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Reducing Information Frictions via High-Speed Rail: Infrastructure-Driven Efficiency in Government Innovation Subsidies

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Abstract: *Government subsidies for innovation are critical policy instruments but often suffer from inefficiencies due to severe information asymmetries between funding agencies and applicant firms. This study leverages the staggered introduction of high-speed rail (HSR) in China as a quasi-natural experiment to examine whether improved physical infrastructure can alleviate such frictions. Using panel data of 3,296 listed firms across 281 prefecture-level cities from 1999 to 2021, we find that the operation of HSR significantly increases the likelihood of firms receiving government innovation subsidies. This effect is especially pronounced for small firms and those with a high proportion of intangible assets, where information opacity is more severe. Moreover, firms located in HSR-connected cities demonstrate stronger post-subsidy performance, suggesting that better information environments enabled by HSR enhance the selection and effectiveness of subsidy allocation. Our findings highlight an important and previously overlooked mechanism: by reducing spatial-temporal distance and facilitating face-to-face communication, transportation infrastructure plays a critical role in converting firm-specific private information into accessible public knowledge. This enhances governmental screening accuracy and subsidy efficacy. The study contributes to literature on innovation policy, infrastructure economics, and information asymmetry, and offers practical insights for designing more effective innovation support schemes in emerging economies.*

Keywords: *High-speed Rail, Government Innovation Subsidies, Information Asymmetry; Quasi-natural Experiment*

1. Introduction

Government programs to finance firms in innovations have attracted a lot of attention in academics and policymaking communities[1]. The main rationale for government to support firm innovations lies in the belief that social returns from the firms' research and development (R&D) investments may exceed their private returns due to the externalities of innovation. Government thus presenting the public and the society has to fix these externalities from innovations to subsidize firms. However, an extensive literatures from innovations, public financing, and regulatory fields have documented that knowing the reason to subsidize innovations does not mean that government is good at doing that in reality because government innovation subsidies might be distorted by the desire of particular interest groups, screening criteria, and adverse selections of firms' fraud conducts[2–4].

Scholars from a broad range of research fields thus start to understand the effectiveness and efficiency of government subsidization programs[5–7]. A key issue prevents governments from effectively subsidizing is governments' information disadvantages in evaluating the quality of applicant firms. Governments, proxied by their screening jury members have incomplete information about the grant applicants and their projects, and more importantly, the applicants have strong incentives to cheat governments by fabricating their application documents because in this way they can obtain additional finance resources and other benefits without costs or little costs[8]. As Stuart and Wang (2016)[4] states that in the case of China, to obtain a state-funded innovation grant, firms often exaggerate their profit levels and to over-state their innovation capabilities and technical achievements. Asymmetric information thus exists between governments and firms, and the governments are in the information disadvantage side. To overcome this information asymmetry previous have provided seminal insights.

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For instance, in Chen and colleague's (2020)[2] work they set their study as an emerging economy, and argue that firms invested in emerging countries by foreign investors in the stock markets would be considered as a valuable signal for governments to select qualified candidates for subsidizing because foreigner investors have information advantages than governments owing their professional analysis and the fact they already putting their money on prospectus firms.

This paper comes under this line of inquiry by present other means that could alleviate governments' information disadvantage. We argue that government might benefit from the HSR's information spillover effect to mitigate its information disadvantages in subsidizing caused by their less information and knowledge about the subsidies applicants. As of 2020, China has the global longest and busiest HSR network with 391,000 kilometers of track in service, connections between more than 200 cities, and an annual ridership of 2 billion. Based on the background of the rapid development of the construction high-speed railways in China in last two decades, we select the opening of high-speed railways as a representative event and empirically its influence on government innovation subsidization. Using a panel of 3,296 firms between 1999 and 2021 in China's 281 prefecture-level cities, we find the operation of HSR strengthens government innovation subsidization, in terms of firms in HSR operating cities have a higher likelihood to be granted innovation subsidies, and this positive correlation is more pronounced in small sized firms and those with a higher proportion of intangible assets.

The rest of this paper is structured as follows. Section 2 reviews the theoretical backgrounds and develops hypotheses. Section 3 describes the data sources and research methods. Section 4 reports the empirical results and conducts a serial of robust checks. Section 5 closes this paper by discussing our results and concluding the study.

2. Theory & Hypotheses

The theoretical foundation of this study rests on information economics, particularly the information asymmetry theory. In Akerlof's (1970)[9] seminal work, he explained how asymmetric information distributed between buyers and sellers leads to failure in the second-hand car market. Analogously, the government innovation subsidizing market faces the same problem. Government and their project screening jury searching for qualified and prospectus innovative firms have incomplete information about the applicants' finance situations, technical advances, growth prospects, asset qualities, key technologies, corporate cultures, development history, and management team, and other detailed aspects of prospective candidates. Such private information is critical in evaluating the quality of applicants, which will have a substantial influence on the effectively usage of government money, and accordingly firm performance.

Thus, governments are often constrained by a lack of information, particularly and knowledge in appropriately assessing the innovation potential, assets, and abilities of firms to successfully conduct their subsidized projects and ensure the government's money have make great sense for society. Even if the applicant already reports some important information in their applications, and likely willing to disclose information to the potential acquirer, such information may not be credible[4], because applicants often fabricate their data in applications. Note, as required by securities law, public listed firms have to disclose finance and other important information to public, and thus this type of information is available for everyone. Information on others, such as mentioned above, like firms' technical skills, human capital, and leaderships is not[10]. Thus, even for public listed firms, there is still severe asymmetrically distributed information existing between firms and external stakeholders[11], like government.

Therefore, such information asymmetry between firms and governments generates barriers in screening process and the government needs to rely on other channels to overcome it. Chen et al. (2020)[2] introduce the investments by foreign institutional investors as a reliable signal. Here, we propose that government may rely on the operation of HSR in the city, and the consequent information spillover role to improve their subsidizing work because the HSR opening could help convert firm private information to public information that might disseminate to innovation subsidies jury members. We explain as follows.

