**How and When Do Subnational Institutions Matter for R&D Investment? Evidence from the Chinese Pharmaceutical Sector**

Pei SUN

School of Management, Fudan University

670 Guoshun Road, Shanghai 200433, China

Email: sunpei@fudan.edu.cn

Tel: +86 21 2501 1114; Fax: +86 21 6564 2411

Zhe QU\*

School of Management, Fudan University

670 Guoshun Road, Shanghai 200433, China

Email: [quz@fudan.edu.cn](mailto:quz@fudan.edu.cn)

Tel: +86 21 2501 1213

Zhixiang LIAO

China Union Pay Data Services Co. Ltd.

1899 Gutang Road, Shanghai 201201, China

Email: zxliao@cupdata.com

\* Corresponding author.

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**Keywords:** R&D; subnational institutions; innovation; emerging economies; China

**Abstract**

Drawing on new institutional economics and the innovation literature, this paper examines how subnational institutions can impact corporate R&D investment in emerging economies. The study further investigates a key contingency of this institutional effect: a firm’s country/ownership identity. Using China’s pharmaceutical sector as the empirical context, we find that the quality of subnational institutions, such as the degree of government deregulation and the effectiveness of local contracting institutions, has a significantly positive impact on corporate R&D intensity. Moreover, this institutional effect is more salient in indigenous firms and international joint ventures than in wholly owned foreign subsidiaries. This study serves to shed light on future research on how multifaceted subnational institutions shape innovation activities across different types of business organizations in emerging economies.

1. **Introduction**

Do institutions matter for corporate R&D investment? Conventional wisdom, which is informed by the literature on the appropriability of innovation [1-3], holds that a robust system of intellectual property rights (IPR) protection is critical to ensuring that firms make adequate investment in innovation activities [4, 5]. This paper aims to enrich our understanding of the relationship between institutions and R&D investment in emerging economies on two related fronts. First, while the prior research generally focuses on the IPR protection embedded at the national level, we know little about whether and how subnational institutions matter for R&D investment. Compared to national-level institutions that establish general frameworks for economic actors, subnational institutions offer more proximate and contextual arrangements that regulate the functioning and enforcement of national institutions [6]. Given the recent research examining the roles of subnational institutions in shaping firm strategy [7-9], we add to this stream of inquiry by exploring the ways in which subnational institutions affect corporate innovation activities.

Second, we broaden the traditional focus on IPR protection by adopting a more holistic and multifaceted view of institutions. According to new institutional economics, institutions encompass a host of “rules of the game” that regulate economic transactions and support the effective functioning of the market mechanism [10, 11]. They involve various interrelated legal and regulatory rules to define/protect property rights, enforce contracts, facilitate information flows, and foster competition. Thus, these institutional arrangements include but go beyond IPR protection to shape the incentives of R&D investment. As the institutional economics perspective treats firms as boundedly rational actors that respond strategically to multifaceted institutional constraints [12, 13], we dedicate this paper to understanding *how* subnational institutional contingencies matter for corporate R&D investment.

Further, we examine *when* the subnational institutional driver of R&D investment will matter more across different types of business organizations. Here, we focus on the country/ownership identity. Multinational enterprises (MNEs) have increasingly located their R&D activities outside their home countries, with emerging economies such as China and India becoming key recipients of foreign R&D investments [14-16]. While prior research abounds on country-level location choice issues that highlight the factors leading to market-seeking and resource-seeking R&D investments [17, 18],[[1]](#footnote-1) we are unaware of any attempts to understand whether and how subnational institutions affect R&D investment decisions once foreign firms have entered an emerging economy. In view of this gap, we attempt to understand whether foreign subsidiaries, international joint ventures, and domestic firms may exhibit different degrees of sensitivity to local institutions.

We empirically address the “how and when” questions through a study of pharmaceutical firms in China, which is the world’s largest emerging economy with considerable variations in subnational institutions. Due to the importance of R&D investment, the crucial role of government regulation, and the significant foreign presence in this sector, we believe that it serves as an ideal context to examine how institutions affect innovation strategy across different types of organizations.

Several theoretical contributions emerge from our study. First, this study joins an emerging strand of literature that highlights the role of subnational regions in general and local institutional context in particular in shaping corporate strategy and outcomes [6, 8, 9, 20-22]. Our findings suggest that firm innovation activities are influenced not only by general country-level institutional frameworks but also by more fine-grained subnational institutional contingencies.

Second, we leverage the emerging economy context to develop a holistic approach of analyzing the institutional driver of corporate R&D investment. Specifically, we extend the traditional focus on IPR protection by investigating the ways in which a broader set of institutional arrangements affect R&D investment through the creation and capture of innovation rents [1, 23]. We believe this research adds to a burgeoning stream of insightful studies that have begun to discover how institutional environments shape corporate innovation behaviors [24-26].

Third, this paper identifies an important boundary condition of this institutional effect by demonstrating how the effect can vary with firms with different ownership/country identities. As such, this research contributes to the literature on R&D internationalization, which concerns how MNEs manage their R&D activities in different countries. The extant research has investigated the coordination of R&D activities among geographically dispersed units and the relationship between autonomy in international R&D units and innovation performance [27-29]. Because an MNE’s organizational structure and R&D operations are also influenced by its host-country subnational environment, the institutional perspective adopted in this study enriches our understanding of global R&D management.

1. **Hypotheses Development**

R&D investment is essential for product/process innovations, which can help generate innovation rents and shape focal firms’ competitive advantages [30]. However, committing resources to R&D projects is risky, since the ultimate rewards are difficult to predict due to the long time horizon and the non-trivial likelihood of project failure [31]. Because most R&D expenses are sunk after projects have been undertaken, managers face important tradeoffs when other business functions/opportunities vie for limited corporate resources. In effect, the performance effect of R&D is far from linear as simply “throwing” money at R&D will not yield desirable results [32].

As such, the incentives of investing in R&D activities hinge, in the first instance, on the magnitude of innovation rents that firms expect to create. This has to do with their internal resource/knowledge stocks and with the external environments. In other words, only when firms believe that innovation is essential to their success do they have strong incentives to engage in intensive R&D activities. Furthermore, once the innovation rents are generated, innovating firms must ensure that the rents can be effectively retained within the organizations rather than flowing to competitors and business partners. The literature on the appropriability of innovation [1, 3] suggests that the ease of capturing these rents plays a key role in shaping firms’ incentives to conduct R&D. Firms will be discouraged from investing in R&D if they expect their innovation outputs to be easily imitated and quickly diffused. Therefore, they must rely on a tight appropriability regime (such as effective IPRs in the form of patents, copyrights, and trademarks) and/or firm-specific complementary assets to establish effective imitation/diffusion barriers [15, 29]. In short, corporate R&D decisions are intimately related to a continual process of creation and capture of innovation rents. We draw on this insight to explicate the mechanisms through which subnational institutions shape R&D investment in the emerging economy context.

