Investor Type and Innovative Performance: Regional Characteristics as a Moderating Variable

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Abstract. Start-ups require external investment to accelerate growth and scale up their businesses. Many works of literature discussed the types of investors and their influence on start-up innovation performance. However, previous literature neglected the influence of the regional characteristics of each start-up. This regional characteristic is significant as a moderating factor for start-ups with high dependency on technologies because of the protection of property rights. To fill the gap, this study investigated the impact of investor type on innovation performance by distinguishing regional characteristics as an essential factor in improving start-ups' innovation performance. In measuring the innovation performance of a start-up, this study used intellectual property rights that consisted of a number of effective patent and trademark registered. From the Crunchbase database, this study employed 5,172 enterprise-level data of start-ups. Using systematic random sampling, 358 data were acquired to test the hypotheses. The regression results showed that the investor type (incubator, accelerator, angel, and venture capital) significantly promoted innovative performance. In addition, the result showed a more significant impact on the regional characteristic with higher protection of property rights.

Keywords: Start-up · Investor Type · Venture Capital · Regional Characteristic · Incubator · Accelerator · Angel · Innovative Performance

1 Introduction

Start-ups require external investment to accelerate growth and scale up their businesses. Lack of capital becomes the leading cause of start-up failure. The funding is used by start-ups for business growth [1, 2], increasing business scale [3, 4], promoting innovation [5], and also achieving innovation performance [6, 7].

Several types of investments are usually given to start-ups: angel investors, incubators, accelerators, and venture capital. Angel investors are wealthy individuals who fund early-stage or small start-ups [8]. Meanwhile, the incubator model helps start-ups

R. Hurriyati et al. (Eds.): GCBME 2022, AEBMR 255, pp. 1642–1652, 2024.
https://doi.org/10.2991/978-94-6463-234-7_172

design their business models and manage their long-term ideas [9]. Accelerators function to accelerate growth, usually in the short term [10]. Finally, venture capital is a prominent source of funds for start-ups to innovate, especially in late venture capital [11]. Compared to other types, venture capital focuses more on mature start-ups by facilitating new products or services development using technology.

Related to technological developments, many studies discuss the effect of the types of investors on start-up innovative performance. For example, venture capital funding [12], incubator [13], accelerator [6], diversified angel investment [14] affected innovative performance. However, previous literature neglected the influence of regional characteristics related to the protection of property rights.

This study analyzed the investment type of different start-ups and locations by measuring their innovation performance using the longitudinal data of start-ups. The measurement of innovation performance requires the intellectual property owned by start-ups. The intellectual property (IP) is represented patents granted and registered trademarks. High-tech start-ups require the protection of property rights based on geographical location. The previous study found that investment types promoted more innovation performance on venture capital, incubators, and accelerators [6, 12, 13] and angel investors as additional factors in influencing innovation performance [14]. However, this study contributes distinct factors of investment type acquired by start-ups, the technology intensity factor, and regional characteristics in moderating the relationship between investment type and innovation performance.

1.1 Research Hypothesis

Investor type and innovation performance

Previous studies identified that investor type influenced innovation [15]. In comparison, some researchers focused on each type of investor, where venture capital [12], incubator [13], accelerator [6], and diversified angel investment [14] affected innovation performances.

Venture capital positively correlated with innovation [12]. This effect occurred both in the early stage of venture capital [16–18] and in the late stage of venture capital [19] There are two reasons why venture capital can promote innovation more than traditional investment models. First, venture capital focuses on long-term investment in start-ups that effectively reduce underinvestment of firms' research and development [20], effectively reduce costs of external financing costs, and will promote innovation performance [21]. Second, venture capital provides value-added services for companies, and it may go to the board of directors to oversee the company [22]. Based on the analysis above, the hypothesis of H1 is:

H1. Venture capital investments will promote start-ups' innovation performance.

Other studies argued that the incubator model positively correlated with innovation performance [13]; the accelerator model positively correlated with innovation performance [6]; and the diversified angel investment [14] affected innovative performance. Thus, the hypothesis of H2, H3, and H4 are:

H2. Incubator model investment will promote start-ups' innovation performance.
H3. Accelerator model investment will promote start-ups' innovation performance.
H4. Diversified angel investment will promote start-ups' innovation performance.

