Firm Age and the Evolution of Borrowing Costs:
Evidence from Japanese Small Firms

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Focus of the paper

- **Evolution of borrowing costs among Japan's small businesses as they age**

  Many studies on the evolution of real activity variables

  Evans (1987), Cabral and Mata (2003), Davis et al. (1996)

  But not many on the financial variables

- **Two distinct channels in the evolution**

  Selection – nonviable firms are separated from survivors and forced to exit

  Adaptation – surviving firms (or surrounding agents) change their behavior as they age

Three questions to be answered

1. **Selection vs. Adaptation?**
2. **Natural vs. Unnatural Selection?**
   - Caballero et al. (2004), Peek and Rosengren (2005), Nishimura et al. (2003)

     Inefficient "zombie" firms are not weeded out: evidence for unnatural selection
3. **Track Record vs. Size?**
   - Does firm age directly (Diamond (1989)), or indirectly (through size) affect borrowing costs?

Empirical approach: Data

- A data set of more than 200,000 small firms
- Able to identify default, “selection,” and “adaptation”

Number of Observations

Year	All Firms	Surviving Firms	Defaulting Firms	Default Ratio (%)
1997	240,384	232,811	7,573	3.150
1998	232,811	224,005	8,806	3.782
1999	224,005	215,404	8,601	3.840
2000	215,404	208,644	6,760	3.138
2001	208,644	203,337	5,307	2.544
2002	203,337	203,337		
Total	1,324,585	1,287,538	37,047	2.797

Empirical approach: Identifying age effects

Borrowing cost as a confluence of the year, cohort, and age effect

$$R_i(t,\tau) = \alpha(t) + \beta(\tau) + \gamma(t-\tau) + \varepsilon_i(t,\tau)$$

Remove the year effect by subtracting a weighted prime lending rate from *R*.

Then the slope of age profile of borrowing cost is

$$R_i'(t+1,\tau) - R_i'(t,\tau) = \gamma(t-\tau+1) - \gamma(t-\tau) + \varepsilon_i(t+1,\tau) - \varepsilon_i(t,\tau)$$