*2.1 Subnational institutions, innovation rent dynamics, and corporate R&D*

Institutions are humanly devised constraints that consist of a variety of ground rules that structure and govern economic transactions [10]. For the sake of simplicity, new institutional economics suggests that institutional environments can vary in two dimensions: Government intervention and contracting institutions [33]. The former captures the “vertical” dimension of institutions because it concerns the rules and regulations that protect the autonomy of markets from government intervention and private actors against government expropriation. On the other hand, contracting institutions concern the “horizontal” dimension by emphasizing market infrastructures and rules/regulations that enable effective contracting and transactions between private actors. The “institutional voids” [34] that prevail in the emerging economies manifest themselves in both dimensions. First, government agencies control enormous resources and discretionary power, thereby generating substantial transaction costs and hazards. Meanwhile, firms also suffer from deficient legal/regulatory systems and underdeveloped intermediaries in product, labor, and capital markets.

Despite these environmental pathologies, market-oriented reforms have been transforming the emerging economies in the past several decades [35], but the process involves frictional and uneven developments on the various fronts of institutional arenas [36]. Consequently, large emerging economies feature substantial heterogeneity in regional institutional environments. Although many countries have uniform de jure legal/regulatory frameworks, the laws and policies mandated by the central government are open to interpretation and revision by local authorities. As noted by foreign senior executives in China, “each province implements them (laws and policies) in a slightly different way, and that slightly different way could have significant impact” [37]. Because of this pluralist institutional arrangement, firms face different degrees of government intervention, property rights protection, and contract enforcement effectiveness across regions [21, 22]. In what follows, we explore how subnational institutional contingencies shape firms’ R&D decisions through the potential of innovation rent creation and the ease of innovation rent capture.

*2.1.1 Government intervention and the potential of innovation rent creation*

Given the non-trivial costs/risks that underlie R&D projects, innovation is not necessarily the only pathway that can be used by a firm to build up competitive advantage. This is particularly the case in emerging economies, where firms usually employ a relationship-based strategy to tackle the uncertainties caused by and exploit the opportunities arising from underdeveloped institutions [35, 38]. The deep involvement of government forces in the business sector encourages the development of “influence/policy rents”, which stem from manipulating the rules of the game of business in favor of firms that are embedded in extant social and political networks [12]. They range from policy favors to direct financial resources such as tax rebates, preferential loans, and government procurement contracts.

At the subnational level, the potential payoffs of undertaking innovations through R&D endeavors *relative to* other sources of rent creation can be related to the degree of government interventions in regional market functioning and business transactions. That is, the innate quality of products/services and the efficiency of the operational processes may be only of secondary importance to inter-firm competition. Instead, the outcome of competition can be heavily influenced by nonmarket forces that favor those with abundant relational capital. For instance, in places where political forces play an important role in many business-to-business sectors, firms may need to secure the majority of their contracts and customers from government organizations and state-owned enterprises. Winning and keeping these customers would require more investments in developing and exploiting relationship-based capabilities than those in market-based technological capabilities [39, 40].

Although investments in creating influence/policy rents can also be costly [41], the potential immediate returns may still eclipse those based on the uncertain, longer-term R&D explorations. Indeed, “developing a capability to generate influence rents may well imply a weakening in the development of some other productive capabilities and thus weaken firms’ ability to earn other forms of rents such as efficiency and innovation rents” [12]. In short, firm resources are less likely to be channeled into innovation activities in regions dominated by capricious government interventions. Conversely, in regions where political forces are less involved in business transactions, a more level playing field leads know-how to gain more prominence over know-who. Firms may have more incentives for R&D investment to generate innovation rents.

*2.1.2 Contracting institutions and the ease of innovation rent capture*

Subnational regions exhibit considerable differences in their contracting institutions. Designing and enforcing contracts entails a well-functioning legal system to resolve business disputes and professional intermediaries in the product and factor markets to reduce transaction costs. In large emerging economies like China and India, the effectiveness of court litigation in resolving disputes and the protection of intellectual property rights vary widely [42]. There is also sizable cross-regional variance in the availability of qualified intermediaries to supply timely market information [34].

When contracting institutions fail to work well, firms face the serious hazard that innovation rents will be misappropriated by other market players. Specifically, firms are likely to incur enormous transaction costs in guarding the fruits of their innovation. The lack of market intermediaries can lead to ex ante information asymmetry that makes it difficult for innovating firms to win market and public endorsements. The deficient legal/regulatory systems increase the costs of ex post bargaining/disputes over innovation rents between focal firms and other stakeholders, such as employees and suppliers. Anticipating the difficulty of capturing innovation rents post R&D, firms located in regions with weak contracting institutions will have fewer incentives to engage in R&D activities in the first place [23]. To summarize, the roles of government intervention and contracting institutions in shaping both the potential of innovation-rent creation and the ease of innovation-rent capture lead us to propose:

***Hypothesis 1*** *There is a positive relationship between the quality of subnational institutions and the intensity of corporate R&D investment in emerging economies. Specifically, 1) the lower the degree of government intervention in the subnational economy where a focal firm resides, the higher the intensity of the firm’s R&D investment; 2) the more effective the contracting institutions in the subnational region where a focal firm resides, the higher the intensity of the firm’s R&D investment.*

*2.2 The reach of subnational institutions: Country/ownership identity as a moderator*

To the extent that subnational institutions matter for corporate R&D, it is of interest to recognize how this institutional effect may vary with firms’ country of origin. Here, we examine how the reach of subnational institutions can be uneven in three types of firms: Foreign subsidiaries, indigenous firms, and international joint ventures (IJVs).

Subsidiaries of MNEs are distinct from indigenous firms in two basic aspects. First, foreign firms face considerable liabilities of foreignness [43] and outsidership [44] in host economies. Compared to their domestic peers, they are “institutional outsiders” [45] less capable of fully understanding the nuances of local institutions and of meeting institutional challenges from local players. Second, foreign subsidiaries can engage in frequent exchanges of resources and knowledge with their headquarters and other subsidiaries across the globe. Compared to their domestic peers, their global linkages both facilitate and constrain their innovation practices [46, 47]. We argue that these two major foreign-domestic differences can give rise to both the *institutional outsider effect* and the *global linkage effect*, which in turn shape different sensitivities to subnational institutions across the three types of organizations.

