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Is IPO Underpricing a Corporate Strategy?

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Abstract: To determine whether Initial Public Offering (IPO) underpricing is a corporate strategy and could improve a firm's long-run performance, I investigate whether IPO underpricing could promote or impede a firm's innovation productivity. I use the firms listed in China's Growth Enterprise Market (GEM) during the period from October 2009 to February 2017. The results of Ordinary Least Sqaure (OLS) show that underpricing is negatively related to innovation productivity, measured as the number of patents. It suggests that managers or underwriters only care about the immediate return and capital accumulation from IPO, rather than a firm's future growth. Managerial myopia is detrimental to a firm's long-term survival and development. Difference-in-Difference (DiD) methodology further establishes causality between underpricing and the number of patents, which compares the difference in the number of patents between the three-year window before IPO and after IPO.This probably suggests that IPO underpricing is not an active strategy to target long-term survival and growth. Industry and IPO suspension are also included to solve the effect from unobservable shock on the firm's innovative capability. My future study could expand to discuss the channel through IPO affect the firm's innovation productivity.

Keywords: *IPO underpricing, Innovation, Managerial myopia, Patent.*
JEL Classification: *G10; G18; O32.*

1. Introduction

Since the last decades, IPO underpricing has been the subject of research, and many studies argue that information asymmetry is a major factor in IPO underpricing. Rock (1986) states that in IPO, fully-informed investors take advantage of uninformed investors. Bancel and Garel (2015) find that to entice investors to express their real demand for new issues without worrying about the increase in IPO price, issuers have to lower the price. Loughran and Ritter (2004) point out the agency problem between investment banking and issuing firms, which states that investment bank allocates IPOs to a company's managers at a low price to get a high probability of undertaking more future underwriting business. Maglio, Petraglia, and Agliata (2018) suggest the usage of International Financial Reporting Standards(IFRS) could improve IPO underpricing. Kao and Chen (2020) find that IPO underpricing can be reduced by increasing financial reporting quality under information asymmetry. Another widely accepted hypothesis to account for underpricing is the behavioral explanation. Ljungqvist (2007) states that the presence of "irrational" investors is the cause of underpricing who lower the price intentionally. Arthurs, Hoskisson, Busenitz, and Johnson (2008) acknowledge the potential conflicts between underwriters, VC firms, and issuing firms.

However, we might ask whether IPO underpricing could benefit corporate performance. In order to determine whether IPO underpricing is a corporate strategy and could improve a firm's long-run performance, my major task in this research is to analyze if IPO underpricing might enhance a firm's capacity for innovation. Innovation productivity is of great interest to a great number of managers, stockholders, and regulators. Rajapathirana and Hui (2018) confirm the relationship between innovation

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capability and firm performance and asserts that innovation is the key to success in a highly competitive and global economy. Existing literature has developed a couple of proxies to capture firm innovation, among which Research & Development (R&D) expenditures and patenting activity are two main variables. Generally, a large sum or a large fraction of R&D expenditure input does not necessarily equal a high-quality innovation. Therefore, patenting activity, as opposed to R&D expenses, better represents the quality of the invention. I thus use patenting activity to measure the firm's innovative ability.

On one hand, IPO underpricing may promote innovation ability by raising the rate of survival. Fischer and Pollock (2004) find that young firms often face challenges in surviving, but there is some evidence that underpricing can help lower the failure rate of firms. Pollock and Gulati (2007) document that underpricing can benefit firms in their alliance formation, and increase their chances of survival. Pollock, Rindova, and Maggitti (2008) further show that greater levels of underpricing can attract more media attention. In this way, the ability to attract media attention is vital to the survival of IPO firms (Fischer & Pollock, 2004). Also, some studies show that greater levels of underpricing can boost mergers and acquisitions (Ragozzino & Reuer, 2011). Bouzouita, Gajewski, and Gresse (2015) find a positive correlation between initial underpricing and liquidity in the secondary market. Further, Lerner, Sorensen, and Strömberg (2011) find that Leveraged buyout firms generate more important patents.

On the other hand, underpricing may limit creativity. IPO underpricing is a way of minimizing the impact of information asymmetry on new issues or a result of the prevalence of irrational investors in the market. Underwriters or managers neither realize underpricing may be an urgent strategy to reduce the effect of information asymmetry or irrational investors nor gives the priority to a firm's long-term survival. An executive survey conducted by Graham, Harvey, and Rajgopal (2005) finds that Chief Financial Officer (CFOs) are frequently willing to sacrifice long-term sustainability to meet short-term earnings targets. Bancel and Garel (2015) state that managerial myopia is detrimental to long-term investors and harms long-term competitiveness, but only generates an immediate return. Ridge, Kern, and White (2014) state that myopia has an impact on corporate strategy. In this way, underpricing is harmful to a company's capacity for innovation if managers are just concerned with short-term profit. When resources are primarily committed to resolving IPO difficulties, there won't be enough left over to develop a firm's core competency. So I also question whether IPO underpricing hinders a company's expansion. Therefore, studying underpricing is of great importance to a firm's innovation productivity, and success.

