Education and Credit: A Matthew effect

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Motivation

Main questions

- What is the role of the credit channel on the effect of entrepreneurs' educational attainment on future individual and firm outcomes?

- What are the key mechanisms underlying such a potential effect?

Using a sharp discontinuity created by the bank's credit score, we find that:

1. Entrepreneurs who obtain university education have higher future income, wealth, and profitability
2. Triggering factors include: Higher probability to apply and to be granted a loan, and investment in more innovative projects that require better-paid employees
3. Overall, the initial advantage of university education is self-amplifying via the credit channel (a "Matthew Effect")

Credit channel and education: Three stages

- **Credit channel:** loan origination → ↑ liquidity → ↑ investment → ↑ firm profitability → ↑ entrepreneurs' future wealth and income

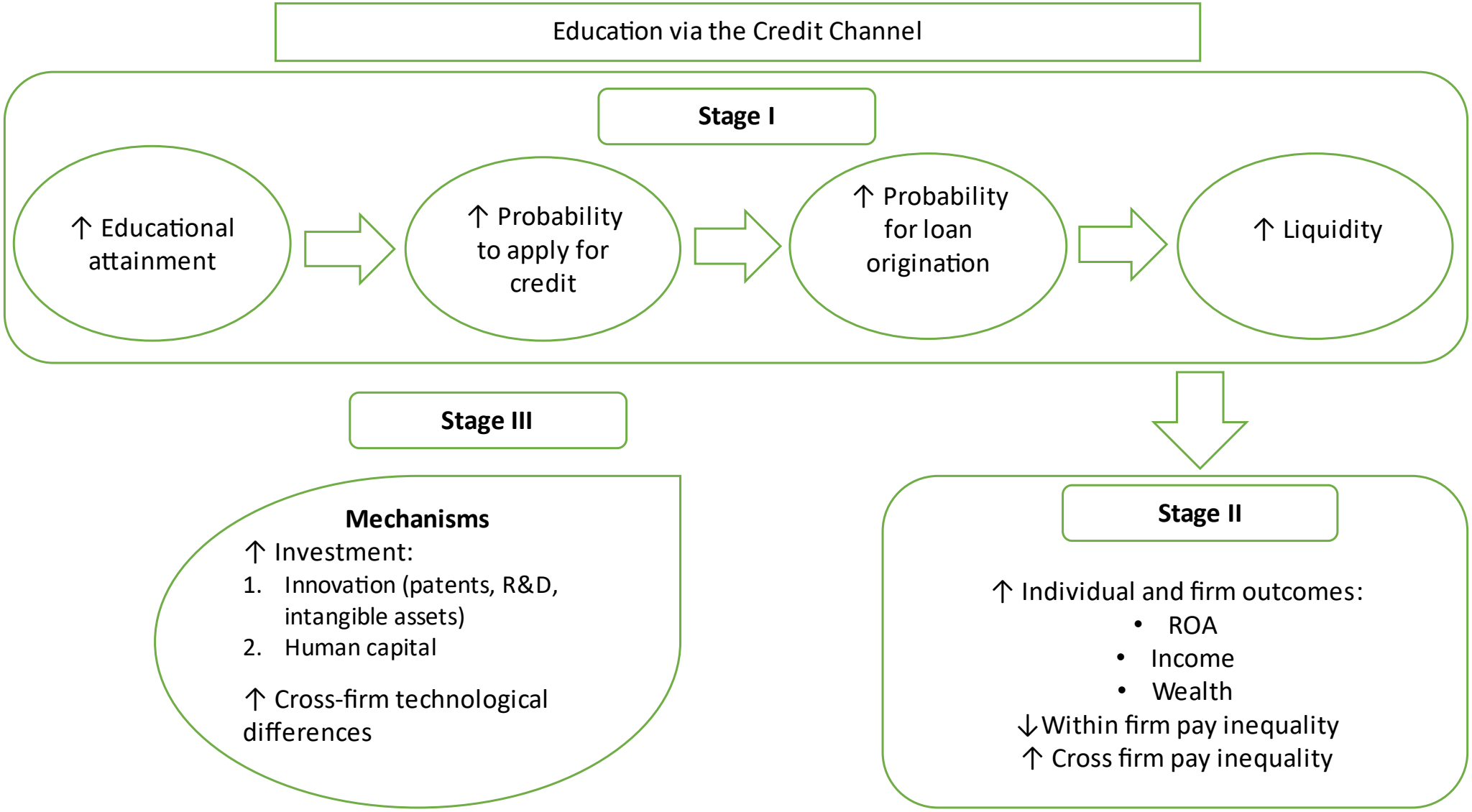
- We identify **three stages** in our analysis:

