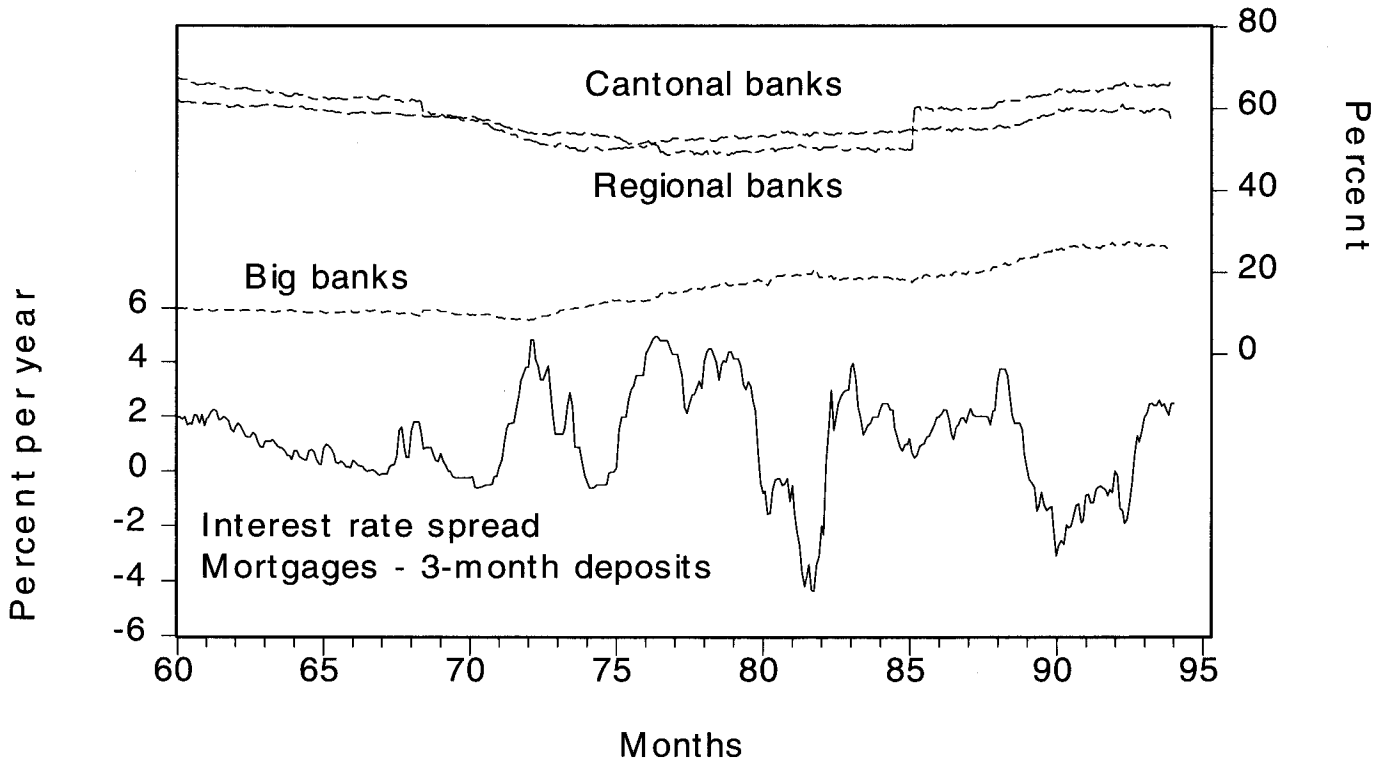


Figure 3: Mortgages/Total Assets



short-term deposits or in corresponding Euro-market instruments. Figure 2 shows that some redistribution between categories of liabilities in fact occurs on banks balance sheets. The volume of savings deposits as a percentage of short-term deposits has a tendency to increase at all categories of banks if the savings rate is higher than the rate on 3-month deposits. The reverse is observed if the spread becomes negative. However, the adjustment apparently occurs only slowly. Visually, Figure 3 shows no such effects for mortgages.

In this study, no attempt is made to build a formal model that could potentially explain all the observed regularities, or better irregularities. The existing theoretical literature is used to interpret the stylized facts. Furthermore, quantitative estimates of various relationships between interest rates and balance sheet positions are provided for different subperiods and groups of banks.

4. Hypotheses

In an efficient market and in the absence of transactions costs, yields on fixed-income investments with the same maturity would be equalized at any point in time. The costs of financial intermediation require positive spreads between interest rates charged by banks on assets and those paid on liabilities. Competition in the banking sector tends to minimize the size of spreads. Spreads should exhibit little variability over time because their fundamental determinants presumably change only slowly.

The empirical regularities documented in the previous section show that these implications of unsegmented and efficient capital markets are clearly not fulfilled. However, the exploitation of the resulting profit opportunities by investors and financial intermediaries might be difficult for essentially two reasons. First, various types of adjustment costs may exist. Second, the banking sector may not be fully competitive. In the following, the existing literature on these two issues is briefly surveyed.[6]

In the context studied here, the typical investor is a private individual holding a relatively small amount in a savings deposit with a bank. Shifting the funds to short-term assets with higher yields involves transaction and information costs, sometimes also called "switching costs", which may be higher than the associated benefits in many cases. A large part of these costs are independent of the amount invested and may therefore be large relative to a small deposit. The best example is the time involved to search for alternatives and actually carry out the transaction. Some form of savings deposits furthermore offer payments services in addition to explicit interest. Limits exist on the amount of funds that the owner can dispose of per month, quarter or year but no minimum balance is required. Moreover, a minimum amount is usually needed for alternatives, in this case short-term deposits with banks or investments in the Euromarket.