In a region dominated by strong government intervention, there is more potential of creating influence/policy rents than innovation rents. However, the ability to realize this potential varies between institutional outsiders and insiders. While foreign firms can develop cooperative relationships with domestic sociopolitical actors [39], foreign firms are, on average, less likely to outcompete their domestic peers in this regard. This should be precisely the case for wholly owned foreign subsidiaries that cannot find support from local partners. Moreover, greater government intervention can result in more policy discriminations against foreign enterprises. Thus, to compete in such challenging business environments, wholly owned foreign subsidiaries may have to compete more on the market-based capabilities that arise from the multinational enterprises’ home country ownership advantages than their relationship-based ones [35]. Accordingly, foreign subsidiaries as institutional outsiders have limited options other than exploiting their knowledge base to create innovation rents, thus appearing less sensitive to local state intervention than indigenous firms.

IJVs represent a hybrid organizational form that seeks to combine the technology and brand resources from the MNEs and the local resources and knowledge from the domestic partners. Teaming up with local firms makes foreign partners more embedded in the local institutional context and provides them with semi-insider status [39, 48]. Consequently, well-managed IJVs can become more capable than foreign subsidiaries to create influence/policy rents by leveraging local networks and nonmarket forces. The semi-insidership of IJVs leads them to be more sensitive than foreign firms to the challenges and opportunities arising from the local state.

With respect to rent capture, foreign subsidiaries are in a more advantageous position than their domestic peers because the former may have crucial complementary assets to militate against rent dissipation. Whereas indigenous firms face great misappropriation hazards in regions with weak contracting institutions, foreign players have taken advantage of their global linkages to develop various alternative mechanisms that can effectively address the appropriability concerns. Prior research has recognized an increasing trend of R&D investment by MNEs in emerging economies *despite* their weak IPR protection [16, 29]. MNEs are found to rely on closely knit internal organizational linkages across countries and subsidiaries and a centralized IPR management system in the headquarters to substitute for weak appropriability regimes in host economies [15, 29, 49].

The efficacy of these rent-capture arrangements can be reduced when foreign firms establish IJVs with local players, because this organizational form naturally involves local partner opportunism [48]. In this context, while foreign partners can still use their global linkages to guard against opportunism, local contracting institutions will play a more important role in regulating potential disputes between foreign and domestic firms. Thus, foreign partners would be hesitant to invest in R&D with their domestic partners in regions with underdeveloped legal/regulatory enforcement.

Finally, a majority of, if not all, domestic firms may lack global linkages and multiple R&D units across different geographical locations; thus, they must rely more on subnational institutions that ensure the de facto enforcement of IPR protection. In sum, the impacts of local contracting institutions on R&D investment will be more significant for indigenous firms than for wholly owned foreign subsidiaries, with the case of international joint ventures lying in between. On the basis of the above arguments regarding institutional insider-outsider distinction and global linkage effect, we propose the following:

***Hypothesis 2*** *The positive effect of subnational institutions on R&D investment is most pronounced in indigenous firms, less so in international joint ventures, and least so in wholly owned foreign subsidiaries.*

1. **Data, Research Setting, Variables, and Method**

*3.1 Data and empirical setting*

Our data are collected and compiled from the Chinese National Bureau of Statistics’ Annual Survey of Industrial Enterprises, which is a census of all firms in China with more than RMB five million in sales revenues. This database has been extensively used in the previous research [50, 51]. The data that are used in our paper include all firms that were surveyed in the pharmaceutical sector during the 2005-2007 period, which is the most recent one when reliable firm-level R&D investment data are available. Concretely, we have 4,971 firms that were surveyed in 2005, 5,367 firms in 2006, and 5,748 firms in 2007.

The pharmaceutical sector is a suitable research setting. First, this sector has been known for its large R&D spending, which plays a central role in shaping firm competitiveness. The R&D expenditures of pharmaceutical companies in the United States, for example, have remained stable at approximately 17% of sales over the years [52]. In addition, pharmaceutical firms have to manage a long, costly, and risky process as they develop new medicines. In general, it takes approximately 10 to 15 years to develop a new medicine [53]. The average cost of taking a drug from concept to successful product launch can amount to US $1 billion. Furthermore, among the drugs that eventually reach the market, only 2 of every 10 generate revenues that break even or exceed the R&D costs [53].

Different from the U.S., there is great variation in R&D spending in China’s pharmaceutical sector: While a significant portion of the firms do not invest in R&D at all, some firms’ R&D intensity level is comparable to that of their developed economy counterparts.[[2]](#footnote-2) Such within-country, within-industry R&D variation suggests that a more disaggregate analysis at the subnational level is in order. Second, the pharmaceutical industry has always been highly regulated [54-56]. Government and regulatory bodies in developed and emerging economies alike are deeply involved in the approval of new drug use, the setting of drug prices, the design of distribution channels, and the protection of patents. As such, these institutional arrangements exert a fundamental impact on firm operations and innovation activities in this sector.

The size of China’s pharmaceutical sector is the largest in the emerging economies, and it was the fifth largest in the world in 2008 [57]. However, the industry-wide R&D investments have been clearly dwarfed by its developed country counterparts. While China’s biomedical R&D expenditure in 2007 totaled $1.5 billion (again, the largest of emerging economies), firms in the United States and Japan, respectively, invested $83.3 billion and $20.9 billion in this sector during the same year. Even as late as 2012, Chinese firms’ aggregate biomedical R&D expenditures were less than 10% of their U.S. peers and less than one quarter of their Japanese peers [58]. As a result, patented drugs in China only accounted for 14% of industry sales, while over-the-counter and generic drugs accounted for 22% and 64% of industry sales, respectively, in 2007 [59]. In fact, most of the domestic companies are generic drug manufacturers that make much fewer R&D investments than do the makers of patented prescription drugs.

Government regulations have a profound impact on the ways in which potential rents can be created in this industry. First, unlike the U.S., private healthcare services account for a negligible portion in China. Both central regulatory bodies and local governments have a large say in setting drug prices in public hospitals, which remain the main outlets for distributing pharmaceuticals in China[[3]](#footnote-3) [57]. Thus, price intervention has a direct impact on the profitability of pharmaceutical firms. For instance, a low price cap on patented drugs will make it difficult for firms to cover their initial R&D expenses, thus generating considerable competitive disadvantages compared to generic drug makers with much lower R&D intensity.

