Differentiated Use of Small Business Credit Scoring by Relationship Lenders and Transactional Lenders

Evidence from Firm-Bank Matched Data in Japan

Ryo Hasumi
(Japan Center for Economic Research)

Hideaki Hirata (Hosei University)

Arito Ono (Mizuho Research Institute)

August 7th, 2011

* The views and opinions expressed are those of the authors and do not necessarily reflect those of any of the institutions with which we are affiliated.

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1. Introduction

Motivations

- Traditionally, loans to small businesses have been based on close "relationships" between borrower firms and lenders
- Rapid expansion of SBCS (small business credit scoring)
  - Credit scoring: quantitative method to evaluate the credit risk of loan applications
  - Effective in increasing the availability of credit and/or in improving the accuracy of risk evaluation (Berger and Frame, 2007)

Motivations

- Growing concerns on the efficacy of SBCS under the recent global financial crisis
  - Prone to type II errors?
    - "[…] business-credit scores – as well as personal credit scores – have become a weak indicator of repayment ability, at least in the eyes of some large lenders." (*Wall Street Journal*, March 18, 2010)
  - Detrimental to firm-bank relationships?
    - May have contributed to the financing difficulties for small businesses under the crisis

Research questions

- What determines the use of SBCS by banks?
  - Large banking organizations with a more "centralized" structure are more likely to adopt SBCS (Akhavein, Frame, and White, 2005; Frame, Srinivasan, and Woosley 2001)
- How does SBCS affect the availability & prices of credit to small businesses?
  - Increase in credit availability: FSW01, Frame, Padhi, and Woosley (2004), Berger, Frame, and Miller (2005), Berger, Cowan, and Frame (2011)
  - Higher loan prices, especially for "discretion" banks (BFM05)
  - Counter-argument: Agarwal and Hauswald (2008)

Research questions

- **Is SBCS more prone to type II errors? (focus of this paper)**
  - SBCS is associated with more type II errors (AH08; DeYoung, Glennon, and Nigro, 2008). BCF11 find no significant effects
  - "Tyranny of distance" disappears in SBCS (FPW04; DGN08)
- **Is SBCS a substitute or complement to relationship lending? (focus of this paper)**
  - SBCS may be a complement to other lending technologies for "discretion" banks, substitute for "rule" banks (BFM05)
  - A borrower that is located further away from its lender is more likely to switch from relationship loans to transactional loans (AH08; AH10)

This paper

- Examines the ex-post performance of SMEs that obtained SBCS loans
- Examines the relationship between the lending attitude of a relationship lender and a firm's usage of an SBCS loan

This paper

- Constructs a unique firm-bank matched dataset from firm-surveys; most previous studies make use of bank survey data
- Distinguishes SBCS loans by relationship lenders (primary banks) from SBCS loans by transactional lenders (non-primary banks)
  - Primary bank: the bank that has the largest amount of loans outstanding to the firm
  - AH08 distinguishes relationship debts (in-person loans) from arm's length debts (online scoring loans) within a large US bank

Main results

- The ex-post probability of default after the SBCS loans were provided significantly increased for SMEs that obtained SBCS loans from non-primary banks
- The lending attitude of primary banks in the midst of the recent global financial crisis was more severe if a non-primary bank had extended an SBCS loan to a firm
- No detrimental effects were found for SBCS loans extended by primary banks

2. The Development of Small Business Credit Scoring in Japan

What is SBCS?

- Credit scoring produces a "score" for a loan applicant, using both qualitative and quantitative data and statistical techniques
- Definition of SBCS loans: loans where the primary lending decision is based on numerical credit scores (Berger an Udell, 2006)
  - Does not rule out the use of other information (e.g. soft information) as a secondary source
  - Recognizes loans as a portfolio: credit decisions are based on the *average* performance of a loan portfolio

The development of SBCS: U.S.

