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FORWARD-LOOKING REACTION TO BANK REGULATION

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Abstract. This paper presents evidence that banks react to regulation in a forward-looking manner. A case study documents a reaction to Basel II as early as 2000, in other words about seven years prior to the implementation of the regulation in 2007. Based on the initial information released on Basel II, banks loosened their credit policies towards households. The changes were substantial, improving household credit availability by 20-50%. A new approach to estimate borrowing constraints from loan samples is also presented.

Keywords: Credit policy, Borrowing constraints, Bank regulation.

JEL classification: D14, E32, E51, G21

Non-technical summary

The paper presents empirical evidence that banks react to regulation in a forward looking manner. In a case study of Finnish banks 1998-2004, a reaction to Basel II is found already at the turn of the century, about seven years before de jure implementation of the regulation in 2007. Identification of the regulatory effect is based jointly on three independent approaches. Loan market indicators are studied to uncover evidence about changes in bank behavior when new information about Basel II was released. Survey techniques are employed to uncover information from banking professionals about changes in credit policies driven by Basel II around this time. Quantitative evidence about changes in credit policies when the regulation was under preparation in the Basel committee is obtained from loan samples based on a novel econometric approach.

The three approaches yield a consistent view about changes in credit policies driven by expectations about Basel II. The study of loan market indicators reveals significant structural changes in the loan market following the first information release about Basel II: an increase in the growth rate of housing loans relative to corporate loans, and a decrease in the interest margin of housing loans. The survey of information from banking professionals yields qualitative evidence about changes in credit policies towards households around this time, based on the expectation that Basel II will decrease the capital cost of household loans. To increase the share of such loans in their portfolios, banks loosened credit policies towards household borrowers. The analysis of loan samples with the novel econometric approach corroborates these findings, and makes the changes in credit policies and credit availability of

borrowers susceptible to quantitative study. The estimations indicate that the changes in credit policies were substantial contributing to an increase in credit availability of households by 20–50 percent on average.

Besides new results, the present paper also contributes to the literature a novel econometric approach to estimate borrowing constraints and the related credit policy parameters of lenders. The methodological contribution builds on the insight that, under specified conditions, stochastic frontier analysis of a loan sample yields quantitative estimates of borrowing constraints in parametric form. The novel approach to estimate borrowing constraints complements the earlier approaches in the finance literature (see Hainz and Nabokin 2013, Bhaumik, Das and Kumbakhar 2012; Campello, Graham, and Harvey 2010; Whited and Wu 2006) by opening the possibility to study borrowing constraints from loan samples. It has broad applicability since suitable data of loans is widely available in household surveys and corporate balance sheets. Compared with earlier approaches, the novel approach seems particularly well suited for testing quantitative hypotheses about borrowing constraints and the related credit policies of lenders.

The estimation results contribute to our understanding about how capital regulation influences bank behavior. The most important new result is the existence of an expectations channel of regulation: banks may react to regulation strongly many years before it is implemented. The results have important policy implications for the design of bank regulation and the timing of regulatory changes. The novel approach to estimate borrowing constraints opens a wide agenda of research about credit availability and its role in economic activity.

1. Introduction

Do banks react to financial regulation before it even becomes law? It is well known that they react to prevailing regulation (Acharya et al., 2013; Hanson et al.., 2011) and prepare for expected macroeconomic developments (Repullo and Suarez, 2013; Jiménez et al., 2012). However, the question of whether banks' react to expected changes in regulation remains largely unexplored. This issue raises concerns about our understanding of banking, especially during times of significant regulatory change. Such periods are not uncommon. In Europe, for example, the implementation of Basel II in 2007 after a decade of preparation was followed shortly by the Basel III project. This study sheds light on whether banks react to regulation in a forward-looking manner. The analysis reveals that there was a strong reaction to Basel II after the first consultative documents about the regulation were released around 2000. The results are based on a case study of Finnish banks over the period 1998-2004, when the Basel II was still under development in the Basel Committee.

These results are the outcome of an innovative approach to identifying regulatory effects. The lack of previous evidence about forward-looking reaction to regulation reflects in part the challenge of identifying it. In the empirical literature, a standard identification strategy is to compare bank behavior across de jure regimes (Delis et al. 2013; Ongena et al., 2013; and references). This standard approach cannot, however, be used to test forward-looking behavior due to the uncertainty about timing. In order to resolve this issue, this paper identifies forward-looking reactions based on three approaches. Loan market indicators are studied to uncover evidence about changes in behavior at the time when new information

about Basel II was released. Survey techniques are employed to glean information from banking professionals about changes in credit policies driven by Basel II around this time. Quantitative evidence on changes in credit policies during the time when the regulation was under preparation in the Basel Committee is obtained from loan samples based on a novel econometric approach.

The three approaches yield a consistent view about changes in credit policies driven by expectations about Basel II. The study of loan market indicators reveals significant structural changes in the loan market after the first information was released about Basel II. The analysis shows an increase in rate of growth in housing loans relative to corporate loans, and a decrease in the interest margin on housing loans. The survey of banking professionals yields qualitative evidence about changes in credit policies towards households around this time, based on the expectation that Basel II would decrease the capital cost of household loans. To increase the share of such loans in their portfolios, banks loosened credit policies towards household borrowers. They cut interest rate margins and improved credit availability by allowing higher loan-to-value ratios and longer loan maturities. The analysis of loan samples using the novel econometric approach corroborates these findings and makes it possible to submit the changes in credit policies and credit availability of borrowers to quantitative study. The estimations indicate that the changes in credit policies were substantial, contributing to an increase in credit availability of households by 20-50% on average.

The three empirical approaches all have weaknesses. However, since the approaches are independent in terms of data and methodology, identification of a forward-looking reaction is

arguably considerably strengthened by consilience. The hypothesis that banks react to regulation in a forward-looking manner is further confirmed by cross-validation with euro area data. Clear signs of early regulatory impact can be found in euro area bank lending surveys, in particular in the run-up to Basel III.

The quantitative assessment of the early impact of Basel II in Finland is based on the use of a novel econometric approach to estimate borrowing constraints and the related credit policy parameters of lenders. This methodology builds on the insight that, under specified conditions, stochastic frontier analysis of a loan sample yields quantitative estimates of borrowing constraints in parametric form. The key assumption is continuity of the loan distribution up to the constraint: the constraint is then the maximum of the loan distribution. This approach to estimating borrowing constraints complements the earlier approaches used in the field of finance (Hainz and Nabokin, 2013, Bhaumik et al., 2012; Campello et al., 2010; Whited and Wu, 2006), by opening up the possibility of studying borrowing constraints based on loan samples. It has broad applicability, since suitable data on loans is widely available in household surveys and corporate balance sheets. Compared with earlier approaches, it seems particularly well suited for testing quantitative hypotheses about borrowing constraints and the related credit policies of lenders.