Prior studies regarding firms' geographical location and information have documented that the spatial distance between the firm and external stakeholders is the main factors causing information problem[12]. These studies assume that the degree of geographical proximity between economic participates impacts the information disclosure, transmissions, disseminations, and thus result the quantity, quality, and timeliness difference for distributed agents in different locations. In essence, the spatial distance is relevant to the time distance between different economic agents because the spatial distance is often correlated to the time distance[13], for instance, going to distant place means the need of more time to

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reach there. The spatial or time distance thus have the effect on information asymmetry between geographically distribute agents.

High-speed railways, generally with an average speed above 200km/h dramatically shortens the time and space distance between cities, which in turn promote the face-to-face communications from different locations[14,15]. Taken China's first line of HSR as the example. In 2008, China opened its' first HSR service line between Beijing and Tianjin. The travel time between Beijing and Tianjin decreased significantly from approximate two hours to 30 minutes. One major effect of HSR is to speed up the mobility of people for business, and lease out more public information that converted from firm private firms due to the rapid and frequent face-to-face communications. According to a report released by the World Bank, the number of passengers taking HSR in 2014 increased from 128 million in 2013 to 672 million, and most of the passengers with ages between 25 and 55, and many of them travel for business purpose. Hence, it is likely to infer that the operation of HSR could significantly foster the endeavors of stakeholders to conduct field visits, and investigations of firms, thus facilitates access to firm information, particularly private information[7]. When a lot of private information was converted to public information, the asymmetry information between governments and firms are likely alleviated[16]. This is HSR's spillover effect beyond riding passengers. Triggered by the HSR, information collection, analysis, and transmission of firms' private information by market participants increases the information completeness, accuracy and timeliness and thus would improve governments' subsidizing screening work, and we thus have the following main hypothesis:

Hypothesis 1: Firms in HSR operation cities have a higher likelihood to obtain government innovation subsidies.

It is note that the rapid development of communication technology, like Wechat, Zoom can help stakeholders obtain firm information from remote locations, however, this technique is hard for them to obtain critical important private information[17]. Thus, the spatial distance still works in limiting the private information delivery which would thus further highlight the information role of HSR in government innovation subsidizing. Next, we develop two hypotheses regarding the boundary conditions of hypothesis 1. Moderation model is a typical means to strengthen the core argument in our main hypothesis[18]. First, we discuss the role of firm size. Small firms, less well-known companies that are often subject to severe information problems[19]. The main reason is that compared to large firms, small firms on one hand might lack a history regarding their performance, product records, status, honesty, reputation that could solve the asymmetric information problems[20], and on the other hand, small firms would receive less attention from the media, investment analysts, investors, and suppliers, customers, and other market intermediaries[21,22]. This leads to less information available for outsiders. So, when the city opening the HSRs, small firms should benefit more in increasing their information availability. In extant literature, firm size is generally considered as the proxy for information asymmetry[23,24], thus we develop the following hypothesis,

Hypothesis 2: The positive relationship between the opening HSR and the likelihood firms obtain government innovation subsidies is stronger in small-sized firms.

A major part of firm private information regarding the firm's intangible asset, which is likely to create asymmetric information between insiders and outsiders. Firm intangible assets refers to technology or proprietary knowledge, such as intellectual property, i.e., patents, brands, copyrights, and other terms with a broader meaning, such as production processes, firms' networks, reputations, culture, R&D processes[25,26]. Intangible assets differ from tangible assets in many aspects, such as publicness, depreciation, transfer costs, and variety, extension and enforcement of property rights[27]. These assets are distinctive or unique to the firm[28], thus hard to be understand by outsiders. Information and knowledge about the quality of firms consisting of a higher proportion of intangible assets thus is less readily available to the public in the pre-HSR era[29]. When the cities are connected by HSR, then these firms thus could benefit more from the HSR information spillover because compared to those firms with a small proportion of intangible assets which are already relative well known by outsiders, these HSR information effect should be stronger. Based on these considerations, we expect the relationship between HSR operation and the likelihood of being given government innovation subsidies will be moderated by the proportion of intangible assets. Thus, the following hypothesis has been developed,

Hypothesis 3: The positive relationship between the opening HSR and the likelihood firms obtain government innovation subsidies is stronger in firms with a higher proportion of intangible asset.

To further illustrate the correctness of our main logic developed in hypothesis 1, we develop an additional hypothesis related to the performance implication of government innovation subsidies for received firms. Previous studies show inconsistent results related to the effect of government innovation

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subsidies on firm performance[7,8]. According to Cohen's (2002)[30] literature review that although this inconsistent results, most studies find a positive relationship between innovation subsidies and recipient firm performance. The main underlying mechanisms can be explained in two different aspects. First, from a resource-based view, government subsidies provide additional financial resources that are particularly beneficial for firms with lower acquisition costs and are crucial for those lacking internal resources. Second, from an information economics perspective, government innovation subsidies signal the quality of certified firms to external agents, such as investors. This helps mitigate information asymmetries that might otherwise preclude certain investments or market transactions. However, these mechanisms are working based on a precondition that governments' pre-screening process is effective. However, as discussed before that government subsidizing processes are often distorted by various conditions (Stuart and Wang, 2016). In this study we introduce the role of HSR with the efforts to remedy the information asymmetry issue or ensure the effective way that the government has used, thus resulting qualified grant recipients, meaning those would meet governments' expectations and make innovation and economic sense. If this argument is correct, then we might observe that firms in HSR operation cities received government innovation subsidies are more likely to improve their performance in the post grant time.

Hypothesis 4: Firms in HSR operation cities received government innovation subsidies are more likely correctly make use of the subsidies, and thus enhance their performance.

