Risto Herrala

Credit crunch? An empirical test of cyclical credit policy

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Abstract

In this paper we test the hypothesis that credit policies are pro-cyclical. Our approach is based on a stochastic frontier analysis of borrower data, as in Chen and Wang (2008). We extend the applicability of the approach, and propose a novel test specification which is informative of many types of pro-cyclicality.

The analysis of representative samples of household borrowers during a huge cycle and its aftermath yields evidence of time-varying credit policy. We find that the focus of credit policy changed from collateral to current income during the cycle. Instead of a credit crunch, ie, an overall tightening of credit during the economic and financial contraction, we find a tightening of credit limits with respect to a minority of borrowers and an easing for the majority.

In the course of the post-crisis period, credit policy became more lenient. Both the level of credit limits and the 'tailoring' of limits to group-specific characteristics of households increased. A reduction in the idiosyncratic variance of limits suggest that banks have become more consistent in their credit policies.

Keywords: credit policy, credit constraints, household borrowing, frontier analysis.

JEL classification numbers: D14, E32, E51, G21

Luottolama? Havaintoja lainapolitiikan syklisyydestä

Suomen Pankin keskustelualoitteita 10/2009

Risto Herrala
Rahapolitiikka- ja tutkimusosasto

Tiivistelmä

Tutkimuksessa testataan hypoteesia, jonka mukaan pankkien lainapolitiikka on myötäsyklistä eli löysää noususuhdanteessa ja kireää laskusuhdanteessa. Lähestymistapana on stokastinen rintama-analyysi, kuten Chenin ja Wangin (2008) tutkimuksessa. Lähestymistavan soveltuvuusaluetta laajennetaan ja testi muotoillaan uudelleen siten, että se kykenee erottelemaan monentyyppistä myötäsyklisyyttä.

Testisykli on Suomen 1990-luvun pankkikriisisykli ja sen jälkeinen aika, ja se on arvioitu yhdeksi kaikkein voimakkaimmista sykleistä kansainvälisissä pankkikriisejä koskevissa vertailuissa. Kotitalouslainanottajien edustavien otosten vertailu paljastaa vaihteluja lainapolitiikassa testisyklin aikana.

Testitulokset eivät viittaa siihen, että pankit olisivat yleisesti tiukentaneen lainapolitiikkaansa lainamarkkinoiden laman aikana. Sen sijaan havaitaan, että lainapolitiikka oli kotitalouksien lainanottajista aiempaa tiukempaa vähemmistöllä ja aiempaa löysempää enemmistöllä. Kriisin jälkeen pankkien lainapolitiikka on selvästi löystynyt kotitalousasiakkailla.

Avainsanat: lainapolitiikka, lainarajoitteet, kotitalouksien lainanotto, rintama-analyysi

JEL-luokittelu: D14, E32, E51, G21

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1 Introduction

The ongoing international economic crisis has been blamed, in part, on credit policies. It has been proposed that lending was too lenient during the pre-crisis period, thus contributing to a build-up of credit risk. When the crisis hit, credit policy tightening further choked the economy. Variants of these views have appeared in connection with numerous historical crisis episodes. They have inspired calls for tighter supervision of the financial system, public intervention to ease the credit crunch, and urgent monetary policy responses to bank behaviour.[1]

In this paper we examine the hypothesis that banks' credit policies are lenient during boom periods and tight during busts. We refer to this hypothesis as the pro-cyclical credit policy hypothesis, or 'the hypothesis' in short. The hypothesis has been associated with Hyman Minsky (1986), who links lenient credit policy during booms with euphoria, and tight credit policy during busts with pessimism. Alternatively, Rajan (1994) links pro-cyclical credit standards with herding, Holmström and Tirole (1997) with capital constraints,[2] and Ruckes (2004) with cyclical changes in the average quality of credit demand. Dell'Ariccia and Marquez (2006) propose that financial liberalization can undermine incentives for credit screening and contribute to a boom of bad credit.

Indirect econometric evidence is provided by Rajan (1994), who finds signs of a 'cover up' in banks' loan/loss reporting during a real estate boom in New England (US). Jiménez and Saurina (2006) report that the allocation of corporate credit to riskier industries developed pro-cyclically and collateralisation counter-cyclically in Spain (1984–2000). Chen and Wang (2008) identify a pro-cyclical contraction in the credit supply in Taiwan in the late 1990's.

Like Chen and Wang (2008),[3] we use stochastic frontier analysis to test the presence of pro-cyclicality in credit policy. By reformulating the link between credit policy and the frontier model, we extend the applicability of the approach. We specify a novel test which is informative of many aspects of credit policy.

For the estimation, we use representative samples of household borrowers from a banking crisis cycle in Finland. The cycle has been ranked among the most extreme in a number of international studies.[4] One sample ten years after the crisis provides insight into a possible post-crisis easing of credit standards in line with

[1] See, eg, various recent speeches by Federal Reserve Chairman Ben Bernanke at www.federalreserve.com. For the earlier discussion, see Jimenez and Saurina (2006) and Kindleberger (2005) and references therein. Gerali et al (2008), and Goodfriend and McCallum (2007) discuss the implications for macroeconomics and monetary policy.

[2] See also Matsuyama (2007).

[3] See also Wang (2003) for a related contribution.

[4] The Finnish crisis is among the 'five most catastrophic cases' in Reinhart and Rogoff (2008). It ranks fourth in terms of loss of GDP on Boyd, Kwak and Smith's (2005) list, and is among the top 10 in terms of restructuring costs on the IMF's (1998) list.

the ‘institutional memory hypothesis’ of Berger and Udell (2004). They propose that credit policies are eased as banks’ memory of a crisis fades.

Our econometric results are consistent with significant changes in credit policies towards household borrowers during the cycle and its aftermath. We find that the focus of credit policy changed from collateral to current income during the cycle. We fail to find a credit crunch, ie, an overall tightening of credit policy during the economic and financial contraction. Credit limits tightened towards a minority and eased towards a majority of household borrowers around that time.

The evidence suggests that credit policy has eased in Finland since the crisis. Banks have become more lenient in granting credit limits. The ‘tailoring’ of limits has increased to account for both age and education-specific factors. At the same time, the idiosyncratic variance of limits has fallen: banks have become more consistent in their policy.

The remainder of the paper is structured as follows. The methodology is explained in the following section. A demonstration of the method and the data follows in the context of a simple model which can be studied visually. We then move to present the main estimation results in connection with an extended econometric model. A summary of the results and our views on future work concludes the paper.