1.2 Influence of High-Tech Intensity

Literature in financial and innovation generally claims that investments encourage the growth of high-technology firms [23]. Reasons for the use of high-intensity technology are very likely to be financially constrained [24] and there is venture capital specifically for high technology [23] and the intensity of innovations is expected to increase rapidly.

Based on the analysis above, the hypothesis H5 is:

H5. For start-ups with higher dependence on technology, investor types play a more significant role to promote start-ups' innovation performance.

1.3 Influence of the Regional Characteristic

Location is essential for start-ups to get the resources they need to grow more efficiently. Resources such as income, talent, capital, and advice are acquired from customers, suppliers, employees, mentors, and investors. The success or failure of a start-up depends largely on the existence of these stakeholders and their relationships. Moreover, another important factor is the location of the start-up. By choosing the right location, the start-up gets the resources it needs to grow. Researchers have widely studied customer, supplier, employee, and mentor factors. However, very few discussed regional characteristics based on copyright protection. Many start-ups rely on key intellectual property (IP) for doing business. For example, trademarks are used to identify the source of a product or service, while patents are related to new inventions. However, IP needs some protection. Because IPs are territorial, this study assumed that start-ups will seek IP protection for their innovations within the country.

The H5 hypothesis emphasizes that venture capital is more likely to make high-tech industry investments, while intellectual property as a result of innovation from the use of high technology requires more legal protections. Previous studies have shown that protection and enforcement of intellectual property rights could effectively improve investment efficiency. As a result, it is necessary to identify the effect of IP protection in various countries on investment for start-ups. This study used an average index of patent rights from 1960–1965 [25] (see Table 1) to measure the degree of protection. Thus, the hypothesis H6 is put forward:

H6. In the areas with a higher degree of IP protection, investor types play a more significant role to promote the innovation performance of start-ups.

2 Method

2.1 Research Design

This study tested the previous hypotheses with an empirical model through longitudinal data at the enterprise level. The model to test the hypotheses is:

$$\text{Innovation}_j = \alpha_0 + \alpha_1 \text{FS}_j + \text{CONTROLS}_j + \mu_j \quad (1)$$

Table 1. Sample based on countries and Ginarte and Park index

No	Country	Sample	Average	2015
1	United States	161	4.88	4.14
2	United Kingdom	18	4.54	3.2
3	China	16	4.08	1.33
4	Poland	5	4.21	1.38
5	Italy	13	4.67	3.16
6	Brazil	2	3.59	1.22
7	Canada	16	4.67	3
8	Finland	4	4.67	2.64
9	France	17	4.67	3.29
10	Germany	19	4.50	3.24
11	Hong Kong	2	3.81	2.44
12	Portugal	1	4.38	1.48
13	Spain	9	4.33	2.74
14	Sweden	5	4.54	2.86
15	The Netherlands	4	4.67	3.43
16	Chile	1	4.28	2.04
17	Czech Republic	3	4.33	3.5
18	Australia	8	4.17	2.35
19	Norway	2	4.17	2.75
20	Austria	5	4.33	2.96
21	Iceland	1	3.51	1.67
22	Ireland	4	4.67	2.15
23	Japan	12	4.67	2.93
24	Singapore	9	4.21	1.64
25	South Korea	7	4.33	2.55
26	Taiwan	2	3.74	1.26
27	Belgium	1	4.67	3.39
28	India	8	3.76	1.03
29	Luxembourg	1	4.14	2.16
30	Mexico	1	3.88	1.19
31	Denmark	1	4.67	2.88
		358		4.14

Table 2 represents the definition of all variables, and among them, j represents the start-up.

For the test of hypotheses H1 to H4, the empirical model is:

$$\begin{aligned}\text{Innovation}_j = &\alpha 0 + \alpha 1\text{VCj} + \alpha 2\text{INCUBATORj} + \alpha 3\text{ACCELERATORj} \\ &+ \alpha 4\text{ANGELj} + \text{CONTROLSj} + \mu j \end{aligned} \quad (2)$$

This study divided the sample into two parts according to start-ups' dependence on high technology intensity. The first part of the sample is a high sub-sample that consists of start-ups with a higher degree of dependence on technology. The other is a low sub-sample. The method for calculating start-up dependence on high technology intensity is as follows: 1) determine the technology ratio, resulting from the division of technology spending with the total funding obtained; 2) determine the average technology ratio of all start-ups (the average yield is 50.71%), and 3) determine the start-ups with high technology-intensity dependence whose technology ratio is above 50.71%. Thus, start-ups with a high-tech ratio above 50.71% are a high sub-sample, and the others are a low sub-sample of high-tech intensity. For testing the hypothesis of H5, this study performed a regression model (2) on each sub-sample.

