



Disruptive Innovation and IPO Outcomes: Evidence from Machine Learning



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Abstract

We develop a new text-based measure of disruptive innovation that does not require data on R&D or patents. We compute a disruptive innovation score (DIS) for firms doing IPOs using textual analysis of prospectuses and a semi-supervised machine learning method. We find that DIS positively predicts IPO outcomes (e.g., initial return, trading volume, bid-ask spread, and price revision). The initial returns of high DIS IPOs do not reverse over the next year, contradicting the hype hypothesis about technology stocks. DIS predicts post-IPO firm policies and higher firm valuation and captures disruptive innovation activities of IPO firms beyond R&D and patenting.

Motivation

- Disruptive innovation (DI) refers to the application of advanced technologies to replace existing products or business models, and create new customers, new competitors, and new approaches to doing business.
- Chen, Wu, and Yang (2019) use patent filings by Fintech firms to measure disruptiveness of innovations by the stock price reactions to patent announcements.
- However, patenting does not fully capture firm innovation activities, and R&D spending is often unreported in financial data.
- One strand of the literature studies the impact of innovation or a culture of innovation on firm performance using textual analysis, but most of this research on text-based innovation focuses on *well-established public companies, not IPO firms, which are private and mostly young firms*.
- We try to fill this gap in the literature by measuring an IPO firm's involvement in DI using machine learning methods on the text of IPO prospectuses, which present the firm's business, strategy, and plans to investors.

Data and Methods

- We obtain 3440 S-1 filings of IPO firms from 1994 to 2021.
- We use keywords for 29 disruptive technologies (e.g., Wifi, Robot, Bluetooth) identified by Bloom et al. (2021) based on discussions between managers and investors during earnings calls as seed words.
- We next compute the average of the vector of seed words.
- We then compute the cosine similarity between each unique word in IPO prospectuses and the average of the vectors of seed words.
- Next, we rank the cosine similarities of words and select 500 words with the highest rank to construct a dictionary of disruptive innovation.
- We then manually inspect the context-based dictionary to include only words relevant to technologies.
- We construct our DIS for a firm as the weighted (using WF.IDF method) relative frequency of words related to disruptive technologies in an IPO prospectus.

Advantages of DIS measure

- DIS provides a broader picture of disruptive innovation activities in IPO firms than patenting and R&D: Most firms do not have patents before doing an IPO and many firms strategically do not separately report R&D.
- DIS measure is likely to comprehensively capture firms' involvement in DI via any means, either by patenting, trade secrets, and non-disclosure agreements related to proprietary technologies or other agreements to use technologies developed by others.

References

- Chen, M.A., Wu, Q. and Yang, B., 2019. How valuable is FinTech innovation? The Review of Financial Studies.
- Bloom, N., Hassan, T.A., Kalyani, A., Lerner, J. and Tahoun, A., 2021. The diffusion of disruptive technologies. National Bureau of Economic Research.
- Li, K., Mai, F., Shen, R. and Yan, X. 2021a. Measuring corporate culture using machine learning. The Review of Financial Studies.

Results

- Validation: IPOs with high DIS have more patents, cites, and patent values at and after IPO.
- High DIS predicts:
 - Higher first-day return, trading volume, bid-ask spread, and price revision
 - Higher post-IPO stock return: Contradicts the hype hypothesis about tech stocks
 - Higher Tobin's Q, cash holdings, and R&D investment after IPO.

Table 1. Validation of Disruptive Innovation Score

	Ln(Patents)	Ln(Citations)	Patent Value	R&D Intensity
DIS	0.886*** (0.314)	1.103*** (0.319)	0.281** (0.130)	40.365*** (5.970)
Observations	3440	3440	3440	3440
Year dummies	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y
Adjusted R-square	0.362	0.570	0.552	0.616

Table 2. Disruptive Innovation and IPO Pricing and Trading Pattern

	First Day Return	Price Revision	Trading Volume	Bid-Ask Spread
DIS	35.469*** (9.146)	15.072*** (4.725)	0.795*** (0.232)	4.873** (2.263)
Observations	3440	3440	3440	3440
Year dummies	Y	Y	Y	Y
Industry dummies	Y	Y	Y	Y
Adjusted R-square	0.206	0.024	0.398	0.384

Table 3. Disruptive Innovation and Post-IPO Stock Performance

	Long-run abnormal return
DIS	67.162*** (23.467)
DIS*First day return	0.066 (0.306)
Observations	2,552
Year dummies	Y
Industry dummies	Y
Adjusted R-square	0.048

Conclusions

- This study is the first to introduce a measure of disruptive innovation, DIS, which measures IPO firms' involvement in disruptive technologies.
- DIS strongly and positively predicts firms' observable innovation activities.
- DI predicts several IPO outcomes and subsequent operations, performance, and valuation of firms going public.
- We find no evidence that the first-day returns of IPOs with high DIS reverse over the following 12 months.
- DI is a risky, but valuable, activity for firms.
- Our DIS measure captures firms' DI activities unexplained by R&D and patents.

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