The available theoretical models typically rely on asymmetric information between different groups of customers or between banks and their clients with respect to the characteristics and prices of deposits. A potentially informative test of these propositions relies on the type of bank involved. It may be argued that customers of big banks invest a larger amount on average and are more sophisticated. They would therefore react faster to differences in yields on similar assets than customers of small banks. This hypothesis is empirically investigated below.

Generally, the models imply asymmetries in the response of deposit interest rates to market rates. Examples are that deposit rates adjust faster when market rates fall than when they rise or that the speed of adjustment not only depends on the change in the market rate but also on its volatility. The quantitative importance of these features is also investigated in the empirical work. The adjustment may moreover differ depending on whether changes in market interest rates are considered to be permanent or transitory.[7]

The second reason for a delayed and incomplete adjustment of deposit rates is seen in a lack of

competition among banks. In principle, competition for funds among financial intermediaries should produce equal interest rates on liabilities with essentially the same characteristics even if customers face significant switching costs. A specific bank would be able to attract funds by offering higher interest rates on its liabilities than the market and invest them at a higher interest rate in the general market. The situation in the most recent years is a typical example. According to Figure 1, a bank could have earned large and essentially riskless profits over many years by investing funds from savings deposits in the Euromarket. In Switzerland, no legal rules prevent banks from exploiting these opportunities.

The speed of adjustment to a competitive equilibrium should have increased over time for a variety of reasons. A relatively large spread between rates on short-term deposits and savings deposits existed for several years in the sixties and early seventies. Both investors and banks should have learned from these experiences. In addition, capital markets have become internationally more integrated leading to increased competition and declining costs of shifting funds between assets. For example, the minimum amount that can be invested in short-term deposits with banks or in the Euromarket has been reduced considerably. A few years ago, the limit for a Euromarket deposit with a bank was still 100'000 Swiss francs. Recently, money market funds have come into existence offering short-term Euromarket investments with a minimum of 5'000 Swiss francs. Moreover, agreements on interest rates no longer exist. Empirical results for different subperiods are presented below in order to get evidence on this effect.

The hypothesized dependencies between banks liabilities and their yields affect the asset side of the balance sheet as well. Mortgages are the most prominent example in Switzerland. Traditionally, banks have refinanced mortgages to a large extent by funds held as savings deposits. This policy avoids interest rate risk affecting banks equity capital because almost all mortgages are on a flexible rate basis. Banks were able to keep mortgage rates relatively low because they were apparently not forced to adjust savings rates to general market conditions. Figure 1 shows that mortgage rates were sometimes even lower than yields on alternative short-term investments, for example in the Euromarket.

Several arguments may be offered to explain these empirical regularities. First, an individual bank may hesitate to replace mortgages by Euromarket investments because liquidation costs are not negligible and it may be difficult to reestablish a position in the mortgage market. Second, it may be advantage ous for banks not to increase rates on existing mortgages too fast because they might end up with substantial holdings of real estate if debtors default. The probability of such events increases when prices of real estate decline. However, banks should deal with such problems on a customer-specific basis. Third, changes in mortgage rates for residential buildings are a heavily politicised issue in Switzerland. It is often argued that increases in rates directly result in higher rents for appartments because the costs of houseowners increase.[8] Moreover, rents constitute a relatively large fraction of expenditures for the average family. These views underlie a Swiss law whereby variations in mortgage rates impose restrictions on houseowners to change rents.[9] As a consequence, banks may hesitate for political reasons to adjust mortgage rates too quickly to market conditions or to restrict access to mortgage credit too severely as long as they are not forced to do so. A strong cartel among banks would obviously help to maintain such arrangements.

The presentation of the empirical work in the following sections proceeds in three steps. The relationships among different interest rates are examined in section 5. Section 6 contains evidence on the interaction between yield spreads and various categories of banks short-term liabilities. The financing of mortgages is evaluated in section 7.

Table 2. Short-term Interest Rates: Stochastic Characteristics

Interest rate	Levels (percent per year)						First Differences (percent per year)						
	Mean	Max.	Min.	Unit root	Cointegration with		Mean	Std. dev.	Auto (1)	Auto (2)	Pairwise Granger causality with		
					3-month deposits	Savings deposits					3-month deposits	Savings deposits	Mort-gages
3-month deposits													
60–72	3.28	5.50	0.50	–1.87			0.01	0.28	0.37	–0.03		2.39	1.91
73–87	3.64	9.92	0.13	–2.78			–0.01	0.50	0.25	0.14		3.08	1.93
88–93	6.07	9.00	1.50	–1.38			0.01	0.45	0.33	0.00		0.78	0.82
Savings deposits													
60–72	3.35	4.25	2.71	0.06	–0.66		0.01	0.03	–0.04	–0.03	2.03		0.67
73–87	3.51	4.98	2.00	–1.44	–1.58		0.00	0.10	0.25	0.08	3.03		0.50
88–93	4.28	5.13	3.01	–1.61	–1.36		0.01	0.09	0.60	0.43	2.49		1.50
Mortgages													
60–72	4.34	5.35	3.74	1.13	–0.34	–2.04	0.01	0.02	0.04	0.12	1.70	2.63	
73–87	5.31	6.00	4.02	–1.49	–1.57	–1.92	0.00	0.09	0.10	0.07	3.55	5.34	
88–93	6.19	6.95	5.00	–1.70	–1.33	–1.17	0.01	0.08	0.41	0.36	1.26	2.14	

