

Article

Scholars' Identity Transition and Its Impact on Spin-Offs' R&D Input

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Abstract: This paper explores the academic entrepreneur's identity transition and its impact on spin-off's innovative input. Central to this study is the factors that influence scholars' position-holding behavior and their impact on spin-offs. Based on the data of the 2005–2010 SME Innovation Fund and 14 interviews, we investigate the influence of scholars' role embeddedness on their entrepreneurial role-taking behavior from the perspective of identity theory. Empirical results show that scholars with higher embeddedness in academia are less likely to hold a spin-offs' CEO position. Besides, follow-up research found that scholars holding CEO positions can increase a spin-off's R&D input, which reveals the influence of scholars' career imprinting and its scientific logic on role-taking behaviors and spin-offs' innovation input. We also empirically test the effect of scientific logic and business logic on a spin-off's innovation input, concluding that conflicts between these two logics are detrimental to a firm's innovation input. This paper contributes to existing literature by providing a new perspective for identity theory and has implications for scholars' entrepreneurial practice. Additionally, it provides a theoretical basis for technology transfer and open innovation policy.

Keywords: academic entrepreneurship; role-taking; identity transition; institutional logics



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1. Introduction

When scholars transit to becoming entrepreneurs has become an important topic in the field of academic spin-offs. The existing studies mainly explore the influence of academics' participation in technology commercialization from the perspectives of social comparison, human capital, social networks, and institutional context [1–4] focusing more attention on the issue of whether to conduct entrepreneurial entry [5] and how to tackle the role identity conflicts regarding the academic role and entrepreneurial role [6,7]. However, little research has further discussed academic entrepreneurs' identity transition according to their occupational position in ventures, and how this position-holding behavior would impact a spin-off's innovation performance.

Few studies have illustrated the academic entrepreneurs' role identity transition and its influence on firm-level performance. For example, Sauermann and Stephan [8] explored the institutional logic conflicts between academia and industry, which induce role identity conflicts in terms of the academic role and scientific role. Lots of scientists would employ delegating and buffering approaches to protect their focal role [6], while separating the conflicts from other roles. Moreover, role identity management strategies would influence venture growth because of individuals' varied expectations for the entrepreneurial role [7]. This constructs the frame of reference to make strategic choices [9] and spin-offs' commercialization path [10]. Additionally, academic entrepreneurs would influence spin-offs' innovative performance through the institutional logic they carry from academia [11,12]. Based on this literature, we drew on theories of imprinting [13] and institutional logics [14] to develop a framework that suggests an individual's institutional logic influences both the

likelihood of pursuing a particular type of entrepreneurial role and a spin-off's innovative input.

In developing the theoretical framework, we introduce the concept of role embeddedness, which we define as the academic entrepreneurs' behaviors that are constrained by ongoing social networks, which make it difficult to transit from a scholar identity to an entrepreneur identity. The role embeddedness focuses on the original values, beliefs, and motivations that shape what is meaningful and legitimate to actors in one specific context [15], and thus impact their role-taking behavior in spin-offs. Accordingly, by introducing two types of institutional logics, scientific logic and business logic deriving from one's social category, this paper depicts the theoretical mechanism of their relevance to innovative performance. Empirical results show that academic entrepreneurs' scientific logic positively influences a spin-off's innovation input. Furthermore, if an academic entrepreneur hold the spin-off's CEO position, two logics would conflict with each other, which will ultimately decrease the spin-off's R&D input.

By using a mixed method, this paper offers several contributions to imprinting theory and research on scholars' engagement in entrepreneurship. First, we contribute to imprinting theory by explaining how institutional logics from a previous career can exert influence in a new context. We argue that scholars' scientific logic, with its emphasis on novel results and knowledge creation, translates to R&D input in an academic entrepreneurship context. Second, we argue that role identity conflicts depend on the specific position a scholar holds in spin-offs. Chief executive officer (CEO) is a position that requires more responsibilities in spin-offs' daily operation, and scholars who are highly embedded in academia are less likely to take the CEO position. In contrast, scholars tend to hold the chief technology officer (CTO), chief scientific officer (CSO), or advisor position to mitigate role identity conflict.

2. Theoretical Background and Hypothesis Development

2.1. Role of Academic Entrepreneurs

As a special group, academic entrepreneurs have received extensive attention in the academic field. Most of the studies focused on the question of "when do scholars become entrepreneurs?" [4,6,16]. For example, Stuart and Ding [4] employed a social influence perspective, pointing out that the peer effect and social network effect are two main mechanisms influencing individuals' propensity to transition to entrepreneurship. It is believed that individuals with coauthors who have become entrepreneurs are more likely to transit. Other scholars have discussed this issue in terms of resource acquisition, policy enactment of the university, individual attributes of scholars, and macro-environmental changes [16–18]. However, few studies distinguished the specific position scholars hold in spin-offs. We interviewed 14 academic entrepreneurs to understand scholars' motivation to become involved in entrepreneurship, the challenges they encounter, and the specific position they hold in operating a firm. By conducting these interviews, we attempt to clarify the underlying mechanism that influences scholars' role-taking behavior. In line with previous research, senior scholars often protect their focal academic role although they are working as a cofounder in a spin-off [6]. The difference is that senior scholars attempt to hold a hybrid identity by participating in businesses that are highly correlated with scientific research, such as guiding spin-offs' technology development direction or giving rigorous suggestions based on their scientific knowledge accumulation. Thus, they are more likely to hold a CTO, CSO, or advisor position in spin-offs. Scholars' position-holding behavior in spin-offs reflects their degree of role identity transition (as shown in Table 1). For entrepreneurs who hold the CEO position, we argue that they suffer more from institutional logic conflicts, since they should obey the game rules based on business logic which significantly conflict with scientific logic [19].