2.2 Measurement of Innovation Performance

According to the previous literature, the measurement of innovation performance used indicators of the number of patents granted [26], trademarks registered [27] and the success of a company's new products and services.

2.3 Data Source

This study considers a subset of all funding statuses available in Crunchbase that consists of 5,161 active start-up companies. The criteria of the filter are first, eliminating exit funding status (IPO, Merger and Acquisition), and second, eliminating private equity. This elimination results in 3.361 start-ups with non-exit funding status. Using systematic random sampling, 358 data were acquired to test the hypotheses. Table 2 shows descriptive statistics of the variables. All data used in this study were obtained from longitudinal data from Crunchbase Database. Crunchbase is a site that contains data on significant companies and start-ups. As of May 20, 2022, 25,747 start-up company data and more than 1 million company data can be found in Crunchbase.

3 Results and Discussion

3.1 Investor Type and Innovation Performance

R2 of 0.144 in Table 3 shows that predictors explain 14.4% of the variance in innovation performance. Furthermore, Table 4 provides the p-value to test the significance of predictors. Predictors of the accelerator, VC, and age with a p-value less than 0.05 are statistically significant in predicting innovation performance. Other variables do not significantly predict innovation performance. From the same table, the standardized beta

Table 2. Variable Definition and Descriptive Statistics

Variable Name	Variable Definition	N	Mean	SD
Explained Variable:				
IP	Log (1 + number of patents granted, trademark registered, active products and application created)	358	0.7238	0.4073
Explaining Variable:				
Accelerator	Whether the start-up is supported by accelerator funding	358	0.0345	0.0960
Angel	Whether the start-up is supported by angel investor funding	358	0.0336	0.0950
Incubator	Whether the start-up is supported by incubator funding	358	0.0429	0.1054
Vc	Whether the start-up is received funding from venture capital	358	0.1900	0.1454
Index average	Log (1 + average Ginarte & Park index)	358	0.6204	0.1126
Size	Log (1 + start-ups' revenue)	358	0.4042	0.1945
Product	Log (1 + number of products)	358	0.9028	0.6285
Tech	Log (1 + number of active products)	358	1.4522	0.3723
Age	Log (1 + start-ups' age)	358	0.9095	0.1791

coefficient for accelerator, angel, incubator, and VC are 0.2660, 0.0341, 0.0630, and 0.4040, indicating positive relations with innovation performance and VC provides a stronger predictor than others. Table 5 provides assumption checks for the model. VIF values for all predictors are less than VIF cut-offs of 5. Thus, all variables are included in the model data.

Table 3. Model Fit Measures

Model	**R**	**R^2**
1	0.379	0.144

Table 4. Model Coefficients – IP

Predictor	Estimate	SE	t	p	Stand. estimate
Intercept	0.11124	0.1266	0.879	0.380	
Accelerator	0.04751	0.0126	3.756	<.001	0.2660
Angel	0.00720	0.0145	0.496	0.620	0.0341
Incubator	0.01483	0.0163	0.910	0.363	0.0630
VC	0.04526	0.0101	4.464	<.001	0.4040
Product	-0.00937	0.0384	-0.244	0.807	-0.0145
Age	0.39678	0.1256	3.159	0.002	0.1745

Table 5. Collinearity Statistics

	VIF	**Tolerance**
Accelerator	2.06	0.486
Angel	1.94	0.516
Incubator	1.96	0.509
VC	3.36	0.298
Product	1.44	0.694
Age	1.25	0.800

3.2 High-Intensity Technology

Tables 6 and 7 report the result of the hypothesis H5 test. Table 6 shows that all predictors have a positive standardized beta coefficient for the sub-samples with high dependence on high technology intensity. Predictors have a positive impact on innovation but are only significant for VC.