3. Data &Method

3.1 Sample

For data on the opening of high-speed railways, we rely primarily on 12306 China Train Official Website, and select the high-speed railways information from the Train Schedule Book (2008-2018). It includes detail information of departure station, arrival station, departure time, arrival time and so on. The governmental innovation subsidy data has been downloaded from the WIND, other firm information comes from the China Stock Market & Accounting Research Database (CSMAR), such as firm size, firm age, and financial indicators. In addition, several prefecture-level factors come from China City Statistical Yearbook.

To construct the research dataset, we sample listed firms that affiliated with the Shenzhen Stock Exchange and Shanghai Stock Exchange. We then identify cases in which firms received governmental subsidy during 2003-2021. After accounting for missing data, extreme data and outliers, we arrive at a sample of 3296 firms located in 281 prefecture-level cities, and a final sample size of 22,998 firm-year observation.

3.2 Variables

Dependent Variable: Governmental innovation subsidy (*Subsidy*). In the WIND, we get the information about the amount of governmental innovation subsidy. In order to keep the data more stable and reduce the common linearity of the model, the logarithm value of subsidy has been adopted in the model.

Independent variable: HSR operation (*HSR*). We have got the information about the opening time of high-speed railways, and we can see that HSR operation of prefecture-level city is gradual. Therefore, according to the previous studies[2,31], time-varying Difference-in-Difference (DID) method is suitable for this study. The research sample is divided into two parts: treat group and control group. If the city has opened the high-speed railways during the observation period, the treat=1, otherwise the treat=0. In addition, if the city has opened the high-speed railways in the observation year or before, the time=1, otherwise=0. And finally, we define HSR=treat*time.

Moderate variables: Firm size (*Size*) and Intangible assets ratio (*Intangible*). According to the hypothesis of this study, firm size may have influence on the HSR operation and governmental innovation subsidy. The logarithm of firm's total assets has been regarded as the proxy variable of firm size[32]. Another conditional variable is intangible assets ratio, which is measured by the ratio of intangible assets amount to total assets amount.

Control variables: In the firm level, we have controlled the following variables. *ROA* (the ratio of net profit to total assets), innovation is an economic activity that needs high investment[33], so the profitability may have influence on the firm innovation activities. *LEV* (the ratio of total debts to the total

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assets), the financial risk is an important factor during the review of governmental innovation subsidy. *Duality* (whether the CEO and the chairman are in the same concurrently), innovation is an high-investment and high-risk activity, if CEO faces strict assessment from the chairman and other shareholders, then the innovation activity may be less implemented[33]. *Age* (the observation year minus the establishment year of firms), age is an important factor among the conditions for firms to receive subsidy. *State* (whether the firm is belonged to state-owned enterprises). *Independent* (the ratio of independent directors to all directors), which reflects the corporate governance. In the regional level, several variables have been controlled. First, *GDP* (the logarithm of gross domestic product), usually, the regional economic development level has a positive relationship with firms' development situation[34]. *Researcher* (the logarithm of personnel engaged in scientific research and technical research), the greater the number, the region focuses more on innovation and development. *Sub-amount* (the logarithm number of companies funded in region in the past three years), regional past performance may have influence on the later performance.

3.3 Methods

The opening of high-speed railway is a top-down policy result, which can be seen as a quasi-natural experiment. In response to this policy effect, DID method is usually preferred. However, the opening of high-speed railway is not spread all at once, it is gradual and need five years or more from planning to actual operation. Therefore, time-varying DID is a better choice for this situation. In the main analysis, we mainly want to find out whether there is a causal relationship between HSR operation and governmental innovation subsidy. In the alternative analyses, we would like to verify whether the mechanism of this study is reasonable. Several models are shown in here.

$$\boldsymbol{Subsidy_{it} = \partial_0 + \partial_1 HSR_{it} + \partial_2 Size_{it} + \partial_3\, intangible_{it} + \partial_4 ROA_{it} + \partial_5 LEV_{it} + \partial_6 Duality_{it} + \partial_7 Age_{it} + \partial_8 Independent_{it} + \partial_9 GDP_{ct} + \partial_{10} Researcher_{ct} + \partial_{11} Sub\_amount_{ct} + City_{ct} + Year_{it} + \varepsilon_{ict} itc} \quad (1)$$

In the equation (1), $\boldsymbol{Subsidy_{it}}$represents $\boldsymbol{i}$firm in the $\boldsymbol{t}$ time received the amount of governmental innovation subsidy. $\boldsymbol{HSR_{it}}$is the interaction term treat*time. $\boldsymbol{ROA_{it}}$, $\boldsymbol{LEV_{it}}$, $\boldsymbol{Duality_{it}}$, $\boldsymbol{Age_{it}}$, $\boldsymbol{Independent_{it}}$ is the firm-level control variables. $\boldsymbol{GDP_{ct}}$,$\boldsymbol{Researcher_{ct}}$,$\boldsymbol{Sub_amount_{ct}}$are the prefecture-level control variables. $\boldsymbol{Size_{it}}$, $\boldsymbol{intangible_{it}}$ are the moderator variables. $\boldsymbol{City_{ct}}$, $\boldsymbol{Year_{it}}$represent the city fixed effect and time fixed effect respectively. $\boldsymbol{\varepsilon_{ict}}$is the error term and $\boldsymbol{i}$,$\boldsymbol{t}$,$\mathcal{C}$ represent firm, time, city respectively. The $\boldsymbol{\partial_1}$is the main coefficient that this study needs to focus on.

$$\boldsymbol{Subsidy_{it} = \partial_0 + \beta_1 HSR_{it} + \beta 2 HSR_{it} * Size_{it} + \beta_2 Size_{it} + \partial_3\, intangible_{it} + \partial_4 ROA_{it} + \partial_5 LEV_{it} + \partial_6 Duality_{it} + \partial_7 Age_{it} + \partial_8 Independent_{it} + \partial_9 GDP_{ct} + \partial_{10}\, Researcher_{ct} + \partial_{11} Sub\_amount_{ct} + City_{ct} + Year_{it} + \varepsilon_{ict} itc} \quad (2)$$