Table 1. Role choice of academic entrepreneurs.

Role Choice	Role Taken	Quotation	Degree of Role Transition
CEO	Management, investment, R&D	<p>“From university to firm operation, the logic is different. You earn money from university and earn money from business is completely different. It also different between how to manage student in university and how to manage people in a firm.”</p> <p>“R&D is the most important thing ... I will keep a close eye on recruitment and interviews, because we are now a firm, not a lab, most of them are R&D personnel...so I definitely have to do these business things, including task distribution, what they do, how they do and research and development issues ... “</p> <p>“Basically, I am helping a little in terms of the core business now. What I am doing is, flicker my classmates (invest in) ...”</p>	High
CTOCSO	Technical support, strategic planning	<p>“He gives us some general technical direction...because he is a professor at Tsinghua University.”</p> <p>“Teacher G’s position in the company is called the chief scientist. He is responsible for the development of these basic technology development of our firm. ... he basically not involved in some daily operations.”</p>	Medium
Advisor	Resource docking, technical support, government coordination	<p>“I feel that during the whole process, they still do the docking of resources ... In fact, he is our advisor until now, or similar to the advisor.”</p> <p>“For example, if the construction of the base involves coordination with the government, I am sure to help...”</p> <p>“I didn’t actually participate in them. I think I am still a scholar, but when they need me sometimes, they will pull me out to help ... they have their own ideas or hire a professional manager for administrative issues.”</p>	Low

Role identity is an important factor affecting academic entrepreneurs' role-taking behavior. For scholars, the development of an academic career involves long-term academic training and socialization [20]. In the meantime, they have long been immersed in the normative system of advocating scientific spirit, adhering to the scientific logic of pursuing technological novelty [8,10], while entrepreneurship itself is a more commercialized activity and pursues business logic, involving a strong focus on financial outcomes, as well as attention on technology robustness and utility [21]. Therefore, there is a huge gap between the scholar role and entrepreneur role in terms of their values, beliefs, and norms. Substantial empirical evidence shows that these two types of logics persist over time [10,22]. For example, Mary and Giovanni [23] assert that scholars often use scientific logic to deal with commercialization problems when they are faced with identity transition.

Moreover, scholars are faced with cognitive inertia, which impedes role identity transition. Cognitive inertia involves from two factors: Firstly, social networks of scholars with higher role embeddedness are locked [4,24]. That is to say, scholars are influenced by the strong social relations and reciprocity standards and have a sense of obligation to the academic community. A number of studies have shown that strong social embeddedness negatively affects the establishment of a firm's new social tie and access to information [25,26]. Secondly, scholars with higher role embeddedness are cognitively locked [27]. That is, a specific role identity confines one's motivation, ability, and skills, which hinders one from adopting new cognitive models [28]. Among the 14 academic entrepreneurs we interviewed, the founding team often adopts a "PhD student + mentor" format, with PhD students delegating business logic and the mentor (professor) sticking to scientific logic. As one professor said, "I think I am a scholar . . . ", but he hopes his technology can impact the whole of society and even human life, and preferred to cooperate with PhD students who are not deeply embedded in academia, and thus protect his salient scholar role. Jain, George [6] found that academic entrepreneurs tend to adopt a hybrid identity, even after participating in entrepreneurship. They still take a scholar role as the focal role identity, and envision an entrepreneurial role as an appendant role identity. This strategy of managing a hybrid identity is called "salience", referring to the likelihood that a given role identity will be awakened in different contexts [29]. "Mentors" are usually more embedded in academia and envision a scholar role as their focal role identity, so they are more likely to hold the position of CTO, CSO, and advisors in entrepreneurship, while PhD students with lower embeddedness in academic social networks have higher propensity to transit to a pure entrepreneur, and hold a CEO position. Based on the above arguments, we propose:

Hypothesis 1. *Scholars with higher role embeddedness in academia are less likely to hold CEO positions in spin-offs.*

2.2. Academics' Role-Taking Behavior and R&D Input

Imprinting theory explains how entrepreneurs transit from their previous career and adapt to the entrepreneurial context [13,30], and these career imprints affect the structure, culture, and practices of ventures [31]. It is believed that individuals with the same profession share the same beliefs and perceptions, and tend to transit professional imprints to their current career [32]. In an entrepreneurship context, researchers highlight founders' career imprinting on ventures' opportunity development and growth pattern [30]. For example, Hahn, Minola, and Eddleston (2019) found that scientist career imprinting provides ventures with novel knowledge, but it also brings rigidity due to scientists' non-commercial goals and the lack of strategic planning.

Following scientific logic, scholars attempt to pursue technology with greater novelty and advancement [8,33] and aim to develop cutting-edge technology. They generally lack business skills and technical knowledge [34], but usually have strong meta-learning ability. Additionally, long-term research training allows them to quickly integrate knowledge from different fields and they tend to give technical solutions when faced with innovation events [35,36]. For example, Dechenaux, Thursby (2011) [37] found that scholars often

prefer to solve new problems compared to the development of existing technological achievements, resulting in a more divergent R&D process and more R&D resources needed. Therefore, scholars are more inclined to increase R&D input in business operations, trying to establish a competitive advantage through technology leadership. At the same time, the cognitive inertia of scholars creates path dependence [38], with spin-offs paying more attention to technology development and ignoring the importance of demand-side strategy. Given the imprinting assumption, scholars are reluctant to invest in technology-irrelevant expenditures during entrepreneurship. As a result, R&D input of academic spin-offs is generally higher than other start-ups. In addition, the basic motivation of scholars' participation in entrepreneurship is to realize the wide application of technology and pursue high-tech technologies, as an academic entrepreneur stated:

"I have tried it. It is very technically weaker. Of course, there are quite a few technical ideas for entrepreneurship, and I have done very basic research ... but in the end, I chose a new technology with higher originality, strong novelty and great advancement. At the same time, I can see its impact on everyone's life shortly and have an impact on society ..."