Monthly data for Switzerland from 1960–1993 are used. Unit root: Dickey-Fuller test, including a constant and four lagged differences. Cointegration: Unit root test applied to the residuals of a regression of the interest rate in the first column on the interest rate indicated at the top of the table. Four lagged differences are included. Auto (1) and Auto (2): Autocorrelation coefficients at lags 1 and 2. Underlined parameters are significantly different from zero on the 5%-level. Pairwise Granger causality: Based on a regression of the interest rate in the first column on the interest rate indicated at the top of the table, including 12 lagged terms of both interest rates. Reported are the F-values testing for the joint significance of the independent variable. Underlined values indicate significance on the 5%-level.

5. Short-Term Interest Rates

The relationships between various short-term interest rates are examined in this section. The whole structure of short-term rates is anchored by the most competitive market which is the Euromarket since it came into existence in the middle of the seventies. Therefore, the Euro Swiss Franc rate on 3-month deposits is considered to be exogenous relative to the other rates.

The rate on 3-month deposits held with banks follows the Euro Swiss Franc rate on 3-month deposits very closely. Using monthly data from 1975 to 1993, the Euro rate is on average 0.55 percentage points per year higher than the rate on 3-month deposits. The spread can be explained by differential transactions costs. The standard deviation of the spread is 0.46 percentage points. A regression of the 3-month deposit rate on the Euro rate yields a constant term of –0.24, which is significantly different from zero, and a slope coefficient of 0.93, significantly below one. The adjusted R^2 is 0.97. A unit root test applied to the residuals confirms that the two interest rates are cointegrated. No significant influence of lagged independent variables can be found. Furthermore, the difference between the two rates does not exhibit any significant serial correlation. These

Table 3. Short-term Interest Rates: Regressions

	Savings deposits – 3 month deposits			Mortgages – 3-month deposits			Mortgages – Savings deposits		
	60–72	73–87	88–93	60–72	73–87	88–93	60–72	73–87	88–93
Constant	0.03	–0.02	0.01	0.02	–0.01	–0.01	0.01	0.01	0.00
Dependent variable									
Lag 1	0.04	0.19	0.06	0.32	0.25	0.51	0.12	–0.21	–0.08
Independent variable									
Lag 0	0.04	–0.06	–0.01	0.00	–0.05	0.07	0.19	0.94	1.91
Lag 1	0.03	0.05	0.06	0.00	0.00	0.03	0.12	0.55	0.43
Lag 2	0.02	0.04	0.10	0.01	0.07	0.05	0.14	0.10	0.17
Lag 3	0.04	0.01	0.09	0.03	–0.02	0.04	0.01	0.08	0.05
Lag 4	–0.01	0.10	0.06	–0.03	0.08	0.07	0.15	–0.13	–0.04
Sum	0.12	0.14	0.30	0.01	0.08	0.26	0.61	1.54	2.52
Independent variable squared									
Lag 0	–0.10	0.00	0.00	0.00	0.01	–0.01	0.03	–0.10	–0.19
Slope dummy * independent variable									
Lag 0	0.00	–0.01	–0.01	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	52	60	24	52	60	24	52	60	24
R^2 adj.	0.14	0.39	0.69	0.13	0.34	0.67	0.49	0.59	0.75
F-value	2.01	5.78	7.37	1.91	4.80	6.88	7.01	11.80	9.65
DW	1.99	2.18	2.05	1.87	2.30	1.70	2.06	1.93	1.41

Quarterly averages of monthly data for Switzerland from 1960–1993 are used. Interest rates are in percent per year. The endogenous variable is indicated at the top, followed by the exogenous variable. Regressions are estimated with ordinary least squares using the correction for heteroskedasticity and serial correlation developed by Newey and West (1987). Data are first differenced before estimation. Slope dummy: Takes the value of one if the exogenous variable increases relative to the previous period and zero otherwise. Obs.: Number of observations. R^2 adj.: R^2, adjusted for degrees of freedom. F-value: Test for the joint significance of the exogenous variables. Underlined coefficients indicate significance on the 5%-level. DW: Durbin-Watson statistic. Underlined parameters are significantly different from zero on the 5%-level (two-sided test).

findings imply that the interest rate on 3-month deposits with commercial banks is determined on a highly liquid international capital market. Consequently, it is assumed to be exogenous relative to savings and mortgage rates as well as to the composition of banks' balance sheets.

Table 2 contains descriptive statistics on various short-term interest rates for the three subperiods using monthly observations. The presence of a unit root cannot be rejected for all rates and all periods. Furthermore, cointegration is absent from all possible pairs of rates. The stationary first differences exhibit much higher volatility for rates on 3-month deposits compared to savings and mortgage rates. Significant serial correlation of first order is observed in some cases.

