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Bank interest rates in a small European economy: Some exploratory macro level analyses using Finnish data

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Suomen Pankki
Bank of Finland
P.O.Box 160
FIN-00101 HELSINKI
Finland
☎ + 358 10 8311

http://www.bof.fi

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The views expressed are those of the author and do not necessarily reflect the views of the Bank of Finland.

This paper has been partly written at the BoF financial markets department but finalised at the research unit.

* e-mail: karlo.kauko@bof.fi

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Karlo Kauko
Monetary Policy and Research Department

Abstract

This paper presents econometric analyses on the determination of bank deposit and lending rates using longitudinal Finnish data. Interest rate pass-through is very strong, possibly complete, in the case of lending rates; in the case of deposit rates the pass-through is far from complete, even in the long term. The monetary union has benefited customers by decreasing the average rate on new loans. Credit and interest rate risk premiums are clearly observable in banks' lending rates. The impact of money market rates on loan stock rates seems to have been non-linear; no obvious explanation for this phenomenon has been found.

Key words: banking, interest rates

JEL classification numbers: G21, E43, E44

Pankkikorot pienessä eurooppalaisessa maassa – makrotason tuloksia suomalaisella aineistolla

Suomen Pankin tutkimus
Keskustelualoitteita 9/2005

Karlo Kauko
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tässä keskustelualoitteessa esitetään suomalaista pitkittäisaineistoa käyttäen ekonometrisiä analyysejä pankkien talletus- ja luottokorkojen määräytymisestä. Markkinakorkojen välittyminen luottokorkoihin on erittäin voimakas, mahdollisesti täydellinen. Talletuskoroissa läpimeno on selvästi epätäydellinen jopa pitkällä aikavälillä. Rahaliitto on hyödyttänyt asiakkaita alentamalla uusien luottojen korkoja. Luotto- ja korkoriskien preemiot ovat selvästi havaittavissa pankkien luottokoroissa. Rahamarkkinakorkojen vaikutus luottokannan korkoihin näyttää olleen tuntemattomasta syystä epälineaarinen.

Avainsanat: pankkitoiminta, korot

JEL-luokittelu: G21, E43, E44

Contents

1 Introduction

1.1 Background

In many fields of economics, the concepts of the interest rate and the yield curve are used in an excessively simple way, as if all the agents in the economy had access to a perfectly competitive loan market. In real life, this assumption barely holds for the government and a few other institutions, including banks and a handful of major corporations. Nearly all the households and most business undertakings have access to loan markets mainly through the banking industry. Banks are the most important source of loans, and deposits are a highly important financial asset in every developed economy. Hence, when one evaluates the impact of the interest rate on households' and SME businesses' behaviour, banks' customer rates are certainly at least as relevant as market rates.

There are two established fields of literature analysing bank rates, namely the monetary policy transmission research and the literature on competition in the banking industry.

Empirical literature on monetary policy transmission analyses the impact of central bank policy rates on the economy. A central field of research has been the transmission of policy rates to bank lending and deposit rates, and the lag between policy rate movements and the rate on bank loans. Cottarelli and Kourelis (1994) compared the strength of the transmission of monetary policy rates to lending rates in 31 countries. The results indicated that the existence of a sizable market for short-term monetary instruments, the absence of constraints on capital movements; the absence of constraints on bank competition and the private ownership of the banking sector reduce the stickiness of lending rates. Mizen and Hofmann (2002) found with UK data that the pass-through of policy rates is complete for deposit rates in the long term, but not for mortgage rates. Sander & Kleimeier (2003) found that monetary policy transmission has become faster and stronger in Europe over time. According to Angeloni & Ehrmann (2003) the monetary policy transmission has probably strengthened because of the EMU.

A separate sub-field of the monetary policy transmission literature has focused on the heterogeneity of banks and their solvency and balance sheet structures, and how these differences have affected banks' behaviour in the credit market. This so-called bank lending channel literature mainly consists of analyses on how changes in central bank policy rates are reflected in the quantity of bank lending, but Gambacorta (2004) analysed the heterogeneity of interest rate pass-through on bank lending rates in Italy; there was evidence in favour of the existence of the credit channel of monetary policy, even though this heterogeneity between banks seemed to be above all a short-term phenomenon.

The analysis of competition between banks as a determinant of bank rates has become an important sub-field of the industrial organisation literature. These studies focus almost by definition on differences between banks. Hutchison (1995) presented a survey of several papers published in the late 1980s and early 1990s and concluded that retail deposit rates tend to be lower in concentrated regional markets. Berstein and Fuentes (2003a) found with Chilean data that banks' deposit rates react more slowly to changes in market rates in concentrated local markets. Canhoto (2003) found evidence of banks' market power in the deposit market with Portuguese data, even though deregulation had enhanced competition. Rosen (2003) found with U.S. data that the presence of large banks in a local market makes deposit rates higher and less rigid, when controlled for market concentration; market concentration decreases deposit rates in urban markets, but not in rural ones. Hannan and Prager (2001) reached a somewhat different result; the local presence of banks with branches in many different areas makes deposit rates lower. Angbazo (1997) found that all banks price default risk in their loan margins, but not all of them price the interest rate risk. Berstein and Fuentes (2003b) found with Chilean data that loan rates were less sticky in big banks with relatively few individual customers. The results of Maudos and Fernández de Guevara (2004) may be particularly interesting because some of their findings might be observable in aggregate longitudinal data. They analysed a large bank level panel data from European countries. They concluded that the bank interest rate margin depends on competition, interest rate risk, credit risk, risk aversion and operating expenses. The margin was proxied by the difference between interest revenue and financial costs in relation to total assets. The authors observed no evidence of increased rivalry, and the decrease in the margin seemed to be due to reduction in interest rate risk, credit risk and operating costs.

This paper takes a somewhat different approach. It is entirely based on aggregate data and no attention is paid to differences between banks or geographic areas. In this sense the analyses to be presented in the following are not essentially different from the literature on monetary policy transmission. However, unlike many contributions in the monetary policy transmission literature, the following analyses pay attention to different kinds of bank rate determinants in longitudinal data, and the focus is not solely on the impact of market and policy rates on bank rates. Some of the explanatory variables to be tested have been used in previous cross-sectional and panel estimations.

1.2 The Finnish banking market after liberalisation

The Finnish banking market was tightly regulated for several decades, but a widespread deregulation took place in the 1980s. A highly important measure was the gradual relaxation of interest rate regulations 1983 onwards. A rapid monetary expansion followed in the late 1980s, leading to an asset price bubble. Over the years 1991–1994 the Finnish economy underwent the worst depression in any OECD country after the Second World War. The banking sector was seriously affected. The problems were mainly manifested as loan losses. The situation was probably worsened by the combination of widespread lending in foreign currencies to customers with no foreign currency denominated income and the devaluation of the Finnish markka first in November 1991 and again in September 1992. Banks' cumulative losses in 1991–1995 exceeded the regulatory capital of deposit banks at the end of 1990 (Vihriälä 1997, p. 40). However, there was no run on any bank, possibly because of government capital injections and an explicit guarantee by the parliament. The sector has been profitable since 1996, and especially during the boom of 1999–2000 banks were very profitable.

The Finnish banking market has been relatively concentrated at least since the 1930s, but concentration increased even further during the crisis when weak banking groups were merged with rivals. The operations of Skopbank, STS bank and most of the small savings banks were taken over by rivals in 1992–1993. The two major commercial banks merged in 1995; the new merged entity has become a member of the Nordea banking group. Currently, there are only three major banking groups, namely Nordea, The OP Bank Group (also known as the amalgamation of cooperative banks) and the Sampo Group. Moreover, there is a number of small banks and banking groups. If concentration is measured with the Herfindahl index of total assets, the Finnish banking market was the most concentrated in EU 15 in 2001 (ECB 2002, Statistical annex, Table 7). Unless Nordea Bank Finland is considered a foreign bank, the presence of foreign institutions has remained limited, especially in retail banking.

