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Institutional Political Connection, Innovation Alliance and Applied Research Institutes' Innovation – Evidence from China's New Research and Development Institutes

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Abstract: Applied research institutes' innovation performance significantly affects developing countries' technology progress and sustainable development. One important factor affecting these institutes' performance is political connection. Current studies mainly explore the effects of personal political connection (ties with the government linked by individuals). Little research investigates how institutional political connection (ties formed by state ownership) might influence applied research institutes' innovation performance. This research attempts to fill this gap. Drawing on a five-year panel data set of 138 applied research institutes in China, this research finds that institutional political connection negatively affects applied research institutes' innovation performance perhaps due to the over-embeddedness in politics. It also finds that innovation alliance's number and diversity positively moderate institutional political connection's effects on applied research institutes' innovation performance. This research contributes to literature on political connection and literature on applied research institutes.

Keywords: Political connection; Innovation alliance; Applied research institute; Technological innovation

1. Introduction

Applied research institutes bridge the gap between scientific research and commercial application. They are important for a country's prosperity and competitiveness. A great example is the Fraunhofer Society in Germany. Research finds that the Fraunhofer Society has significantly promoted Germany's economic growth. It is said that the

Fraunhofer Society can contribute 1.6% to Germany's annual gross domestic product and more specifically, one euro invested in the Fraunhofer Society can result in twenty one euro growth in Germany's gross domestic product (Fraser of Allander Institute, 2020). It also accounts for the country's 1.0 % employment, 2.4% investment, and 1.1% government revenue (Fraser of Allander Institute, 2020).

Besides developed countries like Germany, some developing countries also witness the growing importance of applied research institutes in technological innovation. For example, in China, some new applied research institutes are emerging. In the late 1990s and early 2000s, to narrow the gap between scientific discoveries and applied products, the Chinese government promoted the development of new applied research institutes - New Research & Development Institutes (NRDIs). NRDIs' are new in terms of institutional form and function. Firstly, NRDIs have multiple institutional forms. China's traditional research institutes are usually public institutes with unitary ownership while NRDIs' institutional forms include public institutes, private companies, state-owned enterprises and social organizations, etc. Secondly, NRDIs are more multifunctional compared to their traditional counterparts. Traditional research institutes usually only perform one function (i.e. research) while NRDIs involve multiple functions including basic research, application-oriented research, investment, incubation, training, marketing, etc. Recently, NRDIs has grown rapidly since the Chinese government issued the "Guiding Opinions on Promoting the Development of NRDIs" in 2019. The NRDIs Report released by the Chinese government in 2023 indicates that by the end of 2021, China had 2,412 NRDIs (Ministry of Science and Technology, 2023). These research institutes hired more than 200,000 professionals and undertook 35,000 research projects (Ministry of Science and Technology, 2023). Applied research institutes have played a significant role in China's technological innovation and economic development.

Due to applied research institutes' social significance, they have attracted considerable attention from academia. However, the current literature has two shortcomings. The first is that few studies examine factors affecting applied research institutes' innovation performance in an emerging market context like China. Considering applied research institutes' importance in developing countries and China's huge role in the global economy, research explaining factors that influence Chinese applied research institutes' innovation performance is needed. The second weakness is that little research explores how institutional political connection (ties formed by state ownership) and the interaction of institutional political connection and innovation alliance might affect applied research institutes' innovation performance. This flaw is a pity given the fact that applied research institutes actively build or nurture political ties (e.g. introducing state capital to create a shared ownership structure) and innovation alliance (i.e. a contract-based, innovation-oriented cooperative entity comprised of multiple actors including firms, research institutes, financial organizations, and higher education institutes) (P. Wang et al., 2016). To fill this gap, this research utilizes resource dependence theory and institutional theory to explore how institutional political connection as well as the interaction between institutional political connection and innovation alliance influence applied research institutes' innovation performance. It mainly makes two contributions to the current literature. Firstly, it makes a contribution to the literature on political connection by clarifying the influence of a certain type of political connection (i.e. institutional political connection) and how political connection's effects can be moderated by innovation alliance. Secondly, it contributes to the literature on developing countries' applied research institutes – New Research and Development Institutes in China.

This paper's remaining parts are organized as follows: the second section reviews relevant literature and proposes several hypotheses; the third section introduces the research design; the fourth section presents the statistical analysis; the final part is conclusion and discussion.

