

Bank Specialization and Corporate Innovation

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 - negatively through **zombie lending** (Schmidt et al., 2023 WP)
- We study and uncover a novel channel: **bank specialization** (i.e., the importance of lending to a sector for a bank)

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 - increases **banks' expertise**, leading to better screening and monitoring capabilities, stimulating corporate innovation ([Blickle et al., 2023 WP](#); [Giometti et al., 2022 WP](#))
 - increases **banks' legacy** to potentially adverse effects of technology-induced shocks, impairing corporate innovation ([Aghion and Howitt, 1992 ECTA](#); [Bloom et al., 2013 ECTA](#); [Degryse et al., 2023 WP](#))

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- Empirical analysis spans two (complementary) settings:
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 2. **Belgian credit register data** combined with **innovation survey data** administered by the European Commission

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 - In sectors with **high asset overhang**, bank specialization **hinders innovation**
 - In sectors with **low asset overhang**, bank specialization **enhances innovation**
- Results robust to endogeneity (using bank mergers) and endogenous matching of banks and firms

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- On average, firms borrowing from specialized banks obtain better loan terms (in line with [Blickle et al., 2023 WP](#))
- But firms operating in **innovative sectors with high asset overhang** get worse loan terms if they borrow from specialized banks

Contribution

- **Finance and innovation** (King and Levine, 1993, JME), particularly banking and innovation (Amore et al., 2013, JFE; Benfratello et al., 2008, JFE; Bircan and De Haas, 2020, RFS; Chava et al., 2013, JFE; Herrera and Minetti, 2007, JFE; Hombert and Matray, 2017, RFS; Schmidt et al., 2023, WP)
- **Bank specialization** (Acharya et al., 2006, JB; Blickle et al., 2023, WP; De Jonghe et al., 2024, MS; Giometti et al., 2022, WP; He et al., 2023, WP; Iyer et al., 2022, WP; Paravisini et al., 2023, JF; Cao et al., 2023, WP)
- **The interaction between financial and product markets** (Antón et al., 2023, MS; Cerqueiro et al., 2017, MS; Degryse et al., 2023, WP; Frésard and Phillips, 2024; Hall and Lerner, 2010; López and Vives, 2019, JPE; Minetti, 2011, RoF)

Setting I: US: Data and Methodology

Definition: Bank specialization

$$\text{Bank specialization}_{b,s,t} = \frac{\sum_{f=1}^F \text{Credit}_{b,f,s,t}}{\sum_{s=1}^S \sum_{f=1}^F \text{Credit}_{b,f,s,t}} \quad (1)$$

where $\text{Credit}_{b,f,s,t}$ is the credit granted by bank b to firm f operating in sector s at time t

- This measure ranges from 0 to 1 and captures the importance of a sector in a bank's corporate loan portfolio (De Jonghe et al., 2024 MS; Iyer et al., 2022 WP)

Definition: Innovation output

1. **Quantity:** The total number of patents that firm f filed in year t
2. **Quality:** The average number of citations received by the patents that firm f filed in year t
3. **Novelty:** The average originality (i.e., on how many technologies does a patent rely) and generality (i.e., by how many technologies is a patent cited) of the patents that firm f filed in year t [Details](#)

Definition: Asset overhang

1. **Asset redeployability:** sector level average of asset redeployability scores (computed by [Kim and Kung, 2017 RFS](#)), capturing the extent to which an asset has alternative uses both *within* and *across* sectors. Note: high redeployability is low asset overhang.
2. **Product market rivalry:** sector level average of firms' R&D stock aggregated by pairwise spatial closeness in product market space, used to capture technology-induced competition from rivals' innovation activities ([Bloom et al., 2013 ECTA](#))

These measures relate to the 2 key dimensions through which new technologies can adversely affect banks' legacy positions:

- (a) a devaluation of firms' pledged collateral (asset redeployability)
- (b) a decrease in firms' performance (product market rivalry)

Data

- Syndicated loan data from LPC DealScan
 - Patent data from PATSTAT
 - Firm financial statement data from Compustat
- Our final dataset comprises 5,504 non-financial firms operating in 58 (2-digit SIC) sectors borrowing from 131 unique banks over the period 1996-2013