For the regulatory debate, the novel approach opens up new avenues of research on the bank lending channel of regulation, which is the influence of regulation via banks' credit policies on economic developments. Based on published balance sheets and income statements, previous studies have shed light on the influence of regulation on the portfolios of banks (Klomp and de Haan, 2012; Demirgüc-Kunt and Detragiache, 2011; Barth et al., 2004),

and on the portfolios of borrowers (Vig, 2013; Lilienfeld-Toal et al., 2012). Building on rare data on loan contracts, Jiménez et al. (2012) and Cerqueiro et al. (2011) study the impact of regulation on loan terms and access to loans. Using this novel approach, quantitative evidence about the influence of regulation on banks' credit policies and the credit availability of borrowers may be obtained from widely available data on loans.

The significant benefit of such evidence is that it bridges the gap between what is known about the effects of regulation and what previous research has revealed about the effects of credit policies and credit availability on economic developments. Previous studies (Vig, 2013; Lilienfeld-Toal et al., 2012) have demonstrated that tightening credit standards has a negative impact on borrowing. Previous research has also established a positive link between credit availability and real activity during the run-up to Basel II (Campello et al., 2010). Based on previous findings, it seems likely that the large changes in credit policies and credit availability uncovered in this study had a marked impact on borrowing and real activity. By bringing about a loosening of credit policies towards households and an increase in their credit availability, Basel II may have contributed to an increase in household borrowing and housing demand in the run-up to the global financial crisis.

The present findings also contribute new insights into other channels of influence of the capital adequacy requirements. Besides changes in credit conditions, earlier research has shown that Basel II also contributed to regulatory arbitrage. Acharya et al. (2013) show that capital regulation promoted the rise of 'shadow banking' in the 2000s as banks resorted to specialized financial instruments to minimize capital costs. Shin (2012) puts forward the idea that regulatory arbitrage between Basel II influenced European banks and US banks was

transmitting household credit risks from the United States to Europe as early as the mid-2000s. His view that Basel II was already having an impact on bank behavior before its legal implementation in Europe anticipates our results about forward-looking reactions to regulation.

The main finding of this paper is the existence of an 'expectations channel' of regulation. This result is at odds with the premise in much of the previous literature that regulatory impact starts from the time of implementation. That banks may react strongly to anticipated changes in regulation many years before the change in law takes effect may in part explain why the evidence about the link between banks and regulatory regimes has been mixed (Klomp and de Haan, 2012; Demirgüc-Kunt and Detragiache, 2011; Barth et al., 2004). The finding of an expectations channel has important policy-implications also for the timing of regulatory changes. A failure to account for forward-looking behavior can lead to changes in regulation that are ill timed. As discussed below, there are already signs that the ongoing drive towards tightened capital regulation under Basel III is contributing to a further decline in credit availability during a period of deep macroeconomic disturbance.

Anecdotal evidence points to the presence of many different behavioral drivers in the expectations channel. Early reaction could, for example, promote capacity-building: banks need time to implement changes in information systems and organizational structure, to search for expert personnel and find new customers. Regulation may also influence the economies of commitment: since retail loans are illiquid long-term contracts, it may be economical for banks to condition credit policies on expected regulation throughout the maturity spectrum. The regulatory process may also influence banks via information

building: the process of regulation may reveal new information about the economies of lending which banks utilize to their advantage. Banks may implement regulation early to signal strength to depositors and investors. Regulatory effects may be transmitted via competition even to other financial institutions that are not directly influenced by it. The way in which the expectation channel works has important implications for the design of the regulatory process. Transparency and length of adjustment are, for example, of particular concern when capacity-building and commitment are significant concerns. Legal implementation may not even be necessary where information and signaling dominate as behavioral drivers. Future studies will hopefully shed further light on these issues.

The remainder of the paper is structured as follows. Section 2 presents the methodology. This is followed by a discussion of the data and the estimation period. The estimation results with the three approaches are then presented. In the concluding section, we discuss the extension of the results to the euro area and provide some views about the future agenda.

2. Methodology

To test forward-looking reaction to Basel II, we study banks in Finland in the period 1998-2004, when the regulation was under preparation in the Basel Committee. The analysis is based on loan market indicators, survey data from banking professionals and borrower surveys.

Loan market indicators are tested for signs of instability in response to the main information releases about Basel II. Since the economically most significant change indicated

by the information releases was a decrease in the capital burden of household lending, the analysis focuses on two indicators about pricing and volume of household loans: the interest rate margin between new housing loans and money market instruments, and the growth differential between housing loans and corporate loans. The analysis builds on established statistical methods for testing regime shifts in time series data.

The survey of qualitative evidence from banking professionals combines different data sources and methods based on feasibility. The study covers annual reports from the leading banks, published reports from the banking supervisor, and bank lending survey material from the central bank. We also interviewed insiders who were working as senior loan officers at the largest banks during that period.

The analysis of loan market indicators and the survey of banking professionals yield indirect and qualitative evidence of changes in banks' credit policies towards households in anticipation of Basel II in the early 2000s. The use of a novel econometric approach permits a quantitative study to be carried out of the changes in credit policy.

To formalize the approach, the *borrowing constraints* faced by households are characterised as follows:

$$Loans_{it} < \alpha_t + \beta_t X_{it} + v_{it} \quad (1)$$

where *i* and *t* indicate household and time respectively, *Loans* denotes the loan stock (in logs), *X* denotes household characteristics (to be specified), *v* is an independent normal random variable with zero mean, and α and β are banks' credit policy parameters. A borrowing constraint imposes an upper bound on borrowing, a *credit limit*, at $\alpha + \beta X + v$. *Credit availability* is the value of the limit.

To transform the borrowing constraint into a form that can be estimated, define the distance from the credit limit *u*:

$$u_{it} \equiv \alpha + \beta X_{it} + v_{it} - Loans_{it} \quad (2)$$

Furthermore, include *Wealth*, the market value of wealth, and *Income*, the annual disposable income of the household, in the *X* vector (both in logs). Good banking practice requires that household borrowers show sufficient collateral and loan service ability from current income. Since the collateral requirement and loan service ability requirement apply jointly, we include a cross-term between wealth and income to control for the interrelationship between the two requirements. Group dummies for age and education (see notes to Table II) are included to control variation in long-run income expectations. A clean repayment record was an asset, but this variable is not observed. The robustness of the estimation results to the missing variable bias is tested by a proxy approach.

The borrowing constraint (1) can then be reformulated as a stochastic frontier:

$$Loans_{it} = \alpha + \beta_W Wealth_{it} + \beta_Y Income_{it} + \beta_{WY} Wealth_{it} Income_{it} + v_{it} - u_{it} \quad (3)$$

The parameters α, β_W, β_Y, β_{WY} are respectively the fixed effect, the independent effects of wealth and income, and the cross effect. Since *Loans* and *Wealth* are in natural logarithms, a change in the fixed effect implies, ceteris paribus, a constant proportional change in the borrowing constraint across all levels of wealth and income, i.e. a level shift in the maximum loan-to-value and maximum loan-to-income ratios. Changes in the independent and cross effects imply a shift in the elasticity of the constraint relative to these variables.