2. Theoretical Background and Hypothesis

2.1 Research on Applied Research Institutes

Extant studies on applied research institute fall into four groups. The first group describes applied research institutes' current situation. Researchers analyze applied research institutes' operating mechanisms (Ma et al., 2021; Yu et al., 2023; F. Zhang et al., 2021), resource commitment (Y. Zhang et al., 2018), development modes (X. Chen & Long, 2017; Conlé et al., 2021; Hui

et al., 2021), management systems (Rao et al., 2022; Ye et al., 2023), technology transfer (Póvoa & Rapini, 2010), innovation process (Kang, 2021), and spatial distribution (Zhao & Dai, 2017). The second group of studies puts forward recommendations to improve applied research institutes' performance. They believe that it is necessary for applied research institutes to make adjustments in talent development, strategic management, and operating mechanisms (Wei et al., 2021; Wu & Xu, 2022; Borsi, 2021; Zhi et al., 2021).

The third group of studies explores the performance evaluation issue. Scholars build various performance indexes based on investments, research output, business incubation, human capital, technology transfer and social impact (M. Deng et al., 2023; B. Yang & Tu, 2018; G. Zhang et al., 2021). Furthermore, scholars utilize advanced statistical methods to evaluate applied research institutes' performance at the city or organizational level (Llanos-Paredes, 2023; Pfister et al., 2021). The fourth group of studies explains the variation in applied research institutes' innovation performance or technology transfer performance (C. Jiang et al., 2023; Mao et al., 2022; Y. Zhang et al., 2022, 2022; E. Zhou & Liu, 2018; J. Zhou et al., 2023). Specifically, these studies indicate that applied research institutes' innovation performance is influenced by investments, infrastructure, government support, institutional origins, operating mechanisms and local socio-economic contexts (C. Jiang et al., 2023; Y. Zhang et al., 2022; E. Zhou & Liu, 2018). However, few studies explore political connection's role in applied research institutes' innovation performance. This paper tries to fill this lacuna.

2.2 Institutional Political Connection and Innovation Performance

Political connection refers to organizations' ties with the government through personal participation or state ownership (Song et al., 2015; B. Yang et al., 2022). Prior studies on political connection direct most of their attention to firms. However, political connection is a prevalent phenomenon in non-firm research institutes in developing countries such as China and India (Mathews & Mei-Chih, 2007).

According to whether the tie is built at individual level or organizational level, there are two types of political connection made by a corporation or social organization. The first is personal political connection which means senior managers' relations with the government (e.g. membership in the state representative body) (Song et al., 2015). The second is institutional political connection referring to an organization's legal relations with the government linked by state ownership (Song et al., 2015). Examples of organizations with institutional political connection include public research institutes and state-owned enterprises. In this research, we mainly focus on institutional political connection.

Institutional political connection benefits an organization's innovation performance in several aspects. According to the resource dependence theory (Krammer & Jimenez, 2020; Lapologang & Zhao, 2023), organizations are not self-sufficient and they exploit necessary resources from external entities. The government is an important entity that applied research institutes rely on for scarce resources. Firstly, institutional political connections might help applied research institutes gain financial resources (e.g. loans, subsidies, tax cuts) relatively easily. As shown by empirical research, compared to organizations without political connections, corporations/institutes with such political connections are more likely to get loans, subsidies, tax breaks and other resources controlled by the government (Farrukh et al., 2023). Secondly, institutional political connections also give organizations an edge on competing for government contracts (Cheng et al., 2019) because politically connected applied research institutes are more likely to gain governments' trust due to their familiarity with these institutes, other things being equal. The procurement from the government can increase organizations' revenues and therefore available funds for research and development. Government procurement also provides a market to test innovations' applicability and a basis for further innovation. Thirdly, ties with the government could help gain information about future innovation policy change (Huang et al., 2021). For example, information about governments' policies to promote renewable energy technologies and limit the application of conventional energy technologies might allow a research institute to invest more resources in developing renewable technologies and cut down R&D funds for conventional technologies in advance. This would help applied research institutes save resources and increase their innovation efficiency

(Dong et al., 2022). Fourthly, institutional political connections bestow on applied research institutes legitimacy and reputation. Political connection can be viewed as a positive signal on the market. Corporations/institutes with political connections are more likely to be viewed as legal, reliable and trustworthy (Dong et al., 2022). This allows organizations to gain more cooperative opportunities and other resources (e.g. investments, contracts), therefore increasing their innovation performance.