Second, both central and local government agencies can determine which drug can be included in the reimbursement list. Failure to be included on this list will prevent the urban residents’ basic medical insurance schemes from covering the associated drug expenses [57]. Because the inclusion/exclusion criteria are not transparent, pharmaceutical firms have to develop strong “lobbying” capabilities to persuade government officials/bureaucrats for the inclusion of their own drugs.

Finally, it is estimated that most public hospitals derive 25-60% of their revenues from prescription sales due to the low government funding. As such, doctors may prescribe unnecessary and expensive medicines to patients to make profits for hospitals [57]. In addition, it is not uncommon for many pharmaceutical companies to promote sales by offering kickbacks and commissions to hospital administrators and doctors [59]. In sum, under a weak institutional environment, the potential payoffs from relationship-building activities with government officials and public hospitals may eclipse them from creating innovation rents through risky R&D projects. Regarding IPR protection, the Chinese government has paid increasing attention to it; however, the quality of enforcement varies considerably in different localities [42]. Given the fragmented legal system and local government protectionism, enforcing legal rulings may prove difficult in regions with ineffective legal systems [59].

Many foreign companies have been operating in the Chinese pharmaceutical market since the late 1980s. The first decade of this century witnessed a significant rise in foreign R&D investments in their Chinese subsidiaries. Among the driving factors are the access to the huge talent pool and patient pool in China to facilitate their development of local and global drugs [59]. However, as institutional outsiders, they must manage the institutional idiosyncrasies that are outlined above across different Chinese regions. In short, the pharmaceutical sector in China serves as a good setting to evaluate the potential differing effects of institutional environments on R&D investment decisions across foreign and domestic firms.

*3.2 Dependent and independent variables*

We use *R&D intensity* to gauge the degree of corporate innovation investment, the dependent variable of our study. It is defined as a firm’s R&D expenditure divided by its sales revenues [48, 60]. To measure the quality of *subnational institutions* in China, we use the National Economic Research Institute (NERI) Index of Marketization in China’s provinces [61]. The NERI indices capture the progress of market-oriented reforms in China’s provinces and have been widely used in the previous literature [9, 62]. Appraisals of subnational institutions are made in five dimensions, including (1) the relationship between the government and the market, (2) the development of the private sector, (3) the development of the product market, (4) the development of the factor market, and (5) the development of market intermediaries and legal environments. Yearly indices that measure each of the five dimensions are developed for each province. Further, a weighted average of the five dimensions results in a yearly index that measures the overall quality of the institutions in each province. A higher index indicates a more developed provincial institutional environment.

We use three institutional indices as separate measures of our independent variable. The *overall institutional index* is obviously a comprehensive measure of subnational institutions. The index of the first dimension (*institutional index I*) corresponds to the extent of government intervention in the focal provincial economy, and the index of the last one (*institutional index V*) to the effectiveness of subnational contracting institutions. Concretely, *index I* covers information about the proportion of resources that are allocated by government versus market, government interventions in firm operations, extra-tax financial burdens that are imposed by the government, and the size of government operations. *Index V* measures the development of market intermediaries (lawyers, accountants, industry associations, and technology services) and the protections of producer, consumer, and intellectual property rights.

*3.3 Control variables*

At the industry level, we include the Herfindahl-Hirschman industrial concentration Index (*HHI*), which is calculated at the four-digit industry level to account for the potential impact of market structure on a firm’s R&D intensity [63]. At the firm level, we include the following control variables. *Slack resources* allow a firm to experiment with new ways of operating and impose fewer requirements on performance. We control for a firm’s slack resources by using a ratio of administrative, financial, and selling expenses to sales revenues [64]. *Firm size* is measured as (number of employees in a firm)/(average number of employees in the sample ×100) [65]. R&D intensity may also vary with *firm age* [66], so we control for the age effect by using the difference between the observation year and the establishment year of a firm.

Before conducting R&D, a firm must invest in technological equipment [67]. Investment in R&D equipment, which is similar to investment in ordinary machinery, is typically classified as *fixed asset investment*. Therefore, we control for the effect of capital intensity on R&D intensity using the ratio of fixed asset investment to (value-added × 100). A firm also must invest in human capital to build an efficient R&D team with proper qualifications, knowledge, and skills. We control for the *human resources* of a firm by using the ratio of employee compensation to (number of employees × 100) [67].

A firm’s business may focus on exporting its outputs to international markets or on penetrating local markets [48]. The choice between a local versus an overseas market focus may affect the focal firm’s R&D investment commitment in the corresponding regions [68]. Therefore, we control for a firm’s *export ratio,* which is calculated as the amount of export divided by sales revenues. Prior firm performance also matters for current corporate R&D investment. Underperformance can trigger a firm’s search for causes of performance problems, so a firm may increase its R&D spending when a potential solution to performance problems is to upgrade its technology and product portfolio [64]. However, high-performing firms may have greater resources and capabilities to undertake more R&D activities. Thus, we control for a company’s operating performance and accounting performance by using total factor productivity (*TFP*){Levinsohn, 2003, Estimating Production Functions Using Inputs to Control for Unobservables} and return on assets (*ROA*), respectively. *TFP* is calculated by using the estimator proposed by Levinsohn and Petrin [69]. Detailed information about the implementation of this estimator can be found in [70]{Petrin, 2004, Production function estimation in Stata using inputs to control for unobservables}.

At the subnational level, because the growth of the regional pharmaceutical industry is associated with the strength of a provincial economy [71], we include the log transformed *regional GDP* – the gross domestic product of each province in China as a control variable. This serves as a proxy for the economic size and the associated business opportunities of the provinces where the sample firms are located. In addition, R&D investment decisions are also related to the labor cost of conducting R&D in a province (i.e., the regional supply-side factor), and the price that consumers pay for drugs in a province (i.e., the regional demand-side factor). Presumably, a firm is likely to increase R&D investment in a province with lower drug development cost and higher drug selling price. Hence, we collect provincial wage and drug price data from the official website of National Bureau of Statistics of China (NBSC) (http://www.stats.gov.cn/). NBSC discloses annual wage index and drug price index for each Chinese province. These indices are constructed by setting the wages and drug prices in the previous year at 100, thus helping compare how provincial wage and drug price change between two consecutive years. We include provincial wage index (*Wage*) and provincial drug price index (*Drug Price*) in the ensuing regression analyses.[[4]](#footnote-4) The inclusion of these regional-level variables helps ensure that the regional institutional drivers can be disentangled from the corresponding economic drivers. Finally, our regression analyses also include the year dummy and the four-digit industry dummies.