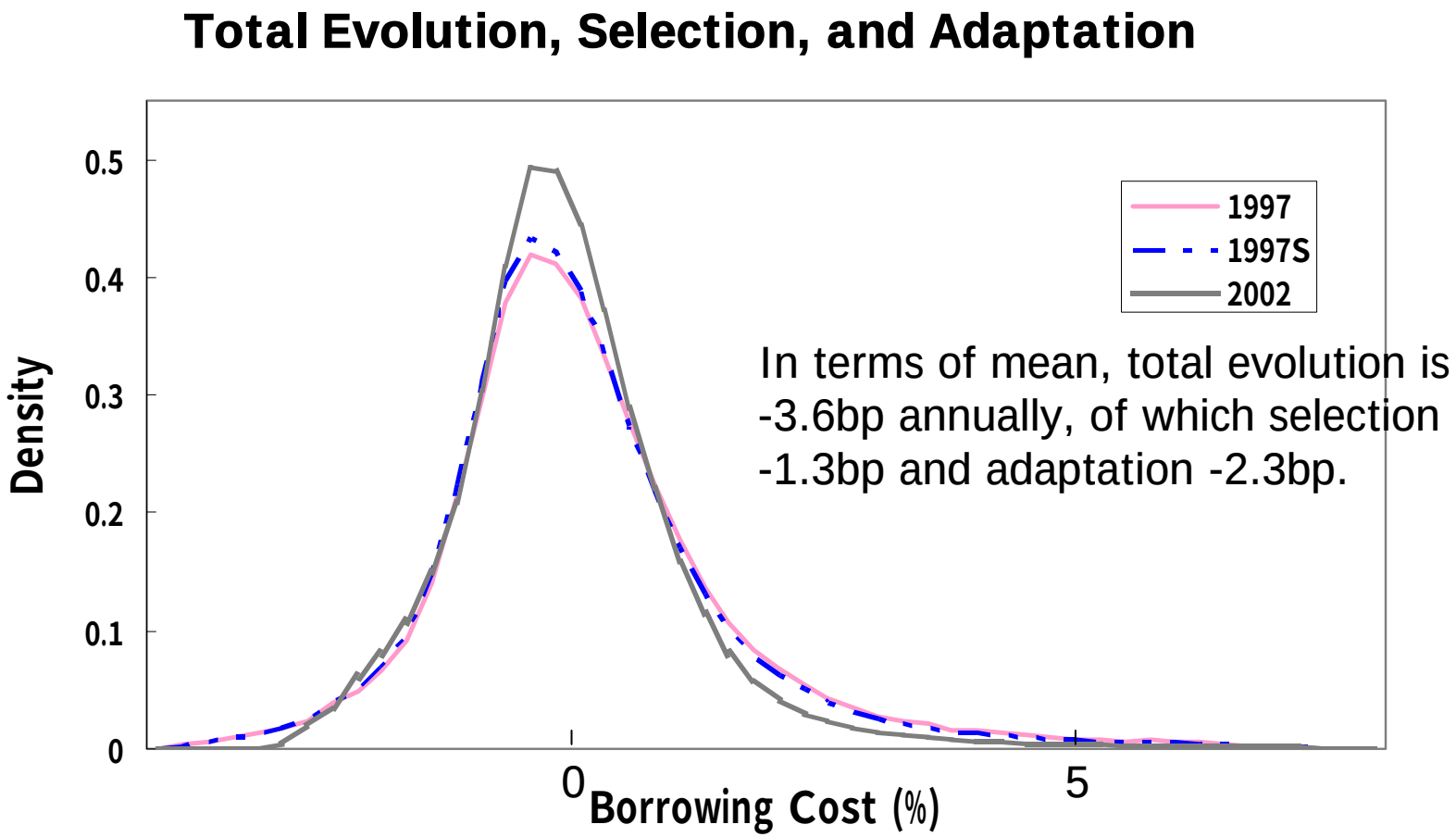
1. Selection vs. adaptation

- Total evolution of borrowing costs from year t to $t+1$ can be decomposed into a "selection" effect and an "adaptation" effect

$$E_{i\in A(t+1,\tau)}R_i(t+1,\tau)-E_{i\in A(t,\tau)}R_i(t,\tau)$$
$$=\underbrace{\theta(t,\tau)\left[E_{i\in S(t,\tau)}R_i(t,\tau)-E_{i\in D(t,\tau)}R_i(t,\tau)\right]}_{\text{Selection Effect}}+\underbrace{E_{i\in A(t+1,\tau)}R_i(t+1,\tau)-E_{i\in S(t,\tau)}R_i(t,\tau)}_{\text{Adaptation Effect}}$$

- Both selection and adaptation are negative
- Adaptation contributes more than selection