Therefore, academic entrepreneurs are also concerned about technological advancement while pursuing profit maximization, and thus increase the spin-off's R&D input.

The CEO has more discretion to increase R&D input. When an academic holds the CEO position, he/she is more involved in the spin-off's daily operations, with great discretion to impact the spin-off's innovative decisions. In contrast, scholars who hold the CTO, CSO, or advisor positions are responsible for the specific engineering issues, and thus they are not active in participating in the "business" things [39]. This mechanism is more salient when the core founder (CEO) is a person from industry, who will focus more attention on market information, rather than the scientific information the scholars give great priority. In summary, we propose:

Hypothesis 2. *Compared to other positions, scholars holding the CEO position are more likely to increase a spin-off's R&D input.*

2.3. Role of Academic Entrepreneurs and the Boundary Conditions of R&D Input

Because scholars have different levels of involvement in business activities when they start a business, the degree of identity transition from scholars and entrepreneurs is not the same. Grimes [40] points out that when individuals gradually participate in related activities of a specific role, they will integrate into the social network associated with it and internalize the social identity of that role. A scholar holding a spin-off's CEO position participates more in business activities, so their entrepreneur identity will become more salient [41]. However, a scholar holding a spin-off's CTO, CSO, or advisor position is less involved in the actual operation of the venture, generally providing technical guidance and promoting knowledge sharing [42]. As a consequence, they are less likely to become a "pure" entrepreneur, trying to protect their focal scholar identity by various strategies [43] or employing a hybrid identity [6]. Reflected at the operational level, scholars tend to follow scientific logic, while entrepreneurs follow business logic [32,44].

Studies on founders' imprinting shows that it is better to share a common mindset to create a cohesive team that generates a consistent pattern of behaviors [31]. As imprinting theory suggested, early imprints can be weakened when they are seen as incompatible with a new context [30]. Studies on technology transfer also show that when scholars feel tension between scientific logic and business logic, discord will be mitigated by conforming to the norms of the current team members [45]. By adapting to local norms, scholars gradually transit to entrepreneur and even create a role that is compatible with both scientific logic and business logic [40]. In turn, as founders converge on common rules, their spin-offs are more likely to adopt actions that are aligned with shared values and beliefs [31]. Therefore, as the number of scholar founders increases, it is reasonable to expect a greater influence of scientific logic on spin-offs' R&D input. This is in line with social influence research that suggests that a given individual's attitudes are shaped by the opinions of socially relevant alters [4,46,47].

However, R&D activities require not only technical-related academic knowledge but also industry knowledge related to user needs [39,48]. Especially in the context of academic entrepreneurship, many spin-offs are in trouble and even go bankrupt after receiving seed financing, because they are unable to commercialize the technology and fit their product in the niche market. A professor told us that, “Many scholars are doing technology transfer, some of their spin-offs grow very fast and also very successful, but most of them did not develop smoothly, some of them have to stop halfway ... In the material industry, there is a long way to go from laboratory results to commercialization, ranging from five or six years to two or three years”. For a CEO who transitioned from a scholar role, to some extent, he inherited the “scientific genes” [49] and was inclined to increase spin-offs’ R&D investment. However, the CEO position also gave him the mission of ensuring the firm’s normal operation and creating profits, which urged him to plan the venture’s development with business logic, so the CEO as an individual is a collection of scientific logic and business logic. The increase in the number of academics in other positions in the founding team will further strengthen the scientific logic [36]. On the one hand, this “information” is redundant and replaceable for the CEO; on the other hand, it strengthens the conflict between science logic and business logic [8]. This is detrimental for the development R&D activities because logic conflict would lead to an unbalanced knowledge base in terms of scientific knowledge and industry knowledge. Additionally, a greater number of scholars may be beneficial for spin-offs to absorb knowledge from academia, because scholars are the “engine” of knowledge creation [36]. Their knowledge breadth and depth are the substitute for R&D activities in terms of knowledge creation. Based on these arguments, we propose:

Hypothesis 3. *The number of scholars in a founding team negatively moderates the relationship between a scholar as CEO and a spin-off’s R&D input.*

3. Research Design

3.1. Sample Selection and Data Sources

To test the research hypotheses, we draw on a sample of Chinese start-ups that applied for the Science and Technology SME Innovation Fund from 2005 to 2011. The sample for this study was identified by drawing on whether start-ups licensed university technology or included a scholar in their founding team, which was the criteria to define spin-offs [50,51]. Of the 1333 innovation fund application materials from technology-based SMEs (Small and Middle-sized Enterprises) in Beijing, we focused on more than 300 in the following industries: electronic information, opto-mechatronics, biomedicine, new materials, new energy vehicles and new energy products, environmental protection, high-tech services, and another seven government-supported industries. These industries are characterized as high-tech, where we could clearly see the possible tension between scientific logic and business logic. For companies that applied for the fund more than once, we only kept one of the samples. All the firm-level data can be obtained from the ventures’ fund application materials, which they are required to report.