In the equation (2), we added the interaction term $\boldsymbol{HSR_{it} * Size_{it}}$, which represents the moderate effect of firm size, and the $\boldsymbol{\beta 2}$ is the coefficient that need to test. Other variables definition are the same with equation (1).

$$\boldsymbol{Performance_{it} = \partial_0 + \chi_1 HSR_{it} + \chi_2 HSR_{it} * intangible_{it} + \chi_3\, intangible_{it} + \partial_2 Size_{it} + \partial_3\, intangible_{it} + \partial_4 ROA_{it} + \partial_5 LEV_{it} + \partial_6 Duality_{it} + \partial_7 Age_{it} + \partial_8 Independent_{it} + \partial_9 GDP_{ct} + \partial_{10}\, Researcher_{ct} + \partial_{11} Sub\_amount_{ct} + City_{ct} + Year_{it} + \varepsilon_{ict}} \quad (3)$$

In the equation (3), we added the interaction term $\boldsymbol{HSR_{it} * intangible_{it}}$, which represents the moderate effect of firm intangible assets ratio, and the $\boldsymbol{\chi_2}$ is the coefficient that need to verify. The definitions of other variables are the same as those in Equation (1).

$$\boldsymbol{Performance_{it} = \partial_0 + \gamma_1 HSR_{it} + \gamma_2 HSR_{it} * subsidy_{it} + \gamma_3 subsidy_{it} + \partial_2 Size_{it} + \partial_3\, intangible_{it} + \partial_4 ROA_{it} + \partial_5 LEV_{it} + \partial_6 Duality_{it} + \partial_7 Age_{it} + \partial_8 Independent_{it} + \partial_9 GDP_{ct} + \partial_{10}\, Researcher_{ct} + \partial_{11} Sub\_amount_{ct} + City_{ct} + Year_{it} + \varepsilon_{ict}} \quad (4)$$

In the equation (4), we would like to verify whether the firm with governmental innovation subsidy can promote the firm performance, and prove that the HSR operation can push the government to choose suitable firms to fund again. $\boldsymbol{Performance_{it}}$ represents the firms' financial performance, $\boldsymbol{HSR_{it} * subsidy_{it}}$ represents the interaction term of HSR operation and governmental innovation subsidy. $\boldsymbol{\gamma_2}$represents the effect of governmental innovation subsidy and HSR operation on firm performance.

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4. Results

4.1 Descriptive Analysis

Table 1 shows the results of the descriptive analysis of all samples and variables. There are 22,998 firm-year observation that have received government subsidies. The logarithm mean value of subsidy is 15.83. The mean value of HSR is 0.44. Other control variables' observation, mean value, standard-error value, min value and max value are shown in table1, we can see that those values are at a reasonable range, which prove that there are no extreme values and outliers among them.

Table 1: Descriptive statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Subsidy	22,998	15.83	2.04	0.00	24.64
HSR	32,442	0.44	0.50	0.00	1.00
ROA	32,330	0.03	3.49	-602.11	321.95
Lev	32,325	0.34	0.18	-0.14	4.65
Duality	32,442	0.47	0.50	0.00	1.00
Age	32,420	2.47	0.60	0.00	3.66
Size	32,330	0.08	0.48	0.00	27.13
Intangible	31,274	0.03	0.05	-0.04	0.85
State	32,442	0.04	0.20	0.00	1.00
Independent	28,818	0.33	0.11	0.00	0.80
GDP	24,147	17.35	1.33	12.24	20.41
Researcher	24,463	4.45	4.50	0.01	13.48
Sub-amount	27,696	0.61	0.49	0.00	1.00

Table 2 illustrates the pairwise correlation value among all variables. There is a prominent correlation between governmental innovation subsidy and independent variable, control variables, and the values are at a reasonable range. In order to test whether there is a collinearity among those variables, Variance Inflation Factor (VIF) test has been adopted. The biggest VIF value is 1.53, no more than the value threshold of 10. Therefore, there are no high correlation and collinearity issues[2,35].

Table 2: Pairwise correlation results

	Subsidy	HSR	ROA	Lev	Duality	Age
Subsidy	1					
HSR	0.103***	1				
ROA	0.018***	0.008	1			
Lev	0.098***	-0.113***	-0.005	1		
Duality	-0.068***	-0.112***	-0.001	-0.056***	1	
Age	0.055***	0.390***	-0.004	0.078***	-0.280***	1
Size	0.205***	0.088***	0.001	0.078***	-0.050***	0.050***
Intangible	-0.032***	-0.033***	-0.005	0.051***	-0.052***	0.081***
State	0.011*	-0.124***	0.001	0.053***	0.073***	-0.093***
Independent	0.039***	0.303***	0.001	-0.027***	-0.310***	0.398***
GDP	0.115***	0.572***	0.001	-0.076***	-0.182***	0.318***
Researcher	0.139***	0.579***	0.003	-0.117***	-0.122***	0.405***
Sub-amount	0.126***	0.337***	0.001	-0.062***	-0.429***	0.367***
	Size	Intangible	State	Independent	GDP	Researcher
Size	1					
Intangible	-0.002	1				
State	0.018***	0.002	1			
Independent	0.058***	0.021***	-0.272***	1		
GDP	0.096***	-0.049***	-0.128***	0.349***	1	
Researcher	0.086***	-0.029***	-0.145***	0.273***	0.537***	1
Sub-amount	0.043***	0.042***	-0.170***	0.478***	0.421***	0.381***

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

4.2 Parallel Trend Test

Facing with policy effect, the DID method is usually preferred, while there is a prerequisite that the sample should satisfy the parallel trend test. Parallel trend test means that there is a experimental group and a control group, we have to get the conclusion that there is no policy effect before the policy. In this study, it means that before HSR operation, there is no prominent effect on the governmental innovation