*3.4 Estimation approach*

Because approximately 60% of the firms in our sample did not conduct formal R&D during the observation period (with zero observations in R&D intensity), our dependent variable is known as a “censored” one. Therefore, a conventional linear regression method cannot distinguish between non-linear “zero” observations and continuous observations; we instead use the Tobit model in the empirical analysis.

We follow three procedures to minimize the potential endogeneity concern. First, we lag all of the independent and control variables by one year to predict the intensity of R&D investments. Second, we remove all of the sample firms that changed their headquarters between 2005 and 2007 to mitigate the potential self-selection of provincial locations in our data analysis. Third, we run an instrumental variable Tobit model to correct potential simultaneity bias in terms of correlations between the key independent variables and the error terms.

Concretely, we use the degree of ad hoc financial burdens that are imposed on the agricultural sector by local governments in each province as the instrumental variable. This variable can be measured by the progress of the *reduction in tax and extra fees imposed on farmers* in each Chinese province. Such progress is also measured by China’s NERI [61]: A higher value that is assigned to a province in a certain year suggests greater progress in reducing the financial burdens of farmers by the local state. We believe that it meets the two essential requirements for a legitimate instrumental variable: instrument relevance and instrument exogeneity. First, there is a significant correlation between the quality of subnational institutions and the degree of local state predation in the agricultural sector. Provinces with more developed institutions experience fewer predatory activities by the local state in their agricultural sector. Estimation of the first-stage instrumental variable Tobit model confirms a significant positive relationship between the two variables. The respective estimated coefficients of the three institutional indices are 1.737 for the *Overall Index*, 0.380 for *Index I*, and 6.760 for *Index V*, with the corresponding *p*-values less than 0.01.[[5]](#footnote-5) Second, a pharmaceutical firm’s R&D investment decisions are unlikely to be associated with the degree of financial burdens that are imposed on local farmers, so the instrumental variable is presumably uncorrelated with the error terms in the regression models.

These procedures lead us to have a total of 9,208 firm-year observations for the test of Hypothesis 1. To test Hypothesis 2, we do not construct dummy variables but split the whole sample into three subsamples: one that consists of indigenous firms, one that consists of wholly owned foreign subsidiaries, and one that consists of IJVs*.* This is because, in contrast to OLS regressions, the moderating effect in limited dependent variable models is rarely indicated by the sign and statistical significance of the estimated coefficient on the interaction term between independent and moderating variables [72, 73]. In the split-sample analysis, we follow the prior literature [74] to calculate the marginal effects of the independent variables in each subsample, and we compare the magnitude of these effects accordingly. In addition, we run the Chow test to evaluate the statistical significance in the hypothesized differential institutional effects across the three types of firms.

1. **Results**

Table 1 presents the descriptive statistics and correlations for the variables that are used in subsequent regressions. It can be seen that there is a significant positive correlation between R&D investment and the quality of subnational institutions. The average R&D intensity is 0.9%. However, its standard deviation and range are considerably large across the sample firms, which suggests that they exhibited varying propensities to invest in innovation activities. Specifically, the percentile analysis of R&D intensity in our sample firms reveals that R&D intensity at the top 1st percentile, 5th percentile, 10th percentile, 30th percentile, and 50th percentile are 11.3%, 4.3%, 2.4%, 0.31%, and 0, respectively. The median of R&D intensity is zero, which indicates that many of the sample firms did not undertake any R&D activities during 2005-2007. This echoes the prior literature that documents the absence of formal R&D investment in many developed economy firms [75].

Table 2 presents the descriptive statistics of R&D intensity in the subsamples of indigenous firms, IJVs and wholly owned foreign subsidiaries. It can be seen that the average R&D intensity is the highest in IJVs (mean R&D intensity = 1.2%) and lowest in indigenous firms (mean R&D intensity = 0.9%). A two-sample t-test reveals that the R&D intensity of IJVs is significantly higher than that of indigenous firms (*p < 0.01*). All of the other two-group comparisons do not yield significant differences.

<Insert Tables 1 and 2 here>

The results of the Tobit regressions using the full sample are reported in Table 3. When only the control variables are included in model 1, the estimated coefficients demonstrate that firms with greater slack resources, larger size, older age, better human resources and a higher export ratio are likely to incur more R&D expenditures. A firm’s prior operational and accounting performance shows no significant effects on R&D. At the regional level, firms tend to make more R&D investments in provinces with lower wage increase, suggesting that firms are quite sensitive to the labor cost of R&D. The coefficient of regional GDP is negative; this negative relation may be driven by the presence of a large number of small and medium-sized enterprises (SMEs) in the Chinese pharmaceutical sector. With a large economic and market size in a province, these SMEs may not have strong incentives to invest in risky R&D, since they can reap financial returns by exploiting the existing market demand and business opportunities.

<Insert Table 3 Here>

In models 2, 3, and 4, we add the three indices of institutional quality to the regression models, respectively. The main effects of subnational institutions on R&D intensity are strongly positive and significant, thus offering unequivocal support for Hypothesis 1. Specifically, all three estimated coefficients are significant at the 1% level. The results of the instrumental variable Tobit regression are reported in Table 4. They demonstrate similar positive and significant effects (models 5-7), which lends further support for Hypothesis 1.

<Insert Table 4 Here>

To test Hypothesis 2, we construct three subsamples and report the Tobit regression results in Table 5. Whereas indigenous firms and IJVs appear to be very responsive to subnational institutions, the institutional effects are found to be negligible in wholly owned foreign subsidiaries. The results hold for all three indices of institutional quality. To compare the magnitude of the institutional effects across the three types of firms, we further calculate the marginal effects of these institutional indices, the results of which are also reported in Table 5.

<Insert Table 5 Here>

Marginal analysis concerns the effect of a one-unit increase in an institutional index on a firm’s R&D intensity. Specifically, the marginal effects in the foreign subsidiaries sample are found to be negligible and statistically insignificant. However, an increase in the overall index by one unit increases the R&D intensity of indigenous firms by 0.3%, compared with 0.2% in joint ventures. An increase in Index I by one unit increases the R&D intensity of indigenous firms by 0.2%, and by 0.4% in the case of joint ventures. An increase in Index V by one unit increases the R&D intensity of both indigenous firms and joint ventures by 0.1%. Overall, these results confirm uneven institutional effects on R&D intensity across different types of firms, and they provide qualified support for Hypothesis 2.