1. Selection vs. adaptation



1. Selection vs. adaptation

Total Evolution, Selection, and Adaptation

		Cohort									
		1950—1955	1956—1960	1961—1965	1966—1970	1971—1975	1976—1980	1981—1985	1986—1990	1991—1995	All
All	Total	-0.010	-0.020	-0.026	-0.031	-0.040	-0.048	-0.046	-0.053	-0.050	-0.036
	Selection	-0.007	-0.009	-0.010	-0.012	-0.012	-0.013	-0.014	-0.018	-0.021	-0.013
	Adaptation	-0.003	-0.011	-0.017	-0.019	-0.029	-0.035	-0.032	-0.036	-0.029	-0.023
Construction	Total	-0.007	-0.021	-0.036	-0.042	-0.056	-0.064	-0.066	-0.076	-0.079	-0.050
	Selection	-0.009	-0.015	-0.014	-0.018	-0.016	-0.021	-0.021	-0.027	-0.030	-0.019
	Adaptation	0.003	-0.005	-0.022	-0.024	-0.040	-0.042	-0.045	-0.049	-0.049	-0.031
Manufacturing	Total	-0.020	-0.020	-0.031	-0.039	-0.053	-0.055	-0.056	-0.075	-0.066	-0.046
	Selection	-0.009	-0.009	-0.010	-0.013	-0.012	-0.013	-0.011	-0.015	-0.018	-0.012
	Adaptation	-0.012	-0.011	-0.021	-0.026	-0.040	-0.042	-0.045	-0.060	-0.047	-0.034
Wholesale	Total	0.002	-0.013	-0.017	-0.018	-0.031	-0.050	-0.049	-0.050	-0.054	-0.031
	Selection	-0.008	-0.014	-0.009	-0.013	-0.012	-0.012	-0.019	-0.017	-0.019	-0.014
	Adaptation	0.010	0.001	-0.008	-0.005	-0.019	-0.038	-0.030	-0.033	-0.036	-0.018
Retail	Total	-0.029	-0.060	-0.048	-0.051	-0.040	-0.039	-0.036	-0.051	-0.038	-0.044
	Selection	-0.006	-0.009	-0.009	-0.010	-0.009	-0.010	-0.011	-0.016	-0.016	-0.011
	Adaptation	-0.023	-0.051	-0.039	-0.041	-0.032	-0.028	-0.025	-0.035	-0.022	-0.033
Real Estate	Total	0.057	0.054	0.024	0.017	0.012	0.000	0.022	0.032	0.019	0.026
	Selection	0.004	0.004	0.010	-0.001	0.004	0.006	0.001	-0.011	-0.013	0.000
	Adaptation	0.053	0.050	0.014	0.018	0.008	-0.006	0.021	0.043	0.032	0.026
Service	Total	0.030	0.008	-0.001	-0.008	-0.015	-0.031	-0.022	-0.016	-0.021	-0.009
	Selection	0.003	-0.004	-0.003	-0.006	-0.007	-0.004	-0.009	-0.009	-0.011	-0.006
	Adaptation	0.027	0.011	0.001	-0.001	-0.009	-0.027	-0.013	-0.007	-0.009	-0.003

2. Natural vs. unnatural selection

- If unnatural selection,

$$\theta(t,\tau)\left(E_{i\in S(t,\tau)}R_i(t,\tau)-E_{i\in D(t,\tau)}R_i(t,\tau)\right)>0 \quad \text{or}$$

$$\theta(t,\tau)\left(E_{i\in S(t,\tau)}Q_i(t,\tau)-E_{i\in D(t,\tau)}Q_i(t,\tau)\right)<0$$

where R is the borrowing cost and Q is firm's quality

- We are able to reject the unnatural selection hypothesis not only for the entire sample, but also for almost all sub-samples

2. Natural vs. unnatural selection

One-tailed t-Test for the Borrowing Cost

	Cohort									
	1950—1955	1956—1960	1961—1965	1966—1970	1971—1975	1976—1980	1981—1985	1986—1990	1991—1995	All
All	-0.410 a (0.032)	-0.529 a (0.038)	-0.521 a (0.032)	-0.614 a (0.029)	-0.562 a (0.027)	-0.600 a (0.027)	-0.614 a (0.027)	-0.689 a (0.023)	-0.729 a (0.027)	-0.613 a (0.008)
Construction	-0.348 a (0.097)	-0.674 a (0.104)	-0.510 a (0.071)	-0.646 a (0.059)	-0.626 a (0.050)	-0.802 a (0.048)	-0.770 a (0.050)	-0.879 a (0.041)	-0.847 a (0.048)	-0.726 a (0.017)
Manufacturing	-0.529 a (0.054)	-0.521 a (0.058)	-0.568 a (0.052)	-0.748 a (0.052)	-0.618 a (0.050)	-0.614 a (0.055)	-0.531 a (0.058)	-0.649 a (0.051)	-0.706 a (0.069)	-0.612 a (0.015)
Wholesale	-0.401 a (0.058)	-0.598 a (0.076)	-0.418 a (0.071)	-0.587 a (0.065)	-0.616 a (0.067)	-0.535 a (0.066)	-0.689 a (0.068)	-0.559 a (0.064)	-0.623 a (0.076)	-0.570 a (0.020)
Retail	-0.386 a (0.082)	-0.594 a (0.112)	-0.598 a (0.097)	-0.574 a (0.084)	-0.488 a (0.079)	-0.549 a (0.077)	-0.477 a (0.072)	-0.651 a (0.063)	-0.578 a (0.068)	-0.523 a (0.024)
Real Estate	0.404 (0.247)	0.185 (0.201)	0.607 (0.178)	-0.009 (0.126)	0.179 (0.119)	0.279 (0.126)	0.033 (0.124)	-0.511 a (0.106)	-0.865 a (0.175)	-0.050 (0.044)
Service	0.222 (0.151)	-0.318 b (0.167)	-0.227 b (0.134)	-0.464 a (0.113)	-0.406 a (0.098)	-0.278 a (0.092)	-0.516 a (0.080)	-0.437 a (0.064)	-0.521 a (0.072)	-0.405 a (0.029)

1) Standard errors are in parentheses
2) a: Significant at the 1 percent level. b: Significant at the 5 percent level. c: Significant at the 10 percent level.