2 Methodology

The pro-cyclical credit policy hypothesis is consistent with various theoretical approaches. The model developed by Minsky (1986) is non-standard with irrational expectations, the Berger and Udell (2004) approach is informal, while other scholars impose rational expectations with imperfect information. Rajan (1993) and Holmström and Tirole (1997) build on the agency cost theory, Ruckes (2004) on auction theory, and Dell’Ariccia and Marquez (2006) on the adverse selection theory of financial intermediation.

A notable insight from the literature is that cyclicality may appear in various forms. Holmström and Tirole (1997) and Dell’Ariccia and Marquez (2006) propose that the collateral requirement is lenient during booms and tight during economic downturns. In Rajan (1994) and Ruckes (2004), there is random variation in whether credit is granted to borrowers with specific characteristics. Credit policy can be pro-cyclical in the sense that ‘bad clients’ have a higher probability of obtaining credit during boom periods than during busts. Rajan (1994) further discusses a third type of pro-cyclicality, related to the types of criteria imposed on loan availability.

We aim to construct an empirical test that identifies the various types of cyclicality in credit policy. To this end, consider the following characterization of credit policy

$$\max(L_i) = \prod_{j=1}^{n} (X_{i,j}^{\beta_j}) \exp(v_i) \quad (2.1)$$

Equation (2.1) states that a 'credit limit', $\max(L_i)$, granted to household i is determined by a vector of characteristics X and a vector of supply parameters β ($X_{i,j}$ and β_j refer to the j:th components of the respective vectors). Stochastic variation in credit supply is characterized by exp(v), where v is a standard normal random variable.

Equation (2.1) is not estimable, as only the realised credits and not the credit limits are observed. Realised credits are generated when borrowers use some proportion of their assigned limit. We denote by utilising $\exp(-u_i)$ (from the unit line) the 'used part of the limit', such that:

$$L_i = \exp(-u_i)*\max(L_i) \quad (2.2)$$

Equation (2.2) decomposes realised credit into demand and supply driven components: the 'used part of the limit' reflects credit demand, and the limit reflects credit supply. As our focus is on credit supply, we do not attempt to model the determinants of demand explicitly in this paper. This interesting challenge is left for future work.

Rather, we make the assumption that the empirical distribution of the demand driven component $\exp(-u_i)$ can be approximated by some well-behaved probability distribution. Formally, we assume that u is either a half-normal or exponential random variable. The distribution of u may be heteroscedastic and time-variant.

Under this distributional assumption, the non-estimable model (2.1) can be transformed into an estimable form. Multiplying both sides of (2.1) by $\exp(-u_i)$, inserting (2.2), and taking logs gives the standard[5] stochastic frontier model

$$\log(L_i) = \beta * \log(X_i) + v_i - u_i \quad (2.3)$$

Credit supply parameters can, then, be estimated by stochastic frontier analysis from borrower data. Comparison of stochastic frontier models, estimated during different cyclical conditions, can reveal different types of cyclicality in credit policy.

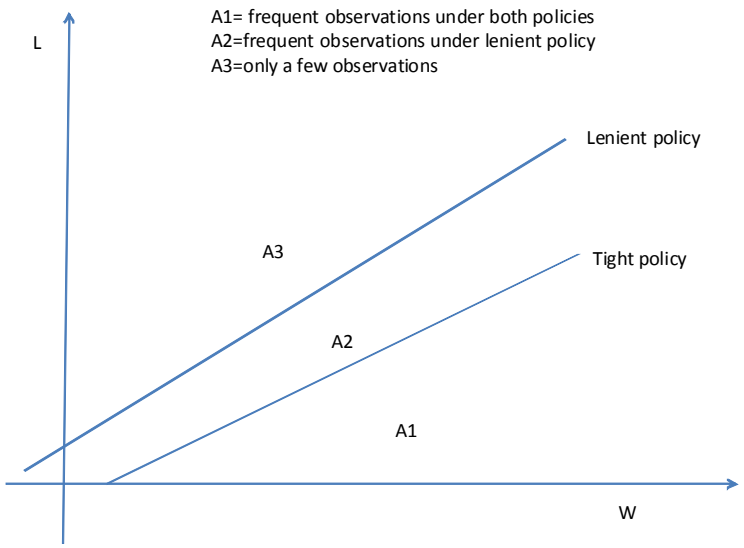
To elaborate, theory predicts that borrower limits are larger during a boom than during a bust on average. Since the expected limit (in logs) is simply the

[5] See Greene 2001 and references for a discussion of the method.

frontier (β*log(X_i)), pro-cyclicality may be tested by comparing estimated frontiers during different cyclical conditions.

The test is graphically illustrated in Chart 1 in a hypothetical case where X consists just of wealth and a constant. In the chart, expected limits are represented by two frontier lines, estimated from two hypothetical distributions of wealth and loans. Tight policy is represented by the lower and lenient policy by the upper frontier line. If the frontier lines intersect within the empirical distribution of borrowers, then one must conclude that the policies cannot be unambiguously ranked. In such cases, we report the percentage of households in each sample, for which one frontier is above the other. We can also characterize the households for which credit policy was pro-cyclical (in accordance with theory) to provide more intuition about the results.

Chart 1. **Comparison of expected credit limits in graphical form**



Note: A hypothetical example where the lower frontier line is estimated from an empirical distribution of loans (L) and gross wealth (W) during tight policy and the higher frontier line during lenient policy. The two frontier lines divide the plane of observations into areas A1, A2 and A3.

Frontier analysis also reveals cyclicality in the variance of v, the consistency of setting limits, and in X, the credit criteria.

The test specification used here is, to our knowledge, novel. Wang (2003) and Chen and Wang (2008) use a variant of the frontier model to identify changes in credit supply and demand. They start from a similar characterization of credit policy as (2.1) and derive a test for credit supply shocks that is based on changes

in the estimated excess demand of credit. From our point of view the main limitation of their approach is that the test is only applicable if all borrowers are credit constrained. By reformulating the link between credit policy (2.1) and the frontier model (2.3), we extend the applicability of the approach to realistic situations in which only some borrowers may be credit-constrained. We specify a novel test which is informative of many aspects of credit policy.

3 Estimation results from a simple model

We move to apply the method to real data under the simplifying assumption that X contains only gross wealth (and a constant). This 'simple model' can be studied visually. The analysis serves as a first look at the data and a demonstration of the method.

The surveys used in estimations are representative cross-sections of the Finnish household sector. From the surveys, four estimation samples can be constructed. The samples include households that increased borrowing during the 'estimation years' 1988, 1995, 1999 and 2004. The number of observations varies from sample to sample between 1774 and 940.