A liquid interbank money market based on certificates of deposits emerged after certain reforms in 1987, and the Bank of Finland began to calculate markka money market rates, known as Helibor rates. The market for bonds remained illiquid, mainly because the public sector had a very limited debt burden and the need to issue government bonds was limited. During the depression of the early 1990s, the financial standing of the government deteriorated dramatically and a liquid market for markka denominated government bonds emerged. Finland was one of the first countries to join the single currency, and the calculation of Helibor rates was discontinued in December 1998. The market for corporate bonds has remained illiquid.

Certain tax laws are also worth mentioning. There was a specific tax (stamp duty) on new loans until April 1998. The tax was 1.5% of the loan sum, irrespective of the maturity. An immediate consequence of the abolition of the tax was that it became easier for debtors to switch between banks because such a switch was no longer taxed.

There was a special tax exemption of interest income from bank deposits. First, this exemption was applied to certain categories of deposits, but since 1989 the tax exemption was conditional on the interest rate. When the exemption was to be abolished in 2000, the interest income on a personal account was not taxable unless the interest rate was higher than 2%; if the rate was higher, the whole interest income was taxable.

Finland has a universal banking model. Deposit banks offer all kinds of financial services, with the exception of insurance. Nothing prevents banks from owning insurance companies, and all the major banking groups have their own life insurance companies.

There is very little systematic analysis on banking competition in Finland. The last research results may have been published by Vesala (1995). His data was from the late 1980s and the early 1990s, and the results indicated that the market for loans was much more competitive than the market for deposits. Some of the following results are consistent with this finding, even though no systematic analysis on competition is presented.

1.3 The data

The analysis is based on aggregate quarterly data on the Finnish banking sector and the Finnish economy in 1993–2003. Some experiments were made with a longer data period covering the years 1987–2003, but it proved to be surprisingly difficult to develop models that would suit the whole era of non-regulated interest rates. The behaviour of banks as interest rate setters seems to have changed permanently and fundamentally during the banking crisis of the early 1990s. It is also possible that bond rates were distorted by illiquidity until central government debt skyrocketed in the early 1990s, implying that regressions using the bond rate as an explanatory variable are affected by this problem. In all the following analyses the estimation period has been Q1/1993–Q4/2003, even though lagged data for 2002 is included in the set of explanatory variables in many cases.

The data on bank interest rates has been collected and compiled by the Bank of Finland, and it includes all the domestic operations of all the deposit banks, including branches of foreign banks. Instead, loans and deposits in domestic banks' offices abroad are not included. The data are collected at the unconsolidated level, ie including intra-group operations and excluding banks' subsidiaries. The data used in the analyses is purely longitudinal; there is no cross-sectional dimension. There are three time series on bank rates, namely the rate on deposits (RDT), the rate on the loan stock (RLB) and the average rate on new loans (RLBN). Each observation of RLB and RDT refers to the last bank day of the quarter, whereas RLBN is the average of monthly observations.

The short-term market rate (MMRATE) is the average of daily observations of the three months money market rate. For the years 1993–1998 it is the Helibor rate, and for the euro era it is the Euribor rate. The long-term interest rate (BR) is the average of daily observations of the yield on a Finnish government bond with four to five years to maturity.

If any conclusions can be drawn on 44 observations, none of the interest rate series seems to have a unit root during this relatively short period, with the possible exception of the average rate on the loan stock (RLB). (See Appendix 1). Interestingly, this result seems to be highly dependent on the sample, and if one includes the years 1991–1992, the unit root hypothesis cannot be rejected. A likely explanation is the very high level of interest rates that prevailed before September 1992. Nevertheless, the fact that most of the interest rates seem to have been stationary (or nearly stationary) over the observation period makes it less problematic to run regressions in levels. Even if there were more observations it would make little sense to make cointegration analyses with the data because the key variables are stationary rather than unit root processes.

2 Empirical results

2.1 Deposit rates

There are certain obvious explanatory variables to be used in the regressions, such as the money market rate (MMRATE) and the bond rate (BR). Market rates should affect the deposit rate irrespective of whether banks have market power or not, even though the effect might be stronger under perfect competition. Moreover, because the deposit rate is probably rather sticky, it is reasonable to include the lagged value of the explained variable as an additional explanatory variable.

If banks have market power, it is likely that the economic benefits of the tax exemption of interest on deposits have been divided between banks and their customers. The dummy variable VTON denotes the era of the tax exemption. EMU membership (EMU) and the trend can also be tested as potential explanatory variables. The trend may be a relatively good proxy for banks' technical and operational efficiency, because processes and banking infrastructure have probably developed rather smoothly.

After a few experiments with different combinations of explanatory variables the following version of the model was reached.

Table 1. **OLS results, determinants of the average interest rate of deposits**

Dependent Variable: RDT
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44

Variable	Coefficient	t-Statistic	Prob.
C	-0.188	-0.501	0.619
RDT(-1)	0.510	19.611	0.000
MMRATE	0.147	7.273	0.000
BR	0.080	6.178	0.000
BR(-2)	0.038	2.409	0.021
VTON	-0.083	-1.606	0.117
EMU	0.028	0.612	0.545
@TREND	-0.001	-0.355	0.724
R-squared	0.997	Mean dependent var	2.1172
Adjusted R-squared	0.997	S.D. dependent var	1.1173
S.E. of regression	0.064	Akaike info criterion	-2.492
Sum squared resid	0.148	Schwarz criterion	-2.167
Log likelihood	62.820	F-statistic	1857.4
Durbin-Watson stat	1.449	Prob(F-statistic)	0.0000

The diagnostics of the residual term are presented in the appendix 2.

The high statistical significance of the lagged value of the explained variable reflects the stickiness of deposit rates. The immediate impact of the money market rate on bank deposits is not particularly strong, but it is highly significant. Moreover, the impact is gradually accumulated because future values of the explanatory variable RDT(-1) depend on it. Instead, in the light of preliminary experiments, lagged values of the money market rate were not close to statistical significance, when controlled for the lagged value of the explained variable. Past values of the bond rate might capture the role of fixed-term deposits made in the past.

Simplistically, we can calculate that the long-term pass-through of a permanent, one percentage shift of the yield curve into the deposit rate is $(0.147+0.080+0.038)/(1-0.510) \approx 0.54$ percentages. The hypothesis that interest rate pass-through would be complete in the very long run can be rejected with these data. If a permanent parallel shift of the yield curve were transmitted to the long term to the deposit rate as such, the sum of interest rates' regression coefficients, including the coefficient of the lagged explained variable, would equal one, which can be rejected with the Wald test. If one does impose this restriction on the equation, the residual term becomes strongly autocorrelated.[1] This finding might be an indication of banks' market power; under perfect competition the interest rate margin would equal the costs of collecting deposits, and there is no obvious reason why these costs would be higher during high interest rates.

There are three highly correlated explanatory variables, namely the trend and the two dummy variables, one for the limited tax exemption of interest income on deposits (until Q2/2000) and the other one for the EMU membership (since Q1/1999). None of these variables is statistically significant alone, but there is evidence on their joint impact on the deposit rate. Moreover, dropping off these variables causes statistically significant autocorrelation in the error term.

