



# **Financial Development and Innovation: Cross-country evidence Journal of Financial Economics, 2013**

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# Introduction

- ▶ Old debate on the direction of causality between Finance and Economic Growth.
- ▶ Finance leads economic growth
  - Schumpeter(1911)
- ▶ Economics with good growth develop financial markets
  - Robinson(1952)

# Situation

- ▶ Effects of financial market development on technological innovation
  - Reducing external capital cost by overcoming moral hazard and adverse selection
  - Evaluating risky innovative projects
  - Managing risks by diversification

# Research Questions

- ▶ Do the development of equity market affects innovation in industries that are more dependent on external finance?
- ▶ Do the development of credit market affects innovation in industries that are more dependent on external finance?
- ▶ Do the development of equity market affects innovation in high-tech industries?
- ▶ Do the development of credit market affects innovation in high-tech industries?

# Main Findings

- ▶ The development of equity markets encourage innovation in industries that are more dependent on external finance and that are more high-tech intensive.
- ▶ However, the development of credit markets discourage innovation in industries with those characteristics.

# Hypothesis Development

- ▶ Equity markets are more likely to have a positive effect on innovation in more external finance-dependent industries due to ...
  - Rights for upside returns and none of collateral requirements
    - ❖ Brown, Fazzari, and Peterson(2009)
  - Relevant information inherent in equilibrium prices
    - ❖ Grossman(1976)
  - Feedback effects of market security prices.
- ▶ Hypothesis 1: Equity market development promote innovation in industries that are more dependent on external finance.

# Hypothesis Development

- ▶ Credit markets are less likely to promote innovation in industries that are more dependent on external finance due to...
  - None of feedback effects in bank financing due to a lack of price signals
    - ❖ Rajan and Zingales (2001)
  - Innovative firm's limited amounts of cash flows to service debt
    - ❖ Brown, Martinsson, and Petersen (2012), Brown, Fazzari, and Petersen(2009)
- ▶ Hypothesis 2: Credit market development discourage innovation in industries that are more dependent on external finance.

# Hypothesis Development

- ▶ Equity markets helpful to innovation in high-tech industries due to...
  - ▶ Its rich set of risk management tools encouraging investment in innovative(or high risk-high return) projects
    - ❖ Levine (2005), Bravo-Biosca (2007)
- ▶ Hypothesis 3: Equity market development will promote innovation in high-tech industries.

# Hypothesis Development

- ▶ Credit markets discourage innovation in high-tech industries due to ...
  - ▶ Under-investment in innovative projects by bank's excessive risk-aversion
    - ❖ Stiglitz (1985), Weinstein and Yafeh (1998)
  - ▶ Possible adverse selection problem and moral hazard issue that high-tech firms substitute high-risk for low-risk projects
    - ❖ Brown, Fazzari, and Petersen(2009)
- ▶ Hypothesis 4: Credit market development will discourage innovation in high-tech industries

# Hypothesis(Summary)

1. Equity market development promote innovation in industries that are more dependent on external finance.
2. Credit market development discourage innovation in industries with above characteristics.
3. Equity market development promote innovation in high-tech industries.
4. Credit market development discourage innovation in high-tech industries.

# Key Variables

## ▶ 4 Dependent variables:

### ▶ Number of patents

- ▶ Proxy for innovation quantities

### ▶ Number of citations

- ▶ Proxy for innovation quality

### ▶ Patent's originality score

- ▶ High score implies patents that cite a wider array of technology classes of patents

### ▶ Patent's generality score

- ▶ High score implies patents that is cited by a wider array of technology classes of patents

# Key variables

- ▶ Independent variables:
  - ▶ Equity market development:
    - ▶ Stock market capitalization / GDP
  - ▶ Credit market development:
    - ▶ Domestic credit provided by banking sector / GDP
  - ▶ Dependence on external finance:
    - ▶ Capital expenditures + R&D expenses – Cash flow from operation
  - ▶ High-tech intensiveness:
    - ▶ Annual gross growth in R&D expenses
  - ▶ Control Variables
    - ▶ Industrial share of total value added & Industrial share of export to US.