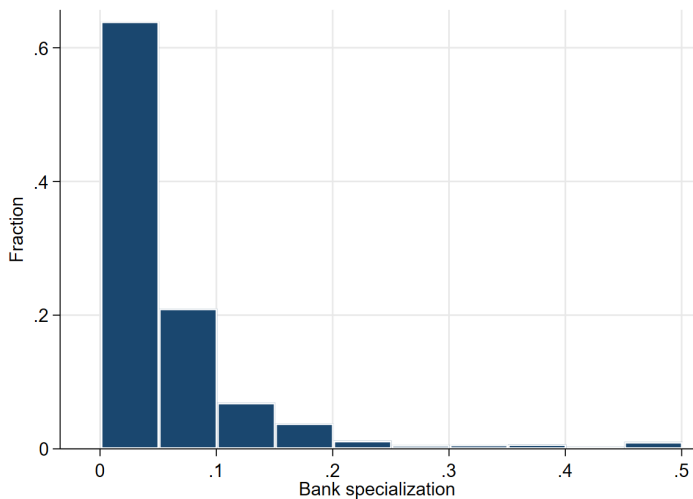
Descriptive statistics: US setting

	Patenting firms		Non-patenting firms		Difference
	Mean	SD	Mean	SD	
Patents	17.87	31.94	0.00	0.00	-17.87***
Patent citations	6.60	9.00	0.00	0.00	-6.60***
Patent originality	0.36	0.30	0.00	0.00	-0.36***
Patent generality	0.58	0.41	0.00	0.00	-0.58***
Size	6.85	1.88	6.43	1.84	-0.42***
Age	4.24	6.33	3.55	5.46	-0.69***
Debt/TA	0.25	0.20	0.34	0.26	0.09***
Equity/TA	0.44	0.22	0.37	0.23	-0.07***
Cash/TA	0.10	0.11	0.06	0.10	-0.04***
ROA	0.01	0.20	-0.00	0.20	-0.01***
Fixed assets/TA	0.50	0.32	0.60	0.41	0.11***
CAPEX/TA	0.05	0.04	0.06	0.06	0.02***
R&D expenses/TA	0.05	0.08	0.01	0.05	-0.04***
Tobin's Q	1.19	1.51	0.64	0.97	-0.55***
Public debt	0.93	0.26	0.65	0.48	-0.28***
HHI	0.21	0.15	0.18	0.14	-0.03***
Bank specialization	0.05	0.06	0.06	0.08	0.01***
Bank market share	0.17	0.15	0.14	0.14	-0.02***
Bank concentration	0.32	0.15	0.29	0.14	-0.03***
Bank geographic diversification	0.89	0.17	0.87	0.19	-0.02***
Number of lending relationships	1.38	0.73	1.37	0.71	-0.01
Lending relationship length	4.47	3.19	4.07	3.05	-0.40***
Observations	10,403		24,620		35,023

Descriptive statistics: Innovation output

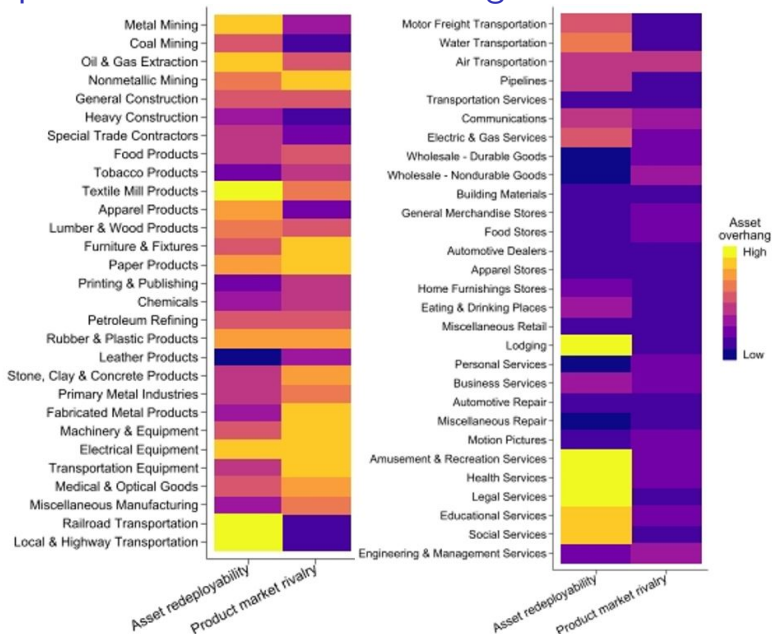
	Median	75%	85%	90%	95%	99%	Mean	SD	N
Patents	0	0	3	10	37	111	5.4	19.3	35,023
Citations	0	0	4.8	7.3	11.5	25.5	2.0	5.8	35,023

Descriptive statistics: Bank specialization



Other descriptives

Descriptive statistics: Asset overhang



Method

- We estimate the following Poisson fixed effects models:

$$y_{f,b,s,t} = \beta \text{Bank specialization}_{b,s,t-1} + \gamma C_{f,b,s,t-1} + \lambda_{s,t} + \lambda_{l,t} + \epsilon_{f,b,s,t} \quad (2)$$

$$y_{f,b,s,t} = \delta (\text{Bank specialization}_{b,s,t-1} \times \text{Asset Overhang}_{s,t-1}) + \beta \text{Bank specialization}_{b,s,t-1} + \gamma C_{f,b,s,t-1} + \lambda_{s,t} + \lambda_{l,t} + \epsilon_{f,b,s,t} \quad (3)$$

where $y_{f,b,s,t}$ is the number of **patents** or **citations**, and f , s , l , b , and t refer to firm, sector, state, bank, and time, respectively

Results for US setting

Results

On average, bank specialization does not affect firms' innovation output

	Patents		Citations	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	0.01 (0.60)	-0.02 (0.61)	0.08 (0.41)	0.19 (0.41)
Observations	31,340	26,346	31,316	26,171
Pseudo R-squared	0.72	0.72	0.37	0.36
Sector FE	Yes	No	Yes	No
State FE	Yes	No	Yes	No
Year FE	Yes	No	Yes	No
Sector×Year FE	No	Yes	No	Yes
State×Year FE	No	Yes	No	Yes

Results

- A potential explanation for this is that, on average, our 2 theoretical predictions offset each other in the data
- To test whether this is the case, we exploit heterogeneity in asset overhang across sectors, using 2 measures of asset overhang (standardized, i.e., mean=0 and standard deviation=1):
 1. Asset redeployability (Kim and Kung, 2017 RFS)
 2. Product market rivalry (Bloom et al., 2013 ECTA)

Results

	Patents		Citations	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	0.54 (0.60)	0.99 (0.68)	0.38 (0.40)	0.64 (0.49)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.92*** (0.73)	-1.61*** (0.59)	-1.84*** (0.49)	-0.90** (0.41)
Observations	26,346	26,346	26,171	26,171
Pseudo R-squared	0.72	0.72	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes

Results: Patent novelty

	Patent originality		Patent generality	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	0.04 (0.03)	0.04 (0.03)	0.02 (0.04)	0.02 (0.04)
Bank specialization _{t-1} × Asset overhang _{t-1}	-0.08*** (0.02)	-0.06** (0.03)	-0.11*** (0.03)	-0.09*** (0.04)
Observations	34,912	34,912	34,912	34,912
Pseudo R-squared	0.35	0.35	0.37	0.37
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes

Results

- When we exploit heterogeneity in asset overhang across sectors, we find that:
 - In sectors with *high* asset overhang, bank specialization *impedes* innovation
 - In sectors with *low* asset overhang, bank specialization *improves* innovation

Setting II: Belgium: Data and Methodology

Data

- Bank specialization (based on credit register data from the National Bank of Belgium)
- Firm financial statement data from the National Bank of Belgium
- Community innovation survey (CIS) data from the European Commission
 - Product innovation, process innovation, world-first innovation

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 - Firm financial statement data from the National Bank of Belgium
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 - Product innovation, process innovation, world-first innovation
- This setting complements the US analysis in 2 ways:
1. It covers non-patented inventions
 2. It covers small, bank-dependent firms

Descriptive statistics: Belgian setting

	N	Mean	Median	SD	Min	Max
Product innovation	15,171	0.39	0.00	0.49	0.00	1.00
Process innovation	15,171	0.50	0.00	0.50	0.00	1.00
World-first innovation	15,171	0.06	0.00	0.23	0.00	1.00
Size	15,171	15.59	15.46	1.68	9.93	19.25
Age	15,171	27.99	25.00	17.21	1.00	150.00
Debt/TA	15,171	0.63	0.64	0.26	0.04	2.89
Equity/TA	15,171	0.36	0.34	0.26	-1.89	0.98
Cash/TA	15,171	0.13	0.08	0.15	0.00	0.90
EBIT/TA	15,171	0.07	0.06	0.12	-0.70	0.63
Fixed assets/TA	15,171	0.24	0.19	0.21	0.00	0.96
CAPEX/TA	15,171	0.00	0.00	0.07	-0.69	0.76
R&D expenses/TA	15,171	0.02	0.00	0.08	0.00	0.65
HHI	15,171	0.05	0.02	0.07	0.00	0.69
Bank specialization	15,171	0.05	0.02	0.06	0.00	0.25
Bank market share	15,171	0.22	0.24	0.08	0.00	0.69
Bank concentration	15,171	0.23	0.22	0.04	0.15	0.83
Bank geographic diversification	15,171	0.01	0.00	0.01	0.00	0.26
Number of lending relationships	15,171	1.87	2.00	0.91	1.00	4.00
Lending relationship length	15,171	11.47	12.00	5.42	1.00	20.00
Capital intensity	15,171	0.00	-0.21	1.00	-2.14	4.33

Setting: Belgian credit registry and innovation survey data

	(1) Product innovation	(2) Process innovation	(3) World-first innovation
Bank specialization _{t-1}	-0.162 (0.416)	0.293 (0.370)	0.035 (0.203)
Observations	15,171	15,171	12,016
Adjusted R-squared	0.252	0.308	0.087
Controls	Yes	Yes	Yes
Sector \times Time FE	Yes	Yes	Yes
Region \times Time FE	Yes	Yes	Yes

Setting: Belgian credit registry and innovation survey data

	(1) Product innovation	(2) Process innovation	(3) World-first innovation
Bank specialization _{t-1}	-0.551 (0.464)	0.334 (0.414)	-0.206 (0.205)
Bank specialization _{t-1} × Asset overhang risk _{t-1}	-0.883** (0.438)	0.093 (0.438)	-0.506** (0.238)
Observations	15,171	15,171	12,016
Adjusted R-squared	0.252	0.308	0.087
Asset overhang measure	Capital intensity	Capital intensity	Capital intensity
Controls	Yes	Yes	Yes
Sector × Time FE	Yes	Yes	Yes
Region × Time FE	Yes	Yes	Yes

Results: Robustness (mainly on US analysis)

- Endogeneity [Details](#)
- Alternative channels [Details](#)
- Alternative measures of bank specialization [Details](#)
- Data sample and measurement [Details](#)
- Empirical model [Details](#)

Mechanism

- Having shown that bank specialization has heterogeneous effects on firms' innovation output, we study how these effects arise
- To do so, we focus on the main channel through which banks can affect firms' innovation activities, i.e., financing conditions (Amore et al., 2013 JFE; Deng et al., 2021 JFQA; Herrera and Minetti, 2007 JFE)

Mechanism

- We aggregate the syndicated loan data to the firm-bank-time level (e.g., as in [Saidi and Streitz, 2021 RFS](#);) and run the following regression model:

$$y_{f,s,b,t} = \beta (\textit{Specialization}_{b,s,t-1} \times \textit{Innovative}_{s,t-1} \times \textit{Overhang}_{s,t-1}) + \lambda_{b,t} + \lambda_{s,t} + \lambda_f + \epsilon_{f,s,b,t} \quad (4)$$

where $y_{f,s,b,t}$ corresponds to the loan terms offered by bank b to firm f operating in sector s at time t

- We analyze 4 key loan terms: contractual loan amounts, loan rates, loan maturities, and loan covenants

Results: Loan rates

	(1)	(2)	(3)
	ln(AISD)	ln(AISD)	ln(AISD)
Bank specialization _{t-1}	0.07 (0.12)	-0.12 (0.17)	-0.06 (0.17)
Bank specialization _{t-1} × Innovative _{t-1} × High asset overhang _{t-1}		0.70* (0.37)	0.71* (0.43)
Observations	18,003	18,003	18,003
Adjusted R-squared	0.71	0.71	0.71
Asset overhang measure		Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
Bank × Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Results: Loan covenants