Individual-level information (i.e., holding of positions and ownership) was mainly collected from the National Enterprise Credit Information Publicity System (<http://www.gsxt.gov.cn/index.html> (January 2019)), spin-offs’ Innovation Fund application materials, and other online repositories, and we also cross-checked and verified the data with a different dataset. For scholars’ role embeddedness, we matched the original sample with role embeddedness information according to the Chinese National Knowledge Infrastructure (CNKI) database (<http://www.cnki.net/> (January 2019)), a Chinese professional website like Google Scholar, which lists all of the scholars’ publications and paper citation data. All the individual information was matched with the year when the spin-off was founded. To focus the analysis on spin-offs that were in their initial stage of the commercialization process, start-ups founded no more than 10 years previously were selected. After removing missing values, the dataset used in this paper contained 289 samples.

To collect information on scholars' position-holding behavior, we interviewed 14 academic entrepreneurs who aimed to commercialize their technology through the establishment of spin-offs. By using a semi-structured interview design, we asked questions about their motivation to establish a spin-off, the founding team composition, their basic rules to operate a firm, and the decision-making process related to R&D input. These qualitative data helped to clarify the underlying mechanism of academic entrepreneurs' role identity management and its influence on spin-offs' innovative performance. These interviews are used to illustrate, not support, our argument.

3.2. Model Setting and Variable Definition

The probit regression model is used to estimate the proposed hypothesis since the dependent variable, scholars' position-taking behavior, is dichotomous. The impact of scholars' role-taking on ventures' R&D investment is estimated by ordinary least squares (OLS). The definition of each variable is as follows:

Dependent and independent variables. Role embeddedness (*Embed*). Embeddedness itself is a concept in the social network literature, which means the behavior and institutions are constrained by ongoing social relations [26,52]. It measures the centrality of the individual in the network. This paper draws on the idea of social network theory, and it is believed that the paper citation quantity, to some extent, reflects the degree of scholars' role embeddedness in the research network, so we eliminate the number of scholars' paper publications for measurement accuracy. Thus, role embeddedness is defined as scholars' paper citation number divided by the paper publication number, adding 1 where the publication number is 0. For academic entrepreneurs' position-holding behavior, we used a dummy variable, where 1 means that a scholar holds the CEO position, with higher degree of identity transition. A value of 0 means a scholar plays a CTO, CSO, or advisor role in the spin-off. Research and development input (*R&D*) is measured by the amount of a spin-off's R&D input. To eliminate the unit effect, we take the logarithm form in the regression equation. The number of academics (*Acade_num*) is the number of academics in the founding team.

Control variables. Substantial empirical evidence shows that human capital is an important factor acting on scholars' role-taking behavior [4,44], so we control for whether scholars are returnees (*Returnee*), their age (*Age*), gender (*Gender*), whether they have a high title (*Hightitle*) in university, and whether they have a relevant social appointment (*Social_appoint*), which is often employed as a proxy for the logic individuals bring to their ventures [53,54]. In line with prior literature, several firm-level variables are controlled, including the size of the spin-off (*Size*), measured by the assets of a spin-off (employing logarithm form in regression), firm age (*Firmage*), and the venture capital (VC) they have retained. To control for the context factors, we added time variables in the model to eliminate other factors' influence and the time effect. Finally, following previous literature, a spin-off's industry is controlled.

4. Results

4.1. Descriptive Statistics and Correlation Analysis

Table 2 presents descriptive statistics and bivariate correlations for all variables included in the statistical models. As is shown in Table 2, the correlation coefficients between role embeddedness and CEO position is -0.082 , indicating that the academics' role embeddedness is related to their position-taking behavior. At the same time, R&D input is also related to scholars' position-taking behaviors. Additionally, the correlation coefficient of each variable is mostly lower than 0.30, and the maximum value is 0.676, which indicates that there is no serious multicollinearity problem in the regression model. Further, the variance inflation factor (VIF) of each variable is also calculated. The maximum value is 2.22 and the mean is 1.48, which further illustrates that there is no serious multicollinearity problem in the regression model.

Table 2. Descriptive statistics and correlation matrices.

	R&D	CEO	Aacadem_num	Embed	Social_Appoint	Returnee	Age	Gender	Firmage	Size	VC	Acade Ratio
R&D	1											
CEO	0.090	1										
Academic_num	−0.030	0.254 ***	1									
Embed	−0.010	−0.082	0.031	1								
Social_appoint	0.089	0.060	0.024	0.088	1							
Returnee	−0.093	−0.004	−0.021	0.057	0.008	1						
Age	0.057	−0.097 *	0.009	−0.031	0.334 ***	0.073	1					
Gender	−0.138 **	−0.010	0.002	−0.046	−0.110 *	0.006	−0.078	1				
Firmage	0.488 ***	0.044	−0.006	0.024	0.070	−0.035	0.159 ***	−0.041	1			
Size	0.676 ***	0.048	−0.005	−0.076	0.079	−0.141 **	0.135 **	−0.102 *	0.500 ***	1		
VC	0.232 ***	0.080	−0.022	−0.052	0.005	0.016	−0.060	0.018	0.117 **	0.288 ***	1	
Acade ratio	−0.170 ***	0.200 ***	0.585 ***	−0.0540	0.093	0.008	0.069	0.016	−0.106 *	−0.090	−0.092	1

Note: *** $p < 0.001$, ** $p < 0.05$, * $p < 0.1$.

4.2. Empirical Research Results

Table 3 presents the regression results. Model 1 and 2 show the probit regression analysis used to test hypothesis 1 (predicting that role embeddedness negatively affects CEO position-holding behavior). Model 1 is the base model including all control variables that might influence one's position-taking behavior. Model 2 supports the hypothesis, that is, scholars' role embeddedness is statistically related with their CEO position-holding behavior in spin-offs, with a significant and negative coefficient (-0.024 , $p < 0.1$). This provides evidence for the idea that senior scholars who are deeply embedded in academia are less likely to transit to be a "pure" entrepreneur.