# Summary Statistics

<b>Panel A</b> Country	<i>Patent*</i>	<i>Citation*</i>	<i>Originality*</i>	<i>Generality*</i>	<i>R&amp;D*</i>	<i>Equity</i>	<i>Credit</i>	<i>Value-Added</i>	<i>US-Export</i>
Argentina	0.002	0.021	0.000	0.000	0.000	0.273	0.369	0.050	0.047
Australia	0.033	0.297	0.004	0.003	0.008	0.821	0.705	0.047	0.044
Austria	0.029	0.189	0.002	0.002	0.007	0.183	1.102	0.050	0.049
Belgium	0.036	0.295	0.006	0.004	0.042	0.557	0.916	0.075	0.049
Brazil	0.004	0.024	0.001	0.000	0.014	0.284	0.792	0.075	0.046
Canada	0.144	1.620	0.023	0.017	0.095	0.821	1.188	0.047	0.047
Denmark	0.020	0.158	0.002	0.002	0.029	0.470	0.796	0.047	0.045
Finland	0.029	0.269	0.005	0.003	0.129	0.853	0.627	0.048	0.047
France	0.220	1.797	0.025	0.027	0.640	0.579	1.018	0.048	0.047
Germany	0.731	5.471	0.076	0.081	0.873	0.370	1.123	0.047	0.046
Hungary	0.019	0.084	0.001	0.001	0.001	0.188	0.802	0.048	0.049
India	0.013	0.053	0.002	0.000	0.007	0.341	0.477	0.045	0.043
Ireland	0.006	0.071	0.002	0.001	0.007	0.617	0.736	0.046	0.047
Israel	0.035	0.422	0.008	0.005	0.008	0.483	1.087	0.054	0.048
Italy	0.096	0.635	0.010	0.009	0.286	0.325	0.936	0.047	0.048
Japan	2.132	23.002	0.337	0.347	1.805	0.828	2.548	0.046	0.046
Korea	0.115	0.853	0.022	0.009	0.095	0.470	0.574	0.046	0.048
Luxembourg	0.003	0.016	0.000	0.000	0.000	1.550	0.946	0.071	0.051
Malaysia	0.002	0.017	0.001	0.000	0.002	1.624	1.125	0.045	0.046
Mexico	0.004	0.026	0.001	0.000	0.000	0.263	0.436	0.047	0.045
Netherlands	0.072	0.641	0.011	0.010	0.190	0.921	1.267	0.048	0.044
New Zealand	0.005	0.037	0.001	0.000	0.000	0.406	0.734	0.123	0.046
Norway	0.010	0.076	0.001	0.001	0.012	0.359	0.638	0.047	0.047
Poland	0.003	0.019	0.000	0.000	0.000	0.136	0.375	0.052	0.049
Russia	0.039	0.248	0.002	0.003	0.001	0.277	0.282	0.047	0.051
Singapore	0.011	0.131	0.004	0.002	0.004	1.611	0.635	0.047	0.047
South Africa	0.006	0.051	0.001	0.001	0.003	1.578	1.211	0.055	0.047
Spain	0.013	0.073	0.001	0.001	0.001	0.541	1.084	0.046	0.047
Sweden	0.063	0.591	0.007	0.007	0.328	0.847	0.984	0.047	0.046
Switzerland	0.092	0.741	0.008	0.011	0.390	1.774	1.632	0.074	0.047
UK	0.203	1.967	0.029	0.029	0.426	1.283	0.972	0.046	0.046
US	4.167	60.604	0.958	0.745	3.579	1.093	1.635	0.046	-

# Empirical Specification

$$\begin{aligned} \text{Innovation}_{j,i,t+1} = & \beta_0 + \beta_1(\text{Equity}_{i,t} \times \text{Industry}_j) \\ & + \beta_2(\text{Credit}_{i,t} \times \text{Industry}_j) \\ & + \beta_3 \text{Value-Added}_{j,i,t} + \beta_4 \text{US-Export}_{j,i,t} \\ & + \eta_{i,t+1} + \mu_j + \varepsilon_{j,i,t+1}, \end{aligned}$$

- ▶ Innovation: One of innovation proxies (Patent, Citation, Originality, Generality)
- ▶ Industry: Either Dependence or High-tech.

# Empirical Specification

$$\begin{aligned} \text{Innovation}_{j,i,t+1} = & \delta_0 + \delta_1(\text{Overall}_{i,t} \times \text{Industry}_j) \\ & + \delta_2 \text{Value-Added}_{j,i,t} + \delta_3 \text{US-Export}_{j,i,t} \\ & + \eta_{i,t+1} + \mu_j + \varepsilon_{j,i,t+1}, \end{aligned}$$

- ▶ Innovation: One of innovation proxies (Patent, Citation, Originality, Generality, R&D)
- ▶ Industry: Either Dependence or High-tech.