1. **Stage I:** Educational attainment affects entrepreneurs' decision to apply for a loan and the bank's decision to grant the loan

2. **Stage II:** Via its role through the credit channel in stage I, educational attainment affects future firm and individual outcomes

3. **Stage III:** How firms use the increased liquidity for investment influences the effects identified in stage I and stage II

Education via the credit channel



Data

Data

- **Major systemic European Bank**: Global scale, credit to all business types
- **Period:** 2002 – 2018
- All types of loans to domestic small and micro firms (total assets of up to 10,000,000 euro)
- Loan applicants: **majority owners** (more than 50%) of the firm
- Repeated loan applications of:

Balanced panel with a total of 414,730 observations
137,321 loan applications by 24,712 unique applicants
From these loan applications 84.2% were originated (114,641 loans)

- **Applicant characteristics:** age, gender, income, wealth, marital status, credit score, dependents
- **Firm characteristics:** size, leverage, ROA, liquidity, profitability, region, industry, forward growth, number of applications before the origination, R&D, patents, salaries
- **Loan deal:** loan amount and maturity applied for, granted loan characteristics (price, amount, maturity, performance pricing provisions, collateral)

Sample representativeness: 4 dimensions

- ***Bank:*** European annual averages (**ratio of liquid assets to total assets, the ratio of market to book value,** and **return on assets**) and Annual Euro Area average **rejection rate** *similar* with those of our bank during our period (Compustat, Survey on Access to Finance of Enterprises)
- ***Firm:*** **Characteristics** similar to that of similar-sized EU firms
- ***Bank-firm:*** 65% of the firms in our full sample have an **exclusive relationship with our bank**. Other studies on lending relationships report similar numbers.
- ***Applicant:*** In our sample, entrepreneurs with higher education consist 50.3% of all loan applicants, within the range of data for North-European countries averaging 47.1% (EU Labor Force Survey)