I focus on China's Growth Enterprise Market (GEM), ranking only to the main board market, which assists new and innovative private corporations, especially high-technology firms to raise funds. It implements low barriers to entry but strict regulation. Although it has a short history, this board, which is quite comparable to NASDAQ, helps high-tech, high-growth, but small in size to incubate science and technology. I believe that GEM more accurately embodies the innovation notion, and this paper could reveal how the innovation concept is applied to GEM.

This paper first investigates the relationship between the level of underpricing and innovation productivity. But OLS is difficult to test such a relationship because a firm's innovation occurs not just following IPO, but before or simultaneous with IPO. Hence, in order to establish causality between underpricing and the number of patents, I then apply Difference-in-Difference (DiD) methodology to compare the innovation productivity preceding and following IPO. In detail, it will compare the innovation productivity of a sample of treatment firms whose underpricing is most severe to that of control firms whose underpricing is least severe, before and after IPO. In addition, different industries have various innovation productivity (Fang, Noe, & Tice, 2009). For example, innovation output in the pharmaceutical business is far more challenging than it is in the electrical engineering industry. The innovation productivity in various industries is also influenced by government industrial policy over time. More testing will therefore be expanded to include industry aspects and policy.

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My paper's main contribution is to shed a light on underpricing. To the best of my knowledge, this paper is the first in the literature to address the relationship between IPO underpricing and innovation productivity. The question of whether underpricing can impede or improve innovation productivity is of great importance to investors and managers. It will advance our understanding of IPO underpricing and may reverse our stubborn impression of IPO underpricing. It will also answer the question of whether IPO underpricing is a passive defense or an active firm's strategy.

The rest of the paper is organized as follows. Section II describes the sample, measurement of variables, and descriptive statistics. Section III presents the main results by using the OLS tests and the DiD application. Section IV concludes.

2. Sample, Measurement of Variables, and Descriptive Statistics

2.1. Sample

I obtain GEM-listed firms' IPO information from the WIND database. Because I am going to investigate the patenting activity up to three years following IPO, my sample period spans from the opening of GEM, October 9, 2009, to January 2017. The number of observations is 793. Based on the IPO dates, I also obtain the firm-year patent from the National Intellectual Property Administration (NIPA). All other control variables are obtained from the WIND database and China Stock Market & Accounting Research Database (CSMAR).

2.2. Measurement of Variables

I investigate the relationship between underpricing and innovation productivity. First, underpricing is calculated as the difference between the offer price and the first-day closing price, thus, is calculated as the first-day return. I also use the market return to adjust the underpricing. Therefore, it is calculated as follows:

$$IPO\ underpricing\ (IPO\ first\ day\ return) = [(closing\ price_{t} - offer\ price_{t-1})/offer\ price_{t-1} - (market\ closing\ index_{t} - market\ closing\ index_{t-1})/market\ closing\ index_{t-1}]/(market\ closing\ index_{t}/market\ closing\ index_{t-1}) \quad (1)$$

where t denotes the dates of IPO. A positive value indicates underpricing, while a negative value indicates overpricing.

Second, in line with Seru (2014) and Lerner et al. (2011) I measure innovation using a company's patenting activities. The National Intellectual Property Administration (NIPA) provides data on patent assignee names, total patent numbers, application and award years, and other specifics. Since there is always a lag between the application year and grant year, I follow (Griliches, Pakes, & Hall., 1986) and use the application year rather than the grant year to better capture the productivity of innovation. I measure innovation productivity one, two, and three years after the first public offering, respectively. I also acquire data on IPO and patenting activity in one, two, and three years in order to capture the variation in the number of patents before and after IPO.

Third, following (Fang et al., 2009) I also control for a vector of the firm and industry characteristics that could affect a firm's innovative capability. All variables are computed for firm i through its fiscal year t. Variables include firm size(*LN_MKT*), which is determined by the natural logarithm of firm market capitalization rather than firm book value because market capitalization more accurately reflects a firm's real value; return on asset(*ROA*); fixed assets(*LN_ASSET*); leverage (*LEV*), measured by debt-to-asset; growth opportunity(*Tobin's Q*); firm age(*LN_AGE*), measured by the natural Logarithm of the difference between the formation date and the IPO date; industry competition(*HHI*), measured by the Herfindahl and *C04/C10* indexes based on the operating income. The squared *HHI* and *C04/C10* are also included to reduce the nonlinear effects.

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Table 1.
Variables definition, summary statistics, and patents by industry.