Furthermore, institutional political connections play a critical role in shaping the institutional environment which, according to the institutional theory, considerably impact organizations' performance (Barbosa & Faria, 2011; Broberg et al., 2013; Lapologang & Zhao, 2023; North, 1990). In emerging economies without sound formal legal systems, political connections can be regarded as the substitute for formal political institutions. Institutional political connections can help protect organizations' intellectual property rights and facilitate the enforcement of contracts. Intellectual property rights protection motivates organizations to innovate because well protected technological patents can bring about huge revenues after being applied for commercial use (Kwak et al., 2023). Successful contract enforcement helps maintain fairness among parties and smooth the functioning of innovation-related business transactions (e.g. patent transfer).

Although institutional political connections have a positive influence on innovation performance, its negative effects cannot be ignored. Firstly, the abundant available resources provided by the government might make organizations less motivated to innovate as they can survive without much innovation compared to their counterparts (Liu et al., 2021). Less competitive pressure gives organizations fewer incentives to become innovative. Secondly, ties with the government can result in over-embeddedness and reduce organizations' investments in innovation (Díaz-Díaz et al., 2022). The government gives corporations/institutes resources not for free. It might ask political connected organizations to help achieve some political goals. For example, the government might urge corporations/institutes to hire redundant staff to maintain social stability. Also, due to their concern for political promotion, government officials might encourage local organizations to produce less innovative (but profitable) products for short-term economic growth (an important indicator for evaluating officials' capability) rather than investing resources for high-quality innovations (Krammer & Jimenez, 2020). Achieving these political goals might result in organizations' fewer investments in technological innovations and decrease their innovation performance.

Based on the above analyses, we come up with the following hypotheses:

H1a: Applied research institutes with institutional political connections are more likely to have better innovation performance in comparison with those without such ties.

H1b: Applied research institutes with institutional political connections are less likely to have better innovation performance in comparison with those without such ties.

2.3 The Moderating Role of Innovation Alliance

Ignoring innovation alliances' moderating role in innovation performance is another gap in extant literature. Although current studies explore how organizations' innovation performance might be affected by alliances' configuration (e.g. horizontal or vertical in the industry chain) (Shin et al., 2016, p. 201; Y. Wang et al., 2022), quantity (Satta et al., 2016; J. Zhang et al., 2019; S. Zhang et al., 2020), diversity (e.g. functional, sectoral, geographic, cultural) (Lucena & Roper, 2016; Elia et al., 2019; C. H. Wang & Quan, 2017; Silva Queiroz et al., 2023), value chain position (e.g. downstream or upstream) (Ardito et al., 2019), and internal industry cognitive distance (Filiou & Massini, 2018), they rarely discuss innovation alliances' moderating effects on innovation performance.

Besides political connections, corporations/institutes also build social connections. One of the most important social connections is joining an innovation alliance. An innovation alliance is a contract-based, innovation-oriented cooperative entity comprised of multiple actors including firms, research institutes, financial organizations, and higher education institutes (P. Wang et al., 2016). Innovation alliances can be seen as a network which can cultivate trust and promote resource sharing among network members (Z. Yang & Wang, 2022). According to social network theories, innovation alliances have two major positive effects on alliance members (Z. Yang & Wang, 2022). Firstly, innovation alliances provide numerous and diverse resources for members. Innovation alliances can

provide some resources such as market information, advanced research infrastructure and advanced technological know-how which cannot be conveniently provided by political connections. With resources (especially diverse resources) from non-state actors, organizations can innovate more efficiently. Secondly, innovation alliances cultivate mutual trust among members by providing a platform for members to interact with each other. This trust can promote cooperation among members to make combined efforts to conduct innovative projects. As a result, all members' innovation performance would be enhanced. Based on this analysis, it is reasonable to argue that if politically connected research institutes join innovation alliances, their innovation performance would be better than other politically connected organizations which do not join. Moreover, if politically connected research institutes participate in innovation alliances with high-level diversity (i.e. having diverse members), they might be more innovative than other institutes joining innovation alliances with low-level diversity.