The data used is a pooled cross-section of household surveys carried out in 1998 and 2004, at the start and the end of the period of the Basel II preparations. The model is estimated by the method of maximum likelihood under the standard assumptions in the stochastic frontier literature that *v* and *u* are independent random variables, *v* is normal and *u* is truncated normal, half normal or exponential. Two model variants are used to test changes in overall credit availability of households and in the fixed, independent and cross effects. Changes in overall credit availability are estimated from the model:

$$Loans_{it} = \alpha + \beta_W Wealth_{it} + \beta_Y Income_{it} + \beta_{WY} Wealth_{it} Income_{it} + \delta T_{2004} + v_{it} - u_{it} \quad (4)$$

where T_{2004} is the time dummy of year 2004. The analysis is based on the t-test of the time-fixed effect δ in model (4). Changes in specific credit policy parameters are estimated from the model:

$$\begin{aligned} Loans_{it} = {} & \alpha + \beta_W Wealth_{it} + \beta_Y Income_{it} + \beta_{WY} Wealth_{it} Income_{it} \\ & + \delta_D T_{2004} + \delta_W T_{2004} Wealth_{it} + \delta_Y T_{2004} Income_{it} \\ & + \delta_{WY} T_{2004} Wealth_{it} Income_{it} \\ & + v_{it} - u_{it} \end{aligned} \quad (5)$$

Parameters δ_D δ_W, δ_Y and δ_{WY} indicate, respectively, changes in the time-fixed effect, the independent effects of wealth and income, and the cross effect.

In order to better understand the novel approach, consider a simplified scenario with a continuum of borrowers and a single common borrowing constraint (Figure 1). The loan distribution is located entirely to the left of the borrowing constraint because, by definition,

the constraint is the maximum amount of borrowing. It is obvious from Figure 1 that the key assumption that allows the constraint to be estimated is continuity of the loan distribution up to the constraint. The constraint is then the maximum of the distribution. Since v, capturing measurement error and random variation in the constraint, is zero by assumption in this example, the observed loan distribution corresponds with the distribution of $-u$ in the stochastic frontier model. In practice, there is always random variation reflecting measurement error or 'luck in credit negotiations': the observed loan distribution is then the distribution of $v-u$. In real data, the 'truncation' of the observed loan distribution at the constraint is therefore not clear cut, and the constraint is not transparent.

In theoretical studies, the loan distribution is shaped by the reaction by agents to an underlying loan demand shock distribution and the borrowing constraint. In large samples at least, it is natural to assume that the loan demand shocks are distributed normally. In a neo-classical economy, where borrowing constraints do not apply, the loan distribution is therefore normal. The stochastic frontier model is not applicable in this case, because the standard assumptions impose a negative skew on the loan distribution. The appropriate negative skew is present in Figure 1, where the loan distribution is simply the loan demand shock distribution truncated at the constraint. Such an outcome arises in the study by Holmström and Tirole (1997), where constrained agents (agents whose loan demand shock exceeds the constraint) exit through bankruptcy. In this case, the normal/truncated normal stochastic frontier model applies. Other cases have been discussed: constrained agents may remain at some feasible level of borrowing (the discrete investment case in Holmström and Tirole, 1997; Kiyotaki and Moore, 1997), and react to the constraint even when it is not

strictly binding (Bernanke et al., 1999). Alternative distributional assumptions of u can be used to approximate the shape of the loan distribution in these cases.

The present approach is not applicable in the limited case where all agents are at the constraint, because the continuity assumption is then violated. In that case, the approach by Bhaumik et al. (2012) may be applicable: the frontier is then interpreted as the desired level of borrowing, and u as the constraint. In the present study, this case is ruled out by the knowledge that most Finnish households have significant unused borrowing opportunities.

Another related previous methodological contribution is by Chen and Wang (2008), who use a variant of the stochastic frontier model to identify excess demand and supply of credit, but they do not make the connection between the stochastic frontier and a borrowing constraint. The borrowing constraint (1) cannot be straightforwardly interpreted as credit supply or demand, since it is influenced by both borrower and lender characteristics. A number of different econometric approaches have been used previously to study borrowing constraints. A large body of literature builds on the idea of identifying borrowing constraints indirectly based on their negative effect on capital accumulation (Fazzari et al., 1988; Whited and Wu, 2006; Bhaumik et al., 2012, and references). The other main approach is to use surveys and other relevant information regarding access to credit (Kaplan and Zingales, 1997; Campello et al., 2010; Hainz and Nabokin, 2013).

The novel approach is a new way of studying borrowing constraints based on loan samples. Estimation data is abundantly available across many countries, sectors and time periods from household surveys and accounting data. Since the novel approach builds on a different set of assumptions than earlier approaches, it may also increase analytical scope. It

seems especially well-suited for testing quantitative hypotheses about the borrowing constraint and credit policy parameters of lenders, since it yields quantitative estimates of the constraint in parametric form. The underlying assumptions are few, and correspond at least approximately with many cases discussed in theory. Work currently underway that employs this methodology (Herrala and Jia, 2012; Herrala and Turk Ariss, 2013) shows signs of early promise. The approach also extends to the study of other types of constraint: it has previously been used to estimate the loanable funds of banks (Fungacóva et al., 2013).

3. The data and the estimation period

To identify forward-looking changes in credit policies in anticipation of Basel II, we focus on the period 1998-2004, when Basel II was still under preparation in the Basel Committee. The Committee first outlined the forthcoming regulation in a consultative paper in June 1999, with subsequent updates in January 2001 and April 2003. The Directive was signed in June 2004, and it became binding at the end of 2006.[2]

According to the Quantitative Impact Studies, the main impact of Basel II was expected to be a substantial decrease in the capital burden of retail loans. Retail lending benefited from the possibility of the application of an internal ratings-based approach, which appeared in all consultative documents from 1999. This led to a significant decrease in the capital burden of

[2] The Basel Committee on Banking Supervision: 'The New Capital Adequacy Framework' in 1999; and 'Overview of the Basel Capital Accord' in 2001 and 2003 (see http://www.bis.org/list/bcbs/tid_22/page_2.htm). The impact studies can be found at http://www.bis.org/bcbs/qis/overview.htm.

household loans, in particular, because the previous mechanical rules exceeded ratings-based estimates of the capital burden. The risk weight of residential mortgages was also dropped from 50% to 35% under the mechanical 'standard approach', starting from the consultative document in 2003. Changes in the capital burden on other types of lending besides retail lending were forecast to be small by comparison.

During the period of Basel II preparations from 1998 to 2004, Finland was part of the European Union (EU) and a member of the euro area. The Finnish economy was characterized by robust growth and low inflation (Figure 2) as well as low interest rates. The banking system was sound, based on profitability, solidity and non-performing loans. The banking sector structure remained broadly stable, based on balance sheet shares and standard competition indicators (IMF, 2012).