# Financial development, dependence on external finance, and innovation

Innovation	$Equity_{i,t} \times Dependence_j$	$Credit_{i,t} \times Dependence_j$	$Overall_{i,t} \times Dependence_j$	Value-Added	US-Export	Adj-R <sup>2</sup>	Obs.
Patent (1)	0.013** (0.006)			0.005 (0.013)	0.061** (0.025)	0.829	7548
Patent (2)		-0.115** (0.058)		0.006 (0.013)	0.053** (0.024)	0.835	7434
Patent (3)	0.047*** (0.018)	-0.128** (0.062)		0.006 (0.013)	0.055** (0.024)	0.836	7354
Patent (4)			-0.037 (0.024)	0.004 (0.013)	0.058** (0.025)	0.831	7354
Citation (5)	0.012** (0.005)			0.009 (0.009)	0.032*** (0.012)	0.763	7548
Citation (6)		-0.077** (0.033)		0.010 (0.009)	0.026** (0.012)	0.767	7434
Citation (7)	0.033*** (0.010)	-0.087** (0.035)		0.011 (0.010)	0.028** (0.012)	0.767	7354
Citation (8)			-0.023 (0.015)	0.009 (0.009)	0.030** (0.012)	0.764	7354
Originality (9)	0.011** (0.004)			0.011 (0.008)	0.035*** (0.013)	0.773	7548
Originality (10)		-0.051* (0.026)		0.012 (0.008)	0.031** (0.013)	0.775	7434
Originality (11)	0.026*** (0.009)	-0.059** (0.028)		0.012 (0.009)	0.033** (0.013)	0.775	7354
Originality (12)			-0.014 (0.012)	0.011 (0.008)	0.034*** (0.013)	0.773	7354
Generality (13)	0.008* (0.004)			0.010 (0.009)	0.041*** (0.015)	0.801	6814
Generality (14)		-0.066 (0.042)		0.010 (0.009)	0.037*** (0.014)	0.804	6700
Generality (15)	0.025** (0.011)	-0.073 (0.044)		0.010 (0.010)	0.039*** (0.015)	0.804	6620
Generality (16)			-0.021 (0.017)	0.009 (0.009)	0.041*** (0.015)	0.802	6620

# Financial development, high-tech intensiveness, and innovation

Innovation	$Equity_{i,t} \times High-tech_j$	$Credit_{i,t} \times High-tech_j$	$Overall_{i,t} \times High-tech_j$	Value-Added	US-Export	Adj-R <sup>2</sup>	Obs.
Patent (1)	0.014*** (0.005)			0.003 (0.003)	0.022*** (0.004)	0.918	7548
Patent (2)		-0.085*** (0.016)		0.002 (0.003)	0.025*** (0.004)	0.920	7434
Patent (3)	0.038*** (0.007)	-0.096*** (0.016)		0.003 (0.003)	0.025*** (0.004)	0.920	7354
Patent (4)			-0.026*** (0.008)	0.002 (0.003)	0.025*** (0.004)	0.919	7354
Citation (5)	0.014*** (0.004)			0.005* (0.003)	0.013*** (0.005)	0.870	7548
Citation (6)		-0.055*** (0.016)		0.005 (0.003)	0.015*** (0.005)	0.874	7434
Citation (7)	0.030*** (0.006)	-0.063*** (0.017)		0.005* (0.003)	0.015*** (0.005)	0.874	7354
Citation (8)			-0.015** (0.007)	0.004 (0.003)	0.015*** (0.005)	0.873	7354
Originality (9)	0.011*** (0.004)			0.005* (0.003)	0.014*** (0.005)	0.872	7548
Originality (10)		-0.021* (0.012)		0.004 (0.003)	0.015*** (0.005)	0.873	7434
Originality (11)	0.018*** (0.005)	-0.026** (0.013)		0.005 (0.003)	0.016*** (0.006)	0.873	7354
Originality (12)			-0.003 (0.005)	0.004 (0.003)	0.016*** (0.006)	0.873	7354
Generality (13)	0.010** (0.005)			0.004 (0.003)	0.016*** (0.006)	0.882	6814
Generality (14)		-0.059*** (0.018)		0.003 (0.003)	0.018*** (0.006)	0.885	6700
Generality (15)	0.028*** (0.007)	-0.067*** (0.020)		0.004 (0.003)	0.019*** (0.006)	0.885	6620
Generality (16)			-0.018** (0.008)	0.003 (0.003)	0.019*** (0.006)	0.884	6620