Loans are measured at the end of each estimation year. We construct a proxy for gross wealth at the end of the estimation year from the market value of wealth at the end of the previous year, and the change in taxable wealth during the estimation year. An exception to this rule is the year 2004, in which case we use the market value of wealth at the end of the estimation year, as given in the survey. We discuss the implications of this methodological issue in more detail at a later stage. All variables are in natural logarithms, and deflated by the CPI index. Appendix provides details on the data and the calculations.

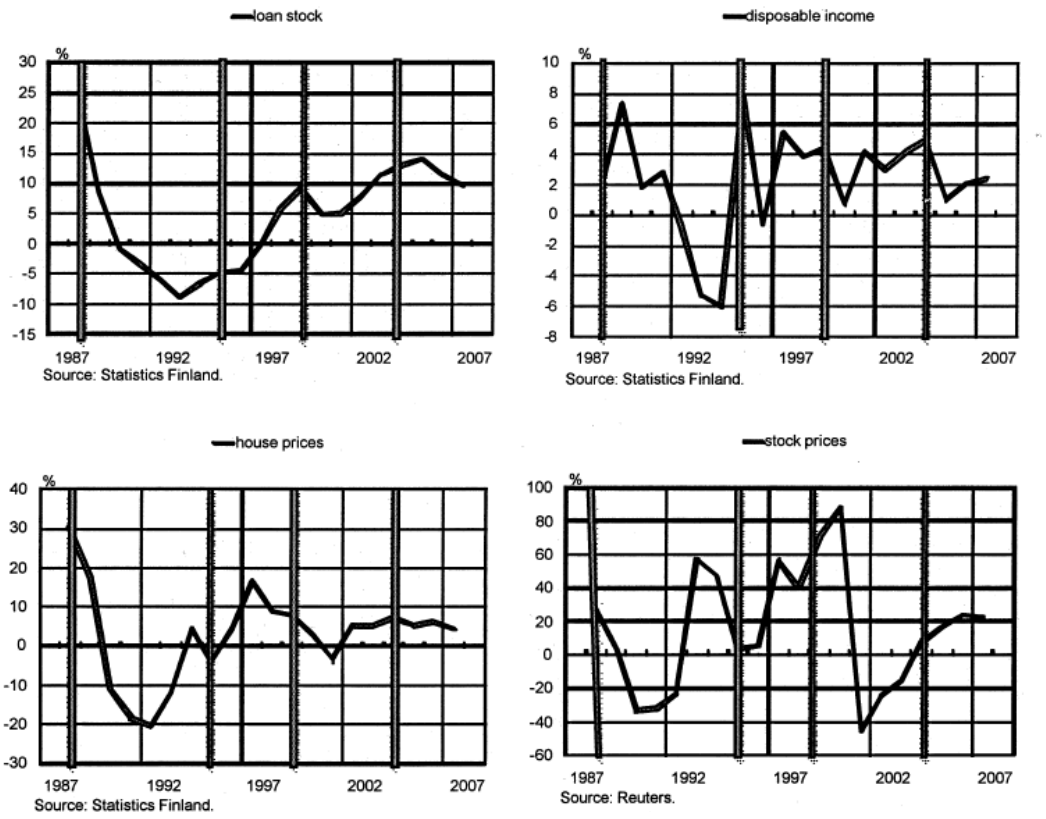
Economic developments around the estimation period are illustrated in Chart 2. The liberalization of credit markets in Finland in 1986 was followed by a display of many of the classical symptoms of economic boom, such as high lending growth and booming stock and housing markets. The estimation year 1988 marks the peak of lending growth. After the boom, the real economy dove into a deep recession, the stock and housing markets collapsed and a systemic banking crisis occurred.[6] In the estimation year 1995 the real economy was recovering, but the financial contraction still continued.

Analysis of the two latter samples provides information about changes in credit policy after the crisis. In 1999, both real and financial growth had returned

[6] For a broader review of the events, see Nyberg and Vihriälä (1994), Koskenkylä and Vesala (1994), and Herrala (1999). The issue of a credit crunch is discussed explicitly by Honkapohja (2009), who argues that the prior evidence about the credit crunch in connection with the Nordic crises seems to be weak.

to positive territory. In 2004, loan growth had accelerated considerably. Fears of a looming banking crisis had, again, surfaced in the public debate.

Chart 2. **Annual change in the household loan stock, disposable income, house prices and stock prices, 1987–2007 (estimation years are marked with a vertical line)**

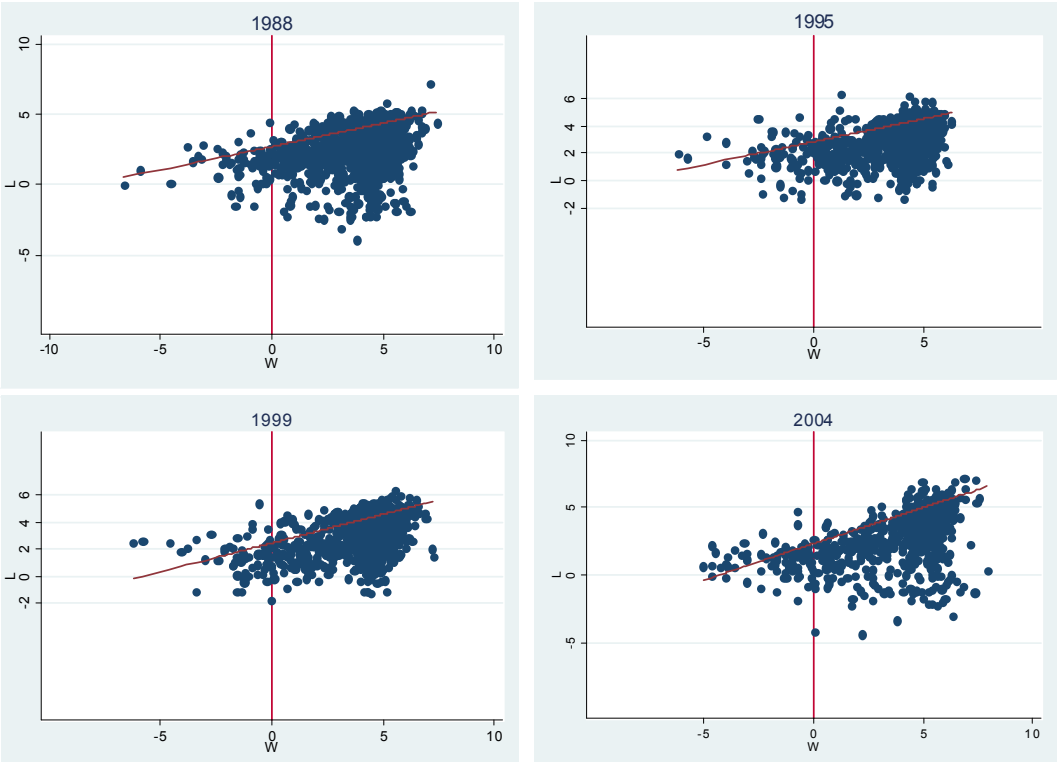


Note: All variables have been deflated by the CPI index. Data sources: CPI, the loan stock, disposable income and house prices from Statistics Finland, and stock prices from Reuters.