- Credit scoring was not used for small business credit until the mid-1990s
  - Heterogeneity of small businesses
  - Lack of standardization of loan documentation
- Underlying factors for the development of SBCS
  - Accumulation of historical loan data
  - Finding on the usefulness of personal credit scores of business owners (Mester, 1997)
- Typically used for loans under $100K

The development of SBCS: Japan

- SBCS has spread among Japanese banks since the early 2000s
  - Regulatory pressure: FSA "2003 Action Program"
- Reliance on business credit scores (Ono, 2006)
  - Banks do not have sufficient access to databases on the personal credit histories of business owners
- Growth in the SBCS loan market has stagnated since the mid-2000s
  - The default rates of SBCS loans have been higher than expected (Hasumi and Hirata, 2010)
  - FSA has ceased to promote the use of SBCS

3. Empirical Hypotheses

Strategies of Implementing SBCS

- Cost-saving in screening loan applications
  - Expanding small business lending
- The mitigation of the borrower opacity problem
  - More efficient lending decisions and/or setting contract terms more accurately (risk-based pricing of loans)
- "Rule" vs. "Discretion" (Berger, Frame, and Miller 2005)
  - Criterion: automated credit decisions by credit scores or not
  - Rule banks: increase in loan volumes
  - Discretion banks: increase in loan premiums

Effects on borrower performance

- Theory (DeYoung, Glennon, and Nigro, 2008)
  - *Higher* default rate due to the risk-taking effect (with greater efficiency, the bank has greater capacity to absorb losses)
  - *Higher* default rate because, if used in isolation, SBCS loans are more prone to type I and/or type II errors
  - *Lower* default rate if SBCS improves the lender's information set by combining the hard & soft info
- Empirics: mixed results
  - DGN08 and Agarwal and Hauswald (2008): positive effect of SBCS on the default rate
  - Berger, Cowan, and Frame (2011): no significant effects on banks' non-performing loan ratio

Effects on borrower performance

Hypothesis 1

- *The average ex-post performance of SBCS loan user firms deteriorates more than that of non-scoring loan user firms if SBCS loans are extended by a transactional lender that implements SBCS for the cost-saving motive.*
- *In contrast, the average ex-post performance of SBCS loan user firms improves more than that of non-scoring loan user firms if SBCS loans are provided by a relationship lender that adopts SBCS in order to evaluate the creditworthiness of prospective borrowers more accurately*

Effects on firm-bank relationships

- Little empirical studies
  - Agarwal and Hauswald (2008, 2010): the intimacy of the firm-bank relationship negatively affects the switch from relationship loans to transactional loans
- The effect of SBCS on a firm-bank relationship may also depend on whether the bank that extends an SBCS loan is a relationship lender or a transactional lender

Effects on firm-bank relationships

Hypothesis 2

- *The lending attitude of a relationship lender to firms that obtain SBCS loans from transactional lenders is more stringent than to firms that do not obtain SBCS loans, particularly during a period of crisis.*
- *In contrast, the lending attitude of a relationship lender to SBCS loan user firms is not adversely affected if the SBCS loan is provided by the same relationship lender.*

4. Data and Variables

Data

- Main sources: the RIETI surveys
  - Survey on Transactions between Enterprises and Financial Institutions (企業と金融機関との取引実態調査), Feb 2008
  - Survey on Transactions between Enterprises and Financial Institutions under Financial Crisis (金融危機下における企業・金融機関との取引実態調査), Feb 2009
  - Survey on Small Business Credit Scoring Loans (スコアリング融資に関する取引実態調査), Nov 2009

Data

- For each firm, we can identify:
  - firm's primary bank (w/ the largest amount of loans outstanding) and its secondary-primary bank
  - whether these banks and/or "other" banks have extended an SBCS loan
- Assumption
  - Primary banks = "relationship" lenders
  - Non-primary banks = "transactional" lenders

Data

- Firm variables
  - RIETI surveys and TSR Financial Information Database
  - Exclude firms w/ annual gross sales ≥ ¥5B
- Bank variables
  - Nikkei Financial Quest Database + other sources
  - Drop observations if a firm has transactions with government-sponsored FIs or non-banks
- Firm-bank relationship variables
  - 2008 RIETI survey
  - Drop observations of firms whose primary banks changed b/w 2008 and 2009

Variables: Hypotheses 1 & 2

- Ex-post performance (F_PD): the probability of default of a firm estimated based on its financial statement (in year 2009) after the SBCS or non-SBCS loan was extended
  - Annualized PD within 3 years calculated using the scoring model of Moody's RiskCalc
- Lending attitude of primary banks ($R\_ATTITUDE$):
  - RIETI survey questionnaire asks firms whether the lending attitude of their primary banks has (1) improved, (2) remained unchanged, or (3) worsened after the failure of Lehman Brothers in Sep. 2008