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subsidy. In order to verify it, we consider a 18-year window, spanning from 8 years before the HSR operation until 10 years after HSR operation. The result is shown in Figure 1, the dashed lines represent 95% confidence intervals, adjusted for firm-level clustering. The estimated coefficients results came from the following equation.

$$\boldsymbol{Subsidy_{it} = \partial + \lambda_1 H^{-8}{}_{it} + \lambda_2 H^{-7}{}_{it} + \ldots + \lambda_{18} H^{+10}{}_{it} + A_c + B_t + \varepsilon_{ict}} \quad (5)$$

In the equation (5), $\boldsymbol{H^{-j}{}_{it}}$ means a firm in the $\boldsymbol{j^{th}}$ year before HSR operation, while $\boldsymbol{H^{+j}{}_{it}}$ means a firm in the $\boldsymbol{j^{th}}$ year after HSR operation. $\boldsymbol{A_c}$ and $\boldsymbol{B_t}$are vectors of city and year dummy variables that represents city and year *fixed effects, respectively.*

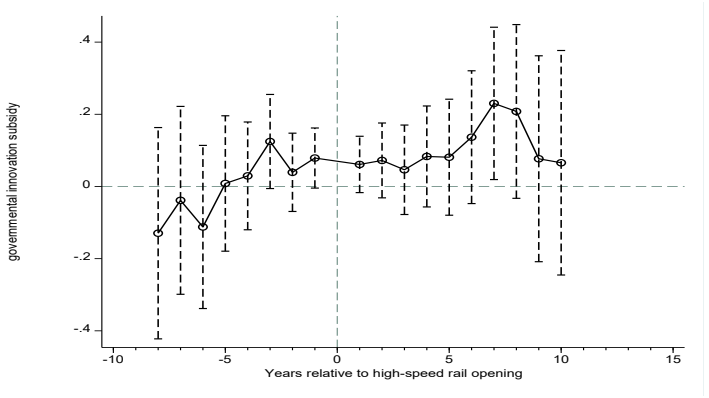

Figure 1: Parallel trend test

From the figure 1, the result shows two points: First, before the HSR operation, there is no direct trend on the governmental innovation subsidies. The coefficients of the HSR are fluctuated around the value of zero. Second, after HSR operation, it has a pronounced effect on the governmental innovation subsidies. Therefore, the sample of this study fits the prerequisite of DID method.

4.3 Regression Results

Table 3 shows the results of HSR operation on governmental innovation subsidy. Model 1 and Model 2 test the main effect, Model 1 without control variables, Model 3 with independent variable and all control variables. The results show that there is a positive causal relationship between HSR operation and governmental innovation subsidy (Coefficient=0.052, P<0.1). The operation of high-speed railways can help firms to get the governmental innovation subsidy. The hypothesis 1 holds. Based on the information economics theory, in order to verify the mechanism of this study, we have adopted two conditional factors. Model 3 and Model 4 have verified the moderator effect of firm size, model 3 without control variables, model 4 with all variables. The interaction term coefficient of HSR operation and firm size is significantly negative (Coefficient=-1.238, P<0.01).

Table 3: The results between HSR operation and governmental innovation subsidy

	Model1	Model2	Model3	Model4	Model5	Model6
VARIABLES	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
HSR	0.650***	0.052*	0.669***	0.125***	0.016	0.01
	(22.59)	(1.98)	(22.95)	(3.15)	(0.43)	(0.24)
Size*HSR			-1.183***	-1.238***		
			(-10.70)	(-7.38)		
Intangible*HS					1.050***	1.057**
					(2.65)	(2.30)
ROA		0.143***		0.142***		0.142***
		(3.07)		(3.05)		(3.05)
Lev		0.649***		0.624***		0.653***
		(6.29)		(6.05)		(6.33)
Duality		-0.053		-0.052		-0.053
		(-1.46)		(-1.43)		(-1.47)
Age		0.015		0.016		0.024
		(0.22)		(0.24)		(0.37)
Size		0.358***	1.719***	1.602***		0.357***
		(10.93)	(14.74)	(9.34)		(10.90)

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Intangible		-0.473		-0.484*	-0.448	-1.073***
		(-1.62)		(-1.66)	(-1.36)	(-2.74)
State		0.275**		0.206*		0.285***
		(2.49)		(1.86)		(2.58)
Independent		-0.534*		-0.499*		-0.536*
		(-1.83)		(-1.71)		(-1.83)
GDP		0.034		0.004		0.016
		(0.81)		(0.11)		(0.39)
Researcher		0.044		0.061**		0.054*
		(1.56)		(2.11)		(1.86)
Sub-amount		-0.028		-0.031		-0.03
		(-0.60)		(-0.68)		(-0.64)
Constant	15.318***	13.145***	15.244***	13.680***	13.786***	13.528***
	(486.06)	(18.06)	(493.72)	(18.83)	(72.97)	(18.54)
City	No	Yes	No	Yes	No	Yes
Year	No	Yes	No	Yes	No	Yes
N	22998	16068	22998	16068	20603	16068
Wald Chi2	510.46***	5531.80**	863.29***	5589.83**	6252.43**	5567.84**

Note: z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

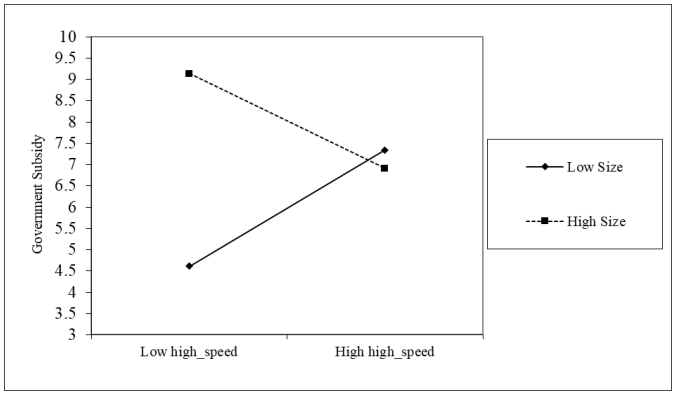

Figure 2: The moderate effect of firm size

Figure 2 depicts the moderate effect paragraph. It shows that in the case of low firm size, the HSR operation has a more significant influence on the governmental innovation subsidy than in the case of high firm size, which is consistent with hypothesis 2.