Panel A: Variables Definition

Variable	Definition
$PATENT_{t+n}$	Natural logarithm of firm *i*'s total number of patents filed (and finally granted) in year *t*+1, *t*+2, *t*+3, respectively.
$Underpricing_t$	The difference between the offer price and the first-day closing price, and adjusted by market return.
LN_MKT_t	Natural logarithm of firm *i*'s market value, measured at the end of fiscal year *t*.
ROA_t	Return on assets, measured at the end of fiscal year *t*.
LN_ASSET_t	Natural logarithm of firm *i*'s total fixed asset, measured at the end of fiscal year *t*.
LEV_t	Firms *i*'s leverage ratio of the book value of debt to total assets, measured at the end of fiscal year *t*.
TOBIN'S Q	Firm *i*'s ratio between market value and replacement value, measured at the end of fiscal year *t*.
LN_AGE_t	Natural logarithm of firm *i*'s age, measured as the difference between a firm's formation date and IPO date.
HHI_t	Herfindahl index, measured at the end of fiscal year *t*.
HHI^2_t	The square of HHI_t.
$C04_t$	Defined as the market share of 4 biggest firms in each industry, measured at the end of fiscal year *t*.
$C04^2_t$	The square of $C04_t$
$C10_t$	Defined as the market share of the 10 biggest firms in each industry, measured at the end of fiscal year *t*.
$C10^2_t$	The square of $C10_t$

Panel B: Summary Statistics

Variable	5%	25%	50%	Mean	75%	95%	SD	N
$PATENT_{t+1}$	0	0	1.610	1.610	2.773	3.989	1.473	600
$Underpricing_t$	-0.050	0.194	0.426	0.386	0.449	0.848	0.301	600
LN_MKT_t	21.140	21.682	22.187	22.267	22.685	23.813	0.806	600
ROA_t	4.932	7.334	9.58	10.144	12.479	17.508	4.104	600
LN_ASSET_t	15.738	17.270	18.113	17.967	18.768	19.678	1.211	600
LEV_t	3.946	8.941	15.300	19.203	26.820	46.517	13.186	600
TOBIN'S Q	1.062	1.352	1.781	2.107	2.296	4.163	1.313	600
LN_AGE_t	1.761	2.133	2.381	2.388	2.651	3.000	0.377	600
HHI_t	0.009	0.015	0.016	0.104	0.134	0.459	0.154	600
$C04_t$	0.126	0.168	0.173	0.332	0.519	0.738	0.241	600
$C10_t$	0.216	0.273	0.278	0.441	0.692	0.877	0.248	600

Panel C: Number and Percentage of Firms with and without Patents by Industry					
SRCICS	**Industry Name**	**Description**	**Firms with Positive Patents**	**Firms with Zero Patents**	**Total No. of Firms**
1	Energy	Oil, gas, and coal extraction and products	4(100%)	0(0%)	4
2	Communication	Publishing, movie, television, data collecting, and other cultural products	3(16.7%)	15(83.3%)	18
3	Utility	Utilities	0(0%)	1(100%)	1
4	Construction	construction	4(50%)	4(50%)	8
5	Transportation	Transportation, storage	0(0%)	2(100%)	2
6	Finance	Finance, insurance, and other financial institution	1(100%)	0(0%)	1
7	Agriculture	Agriculture, forestry, animal husbandry, and fishing	2(40%)	3(60%)	5
8	Wholesale and retail	Retail, mines, materials, tobacco, food, and other consumer nondurables	2(33.3%)	4(66.7%)	6
9	Service	healthcare, advertisement, consultant, research	15(48.4%)	16(51.6%)	31
10	Information science	Computer, telecommunication, and products	84(56.8%)	64(43.2%)	148
11	Manufacturing	Manufacturing (machine, metal, chemical, food, medicine, printing	263(70.1%)	112(29.9%)	375

Note: Panel A provides definitions for the variables I use in this paper. Panel B reports summary statistics for variables constructed from a sample of firms listed in China GEM. Underpricing is measured from the opening of GEM till the end of February 2017 to obtain up-to-three-year information following IPO. Panel C reports the number and the percentage of firms that have at least one patent or zero patents over the period (-3, +3) in each industry. In Panel C, industries are classified following the Securities Regulatory Commission Industry Classification system.

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2.3. Descriptive Statistics

Panel A of Table 1 defines the variables used in this paper. Panel B of Table 1 presents the summary statistics for my main variables. After removing the missing variables, the total sample size was decreased to 600 because I need to run the experiments before and after IPO for up to three years. The number of patents applied one year after IPO ranges from 0 to 6.011. The average number is 1.610. Underpricing is a popular phenomenon in GEM, although some firms have negative values for underpricing. The average underpricing for firms listed in GEM is 0.386. The table also shows an average firm that has a market capitalization of Renminbi (RMB) 4.7 billion, ROA of 10.14%, a fixed asset of RMB 63.5million, leverage of 19.203, Tobin's Q of 2.107, and age of 10.89 years. I also find the average industry competition is 0.104 for HHI, 0.332 for C04, and 0.441 for C10.

