Technology Investment, Firm Performance and Market Value: Evidence from Banks

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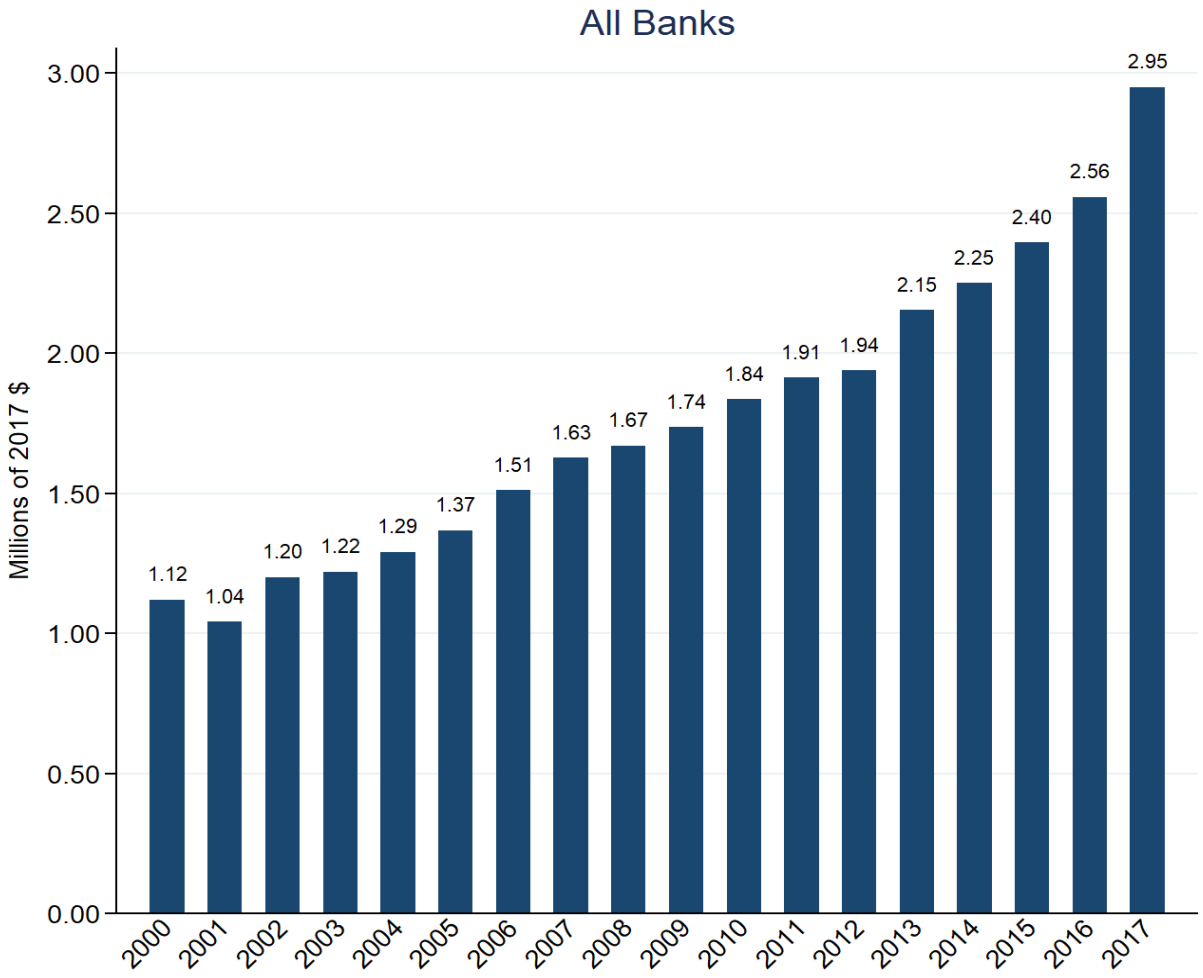


Technology Investment Trend of U.S. Banks

The trend of technology and communication expenses (based on medians) in 2017 dollars.