Model 5 and Model 6 have tested the moderate effect of intangible assets ratio. Model 5 without control variables, Model 6 with all variables. It shows that intangible assets ratio can positively regulate the relationship of HSR operation and governmental innovation subsidy. Combined with the Figure 3, we can see that in the case of high intangible assets ratio, HSR operation has a more significant influence on the governmental innovation subsidy than in the case of low intangible assets ratio, which is consistent with hypothesis 3.

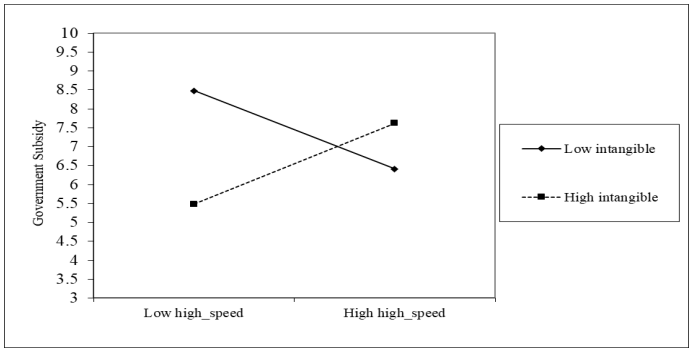

Figure 3: The moderate effect of intangible assets ratio

In addition, according to previous studies, governmental innovation subsidy can promote the firm performance. Then we would like to test whether the governmental innovation fund can promote the firm performance to verify the mechanism is reasonable again. Table 4 shows the results of governmental

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innovation subsidy on firm performance.

Panel A of table 4 has shown the relationship between governmental innovation subsidy and firms' total profit. Model 1 and Model 3 without control variables. Model 2 and Model 4 with control variables. The results show that in the case of HSR operation (Coefficient=0.117, P<0.01), the governmental innovation subsidy has a more prominent effect on firm performance than in the case of without HSR operation (Coefficient=0.081, P<0.01).

Panel B of table 4 shows the results of governmental innovation subsidy on firms' book-to-market. Model 1 and Model 3 without control variables. Model 2 and Model 4 with control variables. The results show that in the case of HSR operation (Coefficient=0.020, P<0.01), the governmental innovation subsidy has a more prominent effect on firm performance than in the case of without HSR operation (Coefficient=0.010, P<0.01).

Table 4: The results of governmental innovation subsidy on firm performance

Panel a: Total profit

	Model1	Model2	Model3	Model4	Model5	Model6
VARIABLES	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
HSR	0.650***	0.052*	0.669***	0.125***	0.016	0.01
	(22.59)	(1.98)	(22.95)	(3.15)	(0.43)	(0.24)
Size*HSR			-1.183***	-1.238***		
			(-10.70)	(-7.38)		
Intangible*HS					1.050***	1.057**
					(2.65)	(2.30)
ROA		0.143***		0.142***		0.142***
		(3.07)		(3.05)		(3.05)
Lev		0.649***		0.624***		0.653***
		(6.29)		(6.05)		(6.33)
Duality		-0.053		-0.052		-0.053
		(-1.46)		(-1.43)		(-1.47)
Age		0.015		0.016		0.024
		(0.22)		(0.24)		(0.37)
Size		0.358***	1.719***	1.602***		0.357***
		(10.93)	(14.74)	(9.34)		(10.90)
Intangible		-0.473		-0.484*	-0.448	-1.073***
		(-1.62)		(-1.66)	(-1.36)	(-2.74)
State		0.275**		0.206*		0.285***
		(2.49)		(1.86)		(2.58)
Independent		-0.534*		-0.499*		-0.536*
		(-1.83)		(-1.71)		(-1.83)
GDP		0.034		0.004		0.016
		(0.81)		(0.11)		(0.39)
Researcher		0.044		0.061**		0.054*
		(1.56)		(2.11)		(1.86)
Sub-amount		-0.028		-0.031		-0.03
		(-0.60)		(-0.68)		(-0.64)
Constant	15.318**	13.145***	15.244**	13.680***	13.786***	13.528***
	(486.06)	(18.06)	(493.72)	(18.83)	(72.97)	(18.54)
City	No	Yes	No	Yes	No	Yes
Year	No	Yes	No	Yes	No	Yes
N	22998	16068	22998	16068	20603	16068
Wald Chi2	510.46**	5531.80**	863.29**	5589.83**	6252.43**	5567.84**

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Panel B: Book-to-Market

	Model1	Model2	Model3	Model4
	WheBA=1	WheBA=1	WheBA=0	WheBA=0
VARIABLES	book-to-	book-to-	book-to-	book-to-
Subsidy	0.010***	0.020***	0.008***	0.010***
	(4.11)	(8.09)	(3.74)	(3.40)
Constant	-1.193***	-2.417***	-1.047***	-2.073***
	(-30.00)	(-9.41)	(-29.16)	(-7.74)
City	No	Yes	No	Yes
Year	No	Yes	No	Yes
Control	No	Yes	No	Yes
N	12996	10576	9595	5461
Wald Chi2	16.86***	4389.62***	14.92***	2208.94***

Note: z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.4 Endogenous Test

According to the previous research, there are many factors that may have influence on the governmental innovation subsidy. Therefore, in order to relieve the endogenous problems that may be caused by the missing variables, this study adopt the instrument variables to solve the problem. In the research of transport infrastructure, there is a series of instrumental variables that we can choose, such as geographic information, climate information and history route and etc. In this study, we choose the geographic information about the prefecture-level city as the instrument variable, the city mean slope. The results are shown in table 5. There is a prominent positive relationship between city mean slope and governmental innovation subsidy, which proves that the main effect of this study is stable.