2. Natural vs. unnatural selection

One-tailed t-Test for the Operating Profit

	Cohort									
	1950－1955	1956－1960	1961－1965	1966－1970	1971－1975	1976－1980	1981－1985	1986－1990	1991－1995	All
All	2.113 a (0.219)	1.897 a (0.257)	1.973 a (0.222)	1.264 a (0.190)	1.596 a (0.169)	1.879 a (0.175)	2.170 a (0.182)	1.993 a (0.162)	2.291 a (0.202)	2.320 a (0.057)
Construction	0.952 c (0.590)	0.942 c (0.656)	1.911 a (0.473)	0.195 (0.377)	1.249 a (0.316)	1.193 a (0.308)	1.457 a (0.332)	0.927 a (0.295)	1.322 a (0.353)	1.448 a (0.116)
Manufacturing	2.951 a (0.408)	3.060 a (0.451)	2.524 a (0.407)	1.519 a (0.378)	1.782 a (0.347)	1.981 a (0.386)	3.069 a (0.410)	2.336 a (0.373)	2.892 a (0.527)	2.934 a (0.112)
Wholesale	2.084 a (0.339)	1.144 a (0.442)	2.068 a (0.439)	2.132 a (0.381)	1.413 a (0.386)	2.637 a (0.392)	2.267 a (0.415)	1.831 a (0.394)	2.089 a (0.515)	2.171 a (0.121)
Retail	1.132 b (0.579)	1.127 c (0.749)	1.889 a (0.672)	0.595 (0.580)	2.454 a (0.525)	1.908 a (0.522)	1.811 a (0.527)	3.131 a (0.461)	3.172 a (0.546)	2.388 a (0.170)
Real Estate	5.301 a (1.378)	2.168 b (1.023)	0.944 (0.855)	3.998 a (0.642)	2.491 a (0.577)	2.150 a (0.652)	1.240 b (0.635)	0.850 c (0.585)	4.317 a (0.889)	2.464 a (0.226)
Service	2.645 a (1.072)	1.793 c (1.208)	1.715 b (0.963)	2.021 a (0.744)	1.351 b (0.671)	3.447 a (0.657)	2.338 a (0.596)	2.976 a (0.495)	2.974 a (0.595)	2.797 a (0.215)

1) Standard errors are in parentheses
2) a: Significant at the 1 percent level. b: Significant at the 5 percent level. c: Significant at the 10 percent level.

3. Track record vs. size

- Adaptation effect among surviving firms

  Diamond (1989)

  Firm's track record of repayment contributes to its reputation and changes risk-taking behavior

  Cooley and Quadrini (2001)