Importance of Technology in Banking

- In 2015, four of the ten biggest technology spenders worldwide were U.S. banks (Bank of America, Citigroup, JP Morgan Chase & Co., and Wells Fargo)

  -- Wall Street Journal, April 21, 2016

- Technology is "an essential core competency and a key differentiator in banking business to drive future growth"

  --Matt Zames, COO of JP Morgan Chase in 2015 10K report

- Technology becomes a critical component in bank operation & production

Limited Research & Mixed Findings on Bank Technology

- Prasad and Harket (1997) find that increase in IT does **not** benefit banks in productivity & profitability (based on survey data on U.S. retail banks from 1993 to 1995).
- Yet, DeYoung, Lang & Nolle (2007) show internet adoption **improves profitability** for community banks (based on U.S. community bank data from 1999 to 2001).
- Evidence from European banks shows **little relationship** between IT and bank profitability (Beccalli (2007), data from 1995 to 2000; Martin-Oliver & Salas-Fumas (2008) and Martin-Oliver, Ruano & Salas-Fumas (2013), Spanish banks).
- Limited research is largely due to lack of relevant data.
  - Technology investment is typically NOT disclosed in financial reports.

Motivation

- Most research in the U.S. uses either limited short-term survey data or data before the "networking" era of computing.
- Results based on European bank data may not be applicable to the U.S. banking industry.
- Effects of technology investment can be different for **small** and **large** banks.
- It is interesting to examine effects of technology investment on U.S. banks using recent data given
  - the importance of technology to U.S. banks
  - the mixed empirical evidence on the effects of technology investment

Research Questions

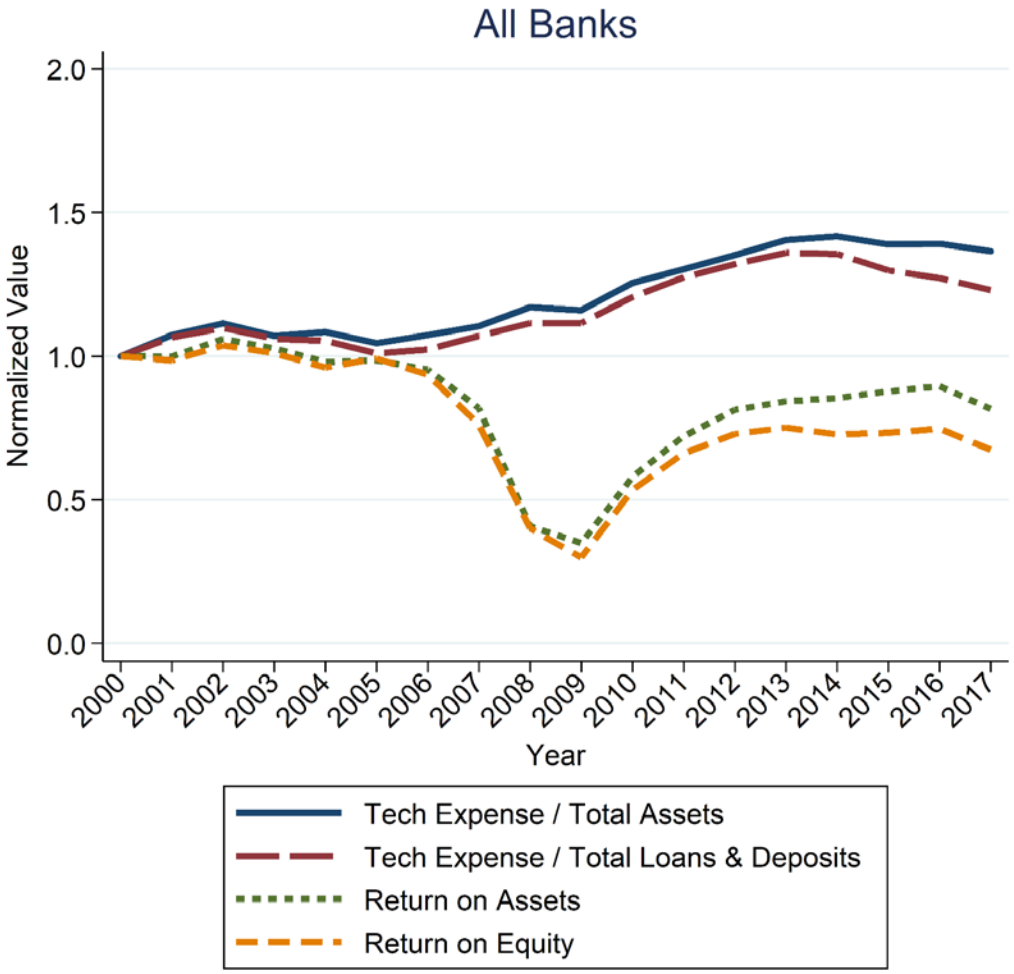
- Does the expanded use of IT increase bank **Performance & Market Value**?
  - Technology may improve production efficiency and reduce operating costs
  - Technology adoption can be very costly, especially for small banks
  - Part of bank profits could be wiped out due to encroaching automation
- Are the effects of technology investment different for **small** and **large** banks?
  - Technology investment is typically lumpy