Panel C of Table 1 reports the number and the percentage of firms with and without patents by industry. Following Securities Regulatory Commission Industry Classification System (SRCICS), I discover that, with two exceptions in the Utility and Transportation sectors, nine out of eleven industries include firms with positive patents. Amongst 16.7% and 100% of companies have non-zero patents, with significant differences between industries.

3. Empirical Evidence

3.1. OLS Specification

In order to test whether underpricing promotes or impedes corporate innovations, I estimate:

$$PATENT_{i,t+n} = \alpha + \beta Underpricing_{i,t} + \gamma CONTROLS_{i,t} + \varepsilon_{i,t} \quad (2)$$

where *i* denotes firms, *t* denotes the dates of IPO, and *n* equals one, two, and three. Corporate innovation is measured as the natural logarithm of the number of patents filed and finally approved (*PATENT*). The coefficient of *Underpricing* indicates the effect of IPO underpricing on the dependent variable—*PATENT*. The vector *CONTROLS* including the variables I discuss above capture firm and industry characteristics that may influence a firm's innovative capability.

Column (1) of Table 2 reports the results of the effect of underpricing on the number of patents filed (and finally approved) in one year. The coefficient estimate on *Underpricing* is negative and statistically significant. The number of patents will decrease by 0.387% for every one percent increase in underpricing. The coefficient estimates are still significantly negative when I replace the proxy for HHI with C04 and C10, as shown in columns (2) and (3). Columns (4)–(6) report the result of the effect of underpricing on the number of patents in the two years following the IPO. When I use HHI, C04, and C10, respectively, it shows that a 1% rise in underpricing will result in a reduction of 0.362%, 0.350%, and 0.341% in the number of patents in two years. Such an effect will reduce more as I prolong the test window to three years and is not significant anymore.

Two findings emerge. First, underpricing has a negative impact on the innovation productivity of GEM-listed companies. A higher amount of underpricing will result in fewer patents, which suggests that underpricing is more likely an immediate effect of information asymmetry or irrational investors than a company strategy intended to improve performance. To get an instant return, there will be a significant reduction in innovation investment under managerial myopia. Second, such a relationship disappears and turns insignificant after three years following IPO. It suggests that after participating more in the capital market, managers and stockholders are less myopic than startup executives since they now focus on the company's long-term survival and expansion. They also realize the core ability of a firm is innovation. Additionally, the complexity of the capital market fosters a variety of factors that have equivocal consequences on the capacity for innovation.

Table 2.
OLS specifications.

Innovations Measured by *PATENT*									
Dependent Variables	**(1) *$PATENT_{i,t+1}$***	**(2) *PATENTi,t +1***	**(3) *PATENTi,t +1***	**(4) *PATENTi,t +2***	**(5) *PATENTi,t +2***	**(6) *PATENTi,t +2***	**(7) *PATENTi,t +3***	**(8) *PATENTi,t +3***	**(9) *PATENTi, t+3***
$Underpricing_t$	-0.387** (0.196)	-0.372* (0.196)	-0.362* (0.196)	-0.362* (0.197)	-0.350* (0.197)	-0.341* (0.197)	-0.182 (0.179)	-0.168 (0.179)	-0.160 (0.180)
LN_MKT_t	-0.120 (0.080)	-0.126 (0.081)	-0.123 (0.081)	-0.136* (0.081)	-0.137* (0.081)	-0.142* (0.081)	-0.124* (0.073)	-0.124* (0.074)	-0.133* (0.074)
ROA_t	0.046*** (0.016)	0.045*** (0.016)	0.045*** (0.016)	0.034** (0.016)	0.033** (0.016)	0.033** (0.016)	0.043*** (0.014)	0.040*** (0.014)	0.041*** (0.014)
LN_ASSET_t	0.074 (0.057)	0.073 (0.057)	0.073 (0.056)	0.084 (0.057)	0.092 (0.057)	0.089 (0.057)	0.023 (0.052)	0.032 (0.052)	0.030 (0.052)
LEV_t	0.015*** (0.005)	0.015*** (0.005)	0.015*** (0.005)	0.013*** (0.005)	0.013*** (0.005)	0.014*** (0.005)	0.018*** (0.005)	0.018*** (0.005)	0.019*** (0.005)
TOBIN'S Q	0.031 (0.047)	0.031 (0.047)	0.030 (0.047)	-0.001 (0.047)	-0.002 (0.047)	-0.004 (0.047)	0.013 (0.043)	0.010 (0.043)	0.008 (0.043)
LN_AGE_t	0.336** (0.163)	0.341** (0.163)	0.333** (0.163)	0.407** (0.164)	0.407** (0.164)	0.410** (0.164)	0.477*** (0.149)	0.477*** (0.149)	0.483*** (0.149)
HHI_t	-2.565** (1.218)			-1.740 (1.221)			-1.776 (1.111)		
HHI^2_t	2.916 (2.366)			0.914 (2.372)			0.525 (2.159)		
$C04_t$		-1.960 (1.412)			-0.012 (1.418)			0.260 (1.291)	
$C04^2_t$		1.298 (1.542)			-0.850 (1.548)			-1.298 (1.409)	
$C10^2$			-1.707 (1.888)			-0.306 (1.896)			-0.286 (1.727)
$C10^2_t$			0.821 (1.708)			-0.419 (1.716)			-0.525 (1.563)
INTERCEPT	1.641 (1.850)	2.035 (1.904)	2.108 (1.973)	1.788 (1.855)	1.676 (1.911)	1.909 (1.982)	1.910 (1.688)	1.726 (1.739)	2.072 (1.806)
Number of obs.	600	600	600	600	600	600	600	600	600
Adjusted R^2	0.061	0.062	0.063	0.067	0.065	0.065	0.097	0.095	0.093