Table 3. Probit and regression results.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
	CEO	CEO	R&D	R&D	R&D
Embed		-0.024^* (0.014)	0.008 (0.008)	0.010 (0.008)	0.008 (0.008)
CEO				0.253^{**} (0.124)	0.708^{**} (0.291)
Academic_num					0.230 (0.154)
CEO * Academic_num					-0.332^* (0.172)
Social_appoint	0.268 (0.174)	0.310^* (0.176)	0.057 (0.132)	0.034 (0.131)	0.036 (0.130)
Returnee	0.050 (0.169)	0.064 (0.170)	-0.240^{**} (0.122)	-0.245^{**} (0.122)	-0.254^{**} (0.121)
Age	-0.019^{**} (0.008)	-0.021^{***} (0.008)	-0.006 (0.005)	-0.004 (0.005)	-0.004 (0.005)
Gender	-0.057 (0.361)	-0.094 (0.362)	0.020 (0.334)	-0.012 (0.341)	-0.006 (0.351)
Firmage	0.048 (0.039)	0.054 (0.039)	0.069^{**} (0.029)	0.065^{**} (0.029)	0.068^{**} (0.030)
Size	0.028 (0.053)	0.019 (0.054)	0.382^{***} (0.068)	0.385^{***} (0.069)	0.388^{***} (0.070)
VC	0.191 (0.164)	0.178 (0.165)	0.292^{**} (0.117)	0.268^{**} (0.116)	0.258^{**} (0.117)
Acade_ratio	0.785^{***} (0.218)	0.766^{***} (0.219)	-0.036 (0.177)	-0.110 (0.178)	-0.151 (0.219)
Year	Included	Included	Included	Included	Included
Industry	Included	Included	Included	Included	Included
Constant	-0.347 (0.457)	-0.208 (0.466)	2.260^{***} (0.476)	2.113^{***} (0.504)	1.819^{***} (0.568)
N	289	289	263	263	263
R-squared			0.4248	0.4353	0.442

Note: *** $p < 0.001$, ** $p < 0.05$, * $p < 0.1$.

Model 3 to model 5 present the results of the OLS regression analyses used to examine the effect of scholars' CEO position-holding behavior on R&D input, as well as the moderating effect of other scholars in the founding team, as predicted by hypotheses 2 and 3. Models 3–5 in Table 3 have R&D input as a dependent variable. In step 1, only control variables are entered. Scholars' CEO position-holding behavior, entered in step 2, has a positive and significant effect on spin-offs' R&D input ($\beta = 0.253$, $p < 0.05$), providing support for hypothesis 2. Thus, scholars holding the CEO position increase the likelihood of spin-offs' R&D investment. Subsequently, the interaction term CEO *Academic_num is entered to test the predictions of hypothesis 3. The interaction term

shows a negative and significant coefficient ($\beta = -0.332$, $p < 0.1$), which supports our hypothesis that the impact of scientific logic (represented as academic number) would weaken the CEO's propensity to increase R&D input. This is consistent with the prediction of Roche et al. (2020) that academic start-ups often have higher innovation performance than non-academic start-ups.

5. Discussion and Conclusions

As an important approach to commercializing lab technology, the establishment of academic spin-offs improves the efficiency of technology transfer by combining inventors and "users" of technology into one organization. However, what kind of role scholars should take in these spin-offs is not clear. Employing the data of the Innovation Fund of Beijing in China, this paper attempts to explore academic entrepreneurs' role-taking behavior and its impact on spin-offs' innovation input from the perspective of imprinting theory and role identity theory. Empirical results show that the role of scholars in entrepreneurship (including CEO, CTO, CSO, and advisor positions) is influenced by their role embeddedness in academia. Specifically, the higher the degree of scholars' role embeddedness, the less likely they are to hold the CEO position, and it is easier to act as an advisor, a role which is relatively marginal to the entrepreneurial role, with little involvement in spin-offs' daily operation. The main reason for this phenomenon is that scholars who have long been embedded in academia will carry a career imprint (scientific logic) during the identity transition process [12,55], which might conflict with business logic in industry [8,33]. Therefore, the stronger the "scientific gene" of scholars with higher role embeddedness in academia, the less likely they are to span the network boundary and become a major player in the industry network (hold a CEO position). This also confirms Jain's conclusion on academics' role identity work, that is, academics often use delegating and buffering strategies to protect their focal identity [6], rather than directly transit to being an entrepreneur.

Scholars' role-taking behavior affects spin-offs' innovation input. The results of this study show that even if scholars transit to being entrepreneurs, they still carry the "scientific genes", pursue advanced and novel technology, and tend to increase investment in R&D. This effect is particularly significant when scholars hold CEO positions, and not statistically significant when scholars act as CTOs, CSOs, and advisors. The underlying theoretical mechanism is that the CEO is deeply involved in the real operation of the spin-offs and has greater discretion in spin-offs' R&D investment. On the contrary, CTOs, CSOs, and advisors generally contribute scientific knowledge to spin-offs and provide guidance for spin-offs' technology development, but these activities merely have an indirect impact on spin-offs' decision making about R&D input.