Pairwise Granger causality in the first differences is examined by regressing the interest rate in the first column of table 2 on 12 own lags and 12 lags of the interest rate listed in the last three columns. A significant F-statistic listed in table 2 indicates Granger causality in the sense that past variations

in the second interest rate help to explain movements in the dependent rate. With some exceptions, the rate on 3-month deposits causes the rates on savings deposits and mortgages. Reverse causality is found for the savings rate. Interestingly, Granger causality runs exclusively from savings to mortgage rates but not vice versa. This finding indicates that banks adjust mortgage rates according to past movements in the rate of savings deposits which has traditionally been the major instrument to refinance mortgages.

Estimates of the dynamic relationships between short-term interest rates are provided in table 3. Based on the results discussed above, all estimates are carried out in the stationary first differences of the original time series. The specification adopted is the following:[10]

$$R_{Dt} = \alpha_1 R_{Dt-1} + \beta_0 R_t + ... + \beta_4 R_{t-4} + \gamma_0 R_t^2 + \delta_0 D_t R_t + \varepsilon_t \quad (1)$$

where R_{Dt} is the deposit rate for period t which is to be explained, R denotes the exogenous interest rate and D is a dummy variable with a value of one if $R_t > R_{t-1}$ and zero otherwise. ε is an error term with the usual properties. The α- and β-parameters form a rational distributed lag function with the long-run adjustment given by $(\beta_0 + ... + \beta_4)/(1 - \alpha_1)$.[11] R_D depends on the volatility of R if γ_0 is significantly different from zero. The last term in equation (1) captures an asymmetry in the adjustment of R_D to R, which is considered to be important by many authors. A negative value of δ_0 implies that banks adjust deposit rates faster if market rates fall than if they rise.[12]

Estimates of equation (1), based on quarterly averages of monthly data, are presented in Table 3.[13] The ordinary least squares technique is used with the correction for heteroskedasticity and serial correlation developed by Newey and West (1987). In the first two blocks of Table 3, the reaction of savings and mortgage rates to changes in the rate on 3-month deposits is shown for various subperiods. As expected, coefficients are generally positive, some of them significantly. But the speed of adjustment is very low. Some increase is however observed over time. In the long-run, interest rates do not converge as implied by the sum of distributed lag coefficients which remains considerably below one even after one year. The explanatory power becomes higher in the later subperiods. The coefficient on the lagged dependent variable is generally not significantly different from zero. No dependencies on the volatility of 3-month rates and on its direction of change are found. This evidence suggests that markets for short-term investments are segmented to a large extent.

The connections between savings and mortgage rates are contained in the last part of Table 3. Banks seem to adjust interest rates on mortgages rapidly to changes in the savings rate, especially in the later subperiods. Individual coefficients are much larger than the ones involving the rate on 3-month deposits. The sum of the parameters even exceeds the theoretically hypothesized value of one.

6. Interest Rate Spreads and the Structure of Banks' Liabilities

Figure 2, discussed in section 3, indicates that customers of banks react to a changing spread between interest rates on savings deposits and short-term deposits by reallocating their wealth towards the alternative with the higher yield. Table 4 exhibits the stochastic characteristics of these variables for three groups of banks and for the same periods as in the previous section. The ratio of savings to short-term deposits is much higher for cantonal and regional banks than for big banks. In all cases, non-stationarity cannot be rejected. The same is true for the interest rate spread. The ratio of savings to 3-month deposits is furthermore not cointegrated with the spread. Consequently, all subsequent estimates are calculated using the first difference of the variables involved. The most interesting results in Table 4 are the estimates for pairwise Granger causality. In most cases, independence cannot be rejected.[14] But F-values are generally higher for

Table 4. Short-Term Deposits and Interest Rate Spreads: Stochastic Characteristics

Variable	Levels					First Differences							
	Mean	Max.	Min.	Unit root	Cointegration with interest rate spread	Mean	Std. dev.	Auto (1)	Auto (2)	Pairwise Granger causality with			
										Interest rate spread	Savings deposits / 3-month deposits		
											Big banks	Cantonal banks	Regional banks
Savings deposits / Short-term deposits (percent)													
Big banks													
75–87	110.95	141.66	74.82	–1.96	–2.64	0.01	2.96	0.25	0.26	8.24			
88–93	81.31	111.15	62.37	–1.17	–1.77	0.08	2.64	0.36	0.34	3.75			
Cantonal banks													
60–72	180.56	217.45	165.87	0.60	0.53	0.20	2.47	0.06	0.00	2.12			
73–87	211.36	259.48	155.34	–1.82	–2.60	–0.10	5.32	0.35	0.12	8.41			
88–93	138.28	206.27	107.02	–1.79	–1.28	–0.34	4.39	0.43	0.31	1.82			
Regional banks													
60–72	272.47	347.23	222.05	–2.14	–2.67	–0.39	6.15	0.08	–0.02	1.52			
73–84	263.43	347.46	184.01	–0.78	–1.52	–0.42	7.50	–0.07	–0.03	1.61			
88–93	202.14	317.92	146.82	–1.66	–1.49	–0.52	7.63	0.39	0.43	1.67			
Interest rate spread: Savings deposits – 3-month deposits (percent per year)													
60–72	0.07	3.65	–1.56	–1.99		0.00	0.28	0.34	–0.03			4.09	1.32
73–87	–0.13	3.33	–6.41	–2.81		0.00	0.52	0.27	0.14			1.17	
75–87	–0.05	3.33	–6.41	–2.65		0.01	0.53	0.26	0.17		0.55		
73–84	–0.09	3.33	–6.41	–2.50		–0.01	0.57	0.27	0.15				1.28
88–93	–1.79	1.79	–5.01	–1.41		0.00	0.46	0.31	–0.06		1.13	1.24	1.30