The banking system was dominated by three main players: Nordea, the OP Group, and Sampo Bank, which accounted for 85% of the total balance sheet of the banking sector in 1998 based on parent company data. Nordea was the largest bank in terms of the size of its balance sheet. It had emerged from a merger between a Finnish bank and a Swedish bank in 1997 under the name Merita-Nordbanken. The name Nordea was adopted in 2001, after banks operating in other Nordic countries joined the group. The OP Group was the largest and Sampo bank was the second largest domestically-owned bank. The name Sampo Bank grew out of the merger between Leonia Bank and the insurance company, Sampo, at the start of 2001.

Finnish household loans originated overwhelmingly from banks, and the traditional liquidity transformation model of banking (from demand deposits to loans) applied. Fixed

term and variable rate housing loans were the largest category. The bulk of housing loans, typically over 90% of the loan stock, were linked to money market interest rates in short maturities. The three-month market rate was a common reference rate, as were 'prime rates' by banks, which followed developments in the short-term market rates.

The two indicators used in the loan market analysis, the interest rate differential between new housing loans and the three-month Euribor, and the growth rate differential between housing loans and corporate loans, are calculated based on the loan market statistics compiled by the Finnish central bank. The growth differential is the difference between the 12-month growth rate for housing loan stock and that for corporate loan stock. For the purposes of this project, the published corporate loan stock was cleaned from the effects of statistical reclassifications by the data provider. The data on the growth differential does not cover the whole period, but it is long enough to allow a statistical analysis of regime shifts around the time of announcements relating to Basel II.

The main sources used for the survey of banking professionals were the annual reports of the largest banks, insider interviews, loan officer surveys by the central bank, and published supervisory reports.[3] The quality of this data is variable, which raises reliability concerns. The risk of misinformation is considerably mitigated by cross-checking.

[3] Annual reports by Sampo Bank (http://annualreports.sampo.com/); Nordea: (www.nordea.com/Investor+Relations/Financial+reports/Local+reports/Local+reports+Finland/799542.html); and OP group (https://www.op.fi/op/op-pohjola-ryhma/media/aineistopalvelu/op-pohjola-ryhman-julkaisut?id=86002&srcpl=8); reports by the financial supervision authority (http://www.finanssivalvonta.fi/fi/Tiedotteet/Pages/Default.aspx).

The two household wealth surveys by Statistics Finland used for the quantitative analysis of borrowing constraints are of good quality by conventional statistical criteria such as sampling and non-response rates. The sampling method is two-stage stratified sampling from the population register. The data supports statistical inference about the underlying population distributions. In contrast with the other household surveys collected annually by the statistical authority, the surveys of 1998 and 2004 include the market value of wealth.

4. Loan market stability

Figure 3, which shows the two loan market indicators, is consistent with a forward-looking reaction to Basel II. A level shift in the interest rate margin and the growth differential can be observed following the release of the first consultative document in June 1999. The interest rate margin of new housing loans fell from around 1.4 percentage points at the turn of the century to 1 percentage point in 2004. At the same time, the rate of growth of housing loans increased by over 10 percentage points relative to that of corporate loans. The direction of the shift in the two series is in line with the information provided in the consultative document regarding the forthcoming decline in the capital burden of household loans.

Standard unit root tests confirm the visual impression of significant instability in the loan market data. As regards the interest rate margin, the ADF and Phillips-Perron tests support the presence of a unit root, and the KPSS test rejects stability (Table I). As regards the growth differential, the results are somewhat mixed: the ADF test rejects and the Phillips-Perron test maintains the unit root hypothesis, while the hypothesis of stability is maintained in the KPSS

test. Figure 3 suggests that the signs of instability revealed by the tests may be indicative of regime breaks in the two series as new information about Basel II became available, rather than the presence of a unit root. Standard unit root tests are not equipped to differentiate between the two sources of instability.

The unit root test with regime break at an unknown date by Lanne et al. (2003) provides statistical evidence that the signs of instability in the two series are, indeed, related to a regime shift that took place after the first information release on Basel II. Under this approach, the regime shift date is first estimated based on a generalized least squares procedure. An ADF-type test is then performed to assess the stability of the regime shift-adjusted series. Under this approach, both series show a significant structural break following the release of the first consultative document. The endogenous break date estimate for the interest rate margin is March 2000, i.e. about nine months after the first report on Basel II (Table I). The regime break date estimate for the growth differential is July 1999, indicating a swift reaction to the first consultative document. After these break dates are accounted for, the unit root hypothesis is rejected for both series.

To strengthen these results, and also to study the possibility of multiple regime shifts, we use the sequential test of Bai and Perron (2003). In this test, the null hypothesis of no structural break is rejected at 10% significance regarding both series (Table I). The growth differential shows two regime breaks: the first structural change in January 2000 contributed to an increase in the growth differential by about 7 percentage points, and the second structural break in April 2001 contributed to a decrease in the growth differential by about 2 percentage points. In contrast to the growth differential, the interest rate margin shows only

one break, which contributed to a decrease in the interest rate margin by about 14 percentage points in October 2000.

All in all, the two tests consistently indicate a significant structural shift in both loan market indicators following the release of the first consultative document about Basel II. In accordance with the information content of the first consultative document, the tests show a significant increase in the growth differential and a decrease in the interest rate margin around this time. This result is robust to different break types, including pre-set breaks immediately after the main announcements, and the use of different lag lengths in the underlying models, with some qualifications. The estimation results for the interest rate margin are broadly robust across the range of lag lengths suggested by standard selection criteria. The statistical significance of the breaks in the growth differential in the Bai-Perron test are maintained in models with either one of two lags.

While the break date estimates calculated using the Bai-Perron (2003) test are at a somewhat later date than the break date estimates given by Lanne et al. (2003), the tests agree that there was, in particular, a reaction to the first information release. This is not surprising, since the main change in the capital requirements for household loans, namely the possibility of using the internal ratings-based approach, was introduced in the first information release. From the standpoint of the largest banks that dominated the loan market, the future information releases brought little new to the table in this regard. While the Bai-Perron (2003) test yields evidence of a second break in the growth differential following the second information release in January 2001, it is unclear whether this break is related to the second information release or whether it reflects something else entirely. Figure 3 suggests that the

second break could be interpreted as a gradual adjustment towards a new equilibrium after an initial strong reaction.