Based on this discussion, we propose the following hypotheses:

H2: The number of innovation alliances joined by an applied research institute can positively regulate institutional political connection's effects on its innovation performance.

H3: Alliance diversity can positively regulate institutional political connection's effects on its innovation performance.

3. Research Design

3.1 Sample and Data

This research's sample is China's NRDIs. As the largest emerging economy, China's experience might be representative and thus enlightening for other developing countries. Specifically, we focus on China's Guangdong Province. Guangdong Province is China's first sub-national region to build NRDIs. NRDIs in this province have rich experience and relatively mature operating mechanisms. Other sub-national regions have seen Guangdong as a role model and attempted to establish their own NRDIs. It is reasonable to say that Guangdong's NRDIs are typical and representative in China (Ou et al., 2019).

We choose all active NRDIs in Guangdong Province during 2017-2022 as our sample. We collect data from local authorities' official websites, NRDIs' websites, online newspapers, Tianyancha (a commonly used online business information platform), the China National Intellectual Property Administration's official website, Soopat patent information platform, etc. The final sample size is 138 after deleting NRDIs which have atypical or missing data. We build a strongly balanced panel data set containing these 138 NRDIs during 2017-2022.

3.2 Measurement of Variables

The dependent variable is NRDI's innovation performance. Following other scholars, we use the number of patent applications to measure NRDIs' innovation performance (E. Zhou & Liu, 2018). Given that relevant factors have lagged effects on technological innovation, this research uses patent data lagged one year.

The key independent variable is institutional political connection, we follow other scholars to measure it as the proportion of a NRDI's ownership that is belonged to the government (Song et al., 2015).

There are also two independent variables related to innovation alliance. It is necessary to firstly clarify the measurement of innovation alliance participated by a NRDI before discussing these variables' measurement. As mentioned before, an innovation alliance is a contract-based, innovation-oriented cooperative entity comprised of multiple actors (P. Wang et al., 2016). There are three approaches to check whether a NRDI has joined an innovation alliance. Firstly, we find out information on a NRDI's official website. For instance, Guangdong HUST Industrial Technology Research Institute's official website (http://www.hustmei.com/index.htm) indicates that it has been a member of three innovation alliances. Secondly, we conduct a thorough search of local online newspapers (e.g. Guangzhou Daily, Shenzhen Economic Daily) to find out the alliance which a NRDI participates in. The search terms are: NRDI's name + innovation alliance. Thirdly, using similar terms, we search local authorities' official websites for information related to NRDI's alliance membership. After determining the innovation alliances that a NRDI has participated in, we exploit information gained from innovation alliances' official websites and other channels (e.g. newspaper, documents) to evaluate whether this alliance is consistent with the definitions given before (P. Wang et al., 2016). Specifically, the

alliance will be included in the research if it satisfies the following criteria: 1) relying on agreements/ contracts to organize the entity; 2) having at least two members; 3) mainly focusing on improving technological innovation.

On the basis of the information related to innovation alliances, we then measure two alliance related moderating variables: number of alliances and alliance diversity. Number of alliances refers to the number of innovation alliances that a NRDI joined in by the end of 2022. As for the second moderating variable alliance diversity, this research is in line with business management literature and measures it as diversity index (which is also called the Blau index) (Collins & Riley, 2013). The diversity index's minimum value is 0 and its maximum value is 1. Index value 0 indicates that this group is fully homogenous while index value 1 refers to a completely heterogenous group. The calculation formula for diversity index is: 1−∑(Pi^2) (Collins & Riley, 2013). P means the proportion of members falling into a certain category while I refers to the category's sequence number. In line with management scholars (R. J. Jiang et al., 2010),we classify alliance members into the following four categories: manufacturing enterprises (the first category), universities (the second category), research institutes (the third category) and others (the fourth category). For instance, if there is an innovation alliance comprised of ten members including three manufacturing enterprises, three universities, three research institutes and one commercial bank, then this alliance's diversity index score is 1-(3/10)^2-(3/10)^2-(3/10)^2-(1/10)^2 = 0.72. If a NRDI joins more than one alliance in a given year, the value on the variable (alliance diversity) is coded as the mean of all these alliances' diversity index values. This is acceptable as using the average to code variables is common in social sciences research (Vanino et al., 2019)