Data on Education: First results

Ordinal variable ranging between 0 - 5

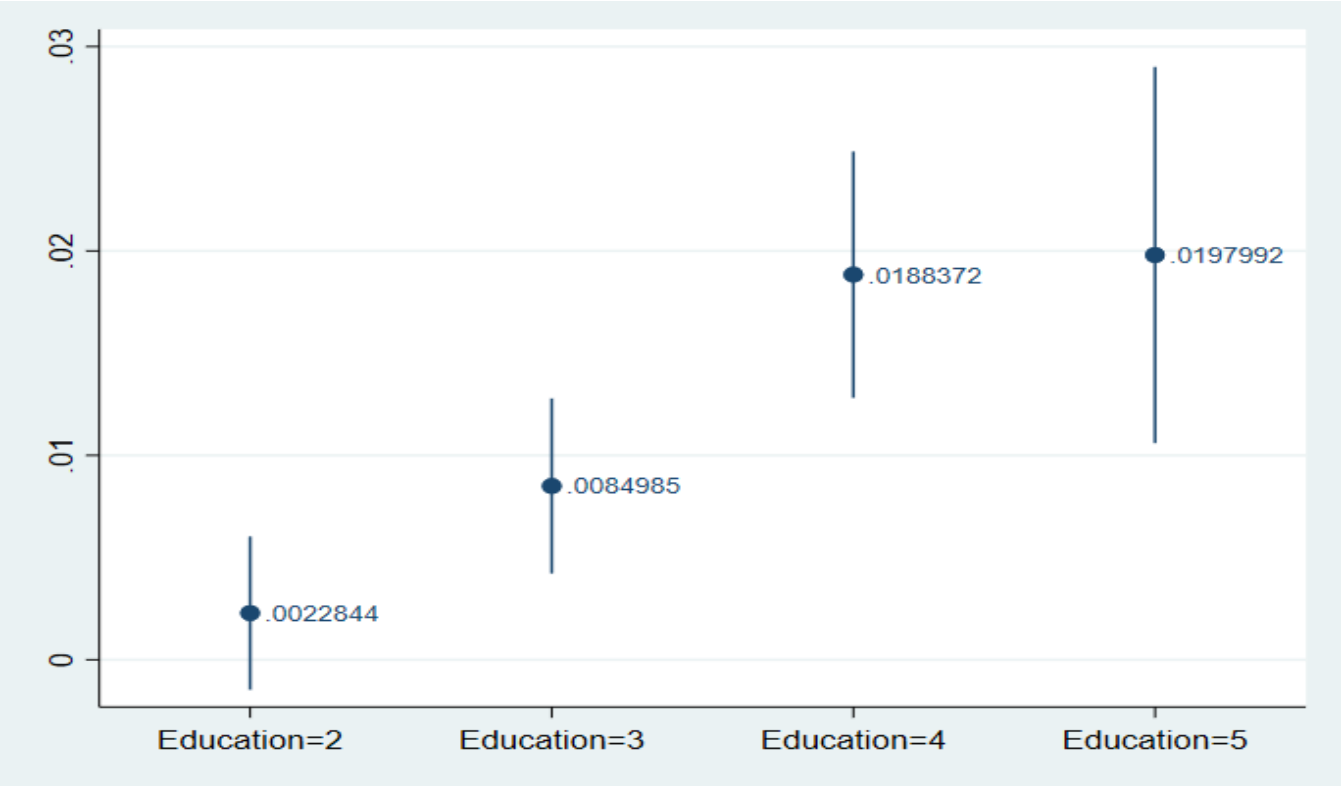
- 0: No secondary (%)

  1: Secondary
- 2: Post-secondary, non-tertiary
- 3: Tertiary

  4: MSc
- 5: MBA or PhD (Professional)

Figure 1. Point increments in education and probability of loan application

The figure reports coefficient estimates and confidence intervals from the estimation of the probability of loan application but including four dummy variables for *Education* (*Education* equals 0+1, 2, 3+4, to *Education* equals 5)



Identification and Empirical analysis

Methodology and identification

- Unit of analysis: **individual level**
- Year, industry, and **individual fixed effects** (more than one application per firm)
- We get identification from the *Switchers of Education*: *2,711* in our sample

We conduct the following analysis at each stage:

Stage I: Loan application, origination, and terms of lending (linear probability models with individual fixed effects)

Stage II: Future firm and individual outcomes (RDD with individual fixed effects, credit score as the assignment variable)

Stage III: Identifying the mechanisms (RDD with different dependent variables)

Stage I: Loan application and origination

Higher education and probability of loan application

Panel A. Results from the full sample

	1	2	3	4
Dependent variable:	Apply	Apply	Granted	Granted
Higher education	**0.019*** **		**0.008*** **	
	(0.002)		(0.002)	
Professional education		**0.023*** **		**0.008*** **
		(0.002)		(0.003)
Credit score	0.316***	0.320***	0.585***	0.585***
	(0.032)	(0.035)	(0.033)	(0.033)
Observations	414,730	414,730	137,321	137,321
R-squared	0.91	0.91	0.97	0.97
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes

Robustness:

- Results around the cutoff become more potent (2.7% and 1.7% for HE)
- Results from Callaway and Sant'Anna are similar (2.1% and 1.1% for HE)

Loan amount, spread, and collateral

Panel A: Higher education

	1	2	3
Dependent variable:	Loan amount	Loan spread	Collateral
Higher education	0.006	**-5.503****	0.001
	(0.0015)	(2.561)	(0.002)
R-squared	0.92	0.94	0.92
Observations	114,641	114,641	114,641