Variables: SBCS

- SBCS dummy variables (SC_DUM_PR, SC_DUM_NPR): 1 if a firm had SBCS loans outstanding as of Feb. 2009, 0 otherwise
- Did a firm know whether it was using an SBCS loan?
  - Many banks had specific names for SBCS loan products
  - About 20% of respondent firms selected the choice "don't know." These observations are dropped from our dataset

Variables: other covariates

- Firm characteristics
  - Ex-ante PD (PD), the log of annual gross sales (LN_SALES), the log of firm age ($LN\_FIRMAGE$), the share of equity holdings by a business representative ($OWNERS\_HOLD$)
- Bank characteristics
  - The log of asset size (BK_LN_ASSETS), the bank's share of bank branches within the prefecture of a borrowing firm (BK_SHARE), Herfindahl Index in each prefecture ($HERFINDAHL$)

Variables: other covariates

- Firm-primary bank relationship
  - The log of the duration of the firm-bank relationship ($R\_LN\_DURATION$), frequency of meeting (R_FREQ), distance b/w a firm and the bank's branch ($R\_DISTANCE$), the percentage share of the primary bank in a firm's loans outstanding ($R\_PRIMESHARE$)

Summary statistics

	All firms						Firms with SBCS loans			Firms without SBCS loans		
	N	Mean	SD	Min	Median	Max	N	Mean	SD	N	Mean	SD
Dependent variables												
F_PD	581	1.577	1.699	0.130	1.010	10.510	58	2.422	2.254	523	1.483	1.602
R_ATTITUDE	819	2.042	0.429	1.000	2.000	3.000	103	2.175	0.532	716	2.022	0.409
SBCS dummies												
SC_DUM_PR	819	0.076	0.265	0.000	0.000	1.000	103	0.602	0.492	716	0.000	0.000
SC_DUM_NPR	819	0.073	0.261	0.000	0.000	1.000	103	0.583	0.496	716	0.000	0.000
Firm characteristics												
LN_SALES	819	13.589	1.051	10.104	13.631	15.419	103	13.041	0.994	716	13.668	1.036
LN_FIRMAGE	819	3.505	0.525	1.099	3.638	4.663	103	3.295	0.527	716	3.535	0.519
PD	819	1.542	1.738	0.130	0.920	10.890	103	2.349	2.177	716	1.426	1.634
OWNERS_HOLD	819	0.642	0.350	0.000	0.720	1.000	103	0.719	0.287	716	0.631	0.357
INDUSTRY_1	819	0.286	0.452	0.000	0.000	1.000	103	0.350	0.479	716	0.277	0.448
INDUSTRY_2	819	0.245	0.431	0.000	0.000	1.000	103	0.146	0.354	716	0.260	0.439
INDUSTRY_3	819	0.286	0.452	0.000	0.000	1.000	103	0.311	0.465	716	0.282	0.450
REGION_1	819	0.179	0.384	0.000	0.000	1.000	103	0.272	0.447	716	0.166	0.373
REGION_2	819	0.095	0.294	0.000	0.000	1.000	103	0.058	0.235	716	0.101	0.301
REGION_3	819	0.127	0.333	0.000	0.000	1.000	103	0.107	0.310	716	0.130	0.336
Primary bank characteristics												
BK_LN_ASSETS	819	15.252	1.701	10.672	15.117	18.755	103	15.086	1.597	716	15.276	1.716
BK_SHARE	819	0.149	0.121	0.000	0.112	0.462	103	0.158	0.130	716	0.148	0.120
HERFINDAHL	819	0.115	0.067	0.037	0.103	0.292	103	0.122	0.070	716	0.113	0.067
Borrower-primary bank relationship												
R_LN_DURATION	819	3.087	0.824	0.000	3.401	4.605	103	2.891	0.824	716	3.115	0.821
R_FREQ	819	5.172	1.185	0.000	5.000	7.000	103	5.155	1.211	716	5.175	1.182
R_DISTANCE	819	2.683	0.898	1.000	3.000	6.000	103	2.728	0.782	716	2.676	0.914
R_PRIMESHARE	819	0.612	0.250	0.000	0.600	1.000	103	0.584	0.230	716	0.616	0.252