Chart 3 shows the scatter plots of loans and wealth along with frontier lines estimated in accordance with equation (2.3). During all the estimation years, the scatter plot starts out ‘thin’ on the left (towards low levels of wealth), and become broader to the right (towards high levels of wealth). It seems that in 1995 and 1999 the distribution of loans was more tightly contained than in 1998 and 2004 on the lower right. In the context of the model, this implies a change in the distribution of loan demand, specifically the demand for small loans among wealthy individuals. Such changes are captured in the model by the parameters of the distribution of u, which are allowed to vary with wealth and across time

periods. It is important to note that the scatter plots are consistent with the presence of a linear stochastic frontier for all the estimation years.

Chart 3. **Scatter plots of observations with frontier line**



Note: Scatter plots of loans (L) and gross wealth (W) in the rating samples with estimated frontier lines. The variables are measured in 1000 euro, deflated by CPI to the 1999 level, and expressed in natural logarithms. Observations are marked by dots and the estimated stochastic frontier by a line. The frontiers are based on the simple model (see Table 1).

The estimation results presented in Table 1 confirm the visual evidence. It can be observed from the table that wealth is a highly significant explanatory variable in the frontier. Its estimated coefficient has a correct sign in all the samples: the frontier is increasing in wealth as predicted by theory. That the coefficient of wealth is significantly below unity in all the cases implies a decreasing maximum loan to value ratio with respect to loan size. The hypothesis that both u and v are heteroscedastic with respect to wealth receives support from the statistical tests. In all the cases, the variance of v decreases with wealth, implying less consistency in setting of credit limits in connection with smaller than with larger loans.

The variance and mean of u are in all the samples increasing in wealth.[7] In the estimations, u is exponentially distributed, implying that the density of exp(–u),

[7] The frontier lines were estimated under the assumption that u is exponentially distributed. Under this assumption, the estimation algorithm converged after only a small number of steps. The

the proportion of the limit used by households, has the form $\frac{X^{\frac{1}{var(u)}-1}}{var(u)}$, where var(u) is the variance of u. The fact that the variance is increasing in wealth suggests that more density appears at the frontier at lower levels of wealth than at higher levels of wealth.

Table 1 **Estimation results for the simple model**

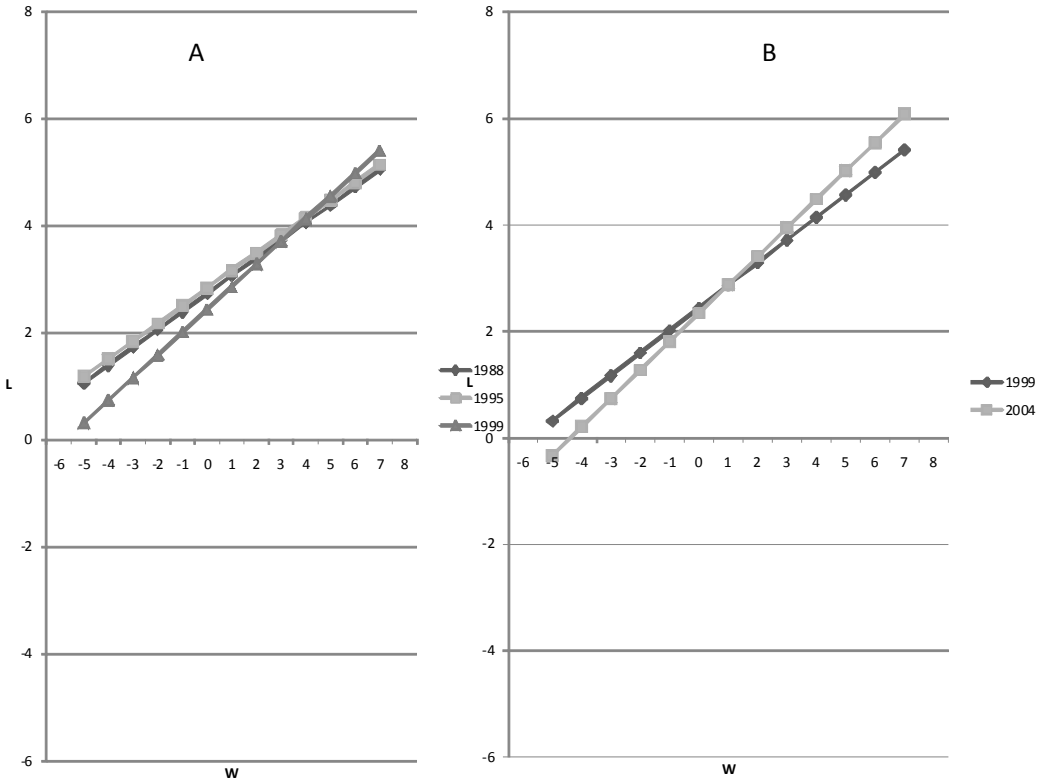
Year	Endog. variable	Exog. variable	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
1988	L	W	0.33	0.03	12.92	0.00	0.28	0.38
		c	2.73	0.11	24.23	0.00	2.51	2.95
	var(v)	W	-0.16	0.06	-2.82	0.01	-0.27	-0.05
		c	-0.43	0.20	-2.11	0.04	-0.82	-0.03
	var(u)	W	0.10	0.05	2.13	0.03	0.01	0.19
		c	0.13	0.21	0.62	0.54	-0.28	0.54
1995	L	W	0.33	0.04	9.20	0.00	0.26	0.40
		c	2.84	0.16	17.92	0.00	2.53	3.15
	var(v)	W	-0.29	0.06	-4.69	0.00	-0.41	-0.17
		c	-0.31	0.24	-1.28	0.20	-0.79	0.17
	var(u)	W	0.10	0.05	1.79	0.07	-0.01	0.21
		c	0.00	0.25	0.01	0.99	-0.50	0.50
1999	L	W	0.42	0.03	12.60	0.00	0.36	0.49
		c	2.44	0.16	14.83	0.00	2.12	2.76
	var(v)	W	-0.24	0.04	-6.45	0.00	-0.31	-0.17
		c	0.13	0.14	0.94	0.35	-0.14	0.39
	var(u)	W	0.19	0.05	3.77	0.00	0.09	0.29
		c	-0.52	0.27	-1.94	0.05	-1.05	0.01
2004	L	W	0.53	0.04	15.13	0.00	0.47	0.60
		c	2.34	0.17	13.82	0.00	2.01	2.67
	var(v)	W	-0.28	0.05	-5.33	0.00	-0.38	-0.18
		c	-0.44	0.22	-1.95	0.05	-0.88	0.00
	var(u)	W	0.15	0.05	2.98	0.00	0.05	0.25
		c	0.15	0.26	0.56	0.58	-0.36	0.66