# Robustness Checks

- ▶ Country-industry fixed effects
  - ▶ Add dummies for country-industry fixed effects
- ▶ Alternative proxies for financial development
  - ▶ Alternative proxy for equity market development:
    - ▶ Stock market traded value / GDP
  - ▶ Alternative proxy for credit market development:
    - ▶ All private credit / GDP

# Robustness Check: Country-industry fixed effects

<b>Panel A</b> Innovation	$Equity_{i,t} \times Dependence_j$	$Credit_{i,t} \times Dependence_j$	Value-Added	US-Export	Adj-R <sup>2</sup>	Obs.
Patent	0.006*** (0.001)	-0.004*** (0.001)	-0.003 (0.009)	-0.014 (0.016)	0.892	7354
Citation	0.005*** (0.001)	-0.011*** (0.002)	0.002 (0.010)	-0.021 (0.023)	0.653	7354
Originality	0.004*** (0.001)	-0.006*** (0.002)	-0.007 (0.012)	-0.025 (0.027)	0.563	7354
Generality	0.007*** (0.001)	-0.006*** (0.002)	0.002 (0.011)	-0.028 (0.029)	0.744	6620
R&D	0.063** (0.027)	-0.100* (0.053)	10.254 (14.360)	-1.579 (61.731)	0.637	3536
<b>Panel B</b> Innovation	$Equity_{i,t} \times High-tech_j$	$Credit_{i,t} \times High-tech_j$	Value-Added	US-Export	Adj-R <sup>2</sup>	Obs.
Patent	0.005*** (0.001)	-0.004*** (0.001)	-0.005 (0.007)	-0.005 (0.014)	0.886	7354
Citation	0.003*** (0.001)	-0.010*** (0.002)	-0.013 (0.009)	-0.012 (0.024)	0.639	7354
Originality	0.004*** (0.001)	-0.010*** (0.002)	-0.013 (0.009)	-0.015 (0.024)	0.621	7354
Generality	0.002*** (0.001)	-0.012*** (0.003)	0.000 (0.007)	-0.014 (0.022)	0.667	6620
R&D	0.143 (0.076)	0.885 (0.541)	0.313 (0.824)	-4.324 (5.781)	0.886	3536

# Robustness Check:

## Alternative proxies for financial development

<b>Panel A</b> Innovation	$Equity_{i,t} \times Dependence_j$	$Credit_{i,t} \times Dependence_j$	<i>Value-Added</i>	<i>US-Export</i>	<i>Adj-R<sup>2</sup></i>	<i>Obs.</i>
<i>Patent</i>	0.057*** (0.015)	-0.132*** (0.027)	0.005 (0.007)	0.055*** (0.012)	0.834	7354
<i>Citation</i>	0.026** (0.013)	-0.074*** (0.028)	0.009* (0.005)	0.028** (0.011)	0.765	7354
<i>Originality</i>	0.014 (0.010)	-0.045* (0.023)	0.011* (0.006)	0.033*** (0.012)	0.774	7354
<i>Generality</i>	0.008 (0.012)	-0.057** (0.029)	0.009 (0.007)	0.040*** (0.013)	0.803	6620
<i>R&amp;D</i>	0.000 (0.843)	-1.004 (1.565)	47.535 (43.459)	16.295 (37.142)	0.237	3536
<b>Panel B</b> Innovation	$Equity_{i,t} \times High-tech_j$	$Credit_{i,t} \times High-tech_j$	<i>Value-Added</i>	<i>US-Export</i>	<i>Adj-R<sup>2</sup></i>	<i>Obs.</i>
<i>Patent</i>	0.033*** (0.010)	-0.094*** (0.020)	0.002 (0.003)	0.025*** (0.004)	0.920	7354
<i>Citation</i>	0.024** (0.010)	-0.058*** (0.020)	0.004 (0.003)	0.016*** (0.006)	0.873	7354
<i>Originality</i>	0.003 (0.007)	-0.014 (0.014)	0.004 (0.003)	0.016*** (0.006)	0.873	7354
<i>Generality</i>	0.017* (0.010)	-0.062*** (0.019)	0.003 (0.003)	0.019*** (0.006)	0.885	6620
<i>R&amp;D</i>	-0.873 (3.002)	0.105 (2.612)	3.781*** (1.064)	3.482*** (1.315)	0.695	3536

# Conclusions

- ▶ The development of equity markets encourage innovation in industries that are more dependent on external finance and that are more high-tech intensive.
- ▶ However, the development of credit markets discourage innovation in industries with those characteristics.