Summary statistics

	SBCS loans from primary banks (*S_DUM_PR* =1)			SBCS loans from non-primary banks (*S_DUM_NPR* =1)			SBCS loans from both primary and non-primary banks (*S_DUM_PR* =1 & *S_DUM_NPR* =1)		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Dependent variables									
F_PD	35	1.715	1.290	33	2.846	2.749	10	1.348	1.523
R_ATTITUDE	62	2.113	0.483	60	2.267	0.548	19	2.263	0.452
SBCS dummies									
SC_DUM_PR	62	1.000	0.000	60	0.317	0.469	19	1.000	0.000
SC_DUM_NPR	62	0.306	0.465	60	1.000	0.000	19	1.000	0.000
Firm characteristics									
LN_SALES	62	13.059	0.986	60	13.059	0.958	19	13.158	0.831
LN_FIRMAGE	62	3.304	0.550	60	3.265	0.530	19	3.230	0.609
PD	62	2.391	2.354	60	2.031	1.818	19	1.479	1.519
OWNERS_HOLD	62	0.733	0.283	60	0.690	0.290	19	0.676	0.285
INDUSTRY_1	62	0.371	0.487	60	0.317	0.469	19	0.316	0.478
INDUSTRY_2	62	0.194	0.398	60	0.083	0.279	19	0.105	0.315
INDUSTRY_3	62	0.306	0.465	60	0.317	0.469	19	0.316	0.478
REGION_1	62	0.226	0.422	60	0.317	0.469	19	0.263	0.452
REGION_2	62	0.081	0.275	60	0.033	0.181	19	0.053	0.229
REGION_3	62	0.081	0.275	60	0.150	0.360	19	0.158	0.375
Primary bank characteristics									
BK_LN_ASSETS	62	15.036	1.568	60	15.214	1.649	19	15.326	1.676
BK_SHARE	62	0.178	0.137	60	0.139	0.126	19	0.163	0.153
HERFINDAHL	62	0.133	0.069	60	0.117	0.073	19	0.140	0.078
Borrower-primary bank relationship									
R_LN_DURATION	62	2.954	0.804	60	2.787	0.878	19	2.766	0.951
R_FREQ	62	5.226	1.122	60	5.133	1.228	19	5.316	0.946
R_DISTANCE	62	2.774	0.876	60	2.700	0.671	19	2.789	0.787
R_PRIMESHARE	62	0.630	0.228	60	0.515	0.200	19	0.515	0.165

5. Empirical Approach and Results

Baseline estimations

$$F\_PD_i = \beta_0 + \beta_1 \cdot SC\_DUM\_PR_i + \beta_2 \cdot SC\_DUM\_NPR_i + \mathbf{X}_i'\boldsymbol{\beta} + \varepsilon_i$$

$$R\_ATTITUDE_{ij} = \gamma_0 + \gamma_1 \cdot SC\_DUM\_PR_i + \gamma_2 \cdot SC\_DUM\_NPR_i + \mathbf{X}_i'\boldsymbol{\gamma} + u_i$$

- F_PD : expected PD as of year 2009
- $R\_ATTITUDE$: the change in lending attitude of a firm's primary bank after Sep. 2008
- SBCS loan dummies are as of Feb. 2009, although most loans were provided before Feb. 2009
- Firm variables: 2009 RIETI survey and most recent financial statements (Mar. 2006 – Dec. 2008)
- Bank variables: Mar. 2008 / Oct. 2007
- Firm-bank relationship variables: 2008 RIETI survey