Table 2. **Testing the joint significance of deposits' tax exemption, EMU and the trend in the table 1 equation**

Redundant Variables: VTON EMU @TREND

F-statistic	3.265229	Probability	0.032353
Log likelihood ratio	10.58952	Probability	0.014166

Because of their high correlation it is difficult to say which of the three variables has affected deposit rates. If any conclusions can be drawn on the above results, it seems that the abolition of the tax exemption is the most likely candidate for being the 'correct' explanatory variable; this variable is relatively close to statistical significance. If the trend variable is omitted, the tax exemption becomes statistically significant (t-value -2.2) whereas the EMU membership does not (t-value 0.5). Thus, these results give some relatively weak evidence to support the hypothesis that the economic burden of taxation of the interest on deposits is partly borne by banks, not solely by depositors. (See equations 2 and 3 in the table 3)

Paroush (1994) proposed that the minimum reserve requirement imposed on banks is reflected in the rate paid to depositors. If no interest is paid on required

[1] Wald-test F-statistic (1,36) = 128.8 Prob = 0.0000. The residual term of the resulting regression is strongly autocorrelated; Obs R squared of Breusch-Godfrey with 4 lags equals 19,23, which is significant at the 0.001 level. The assumption of residual normal distribution is close to being rejected, mainly because of skewness.

minimum reserve deposits with the central bank, banks incur an indirect cost that is proportional to the deposit base, the minimum reserve requirement and the opportunity cost of reserves. This opportunity cost is probably strongly dependent on the money market rate. An interest rate was paid on these minimum reserve deposits still during the first half of the year 1993, but a new system was introduced in July 1993, and the interest rate was annulled. This system was in use until December 1998. The minimum reserve deposit requirement was 2% of sight deposits, 1.5% of time deposits and 1% of many domestic non-deposit debts. However, the interaction term of the dummy variable for the Q3/1993–Q4/1998 era (MIRE) and the money market rate did not prove to be close to statistical significance as an explanatory variable. (See equation 1 in the table 3)

Table 3. **OLS results, alternative equations for the average interest rate of deposits**

	1	*2*	*3*
C	-0.333	-0.319	-0.294
	(-0.770)	(-5.018***)	(-7.458***)
RDT(-1)	0.520	0.513	0.514
	(17.555***)	(21.327***)	(21.560***)
MMRATE	0.148	0.148	0.151
	(7.244***)	(7.441***)	(8.041***)
BR	0.080	0.082	0.081
	(6.067***)	(7.025***)	(7.118***)
BR(-2)	0.037	0.038	0.035
	(2.232*)	(2.431*)	(2.443*)
VTON	-0.067	-0.069	-0.078
	(-1.179)	(-2.178*)	(-3.137**)
EMU	0.045	0.018	
	(0.853)	(0.504)	
@TREND	0.000		
	(0.007)		
MIRE*MMRATE	0.007		
	(0.693)		
R-squared	0.997	0.997	0.997

2.2 Rates on new loans

It is relatively easy to list a number of factors that could affect bank lending rates. The most obvious factor is the marginal cost of funding, which can be measured with market rates, both the short money market rate and the bond rate. At least according to the Monti-Klein banking model the money market rate is the relevant cost of funding when banks' set their loan rates, and the price and availability of deposits is basically irrelevant (See Freixas & Rochet 1997, 57–61 for reference). All the banking groups of the sample have had access to the wholesale market and none of them has had to pay a significant risk premium for its loans during the data period, which is a central assumption of the Monti-Klein model.

A second rather obvious cost factor is the technical efficiency of banks: if the operational costs of granting new loans are high, this should be reflected in banks' lending rates. Unfortunately there is no straightforward way to measure operational unit costs of granting a new loan. It is likely that the efficiency of banks as lenders has improved gradually over time, implying that this factor can be proxied by the trend.

As a third factor one could mention the risks of lending. The perceived credit risk is the most obvious risk factor to be included. The simple number of corporate bankruptcy proceedings filed during the quarter (BNKRPTC) was used as a proxy for credit risks. The logarithmic value of the number of bankruptcies was tested as an alternative specification, but in preliminary estimations it proved to have less explanatory power, which is basically intuitive: the loan losses caused by a bankrupt customer do not depend on the number of other insolvent debtors, implying that the specification should be linear.

The bank may also have to run interest rate risks if it grants loans. These risks can be proxied by the volatility of interest rates, as in the paper by Maudos and Fernandez de Guevara. The bond rate volatility (BNDRV) is measured with the weekly volatility of the five years bond rate.

Moreover, it is possible that the EMU has reduced certain financial risks, mainly interest rate risks. EMU membership might also have increased competition in the case of corporate loans, because the number of banks in companies' home currency area increased when the euro was introduced. Moreover, there was a change in statistical definitions. The data includes nothing but markka denominated loans until 1998 and euro denominated loans 1999 onwards. Many companies took DEM denominated loans before the introduction of the euro, and the closest substitute of DEM is probably EUR in the new financial landscape. Hence a dummy variable for the EMU era (Q1/1999 onwards) is included as an explanatory variable.

The cyclical situation is also a potentially important determinant of lending rates. Two opposing hypotheses can be presented.

– The credit risk depends on the business cycle; during recessions risk premiums and loan rates are higher.
– If banks have market power, higher demand for loans is reflected in higher lending rates, implying that the rate on new loans is higher during booms.

The business cycle is measured by the GDP gap (GDPGAP). This gap is the Hodrick-Prescott filter ($\lambda = 1600$) residual of the logarithmic real quarterly GDP.

The filtering was done with data for the 1987–2003 period. No structural model was used to measure this gap. This residual has negative values during recessions and positive values during booms.

There is no obvious reason why the rate on new loans would be affected by its own past. The set of loan contracts negotiated during a period is independent of the contracts negotiated during the previous period. Hence, the lagged value of the explained variable is not used as an explanatory variable. As will be seen, this specification is consistent with the data.

The following final specification of the model was reached after various experiments with different combinations of explanatory variables and their lagged values.

Table 4. **OLS results, determinants of the average rate on new loans**

Dependent Variable: RLBN
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44

Variable	Coefficient	t-Statistic	Prob.
C	0.6471	3.1378	0.0034
MMRATE	0.8453	22.1270	0.0000
GDPGAP	-8.1985	-3.7643	0.0006
EMU	-0.4736	-6.7139	0.0000
BNDRV	9.5955	3.2545	0.0025
BNDRV(-5)	7.8281	2.4225	0.0206
BR	0.0748	2.5802	0.0141
BNKRPTC(-1)	0.000679	3.9283	0.0004
R-squared	0.993774	Mean dependent var	5.651523
Adjusted R-squared	0.992563	S.D. dependent var	1.871198
S.E. of regression	0.161364	Akaike info criterion	-0.647341
Sum squared resid	0.937382	Schwarz criterion	-0.322943
Log likelihood	22.2415	F-statistic	820.8873
Durbin-Watson stat	1.48776	Prob(F-statistic)	0.0000

As can be seen, the fit of the regression is excellent. There are no obvious diagnostic problems in the residual term (see Appendix 3). Most of the explanatory variables of this final version of the model have the expected signs.

In 1993–1994, the average difference between the rate on new loans (RLBN) and the three months money market rate (MMRATE) was 2.09. In 2002–2003 it was 1.19. Technically, the above regression results indicate that the reduced number of bankruptcies and EMU membership contribute to explaining the squeeze of the margin.

– EMU membership has contributed 0.47 percentages to the decline in bank lending rates.
– In 1993–1994, the average number of bankruptcies per quarter was 1629; in 2002–2003 it was 894. This decline, in the light of the results, has lowered the rate on new loans by (1629-894)*0.000679 ≈ 50 basis points.

In total, these two factors seem to have caused a 0.97 percentage points decline in loan rates over the observation period. They are more than sufficient to explain the observed margin squeeze of 0.8 percentages. The trend variable, instead, did not prove to be close to statistical significance (see equations 2 and 3 in table 5), even though the technical efficiency of banks has certainly improved substantially during the observation period. This may indicate that not much of the productivity improvement that has probably taken place has been reflected in interest rates paid by customers. Therefore, one might even argue that contrary to common beliefs, competition in lending has eased rather than intensified over the observation period. This conclusion is similar to the one of Maudos and Fernandez de Guevara (2004); if anything, competition eased in European banking markets in the 1990s, but this effect was counteracted by a fall in credit risks and improving operational efficiency. On the other hand, analysing the mere interest rate spread may be a biased way to study banks' competition in the loan market. Casual observations indicate that there has been a decrease in the lending-related fees paid by customers in Finland. Unfortunately there is no systematically collected data on these fees.