Note: Table 2 reports the OLS regression results of the model: $PATENT_{i,t+n} = \alpha + \beta Underpricing_{i,t} + \gamma CONTROLS_{i,t} + \varepsilon_{i,t}$. The dependent variable is PATENTi,t+1 in column(1)-(3), which is replaced with PATENTi,t+2 and PATENTi,t+3 in column (4)-(6) and (7)-(9), respectively. Standard errors are displayed in parentheses below. ***, **, and * significance at the 1%,5% and 10% two-tailed level.

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3.2. Difference-in-Difference Tests with Underpricing Subsamples

The aforementioned findings demonstrate how IPO underpricing hinders company innovation. The amount of patents applied after an IPO, however, cannot account for the reason for an IPO if patenting activity is ongoing during the whole life of a company. As a result, I use the Difference-in-Difference (DiD) methodology to establish a causal link between underpricing and innovation productivity and determine if the change in innovation productivity is the result of IPO underpricing. I construct two groups: one with underpricing that is less than average and another with underpricing that is more than average. I first calculate the difference in the number of patents before IPO and after IPO for each of the two groups; then I compare the difference between the two groups, which I called DiD methodology.

Panel A of Table 3 provides definitions of the new variables used in Table 3. Panel B presents the summary statistics of underpricing in the top and bottom subsamples. Top firms are those whose underpricing level is higher than the average level, while bottom firms have underpricing levels that are lower than normal. As can be seen, for the 235 firms in the bottom subsample, underpricing spans from -0.159 to 0.383, whereas there are 365 observations in the top subsample, showing that more than half of the firms exhibit very severe underpricing. Panel C presents the coefficient estimates. Dummy variable *D* is 1 for firms in the bottom group, and 0 for the top group. Column (1) reports the average change in the number of patents (denoted *D_PATENT*) in the bottom subsamples. These metrics are calculated by first deducting the total number of patents over the three years prior to the initial public offering from the number of patents during the three years after the initial public offering. The difference is then averaged over the total number of firms. Similarly, for column (2) I calculate the differences in top subsamples. Columns (3) and (4) provide the difference estimator and the corresponding t-statistics. I find first, the innovation productivity of both subsamples increases after IPO, which suggests that firms going public could increase the investment in innovation and improve innovation productivity. Second, the increase in innovation productivity is larger for the bottom group than for the top group as the difference estimators are both positive and statistically significant at 1% level. The magnitude suggests that, on average, IPO underpricing resulted in an increase of approximately 0.555 patents for the bottom group than for the top group during the three years following IPO in comparison to the three years prior to IPO. This is consistent with the results in Table 2 that underpricing is negatively correlated with the number of patents.

Figure 1 depicts the number of patents for the top and bottom samples over (-3, +3) window. The number of patents for businesses with various levels of underpricing is shown by the vertical lines. Both groups show an upward trend, demonstrating that the increased IPO activity supports the patenting activity. Furthermore, the line is much steeper for the lowest group than for the top groups, which is consistent with the finding in Table 2 and suggests that IPO underpricing prevents the growth in the number of patents.

Panel D reports the DiD result. The dependent variable is *N_PATENT*, which is the firm *i*'s number of patents in a given year. $Before^{-1}$ is 1 if a firm-year observation is from one year before IPO. $After^{1,2,3}$ states a firm-year observation is from one, two, or three years following IPO. Standards errors are given below. The coefficient estimates of $D*Before^{-1}$ and $D*After^{1,2,3}$ are positive, but insignificant for $D*Before^{-1}$ and significant for $D*After^{1,2,3}$, which means there is no significant difference between the two groups before IPO, but after IPO, the bottom group with less severe underpricing generates a larger number of patents than the top group with greater underpricing.