Panel B: Professional education

	4	5	6
	Loan amount	Loan spread	Collateral
Professional education	**0.020****	**-7.316****	0.002
	(0.010)	(3.650)	(0.002)
R-squared	0.92	0.94	0.92
Observations	63,053	63,053	63,053
Other controls + Credit score	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes

Stage 2: Future firm and individual outcomes

Education, credit decision, and future firm outcomes

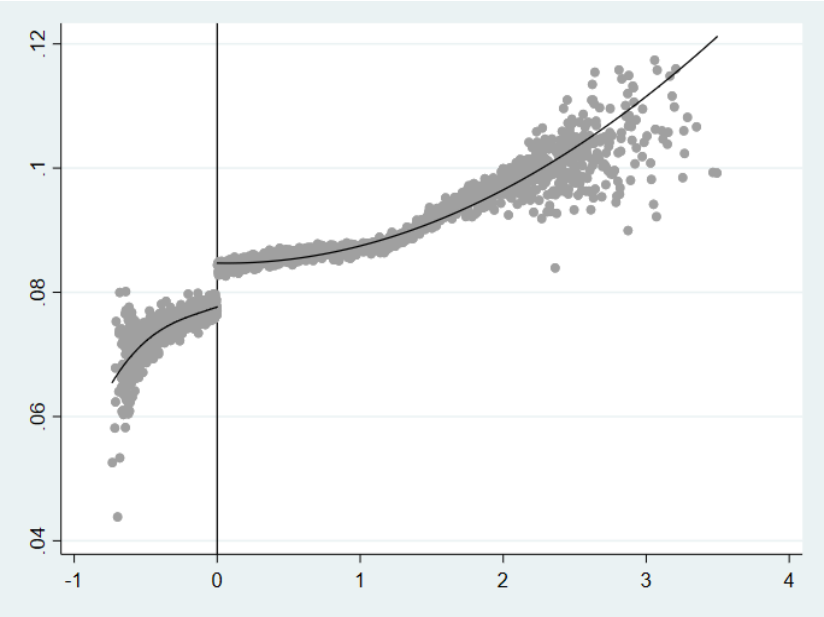
	1	2	3	4	5	6
	Applicants with higher education			Applicants without higher education		
Dependent variable:	Default	Future ROA	Future leverage	Default	Future ROA	Future leverage
Granted	-0.164***	0.067***	0.013**	-0.245***	0.061***	0.008
	(0.029)	(0.015)	(0.006)	(0.031)	(0.016)	(0.006)
Observations	75,801	75,801	75,801	61,520	61,520	61,520

	7	8	9
	Applicants with professional education		
Dependent variable:	Default	Future ROA	Future leverage
Granted	-0.150***	0.077***	0.020***
	(0.038)	(0.023)	(0.006)
Observations	14,556	14,556	14,556

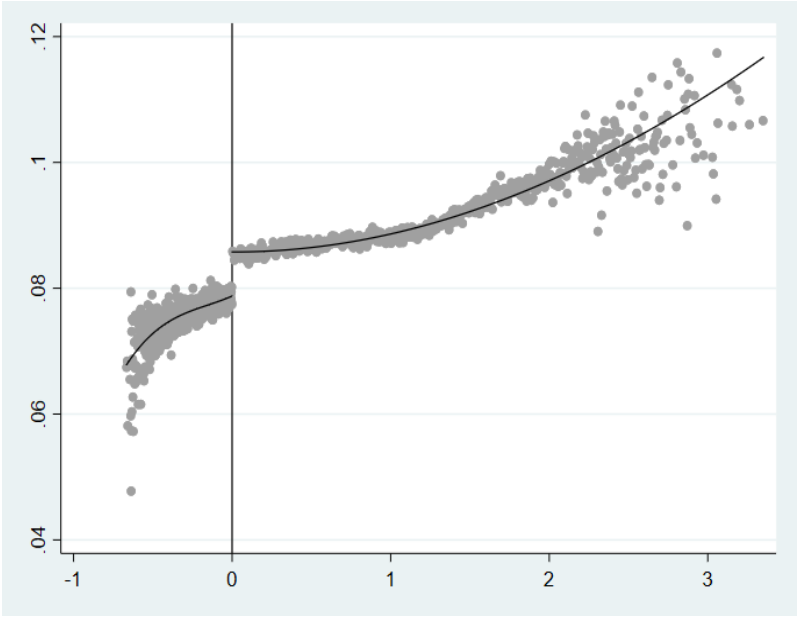
Response of forward ROA at the credit score's cutoff