It seems that the impact of the business cycle on the credit risk premium is stronger than the potential impact of the assumed procyclicality of loan demand on lending rates. Bond rate volatility seems to have had a substantial impact on loan rates, which is consistent with the results of Maudos and Fernandez de Guevara (2004). Volatility seems to have a long-lasting impact on rates of new loans.

As one might expect, the coefficient on the lagged value of the interst rate on new loans does not enter significantly and excluding it has little impact on the coefficients of other variables (equation 4 in table 5). This finding is consistent with the hypothesis that the rate of new loans is not directly affected by the average rate of loans granted in the past, which is intuitive. On the other hand GDPGAP is now only marginal, probably reflecting its correlation with the lagged value of the rate on new loans.

The stamp duty (SDUTY) may have been reflected in lending rates, especially if banks have market power. As can be seen in equation 2 in table 5, it is possible that the stamp duty made lending rates somewhat higher than what they would have otherwise been. This result is counterintuitive; as if customers' share of the economic burden of the tax had been higher than 100%.

Equation five seems to indicate that the cyclical situation has little impact on the transmission of monetary policy; the interaction of money market rates and the macroeconomic cycle has no explanatory power. Equation six tests the average BIS solvency ratio (BISRATIO) of banks as an explanatory variable. The number of degrees of freedom is very limited because quarterly data for the pre 1999 era is not readily available, but the results based on the very small sample give no support to the hypothesis that bank solvency problems would have forced banks to restrict loans supply, which would have enabled them to charge higher interest rates. In fact, the coefficient is positive, which makes little sense.

Table 5. **OLS results, alternative equations for the average rate of new loans**

	1	2	3	4	5	6
						(1999-2003)
C	0.539	-0.486	-0.262	0.507	-0.167	1.165
	(2.627*)	(-0.681)	(-0.353)	(2.183*)	(-0.218)	(1.257)
MMRATE	0.879	0.88	0.845	0.755	0.861	0.822
	(21.814***)	(22.221***)	(22.298***)	(9.356***)	(18.915***)	(7.850***)
GDPGAP	-7.636	-6.706	-7.395	-5.383	-9.938	-3.093
	(-3.623***)	(-3.100**)	(-3.287**)	(-1.739)	(-1.943)	(-0.648)
EMU	-0.272	-0.385	-0.584	-0.370	-0.586	
	(-2.263*)	(-2.746**)	(-5.238***)	(-4.298***)	(-5.164***)	
BNDRV	10.838	10.882	9.575	9.091	9.351	4.575
	(3.745***)	(3.825***)	(3.275**)	(3.081**)	(3.059**)	(0.624)
BNDRV(-5)	6.121	6.283	8.055	6.991	8.207	16.748
	(1.905)	(1.989)	(2.510*)	(2.137*)	(2.422*)	(2.518*)
BR	0.050	0.064	0.088	0.083	0.081	-0.052
	(1.651)	(2.050*)	(2.884**)	(2.820**)	(2.340*)	(-0.588)
BNKRPTC(-1)	0.001	0.001	0.001	0.001	0.001	-0.000
	(3.280**)	(3.608**)	(3.961***)	(3.363**)	(3.104**)	(-0.439)
SDUTY	0.287	0.302				
	(2.028)	(2.168*)				
@TREND		0.010	0.009		0.009	
		(1.496)	(1.274)		(1.169)	
RLBN(-1)				0.096		
				(1.270)		
GDPGAP*MMRATE					0.893	
					(0.847)	
GDPGAP(-1)*MMRATE(-1)					-0.516	
					(-0.848)	
BISRATIO						3.119
						(1.244)
R-squared	0.994	0.995	0.994	0.994	0.994	0.978

Redundant Variables in equation 5: GDPGAP*MMRATE GDPGAP(-1)*MMRATE(-1)			
F-statistic	0.496881	Probability	0.612904
Log likelihood ratio	1.305458	Probability	0.520623

The hypothesis of complete pass-through of interest rates into banks' lending rates is, at least on the surface, somewhat inconsistent with the data. The sum of the regression coefficients of the money market rate (MMRATE) and the bond rate (BR) is relatively close to +1, about 0.92, but Wald test rejects the hypothesis that the sum would actually equal one in table 4.[2] Nevertheless, because the Wald test can be unreliable, and because the fit of the regression is good with reasonable diagnostic moderate (there is some residual autocorrelation, see appendix 4), the resulting equation presented in table 6 may be of some interest.

Table 6. **Complete pass-through of market rates to new loan rates imposed on the equation**

Dependent Variable: RLBN
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44
RLBN = C(1)+C(2)*MMRATE +C(3)*GDPGAP +C(4)*EMU+C(5)*BNDRV+C(6)*BNDRV(-5)+(1-C(2))*BR+C(8)*BNKRPTC(-1)

	Coefficient	t-Statistic	Prob.
C(1)	0.5584	2.3243	0.0257
C(2)	0.9227	28.3830	0.0000
C(3)	-7.5346	-2.6336	0.0123
C(4)	-0.4604	-5.7597	0.0000
C(5)	12.1044	3.7458	0.0006
C(6)	6.1321	1.6738	0.1026
C(8)	0.0004	2.8819	0.0065

R-squared	0.991629	Mean dependent var	5.651858
Adjusted R-squared	0.990272	S.D. dependent var	1.870801
S.E. of regression	0.184518	Akaike info criterion	-0.397232
Sum squared resid	1.259732	Schwarz criterion	-0.113383
Log likelihood	15.7391	Durbin-Watson stat	1.188941

2.3 Loan stock rates

2.3.1 Potential determinants of the loan stock rate

We will next present estimation results from a model for the average rate on the outstanding stock of loans. Our measure of average rate includes interest rates on both corporate loans and household loans. In practice, household loans account for more than 50% of the loan stock. The relative share of household loans in the stock is larger than in the case of new loans because the average maturity of corporate loans is shorter. A typical corporate loan remains in the stock of outstanding loans for a relatively short period of time.

Lending at fixed rates is not particularly commonplace in Finland; fixed rate loans accounted for 7% of the loan stock in June 2002 (BoF 2003, p. 139). Most loans are re-priced regularly according to changes in reference rates. For corporate

[2] F-statistic (1,36) = 8.2207; Prob = 0.0069.

loans the typical reference rate is a relatively short money market rate, whereas household loans are usually pegged on either the 12 months rate or the prime rate of the bank itself. Each major banking group has such a prime rate. The bank itself adjusts its prime rate regularly according to changes in the general interest rate level. The use of money market rates has increased and the use of the base rate, a reference rate set by the government, has decreased over time (see BoF 2003, p. 136). Both the base rate and the prime rates reflect the general level of market rates.

The average interest rate of the loan stock is a simple function of relatively few factors, including changes in reference rates, the rates of new loans, the quantity of new loans and amortizations of old loans. Very few components of this process reflect behavioural choices of optimising agents. Basically, there are only two such factors, namely the prime rates that are set by banks themselves and the renewal process of the loan stock. Neither of these variables is explicitly included in the model of the table 7.

The loan stock re-pricing process is rather fuzzy because of the huge diversity of interest rate pegs, changes in the structure of these pegs and endogenously determined loan stock turnover. The amount of prepayments and the demand for new loans probably depend on macroeconomic factors and interest rates, which makes the impact of market rates on the average rate of the loan stock even more complicated. The abolition of the stamp duty probably changed the dynamics of prepayments. Therefore, it is not possible to say ex ante which combination of explanatory variables should be the best one. It would hardly be possible to construct a universally valid specification that would not be sample period specific.