Baseline estimations

	Dep. variable: *F_PD* Estimation method: OLS				Dep. variable: *R_ATTITUDE* Estimation method: OLS			
	Coef.	Std. Err.	t	P>t	Coef.	Std. Err.	t	P>t
SBCS dummies								
SC_DUM_PR	-0.459 **	0.223	-2.060	0.040	-0.028	0.057	-0.490	0.626
SC_DUM_NPR	0.816 ***	0.233	3.500	0.000	0.211 ***	0.059	3.610	0.000
Firm characteristics								
LN_SALES	-0.133 **	0.062	-2.150	0.032	0.018	0.017	1.030	0.305
LN_FIRMAGE	-0.004	0.128	-0.030	0.973	0.023	0.035	0.670	0.506
PD	0.719 ***	0.037	19.600	0.000	0.068 ***	0.009	7.460	0.000
OWNERS_HOLD	0.179	0.155	1.160	0.249	0.051	0.044	1.150	0.251
INDUSTRY_1	0.121	0.166	0.730	0.465	0.022	0.045	0.500	0.619
INDUSTRY_2	0.227	0.167	1.360	0.176	0.109 **	0.046	2.340	0.019
INDUSTRY_3	0.031	0.164	0.190	0.849	-0.009	0.044	-0.200	0.844
REGION_1	-0.102	0.180	-0.560	0.573	0.093 *	0.050	1.880	0.061
REGION_2	0.079	0.199	0.400	0.691	0.093 *	0.054	1.720	0.086
REGION_3	-0.050	0.173	-0.290	0.773	0.075	0.049	1.520	0.128
Primary bank characteristics								
BK_LN_ASSETS	-0.002	0.038	-0.060	0.955	-0.004	0.011	-0.350	0.723
BK_SHARE	0.929	0.605	1.540	0.125	-0.033	0.171	-0.190	0.846
HERFINDAHL	-2.257 *	1.209	-1.870	0.062	0.150	0.337	0.440	0.657
Borrower-primary bank relationship								
R_LN_DURATION	-0.076	0.084	-0.910	0.363	-0.037 *	0.022	-1.660	0.098
R_FREQ	0.079 *	0.045	1.770	0.078	-0.022 *	0.013	-1.690	0.091
R_DISTANCE	0.108 *	0.059	1.830	0.068	-0.004	0.017	-0.240	0.811
R_PRIMESHARE	0.060	0.212	0.280	0.778	-0.114 *	0.060	-1.910	0.056
Constant	1.840 *	0.990	1.860	0.064	1.857 ***	0.274	6.780	0.000
Number of observations	581				819			
Adj.-R^2	0.487				0.094			
Prob. > F	0.000				0.000			

Baseline estimations

- Ex-post borrower performance (F_PD)
  - S_DUM_NPR is significantly positive: the provision of an SBCS loan by non-primary banks is associated with a deterioration in borrower ex-post performance
  - In contrast, S_DUM_PR is significantly negative
- Lending attitude of primary banks ($R\_ATTITUDE$)
  - S_DUM_NPR is significantly positive: the provision of SBCS loans by non-primary banks has an adverse effect on firm-primary bank relationships
  - S_DUM_PR is insignificant

Treatment effects estimations

- Positive effect of SC_DUM_NPR on F_PD may be due to:
  - Selection effect (selection bias): SBCS loans by non-primary banks are more prone to type II errors
  - Treatment effect: a firm's performance deteriorated as a result of less intensive monitoring by a non-primary bank that provided an SBCS loan as well as by the primary bank whose relationship with the firm became less intimate
- We employ propensity score matching in order to make inferences on the mechanism underlying the empirical results obtained from baseline estimations

Treatment effects estimations

- Procedure of matching estimation
  - Step 1: Implement the probit estimations that model the probability of a firm obtaining an SBCS loan from a primary bank or non-primary bank
  - Step 2: For each treatment observation (SBCS loan user), identify matched observations (control observations) from non-treatment observations. We employ kernel matching
    - Balancing condition of the covariates given the propensity score must be satisfied
  - Step 3: Compare F_PD and $R\_ATTITUDE$ of the treatment group and the control group
    - Note that we are effectively looking at the *change* in the PD and the lending attitude of the primary bank