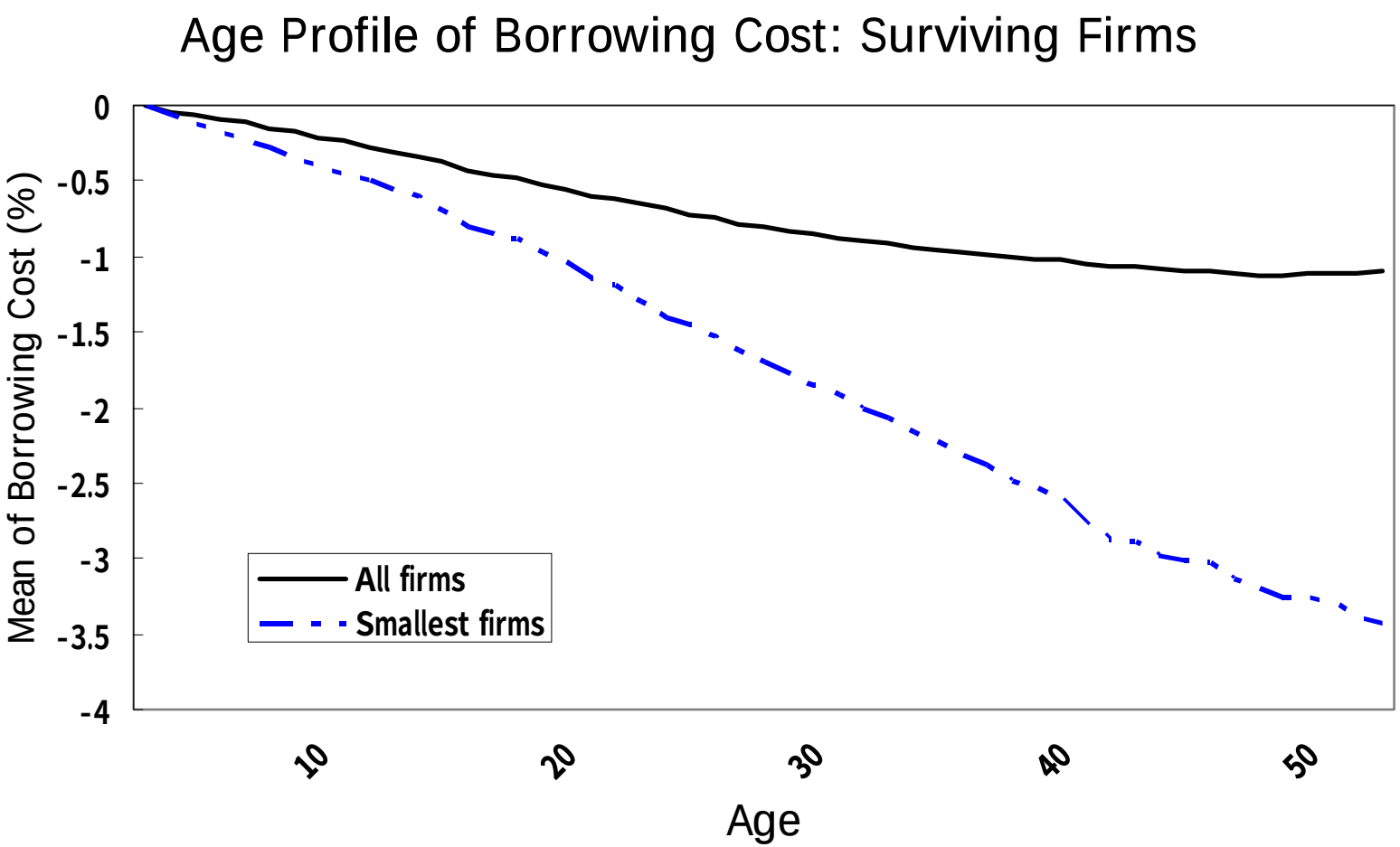
  More sizable firms borrow less to reduce the default probability

- If track record story holds, age profile conditional on size is downward sloping

$$E_{i\in A(t+1,\tau)}R_i(t+1,\tau)-E_{i\in S(t,\tau)}R_i(t,\tau)=\sum\gamma_{t-\tau}(age\_dummies_{t-\tau})$$