	(1) Covenant strictness	(2) Covenant strictness	(3) Covenant strictness
Bank specialization _{t-1}	-0.29** (0.15)	-0.32* (0.18)	-0.33* (0.18)
Bank specialization _{t-1} × Innovative _{t-1} × High asset overhang _{t-1}		1.20* (0.73)	0.97** (0.45)
Observations	7,943	7,943	7,943
Adjusted R-squared	0.50	0.50	0.50
Asset overhang measure		Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
Bank × Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Results: Loan maturities

	(1) ln(Maturity)	(2) ln(Maturity)	(3) ln(Maturity)
Bank specialization _{t-1}	0.28*** (0.11)	0.30** (0.12)	0.24* (0.14)
Bank specialization _{t-1} × Innovative _{t-1} × High asset overhang _{t-1}		0.39 (0.46)	-0.82* (0.48)
Observations	19,784	19,784	19,784
Adjusted R-squared	0.42	0.42	0.42
Asset overhang measure		Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
Bank × Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Loan amounts

Mechanism

- In general, firms get more favorable loan conditions from specialized banks
- However, this does not hold for firms operating in innovative sectors with high asset overhang
- This suggests that **banks internalize the potential spillovers of new technologies** on their legacy loan portfolio which, in turn, influences firms' financing conditions and innovation activities

Conclusion

Conclusion

- Employing 2 complementary settings (US syndicated loans/patents and Community Innovation Survey/Belgian credit registry), we provide the **first empirical evidence** that **lenders' sectoral specialization** affects firms' innovation output,
- We find that the effect is **positive or negative**, depending on the **underlying asset overhang**
- These heterogeneous effects seem to arise through the **financing conditions** that lenders offer to firms
- Overall, these findings provide **new insights** into the **dual facets of bank specialization** and the **finance-innovation nexus**

Thank you!

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Appendix

Patent novelty

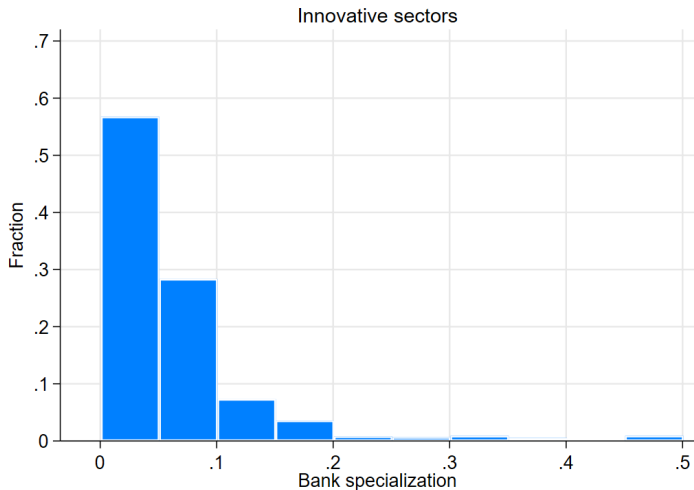
$$\textit{Patent originality} = 1 - \sum_{j=1}^{N_j} f_{ij}^2 \quad (5)$$

where f_{ij} denotes the ratio of the number of cited patents belonging to technology class j to the number of patents cited by patent i . A patent has a high value of originality if it cites prior patents from many different technological classes.

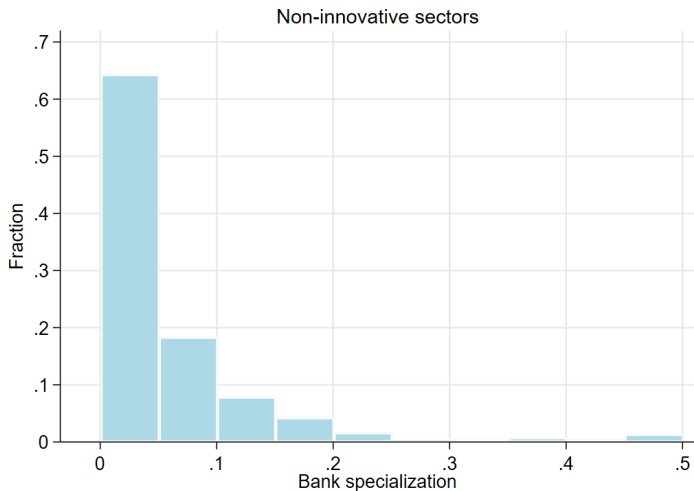
$$\textit{Patent generality} = 1 - \sum_{j=1}^{N_j} b_{ij}^2 \quad (6)$$

where b_{ij} denotes number of patents citing patent i belonging to technology class j scaled by the number of patents citing patent i . A patent has a high value of generality if it is cited by patents from many different technological classes.