Table 6. Model Coefficients - IP (a high sub-sample of high technology intensity)

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.0326	0.2115	0.154	0.878	
Accelerator	0.0332	0.0198	1.672	0.097	0.1886
Angel	0.0191	0.0285	0.672	0.503	0.0651
Incubator	0.0532	0.0274	1.946	0.054	0.2068
VC	0.0485	0.0158	3.062	0.003	0.4202
Product	0.0683	0.0705	0.969	0.334	0.0937
Age	0.3287	0.2062	1.594	0.113	0.1433

Table 7. Model Coefficients - IP (a low sub-sample of high technology intensity)

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.13308	0.1572	0.8466	0.398	
Accelerator	0.05627	0.0164	3.4342	<.001	0.31133
Angel	-3.99e - 4	0.0173	-0.023	0.982	-0.0022
Incubator	-0.00447	0.0203	-0.220	0.826	-0.0200
VC	0.04115	0.0133	3.1042	0.002	0.36736
Product	-0.01522	0.0490	-0.310	0.756	-0.0230
Age	0.43187	0.1598	2.7025	0.007	0.19070

Otherwise, the low sub-sample of high technology intensity (Table 7) shows that angel, incubator, and product predictors have negative relations with innovation performance. Conversely, accelerators and VC show a significant impact on innovation performance. Other predictors show a positive but not significant impact on innovation performance.

3.3 Influence of Regional Characteristics

Table 8 shows that all predictors have a positive standardized beta coefficient for the sub-samples with high dependence on high technology intensity. All predictors have a positive impact on innovation, and VC has a significant impact on innovation performance.

The low sub-sample of the regional characteristic in Table 9 shows that predictors angel, incubator, and product negatively affect innovation performance. Other predictors show positive relations with innovation performance, but only accelerator and VC significantly impact innovation performance.

Table 8. Model Coefficients - IP (a high sub-sample of regional characteristics)

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.03144	0.1678	0.187	0.852	
Accelerator	0.05878	0.0159	3.706	<.001	0.4054
Angel	0.00580	0.0230	0.252	0.801	0.0228
Incubator	0.04062	0.0249	1.630	0.105	0.1365
VC	0.05365	0.0146	3.662	<.001	0.4715
Product	0.07109	0.0674	1.055	0.293	0.0913
Age	0.32211	0.1783	1.806	0.073	0.1385

Table 9. Model Coefficients - IP (a low sub-sample of regional characteristics)

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.24468	0.1979	1.237	0.218	
Accelerator	0.01505	0.0262	0.574	0.567	0.0476
Angel	-0.00655	0.0196	-0.34	0.738	-0.0357
Incubator	-0.01866	0.0233	-0.80	0.425	-0.0926
VC	0.02638	0.0150	1.764	0.079	0.2385
Product	-0.06893	0.0507	-1.36	0.176	-0.1143
Age	0.44534	0.1832	2.431	0.016	0.2005

4 Conclusion

This study analyzed the innovation performance of start-ups based on the investment type. Bonnet and Wirtz [15] argued that the investor type influenced innovations. The types of investments that affected innovation performance include venture capital [12], incubator [13], accelerator [6], and diversified angel investment [14].

This study acquired 358 longitudinal data from the Crunchbase database as of May 20, 2022. This study's results support previous research's hypothesis that venture capital investment, incubator, accelerator, and angel investment would promote the innovation performance of start-ups.

Furthermore, venture capital investment provided a stronger predictor than others, followed by the accelerator. This result confirms that venture capital investment is widely used in the scaling stage of a start-up [4].

Funding in the scaling phase requires venture capital financing (Series A, B, C, and D). Series A funding supports companies to build products and customer bases with consistent revenue so start-ups can start scale-up to different markets.

In the early stage of this venture capital, it is also marked by the existence of series B funding. Series B funding allows start-ups to meet various customer demands and continue to grow amid increasingly fierce market competition. Funding sources for this early-stage venture capital include accelerators, super angel investors, and venture capitalists.

Start-ups search for more funding through series C funding to develop new products, enter new markets, and acquire other start-ups in the same industry. Not many start-ups need to get series D funding as it is for a particular situation (i.e., merger, target growth). As start-ups have already successfully operated, business operations become less risky in the late venture capital (series C and D). Investors are private equity firms, venture capitalists, hedge funds, and banks.

This study further discussed the influences of high-intensity technology and regional characteristic of intellectual property rights protection. The result showed that high-intensity technology positively increased the impact on innovation performance. Furthermore, regarding the regional characteristic, countries with high protection of intellectual property right increased the impact of investment type on innovation performance.

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