Monthly data for Switzerland from 1960–1993 are used. Unit root: Dickey-Fuller test, including a constant and four lagged differences. Cointegration: Unit root test applied to the residuals of a regression of the variable in the first column on the interest rate spread. Four lagged differences are included. Auto (1) and Auto (2): Autocorrelation coefficients at lags 1 and 2. Underlined parameters are significantly different from zero on the 5%-level. Pairwise Granger causality: Based on a regression of the variable in the first column on the variable indicated at the top of the table, including 4 lagged terms of both variables. Reported are the F-values testing for the joint significance of the independent variable. Underlined values indicate significance on the 5%-level.

Table 5: Short-Term Deposits and Interest Rate Spreads: Regressions

	Savings deposits / Short-term deposits – (Interest rate on savings deposits – interest rate on 3-month deposits)							
	Big banks		Cantonal banks			Regional banks		
	75–87	88–93	60–72	73–87	88–93	60–72	73–84	88–93
Constant	–0.06	0.07	0.28	0.23	–1.03	–1.27	–0.46	–2.06
Dependent variable								
Lag 1	0.32	0.35	–0.12	0.02	0.07	0.14	0.25	–0.02
Independent variable								
Lag 0	2.02	4.91	1.82	3.43	6.43	6.99	4.61	14.81
Lag 1	1.78	1.28	0.96	2.75	2.67	–0.59	0.41	7.11
Lag 2	–0.14	1.43	–0.33	0.65	3.62	–3.62	2.60	8.10
Lag 3	1.44	1.13	2.72	1.89	3.06	1.10	–0.36	4.90
Lag 4	1.11	–0.15	4.25	3.60	0.68	6.58	3.45	3.27
Sum	6.21	8.60	9.43	12.32	16.46	10.46	10.71	38.19
Independent variable squared								
Lag 0	–0.15	0.44	0.05	–0.16	0.17	–0.11	0.00	1.90
Slope dummy * independent variable								
Lag 0	–0.02	0.14	0.62	0.76	1.27	0.02	–0.09	–0.23
Obs.	48	24	52	60	24	52	48	24
R^2 adj.	0.63	0.83	0.40	0.40	0.76	0.04	0.35	0.84
F-value	10.82	15.01	5.19	5.97	10.14	1.29	4.15	16.65
DW	1.73	1.68	1.84	1.91	1.54	1.88	1.99	1.59

Quarterly averages of monthly data for Switzerland from 1960–1993 are used. Dependent variable: Savings deposits/Short-term deposits (percent). Independent variable: Interest rate on savings deposits – interest rate on 3-month deposits (percent per year). Regressions are estimated with ordinary least squares using the correction for heteroskedasticity and serial correlation developed by Newey and West (1987). Data are first differenced before estimation. Slope dummy: Takes the value of one if the exogenous variable increases relative to the previous period and zero otherwise. Obs.: Number of observations. R^2 adj.: R^2, adjusted for degrees of freedom. F-value: Test for the joint significance of the exogenous variables. Underlined coefficients indicate significance on the 5%-level. DW: Durbin-Watson statistic. Underlined parameters are significantly different from zero on the 5%-level (two-sided test).

causality going from spreads to deposit ratios than vice versa. Consequently, a recursive structure is chosen in the empirical work assuming that interest rates are exogenous relative to balance sheet positions.

Table 5 contains estimates of the relationships between the ratio of savings to short-term deposits and changes in interest rate spreads. An analogous specification as in section 4 is chosen. In general, the results are in agreement with the hypotheses outlined in section 2. Most coefficients have the correct positive sign and many of them are significantly different from zero. The speed of adjustment and the long-run effect increase over time. The strongest influences are found for cantonal and regional banks over the last subperiod. But the effects remain surprisingly weak given the often large and persistent interest differentials. No evidence can be found for the hypothesis that the speed of adjustment is a

positive function of the interest differential or that it depends on the direction of change in the spread.

7. Mortgages

Individual banks may get into difficult situations if the interest rate on 3-month deposits increases relative to the savings rate. The years 1980 to 1982 and 1989 to 1991 are typical in this respect, as can be seen in Figure 1. According to the results shown in Table 5, customers will gradually start to move their funds from savings deposits to investments with higher yields. The average costs of refinancing assets increases for the individual bank. Consequently, adjustments have to be made on the asset side of the balance sheet in order to keep the bank profitable.