Since innovation activities might vary across different types of industries, we control for industry types that NRDIs fall into. Following other scholars (Xu & Li, 2020),we divide NRDIs into three types: labor-intensive, capital-intensive and technology-intensive, according to the specific industry that they belong to. For example, the food industry belongs to the labor-intensive category while the metallurgical industry and computer industry are capital-intensive and technology-intensive respectively. Based on this, we create three dummy variables (industry_a, industry_b and industry_c) corresponding to the labor-intensive, capital-intensive and technology-intensive category. If a NRDI falls into a particular type, then we will code 1 on the related dummy variable. Otherwise, we code it as 0. Soopat database provides the relevant information and we exploit it to do the coding.

We also control for variables at the organization level and regional level based on the data from Tianyancha, NRDIs' official websites, local newspapers and statistical yearbooks. The first control variable is individual political connection. In line with business management scholars (Song et al., 2015), individual political connection is measured as senior managers' membership in China's state power organizations including the Chinese People's Congress (CPC) (the highest state power organ in China), or the Chinese People's Political Consultative Conference (CPPCC) (a political advisory organization providing social issue-related advice for government agencies). If a NRDI's senior management has membership in either state power organizations, then the value on this variable is coded as 1. Otherwise, the value is 0. Other organizational level variables include organization type, age, size and registered capital as research finds that these characteristics at the organizational level might affect innovation performance (T. Chen et al., 2024). The regional level control variable included in the model is city's economic condition, measured by GDP per capita (10 thousand RMB). Local economic conditions might influence investments, human capital, cooperative opportunities, technology support and other resources that a NRDI can benefit from (J. Deng et al., 2019). It may have a direct or indirect impact on NRDI's performance and we use it as a control variable. Data drawn from China Statistical Yearbooks is used to code this variable. **Table 1** summarizes all variables' measurement and data sources.

Table 1 Measurement of Variables and Data Sources

Variables	Measurement	Source
Innovation performance	Number of patent applications	Soopat database, China National Intellectual Property Administration official websites

Continuation Table:

Variables	Measurement	Source
Institutional political connection	The proportion of state ownership	Tianyancha, local newspapers; NRDI's official websites
Number of alliances	Number of alliances which a NRDI participate in	NRDI's official websites, local newspapers
Alliance diversity	Alliance's diversity index (Blau index) = $1-\sum(P_i)^2$; for a NRDI joining several alliances, the value is the average.	NRDI's official websites, local newspapers
Individual political connection	Whether a NRDI's managers have membership in China's state power organizations including the Chinese People's Congress (CPC) (the highest state power organ in China), or the Chinese People's Political Consultative Conference (CPPCC). Yes = 1, no = 0.	Tianyancha; local newspapers; NRDI's official websites
Industry type	Whether a NRDI belongs to a certain industry type; yes = 1, no = 0.	Soopat patent database
type	Whether a NRDI is a public institute or not; yes = 1, no = 0.	NRDI's official websites; Tianyancha
Size	Number of employees	NRDI's official websites, local newspapers, Tianyancha
Age	Years of existence	NRDI's official websites, local newspapers, Tianyancha
Registered capital	Total amount of capital committed to invest in a company	NRDI's official websites; Tianyancha
Local economic condition	GDP per capita	China City Statistical Yearbooks 2018-2022

3.3 Descriptive Analysis and Statistical Models

This research utilizes the negative binomial regression model to test the hypotheses. The dependent variable is non-negative count data and linear regression models are not suitable. Among non-linear regression models, the negative binomial regression model is preferable because the dependent variable's mean and standard deviation are not equal. Compared to other non-linear regression models such as the Poisson model, the negative binomial regression model can better judge the root-mean-square error and the significant level. For this reason, we use the binomial regression model to do the data analysis based on the panel data. **Table 2** reports the descriptive statistics and independent variables' variance inflation factor (VIF). VIFs of the dependent variable and the dummy variable industry_a (used as the reference group) are not available. The remaining independent variables' VIFs are all smaller than 10 which suggests that multicollinearity problem is not a concern (Robinson & Schumacker, 2009) and regression analysis can be effective. We conduct Hausman tests on every model and then use random-effects or fixed-effects model to do the regression based on the test results.