5. Survey of qualitative evidence from banking professionals

The survey focuses on the three large banks (Nordea, the OP Group and Sampo) that dominated the loan market throughout the period in question. A comparison of their annual reports suggests that preparations for Basel II proceeded at different speeds across the three banks. The most proactive of the three appears to have been Sampo Bank, which held a share of about one-fifth to one-sixth of the banking sector balances. It participated in the Quantitative Impact Studies undertaken by the Basel Committee in 2001 and 2002. In 2001, the bank launched an internal Basel II compliance project to analyze the regulatory change in terms of its own portfolio. The bank stated in its annual reports (2001, 2002) that its focus was on products that did not tie up much capital. Sampo chose the internal ratings-based method for household loans**.** Nordea participated in the third impact study in 2002. It concluded that Basel II would have a positive impact on its minimum required capital. At that time, it set up an internal program to achieve compliance with the requirements of the Basel II internal ratings-based system. In the early 2000s, the OP Group indicated in its annual reports that the bank considered its capital position to be so strong that it did not see a need to economize on capital. Based on a major strategic review in 2002, the bank declared it to be its long-term objective to use its strong capital position to become the leader in all of its major operational areas.

Qualitative evidence on how credit policies changed during the early 2000s can be found in the annual reports of one of the banks, in published supervisory material, as well as in the bank lending surveys by the central bank.[4] In its annual reports, Sampo Bank reveals increased interest rate competition in 2000 and decreased margins in the housing loan market in 2002, 2003 and 2004, but not in the corporate loan market. In 2004, the financial supervisory authority noted a trend towards loosening credit standards in the housing loan market. According to the supervisor, loan-to-value ratios had been relaxed significantly during the previous years, and loan maturities increased to diminish the short-term loan service requirement of household borrowers.[5] The bank lending surveys undertaken by the central bank, which started in 2003, show loosening credit policies in the housing loan market in the first and second quarters of 2003, and in the second quarter of 2004. The loan officers interviewed for the surveys reported decreasing loan margins, loosening collateral requirements and increasing loan maturities in the housing loan market. At the same time, the reports show mixed developments in credit policies towards corporations.

The bank lending surveys also inquired about the reasons behind the loosening of credit policies towards household borrowers, and the most common answer was 'increased competition'. Basel II did not feature as an option among the list of possible answers. Banks

[4] The Bank of Finland started the bank lending surveys in the first quarter of 2003 as part of a euro area survey with the same name. In 2003-2004, the surveys were conducted by means of interviews with the senior loan officers of the four largest banks regarding credit policies and demand in the corporate and household loan markets. The bank-level results were not published, but were made available for this project.

[5] RATA TEDOTTAA, Tiedote 5/2004, (28.9.2004) (in Finnish)

did have the possibility of inserting additional comments at the end of the questionnaire, but seldom did so. During the very first survey in 2003Q1 the loan officer of one of the big three banks inserted the comment 'uncertainty about Basel II affects credit supply'. This comment is further evidence that Basel II was already having an impact on banks' credit policies at this time.

All in all, the most credible evidence that the preparations for Basel II were having an impact on credit policies comes from the data provided by Sampo Bank. Its annual reports indicate that to economize on capital, the bank wanted to increase the share of household loans in its portfolio, and that it therefore loosened credit policies in that market segment in the early 2000s. To validate this information, an interview was conducted with a senior loan officer at Sampo Bank of that period. He confirmed that Basel II had a significant impact on Sampo Bank's credit policies at that time and that, indeed, Sampo Bank re-directed its lending efforts towards household loans and away from corporate credit in anticipation of Basel II to economize on the capital burden.

While the other banks did not explicitly discuss the strategic impact of Basel II in their annual reports, it is nevertheless clear that they were ready to respond to competition from their main rivals. The OP Group, in particular, was determined to establish itself as a leader in the Finnish loan market. We also interviewed a senior credit officer at OP Group, who confirmed this interpretation based on the annual reports. In his view, there was stiff competition in the loan markets, leading to significant changes in credit policies towards household customers. The most significant changes occurred in pricing and repayment ability

evaluation in the housing loan market. In his view, collateral policies did not so much as weaken, as they were replaced by other arrangements, such as loan insurance.

We also studied the survey material in order to determine any other factors that may have contributed significantly to changes in credit policies during the period in question. Macroeconomic conditions arise as a significant contributing factor to credit policies. In the discussions with the industry professionals, changes in leadership at specific banks may also have contributed to changes in policy. However, neither macroeconomic developments nor leadership changes can easily account for the finding that credit policies were loosened for household borrowers in particular, rather than for the corporate loan market.

Based on the survey material, it is difficult to pinpoint exactly when banks' credit policies started to change in response to Basel II. However, it is noteworthy that the annual reports first discuss Basel II after the estimated regime break dates in the two loan market indicators. A tentative interpretation of this finding is that the regime breaks mark the beginning of the impact of Basel II on credit policies, with discussion in the annual reports following when these changes started to show in banks' income statements.

To summarize, the survey of qualitative material from banking industry professionals regarding banks' credit policies indicates increased competition and a significant loosening of credit policies in the early 2000s in the household loan market in anticipation of of Basel II.

6. Analysis of loan samples

The analysis of loan samples based on the novel approach quantifies changes in borrowing constraints and banks' credit policies towards households between 1998 and 2004. The six variants of models (4) and (5) in Table III are based on alternative assumptions about the residual distributions. Models 4.1 and 5.1 are half normal-normal; models 4.2, 4.3, 5.2 and 5.3 are exponential-normal; models 4.3 and 5.3 allow heteroscedasticity in the residual distributions with respect to time.

Of the total 7,140 households in the original sample, the variables *Loans*, *Wealth* and *Income* can be calculated for 4,022 households. The possible selection bias caused by omission of a part of the sample is investigated at the estimation stage. Standard statistical tests are supportive of the econometric model. The z-statistic of the skew test by Coelli (1995) rejects the null of no skew at standard significance levels, providing support for the stochastic frontier model over OLS. The chi2 statistic for the Wald test of the variable vector is also highly significant. The parameter estimates are in broad terms of expected sign and magnitude.

Models 4.1-4.3, which are used to test changes in overall credit availability, show highly significant positive cross effects and negative independent effects of wealth and income. The positive cross effect confirms that collateral policies and repayment requirements are interdependent: the marginal effect of collateral on credit availability increases with repayment ability, and vice versa. This result is quite expected: when a household applies for a loan, the bank checks that the borrower has both sufficient collateral and loan service

ability. The negative independent effects show the cost in terms of credit availability of having only collateral or repayment ability, but not both. From the point of view of the research focus, the most interesting result from models 4.1-4.3 is the consistent positive and highly statistically significant time-fixed effect, which varies between +0.19 and +0.45 across the three models. Rounding to first decimals, this result indicates that the overall credit availability of households improved by about 20-50% between 1998 and 2004, when Basel II was under preparation.

Models 5.1-5.3 yield more detailed insight into changes in credit policies based on changes in the fixed, independent and cross effects in equation (5). A very consistent result emerges from the three models. All estimations show a positive and significant increase in the time-fixed effect for households in the age group 31-45 years. In Finland, the demand for housing loans is typically heavily concentrated in this age group. Families tend to move from rented apartments to own homes and subsequently to larger homes as family size and income grow. The significant time-fixed effect in this group indicates that banks increased credit availability, in particular, in the age group that had a significant need for external financing.