In Switzerland, this adjustment mainly concerns mortgages. Traditionally, mortgages are granted

Table 6: Financing of Mortgages

	Mortgages/Total assets (percent)								
	Big banks			Cantonal banks			Regional banks		
	60–72	73–87	88–93	60–72	73–87	88–93	60–72	73–84	88–93
Constant	0.00	0.02	0.05	–0.05	0.01	0.07	–0.06	0.00	0.10
Dependent variable									
Lag 1	0.18	0.23	0.30	0.20	0.12	–0.25	0.26	0.10	–0.06
Short-term deposits/Total assets (percent)									
Lag 0	0.01	0.02	0.01	0.07	0.08	0.32	–0.08	0.05	0.35
Lag 1	0.02	0.02	–0.02	0.09	–0.01	0.20	–0.14	0.04	0.02
Savings deposits/Total assets (percent)									
Lag 0	0.83	0.53	0.38	0.42	0.36	0.34	0.46	0.32	0.51
Lag 1	–0.28	–0.26	–0.49	–0.23	–0.18	–0.12	–0.29	–0.02	–0.09
Savings bonds/Total assets (percent)									
Lag 0	0.04	0.14	0.98	0.70	0.55	0.78	1.10	0.92	0.83
Lag 1	0.07	–0.12	–1.00	–0.25	–0.37	0.21	–0.29	–0.51	–0.04
Bonds/Total assets (percent)									
Lag 0	0.00	2.02	2.25	0.51	0.35	0.19	–0.46	0.49	–0.10
Lag 1	–0.08	0.44	0.73	–0.11	0.04	–0.02	–0.16	0.04	0.16
Obs.	156	180	72	156	180	72	156	144	72
R^2 adj.	0.71	0.79	0.74	0.56	0.53	0.28	0.72	0.58	0.56
F-value	42.29	77.78	24.03	23.25	23.55	4.13	46.05	23.28	11.02
DW	2.03	2.06	2.13	1.97	2.06	1.66	2.00	1.91	1.91

Monthly data for Switzerland from 1960–1993 are used. The endogenous variable is the volume of mortgages as a percentage of total assets. Short-term deposits at big banks include accounts denominated in foreign currency. Regressions are estimated with ordinary least squares using the correction for heteroskedasticity and serial correlation developed by Newey and West (1987). Data are first differenced before estimation. Obs.: Number of observations. R^2 adj.: R^2, adjusted for degrees of freedom. F-value: Test for the joint significance of the exogenous variables. Underlined coefficients indicate significance on the 5%-level. DW: Durbin-Watson statistic. Underlined parameters are significantly different from zero on the 5%-level (two-sided test).

on a flexible rate basis and are refinanced to a large extent with savings deposits. The bank management has essentially three alternatives to react to a widening spread between rates on short-term deposits and savings deposits. First, it can increase the interest rate on mortgages more than the savings rate. Second, it can reduce the volume of mortgages to keep it in line with the declining amount of savings deposits. Third, it can refinance mortgages with longer-term liabilities.

Apparently, Swiss banks prefer the second and third alternative. The spread between the mortgage and the savings rate is remarkably stable over time. From 1950 to 1975, it was about 1.3 percentage points and shifted to about 2.0 percentage points thereafter. Furthermore, Figure 3 as well as regression estimates show no significant connections between this spread and the ratio of mortgage credit to total assets.

Table 6 contains evidence on the reaction of mortgages to a change in the volume of various forms of deposits, all expressed as a percentage of total assets. The same categories of banks and the same subperiods are distinguished as above. The connection between savings deposits and mortgages is generally significantly positive with a short delay in the adjustment.[15] But the evidence indicates also that other forms of funds partially replace savings deposits as a vehicle of refinancing mortgages. The consequences for the interest rate risk of banks' equity and its management are discussed in the next section.

8. Management of Interest Rate Risk by Banks

The empirical regularities documented above are especially relevant for cantonal and regional banks holding on average about 60 percent of total assets in the form of mortgages. On the other hand, savings deposits have for example declined from about 40 percent of total assets in 1989 to about 30 percent in 1992 for both types of institutions, requiring refinancing by other categories of liabilities. But short-term deposits have generally been more expensive than savings accounts since 1980 and longer-term liabilities imply considerable interest rate risk for bank equity. It is therefore not too surprising that a number of banks have encountered severe problems during the most recent years when interest rates first increased and then started to decline again. These problems were enhanced by a historically large fall in prices of real estate.[16]

The estimates shown in the previous sections are useful for quantifying the effects of changing interest rates on the profits and consequently on the equity of banks. As an example, the case of regional banks for the years is considered. Table 7 contains the respective results. April 1988 is chosen as the starting date when short-term interest rates were at a minimum of 1.50% p.a. with rates on savings deposits at 3.29% p.a. and long-term rates around 4.00% p.a. Rates on existing mortgages were the highest with 5.23% p.a. At this time, regional banks had a healthy structure of the balance sheet even if the largest part of mortgages had to be refinanced by relatively expensive savings deposits.

