Innovation, Industry Equilibrium, and Discount Rates

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Discussion – FIRS – June 2022

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This Paper

Link between innovation and discount rates

- Insight of industry equilibrium
- Standard q-theory view of innovation
  - High discount rates $\rightarrow$ low investment or innovation
- Equilibrium thinking
  - High discount rates discourage entry and foster breakthrough innovation
  - Example: infant-industry protectionism

In the background

- Linear quadratic model of innovation with type transition
- Two types of innovation
  - exploitative (horizontal or tinkering): pure business-stealing effect
  - break-through (vertical): creates a new industry, knowledge spillovers

This Discussion

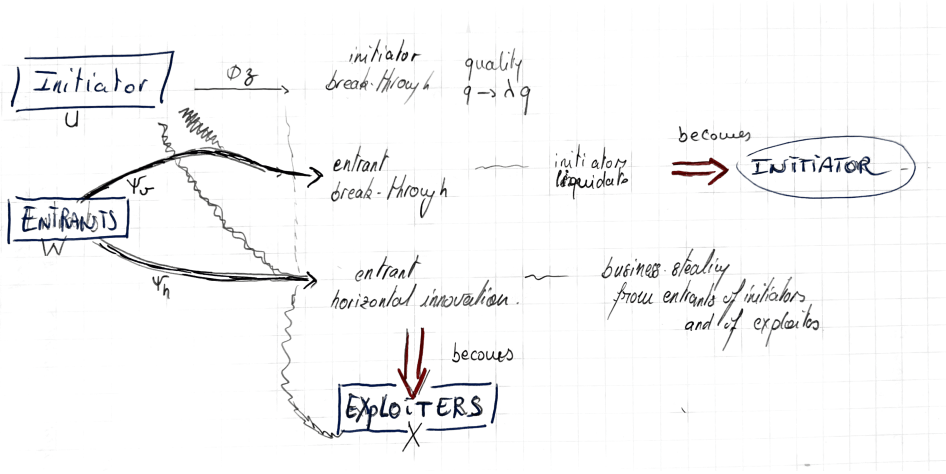
A lot to cover ...

- The mechanics of the model
  - quite involved: 2 types of innovation, 3 types of firms, transition dynamics...
- Quantitative content of the model
- Empirical content of the model

Plan

1. Model mechanics
2. Comments on the theory
3. Empirical opportunities

The Model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horizontal innovation.
business stealing
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and of exploiters
becomes
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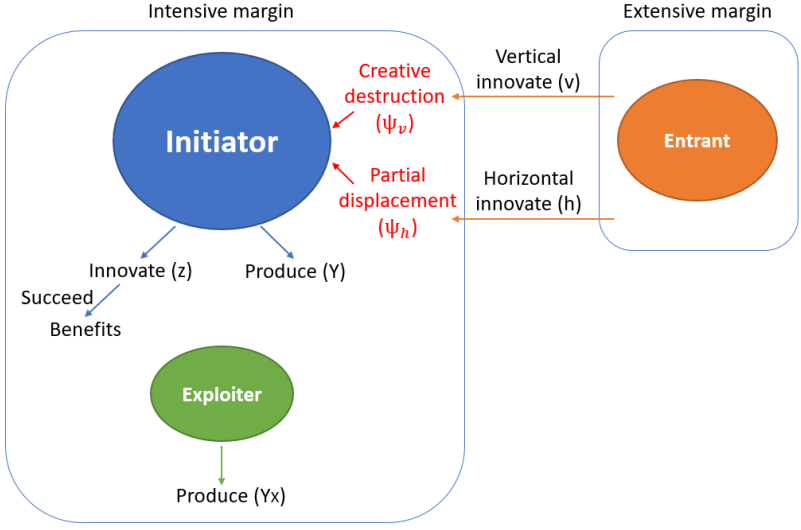
X

The Model (HT Yao Deng)

The Model



Protagonists

Two types of innovation

- **Tinkering** *(Horizontal Innovation)*: new products which take market shares from incumbents
  - Decreasing returns-to-scale; Business-stealing spillovers
- **Breakthrough** *(Vertical innovation)*: new product line which makes old products obsolete but opens the industry to tinkering
  - Knowledge spillovers as other firms build on product line; reset tinkering level

Three types of firms

- Entrants
  - Can do either horizontal (breakthrough) or vertical innovation
  - Displace initiator (if breakthrough) or steal market shares from exploiters/initiator
- Initiator
  - Former entrant who "broke-through"; exploits the product line
  - Initiators still innovate but only seek breakthrough (vertical innovation)
- Exploiter
  - Only horizontal innovation

Action

Firm type dynamics akin to a labor search model

- Interesting transition dynamics between types
- Incentives of three types of firms shape the type and the dynamics of innovation

Many interesting predictions from dynamics

- High discount rates discourage entry and innovation for all actors
- Fewer entrants means incumbents are protected (e.g. see the work on infant industries)
- Vertical innovation is more profitable (protected) while horizontal innovation returns go down
- Summary: *high discount rates* $\rightarrow$ *less entry* $\rightarrow$ *industry competition* $\downarrow$ $\rightarrow$ *returns to incumbent (vertical-)innovation is high!*

Action

A lot more stuff...