Additionally, we also use Chow tests to confirm that the magnitudes of the estimated coefficients in the subsamples of indigenous firms and IJVs are statistically stronger than those in the wholly owned foreign subsample; however, again, we do not find significantly different institutional effects between indigenous firms and IJVs.[[6]](#footnote-6) Finally, to ensure the robustness of our findings, we use the instrumental variable Tobit regression model to conduct the subsample analysis and obtain very similar results in Table 6.

<Insert Table 6 Here>

1. **Discussion and Conclusion**

*5.1 Theoretical contributions and implications*

What drives corporate R&D investment in emerging economies? This paper builds an important bridge between new institutional economics and the conventional innovation literature by advancing our knowledge about how subnational institutions matter for innovation activities. While the former stream of literature has yet to pay sufficient attention to the institutional impacts of corporate innovation, most of the latter research that originates from the developed economy context is concerned with the firm- and industry-level determinants of R&D investments. The prior linkages between the strands of research reside largely in the appreciation of the role of IPR protection in facilitating innovation activities. However, it has also been found that this specific dimension of national institutions has limited explanatory power in understanding the underlying environmental driving forces of corporate R&D [2, 76].

In this paper, we offer a detailed account of the roles of subnational institutions in shaping the incentives of corporate R&D investment. By explicating the mechanisms through which local government interventions and regional contracting institutions affect R&D incentives, we contribute to the development of a more nuanced understanding of how institutional environments have an impact upon corporate innovation strategy. In particular, our research findings highlight the crucial relevance of subnational institutions in shaping organizational actions in large emerging economies. Contributing to the recent studies on subnational regions, we suggest that local contexts vary not only in terms of economic development stages and resource endowments, but also with regard to the quality of institutions. Thus, this research reveals the multifaceted nature of local contexts and their varying impacts on corporate R&D. For instance, although R&D investments may be attracted to regions with a low-cost base, institutional quality still enters firms’ cost-benefit calculations regarding their R&D decision. This can likely explain why in the empirical studies we find different R&D impacts of local institutions and wage growth. Future research can further explore the confluence or potential tensions that are involved in the multiple dimensions of local institutions and examine how these situations might relate to firm-level actions and outcomes.

Moreover, our research findings reveal a critical boundary condition of this institutional impact: country/ownership identity. This finding complements insights from the prior innovation literature that complementary firm-level assets can substitute for IPR protection to reduce appropriability hazards. It demonstrates that some internal capabilities that are embedded in organizational/global linkages can moderate the effects of surrounding institutions on strategic decision making.

Regarding the reach of subnational institutions across foreign subsidiaries and indigenous firms in a host country, our study contributes to the emerging research on the different responses of foreign and domestic firms to host country institutions [45]. At first glance, the liabilities of foreignness and outsidership may lead us to suspect that foreign subsidiaries require a higher level of institutional protection for motivating them to engage in innovation activities in emerging economies. However, our study, which is based on the institutional outsider and global linkage effects, suggests otherwise. While being an institutional outsider leaves fewer potential influence/policy rents that foreign companies could create than their domestic competitors, the possession of extensive global linkages equips the former with more powerful complementary assets to partially circumvent weak local contracting institutions. Therefore, we hope this research informs future studies that will continue to reveal how the interplay between host country institutions and the global nature of foreign subsidiaries shapes firm strategy and outcomes.

Different from our initial theoretical prediction, our empirical results show that IJVs are no less responsive than their domestic counterparts to local institutional contingencies. We suspect that this has to do with the impact of particular government policies on foreign direct investment in China during the 1990s and 2000s. In many sectors that are deemed to be strategically important by the Chinese government, establishing joint ventures with well-connected local firms designated by the Chinese government may be the only viable entry mode for MNEs, whereas entry through wholly owned foreign subsidiaries is discouraged, if not forbidden [39].[[7]](#footnote-7) Thus, these IJVs are not the normal, voluntary strategic alliances in the developed economies, because MNEs that seek to penetrate the Chinese market must work with strong, local partners that are well connected to the local institutions in the ventures. As a result, these IJVs are deeply embedded in local institutional contexts and exhibit very limited behavioral differences from domestic firms.

*5.2 Managerial and policy implications*

This paper offers important implications for the making of managerial decisions and government policies. First, the finding that more robust subnational institutions drive greater innovation investments should prompt senior executives to develop a more comprehensive checklist when they make their location choices for projects that rely on significant R&D inputs. Not only do firms need to evaluate local economic conditions regarding business growth potential and the costs of R&D investment, but they should also develop a deeper understanding of the local institutional contingencies that will profoundly shape the underlying dynamics of innovation rent creation and capture.

Furthermore, our split-sample analysis implies that MNEs that operate in emerging markets can afford to care less about the local institutional idiosyncrasies when they make their investment decision on innovation activities. In contrast, indigenous firms’ R&D strategy will be more susceptible to regional institutional contingencies. Interestingly, MNEs that enter China through IJVs should realize that their strategic actions will be deeply shaped by local institutions.

Finally, policy makers in emerging economies must develop a more nuanced view about how to motivate more innovation activities under their jurisdiction. Our findings suggest that institutional reforms induce greater corporate R&D investments, and the primary beneficiaries of these reform initiatives tend to be domestic enterprises and IJVs. Under many circumstances, it is these players, not high-performing foreign subsidiaries, that the government really intends to help. Thus, in addition to offering financial incentives to these firms, institutional reforms that aim to change the local institutional infrastructures will have a more lasting effect of promoting corporate innovation.

*5.3 Limitations and future research*

The current paper has several notable limitations that should be addressed in future research. First, the findings are obtained by analyzing data from one R&D intensive industry in one emerging economy, so we cannot rule out the possibility that other industry- and country-specific factors can affect these findings. Future studies can use data from other industries, especially mid-tech sectors, and other emerging markets, to test and hopefully extend the current research hypotheses.

Second, we are not certain of whether the current research framework and findings can be readily extended to the cross-national level. Thus, if future research can have access to measures and data on country-level institutions and firm-level variables, we can quickly test whether the current findings will also hold in the cross-national setup and hopefully identify possible differences between the contexts.