The effects of changing interest rates on the profitability of regional banks are illustrated in the lower part of Table 7. Only short-term liabilities and mortgages are considered because they pose the most important and interesting problems. Longer-term positions as a fraction of total assets do moreover not change to a significant degree over this period. On an annualized basis, net income from short-term positions amounted to 1'227 Mio. SFr. or 1.70% of total assets in 1988. As shown in scenario C, the situation would have been even better with completely integrated markets, that is with interest rates on savings deposits equal to those on 3-month deposits.[17]

The rapid increase in interest rates until January 1991 resulted in a considerable deterioration of profits. The reason is twofold: First, interest rates on savings accounts and mortgages remained almost constant. Second, regional banks lost a large amount of now cheap savings deposits. The consequence is that net income from short-term

Table 7: Interest Rate Risk of Regional Banks

	April 1988	January 1991	July 1992
Interest rates (% per year)			
Short-term deposits	1.50	9.00	8.03
Savings deposits	3.29	3.99	5.09
Savings bonds	4.01	6.31	7.25
Bonds (yield to mat. on govt. bonds)	3.96	6.17	6.96
Mortgages (existing)	5.23	5.92	6.89
Positions in Mio. SFr. (percent of total assets)			
Short-term deposits	9'421 (13.0)	16'578 (18.8)	16'036 (18.8)
Savings deposits	29'656 (41.0)	25'304 (28.7)	24'519 (28.7)
Savings bonds	14'035 (19.4)	18'620 (21.1)	18'112 (21.2)
Bonds	3'561 (4.9)	4'722 (5.4)	4'741 (5.6)
Mortgages	44'820 (62.0)	56'595 (64.3)	56'109 (65.8)
Total assets	72'265	88'072	85'321
Income and expenses on short-term positions in Mio. SFr.			
A. Actual			
Mortgages	2'344	3'350	3'866
– Short-term deposits	–141	–1'492	–1'288
– Savings deposits	–976	–1'010	–1'248
Total (percent of total assets)	1'227 (1.70)	848 (0.96)	1'330 (1.56)
B. No adjustment (structure of deposits as in April 1988*)			
Mortgages	2'344	3'350	3'866
– Short-term deposits	–141	–907	–784
– Savings deposits	–976	–1'269	–1'567
Total	1'227 (1.70)	1'174 (1.33)	1'515 (1.78)
C. Full adjustment (rate on savings deposits = rate on 3-month deposits)			
Mortgages	2'344	3'350	3'866
– Short-term deposits	–141	–1'492	–1'288
– Savings deposits	–445	–2'277	–1'969
Total	1'758 (2.43)	–419 (–0.48)	609 (0.71)

The total of short-term deposits and savings deposits in January 1991 and July 1992 is allocated to the two categories as in April 1988.

positions decreased by about 30% to 848 Mio. SFr. or 0.96% of total assets. In scenario B, the effect of changes in interest rates is isolated by assuming that the structure of short-term liabilities remained the same as in April 1988. In this case, the fall in profits is only 53 Mio. SFr. The difference of 326 Mio. SFr. can therefore be attributed to the structural change in the balance sheet. The situation improved again until July 1992, mainly due to increases in the rates on savings deposits and mortgages.

An even worse situation would have materialized with fully integrated financial markets implying the same interest rates on savings accounts as on

short-term deposits. An annualized loss of 419 Mio. SFr. in January 1991 and only a small profit of 609 Mio. SFr. in July 1992 would have been the outcome. Under such conditions, the mortgage rate must increase above the rate on 3-month deposits in order to keep banks profitable.

9. Conclusions

The relationships between various short-term interest rates and the respective positions on banks balance sheets are explored using Swiss data from 1960 to 1993. The major results can be summarized as follows. First, considerable spreads between Euromarket rates and short-term deposit rates on the one hand and savings and mortgage rates on the other exist over extended periods of time. The adjustment has become faster during the more recent years but remains sluggish and incomplete.

Second, the composition of banks' balance sheets changes in response to yield spreads. The ratio of savings deposits to short-term deposits increases and declines as a function of the difference between the savings rate and the rate on 3-month deposits. There is some evidence for a larger effect and an increased speed of adjustment during the more recent subperiods. But again, the reaction is not very strong given the size and the persistence of the observed interest differentials. Following traditional procedures of refinancing, the volume of mortgages is partially adjusted to the volume of savings deposits. However, this link has become considerably weaker in recent years but the spread between the interest rates on savings deposits and mortgages has remained remarkably stable. As a consequence, total costs of refinancing mortgages must have increased considerably as the spread between the rate on 3-month deposits and savings deposits has reached very high values around 1990. Some illustrative calculations indicate that the negative effects on the profitability of banks are substantial.

These results are consistent with the notion of partially segmented markets. However, the exact reasons for this segmentation are not clear. Information and transaction costs for bank customers are not excessively large and have certainly become much lower over time as new investment instruments have been created and competition between banks has increased.

Footnotes

[1] Respective stylized facts are documented by AUSUBEL (1991), BACCHETTA and CAMINAL (1992), BORIO and FRITZ (1995), CALEM and MESTER (1995), DIEBOLD and SHARPE (1990), FLANNERY (1982), GENBERG, HELBLING and NEFTCI (1991), GUAL and NEVEN (1992), PASSMORE and SPARKS (1993) and ROSEN (1993).

[2] The composition of the different categories undergoes only minor changes over time. An exception occurs for regional banks in March 1985. This break is accounted for in the empirical work by defining appropriate subperiods. The sample period ends in 1993 because a relatively large number of regional banks were subsequently taken over by big banks so that later numbers are not completely comparable to previous ones.