Note: The estimation results are from the simple model. Estimations were performed with the 'frontier' command with probability weights in Stata. In the frontier equation, loans (L) are regressed by gross wealth (W) and a constant (c). L and W are in natural logarithms, and deflated to 1000 euro of the year 1999 by the CPI Index. var(v) and var(u) refer to the natural logarithm of the variance of v and u respectively. u is assumed to be exponentially distributed, and v standard normally distributed. Since the frontier is linear in logs, (a small) number of observations which had zero wealth were omitted from each sample. The number of observations in each estimation sample was 1748, 1059, 1057 and 936 households in 1988, 1995, 1999 and 2004 respectively.

The estimated frontier lines are re-plotted in Chart 4 to promote an assessment of their relative positions during the crisis cycle and its aftermath. For clarity, Chart 4A shows the estimated frontier lines for 1988, 1995 and 1999, and Chart 4B shows the frontier lines for 1999 and 2004.

estimation algorithm does not converge under the alternative distributional assumption of half normality suggesting possible misspecification.

Chart 4. **Estimated frontiers in the simple model**

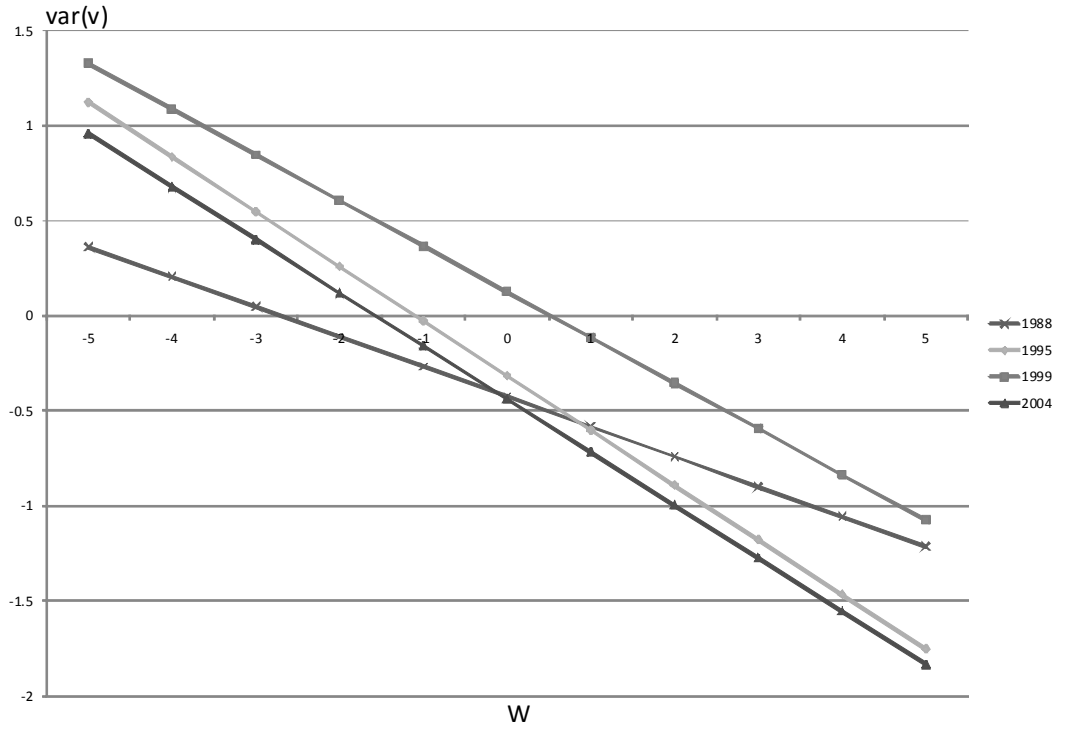


Note: Frontier lines estimated from the empirical distribution of loans (L) and gross wealth (W) in four samples by using the simple model. Variables measured in 1000 euro, deflated by CPI to the 1999 level, and expressed in natural logarithms.

Chart 4A reveals that the fitted frontier line of 1988 was slightly below that of 1995. The fitted frontier lines are very close to each other and the hypothesis that the two frontiers were equal cannot be rejected at the 5% level in a chi^2 test (the p value is 8%). These results are thus contrary to the hypothesis of pro-cyclicality of expected limits. Under this hypothesis, we should observe that the frontier line of 1995 was significantly below that of 1988. At the same time, the test gives mixed support for the institutional memory hypothesis. It appears that, as time since the crisis has passed, banks have tightened credit limits at low levels of wealth, but eased at high levels of wealth.

The variance of the credit limits was small in connection with small loans, and large in connection with large loans in 1988 in comparison with 1995 (Chart 5). These differences are statistically significant. The estimation results of the simple model, then, suggest an increase in consistency in (a decrease in the variance of) credit policy related to smaller loans, and decreased consistency in connection with larger loans during the credit contraction.

Chart 5. **Variance of v (consistency) in the simple model**



Note: Estimated variance lines of v from the empirical distribution of loans (L) and wealth (W) in four samples. Loans and wealth measured in 1000 euro, deflated by CPI to the 1999 level, and expressed in natural logarithms. var(v) is the natural logarithm of the variance of v.

4 Estimation results of an extended model

We proceed to relax the limiting assumption that credit criteria include only wealth. Credit availability may also be significantly affected by current income and other characteristics that predict the longer-term repayment prospects of borrowers.