Table 5: Endogenous test

	Model1	Model2	Model3	Model4	Model5	Model6
	Ols_no_train	Ols_with_train	Tsls	Liml	Gmm	Igmm
VARIABLES	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy	Subsidy
Post		0.06*	0.826***	0.826***	0.826***	0.826***
		(1.95)	(3.78)	(3.78)	(3.78)	(3.78)
Constant	14.272***	14.351***	16.556***	16.556***	16.556***	16.556***
	(22.34)	(22.53)	(31.70)	(31.70)	(31.70)	(31.70)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.211	0.211	0.192	0.192	0.192	0.192
N	16086	16086	15996	15996	15996	15996

Note: Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

4.5 Placebo Test

Under normal circumstances, there are two main methods for placebo testing. The first is to construct a false policy effect, that is, to postpone or advance the time of the policy effect by a few years. If the same result is obtained, the conclusion is unreliable. If different results are obtained, the conclusion is reliable. The second method is to randomly select part of the observation samples, perform multiple regression analysis on the variables, and compare the coefficients obtained by the regression analysis with the coefficients of the benchmark regression to determine whether the coefficients are consistent. If there is a big difference, it is explained the conclusion is reliable. Therefore, in this study, we construct a false policy effect, let the high-speed railways in all prefecture-level cities have been postponed for two years, three years and four years. The results are shown in table 6. The results show that there is no obvious related relationship even negatively related.

Table 6: Placebo test

	Model1	Model2	Model3
VARIABLES	Subsidy	Subsidy	Subsidy
HSR+2	-0.038		
	(-1.03)		
HSR+3		-0.074**	
		(-1.98)	
HSR+4			-0.035

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			(-0.91)
Constant	13.676***	13.598***	13.671***
	(20.09)	(19.94)	(20.04)
Year	Yes	Yes	Yes
Control	Yes	Yes	Yes
N	16098	16098	16098
Wald Chi2	5284.89***	5288.84***	5284.37***

Note: z-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5. Discussion & Conclusions

Since it is well known that a lack of information and particularly it is asymmetrically distributed between government and firms in innovation subsidizing, the availability, quality, and timeliness of information will thus facilitate the governments' estimation of the quality of the candidates' innovation capabilities, potential and other important aspects concerning the effective use of public finance resources (e.g., money). Owing the opening of high-speed railways shortens travel time and possibly costs, thereby strengthening face-to-face communications. In this way, it would generate the information spillover effect because convenient and frequent contacts between firms and market intermediaries, and other important stakeholders will convert important firms' private information into public information. Disseminating this information among industrial community and the society would improve government screening members' information environment, and thus help them to better select qualified, and prospectus firms in subsidizing. Given the remarkable advances in the construction of high-speed railways in China, and its severe information regulation environment, empirical work thus sets China as the context, and make use of a panel of 3,296 firms between 1999 and 2021 in China's 281 prefecture-level cities to test our arguments. Specifically, we find that there is a positive correlation between firms' likelihood to obtain government innovation subsidies and the opening of HSR the cities, and this relationship becomes stronger in small-sized firms and firms with a higher proportion of intangible assets. Furthermore, innovation subsidies recipient firms in HSR operation cities are more likely to outperform those without HSR operation.

Our findings contribute to extant literature in several ways. First, to our best knowledge, this is the first time to link the physical infrastructure development, specifically, the construction of HSR to government innovation subsidies. Unlike previous studies which focus on legal, economic system development, and other "soft" infrastructure[2,4] to improve the effectiveness and efficiency of public subsidies, we shift this attention to "hard" infrastructure. Second, likewise we explain the development of transport infrastructure facilitates rapid people mobility, and thereby speeding up information transformation from private to public domain, which may help government innovation subsidizing work. Thus, it extends the work which focuses on information issue of government innovation subsidies[2], and highlights the important role of the general information environment. Third, we contribute to the burgeoning literature on economic, social and environmental effect of HSR. HSRs were development first in Japan in 1960s, and then in France in 1980s, and later in the UK, the US, Spain, Germany, China and other regions. Ever since the birth of HSR, research has proliferated beyond technique issue, including a lot research in social science field. Particularly, in recent decades, as the rapid development of HSR, there have been emerged a lot of literature from a broader range of research disciplines[14,15]. Our study thus contributes to this line literature in examining HSR's broader social effect by investigating its' information role in government innovation subsidies, a new field has not been touched in previous studies.

Beyond these theoretical contributions our study also provides profound practice implications. First, to improve the effectiveness of government subsidies, including innovation-oriented and other purpose-driven forms, government may enlarge number of jury members, particularly emphasize the diverse source, for instance to include more members from industrial community because they might have a better access to firms private and real information. In addition, the construction of HSR is a gigantic project, and its impact for society may be huge with positive and negative aspects. A thorough assessment of the HSR projects, and its subsequent effects for society thus deserves special attentions because the HSR effect might be evaluated from many angles, for instance the implication for government subsidies in this study.

Our study may be subject to several limitations, and probably which consist of future research direction. First, our study is based on Chinese setting, and to what extent these findings can be applied to other countries is unclear, meaning the generalizability is still a matter. Second, government subsidies

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contain various forms, and we take innovation subsidization as the case because it is severely subject to information problem. This setting is appropriate for the test of our arguments, while to what extent it can be used in other forms of subsidization deserves future investigations. Third, concerning the research methods, although we have dedicated into providing robust results including using different robust check methods, we think there is still efforts can be invested into provide more sound results, such as using multiple level models.