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Table 3.
Variables definition, underpricing by levels, and DiD tests.

Panel A New Variables Definition Variables	
Variables	Definition
D_PATENT	Calculated by first deducting the total number of patents over the three years prior to the initial public offering from the number of patents during the three years after the initial public offering. The difference is then averaged over the total number of firms.
N_PATENT	Firm *i*'s number of patents in a given year.
$Before^{-1}$	A dummy that equals one for a firm-year observation is from one year before IPO.
$After^{1,2,3}$	A dummy that equals one for a firm-year observation is from one, two, or three years after IPO.
D	A dummy that equals one for bottom firms with lower-than-average underpricing, and zero for firms with greater-than-average underpricing.

Panel B Summary Statistics for Underpricing					
Subsamples	MIN	MEAN	MAX	STD	Number of obs.
BOTTOM	-0.159	0.135	0.383	0.144	235
TOP	0.393	0.547	2.502	0.262	365

Panel C Difference-in-Difference Tests				
	(1) D=1	(2) D=0	(3) (1)-(2)	(4) T-statistics
D_PATENT	1.536 (0.022)	0.981 (0.026)	0.555*** (0.220)	-2.530

Panel Difference-in-Difference Analysis for Patents	
Dependent Variables	*N_PATENT*
$D*Before^{-1}$	0.060 (0.152)
$D*After^{1,2,3}$	0.210* (0.113)
$Before^{-1}$	0.182* (0.095)
$After^{1,2,3}$	0.386*** (0.071)
D	-0.323*** (0.088)
INTERCEPT	1.529*** (0.055)
Number of obs.	3,600
Adjusted R^2	0.024

Note: In Table 3, firms are sorted into two groups according to underpricing levels. The top group is defined as the firms with greater-than-average underpricing, while the bottom group is defined as the firms with lower-than-average underpricing. Dummy variable D is 1 for the bottom group and 0 for the top group. Panel A provides definitions of the new variables used in Table 3. Panel B reports minimum, mean and maximum values of underpricing in the top and bottom samples. In Panel C, I calculate the difference in the sum of the firm i' s number of patents in the three-year window before and after the IPO. I also compare the difference between the two groups. Standard errors are given in parentheses below. Panel D reports the OLS regression results of the model: $N\_PATENT_i = \alpha + \beta D * Before^{-1} + \delta D * After^{1,2,3} + \phi Before^{-1} + \gamma After^{1,2,3} + \lambda D + \varepsilon$ Standard errors displayed in parentheses below. ***, * significance at the 1%, and 10% two-tailed level.

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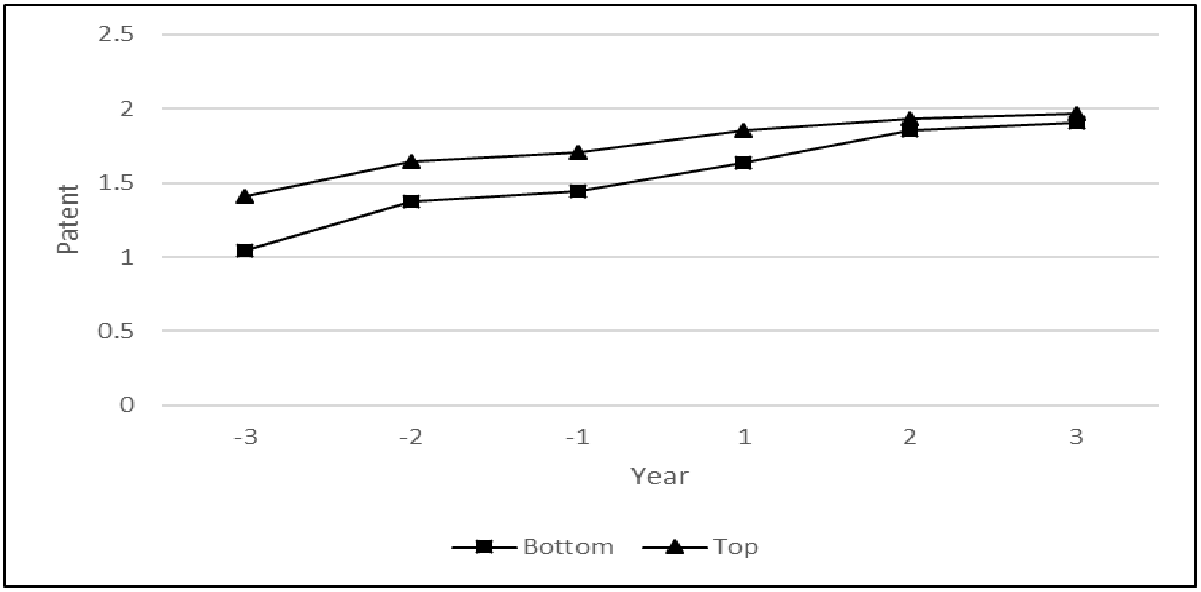

Figure 1.
Number of patents surrounding IPO.