Data

- Using technology spending as a proxy for technology investment

- Technology spending data: S&P Global Market Intelligence
  - US Listed Commercial banks (SIC code: 60) from 2000-2017
  - Primarily constructed based on U.S. GAAP standard Statement of Financial Accounting Standards (FAS) No. 86
  - Technology and Communications Expenses, including data processing, Internet banking, ATM expenses, technology advice, software, and cloud-based services, etc.

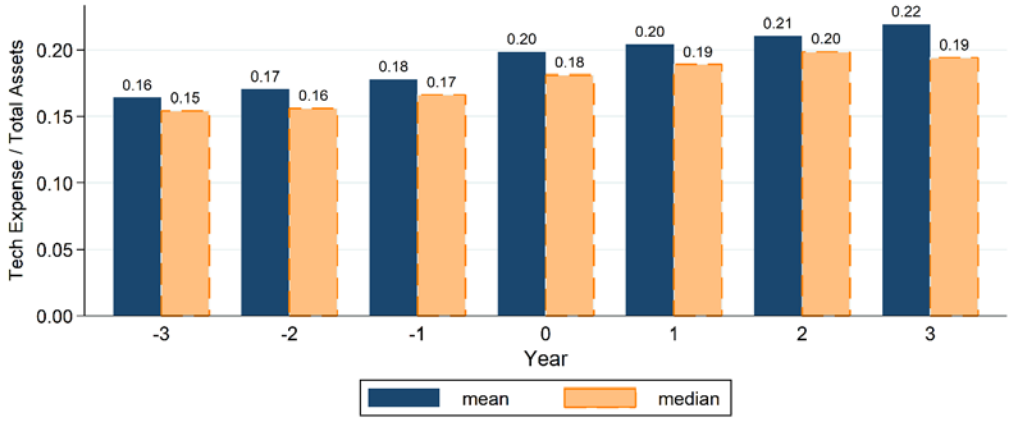
- Firm-level Financial data: Compustat



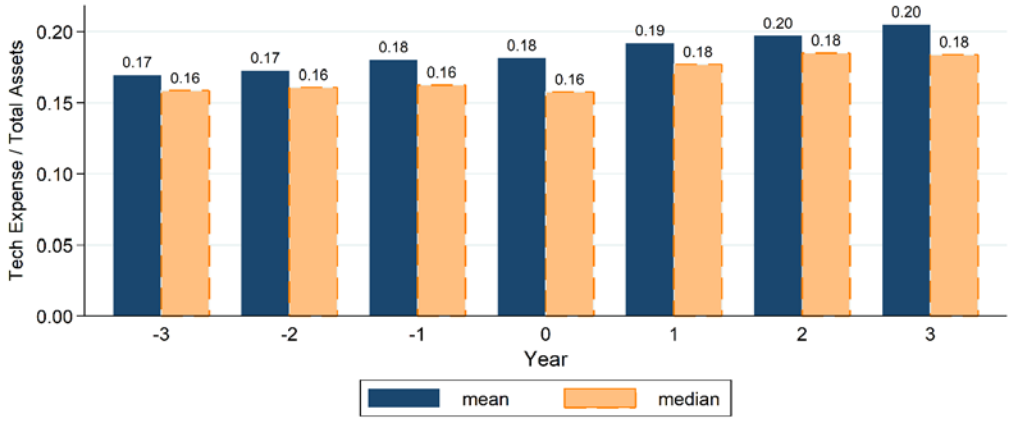
Bank Technology and Performance over time

The graph is based on the medians of bank performance measures and technology investment measures.