2.3.2 Searching for a good fit

Different combinations and interactions of explanatory variables were tested. In practice, the final version of the regression equation was developed with an exploratory three stage process

1. Different combinations and interactions of potentially relevant explanatory variables and their squared values to detect possible non-linearity were tested. These explanatory variables included market rates, the trend and the lagged value of the dependent variable.
2. All the promising explanatory variables, including interactions between them and lagged values, were included in the model. The number of lags was optimised with the Akaike and Schwartz criteria; the optimal number of lags was found to be two on both criteria.

3. All the non-significant explanatory variables (each lag of an explanatory variable being treated as a separate variable) were dropped off.

As can be seen in the following table, the resulting equation has a very strong explanatory power.

Table 7. **OLS results, determinants of the average interest rate of the loan stock**

Dependent Variable: RLB
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44

Variable	Coefficient	t-Statistic	Prob.
C	-0.1520	-1.7762	0.0847
RLB(-1)	0.7843	20.1731	0.0000
RLBN(-2)	0.0811	2.3324	0.0257
MMRATE(-1)	0.2496	4.8625	0.0000
MMRATE(-1)^2	-0.0378	-5.1694	0.0000
MMRATE(-2)^2	0.0164	5.3403	0.0000
BR	0.0762	3.2654	0.0025
BR(-1)	-0.0794	-2.2368	0.0320
BR(-2)	0.0616	2.6523	0.0121
(MMRATE-MMRATE(-2))*@TREND	0.0056	17.5184	0.0000

R-squared	0.999119	Mean dependent var	6.243722
Adjusted R-squared	0.998885	S.D. dependent var	1.777903
S.E. of regression	0.059362	Akaike info criterion	-2.613617
Sum squared resid	0.11981	Schwarz criterion	-2.20812
Log likelihood	67.49958	F-statistic	4281.989
Durbin-Watson stat	2.184319	Prob(F-statistic)	0.0000

As can be seen in the appendix 5, there is no evidence on residual term autocorrelation or non-normality of residuals. Nevertheless, the evidence on heteroscedasticity of residuals is relatively close to significance.

Two explanatory variables of this equation need to be commented, namely

1. the interaction of the difference of the money market rate and the trend
2. the squared value of the money market rate.

As can be seen in table 7, the short-term impact of the interaction of the trend and the change of the money market rate {@TREND*(MMRATE-MMRATE(-2))} is highly significant, implying that the immediate impact of the money market rate on the average rate of the loan stock has been strengthening over time. This probably reflects the increasing use of Helibor and Euribor rates as reference rates. In this specification the long-term impact of this interaction on the loan stock rate is forced to zero. A permanent increase in the money market rate has an immediate impact on the loan stock rate, but despite of the persistence of the loan stock rate, the effect through this interaction term gradually vanishes. As can be seen in the second equation of table 8, if one relaxes the condition that the interaction of the trend and the money market rate cannot have a permanent impact on the average rate of the loan stock, two problems arise. First, the R^2 adjusted for the number of degrees of freedom marginally deteriorates. Secondly, the error term becomes autocorrelated. In this alternative specification the two interaction terms have regression coefficients that almost offset each other, and Wald test does not reject the null hypothesis that the coefficients of @TREND*MMRATE and @TREND*MMRATE(-2) in equation 2 of the table 8 sum up to zero (F-stat 0.524, prob 0.47). Hence, the specification used in the table six is consistent with the data.

The significance of the squared terms reflects the non-linear relationship between the loan stock rate and the money market rate. The main conclusion related to this non-linearity is that the money market rate affects the average rate of the loan stock weakly when interest rates are high. The presence of the squared terms gives rise to the possibility of a perverse effect of money market rates on loan rates. Technically, if the money market rate were higher than 5.83, the long-term direct impact of a small change in the money market rate on the bank lending rate would, according to the results, be negative. If the indirect impact of money market rates through the rate on new loans is included, the total long-term impact of the money market rate on the rate on new loans would be negative with a money market rate higher than 7.42. Money market rates higher than this were observed only during the first half of the year 1993, but not under more normal economic circumstances since then. Nevertheless, the results of the above analysis are local in the sense that they do not apply at very high market rates.

One possible explanation to the non-linear relationship between money market rates and bank loan rates might be the impact of interest rates on the demand for new loans; if rates are low, the demand for loans strengthens and new loans become rapidly a substantial part of the loan stock, implying that the market rate affects strongly the average rate of the loan stock. However, the evidence does not seem to favour such an interpretation. The ratio of new loans to the loan stock multiplied by the rate on new loans was not close to statistical significance, at least not in a relatively simple specification. The results are presented in the first equation in table 8. (NEWLOAN = Quantity of new loans granted during the period, LBTOT = Stock of loans at the end of the period.) Unsurprisingly, the statistical significance of the average rate on new loans weakens, but there is almost no change in the regression coefficients of the squared market rates.

Controlling for the 12 month Helibor/Euribor rate (RATE12M) has no impact on the statistical significance of the squared terms, implying that a possible correlation between the convexity of the yield curve and the level of short rates is not a likely explanation to the statistical significance of the squared term (see equation 3 in table 8). Neither can the non-linearity be explained by a hypothetical non-linear impact of money market rates on the rate of new loans. It might also be possible that the reference rates defined by banks themselves, the prime rates, have reacted to market rates in a non-linear way, but the median of the prime rates of the major banking groups does not seem to have such a property. (See appendix 6.)

It would also be possible to argue that there has been a reverse causality; high interest rates of the bank loan stock affect the money market rate, possibly in a non-linear way. This might have been possible especially before the introduction of the euro because the Helibor rate was an indicator of the market rate of Finnish banks' CDs, and the risk premium of these instruments may have depended on banks' interest income. This argument would, consequently, suggest that we use IV-estimation to account for the implied endogeneity problem. However, the 2SLS estimation results presented in equation 4 of the table 8, do not seem to contradict our previous OLS-results. The monetary policy tender rate (MPR) is a highly important instrument in the 2SLS estimation.

It is possible to calculate an estimate for the long-term impact of market interest rates on the rate of the bank loan stock. There are three factors to be taken into account.

– According to the results of table 4, a one percentage point increase in the short-term money market rate increases the rate on new loans by 0.845 percentage points, which increases the rate of the loan stock by $0.0811*0.845 \approx 0.0685$ percentage points, when no cumulative effects are taken into account.
– Moreover, there is the direct linear impact, which is 0.2496 percentage points. If one takes the sample mean of MMRATE (4.23) as a reference point, the total direct impact of the squared MMRATE on RLB is $2*4.23*(-0.0378+0.0164) = -0.18086$; the total direct impact of MMRATE on RLB is $+0.2496-0.18086 = +0.0688$, which is surprisingly close to zero.
– The aggregate impact of the two above mentioned effects is 0.1373.
– Because RLB depends on its own past, the effect is accumulated over time, and the total long-term impact of a permanent change of MMRATE on RLB, taking all the direct and indirect effects into account, equals
$0.1373+0.7843*0.1373+0.7843^2*0.1373+0.7843^3*0.1373\ldots =$
$0.168*\{1/(1-0.7843)\} \approx 0.637$

Table 8. **OLS results, determinants of the average interest rate of the loan stock**