Institutional logic conflicts are not conducive to increasing the venture's R&D input. Since 1968, Merton has proposed conflicting logics in academia and industry, and Sauer-mann and Stephan [8] empirically validated this theory. However, what happens when both institutional logics exist in one organization? This issue has received researchers' attention but lacks empirical testing [12]. Our empirical results show that academic entrepreneurs holding CEO positions carry scientific genes and tend to follow scientific logic in the entrepreneurial process, but when faced with identity transition, a CEO will incorporate scientific logic and business logic. As the size of the company grows, the CEO's entrepreneurial identity becomes his/her focal identity instead of the original academic identity. Although the increase in scholar numbers in the founding team will definitely increase the scientific logic of the spin-off, it is "redundant information" for the CEO and conflicts with his/her focal identity, entrepreneur, which will ultimately discourage spin-off R&D input.

In summary, the possible contributions of this paper include the following aspects: Firstly, this study investigates spin-offs' innovation input from the perspective of imprinting theory and identity theory, providing a new perspective and theoretical basis for academic entrepreneurship. Additionally, we fill the research gap by empirically testing the influence

of scholars' professional imprinting on their entrepreneurial role-taking behavior. This is important since previous literature predominantly focused on scholars' role transitions without exploring their specific positions in the founding team [6,56]. Secondly, it enriches the mechanism of scholars' participation in entrepreneurship in venture innovation input. Most studies have focused on the impact of collaboration between universities and industry in open innovation [39], and there is a lack of studies on the relationship between scholars' role-taking behavior and innovation performance. Thirdly, the empirical test of the impact of the conflict between scientific logic and business logic on a spin-off's innovative performance helps to deeply understand the academic entrepreneur's entrepreneurial entry and role-taking behavior. Furthermore, this study has a strong practical significance for scholars engaged in entrepreneurship. Although the Chinese government enacted lots of policies to encourage scholars to start a business, whether scholars are suitable for entrepreneurship has been controversial. This study shows that scholars with higher role embeddedness might not be the appropriate person to be involved. Research on questions such as "what role does an academic take during the technology commercialization process?", may have a long way to go, and this study is a starting point by providing subsequent studies with insightful direction and theoretical perspectives. Moreover, this paper provides practical implications for spin-offs' innovation strategy regarding leveraging scholars' knowledge for commercial use.

5.1. Limitations and Future Research Directions

Notwithstanding its contributions, this study presents some limitations, offering opportunities for further investigation. First, scholars' role-taking behavior is related to an individual self-selection process. To exclude this potentially endogenous problem, this paper controlled lots of individual-level variables, such as human capital and social capital, and also includes preliminary case studies to clarify scholars' motivation on entrepreneurial entry. However, endogenous problems cannot be completely ruled out. Future research could be directed to teasing out the imprinting effect from the self-selection effect. Second, results show that there is a positive relationship of scholars' role-taking behavior on spin-off's innovation input, but identity itself is always changing with the growth of spin-offs. Simply measuring business logic by academics' role-taking behavior cannot support all of the interpretations. Future research should verify the reliability of this conclusion by employing panel data covering the whole process of scholars' identity transition. Several related research questions deserve exploration: How do scholars' roles change with the growth of spin-offs? Do scholars change their position during the entrepreneurial process? Does scholars' entrepreneurial entry complement their scientific research performance while facilitating spin-offs' innovative performance?

5.2. Practical Implications

By illustrating what kind of role scholars should take in entrepreneurship and its impact on spin-offs' innovative input, this study offers several managerial and policy implications. First, since scientific research and business operation obey different institutional logic, academic entrepreneurs should pay more attention to the distinctiveness between these two innovation systems and avoid the career imprinting effect. Specifically, academic entrepreneurs should consider involving members from industry in the founding team or learn user knowledge needed for product innovation, because more scholars in the founding team could further strengthen the scientific genes of the spin-off. If academic entrepreneurs act more like scientists by appreciating the scientific logic, their spin-offs may accrue disadvantages in the technology commercialization process. Second, the empirical results—scholars with higher role embeddedness in academia do not more easily transit to a pure entrepreneur identity—offer important implications for university technology transfer policies. The Chinese government enacted lots of policies to encourage scholars to engage in entrepreneurship, but there is an ongoing debate on whether scholars are suitable for entrepreneurship. Our findings partially support the idea that scholars with higher

role embeddedness can assist in spin-offs through knowledge spillover and technology development guidance, but not by playing a leading role in the entrepreneurial process. This argument is also consistent with some of the interviewees' opinions. An academic entrepreneur said that, "I think I am still a scholar . . . they (other entrepreneurs) have their own ideas or hire a professional manager". Third, despite the negative impact of scholars' career imprinting on spin-off performance, it does bring norms to the industry that encourage communism and universalism [6], which are beneficial for open innovation. This has implications for policy makers to highlight the importance of tacit "knowledge" transfer when designing innovation policy. Additionally, it is necessary to encourage the establishment of spin-offs to transfer tacit knowledge that traditional channels, such as TTO (Technology Transfer Officer), incubators, and science parks, cannot achieve.