Accordingly, we estimate an 'extended model', in which X consists of two continuous variables, wealth and income (Y), and two sets of group indicators, age and education level (edu).[8] These group indicators most likely correlate with the life-cycle income profiles of the households and, thus, potentially affect credit

[8] Age and education refer to the head of the family, as identified in the surveys. For the analysis, age is divided into three groups: age(1): age below 31 years; age(2): 31–50 years old; age(3): 51 and over. Education is divided into six groups: edu(0): lowest level or no education; edu(3): mid-level; edu(5): lowest level higher education; edu(6): lowest university degree; edu(7): higher university degree; edu(8): highest university degree. Other groupings related to profession, socioeconomic status or sector of employment were considered but not included in the final analysis because the estimation algorithm failed to converge when more groups were added.

policy. We allow both group-specific fixed effects and variable effects in the frontier.

Chi^2 tests indicate (Table 2) that group effects are jointly statistically significant in all the samples. In 1988 and 1995, the parameters of the frontier varied across educational groups. In the two latter samples, for 1999 and 2004, significant variation in the parameters is observed with respect to both age and educational groups. It appears, then, that group characteristics affected credit policy more in the latter samples than in the earlier samples.

Table 2. **Probability values for Chi^2 tests for group effects in the frontier (H0: no group effects)**

type	group	variable	1988	1995	1999	2004
fixed and variable effects	age		0 %	0 %	0 %	0 %
	edu		0 %	0 %	0 %	0 %
fixed effects	age		19 %	12 %	8 %	2 %
	edu		62 %	16 %	1 %	85 %
variable effects	age	W	62 %	19 %	75 %	2 %
	edu	W	0 %	20 %	0 %	3 %
	age	Y	39 %	30 %	13 %	3 %
	edu	Y	27 %	0 %	1 %	0 %

Note: Fixed effects and variable effects of gross wealth (W) and income (Y) across age and educational (edu) groups in four samples.

Table 3 gives the parameter estimates of the extended model. In the estimation, the comparison group comprises age group 3 (over 50) and educational group 3 (lowest or no education). For this group, the estimated signs of the coefficients are as expected, and the levels make sense in broad terms. Interestingly, the significance tests for the coefficients (z-tests) suggest that the focus of credit policy changed from collateral to current income during the cycle.

Due to the high dimensionality of the model, graphical analysis of the estimated frontier is not practical. As an indication of the tightness of credit policy, we report in Table 4 for each sample year the proportion of households in that sample that would encounter tighter policy during the other estimation years. To perform the test, we used the extended model to calculate for each household in each of the estimation samples four frontiers and four idiosyncratic variances of the frontier, reflecting credit conditions during each estimation year. Table 4A reports a comparison of the frontiers and Table 4B a comparison of the idiosyncratic variances from the point of view of the borrowers in each sample.

Table 3. **Parameter estimates from the extended model**
(*/**/*** = 5%/1%/0.1% significance)

exogenous	endogenous	1988	1995	1999	2004
L	W	.31***	.27*	.42**	0.38
	Y	0.15	.89***	0.35	0.32
	c	2.3***	0.29	1.3	2*
	age(1)*W	0.049	-0.097	0.051	0.13
	age(1)*Y	0.21	-0.33	-0.51	-0.0099
	age(1)	-1	1.2*	1.6*	-0.51
	age(2)*W	-0.0066	-0.068	0.013	-0.12
	age(2)*Y	-0.048	-0.19	-0.087	.52*
	age(2)	-0.56	0.34	-0.38	-1.7**
	edu(3)*W	-0.013	0.071	-.24*	0.044
	edu(3)*Y	0.085	-0.068	.86*	-0.083
	edu(3)	-0.085	-0.032	-1.9	0.12
	edu(5)*W	-0.032	0.1	-.23**	0.065
	edu(5)*Y	0.28	-0.33	1.1**	-0.031
	edu(5)	-0.5	0.73	-2.7**	-0.29
	edu(6)*W	-.34***	0.1	-0.052	-0.0063
	edu(6)*Y	0.4	-.64*	0.64	-0.032
	edu(6)	0.56	1.9*	-1.9	0.25
	edu(7)*W	-0.12	-0.14	-.27***	0.22
	edu(7)*Y	0.16	0.54	0.32	-0.12
	edu(7)	0.31	-1.3	0.26	-0.67
	edu(8)*W	-.54*	-0.96	0.25	1.3**
	edu(8)*Y	1.1	1.8***	0.22	-2.1***
	edu(8)	-1.3	-2.8	-2.2	0.93
var(v)	W	-0.13	-0.2	-0.0052	-0.06
	Y	0.22	-0.39	-0.65	-0.49
	c	-1.2	0.91	1.5	0.58
var(u)	W	0.17	0.099	0.0035	0.073
	Y	-.68*	-0.12	0.21	-0.15
	c	1.6**	-0.13	-1.1	0.68

Note: Estimations were performed with the 'frontier' command with probability weights in Stata. In the frontier equation, loans (L) are regressed by gross wealth (W), income (Y) and a constant (c). Fixed affects and variable effects wrt W and Y are allowed in the frontier across age and educational (edu) groups. L, W and Y are measured in 1000 euro, deflated by CPI to the 1999 level, and expressed in natural logarithms. var(v) and var(u) refer to the natural logarithm of the variance of v and u respectively. u is assumed to be exponentially distributed, and the v standard normally distributed. Since the frontier is linear in logs, (a small) number of observations which had zero wealth was omitted from each sample. The number of observations in each estimation sample was 1748, 1059, 1057 and 936 households in 1988, 1995, 1999 and 2004 respectively.

Table 4. **The proportion of households in each sample for whom policy would be tighter during the year of comparison**[9]

A Tightness in expected limit

year of sample:	1988	1995	1999	2004
year of comparison:				
1988	-	67 %	59 %	83 %
1995	36 %	-	45 %	84 %
1999	44 %	56 %	-	88 %
2004	17 %	20 %	22 %	-

B Tightness in variance

year of sample:	1988	1995	1999	2004
year of comparison:				
1988	-	47 %	79 %	22 %
1995	54 %	-	79 %	29 %
1999	10 %	16 %	-	0 %
2004	70 %	81 %	97 %	-

Note: Calculated with the extended model. See the main text for more details.

To elaborate, the second column in Sub-table 4A shows that 36% of households in the 1988 sample would find a lower frontier in 1995 than in 1988. The last column of Sub-table 4B shows that a negligible proportion (0%) of households in the 2004 sample would find a lower variance of the frontier in 1999 than in 2004. In almost all the cases, assessments of policy tightness vary across households. Consequently, the estimation years cannot be unambiguously ranked in terms of policy tightness.

However, the year 2004 is lenient in terms of expected limits and tight in consistency of the limits from the point of view of most households. It is observed from the bottom row of Sub-table 4A that, in other samples, only 17–22% of households expected to find tighter limits in 2004 than during their own sample period. At the same time, 83–88% of households in 2004 expected to find tighter limits during other sample periods. In terms of the variance of the limit, the situation is qualitatively reversed.