Third, due to data limitations, we treat wholly owned foreign subsidiaries as a uniform group and ignore intragroup heterogeneity. This needs to be addressed by using datasets that contain more fine-grained measures of both the parent- and subsidiary-level factors that influence corporate R&D decisions. Similarly, because of data availability issues, we assume away potential global and cross-regional linkages on the part of domestic firms. Although this assumption may be tenable in China’s pharmaceutical sector during the mid-2000s, emerging market firms have begun to internationalize and create significant global linkages in the recent years. Thus, future research can leverage this new context to compare and contrast the intragroup linkages between firms from the developed and emerging economies.[[8]](#footnote-8)

Finally, although we follow prior literature to include a host of firm-level control variables in the regression analyses, we cannot rule out all the unobserved firm-level factors that may affect R&D intensity. This is particular because a fixed effects model is not defined in Tobit regressions. Thus, this methodological limitation needs to be addressed in future research.

In closing, despite all of these limitations, we believe this paper opens the door to future inquiries that can further explore how multifaceted subnational institutions and firm-specific attributes interact to shape corporate innovation activities around the emerging economies.

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**Table 1. Descriptive Statistics and Correlation Coefficients**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **Mean** | **S.D.** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| 1 R&D Intensity | 0.009 | 0.033 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 Slack Resources | 0.264 | 2.318 | 0.154\* | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 Firm Size | 0.010 | 0.022 | 0.017 | 0.008 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 Fixed Asset | 0.035 | 3.084 | -0.002 | -0.001 | -0.023\* | 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 Human Resources | 0.184 | 0.228 | 0.114\* | 0.025\* | 0.031\* | -0.005 | 1 |  |  |  |  |  |  |  |  |  |  |  |
| 6 Firm Age | 9.997 | 12.989 | 0.022\* | 0.033\* | 0.176\* | -0.016\* | 0.066\* | 1 |  |  |  |  |  |  |  |  |  |  |
| 7 Export Ratio | 0.075 | 0.215 | -0.012 | -0.017\* | 0.056\* | -0.002 | 0.033\* | 0.026\* | 1 |  |  |  |  |  |  |  |  |  |
| 8 TFP | 1.472 | 1.678 | 0.032\* | 0.021\* | -0.012 | 0.006 | 0.051\* | -0.017\* | -0.016\* | 1 |  |  |  |  |  |  |  |  |
| 9 ROA | 0.087 | 0.203 | -0.019 | -0.032\* | 0.008 | -0.008 | 0.020\* | -0.055\* | 0.019\* | 0.026\* | 1 |  |  |  |  |  |  |  |
| 10 HHI | 0.010 | 0.004 | 0.064\* | 0.014 | 0.001 | -0.006 | 0.063\* | -0.046\* | 0.105\* | 0.025\* | 0.051\* | 1 |  |  |  |  |  |  |
| 11 Regional GDP | 9.148 | 0.738 | -0.039\* | -0.021\* | 0.017\* | -0.005 | 0.106\* | 0.021\* | 0.132\* | -0.019\* | 0.132\* | 0.149\* | 1 |  |  |  |  |  |
| 12 Wage | 0.129 | 0.035 | -0.026\* | 0.007 | 0.013 | -0.003 | -0.087\* | -0.058\* | -0.116\* | 0.020\* | 0.030\* | -0.062\* | -0.307\* | 1 |  |  |  |  |
| 13 Drug Price | -0.005 | 0.023 | 0.003 | -0.003 | -0.004 | 0.008 | 0.096\* | 0.024\* | -0.041\* | -0.008 | 0.041\* | -0.161\* | 0.145\* | -0.063\* | 1 |  |  |  |
| 14 Overall Index | 7.587 | 1.698 | 0.041\* | -0.003 | 0.001 | 0.005 | 0.178\* | 0.075\* | 0.218\* | -0.002 | 0.053\* | 0.172\* | 0.800\* | -0.449\* | 0.073\* | 1 |  |  |
| 15 Index I | 8.941 | 1.160 | 0.014 | -0.008 | 0.011 | 0.003 | 0.094\* | 0.035\* | 0.174\* | -0.022\* | 0.023\* | 0.184\* | 0.720\* | -0.304\* | -0.083\* | 0.799\* | 1 |  |
| 16 Index V | 7.186 | 4.104 | 0.084\* | 0.011 | -0.005 | 0.005 | 0.182\* | 0.099\* | 0.158\* | 0.017\* | -0.007 | 0.106\* | 0.433\* | -0.347\* | 0.043\* | 0.662\* | 0.390\* | 1 |

Notes: N = 9,208. \* denotes statistical significance at or below the 5% level.

**Table 2. R&D Intensity in the Full Sample and Subsamples**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Firm Types** | **Mean** | **Std. Dev.** | **Median & Min** | **Max** |
| Full sample | 0.009 | 0.033 | 0.000 | 0.751 |
| Indigenous firms | 0.009 | 0.030 | 0.000 | 0.749 |
| International joint ventures | 0.012 | 0.043 | 0.000 | 0.751 |
| Foreign firms | 0.011 | 0.047 | 0.000 | 0.749 |

Note: Because more than 50% of the sample and subsample firms do not invest in R&D, the median and the minimum are the same and equal to zero.

**Table 3. Tobit Regressions Examining the Effects of Subnational Institutions on Corporate R&D Intensity**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Model 1 | Model 2 | Model 3 | Model 4 |
| *Control Variables* |  |  |  |  |
| Slack Resources | 0.025\*\*\* | 0.023\*\*\* | 0.024\*\*\* | 0.023\*\*\* |
| (0.002) | (0.002) | (0.002) | (0.002) |
| Firm Size | 0.234\*\*\* | 0.249\*\*\* | 0.239\*\*\* | 0.250\*\*\* |
| (0.028) | (0.028) | (0.028) | (0.028) |
| Fixed Asset | 0.001 | 0.001 | 0.001 | 0.000 |
| (0.000) | (0.000) | (0.000) | (0.000) |
| Human Resources | 0.038\*\*\* | 0.032\*\*\* | 0.037\*\*\* | 0.030\*\*\* |
| (0.004) | (0.004) | (0.004) | (0.004) |
| Firm Age | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* |
| (0.000) | (0.000) | (0.000) | (0.000) |
| Export Ratio | 0.007\*\* | 0.001 | 0.005 | 0.002 |
| (0.004) | (0.004) | (0.004) | (0.004) |
| TFP | -0.000 | -0.000 | 0.000 | -0.000 |
| (0.000) | (0.000) | (0.000) | (0.000) |
| ROA | 0.006 | 0.007 | 0.007\* | 0.009\* |
| (0.004) | (0.004) | (0.004) | (0.004) |
| HHI | 0.532 | 0.447 | 0.412 | 0.564 |
| (0.839) | (0.833) | (0.837) | (0.834) |
| Regional GDP | -0.007\*\*\* | -0.022\*\*\* | -0.016\*\*\* | -0.014\*\*\* |
| (0.001) | (0.002) | (0.002) | (0.001) |
| Wage | -0.162\*\*\*  (0.024) | -0.082\*\*\*  (0.024) | -0.161\*\*\*  (0.024) | -0.096\*\*\*  (0.024) |
| Drug Price | -0.045  (0.059) | 0.084  (0.059) | 0.029  (0.059) | 0.041  (0.059) |
| *Predictors* |  |  |  |  |
| Overall Index |  | 0.009\*\*\* |  |  |
|  | (0.001) |  |  |
| Index I |  |  | 0.008\*\*\* |  |
|  |  | (0.001) |  |
| Index V |  |  |  | 0.004\*\*\* |
|  |  |  | (0.000) |
| Log Likelihood | 2431.394 | 2494.412 | 2467.137 | 2489.371 |