As discussed above, the correct interpretation of a change in the fixed effect is an increase in the maximum loan-to-value ratio and the maximum loan-to-income ratio in the age group 31-45 years. This finding corroborates the survey results concerning the increase in loan-to-value ratios during this time. The increase in the maximum loan-to-income ratio is consistent with an increase in loan maturities, in line with the survey results. An increase in the maturity of a loan reduces the loan service burden relative to current income and thereby increases the amount of loans the household can service. Since changes in the independent

effects and cross effects are negligible, the related elasticities were not affected: the change in the two ratios was constant across income and wealth levels.

The main results are robust to the addition of indicators regarding family size, labour market and socioeconomic status, professional groups, alternative age groups, age as a continuous variable and alternative distributions of u.[6] The main results hold under alternative formulations of the second moments. The results are also robust to outliers, based on extreme values in the loan-to-value distribution. The results also hold if households that report payment difficulties are excluded from the sample of households that indicate activity in the loan market, as well as in the non-weighted sample. We used the method by Greene (2008) and the standard Mill's ratios to control for possible sampling bias, but this did not challenge the results.

Since this is a new econometric approach, we validate the quantitative estimates with outside information. To this end, we used the econometric model to estimate the maximum loan-to-value ratios employed by banks in the housing loan market in 2004, and compared these with rare supervisory and central bank data on the actual ratios employed by banks. We find that the estimation results are consistent with the information from the authorities.

[6] For details on how the group indicators are constructed in the data, see http://tilastokeskus.fi/meta/til/vtutk.html.

7. Concluding remarks

This study tests the forward-looking reaction of banks to Basel II requirements. The regulatory impact is identified based on an econometric study of the reaction of loan market indicators to information released about Basel II, a survey of banking industry professionals regarding banks' credit policies during the period in question, and econometric analysis of changes in banks' credit policies from loan samples. The results show that banks in Finland significantly loosened their credit policies towards households in the early 2000s in response to the first consultative document on the new regulation.

While a fully developed study of euro area developments is beyond the scope of this study, we have cross-validated the results with euro area data. A priori, there is reason to expect that the Finnish case offers valuable insight into the effects of Basel II across Europe more broadly. Finland was a euro area insider with a banking system that was de facto open to competition from banks in other EU Member States. At the time of the study, almost half of the banking sector was under foreign ownership, and this share has increased markedly since then. Thus, while the local banking market is small, it is arguably connected with developments in the wider European banking scene. Tentative signs that Basel II had an early impact can be observed in euro area loan market data. In line with the Finnish case, the rate of growth of housing loans relative to corporate loans increased in the euro area around 2000 according to statistics by the European Central Bank. The euro area bank lending survey shows loosening credit policies towards households in 2004. The broader economic developments in some EU Member States, for example, the sharp increases in housing prices

in Spain, the United Kingdom and Ireland prior to the financial crisis, are also consistent with the regulation having an early effect. The hypothesis that Basel II had an early effect in the euro area has previously been put forward by Shin (2012).

Against this backdrop, there is cause for concern that the ongoing Basel III project may already be exerting a dampening influence on economic developments on the troubled European continent. It is widely foreseen that Basel III, by tightening capital requirements, will limit access to credit and, thereby, weigh on economic growth (Macroeconomic Assessment Group, 2010). The regulation, which will be implemented in the euro area at the start of 2014, does allow for long adjustment periods, but this is no guarantee against early implementation. Our results suggest that Basel III may have already started to have an impact as early as 2009, when the blueprint for the forthcoming regulation was released by the Committee. In fact, there is already evidence to suggest that this is happening. A direct question about the impact of Basel III has been included in the euro area bank lending surveys since January 2011. Ever since then the surveys have shown that banks have tightened their credit policies in order to adjust to the upcoming regulatory requirements.[7]

The estimates of the quantitative impact of Basel II are based on a novel empirical methodology for estimating borrowing constraints and the related credit policy parameters from loan distributions. This approach opens up a broad avenue for further research into

[7] See http://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html, for the euro area bank lending surveys.

banks' credit policies and credit availability. Such work is ongoing by us and others along these lines.

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Figure 1. An illustration of a loan distribution with a borrowing constraint