- Model easier to approach from perspective of textbook DMP model
- Search models are used to explain employment dynamics, volatility, job to job transition, skill premia, etc.
- What would be the counterparts here
  - worker skill $\leftrightarrow$ type of innovator
  - jobs transition $\leftrightarrow$ firm innovation cycle (from vertical to horizontal)
  - wage volatility $\leftrightarrow$ price volatility (Shimer puzzle)
  - wage premium $\leftrightarrow$ price difference
  - etc.
- All these links can be useful to think about how to approach the model predictions

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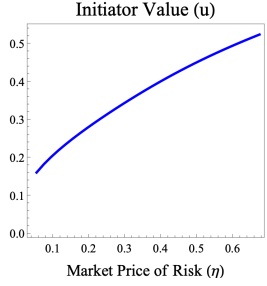
Are the dynamics realistic?

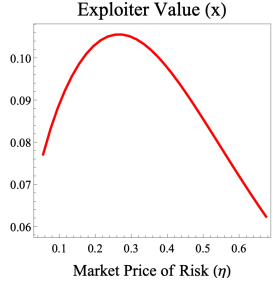
Main results: comparative statics on the risk premium

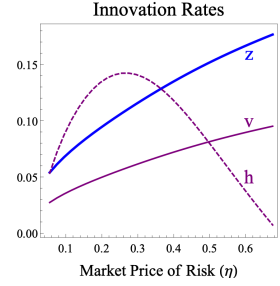
- What about taking these numbers seriously; e.g. take initiators' return in an industry for calibration

$$R_{\text{initiator},j} = \rho\sigma\eta_j \frac{y_j}{u_j} + \dots$$

- Industries with low risk-premium (low exposure to aggregate risk or low expected returns)
- lots of entrants, more exploiter, little vertical innovation?







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- Model makes surprising and very interesting predictions (refinement of q-theory)
- Important to present some direct evidence of the mechanism at play

Other comments

Main results: comparative statics on the risk premium

- Model is in partial equilibrium (it is in the title!)
- Innovation itself affects discount rates (Pastor and Veronesi)
- Interesting to flag the general equilibrium implications given that different types of innovation have different effects
  - horizontal innovation lowers risk premium (cash-flows are more stable)
  - vertical innovation could increase risk premium as industry becomes more dominant (P-V)

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Empirical relevance

Distinguish the type of innovation

- How does the risk premium change the quality of innovation
- Hard to interpret periods of high breakthrough innovation with asset prices (see Haddad, Ho, and Loualiche, JFE)
- Regress spillovers on discount rates (controlling for quality)

Some empirical explorations

	Market-based Spillovers			Outcome Spillovers		
	Jaffe	Mahalanobis	IV Jaffe	Jaffe	Mahalanobis	IV Jaffe
	(1)	(2)	(3)	(4)	(5)	(6)
Bubble x Spill-SIC	0.152^{***}	0.200^{***}	0.178^{***}	0.004	-0.000	0.007^{***}
	(0.027)	(0.037)	(0.038)	(0.009)	(0.013)	(0.002)
Spill-SIC	-0.088^{***}	-0.103^{***}	-0.314^{***}	-0.021^{***}	-0.021^{**}	-0.044
	(0.016)	(0.033)	(0.104)	(0.006)	(0.010)	(0.046)
Spill-Tech	0.405^{***}	0.844^{***}	1.214^{***}	0.175^{***}	0.159^{***}	0.188^{**}
	(0.145)	(0.174)	(0.171)	(0.025)	(0.040)	(0.074)
Fixed Effects	Y, F	Y, F	Y, F	Y, F	Y, F	Y, F
Observations	8,896	8,946	8,896	8,775	8,825	8,775
R^2	0.74	0.74	0.74	0.99	0.99	0.99

Some empirical explorations

	Market-based Spillovers			Outcome Spillovers		
	Jaffe (1)	Mahalanobis (2)	IV Jaffe (3)	Jaffe (4)	Mahalanobis (5)	IV Jaffe (6)
Risk Premium x Spill-SIC	-0.397^{***}	-0.607^{***}	-0.425^{***}	0.129^{***}	0.008	0.146^{***}
	(0.118)	(0.186)	(0.119)	(0.044)	(0.068)	(0.050)
Spill-SIC	-0.095^{***}	-0.105^{*}	-0.193^{**}	-0.022^{***}	-0.026^{*}	0.112^{**}
	(0.025)	(0.062)	(0.090)	(0.008)	(0.015)	(0.047)
Risk Premium x Spill-Tech	-1.026^{***}	-1.087^{***}	-0.969^{***}	-0.245^{***}	0.052	-0.088^{**}
	(0.185)	(0.250)	(0.239)	(0.087)	(0.098)	(0.039)
Spill-Tech	0.658^{***}	0.818^{***}	0.960^{***}	0.612^{***}	0.712^{***}	0.607^{***}
	(0.125)	(0.143)	(0.093)	(0.038)	(0.056)	(0.048)
Fixed Effects	Y, F	Y, F	Y, F	Y, F	Y, F	Y, F
Observations	10,159	10,226	10,159	10,153	10,236	10,153
R^2	0.72	0.72	0.72	0.99	0.99	0.99

Final Thoughts

Very interesting Paper!

Take away

- Dynamic models of innovation
- Very rich: two types of innovation, three types of agents (search model structure)
- ... subtle effect of risk on the incentives to innovate and the type of innovation