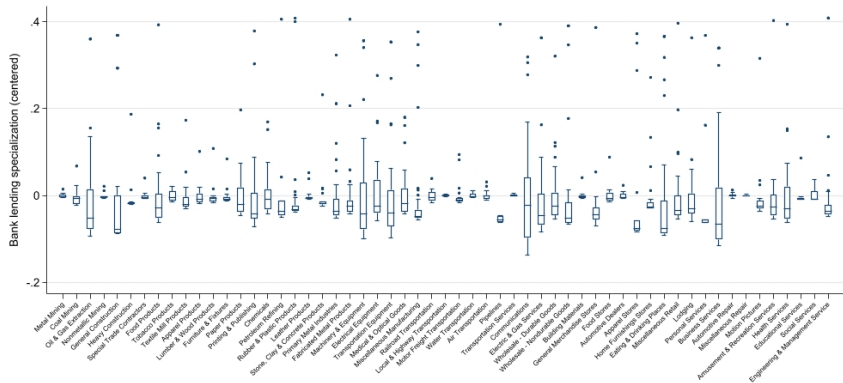
Descriptive statistics: Bank specialization



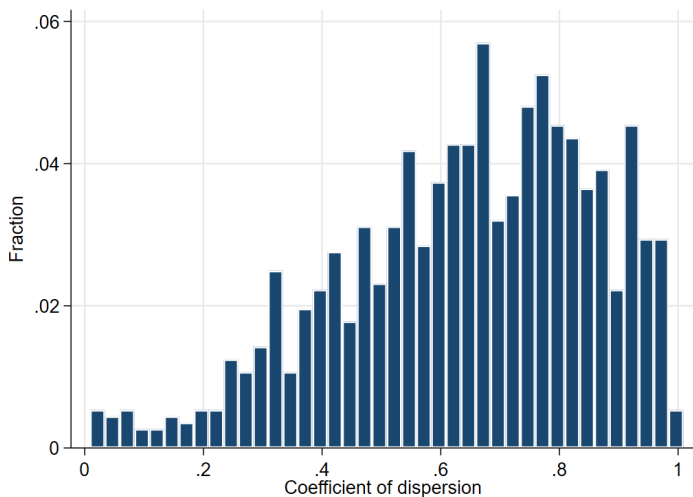
Descriptive statistics: Bank specialization



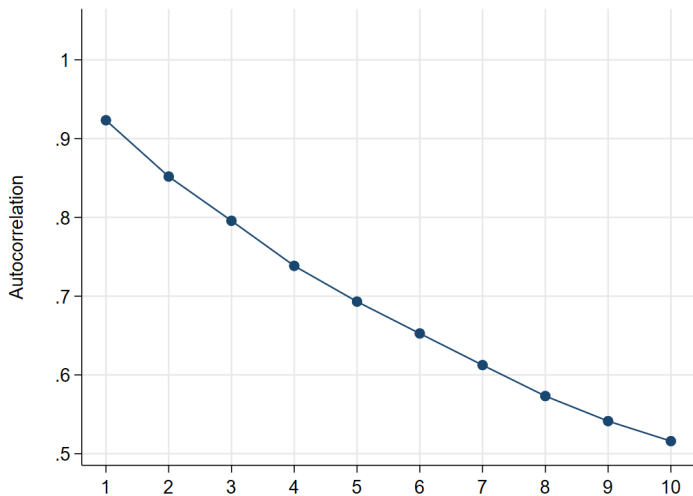
Descriptive statistics: Bank specialization



Descriptive statistics: Bank specialization



Descriptive statistics: Bank specialization



Descriptive statistics: Summary statistics

	N	Mean	Median	SD	Min	Max
Patents	35,023	5.31	0.00	19.23	0.00	159.00
Patent citations	35,023	1.96	0.00	5.76	0.00	82.90
Patent originality	35,023	0.11	0.00	0.23	0.00	0.83
Patent generality	35,023	0.17	0.00	0.35	0.00	0.97
Size	35,023	6.55	6.54	1.86	0.33	10.26
Age	35,023	3.75	0.00	5.74	0.00	23.00
Debt/TA	35,023	0.31	0.28	0.25	0.00	1.52
Equity/TA	35,023	0.39	0.39	0.23	0.00	0.93
Cash/TA	35,023	0.08	0.03	0.10	0.00	0.80
ROA	35,023	0.00	0.03	0.20	-3.00	0.22
Fixed assets/TA	35,023	0.57	0.51	0.39	0.00	1.55
CAPEX/TA	35,023	0.06	0.04	0.06	0.00	0.25
R&D expenses/TA	35,023	0.02	0.00	0.06	0.00	0.59
Tobin's Q	35,023	0.80	0.48	1.18	0.00	11.87
Public debt	35,023	0.73	1.00	0.44	0.00	1.00
HHI	35,023	0.19	0.15	0.14	0.02	0.69
Bank specialization	35,023	0.06	0.03	0.08	0.00	0.46
Bank market share	35,023	0.15	0.11	0.15	0.00	0.59
Bank concentration	35,023	0.30	0.26	0.14	0.09	1.00
Bank geographic diversification	35,023	0.87	0.95	0.19	0.00	0.99
Number of lending relationships	35,023	1.37	1.00	0.72	1.00	11.00
Lending relationship length	35,023	4.19	3.00	3.10	1.00	23.00



Descriptive statistics: Number of lending relationships

Number of lending relationships	Percentage	Cumulative Percentage
1	70.59	70.79
2	22.74	93.52
3	4.92	98.44
4	1.01	99.45
5+	0.55	100.00
Total	100.00	



Robustness: Mergers

- We use mergers as a source of exogenous variation in bank specialization (e.g., [Iyer et al., 2022 WP](#))
- Specifically, we analyze how the innovation output of borrowers from target banks changes after the target banks' sectoral specialization alters due to the acquisition by acquirer banks:

$$\begin{aligned} \Delta y_{f,b,s} = & \\ & \beta \Delta \text{Bank specialization}_{b,s}^{\text{merger}} + \\ & \delta (\Delta \text{Bank specialization}_{b,s}^{\text{merger}} \times \text{Asset overhang risk}_s) + \\ & \gamma C_{f,b,s} + \lambda_s + \lambda_I + \epsilon_{f,b,s} \end{aligned} \quad (7)$$

where $\Delta \text{Bank specialization}_{b,s}^{\text{merger}} =$
 $\text{Bank specialization}_{\text{acquirer},s,t,t+3} - \text{Bank specialization}_{\text{target},s,t-3,t}$