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References

[1] Bertoni F, Tykovová T. Does governmental venture capital spur invention and innovation? Evidence from young European biotech companies[J]. Research Policy, 2015, 44(04): 925-935.
[2] Chen Y, Wang Y, Hu D, et al. Government R&D subsidies, information asymmetry, and the role of foreign investors: Evidence from a Quasi-Natural experiment on the Shanghai–Hong Kong stock connect[J]. Technological Forecasting and Social Change, 2020, 158: 120162.
[3] Jaffe A B, Lerner J. Innovation and its discontents: How our broken patent system is endangering innovation and progress, and what to do about it[M]. Princeton University Press, 2004.
[4] Stuart T, Wang Y. Who cooks the books in China, and does it pay? Evidence from private, high-technology firms[J]. Strategic Management Journal, 2016, 37(13): 2658-2676.
[5] Arbix G. Structural change and the emergence of the Brazilian MNEs[J]. International Journal of Emerging Markets, 2010, 05(3-4): 266-288.
[6] Collewaert V, Manigart S, Aernoudt R. Assessment of government funding of business angel networks in Flanders[J]. Regional Studies, 2010, 44(01): 119-130.
[7] Guo D, Guo Y, Jiang K. Funding forms, market conditions, and dynamic effects of government R&D subsidies: Evidence from China[J]. Economic Inquiry, 2017, 55(02): 825-842.
[8] Jourdan J, Kivleniece I. Too much of a good thing? The dual effect of public sponsorship on organizational performance[J]. Academy of Management Journal, 2017, 60(01): 55-77.
[9] Akerlof G A. The market for "lemons": Quality uncertainty and the market mechanism[J]. The Quarterly Journal of Economics, 1970, 84(03): 488-500.
[10] Cartwright S, Cooper C L. The role of culture compatibility in successful organizational marriage[J]. Academy of Management Perspectives, 1993, 07(02): 57-70.
[11] Chen Z, Kale P, Hoskisson R E. Geographic overlap and acquisition pairing[J]. Strategic Management Journal, 2018, 39(02): 329-355.
[12] Agarwal S, Hauswald R. Distance and private information in lending[J]. The Review of Financial Studies, 2010, 23(07): 2757-2788.
[13] Guo H, Wu K. Does opening high-speed railways affect the cost of debt financing? A quasi-natural experiment[J]. China Finance Review International, 2020, 10(04): 473-496.
[14] Hong Y, Li Y. Could the introduction of high-speed railway inhibit the IPO underpricing in China?[J]. Applied Economics Letters, 2020, 27(18): 1479-1484.
[15] Lin Y. Travel costs and urban specialization patterns: Evidence from China's high speed railway system[J]. Journal of Urban Economics, 2017, 98: 98-123.
[16] Jensen M C, Meckling W H. Theory of the firm: Managerial behavior, agency costs and ownership structure[J]. Journal of Financial Economics, 1976, 03(04): 305-360.
[17] Petersen M A, Rajan R G. Does distance still matter? The information revolution in small business lending[J]. The Journal of Finance, 2002, 57(06): 2533-2570.
[18] Shi W, Gao C, Aguilera R V. The liabilities of foreign institutional ownership: Managing political dependence through corporate political spending[J]. Strategic Management Journal, 2021, 42(01): 84-113.
[19] Krishnaswami S, Spindt P A, Subramaniam V. Information asymmetry, monitoring, and the placement structure of corporate debt[J]. Journal of Financial Economics, 1999, 51(03): 407-434.
[20] Lopez-Valeiras E, Gomez-Conde J, Fernandez-Rodriguez T. Firm size and financial performance: Intermediate effects of indebtedness[J]. Agribusiness, 2016, 32(04): 454-465.
[21] Chiang R, Venkatesh P C. Insider holdings and perceptions of information asymmetry: A note[J]. The Journal of Finance, 1988, 43(04): 1041-1048.

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[22] Yoon H, Zo H, Ciganek A P. Does XBRL adoption reduce information asymmetry?[J]. Journal of Business Research, 2011, 64(02): 157-163.
[23] Greenstein M M, Sami H. The impact of the SEC's segment disclosure requirement on bid-ask spreads[J]. The Accounting Review, 1994, 69(01): 179-199.
[24] Leuz C, Verrecchia R E. The economic consequences of increased disclosure[J]. Journal of Accounting Research, 2000, 38: 91-124.
[25] Cohen W M, Goto A, Nagata A, et al. R&D spillovers, patents and the incentives to innovate in Japan and the United States[J]. Research Policy, 2002, 31(08): 1349-1367.
[26] Contractor F, Yang Y, Gaur A S. Firm-specific intangible assets and subsidiary profitability: The moderating role of distance, ownership strategy and subsidiary experience[J]. Journal of World Business, 2016, 51(06): 950-964.
[27] Teece D J. Managing intellectual capital: Organizational, strategic, and policy dimensions[M]. Oxford University Press, 2002.
[28] Barth M E, Kasznik R, McNichols M F. Analyst coverage and intangible assets[J]. Journal of Accounting Research, 2001, 39(01): 1-34.
[29] Mohd E. Accounting for software development costs and information asymmetry[J]. The Accounting Review, 2005, 80(04): 1211-1231.
[30] Cohen W M, Nelson R R, Walsh J P. Links and impacts: The influence of public research on industrial R&D[J]. Management Science, 2002, 48(01): 1-23.
[31] Beck T, Levine R, Levkov A. Big bad banks? The winners and losers from bank deregulation in the United States[J]. The Journal of Finance, 2010, 65(05): 1637-1667.
[32] Quacoe D, Wen X, Quacoe D, et al. Firm size, compensation and firm deaths in SMEs: Evidence from America[J]. British Journal of Interdisciplinary Research, 2018, 8(01):10-19.
[33] Jia N, Huang K G, Man Zhang C. Public governance, corporate governance, and firm innovation: An examination of state-owned enterprises[J]. Academy of Management Journal, 2019, 62(01): 220-247.
[34] Gao X, Guo X, Sylvan K J, et al. The Chinese innovation system during economic transition: A scale-independent view[J]. Journal of Informetrics, 2010, 4(04): 618-628.
[35] Chatterjee S, Hadi A S. Qualitative variables as predictors[M]//Regression analysis by example. John Wiley & Sons, Ltd, 2006: 121-150.