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References

1. Moog, P.; Werner, A.; Houweling, S.; Backes-Gellner, U. The impact of skills, working time allocation and peer effects on the entrepreneurial intentions of scientists. *J. Technol. Transf.* **2015**, *40*, 493–511. [[CrossRef](#)]
2. Nicolaou, N.; Birley, S. Academic networks in a trichotomous categorisation of university spinouts. *J. Bus. Ventur.* **2003**, *18*, 333–359. [[CrossRef](#)]
3. Rothaermel, F.T.; Agung, D.; Jiang, L. University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change*, 2007, *16*, 691–791. *Industrial and Corporate Change* **2017**, *16*, 691–791. [[CrossRef](#)]
4. Stuart, T.E.; Ding, W.W. When Do Scientists Become Entrepreneurs? The Social Structural Antecedents of Commercial Activity in the Academic Life Sciences. *Am. J. Sociol.* **2006**, *112*, 97–144. [[CrossRef](#)]
5. Kacperczyk, A.J. Social Influence and Entrepreneurship: The Effect of University Peers on Entrepreneurial Entry. *Organ. Sci.* **2013**, *24*, 664–683. [[CrossRef](#)]
6. Jain, S.; George, G.; Maltarich, M. Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Res. Policy* **2009**, *38*, 922–935.
7. Mathias, B.D.; Williams, D.W. Giving up the hats? Entrepreneurs' role transitions and venture growth. *J. Bus. Ventur.* **2018**, *33*, 261–277. [[CrossRef](#)]
8. Sauermann, H.; Stephan, P. Conflicting Logics? A Multidimensional View of Industrial and Academic Science. *Organ. Sci.* **2013**, *24*, 889–909. [[CrossRef](#)]
9. Wry, T.; York, J.G. An Identity-Based Approach to Social Enterprise. *Acad. Manag. Rev.* **2017**, *42*, 437–460. [[CrossRef](#)]
10. Ciuchta, M.P.; Miner, A.S.; Kim, J.-Y.; O'Toole, J. Founding logics, technology validation, and the path to commercialization. *Int. Small Bus. J. Res. Entrep.* **2017**, *36*, 307–330. [[CrossRef](#)]
11. Hahn, D.; Minola, T.; Eddleston, K.A. How do Scientists Contribute to the Performance of Innovative Start-ups? An Imprinting Perspective on Open Innovation. *J. Manag. Stud.* **2019**, *56*, 895–928. [[CrossRef](#)]
12. Roche, M.P.; Conti, A.; Rothaermel, F.T. Different founders, different venture outcomes: A comparative analysis of academic and non-academic startups. *Res. Policy* **2020**, *49*, 104062. [[CrossRef](#)]
13. Marquis, C.; Tilcsik, A. Imprinting: Toward a Multilevel Theory. *Acad. Manag. Ann.* **2013**, *7*, 195–245. [[CrossRef](#)]
14. Thornton, P.H. The rise of the corporation in a craft industry: Conflict and conformity in institutional logics. *Acad. Manag. J.* **2002**, *45*, 81–101.
15. Thornton, P.H.; Ocasio, W. Institutional Logics and the Historical Contingency of Power in Organizations: Executive Succession in the Higher Education Publishing Industry 1958–1990. *Am. J. Sociol.* **1999**, *105*, 801–843. [[CrossRef](#)]
16. Han, X.; Niosi, J. Star scientists in PV technology and the limits of academic entrepreneurship. *J. Bus. Res.* **2016**, *69*, 1707–1711. [[CrossRef](#)]