This figure shows the average innovation productivity indicated by the number of patents for top and bottom firms, from three years before IPO to three years after IPO. The sample comprises 235 bottom firms and 365 top firms.

3.3. Within-Industry Regression

According to previous industry classifications, some firms may have more or fewer patents in a particular industry. Because of this, I look into the relationship within each of the industry groups to see if any particular industries are responsible for the inverse relationship between underpricing and innovation. However, due to the limited number of observations in each industry, I only focus on communication, service, information science, and manufacturing four industries. Table 4 presents the results. The coefficients are positive for the communication industry, while negative for the other three industries, but insignificant for all. The findings show that the inverse relationship between IPO underpricing and innovation productivity cannot be attributed to industry characteristics.

Table 4.
Within-industry regression.

SRCICS	**Industry Name**	**Description**	***$PATENT_{i,t+1}$***	**Number of obs.**
2	Communication	Publishing, movie, television, data collecting, and other cultural products	0.003 (0.292)	18
9	Service	healthcare, advertisement, consultant, research	-0.044 (1.173)	31
10	Information science	Computer, telecommunication, and products	-0.747 (-1.650)	148
11	Manufacturing	Manufacturing (machine, metal, chemical, food, medicine, printing	-0.213 (-0.264)	375

Note: This table reports the coefficient on the underpricing from OLS regression estimates of the model $PATENT_{i,t+1} = \alpha + \beta Underpricing_{i,t} + \gamma CONTROLS_{i,t} + YR_t + FIRM_i + \varepsilon_{i,t}$ within each industry. The Underpricing coefficient estimates are shown, and standard errors are also reported in parentheses below.

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3.4. Difference-in-Difference Tests with IPO Suspension

As mentioned above, my concern is that there may be some unobservable shock that may affect the relationship between underpricing and the number of patents. In past years, the government carries a series of IPO suspensions since the launch of the IPO, and among which, 2013 is an important year in which there is no IPO issued on any boards. In order to avoid shocks from IPO suspension, I further investigate the effects of underpricing on innovation productivity for both pre-2013 and post-2013 periods. Panel A of Table 5 indicates that the post-2013 firm group exhibits more serious underpricing than the pre-2013 firm group; however, this could be due to the smaller size of the post-2013 sample. The dummy variable equals 1 for firms listed before 2013, and 0 otherwise. In Panel B, I find first, the innovation productivity of both subsamples increases after IPO, which is consistent with my previous conclusion that going public could improve innovation productivity. Second, the increase in innovation productivity is larger for the pre-2013 group than for the post-2013 group as the difference estimate is both positive and statistically significant at 1% level. For companies listed before 2013 as opposed to after 2013, the 2013 IPO suspension causes a rise of around 0.981 more patents in the three years following the IPO in comparison to the three years prior to the IPO. This implies that an IPO suspension strategy does not help a company's survival or growth. In Panel C, the coefficient estimates of $D^*Before^{-1}$ and $D^*After^{1,2,3}$ are positive, but insignificant for $D^*Before^{-1}$ and significant for $D^*After^{1,2,3}$, which means compared to the post-2013 group, the pre-2013 group with smaller underpricing generates a larger number of patents. The results are consistent with Figure 2, which exhibits a steeper trend in the number of patents for firms listed before 2013.

Table 5.
Underpricing before- and after 2013 and DiD tests.

Panel A: Summary Statistics for Underpricing

Subsamples	**MIN**	**MEAN**	**MAX**	**STD**	**Number of obs.**
Pre-2013	-0.159	0.345	2.065	0.370	354
Post-2013	0.170	0.444	2.502	0.135	246

Panel B: Difference-in-Difference Tests

	(1) D=1	(2) D=0	(3) (1)-(2)	(4) T-statistics
D_PATENT	1.600 (0.022)	0.619 (0.026)	0.981*** (0.215)	-4.558

Panel C: Difference-in-Difference Analysis for Patents

Dependent Variables	N_PATENT
$D^*Before^{-1}$	-0.175 (0.149)
$D^*After^{1,2,3}$	0.229** (0.111)
$Before^{-1}$	-0.238** (0.093)
$After^{1,2,3}$	0.207*** (0.070)
D	-0.673*** (0.086)
INTERCEPT	1.836*** (0.054)
Number of obs.	3,600
Adjusted R^2	0.006

Note: Panel A reports minimum, mean and maximum values for underpricing in pre-2013 and post-2013 subsamples. In Panel B, I calculate the difference in the sum of the firm i' s number of patents in the three-year window before and after the IPO. I also calculate the difference in the number of patents between the two subsamples. Standard errors are given in parentheses below. Panel C reports the OLS regression results of the model: $N\_PATENT_i = \alpha + \beta D * Before^{-1} + \delta D * After^{1,\ 2,\ 3} + \phi Before^{-1} + \gamma After^{1,\ 2,\ 3} + \lambda D + \varepsilon$. Standard errors are displayed in parentheses below. ***, **, and * significance at the 1%,5%m and 10% two-tailed level.