Robustness: Mergers

	$\Delta \ln(1+\text{patents})$		$\Delta \ln(1+\text{citations})$	
	(1)	(2)	(3)	(4)
Δ Bank specialization ^{Merger implied}	-0.13 (0.14)	-0.15 (0.19)	-0.12 (0.21)	-0.12 (0.30)
Observations	1,926	1,848	1,926	1,848
R-squared	0.07	0.18	0.06	0.18
Controls	Yes	Yes	Yes	Yes
Sector FE	Yes	No	Yes	No
State FE	Yes	No	Yes	No
Year FE	Yes	No	Yes	No
Sector \times Year FE	No	Yes	No	Yes
State \times Year FE	No	Yes	No	Yes



Robustness: Mergers

	$\Delta \ln(1+\text{patents})$		$\Delta \ln(1+\text{citations})$	
	(1)	(2)	(3)	(4)
$\Delta \text{Bank specialization}^{\text{Merger implied}}$	-0.28 (0.23)	-0.27 (0.24)	-0.34 (0.35)	-0.31 (0.36)
$\Delta \text{Bank specialization}^{\text{Merger implied}} \times \text{Asset overhang}$	-0.52* (0.31)	-0.52 (0.32)	-0.90** (0.39)	-0.81* (0.42)
Observations	1,848	1,848	1,848	1,848
Adjusted R-squared	0.18	0.18	0.18	0.18
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector \times Year FE	Yes	Yes	Yes	Yes
State \times Year FE	Yes	Yes	Yes	Yes



Robustness: Sorting

- We analyze potential endogenous matching of more (less) innovative firms with more (less) specialized banks in sectors with low (high) asset overhang:

$$y_{f,b,s,t} = \delta(\text{Bank specialization}_{b,s,t-1} \times \text{Asset Overhang Risk}_{s,t-1}) + \beta \text{Bank specialization}_{b,s,t-1} + \gamma C_{f,b,s,t-1} + \lambda_{s,t} + \lambda_{l,t} + \epsilon_{f,b,s,t} \quad (8)$$

where f , s , b , and t refer to firm, sector, bank, and time, respectively

- This regression model is estimated at the bank-firm-time level using the first observation of each firm-bank match

Robustness: Sorting

	Patents _[t-3,t-1]		Citations _[t-3,t-1]	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	1.78 (1.12)	-0.14 (1.63)	0.16 (0.65)	0.04 (0.73)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.57 (1.17)	1.68 (1.18)	-0.94 (0.66)	-0.09 (0.57)
Bank size _{t-1}	0.66*** (0.24)	0.63*** (0.22)	-0.16** (0.08)	-0.17** (0.08)
Bank deposits/TA _{t-1}	-4.72*** (0.65)	-4.83*** (0.65)	-1.43*** (0.30)	-1.43*** (0.30)
Bank equity/TA _{t-1}	21.90*** (5.65)	22.05*** (5.77)	-0.38 (2.80)	-0.56 (2.80)
Bank LLP/TA _{t-1}	34.05 (25.89)	36.06 (25.85)	16.49 (15.53)	18.13 (15.58)
Bank ROA _{t-1}	-3.53 (17.84)	0.01 (17.57)	-6.28 (8.69)	-5.16 (8.60)
Bank market share _{t-1}	1.79*** (0.48)	1.83*** (0.48)	0.23 (0.29)	0.26 (0.29)
Bank geographic diversification _{t-1}	-0.39 (0.40)	-0.42 (0.41)	0.01 (0.19)	0.01 (0.19)
Bank concentration _{t-1}	-1.01 (0.70)	-1.05 (0.70)	-0.01 (0.27)	-0.03 (0.27)
Observations	4,040	4,040	4,040	4,040
Adjusted R-squared	0.59	0.59	0.26	0.26
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Alternative channels

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Controlling for banks' sectoral zombie lending				
Bank specialization _{t-1}	0.59 (0.59)	1.07 (0.67)	0.36 (0.40)	0.63 (0.49)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.87*** (0.72)	-1.65*** (0.59)	-1.85*** (0.49)	-0.90** (0.41)
Bank zombie lending _{t-1}	-5.93*** (1.94)	-6.25*** (1.97)	0.69 (1.55)	0.38 (1.57)
Observations	26,346	26,346	26,171	26,171
Pseudo R-squared	0.72	0.72	0.36	0.36
Panel B: Controlling for sectoral complexity				
Bank specialization _{t-1}	0.80 (1.13)	0.82 (1.10)	-0.65 (0.77)	-0.37 (0.78)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.86** (0.74)	-1.63*** (0.59)	-1.95*** (0.49)	-1.03** (0.41)
Bank specialization _{t-1} × Complex _{t-1}	-0.36 (1.30)	0.36 (1.29)	1.48 (0.91)	1.51 (0.95)
Observations	26,346	26,346	26,171	26,171
Pseudo R-squared	0.72	0.72	0.36	0.36
Asset overhang measure	Asset	Product market	Asset	Product market
	redeployability	rivalry	redeployability	rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Other bank interactions