- **The points represent local sample means of the applicant's income for a set of disjoint bins of control and treatment units spanning the full sample**

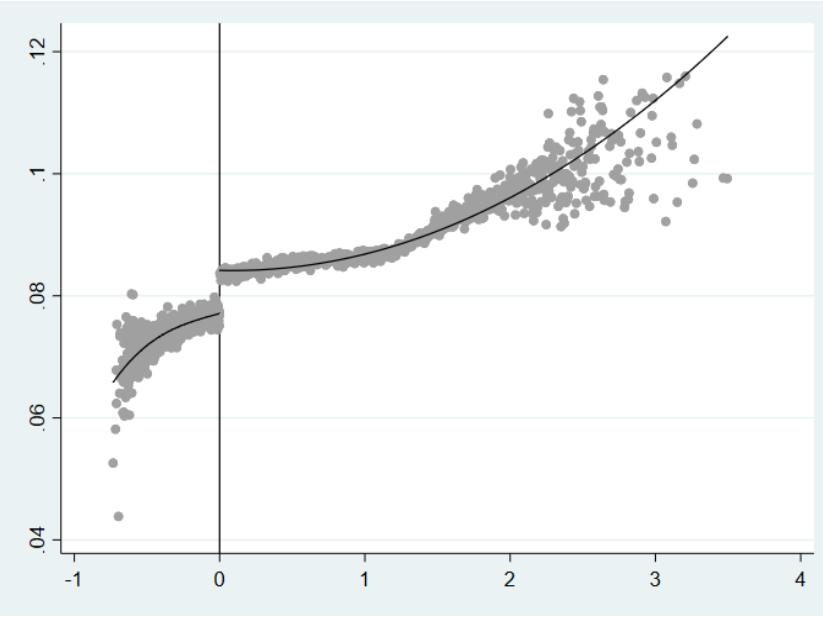
Full Sample



With University Education



With No University Education



Education, credit decision, and future individual outcomes

	1	2	3	4	5	6
	Applicants with higher education			Applicants without higher education		
Dependent variable:	Future income	Future wealth	Future pay inequality	Future income	Future wealth	Future pay inequality
Granted	**0.038*** **	**0.031*** **	**0.016**	**0.021*** **	**0.017** **	**0.040*** **
	(0.011)	(0.013)	(0.012)	(0.008)	(0.007)	(0.013)
Observations	75,801	75,801	75,801	61,520	61,520	61,520

	7	8	9
	Applicants with professional education		
Dependent variable:	Future income	Future wealth	Future pay inequality
Granted	**0.050*** **	**0.035*** **	**0.021** *
	(0.013)	(0.017)	(0.011)
Observations	14,556	14,556	14,556

Stage 3: Identifying the mechanisms

Hypotheses

- Entrepreneurs with higher education undertake different managerial and investment decisions:

1. **Investment in innovation** (R&D, patents, and intangible assets) → ↑ *future firm performance and individual outcomes*
2. **Hire employees with similar education** →↓ *within-firm pay inequality*

- Steps to identify mechanisms:

1. Re-estimate RDD with dependents: *Asset intangibility*, *R&D* expenses, and *Patents*
2. Re-estimate RDD with *Future ROA* and *Future wealth* as dependents **while controlling** for *asset intangibility* and *within-firm-pay inequality*

Education, credit decision, and intangible assets I

Panel A: Effect of the credit decision on asset intangibility, R&D expenses, and patents