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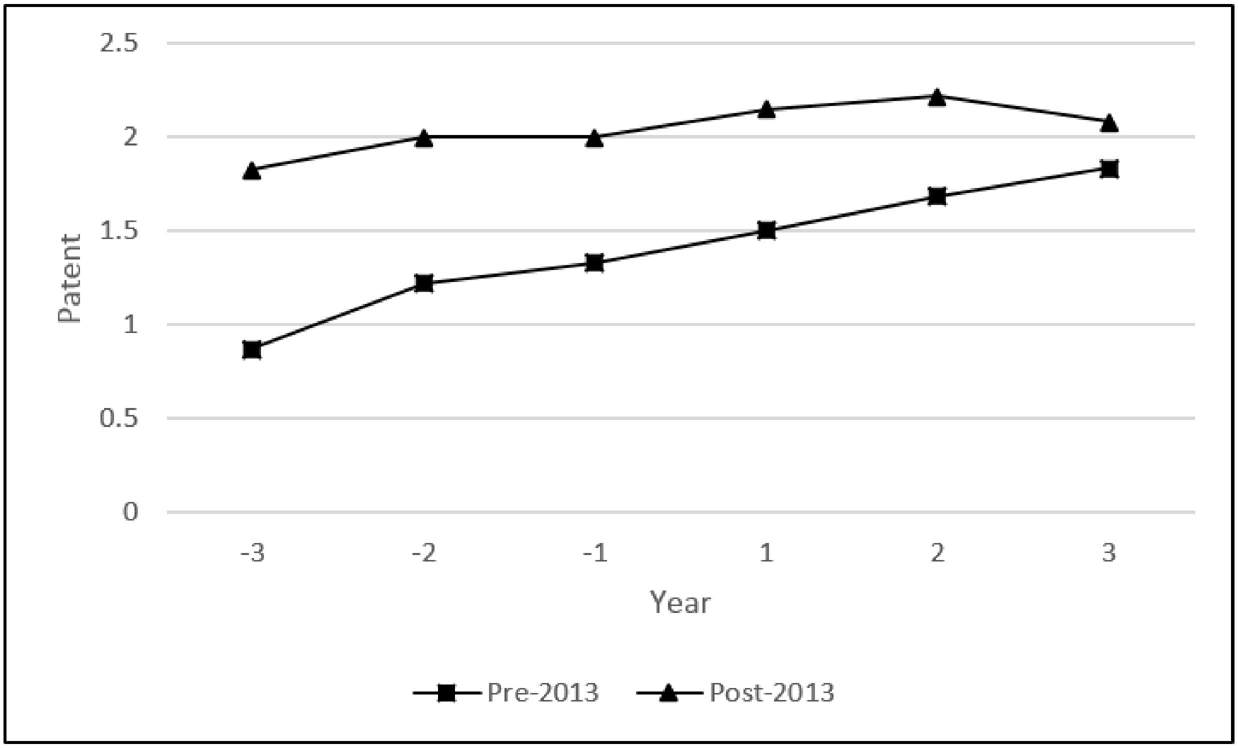

Figure 2.
Number of patents surrounding IPO.

This figure shows the average innovation productivity indicated by the number of patents for firms listed before 2013 and after 2013 in the three-year window before IPO and after IPO. The sample comprises 354 pre-2013 firms and 246 post-2013 firms.

4. Conclusion

My OLS empirical evidence shows that underpricing is negatively correlated with patenting activity. Initially, managers or underwriters only care about the immediate return and capital accumulation from IPO, rather than a firm's future growth. Managerial myopia is detrimental to a firm's long-term survival and development. As I prolong the test window up to three years, it shows that the negative relationship between underpricing and the patenting activity disappears. Explanation might be that after being allocated sufficient capital, managers turn to realize the core ability of a firm and innovation ability is the key to its success.

To build causality between underpricing and the number of patents, I apply DiD methodology to compare the difference in the number of patents between the three-year window before IPO and after IPO. The results show that firms with greater-than-average underpricing generate a smaller increase in the number of patents after IPO than firms with lower-than-average underpricing. To avoid unobservable shock, I also investigate whether industry and IPO suspension could influence innovation productivity. The results show that while industry characteristics cannot explain the relationship between underpricing and innovation productivity, IPO policy produces a greater number of patents following IPO for firms listed before 2013 than for firms listed after 2013.

My findings do not support underpricing is an active strategy, but we cannot deny that going public could increase capital and innovation investment. Our further investigation could focus on the mechanism through which underpricing influences innovation productivity.

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