	1	2	3	4 (2SLS)
C	-0.310	-0.189	-0.158	-0.227
	(-1.846)	(-1.889)	(-1.866)	(-2.214*)
RLB(-1)	0.827	0.810	0.757	0.822
	(15.256***)	(15.466***)	(17.449***)	(16.442***)
RLBN(-2)	0.050	0.087	0.097	0.031
	(0.990)	(2.417*)	(2.470*)	(0.612)
MMRATE(-1)	0.246358	0.173	0.232	0.296
	(2.609*)	(1.469)	(2.693*)	(-4.984***)
BR	0.074	0.071	-0.003	0.061
	(2.786**)	(2.878**)	(-0.078)	(2.373*)
BR(-1)	-0.078690	-0.075	-0.068	-0.048
	(-1.990)	(-2.070*)	(-1.242)	(-1.197)
BR(-2)	0.066	0.058	0.103	0.046
	(2.534*)	(2.451**)	(2.428*)	(1.807)
@TREND*(MMRATE-MMRATE(-2))	0.006		0.004	0.006
	(13.789***)		(6.198***)	(15.718***)
MMRATE(-1)^2	-0.040	-0.033	-0.038	-0.049
	(-3.771***)	(-3.185**)	(-4.524***)	(-5.436***)
MMRATE(-2)^2	0.017927	0.015	0.016	0.024
	(4.131***)	(3.674***)	(4.039***)	(5.363***)
RLBN*NEWLOAN/LBTOT	0.054			
	(0.317)			
RLBN(-1)*NEWLOAN(-1)/LBTOT(-1)	0.025			
	(0.186)			
RLBN(-2)*NEWLOAN(-2)/LBTOT(-2)	0.039			
	(0.258)			
@TREND*(MMRATE)		0.006		
		(13.124***)		
@TREND*MMRATE(-2)		-0.005		
		(-12.919***)		
RATE12M			0.161	
			(2.350*)	
RATE12M(-1)			0.021	
			(0.208)	
RATE12M(-2)			-0.111	
			(-1.442)	
R-squared	0.9991	0.9991	0.9993	0.9988
Adj R squared	0.9987	0.9989	0.9990	0.9985

Redundant variables in equation 1

RLBN*NEWLOAN/LBTOT RLBN(-1)*NEWLOAN(-1)/LBTOT(-1) RLBN(-2)*NEWLOAN(-2)/LBTOT(-2)

F-statistic	0.126	Probability	0.944
Log likelihood ratio	0.544	Probability	0.909

Breusch-Godfrey Serial Correlation LM Test for equation 2:

F-statistic	2.382	Probability	0.075
Obs*R-squared	10.883	Probability	0.028

Instrument list in equation 4

RLB(-1) RLBN(-2) BR(0 TO -2) MPR(0 TO -3) MPR^2 MPR(-1)^2 MPR(-2)^2 @TREND @TREND*(MMRATE-MMRATE(-2))

The long-term impact of the bond rate is somewhat simpler to calculate. It is (0.0762 -0.0794 +0.0616 +0.0811*0.0748)/(1-0.7843) ≈ 0.299. The results imply that in the long term, of a permanent, parallel one percentage point shift in the yield curve is transmitted to the average rate of the loan stock as a 0.64+0.30 = 0.94 percentage point shift. With lower short-term rates the impact is somewhat stronger, and with higher rates it is somewhat weaker.

2.3.3 Imposing linearity and complete long term pass through

The non-linear specification of the loan stock equation of table 7 is strongly supported by the data. However, it is difficult to understand why the effects of market rates on the loan stock rate would be non-linear. It is possible, of course, that this non-linearity may depend on some unknown sample-specific factors. Thus, it may also be reasonable to simply ignore the statistical evidence in this context and impose linearity on the equation. In the following specification, all the squared terms are omitted.

Moreover, there is another property that has been imposed on the following equation, namely complete long term pass-through of market rates and rates on new loans on the average rate on the loan stock. Hence, in the following specification, the sum of regression coefficients of all the interest rates, including the rate on new loans, is forced to equal one. After some experiments, the bond rate was dropped out because it did not enter significantly.

Table 9. **OLS results, determinants of the average interest rate of the loan stock**

Dependent Variable: RLB
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44
RLB= C(1)+C(2)*RLB(-1)+C(3)*MMRATE+C(4)*MMRATE(-1)
+(1-C(2)-C(3)-C(4))*RLBN(-2)+C(5)*(MMRATE-MMRATE(-2))*@TREND

	Coefficient		t-Statistic	Prob.
C(1)	0.1083		2.7369	0.0093
C(2)	0.8426		26.6552	0.0000
C(3)	0.2523		5.8566	0.0000
C(4)	-0.2008		-4.8594	0.0000
C(5)	0.0036		7.6927	0.0000
R-squared	0.998545	Mean dependent var		6.243675
Adjusted R-squared	0.998395	S.D. dependent var		1.777975
S.E. of regression	0.071223	Akaike info criterion		-2.33935
Sum squared resid	0.197837	Schwarz criterion		-2.136601
Log likelihood	56.4657	Durbin-Watson stat		2.008705

In the light of the Wald test the hypothesis that the sum of the regression coefficients on interest rates on equals one is well consistent with the data, which is not very surprising. There are no serious diagnostic problems (See appendix 7). Because the hypothesis of complete market rate pass-through to the rate of new loans is not entirely inconsistent with the data (see section 2.2), it is possible that the pass-through of market rates is complete in the long term.

3 Conclusions

This paper presents equations on bank rates in Finland over the period 1993–2003, one for the rate on deposits, two for the rate on new loans and two different versions of the equation of the average rate on the loan stock. These equations were estimated entirely separately. There is almost no correlation in the error terms of the three main regressions of the tables 1, 4 and 7, implying no particular need to run SUR regressions. (See appendix 8).

Most of the findings are not particularly surprising. Market rates have a very strong impact on bank rates, which should not surprise anyone. Money market rates have a stronger impact than bond rates. In the case of lending rates, the long-term pass-through is at least almost perfect. In the case of deposits, the pass-through is far from perfect even in the long term. There is no evidence that banks' competition with interest rates would have intensified, either in the market for deposits or in the market for loans.

If banks have market power in the lending market, one might expect that the margin between market rates and rates on new loans would be higher during booms; a firm with market power would normally react to intense demand not only by serving more customers but also by charging higher prices. There is, however, no evidence of this kind of pricing. Instead, there is some evidence on the existence of extra credit risk premiums during recessions. The credit risk can also be relatively well proxied by the number of bankruptcies which does also have clear predictive power.

Interest rate risks seem to be reflected in the statistical significance of the bond rate volatility. As to the development of the average rate on the loan stock, it seems that the immediate impact of the money market rate has been strengthening over time. Interestingly, the impact of the money market rate on the loan stock rate is non-linear; with low interest rates the effect is stronger. No satisfactory explanation to this phenomenon was found.

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Appendix 1

Unit root tests of interest rates

Null hypothesis: variable has a unit root.
Exogenous: Constant
Test equation sample Q1/1993-Q4/2003

Variable	Lag Length (Automatic, based on SIC, MAXLAG=10)	Augmented Dickey-Fuller test statistic, t-statistic	Prob*
RLBN	1	-3.5460	0.0112
RLB	1	-2.7882	0.0682
RDT	5	-6.2490	0.0000
BR	1	-3.0740	0.0359
MMRATE	1	-3.0341	0.0394

* MacKinnon (1996) one-sided p-values

Test critical values	1% level	-3.58851
	5% level	-2.92973
	10% level	-2.60306

Appendix 2

Residual tests for the equation for deposits

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.575507	Probability	0.2047
Obs*R-squared	7.239543	Probability	0.1238

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	t-Statistic	Prob.
C	-0.160	-0.413	0.683
RDT(-1)	0.008	0.302	0.765
MMRATE	-0.010	-0.437	0.665
BR	0.009	0.632	0.532
BR(-2)	0.000	0.028	0.978
VTON	0.028	0.495	0.624
EMU	0.002	0.049	0.961
@TREND	0.001	0.367	0.716
RESID(-1)	0.193	0.929	0.360
RESID(-2)	-0.235	-1.167	0.252
RESID(-3)	-0.266	-1.361	0.183
RESID(-4)	-0.077	-0.360	0.722

R-squared	0.164535	Mean dependent var	0.0000
Adjusted R-squared	-0.122656	S.D. dependent var	0.0587
S.E. of regression	0.062204	Akaike info criterion	-2.49
Sum squared resid	0.12382	Schwarz criterion	-2.003
Log likelihood	66.77529	F-statistic	0.5729
Durbin-Watson stat	1.915097	Prob(F-statistic)	0.8361