The other observation years are more difficult to rank. Arguably the credit crunch year 1995 could be ranked as more lenient than the boom year 1988 in terms of expected limits, because a majority (67%) of the households in 1995

[9] It may be interesting to note that the tables are not symmetrical in the sense that across-diagonal elements do not (usually) sum up to 100%. This feature reflects changes in the underlying samples, for example the characteristics of households in the sample of 1988 are not identical with the characteristics of households in the sample of 1995. It is unclear why the across-diagonal elements in Table 4A tend to sum to more than and in Table 4B to less than 100%.

would face a tighter limit in 1988 than in 1995. Only 36% of the households in the 1988 sample would face tighter limits in 1995 than in 1988.

The results, then, point to the conclusion that, rather than a general tightening of policy in 1995 during the credit crunch, credit policy was tightened towards a minority of borrowers. By investigating the extended model further, we are able to provide insight into what types of household borrowers experienced a tightening in credit conditions during the crisis.

Consider the following decomposition of the frontier with respect to education and age effects

$$E_i\{\max(L_i)\} = \underbrace{(\alpha_{edu} + \beta_{Y,edu} * Y_i + \beta_{w,edu} * W_i)}_{1.} + \underbrace{(\alpha_{age} + \beta_{Y,age} * Y_i + \beta_{W,age} * W_i)}_{2.}$$

The extended model can be used to make this decomposition applicable to all households in all samples (except the group of comparison). The first part in parentheses is referred to as the 'education-specific component' and the second part as 'the age-specific component' of the limits.

We have studied the cyclical development of these components for many different types of households during the boom-bust cycle. An interesting pattern emerged from this study that is illustrated in Table 5 in connection with a hypothetical household that would be roughly at the middle of the income and wealth distribution during all estimation years. It can be observed from the table that the education-specific components of the credit limit tended to develop pro-cyclically and the age-related components counter-cyclically. This regularity holds throughout a large part of the distribution of households.

Most likely, the pro-cyclical development of the education-specific components reflects the significant tightening of the government-subsidized student loan facility in the early 1990's in Finland.[10] It is a merit to the approach used in this paper that it signals this supply shock at the credit market.

[10] As a result of this move, the use of student loans fell markedly. To further investigate this issue, we used the extended model to calculate the tightness of expected limits during the years 1988 and 1995 from the point of view of households belonging to socioeconomic group 6 (students). As many as 87% of student households in 1988 would face a tightening of expected credit limits in 1995 compared with 1988. At the same time, only 14% of student households in 1995 would have encountered a tightening of the expected limits in 1988 compared with 1995.

Table 5. **Qualitative assessment of tightening (1) and easing (0) of the group-specific components of expected limits between 1988 and 1995 for households with W=Y=3.**

group	pro-cyclicality of the group specific component
age3, edu0	0
age1	0
age2	0
edu3	1
edu5	1
edu6	1
edu7	1
edu8	1

Note: Borrowers characterized by gross wealth (W), income (Y), age and educational group (edu). Both variables measured in 1000 euro, deflated by CPI to the 1999 level, and expressed in natural logarithms. The test is based on the extended model.

5 Concluding remarks

We have studied banks' credit policy during a pronounced cycle in Finland to test the pro-cyclical credit policy hypothesis. Our tests indicate that the focus of credit policy changed from collateral to current income during the cycle. Our evidence does not support the hypothesis of a general tightening of policy during the period of financial contraction. Rather, we find credit policy tightening towards a minority and easing towards a majority of household borrowers. An analysis of why we fail to find a general tightening of policy in line with the theoretical predictions is an important area for further study.

We find that credit policy in Finland had eased markedly by 2004, ten years after the banking crisis. Credit policy appears to have eased in the sense that the expected limits were raised, and the tailoring of limits increased to account for age- and education-specific factors of household borrowers. This result is consistent with abundant other information about the loosening of credit policy during the current decade which has resulted in the fall in pre-saving for a house purchase among young households in Finland.[11]

One caveat is that any comparison of the results of 2004 with the other periods is complicated by the fact that wealth in 2004 was measured by using a different method than during the other years. We have studied the effect that this has on the estimation results, by comparing two frontiers in 1988, estimated by using the two methods of measuring wealth. The year 1988 is the only sample in

[11] This has been reported in a number of surveys by the Federation of Finnish Financial Services, www.fkl.fi.

which both measures are available. Based on this comparison, it seems likely that the method used in connection with the year 2004 gives a somewhat lower frontier at low levels of wealth than the other method. The level of the estimated frontier is about the same at higher levels of wealth, irrespective of the method of estimation. It appears, then, that the estimation results concerning the year 2004 cannot be explained by the measurement issue.

Our analysis ought to be viewed in connection with the caveat that the results refer to a specific client group (households), and selected periods of a specific historical episode. Much more empirical study is needed to establish with any certainty whether, how, and how often pro-cyclical credit policy plays a role in the propagation of boom-bust cycles. We hope to have demonstrated one viable econometric approach with which such evidence can be gathered.

Our approach is based on stochastic frontier analysis, which is a well-established method in efficiency analysis but relatively new in the study of credit constraints. We are able to extend the applicability of the approach and propose a test that is informative of many aspects of credit policy. Application of the method yields evidence of the presence of credit constraints in line with the prediction of the agency cost literature on credit. Confidence in the method is promoted by the fact that it successfully signals two well known loan supply events: the tightening of the government sponsored student loan facility and the easing of credit supply during the 2000's.

We hope that our work and the work of Chen and Wang (2008) as well as Wang (2003), inspires further methodological debate in this field. The approach may offer a way to address the difficult issues of how credit constraints affect behaviour and, thus, macroeconomic development.

References

Berger, A – Udell, G (2004) **The Institutional Memory Hypothesis and the Procyclicality of Bank Lending Behavior.** Journal of Financial Intermediation 13, 458–495.

Boyd, J – Kwak, S – Smith, B (2005) **The Real Output Losses Associated with Modern Banking Crises.** Journal of Money, Credit, and Banking, Vol. 37, No. 6, 977–999.

Chen, N – Wang, H-J (2008) **Demand and Supply Effects in Financial Crises.** Southern Economic Journal 2008, 75(1), 26–49.

Dell'Arccia, G – Marquez, R (2006) **Lending Booms and Lending Standards.** The Journal of Finance, Vol. LXI, No. 5, 2511–2546.

Gerali, A – Neri, S – Sessa, L – Signoretti, F (2008) **Credit and Banking in a DSGE Model.** Unpublished manuscript.