All values are normalized to equal one in the year 2000.



Panel A ROA from positive to negative.



Panel B ROA drops two std. dev.

Concern over Endogenous Relationship:

Performance Shock and Technology Investment

Technology spending continues to increase even after banks experience a negative performance shock.

It suggests a negative shock on performance does NOT affect bank technology spending.

Panel A banks with at least 5 years ROA and technology investment

Panel B banks with all 18 years ROA and technology investment

Concern over Endogenous Relationship:

Technology Investment Sorted by Performance

More profitable banks do NOT necessarily invest more in technology.

It suggests bank performance is NOT the main driver for bank technology spending.

Regression Specification: Performance and Technology Investment

$$Perf_{i,t} = \beta_0 + \boldsymbol{\beta_1 Tech_{i,t-1}} + \beta_2 LnSize_{i,t-1} + \beta_3 Leverage_{i,t-1} + \beta_4 Loans/Assets_{i,t-1}$$
$$+\beta_5 Deposits/Assets_{i,t-1} + \beta_6 Deposits/Liability_{i,t-1} + \eta_i + \alpha_t + \varepsilon_t \quad (1)$$

$Perf_{i,t}$: ROA or ROE of bank i at year t
$Tech_{i,t-1}$: ratio of technology expenses over total assets, or over loans & deposits

We estimate the model using the *full sample*, *small bank* and *large bank* sample.

Results: Performance and Technology Investment

	Panel A. All Banks			
Variables	(1) Return on Assets	(2) Return on Assets	(3) Return on Equity	(4) Return on Equity
Tech Expense/Total Assets, *t-1*	0.60*		10.59**	
	[1.90]		[2.03]	
Tech Expense/Loans & Deposits, *t-1*		0.85*		15.14**
		[1.84]		[1.98]
Number of Observations	6,652	6,652	6,652	6,652
Number of Banks	912	912	912	912
Adjusted *R*-squared	0.29	0.29	0.21	0.21
Bank Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

Positive Correlation

Significant at the 1% or 5% level

Banks that spend more technology, on average, have higher ROA and ROE.

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Results: Small Banks vs. Large Banks

Panel B. Small Banks and Large Banks

	Small Banks				Large Banks			
Variables	(1) Return on Assets	(2) Return on Assets	(3) Return on Equity	(4) Return on Equity	(5) Return on Assets	(6) Return on Assets	(7) Return on Equity	(8) Return on Equity
Tech Expense/Total Assets, *t-1*	0.09		3.59		0.97***		16.36***	
	[0.16]		[0.42]		[3.23]		[3.35]	
Tech Expense/Loans & Deposits, *t-1*		0.13		5.98		1.38***		23.09***
		[0.16]		[0.47]		[3.36]		[3.43]
Number of Observations	3,093	3,093	3,093	3,093	3,559	3,559	3,559	3,559
Number of Banks	467	467	467	467	445	445	445	445
Adjusted *R*-squared	0.24	0.24	0.17	0.17	0.34	0.34	0.25	0.25
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Small Banks: the coefficients are not significant

- Partly explain IT profitability paradox in Beccalli (2007)

Large banks: all *positive*, at the *1% significance*.

- Consistent with Mithas, Tafti, Nardhan & Goh (2012), whose sample includes more than 400 large global firms.

Results: How Technology Influences Bank Performance?

ROA = Profit Margin * Asset Turnover

- Profit Margin, measuring profitability from sales
- Asset Turnover, measuring sales volume effect
- Profit Margin: positive but insignificant
- Asset Turnover: positive, at the 1% significance

Panel A. All Banks				
Variables	(1) Profit Margin	(2) Profit Margin	(3) Asset Turnover	(4) Asset Turnover
Tech Expense/Total Assets, *t-1*	6.90		1.88***	
	[0.86]		[6.14]	
Tech Expense/Loans & Deposits, *t-1*		8.45		2.78***
		[0.73]		[6.29]
Number of Observations	6,652	6,652	7,291	7,291
Number of Banks	912	912	963	963
Adjusted *R*-squared	0.28	0.28	0.14	0.14
Bank Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Results: Small Banks vs. Large Banks

Small Banks:

- Profit Margin: negative and insignificant
- Asset Turnover: positive and significant

It implies technology helps small banks increase their sales volume, but not improve their ability to convert income into profit.