	Patents		Citations	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	0.64 (0.61)	0.79 (0.71)	0.40 (0.40)	0.61 (0.51)
Bank specialization _{t-1} × Asset overhang risk _{t-1}	-2.28*** (0.78)	-1.38** (0.61)	-2.04*** (0.51)	-0.90** (0.43)
Bank concentration _{t-1}	-0.42 (0.27)	-2.28*** (0.62)	-0.27 (0.24)	-0.79* (0.44)
Bank concentration _{t-1} × Asset overhang risk _{t-1}	-0.63 (0.44)	1.53*** (0.47)	0.20 (0.32)	0.61* (0.33)
Bank market share _{t-1}	0.26 (0.30)	0.38 (0.48)	0.17 (0.24)	0.28 (0.33)
Bank market share _{t-1} × Asset overhang risk _{t-1}	-0.35 (0.48)	-0.10 (0.39)	-0.67** (0.27)	-0.30 (0.27)
Bank geographic diversification _{t-1}	0.51** (0.25)	0.26 (0.38)	-0.05 (0.17)	-0.12 (0.24)
Bank geographic diversification _{t-1} × Asset overhang risk _{t-1}	-0.40 (0.40)	0.06 (0.30)	-0.18 (0.23)	0.02 (0.19)
Lending relationship length _{t-1}	0.00 (0.01)	-0.01 (0.02)	-0.01 (0.01)	-0.01 (0.01)
Lending relationship length _{t-1} × Asset overhang risk _{t-1}	0.01 (0.02)	0.02 (0.01)	0.01 (0.01)	0.00 (0.01)
Number of lending relationships _{t-1}	0.02 (0.03)	0.05 (0.06)	-0.06** (0.03)	-0.05 (0.05)
Number of lending relationships _{t-1} × Asset overhang risk _{t-1}	0.01 (0.07)	-0.02 (0.04)	0.09** (0.05)	0.01 (0.03)
Observations	26,346	26,346	26,171	26,171
Pseudo R-squared	0.72	0.72	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes

Robustness: Fixed effects

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Including firm fixed effects				
Bank specialization _{t-1}	-0.74 (0.56)	0.21 (0.74)	0.61 (0.58)	1.25* (0.74)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.25* (0.72)	-1.63*** (0.58)	-1.50** (0.73)	-1.34** (0.53)
Observations	9,923	9,923	9,787	9,787
Adjusted R-squared	0.86	0.86	0.43	0.43
Panel B: Including bank-by-time fixed effects				
Bank specialization _{t-1}	0.86 (0.62)	1.48** (0.70)	-0.59 (0.71)	-0.40 (0.64)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.56* (0.93)	-1.45* (0.76)	-1.85*** (0.45)	-0.76** (0.36)
Observations	15,622	15,622	15,467	15,467
Pseudo R-squared	0.75	0.75	0.41	0.40
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Alternative bank specialization measures

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Bank specialization based on number of lending relationships				
Bank specialization _{t-1}	0.43 (0.68)	0.70 (0.75)	0.13 (0.45)	0.46 (0.49)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.58* (0.83)	-1.15* (0.65)	-1.86*** (0.56)	-0.98** (0.44)
Observations	26,346	26,346	26,171	26,171
Adjusted R-squared	0.72	0.72	0.36	0.36
Panel B: Bank specialization based on 3-digit SIC codes				
Bank specialization _{t-1}	-0.88 (0.83)	-0.55 (0.86)	0.52 (0.51)	0.43 (0.55)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.65* (0.89)	-1.89*** (0.73)	-1.30** (0.51)	-0.43 (0.46)
Observations	20,592	20,592	20,414	20,414
Pseudo R-squared	0.77	0.77	0.37	0.37
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Lead arranger definition

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Bank specialization based on lead arranger definition from Ivashina (2009)				
Bank specialization _{t-1}	0.81 (0.53)	1.31** (0.60)	0.44 (0.35)	0.66 (0.42)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.78*** (0.64)	-1.71*** (0.52)	-1.55*** (0.42)	-0.82** (0.36)
Observations	25,853	25,853	25,678	25,678
Adjusted R-squared	0.72	0.72	0.36	0.36
Panel B: Bank specialization based on lead arranger's exact loan share				
Bank specialization _{t-1}	0.54 (0.60)	1.10* (0.67)	0.37 (0.41)	0.67 (0.46)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.22 (0.83)	-1.46** (0.61)	-1.64*** (0.55)	-0.85** (0.41)
Observations	24,359	24,359	24,184	24,184
Pseudo R-squared	0.73	0.73	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Loans

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Excluding term loans B				
Bank specialization _{t-1}	0.66 (0.81)	1.23 (1.04)	0.42 (0.34)	0.65 (0.41)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.65** (0.77)	-1.74** (0.70)	-1.53*** (0.52)	-0.81** (0.36)
Observations	24,209	24,209	24,035	24,035
Adjusted R-squared	0.73	0.73	0.36	0.36
Panel B: Excluding bank-sector-time bins with less than ten loans				
Bank specialization _{t-1}	0.34 (0.76)	0.88 (0.88)	-0.05 (0.53)	0.33 (0.58)
Bank specialization _{t-1} × Asset overhang _{t-1}	-2.05** (0.93)	-1.87** (0.74)	-1.94*** (0.58)	-1.32*** (0.50)
Observations	19,931	19,931	19,791	19,791
Pseudo R-squared	0.74	0.74	0.37	0.37
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Data sample