[3] Due to the reasons stated in footnote 2, the second period ends in 1984 for regional banks. Investigations on short-term deposits at big banks start with the year 1975 because respective data for individual currency denominations are not available for previous years.

[4] Rates on 3-month deposits move very closely with rates on Swiss Franc deposits in the Euromarket with the same maturity. Formal evidence is provided in section 5.

[5] The usual notification period for changes in the mortgage rate or termination of the contract is six months.

[6] The relevant studies are AUSUBEL (1991), BACCHETTA and CAMINAL (1992), BALTENSPERGER (1980), FLANNERY (1982), FLANNERY and JAMES (1984), GENBERG, HELBLING and NEFTCI (1991), HANNAN and BERGER (1991), HESS (1991), NEUMARK and SHARPE (1992), PASSMORE and SPARKS (1993), ROSEN (1993) and SANTOMERO (1984).

[7] The empirical evidence in section 5 shows that interest rates behave very much like random walks implying that rational investors should view all changes as being permanent.

[8] WASSERFALLEN (1979) shows that these arguments are flawed for a number of reasons. For example, no distinctions are made between the stock of existing houses and the construction of new ones, between changes in nominal and real interest rates and between variations in mortgage rates relative to rates on other forms of bank credit.

[9] No systematic evidence on the effects of this law is available. Casual evidence indicates that the influence is small. For example, the usual effects of binding rent controls, such as a deteriorating housing stock, are not observed.

[10] Additional lags of all terms never produced any significant coefficients.

[11] The familiar partial adjustment model implies $0 < \alpha_1 < 1$.

[12] ROSEN (1993) also includes a variety of error correction terms in $(R_{Dt-1} - R_{t-1})$ in equation (1). As documented in table 2, these spreads are however not stationary.

[13] The results are virtually identical if interest rates at the beginning of the quarter are used instead of averages over the quarter.

[14] These results do not change if quarterly averages are used.

[15] Additional lags of the various exogenous variables in the regressions shown in Table 6 have no explanatory power.

[16] It may be the case that rates on mortgages for business firms are adjusted faster. Information on these rates and the distribution of mortgages for residential and business purposes is however not publicly available.

[17] Most likely, competition would have resulted in lower mortgage rates under these circumstances. This effect is not considered here.

References

AUSUBEL, L. M. (1991): "The failure of competition in the credit card market", American Economic Review 81, pp. 50–81.
BACCHETTA, P. and R. CAMINAL (1992): "Reducing the implicit taxation on the Spanish banking system: Who gains and who loses", Papers ESADE 88.
BALTENSPERGER, E. (1980): "Alternative approaches to the theory of the banking firm", Journal of Monetary Economics 6, pp. 1–37.
BORIO, C. E. V. and W. FRITZ (1995): "The response of short-term bank lending rates to policy rates: A cross-country perspective", Bank for International Settlements, working paper no. 27.
CALEM, P. S. and L. J. MESTER (1995): "Consumer behavior and the stickiness of credit-card interest rates", American Economic Review 85, pp. 1327–1336.
DIEBOLD, F. X. and S. A. SHARPE (1990): "Post-deregulation bank-deposit rate pricing: The multivariate dynamics", Journal fo Business and Economic Statistics 8, pp. 281–291.
FLANNERY, M. J. (1982): "Retail bank deposits as quasi-fixed factors of production", American Economic Review 72, pp. 527–536.
FLANNERY, M. J. and C. M. JAMES (1984): "Market evidence on the effective maturity of bank assets and liabilities", Journal of Money, Credit, and Banking 16, pp. 435–445.
GENBERG, H., T. HELBLING and S. NEFTCI (1991): "Monopoly power in Swiss financial markets", in N. Blattner, H. Genberg and A. Swoboda (eds.): Competitiveness in banking, Heidelberg: Physica-Verlag.
GUAL, J. and D. NEVEN (1992): "Deregulation of the European banking industry (1980–1991)", CEPR Discussion Paper 703.
HANNAN, T. H. and A. N. BERGER (1991): "The rigidity of prices: Evidence from the banking industry", American Economic Review 81, pp. 938–945.
HESS, A. C. (1991): "The effects of transaction costs on households' financial asset demands", Journal of Money, Credit, and Banking 23, pp. 383–409.
NEUMARK, D. and S. A. SHARPE (1992): "Market structure and the nature of price rigidity: Evidence from the market for consumer deposits", Quarterly Journal of Economics 107, pp. 657–680.
NEWEY, W. and K. WEST (1987): "A simple positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix", Econometrica 51, pp. 703–708.
PASSMORE, W. and R. SPARKS (1993): "An efficiency model of deposit pricing and rate rigidity", Finance and Economics Discussion Series 93–38, Federal Reserve Board.
ROSEN, R. J. (1993): "What goes up must come down? Asymmetries and persistence in bank deposit interest rates", Finance and Economics Discussion Series 93–36, Federal Reserve Board.
SANTOMERO, A. M. (1984): "Modeling the banking firm, a survey", Journal of Money, Credit, and Banking 16, pp. 576–616.
WASSERFALLEN, W. (1979): "Wohnungsmarkt und Kreditmärkte", Schweizerische Zeitschrift für Volkswirtschaft und Statistik 115, pp. 139–152.