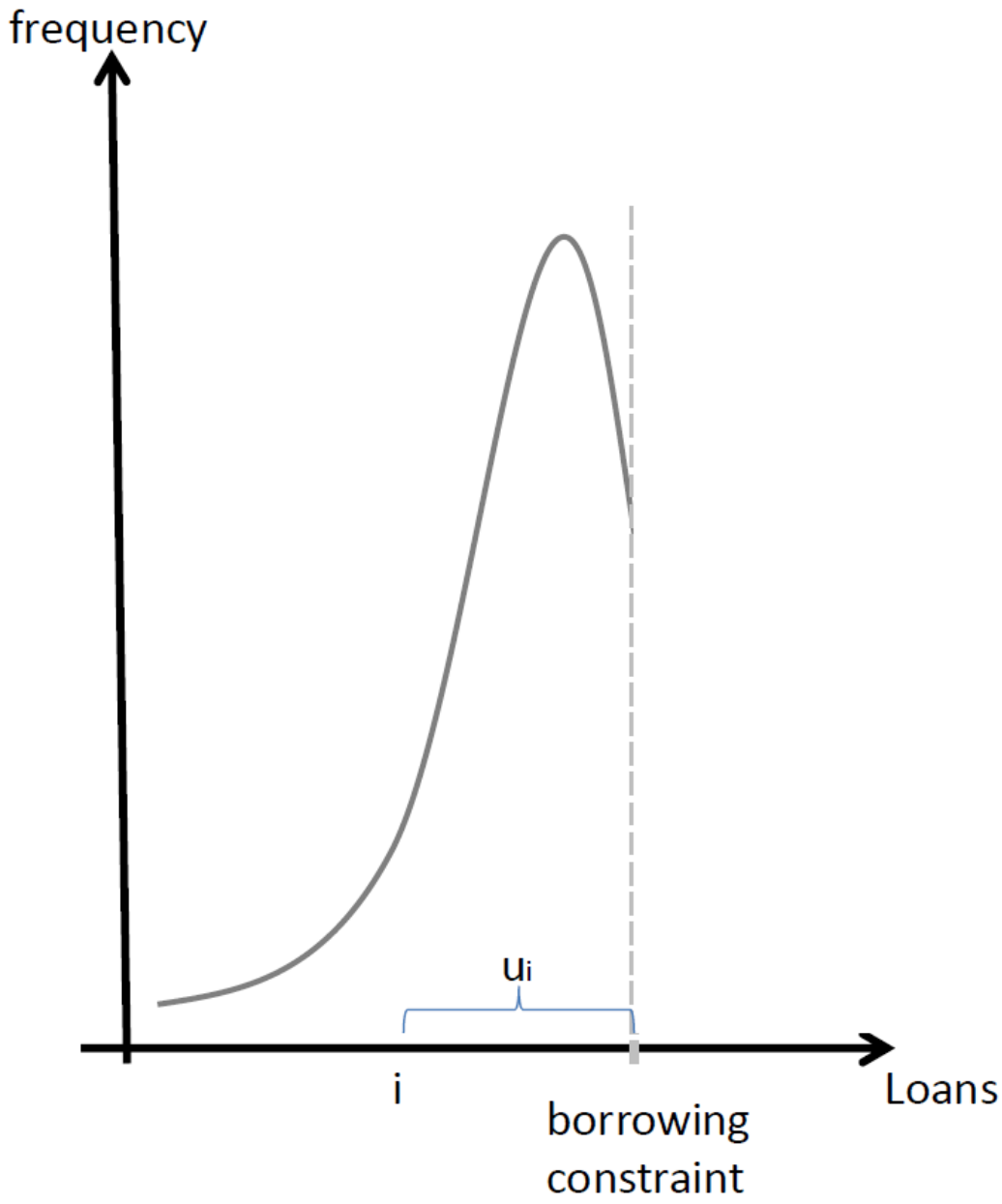
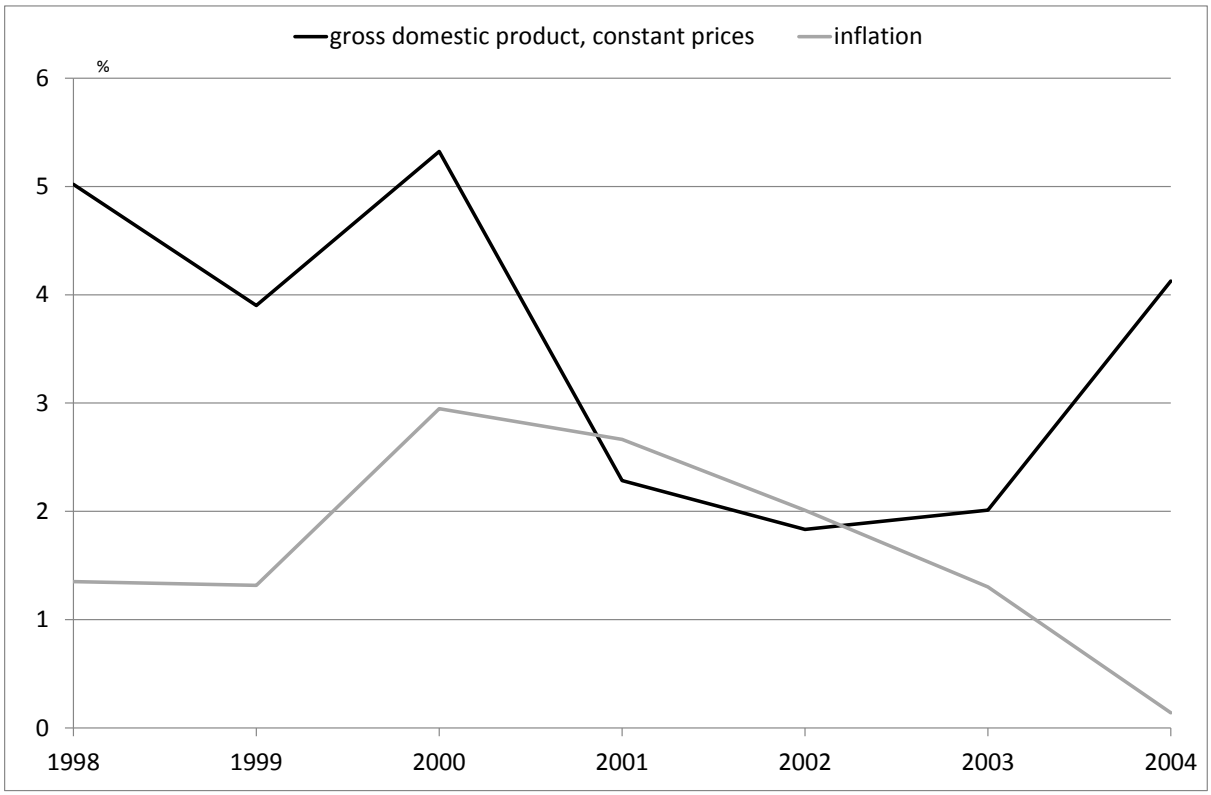
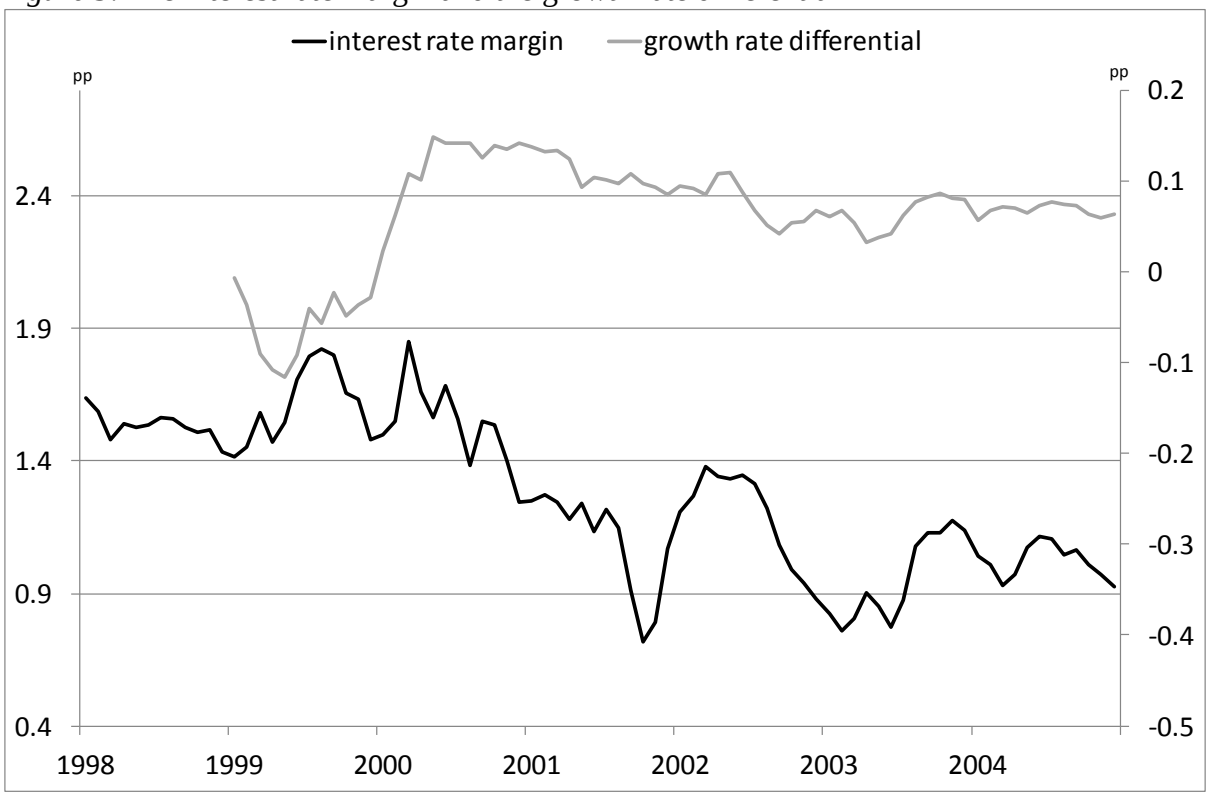


Figure 2. Economic developments



Source: International Monetary Fund.
Notes: annual changes.