Table 2 Descriptive Statistics and Variance Inflation Factor (VIF)

	Obs	Mean	Std. Dev.	Min	Max	VIF
Innovation performance	690	14.0812	50.5677	0.0000	743.0000	Not available
Institutional political connection	690	0.4652	0.4735	0.0000	1.0000	5.3700
Number of alliances	690	0.7319	1.2056	0.0000	9.0000	2.6800
Alliance diversity	690	0.2265	0.2859	0.0000	0.7439	2.2400
Individual political connection	690	0.1304	0.3370	0.0000	1.0000	1.2000
Industry_a	690	0.2826	0.4506	0.0000	1.0000	Not available
Industry_b	690	0.2319	0.4223	0.0000	1.0000	1.4900
Industry_c	690	0.4855	0.5002	0.0000	1.0000	1.7500
Type	690	0.3768	0.4849	0.0000	1.0000	5.6600

Continuation Table:

	Obs	Mean	Std. Dev.	Min	Max	VIF
Size	690	197.8333	410.4908	5.0000	3000.0000	1.4900
Age	690	9.5739	7.1121	0.0000	39.0000	1.5100
Registered capital	690	3853.9816	6869.8721	1.0000	41408	1.2700
Local GDP Per Capita	690	12.7415	4.5089	3.0825	20.3489	1.2400

4. Results and Robustness Check

4.1 Results

Model 1-3 present the regression results. We conduct chi square tests for each model and the tests show that all models have some explanatory power (significant at the 0.01 level). Model 1 examines institutional political connection's effects on NRDIs' innovation performance. Model 1 shows that institutional political connection has significant adverse effects on NRDIs' innovation performance (the coefficient is negative and significant at 0.01 level). This is probably due to the detrimental effects of over-embeddedness caused by institutional political connection. Compared to individual political connection, institutional political connection are more likely to make NRDIs become over-embedded in politics. NRDIs with institutional political connection (i.e. becoming state-owned or partially state-owned institutes) might be greatly affected by the government and may allocate resources (which can be used for innovation) to achieve political goals (e.g. investing in producing less innovative products to boost short-term economic growth desired by officials; hiring unnecessary staff to provide extra job opportunities for the purpose of maintaining social stability). Due to the effects of over-embeddedness brought by institutional political connection, NRDIs' innovative progress might be slowed down. Thus, the results provide support for hypothesis 1b (institutional political connection negatively affects NRDIs' innovation performance). Model 1 also indicates that there is a positive correlation between individual political connection and innovation performance (the coefficient is positive and significant at the 0.01 level). Individual political connection might promote NRDIs' performance by providing more resources (e.g. loans, social reputation) or creating better institutional environments (e.g. enabling the enforcement of contracts). At the same time, individual political connection's negative effects (e.g. assuming social responsibilities and hiring redundant staff) are limited. This might be partially because individual political connection is a relatively superficial connection (e.g. institutes' ownership is not legally controlled by the government) and institutes remain autonomous to make innovation related decisions, preventing the negative influence exerted by over-embeddedness in politics. This is in contrast to institutional political connection which makes research institutes deeply involved in political concerns. Overall, individual political connection's positive effects surpass its negative effects.

Model 2-3 test alliance number's moderating effects on political connection. As shown by model 2, alliance number positively moderates institutional political connection's influence. As illustrated by the simple slope analysis (**Figure 1**), when NRDIs are involved in a large number of alliance networks, institutional political connection's negative effects on innovation performance are reduced. By contrast, when NRDIs join a small number of alliances, institutional political connection's adverse effects on innovation activities become larger. It is possible that alliance number (alliance resources) can help NRDIs overcome the negative effects of over-embeddedness. With abundant resources from alliances, NRDIs rely less on the government for resources and thus act more autonomously to implement policy decisions promoting innovation activities rather than fulfilling political goals only. Similarly, model 3 indicates that alliance diversity positively regulates institutional political connection's detrimental effects. Diverse resources provided by alliances help solve the problem of over-embeddedness in politics and enable NRDIs to become autonomous and more innovation-oriented. In fact, when alliances become more diverse, institutional political connection's adverse effects turn more insignificant as illustrated by the simple slope analysis (**Figure 2**). Overall, hypothesis 2 and hypothesis 3 pass the test.