Goodfriend, M – McCallum, B (2007) **Banking and Interest Rates in Monetary Policy Analysis A Quantitative Exploration.** NBER Working Paper series 13207.

Greene, W (2001) **Fixed and Random Effects in Stochastic Frontier Models.** New York University Working Paper No. EC-01-01.

Herrala, R (1999) **Banking Crises vs. Depositor Crises: The Era of the Finnish Markka 1865–1998.** Scandinavian Economic History Review, Vol. 47, No. 2, 5–22.

Herrala, R – Kauko, K (2007) **Household Loan Loss Risk in Finland – Estimations and Simulations With Micro Data.** Bank of Finland Discussion Papers 5/2007.

Holmström, B – Tirole, J (1997) **Financial Intermediation, Loanable Funds, and the Real Sector.** The Quarterly Journal of Economics, Vol. CXII, Issue 3, 663–691.

Honkapohja, S (2009) **The 1990's Financial Crises in Nordic Countries.** Bank of Finalnd Research Discussion Papers 5/2009.

Hyytinen, A – Määttänen, N – Johansson, E (2006) **Omistusasunnon ja asuntolainan rooli kotitaloudessa** (the role of own house and mortgage in a household in Finnish), Kansantaloudellinen aikakauskirja, Vol. 102.

International Monetary Fund (1998) **Financial Crises: Characteristics and Indicators of Vulnerability.** In IMF: World Economic Outlook.

Jiménez, G – Saurina J (2006) **Collateral, Type of Lender and Relationship Banking as Determinants of Credit Risk.** Journal of Banking and Finance 28, 2191–2212.

Koskenkylä, H – Vesala, J (2004) **Finnish Deposit Banks 1980–1993: Years of Rapid Growth and Crisis.** Bank of Finland Discussion Paper 16/94.

Matsuyama, K (2007) **Credit Traps and Credit Cycles.** The American Economic Review, Vol. 97, No. 1, 503–516.

Minsky, H (1986) **Stabilizing an Unstable Economy.** McGraw-Hill, our edition from 2008, foreword by H. Kaufman.

Nyberg, P – Vihriälä, V (2004) **The Finnish Banking Crisis and its Handling.** Bank of Finland Discussion Paper 7/94.

Rajan, R (1994) **Why Bank Credit Policies Fluctuate: A Theory and Some Evidence.** Quarterly Journal of Economics, Vol. 109, No. 2, 399–441.

Reinhart, C – Rogoff, K (2008) **Is the 2007 U.S. Sub-Prime Financial Crisis so Different? An International Historical Comparison.** National Bureau of Economic Research, Working Paper 13761.

Ruckes, M (2004) **Bank Competition and Credit Standards.** Review of Financial Studies, Vol. 17, No. 4, 1073–1102.

Wang, H-J (2003) **A Stochastic Frontier Analysis of Financing Constraints on Investment: The Case of Financial Liberalization in Taiwan.** Journal of Business and Economic Statistics, 21, 406–419.

Appendix

The data comprises complex surveys by Statistics Finland. The sampling clusters are households and the stratification is by income class. The imputations of missing variables and reweighting to account for missing observations have been carried out by the data provider.[12]

Table A1. **Construction of the data**

Estimation year	Construction of the data
1988	The surveys for saving and indebtedness from 1987 and 1988 were merged to obtain a sample of 5248 households. The number of households that increased borrowing in 1988 is 1764. 'pkor8' from the 1988 survey was used as the probability weight. Loans (luoto8+vnyht8) and monetary income (kturaha88) are given in the survey of 1988. Wealth is estimated by adding to the value of wealth given in the survey of 1987 (bruttoy7) a proportionality factor times the change in taxable wealth in 1988 (vsvar8–vsvar7). The proportionality factor is estimated from the data by a linear regression of wealth on taxable wealth in 1987.[13]
1995	The wealth survey of 1994 and the income distribution surveys for the years 1994 and 1995 were merged to obtain a sample of 4951 households. The number of households that increased borrowing in 1995 was 1082. 'pkor' from the 1995 survey was used as the probability weight. Loans (aslaimk+muulaimk) and monetary income (kratulo-kmakstu+tlue+tlue1+tlue2) are given in the income distribution survey of 1995. Wealth is estimated by adding to the value of wealth given in the survey of 1994 (bruttoy) a proportionality factor times the change in taxable wealth in 1995 (svarat1995–svarat1994). The proportionality factor is estimated from the data by a linear regression of wealth on taxable wealth in 1994, as in the earlier sample.
1999	The wealth survey of 1998 and the income distribution surveys for the years 1998 and 1999 were merged to obtain a sample of 3685 households. The number of households that increased borrowing in 1999 was 1072. 'pkor' from the 1999 survey was used as the probability weight. Loans (aslaimk+laiopin+laimuut) and monetary income (kturaha) are given in the income distribution survey of 1999. Wealth is estimated by adding to the value of wealth given in the survey of 1998 (bruttoy) a proportionality factor times the change in taxable wealth in 1999 (svarat1999-svarat1998). The proportionality factor is estimated from the data by a linear regression of wealth on taxable wealth in 1998, as in the earlier samples.
2004	The wealth survey of 2004 of 3455 households was used in the estimation. The number of households that increased borrowing in 2004 was 940. 'koro04' was used as the probability weight. Loans (asuvel+opivel+muuvel+yrilm), monetary income (kturaha) and wealth (bruttoy) are given in the survey.

[12] Hyytinen, Määttänen and Johansson (2006) and Herrala and Kauko (2007) have previously used some of the surveys to study household finance.

[13] The proportionality factor is the coefficient of wealth in the regression 'regress bruttoy7 vsvar7' in Stata.

Table A2. **Analysis of population means of the continuous variables**

Year	Variable	Mean	S.E.	[95% Conf.	Interval]
1988	L	2.59	0.05	2.50	2.68
	W	3.36	0.06	3.24	3.49
	Y	3.03	0.02	2.99	3.07
1995	L	2.69	0.05	2.58	2.79
	W	3.04	0.08	2.88	3.21
	Y	3.03	0.02	2.99	3.07
1999	L	2.71	0.06	2.59	2.82
	W	3.06	0.10	2.86	3.26
	Y	3.11	0.02	3.07	3.15
2004	L	2.82	0.07	2.68	2.97
	W	3.51	0.10	3.32	3.70
	Y	3.22	0.03	3.17	3.28

Note: Loans (L), gross wealth (W) and income (Y) in 1000 euro, deflated by CPI to the 1999 level, in natural logarithms.

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