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Excluding recession periods				
Bank specialization _{t-1}	0.36 (0.61)	0.74 (0.70)	0.42 (0.41)	0.66 (0.51)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.74** (0.76)	-1.37** (0.60)	-1.80*** (0.51)	-0.79* (0.42)
Observations	22,303	22,303	22,128	22,128
Pseudo R-squared	0.72	0.72	0.36	0.36
Panel B: Excluding multiple-bank borrowers				
Bank specialization _{t-1}	0.32 (0.69)	0.57 (0.82)	0.27 (0.43)	0.59 (0.54)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.81** (0.80)	-1.08 (0.68)	-1.93*** (0.51)	-0.90** (0.45)
Observations	16,381	16,381	16,247	16,247
Pseudo R-squared	0.73	0.73	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: OLS estimation

	ln(1+patents)		ln(1+citations)	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1}	0.17 (0.14)	0.14 (0.14)	0.04 (0.12)	0.02 (0.12)
Bank specialization _{t-1} × Asset overhang _{t-1}	-0.44*** (0.12)	-0.37*** (0.14)	-0.30*** (0.09)	-0.24** (0.11)
Observations	34,912	34,912	34,912	34,912
Adjusted R-squared	0.42	0.42	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Clustering method

	Patents		Citations	
	(1)	(2)	(3)	(4)
Panel A: Standard errors clustered by sector				
Bank specialization _{t-1}	0.54 (0.81)	0.99 (1.03)	0.38 (0.35)	0.64 (0.48)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.92*** (0.69)	-1.61** (0.64)	-1.84*** (0.46)	-0.90** (0.38)
Observations	26,346	26,346	26,171	26,171
Pseudo R-squared	0.72	0.72	0.36	0.36
Panel B: Standard errors clustered by bank				
Bank specialization _{t-1}	0.32 (0.48)	0.57 (0.64)	0.27 (0.40)	0.59 (0.45)
Bank specialization _{t-1} × Asset overhang _{t-1}	-1.81*** (0.57)	-1.08 (0.75)	-1.93*** (0.38)	-0.90*** (0.30)
Observations	16,381	16,381	16,247	16,247
Pseudo R-squared	0.73	0.73	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes



Robustness: Alternative empirical specification

- We employ an alternative empirical model that allows for asymmetries in the effect of bank specialization (depending on the underlying asset overhang):

$$\begin{aligned} y_{f,b,s,t} = & \\ & \delta_1 \text{Bank specialization}_{b,s,t-1}^{\text{Low asset overhang risk}} + \\ & \delta_2 \text{Bank specialization}_{b,s,t-1}^{\text{Moderate asset overhang risk}} + \\ & \delta_3 \text{Bank specialization}_{b,s,t-1}^{\text{High asset overhang risk}} + \\ & \gamma C_{f,b,s,t-1} + \lambda_{s,t} + \lambda_{l,t} + \epsilon_{f,b,s,t} \end{aligned} \quad (9)$$



Robustness: Alternative empirical specification

	Patents		Citations	
	(1)	(2)	(3)	(4)
Bank specialization _{t-1} <i>Low asset overhang</i>	4.95*	1.57*	3.87*	1.50**
	(3.04)	(0.94)	(2.05)	(0.68)
Bank specialization _{t-1} <i>Moderate asset overhang</i>	1.96**	1.07	1.37**	-0.28
	(0.82)	(1.04)	(0.61)	(0.78)
Bank specialization _{t-1} <i>High asset overhang</i>	-1.59*	-1.96**	-1.06**	-0.83
	(0.83)	(0.85)	(0.50)	(0.53)
Observations	26,346	26,346	26,171	26,171
Adjusted R-squared	0.72	0.72	0.36	0.36
Asset overhang measure	Asset redeployability	Product market rivalry	Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes

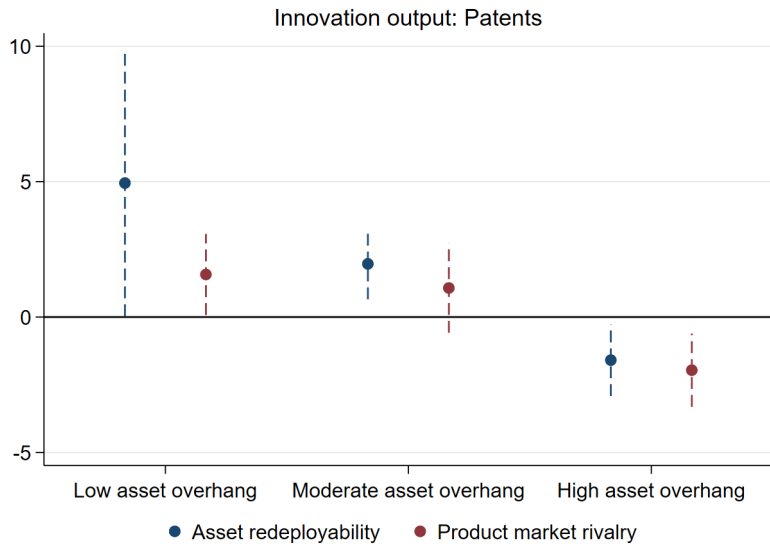


Results: Loan amounts

	(1) ln(Amount)	(2) ln(Amount)	(3) ln(Amount)
Bank specialization _{t-1}	1.56*** (0.22)	1.66*** (0.23)	1.57*** (0.27)
Bank specialization _{t-1} × Innovative _{t-1}		-0.28 (0.48)	0.03 (0.93)
Bank specialization _{t-1} × High asset overhang _{t-1}		-0.29 (0.38)	0.06 (0.40)
Bank specialization _{t-1} × Innovative _{t-1} × High asset overhang _{t-1}		-0.68 (1.02)	-0.43 (1.03)
Observations	19,815	19,815	19,815
Adjusted R-squared	0.78	0.78	0.78
Asset overhang measure		Asset redeployability	Product market rivalry
Controls	Yes	Yes	Yes
Sector × Year FE	Yes	Yes	Yes
Bank × Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes



Results



Results