Table 3 Negative Binomial Regression Results

	Dependent variable = innovation performance		
	Model 1	Model 2	Model 3
Institutional political connection	-1.32495***	-1.64828***	-1.91701***
Number of alliances	0.13903***	-0.24674*	
Alliance diversity	0.52051*		-0.25443
Number of alliances * Institutional political connection		0.42437***	
Alliance diversity * Institutional political connection			1.91939***
Individual political connection	0.51515***		
Industry_b	0.87074***	1.06916***	0.94598***
Industry_c	0.17371	0.37506	0.34894
Type	1.53007***	1.32425***	1.55505***
Size	0.00077***	0.00113***	0.00062***
Age	-0.02428*	-0.03303**	-0.01883
Registered capital	-0.00000	0.00000	0.00000
Local GDP per capita	0.04331**	0.04079**	0.03223*
Observations	640	640	640
Fixed or random effects	Fixed	Fixed	Fixed

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

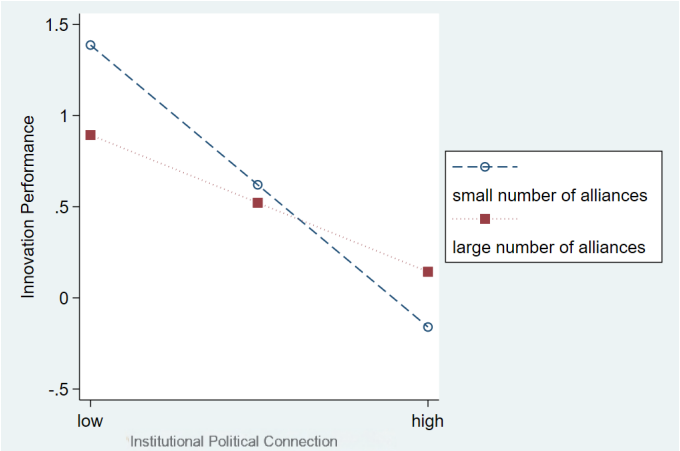

Figure 1 Moderating Effects of Alliance Number

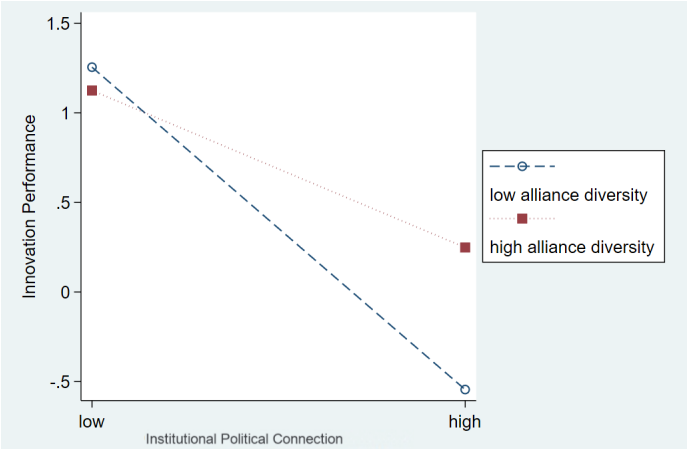

Figure 2 Moderating Effects of Alliance Diversity

4.2 Robustness Check

In accordance with some management literature (Q. Chen et al., 2020), we use winsorized data (i.e. data after transforming extreme values) to do the robustness check. Since there are outliers in registered capital, we winsorize the data at 1% percentile based on this variable and then use the winsorized data to redo the regression analysis. It turns out that major independent variables and interaction terms are still significant (**Table 4**). Similarly, we winsorize the data at the 1% percentile based on size and then used the data to redo the regression analysis. The main results remain significant.