Probit estimations

	Dep. variable: *S_DUM_PR* Estimation method: Probit				Dep. variable: *S_DUM_NPR* Estimation method: Probit			
	Coef.	Std. Err.	z	P>z	Coef.	Std. Err.	z	P>z
Firm characteristics								
LN_SALES	-0.219 ***	0.084	-2.610	0.009	-0.311 ***	0.089	-3.480	0.001
LN_FIRMAGE	-0.292 *	0.166	-1.760	0.078	-0.292 *	0.167	-1.750	0.081
PD	0.091 **	0.037	2.490	0.013	0.082 **	0.040	2.030	0.043
OWNERS_HOLD	0.265	0.229	1.160	0.246	0.066	0.239	0.280	0.782
INDUSTRY_1	0.228	0.226	1.010	0.313	-0.159	0.208	-0.760	0.446
INDUSTRY_2	0.235	0.247	0.950	0.342	-0.520 *	0.269	-1.930	0.053
INDUSTRY_3	0.308	0.230	1.340	0.180	-0.051	0.204	-0.250	0.803
REGION_1	0.707 ***	0.241	2.940	0.003	0.781 ***	0.240	3.260	0.001
REGION_2	0.122	0.280	0.440	0.663	-0.064	0.367	-0.170	0.862
REGION_3	0.103	0.260	0.400	0.693	0.573 **	0.243	2.350	0.019
Primary bank characteristics								
BK_LN_ASSETS	0.013	0.056	0.240	0.812	0.020	0.054	0.370	0.708
BK_SHARE	0.917	0.840	1.090	0.275	-0.483	0.861	-0.560	0.575
HERFINDAHL	2.354	1.678	1.400	0.161	2.597	1.691	1.540	0.125
Borrower-primary bank relationship								
R_LN_DURATION	-0.018	0.115	-0.160	0.873	-0.027	0.110	-0.240	0.807
R_FREQ	0.091	0.066	1.380	0.167	0.100	0.067	1.490	0.136
R_DISTANCE	0.137 *	0.083	1.660	0.098	0.106	0.089	1.190	0.235
R_PRIMESHARE	-0.209	0.291	-0.720	0.473	-1.112 ***	0.312	-3.560	0.000
Constant	0.510	1.366	0.370	0.709	2.810 **	1.378	2.040	0.041
Number of observations	785				782			
Log likelihood	-193.8				-177.6			
Pseudo R^2	0.1162				0.1612			

Treatment effects estimations

[Primary Bank]

Variable		Treated	Controls	Difference	S.E.	T-stat.
F_PD	Unmatched	1.715	1.483	0.232	0.277	0.84
	ATT	1.715	1.981	-0.266	0.236	-1.13
R_ATTITUDE	Unmatched	2.113	2.022	0.091 *	0.055	1.65
	ATT	2.113	2.077	0.036	0.065	0.56

[Non-primary Bank]

Variable		Treated	Controls	Difference	S.E.	T-stat.
F_PD	Unmatched	2.846	1.483	1.363 ***	0.303	4.50
	ATT	2.846	1.801	1.045 **	0.490	2.13
R_ATTITUDE	Unmatched	2.267	2.022	0.244 ***	0.057	4.31
	ATT	2.267	2.055	0.211 ***	0.075	2.83

Treatment effects estimations

- SBCS loans by non-primary banks
  - Treatment effects on both F_PD and $R\_ATTITUDE$ are positive and significant
  - SBCS loans by a non-primary bank are detrimental to a primary bank's incentive to monitor SMEs and maintain relationships
- SBCS loans by primary banks
  - No significant treatment effects
  - Improvement in the ex-post performance of SBCS loan borrowers from primary banks that was found in the baseline estimation is driven by a reduction in type II errors due to effective screening

6. Conclusion

Conclusion

- A firm's ex-post PD increased if the firm had obtained an SBCS loan from a non-primary bank
  - Consistent with the hypothesis that a transactional lender adopts SBCS for the cost-saving motive and is more prone to type II errors
  - Weakening monitoring activity by banks after SBCS loans were provided also played a role
- SBCS loans by a primary bank were associated with a decrease in the ex-post PD of user firms
  - Consistent with the hypothesis that a relationship lender uses SBCS in order to augment the information set

Conclusion

- The lending attitude of a firm's primary bank in the midst of the recent crisis was adversely affected by the use of an SBCS loan extended by non-primary banks
  - No such detrimental effects were found for an SBCS loan provided by primary banks
- SBCS loans from transactional lenders appear to be beneficial in that they increase the availability of credit. However, such loans may be detrimental to the close ties a borrower has with its relationship lender, which may be particularly valuable during times of crisis

Extensions

- Widening the time window for ex-post performance variables
  - Actual default rates may become available over time
- Examining how banks determine their strategy of implementing SBCS
  - Composition of relationship-based SBCS loans and transaction-based SBCS loans within a bank may differ across banks
- Analyzing the loan contract terms (interest rates, collateral, etc.) of SBCS loans