	1	2	3	4	5	6
	Applicants with higher education			Applicants without higher education		
Dependent variable:	Asset intangibility	R&D expenses	Patent dummy	Asset intangibility	R&D expenses	Patent dummy
Granted	**0.112*** **	**0.098*** **	**0.083*** **	**0.054**	**0.061** **	**0.007**
	(0.023)	(0.015)	(0.028)	(0.031)	(0.029)	(0.023)
	7	**8**	**9**			
	Applicants with professional education					
Dependent variable:	Asset intangibility	R&D expenses	Patent dummy			
Granted	**0.130*** **	**0.152*** **	**0.119*** **			
	(0.028)	(0.029)	(0.040)			

Education, credit decision, and intangible assets II

Panel B: Heterogeneous effect of the credit decision on firm and individual outcomes due to asset intangibility

	Applicants with higher education		Applicants without higher education		Applicants with professional education	
	Future ROA	Future wealth	Future ROA	Future wealth	Future ROA	Future wealth
	1	**2**	**3**	**4**	**5**	**6**
Granted	**0.067*** **	**0.031*** **	**0.061*** **	**0.017** **	**0.077*** **	**0.035*** **
	(0.015)	(0.013)	(0.016)	(0.007)	(0.023)	(0.017)
	7	**8**	**9**	**10**	**11**	**12**
Granted (with Asset intangibility control)	**0.048*** **	**0.026** **	**0.059*** **	**0.016** **	**0.044** **	**0.027** **
	(0.016)	(0.013)	(0.018)	(0.007)	(0.021)	(0.012)
	13	**14**	**15**	**16**	**17**	**18**
Granted (with Pay inequality control)	**0.054*** **	**0.024*** **	**0.055*** **	**0.014** **	**0.059*** **	**0.025** **
	(0.016)	(0.013)	(0.019)	(0.007)	(0.020)	(0.011)
	19	**20**	**21**	**22**	**23**	**24**
Granted (with Asset intangib. and Pay inequality controls)	**0.035***	**0.021**	**0.054*** **	**0.014***	**0.029***	**0.019**
	(0.018)	(0.014)	(0.020)	(0.008)	(0.015)	(0.012)

Sensitivity analysis

Stage I:

- Full unbalanced panel
- Exclude individual fixed effects
- 2SLS-IV
- Restrict the sample around the cutoff
- Callaway and Sant'Anna for treatment heterogeneity
- Two-stage Heckman model for sample selection bias
- Clustering at the regional level

Stage II and III

- Manipulation test for the RDD
- Examine change of average wages
- Falsification test for the RDD on the Lagged (t-1) outcome variables

Conclusions

- Higher educated entrepreneurs **have higher probability to apply for and be granted a loan**, and with **better lending terms**

- Higher educated entrepreneurs **invest in more innovative projects** that require **higher paid employees** leading to **better future individual and firm outcomes** (via the credit channel)

- **Key mechanisms: Differential managerial and investment decisions**, which accentuate *cross-firm technological differences* and *within-firm pay inequalities*
  - **Investment decisions**: increasingly oriented towards **technological innovation** (R&D, intangible assets, and patents)
  - **Managerial decisions**: focus on investments in **human capital and selecting higher-wage workers** i.e. rising segregation

Overall, our results highlight a **Matthew effect where the initial advantage of higher education magnifies over time** to produce greater firm and individual outcomes, via the credit channel

Thank you!

Appendix

Dataset: Things to note

- The disclosure of the precise cutoff is not permitted; we normalize it to the value of zero
- The bank can identify which firms apply for loans to other banks, knows the timing of these applications, and their outcome through the firms' and the country's credit register
- Our full sample suggests that 65% of the firms have an exclusive relationship with the bank (this is common for small firms)
- For education and marital status, we observe enough changes from year to year
- When we do not know the precise year of the change, we assume that it happens in the middle of the time interval between the two loan applications (this assumption does not affect our main results)
- We complete the observations with the last credit score calculated by the bank, if there is a loan application in year t but not one in year t+1, we impute in year t+1 the credit score in year t