for each size category

3. Track record vs. size



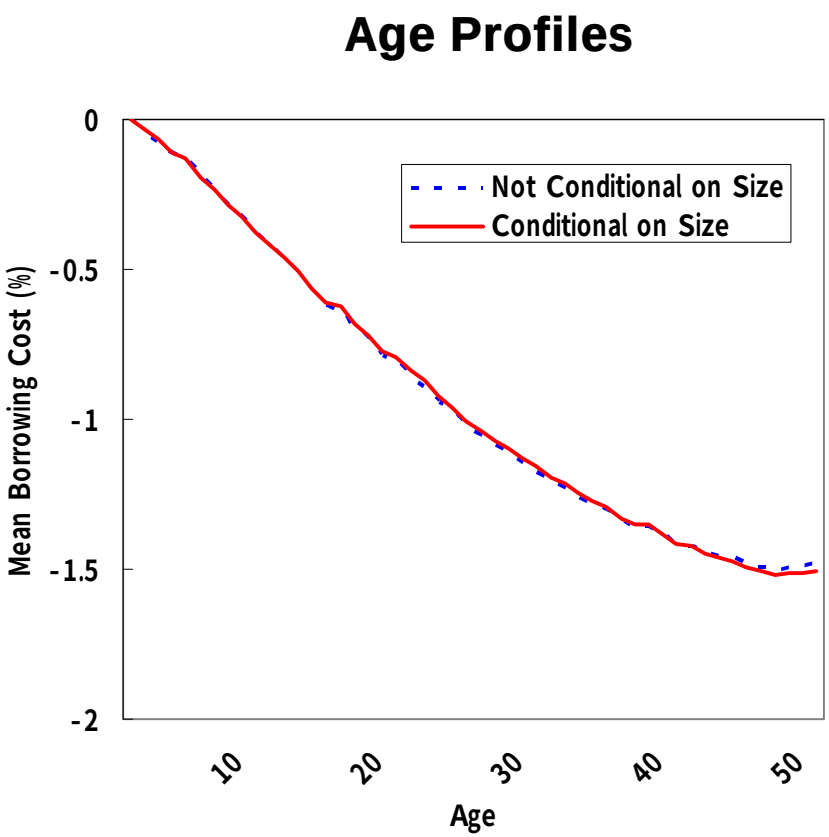
3. Track record vs. size (additional)

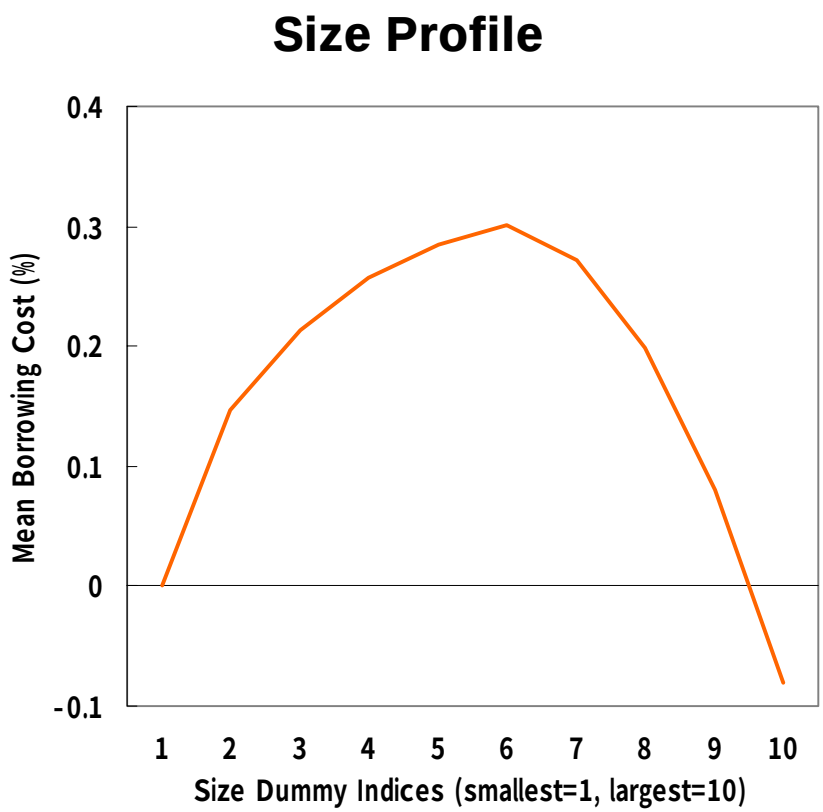
- Another test between track record vs. size

$$R_i(t,\tau,s) = \sum \gamma_{t-\tau}(age\_dummies_{t-\tau}) + \sum \phi_{\tau}(cohort\_dummies_{\tau}) + \sum \delta_s(size\_dummies_s)$$

- Age profiles with/without size dummies are almost identical
- Size profile conditional on age shows non-linearity between size and borrowing cost

3. Track record vs. size (additional)





Conclusion

- **Selection vs. adaptation?**

  Adaptation dominates in the evolution of borrowing costs

- **Natural vs. unnatural selection?**

  Natural selection prevails among small firms

- **Track record vs. size in adaptation?**

  Track record story is more consistent

  Still some inconsistencies in explaining firms' risk-taking behavior