Heteroscedasticity

ARCH Test:			
F-statistic	1.323812	Probability	0.2804
Obs*R-squared	5.256448	Probability	0.262

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1994Q1 2003Q4
Included observations: 40 after adjustments

Variable	Coefficient	t-Statistic	Prob.
C	0.003	2.550	0.015
RESID^2(-1)	0.389	2.228	0.032
RESID^2(-2)	-0.227	-1.225	0.229
RESID^2(-3)	0.100	0.539	0.594
RESID^2(-4)	-0.103	-0.592	0.558

R-squared	0.131411	Mean dependent var	0.0034
Adjusted R-squared	0.032144	S.D. dependent var	0.0046
S.E. of regression	0.004504	Akaike info criterion	-7.851
Sum squared resid	0.00071	Schwarz criterion	-7.64
Log likelihood	162.0206	F-statistic	1.3238
Durbin-Watson stat	1.963096	Prob(F-statistic)	0.2804

Residual normality

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	1.24E-16
Median	0.001761
Maximum	0.104531
Minimum	-0.145503
Std. Dev.	0.058708
Skewness	-0.405547
Kurtosis	2.669989
Jarque-Bera	1.405762
Probability	0.495157

Appendix 3

Residual tests for the first equation for new loans

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.004228	Probability	0.419794
Obs*R-squared	4.907255	Probability	0.296947

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	t-Statistic	Prob.
C	-0.1456	-0.6226	0.538
MMRATE	-0.0084	-0.2166	0.8299
GDPGAP	1.3229	0.5325	0.598
EMU	0.0458	0.5552	0.5826
BNDRV	0.4715	0.1548	0.8779
BNDRV(-5)	0.3502	0.1061	0.9162
BR	0.0016	0.0561	0.9556
BNKRPTC(-1)	0.0001	0.6228	0.5378
RESID(-1)	0.3364	1.7589	0.0882
RESID(-2)	-0.0562	-0.3008	0.7655
RESID(-3)	-0.0758	-0.3813	0.7055
RESID(-4)	0.2046	0.9946	0.3274

R-squared	0.111529	Mean dependent var	4.89E-16
Adjusted R-squared	-0.193884	S.D. dependent var	0.147647
S.E. of regression	0.161326	Akaike info criterion	-0.583775
Sum squared resid	0.832837	Schwarz criterion	-0.097178
Log likelihood	24.84306	F-statistic	0.365174
Durbin-Watson stat	1.874549	Prob(F-statistic)	0.960476

Heteroscedasticity

ARCH Test:			
F-statistic	0.700529	Probability	0.596841
Obs*R-squared	2.965035	Probability	0.563694

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1994Q1 2003Q4
Included observations: 40 after adjustments

Variable	Coefficient	t-Statistic	Prob.
C	0.031	3.11412	0.0037
RESID^2(-1)	-0.142	-0.852207	0.3999
RESID^2(-2)	-0.115357	-0.687478	0.4963
RESID^2(-3)	-0.196368	-1.136188	0.2636
RESID^2(-4)	0.090629	0.526154	0.6021

R-squared	0.074126	Mean dependent var	0.022968
Adjusted R-squared	-0.031688	S.D. dependent var	0.031111
S.E. of regression	0.0316	Akaike info criterion	-3.954839
Sum squared resid	0.03495	Schwarz criterion	-3.743729
Log likelihood	84.09678	F-statistic	0.700529
Durbin-Watson stat	2.004271	Prob(F-statistic)	0.596841

Residual normality

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	4.89E-16
Median	0.001629
Maximum	0.298531
Minimum	-0.400182
Std. Dev.	0.147647
Skewness	-0.115377
Kurtosis	2.955387
Jarque-Bera	0.101269
Probability	0.950626

Appendix 4

Residual tests for the second equation for new loans; Complete pass-through of market rates

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.105238	Probability	0.102397
Obs*R-squared	8.945276	Probability	0.062482

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	t-Statistic	Prob.
C(1)	-0.132257	-0.55087	0.5854
C(2)	-0.001852	-0.059856	0.9526
C(3)	0.59123	0.214206	0.8317
C(4)	0.048036	0.573851	0.57
C(5)	0.615629	0.199763	0.8429
C(6)	0.684464	0.193748	0.8476
C(8)	7.11E-05	0.477293	0.6363
RESID(-1)	0.441359	2.475136	0.0186
RESID(-2)	0.082697	0.443253	0.6605
RESID(-3)	-0.182603	-0.949539	0.3492
RESID(-4)	0.171799	0.866413	0.3925

R-squared	0.203302	Mean dependent var	1.41E-16
Adjusted R-squared	-0.038122	S.D. dependent var	0.171161
S.E. of regression	0.174393	Akaike info criterion	-0.442693
Sum squared resid	1.003626	Schwarz criterion	0.003355
Log likelihood	20.73924	Durbin-Watson stat	1.851112

Heteroscedasticity

ARCH Test:			
F-statistic	0.545116	Probability	0.703695
Obs*R-squared	2.345815	Probability	0.672441

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1994Q1 2003Q4
Included observations: 40 after adjustments

Variable	Coefficient	t-Statistic	Prob.
C	0.036	2.688	0.011
RESID^2(-1)	-0.084	-0.503	0.618
RESID^2(-2)	-0.158	-0.916	0.366
RESID^2(-3)	-0.073	-0.407	0.687
RESID^2(-4)	0.138	0.771	0.446

R-squared	0.058645	Mean dependent var	0.030495
Adjusted R-squared	-0.048938	S.D. dependent var	0.040015
S.E. of regression	0.040982	Akaike info criterion	-3.434882
Sum squared resid	0.058784	Schwarz criterion	-3.223772
Log likelihood	73.69763	F-statistic	0.545116
Durbin-Watson stat	1.954661	Prob(F-statistic)	0.703695

Residual normality

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	1.41E-16
Median	-0.010683
Maximum	0.360542
Minimum	-0.421669
Std. Dev.	0.171161
Skewness	-0.050696
Kurtosis	2.777608
Jarque-Bera	0.109521
Probability	0.946712

Appendix 5

Residual tests for the first loan stock equation

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.958508	Probability	0.444469
Obs*R-squared	4.986027	Probability	0.288734

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	t-Statistic	Prob.
C	0.0045	0.0516	0.9592
RLB(-1)	0.0110	0.2768	0.7838
RLBN(-2)	-0.0024	-0.0681	0.9462
MMRATE(-1)	-0.0145	-0.2684	0.7903
MMRATE(-1)^2	0.0027	0.3379	0.7378
MMRATE(-2)^2	-0.0012	-0.3557	0.7246
BR	-0.0030	-0.1199	0.9054
BR(-1)	0.0048	0.1208	0.9047
BR(-2)	-0.0064	-0.2510	0.8035
MMRATE*@TREND-MMRATE(-2)*@	-0.0001	-0.2018	0.8414
RESID(-1)	-0.1776	-0.9096	0.3703
RESID(-2)	-0.3487	-1.8340	0.0766
RESID(-3)	-0.1339	-0.6642	0.5117
RESID(-4)	-0.0335	-0.1639	0.8709

R-squared	0.113319	Mean dependent var	1.66E-15
Adjusted R-squared	-0.27091	S.D. dependent var	0.052785
S.E. of regression	0.059507	Akaike info criterion	-2.552069
Sum squared resid	0.106233	Schwarz criterion	-1.984372
Log likelihood	70.14551	F-statistic	0.294926
Durbin-Watson stat	2.000207	Prob(F-statistic)	0.988367

Heteroscedasticity

ARCH Test:			
F-statistic	2.420188	Probability	0.066768
Obs*R-squared	8.666598	Probability	0.069995

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1994Q1 2003Q4
Included observations: 40 after adjustments