Large banks:

- Technology improves both Profit Margin and Asset Turnover.

Panel B. Small Banks and Large Banks

	Small Banks				Large Banks			
Variables	(1) Profit Margin	(2) Profit Margin	(3) Asset Turnover	(4) Asset Turnover	(5) Profit Margin	(6) Profit Margin	(7) Asset Turnover	(8) Asset Turnover
Tech Expense/Total Assets, *t-1*	-3.97		1.64***		15.71**		1.96***	
	[-0.29]		[4.33]		[2.16]		[4.15]	
Tech Expense/Loans & Deposits, *t-1*		-6.84		2.44***		21.16**		2.89***
		[-0.34]		[4.14]		[2.11]		[4.47]
Number of Observations	3,093	3,093	3,311	3,311	3,559	3,559	3,980	3,980
Number of Banks	467	467	486	486	445	445	477	477
Adjusted *R*-squared	0.24	0.24	0.12	0.12	0.31	0.31	0.16	0.16
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Results: Bank Value and Technology Investment

Coefficient estimates based on the full sample are all **positive**, but **insignificant**.

	Panel A. All Banks			
Variables	(1) Market-to-Book	(2) Market-to-Book	(3) Q	(4) Q
Tech Expense/Total Assets, *t-1*	0.25		0.02	
	[1.64]		[1.27]	
Tech Expense/Loans & Deposits, *t-1*		0.30		0.02
		[1.42]		[1.13]
Number of Observations	7,256	7,256	7,285	7,285
Number of Banks	962	962	963	963
Adjusted *R*-squared	0.56	0.56	0.56	0.56
Bank Fixed Effects	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Results: Small Banks vs. Large Banks

Small Banks:

- all insignificant

Large banks:

- positive, significant.

Consistent with Anderson, Banker & Ravindran (2006), who focus on Fortune 1000 firm and show that firm value increased on average with Y2K spending on technology.

Panel B. Small Banks and Large Banks

	Small Banks				Large Banks			
Variables	(1) Market-to-Book	(2) Market-to-Book	(3) Q	(4) Q	(5) Market-to-Book	(6) Market-to-Book	(7) Q	(8) Q
Tech Expense/Total Assets, *t-1*	-0.12		-0.01		0.53**		0.04**	
	[-0.64]		[-0.81]		[2.41]		[1.99]	
Tech Expense/Loans & Deposits, *t-1*		-0.16		-0.02		0.66**		0.05*
		[-0.60]		[-0.87]		[2.21]		[1.92]
Number of Observations	3,293	3,293	3,305	3,305	3,963	3,963	3,980	3,980
Number of Banks	486	486	486	486	476	476	477	477
Adjusted *R*-squared	0.54	0.54	0.57	0.57	0.59	0.59	0.57	0.57
Bank Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effects	YES	YES	YES	YES	YES	YES	YES	YES

Control Variables: Previous year Market Capitalization, Leverage, Loans/Assets, Deposits/Assets, Deposits/Liability

Results: Robustness

- *Too-Big-To-Fail (TBTF) Banks are Excluded from Large Banks*
- *An Alternative Size Cutoff*
  - Re-run analysis using a $1 million and $3 million technology expense cutoff, respectively
  - Quantitatively and qualitatively similar results.
- *Long Lags of Technology Spending Measures*
  - Bank performance of the large banks is associated with up to four-year lags of technology spending measures

Conclusions

Using a newly-available sample of U.S. listed commercial banks from 2000-2017, we document:

1. Bank **technology spending growth is almost monotonic** even during the financial crisis.
2. Little evidence is found that technology spending is affected by the negative performance shock during the financial crisis or by slow revenue growth.
3. There is a strong **positive correlation** between bank performance (and market value) and their lagged technology spending measures.

Conclusions

4. The positive correlation between bank performance (market value) and the technology investment is mainly **driven by large banks**.

5. While technology spending increases Asset Turnover for both small and large banks, it only improves Profit Margin of the large banks.

6. Policy implication given the bank *size effect* of technology investment as identify in this paper, it is important for regulators to **make new polices and help small (community) banks** improve performance and valuation in times of the rapid technological progress.