Figure 3. The interest rate margin and the growth rate differential



Source: Bank of Finland.

Notes: pp = percentage points; interest rate margin is the difference between the average lending rate of new housing loans and the 3-month Euribor; loan growth differential is the difference between the 12-month growth rate in the stock of housing loans and corporate loans.

Table I. Stability of loan market indicators

	interest rate margin		loan growth differential	
estimation sample	1998M1-2004M12		1999M1-2004M12	
Stability tests				
Augmented Dickey-Fuller	0.48		-3.48**	
Phillips-Perron	0.4		0.41	
Kwiatkowski-Phillips-Schmidt-Shin	1.02***		0.26	
Test for unit root with regime break at unknown date (Lanne et al., 2003)				
break type	shift dummy		rational break	
break date estimate	2000M3		1999M7	
lags	1		2	
test statistics	coefficient	t-statistic	coefficient	t-statistic
d(trend)	-0.013	-0.142	0.000	-0.004
d(constant)	1.660	166.370	0.014	7.204
shift parameter 1	0.342***	34.31	0.0412***	12.63
shift parameter 2 (for rational break)			-0.021***	-6.32
UR test for unit root after accounting for regime break	-2.77*		-3.6***	
Test of L+1 vs. L sequentially determined breaks (Bai and Perron, 2003)				
lag length	2		2	
test statistics	Scaled F -statistic	10% critical value	Scaled F -statistic	10% critical value
0 vs. 1	14.2*	12.08	22.9*	14.26
1 vs. 2	21.6*	13.91	8.08	16.11
2 vs. 3	7.7	14.96		
break date estimates at 10%	2000M1, 2001M4		2000M10	

Source: Bank of Finland.

Notes: Then interest rate margin is the difference between the average lending rate of new housing loans and the 3-month Euribor; loan growth differential is the difference between the 12-month growth rate in the stock of housing loans and corporate loans. The test by Lanne et al (2003) performed with a constant term and trend, */**/***:10%/5%/1% significance. Lag length and regime break type are selected based on the recommendations of the authors. The Bai and Perron (2003) break test options: Trimming: 0.15, Maximum breaks: 5, Significance level: 0.10.

Table II. Variable means in the household surveys

	Loans	Wealth	Income	Age <31	Age 31-45	University
1998	9.3	10.1	9.9	0.3	0.5	0.1
2004	9.5	10.5	10.0	0.3	0.6	0.2

Source: Wealth surveys by Statistics Finland

Notes: Sample size 7,348 households. Sample-weighted estimates. Loans, Wealth and Income are in natural logarithms of euro, deflated to the year 1998 by the living cost index. Group dummies: AgeY=age group Y years; University=university level education.

Table III. Estimates of the credit policy parameters

VARIABLES	Model 4.1 Loans	Model 4.2 Loans	Model 4.3 Loans	Model 5.1 Loans	Model 5.2 Loans	Model 5.3 Loans
frontier						
Wealth	-0.493**	-0.464**	-0.397**	-0.534	-0.432	-0.406
	[0.217]	[0.203]	[0.193]	[0.347]	[0.355]	[0.333]
Income	-0.478*	-0.487*	-0.408*	-0.506	-0.442	-0.425
	[0.269]	[0.250]	[0.238]	[0.416]	[0.423]	[0.395]
Wealth*Income	0.0793***	0.0785***	0.0715***	0.0812**	0.0734**	0.0720**
	[0.0224]	[0.0210]	[0.0200]	[0.0354]	[0.0362]	[0.0340]
Age31-45	-0.00194	-0.00709	-0.0262	0.00545	0.0151	-0.00415
	[0.0569]	[0.0571]	[0.0536]	[0.0880]	[0.0851]	[0.0840]
Age>45	-0.663***	-0.709***	-0.705***	-0.655***	-0.688***	-0.746***
	[0.0629]	[0.0649]	[0.0639]	[0.0886]	[0.0911]	[0.0936]
University	0.132**	0.123**	0.137**	0.0495	0.0403	0.0446
	[0.0583]	[0.0540]	[0.0553]	[0.0714]	[0.0699]	[0.0704]
T2004	0.192***	0.226***	0.450***	-1.105	0.554	0.235
	[0.0421]	[0.0419]	[0.0676]	[4.713]	[4.598]	[4.489]
T2004*Age31-45				4.013**	4.479***	3.611**
				[1.631]	[1.730]	[1.708]
T2004*Age>45				1.946	2.747	1.645
				[1.837]	[1.888]	[1.899]
T2004*University				0.0278	1.026	0.983
				[1.551]	[1.553]	[1.498]
T2004*Wealth*Age<31				-0.0242	-0.240	-0.105
				[0.420]	[0.420]	[0.405]
T2004*Wealth*Age31-45				0.0250	-0.183	-0.0610
				[0.424]	[0.421]	[0.408]
T2004*Wealth*Age>45				-0.147	-0.370	-0.239
				[0.420]	[0.416]	[0.404]
T2004*Wealth*University				0.0388	0.0667	0.0670
				[0.0711]	[0.0665]	[0.0705]
T2004*Income*Age<31				0.0441	-0.110	-0.0434
				[0.499]	[0.484]	[0.477]
T2004*Income*Age31-45				-0.410	-0.622	-0.454
				[0.502]	[0.500]	[0.484]
T2004*Income*Age>45				-0.0255	-0.254	-0.0624
				[0.524]	[0.517]	[0.505]
T2004*Income*University				-0.0317	-0.157	-0.152
				[0.191]	[0.192]	[0.190]
T2004*Wealth*Income				0.0107	0.0316	0.0166
				[0.0431]	[0.0427]	[0.0415]
other statistics						
Observations	4,022	4,022	4,022	4,022	4,022	4,022
z	-29.41	-29.41		-28.88	-28.88	
chi2	1103	1203	1197	1571	1800	1800

Robust standard errors in brackets
*** p<0.01, ** p<0.05, * p<0.1

Notes: Sample weighted estimates. All variables in natural logarithms and deflated to euro of year 1999 by the CPI Index. All models include a constant term which is not shown. Group dummies: AgeY=age group Y years; University=university-level education.