Variable	Coefficient	t-Statistic	Prob.
C	0.003	3.132981	0.0035
RESID^2(-1)	-0.079	-0.498721	0.6211
RESID^2(-2)	0.365	2.448334	0.0195
RESID^2(-3)	-0.132187	-0.890733	0.3792
RESID^2(-4)	-0.320548	-2.158693	0.0378

R-squared	0.216665	Mean dependent var	0.002439
Adjusted R-squared	0.127141	S.D. dependent var	0.003882
S.E. of regression	0.003627	Akaike info criterion	-8.284564
Sum squared resid	0.00046	Schwarz criterion	-8.073454
Log likelihood	170.6913	F-statistic	2.420188
Durbin-Watson stat	2.019427	Prob(F-statistic)	0.066768

Residual normal distribution

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	1.66E-15
Median	0.003306
Maximum	0.091521
Minimum	-0.147835
Std. Dev.	0.052785
Skewness	-0.348915
Kurtosis	3.078721
Jarque-Bera	0.904131
Probability	0.636312

Appendix 6

Hypotheses on the non-linear relationship between loan stock rates and money market rates

Dependent Variable: RLBN
Method: Least Squares
Sample: 1993Q1 2003Q4
Included observations: 44

Variable	Coefficient	t-Statistic	Prob.
C	-0.106	-0.101	0.920
MMRATE	0.789	5.096	0.000
GDPGAP	-8.132	-3.161	0.003
EMU	-0.591	-4.947	0.000
BNDRV	9.062	2.884	0.007
BNDRV(-5)	7.407	2.049	0.049
BR	0.076	2.090	0.045
BNKRPTC(-1)	0.001	3.474	0.002
@TREND	0.009	1.085	0.286
MMRATE^2	0.010	0.504	0.618
MMRATE(-1)^2	0.001	0.093	0.926
MMRATE(-2)^2	-0.003	-0.509	0.614
R-squared	0.994147	Mean dependent var	5.651523
Adjusted R-squared	0.992134	S.D. dependent var	1.871198
S.E. of regression	0.165953	Akaike info criterion	-0.52723
Sum squared resid	0.88129	Schwarz criterion	-0.04063
Log likelihood	23.599	F-statistic	494.0797
Durbin-Watson stat	1.56675	Prob(F-statistic)	0.0000

Redundant Variables: MMRATE^2 MMRATE(-1)^2 MMRATE(-2)^2

F-statistic	0.175985	Probability	0.911871
Log likelihood ratio	0.720017	Probability	0.868486

Dependent Variable: PRIMEMEDIAN Method: Least Squares Sample (adjusted): 1993Q2 2003Q4 Included observations: 43 after adjustments Dependent variable: Median of major banks' prime rates			
Variable	**Coefficient**	**t-Statistic**	**Prob.**
C	-0,322	-0,870	0,391
PRIMEMEDIAN(-1)	0,271	1,763	0,088
MMRATE	0,319	0,905	0,372
MMRATE(-1)	0,803	1,709	0,097
MMRATE(-2)	-0,653	-2,755	0,010
BR	0,398	5,087	0,000
BR(-1)	-0,257	-2,174	0,037
BR(-2)	0,254	2,867	0,007
MMRATE^2	-0,003	-0,087	0,931
MMRATE(-1)^2	-0,052	-1,153	0,258
MMRATE(-2)^2	0,035	1,740	0,091
R-squared	0,988904	Mean dependent var	4,706395
Adjusted R-squared	9,85E-01	S.D. dependent var	1,5146
S.E. of regression	1,83E-01	Akaike info criterion	-0,344943
Sum squared resid	1,06903	Schwarz criterion	0,105596
Log likelihood	18,41628	F-statistic	285,1926
Durbin-Watson stat	2,155448	Prob(F-statistic)	0,0000

Redundant Variables: MMRATE^2 MMRATE(-1)^2 MMRATE(-2)^2			
F-statistic	1,174747	Probability	0,3347
Log likelihood ratio	4,492615	Probability	0,21295

PRIMEMEDIAN is the median of the prime rates of the following banking groups:

Q1/1993: Okobank group, Postipankki
Q2/1993–Q1/1995: Okobank group, Postipankki, KOP, Union Bank of Finland
Q2/1995–Q4/2003: Okobank group, Postipankki/Leonia/Sampo, Merita/Nordea

Appendix 7

Tests for the second loan stock equation

Hypothesis of complete pass-through of interest rates

Wald Test:
Equation: RLBYHT2
RLB= C(1)+C(2)*RLB(-1)+C(3)*MMRATE+C(4)*MMRATE(-1)+C(5)*RLBN(-2)+C(6)*(MMRATE-MMRATE(-2))*@TREND

Test Statistic	Value	df	Probability
F-statistic	0.150326	(1, 38)	0.7004
Chi-square	0.150326	1	0.6982

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(2) + C(3) + C(4) + C(5) = 0	0.003782	0.009754

Restrictions are linear in coefficients.

Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.009723	Prob. F(4,35)	0.415692
Obs*R-squared	4.552158	Prob. Chi-Square(4)	0.336408

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	t-Statistic	Prob.
C(1)	-0.0021	-0.0522	0.9587
C(2)	0.0074	0.2252	0.8231
C(3)	-0.0107	-0.2115	0.8337
C(4)	0.0112	0.2310	0.8187
C(5)	0.0000	0.0619	0.9510
RESID(-1)	-0.0515	-0.2933	0.7710
RESID(-2)	-0.3037	-1.7182	0.0946
RESID(-3)	-0.0865	-0.4591	0.6490
RESID(-4)	0.0549	0.2784	0.7823

R-squared	0.103458	Mean dependent var	4.03E-16
Adjusted R-squared	-0.101466	S.D. dependent var	0.06783
S.E. of regression	0.071188	Akaike info criterion	-2.266742
Sum squared resid	0.177369	Schwarz criterion	-1.901794
Log likelihood	58.86833	Durbin-Watson stat	1.977186

Heteroscedasticity

ARCH Test:			
F-statistic	1.330166	Prob. F(4,35)	0.278093
Obs*R-squared	5.278351	Prob. Chi-Square(4)	0.25991

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample (adjusted): 1994Q1 2003Q4
Included observations: 40 after adjustments

Variable	Coefficient	t-Statistic	Prob.
C	0.0026	2.3773	0.0230
RESID^2(-1)	0.1691	1.0142	0.3175
RESID^2(-2)	0.1545	1.1404	0.2619
RESID^2(-3)	0.0664	0.4865	0.6297
RESID^2(-4)	-0.1461	-1.1871	0.2432

R-squared	0.131959	Mean dependent var	0.003501
Adjusted R-squared	0.032754	S.D. dependent var	0.004809
S.E. of regression	0.00473	Akaike info criterion	-7.753286
Sum squared resid	0.000783	Schwarz criterion	-7.542177
Log likelihood	160.0657	F-statistic	1.330166
Durbin-Watson stat	2.038998	Prob(F-statistic)	0.278093

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	4.03E-16
Median	0.002998
Maximum	0.138038
Minimum	-0.171716
Std. Dev.	0.06783
Skewness	-0.202192
Kurtosis	2.989357
Jarque-Bera	0.300007
Probability	0.860705

Residual normal distribution

Series: Residuals
Sample 1993Q1 2003Q4
Observations 44

Mean	4,03E-16
Median	0,002998
Maximum	0,138038
Minimum	-0,171716
Std. Dev.	0,06783
Skewness	-0,202192
Kurtosis	2,989357
Jarque-Bera	0,300007
Probability	0,860705

Appendix 8

Correlations between regression residuals

Residuals of the regressions presented in the tables 1, 4 and 7

	RLBRESID	*RLBNRESID*	*RDTRESID*
RLBRESID	1.0000	0.2001	0.1428
RLBNRESID	0.2001	1.0000	0.1333
RDTRESID	0.1428	0.1333	1.0000

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