17. Nicolaou, N. and S. Birley. Social networks in organizational emergence: The university spinout phenomenon. *Manag. Sci.* **2003**, *49*, 1702–1725. [[CrossRef](#)]
18. Shane, S.; Khurana, R. Bringing individuals back in: The effects of career experience on new firm founding. *Ind. Corp. Chang.* **2003**, *12*, 519–525. [[CrossRef](#)]
19. Zucker, L.G.; Darby, R.; Brewer, M.B. Intellectual human capital and the birth of u.s. biotechnology enterprises. *Nonprofit Policy Forum* **1998**, *88*, 290–306.
20. Perkmann, M.; McKelvey, M.; Phillips, N. Protecting Scientists from Gordon Gekko: How Organizations Use Hybrid Spaces to Engage with Multiple Institutional Logics. *Organ. Sci.* **2019**, *30*, 298–318. [[CrossRef](#)]
21. Van Maanen, J.E.; Schein, E.H. *Toward a Theory of Organizational Socialization*; Massachusetts Institute of Technology (MIT), Sloan School of Management: Cambridge, MA, USA, 1977; pp. 960–977.
22. Berman, E.P. Explaining the move toward the market in US academic science: How institutional logics can change without institutional entrepreneurs. *Theory Soc.* **2012**, *41*, 261–299. [[CrossRef](#)]
23. Shinn, T.; Lamy, E. Paths of commercial knowledge: Forms and consequences of university–enterprise synergy in scientist-sponsored firms. *Res. Policy* **2006**, *35*, 1465–1476. [[CrossRef](#)]
24. Mary, T.; Giovanni, G. Capabilities, cognition, and inertia: Evidence from digital imaging. *Strateg. Manag. J.* **2000**, *21*, 1147–1161.
25. Breschi, S.; Catalini, C. Tracing the links between science and technology: An exploratory analysis of scientists’ and inventors’ networks. *Res. Policy* **2010**, *39*, 14–26. [[CrossRef](#)]
26. Tranmer, M. Pallotti, and A. Lomi. The embeddedness of organizational performance: Multiple Membership Multiple Classification Models for the analysis of multilevel networks. *Soc. Netw.* **2016**, *44*, 269–280. [[CrossRef](#)]
27. Uzzi, B. Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing. *Am. Sociol. Rev.* **1999**, *64*, 481–505. [[CrossRef](#)]
28. Fini, R.; Fu, K.; Mathisen, M.T.; Rasmussen, E.; Wright, M. Institutional determinants of university spin-off quantity and quality: A longitudinal, multilevel cross-country study. In *Small Bus. Econ.*; 2016; Volume 48, pp. 361–391.
29. Maurer, I.; Ebers, M. Dynamics of social capital and their performance implications: Lessons from biotechnology start-ups. *Adm. Sci. Q.* **2006**, *51*, 262–292. [[CrossRef](#)]
30. Stryker, S.; Serpe, R.T. Commitment, identity salience, and role behavior: Theory and research example. In *Personality, Roles, and Social Behavior*; Ickes, W., Knowles, E.S., Eds.; Springer-Verlag: New York, NY, USA, 1982; pp. 199–218.
31. Simsek, Z.; Fox, B.C.; Heavey, C. “What’s past is prologue” A framework, review, and future directions for organizational research on imprinting. *J. Manag.* **2015**, *41*, 288–317.
32. Bryant, P.T. Imprinting by Design: The Microfoundations of Entrepreneurial Adaptation. *Entrep. Theory Pr.* **2014**, *38*, 1081–1102. [[CrossRef](#)]
33. McEvily, B.; Jaffee, J.; Tortoriello, M. Not All Bridging Ties Are Equal: Network Imprinting and Firm Growth in the Nashville Legal Industry, 1933–1978. *Organ. Sci.* **2012**, *23*, 547–563. [[CrossRef](#)]
34. Merton, R.K. The Matthew effect in science. The reward and communication systems of science are considered. *Science* **1968**, *159*, 56–63. [[CrossRef](#)]
35. Mosey, S.; Wright, M. From Human Capital to Social Capital: A Longitudinal Study of Technology-Based Academic Entrepreneurs. *Entrep. Theory Pr.* **2007**, *31*, 909–935. [[CrossRef](#)]
36. Gruber, M.; Harhoff, D.; Hoisl, K. Knowledge Recombination across Technological Boundaries: Scientists vs. Engineers. *Manag. Sci.* **2013**, *59*, 837–851. [[CrossRef](#)]
37. Dechenaux, E.; Thursby, J.; Thursby, M. Inventor moral hazard in university licensing: The role of contracts. *Res. Policy* **2011**, *40*, 94–104. [[CrossRef](#)]
38. Rasmussen, E.; Mosey, S.; Wright, M. The evolution of entrepreneurial competencies: A longitudinal study of university spin-off venture emergence. *J. Manag. Stud.* **2011**, *48*, 1314–1345. [[CrossRef](#)]
39. Babaa, Y.; Shichijob, N.; Sedita, S.R. How do collaborations with universities affect firms’ innovative performance? The role of “pasteur scientists” in the advanced materials field. *Res. Policy* **2009**, *38*, 756–764. [[CrossRef](#)]
40. Grimes, M.G. The Pivot: How Founders Respond to Feedback through Idea and Identity Work. *Acad. Manag. J.* **2018**, *61*, 1692–1717. [[CrossRef](#)]
41. Stryker, S.; Serpe, R.T. Identity salience and psychological centrality: Equivalent, overlapping, or complementary concepts? *Soc. Psychol. Q.* **1994**, *57*, 16–35. [[CrossRef](#)]
42. Hess, S.; Siegwart, R.Y. R&D Venture: Proposition of a technology transfer concept for breakthrough technologies with R&D cooperation: A case study in the energy sector. *J. Technol. Transf.* **2012**, *38*, 153–179.
43. Lam, A. From ‘Ivory Tower Traditionalists’ to ‘Entrepreneurial Scientists’? Academic Scientists in Fuzzy University–Industry Boundaries. *Soc. Stud. Sci.* **2010**, *40*, 307–340. [[CrossRef](#)]
44. Agarwal, R.; Ohyama, A. Industry or Academia, Basic or Applied? Career Choices and Earnings Trajectories of Scientists. *Manag. Sci.* **2013**, *59*, 950–970. [[CrossRef](#)]
45. Bercovitz, J.; Feldman, M. Academic entrepreneurs: Organizational change at the individual level. *Organ. Sci.* **2008**, *19*, 69–89. [[CrossRef](#)]
46. Friedkin, N.E. Norm formation in social influence networks. *Soc. Netw.* **2001**, *23*, 167–189. [[CrossRef](#)]
47. Turner, J.C. *Social Influence*; Thomson Brooks/Cole Publishing Co.: Belmont, CA, USA, 1991.

48. Main, I.; Garnsey, E. Commercializing generic technology: The case of advanced materials ventures. *Res. Policy* **2006**, *35*, 375–393. [[CrossRef](#)]
49. Stern, S. Do Scientists Pay to Be Scientists? *Manag. Sci.* **2004**, *50*, 835–853. [[CrossRef](#)]
50. Hayter, C.S.; Nelson, A.J.; Zayed, S.; O'Connor, A.C. Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *J. Technol. Transf.* **2018**, *43*, 1039–1082. [[CrossRef](#)]
51. Miranda, F.J.; Chamorro, A.; Rubio, S. Re-thinking university spin-off: A critical literature review and a research agenda. *J. Technol. Transf.* **2017**, *43*, 1007–1038. [[CrossRef](#)]
52. Granovetter, M. Economic Action and Social Structure: The Problem of Embeddedness. *Am. J. Sociol.* **1985**, *91*, 481–510. [[CrossRef](#)]
53. Almandoz, J. Founding Teams as Carriers of Competing Logics. *Adm. Sci. Q.* **2014**, *59*, 442–473. [[CrossRef](#)]
54. Scarlata, M.; Zacharakis, A.; Walske, J. The effect of founder experience on the performance of philanthropic venture capital firms. *Int. Small Bus. J.* **2016**, *34*, 618–636. [[CrossRef](#)]
55. Azoulay, P.; Liu, C.C.; Stuart, T.E. Social Influence Given (Partially) Deliberate Matching: Career Imprints in the Creation of Academic Entrepreneurs. *Am. J. Sociol.* **2017**, *122*, 1223–1271. [[CrossRef](#)]
56. Hoang, H.; Gimeno, J. Becoming a founder: How founder role identity affects entrepreneurial transitions and persistence in founding. *J. Bus. Ventur.* **2010**, *25*, 41–53. [[CrossRef](#)]