Means of key variables by level of educational attainment

	Below secondary	Secondary	Postsecondary/ Nontertiary	Tertiary	MSc	Ph.D./MBA
Apply	**0.291**	**0.326**	**0.328**	**0.335**	**0.345**	**0.348**
Income	**10.525**	**10.864**	**11.946**	**10.978**	**10.990**	**11.000**
Wealth	**11.722**	**12.001**	**12.076**	**12.102**	**12.112**	**12.123**
Gender	0.788	0.799	0.802	0.804	0.802	0.803
Age	44.413	44.913	44.937	44.957	44.963	44.928
Marital status	0.592	0.589	0.588	0.589	0.590	0.585
Dependents	1.887	1.893	1.904	1.896	1.847	1.820
Firm size	12.871	12.888	12.896	12.895	12.897	12.905
Leverage	0.201	0.205	0.206	0.207	0.207	0.207
ROA	**0.075**	**0.078**	**0.079**	**0.080**	**0.079**	**0.080**
Cash	0.077	0.079	0.080	0.080	0.080	0.080
Credit score	0.397	0.591	0.655	0.687	0.708	0.729
Applications	6.706	6.813	6.830	6.853	6.843	6.877
Granted	**0.820**	**0.829**	**0.836**	**0.861**	**0.868**	**0.875**
Default	**0.018**	**0.019**	**0.017**	**0.017**	**0.017**	**0.016**
Loan amount	0.763	3.345	3.528	3.601	3.618	3.646
Loan spread	**355.32**	**350.14**	**352.19**	**340.20**	**330.88**	**331.72**
Maturity	43.560	47.454	47.020	47.775	48.042	49.227
Loan provisions	0.465	0.415	0.413	0.407	0.383	0.339
Collateral	0.642	0.695	0.710	0.709	0.608	0.613
Share in the sample (all applications)	0.003	0.209	0.285	0.301	0.093	0.109
Share in the sample (granted)	0.003	0.197	0.248	0.338	0.108	0.106

Heckman test

	1	2	3	4	5	6
Dependent variable:	Apply	Apply	Granted	Granted	Granted	Granted
Higher education	0.020***		0.008***		0.010***	
	(0.002)		(0.002)		(0.003)	
Professional education		0.024***		0.009***		0.011***
		(0.003)		(0.002)		(0.003)
Lambda					-0.169	-0.174
					(0.290)	(0.283)
Observations	551,354	551,354	216,420	216,420	551,354	551,354
R-squared	0.91	0.91	0.97	0.97		
Other controls + Credit score	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	No	Yes	Yes	Yes

Stage 1 results: No fixed effects

	1	2	3	4
Dependent variable:	Apply	Apply	Granted	Granted
Higher education	0.020***		0.023***	
	(0.002)		(0.002)	
Professional education		0.009***		0.008***
		(0.002)		(0.003)
Observations	414,730	414,730	137,321	137,321
R-squared	0.91	0.91	0.97	0.97
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	No	No	No	No

Credit decision, education, and income and wealth: Lagged outcomes

	1	2	3	4	5	6
	Applicants with higher education			Applicants without higher education		
Dependent variable:	Default	ROA	Leverage	Default	ROA	Leverage
Granted	-0.007	0.005	0.002	-0.026	0.009	0.001
	(0.024)	(0.016)	(0.006)	(0.034)	(0.015)	(0.006)
Observations	75,801	75,801	75,801	61,520	61,520	61,520
	7	8	9			
	Applicants with professional education					
Dependent variable:	Default	ROA	Leverage			
Granted	-0.022	0.005	0.003			
	(0.040)	(0.023)	(0.006)			
Observations	14,556	14,556	14,556			

Credit decision, education, and income and wealth: Lagged outcomes

	1	2	3	4	5	6
	Applicants with higher education			Applicants without higher education		
Dependent variable:	Income	Wealth	Pay inequality	Income	Wealth	Pay inequality
Granted	0.001	-0.000	0.000	0.001	0.002	-0.001
	(0.011)	(0.015)	(0.011)	(0.008)	(0.008)	(0.016)
Observations	75,801	75,801	75,801	61,520	61,520	61,520

	7	8	9
	Applicants with professional education		
Dependent variable:	Income	Wealth	Pay inequality
Granted	0.002	0.004	-0.003
	(0.011)	(0.019)	(0.015)
Observations	14,556	14,556	14,556