Table 4 Robustness Check

	Dependent Variable = Innovation Performance		
	Model 1	Model 2	Model 3
Institutional political connection	-1.32419***	-1.64728***	-1.91284***
Number of alliances	0.13884***	-0.24582*	
Alliance diversity	0.52357*		-0.24186
Number of alliances * Institutional political connection		0.42323***	
Alliance diversity * Institutional political connection			1.90659***
Individual political connection	0.51521***		
Industry_b	0.87005***	1.06818***	0.94546***
Industry_c	0.17386	0.37375	0.34723
Type	1.53090***	1.32535***	1.55575***
Size	0.00077***	0.00113***	0.00062***
Age	-0.02403*	-0.03280**	-0.01848
Registered capital	-0.00000	0.00000	0.00000
Local GDP per capita	0.04347**	0.04094**	0.03244*
Observations	640	640	640
Fixed or random effects	Fixed	Fixed	Fixed

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Moreover, we recode institutional political connection as a dummy variable. If a NRDI has more than 50 percent state ownership, it is coded as having institutional political connection in a strict sense. Otherwise, the value on this variable is 0. We also recode type by changing the reference group. If a NRDI is an enterprise, it is coded as 1. Otherwise, we code it as 0. We find that using these recoded variables to do regression analysis does not change the results. Institutional political connection and interaction terms' effects remain significant.

Thirdly, given that there is a possible reverse causality between institutional political connection and innovation performance. For example, NRDIs with better performance are more likely to be selected by the government and their senior leaders are more likely to be given a membership of the state power organ. Considering this possibility, we lagged the independent variable one year behind the dependent variable and did the analysis. Political connection's effects on innovation performance are still significant and consistent with the previous analysis. Since the independent variable is lagged behind the dependent variable, the reverse causality can be excluded. Therefore, our results remain robust.

To further solve the problem of endogeneity, we build two instrumental variables and redo the statistical analysis. In line with political economy scholars (Fisman & Svensson, 2007), we use the independent variables' location-industry (i.e. town-industry in this research) mean values to create the instrumental variable. The rationale behind this approach is that location-industry mean values of an independent variable positively correlate with individual institutes' values on this variable but do not affect the outcomes (Fisman & Svensson, 2007). Specifically, we utilize the two-stage-least-square method to test the finding's robustness. To begin with, we test whether our

instrumental variable is weak. The F test in the first stage analysis (F statistic is greater than 10) indicates that this instrumental variable is not weak. The second stage suggests that our independent variable significantly affects innovation performance. This means that our analysis is robust.

5. Conclusion and Discussion

5.1 Conclusion

This paper investigates institutional political connection's effects on innovation performance based on a panel dataset of 138 Chinese applied research institutes (NRDIs). It finds that institutional political connection negatively affects innovation performance probably due to the adverse effects of over-embeddedness in politics while individual political connection has positive effects on innovation performance. Moreover, alliance number and alliance diversity positively moderate the relationship between institutional political connection and innovation performance probably because alliance networks provide alternative channels for NRIDs to get resources and thus avoid being over-embedded in politics.

5.2 Contribution

This paper makes two contributions to the current literature. Theoretically, it contributes to political connection literature. Previous studies rarely pay attention to an important type of political connection – institutional political connection. This research focuses on institutional political connection's effects on innovation performance and it furthers our understanding about the nuanced relationship between political connection, innovation alliance and innovation performance by clarifying that institutional political connection's effects on innovation performance can be moderated by alliance numbers and alliance diversity. Empirically, it makes contributions to the applied research institutes literature by examining political connection's effects on applied research institutes' innovation performance. Previous research on applied research institutes rarely explains innovation performance from a political connection perspective. This paper, drawing on resource independence theory and institutional theory, provides a political connection based perspective to understand applied research institutes' innovation performance.

5.3 Policy Implication

This research has several policy implications. Firstly, applied research institutes can benefit from building political connections which provide easier access to financial resources, government-backed market as well as facilitate intellectual property rights and contract enforcement. Secondly, over embeddedness in politics (i.e. strong institutional political connection) might negatively affect institutes' innovation performance as institutes might sacrifice innovation oriented goals for political goals. Newly established research institutes might consider avoiding being overly involved in politics while maintaining personal political connections with the government. Thirdly, institutes can alleviate the negative effects of political connections by joining innovation alliances and increasing their innovation alliances' diversity.

5.4 Limitation

This study has several limitations. Firstly, the empirical evidence is from a southern province in China, and whether the findings based on this data can be applied to other Chinese regions (e.g. Jiangsu Province, Shandong Province) or other countries (e.g. India, Indonesia, Vietnam) remains unknown.

Secondly, the measurement of some variables might be flawed. For example, using patent applications to measure innovation performance is controversial as there is a gap between patents and innovations (e.g new products on the market).

Data availability:

The data is available on request from the corresponding author.

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