Notes: N = 9,208. All the regressions shown above have controlled for the year dummy and industry dummies. Standard errors are in parentheses. \*, \*\*, \*\*\* denote statistical significance at 10%, 5%, and 1% levels, respectively (two-tailed tests).

**Table 4. Instrumental Variable Tobit Regressions Examining the Effects of Subnational Institutions on Corporate R&D Intensity**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Model 5 | Model 6 | Model 7 |
| *Control Variables* |  |  |  |
| Slack Resources | 0.022\*\*\* | 0.020\*\*\* | 0.023\*\*\* |
| (0.002) | (0.003) | (0.002) |
| Firm Size | 0.262\*\*\* | 0.279\*\*\* | 0.253\*\*\* |
| (0.029) | (0.039) | (0.028) |
| Fixed Asset | 0.001 | 0.000 | 0.000 |
| (0.000) | (0.000) | (0.000) |
| Human Resources | 0.027\*\*\* | 0.025\*\*\* | 0.028\*\*\* |
| (0.004) | (0.005) | (0.004) |
| Firm Age | 0.000\*\*\* | 0.000\*\* | 0.000\*\*\* |
| (0.000) | (0.000) | (0.000) |
| Export Ratio | -0.003 | -0.018\*\*\* | 0.001 |
| (0.004) | (0.007) | (0.004) |
| TFP | -0.000 | 0.001 | -0.000 |
| (0.000) | (0.001) | (0.000) |
| ROA | 0.008\* | 0.025\*\*\* | 0.009\*\* |
| (0.004) | (0.007) | (0.004) |
| HHI | 0.342 | -0.623 | 0.553 |
| (0.837) | (1.043) | (0.834) |
| Regional GDP | -0.033\*\*\* | -0.096\*\*\* | -0.015\*\*\* |
| (0.005) | (0.018) | (0.002) |
| Wage | -0.021  (0.034) | -0.106\*\*\*  (0.032) | -0.085\*\*\*  (0.027) |
| Drug Price | 0.175\*\*  (0.069) | 0.736\*\*\*  (0.178) | 0.052  (0.060) |
| *Predictors* |  |  |  |
| Overall Index | 0.016\*\*\* |  |  |
| (0.003) |  |  |
| Index I |  | 0.078\*\*\* |  |
|  | (0.016) |  |
| Index V |  |  | 0.004\*\*\* |
|  |  | (0.001) |

Notes: N = 9,208. All the regressions shown above have controlled for the year dummy and industry dummies. Standard errors are in parentheses. \*, \*\*, \*\*\* denote statistical significance at 10%, 5%, and 1% levels, respectively (two-tailed tests).

**Table 5. Tobit Regressions Examining the Effects of Subnational Institutions on Corporate R&D Intensity in Wholly Owned Foreign Subsidiaries, Indigenous Firms and Joint Ventures**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Wholly Owned Foreign Subsidiaries | | | Indigenous Firms | | | Joint Ventures | | |
|  | Model 8 | Model 9 | Model 10 | Model 11 | Model 12 | Model 13 | Model 14 | Model 15 | Model 16 |
| *Control Variables* |  |  |  |  |  |  |  |  |  |
| Slack Resources | 0.010\* | 0.010\* | 0.010\* | 0.028\*\*\* | 0.030\*\*\* | 0.028\*\*\* | 0.063\*\*\* | 0.063\*\*\* | 0.063\*\*\* |
| (0.006) | (0.006) | (0.006) | (0.002) | (0.002) | (0.002) | (0.008) | (0.008) | (0.008) |
| Firm Size | 0.768\*\* | 0.807\*\*\* | 0.757\*\* | 0.265\*\*\* | 0.258\*\*\* | 0.270\*\*\* | 0.089 | 0.082 | 0.084 |
| (0.310) | (0.309) | (0.308) | (0.030) | (0.030) | (0.030) | (0.068) | (0.068) | (0.068) |
| Fixed Asset | -0.029 | -0.028 | -0.029 | 0.000 | 0.000 | 0.000 | -0.001 | -0.001 | -0.001 |
| (0.021) | (0.020) | (0.021) | (0.000) | (0.000) | (0.000) | (0.026) | (0.026) | (0.026) |
| Human Resources | 0.059\*\*\* | 0.057\*\*\* | 0.060\*\*\* | 0.039\*\*\* | 0.044\*\*\* | 0.036\*\*\* | 0.006 | 0.008 | 0.003 |
| (0.017) | (0.016) | (0.017) | (0.004) | (0.004) | (0.004) | (0.000) | (0.009) | (0.009) |
| Firm Age | -0.000 | -0.000 | -0.000 | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* | 0.001\* | 0.001\* | 0.001 |
| (0.001) | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Export Ratio | -0.006 | -0.007 | -0.004 | 0.009\*\* | 0.014\*\*\* | 0.011\*\* | -0.018\* | -0.018\* | -0.017\* |
| (0.015) | (0.014) | (0.015) | (0.004) | (0.004) | (0.004) | (0.010) | (0.009) | (0.009) |
| TFP | -0.005 | -0.005 | -0.005 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| (0.004) | (0.004) | (0.004) | (0.000) | (0.000) | (0.000) | (0.002) | (0.002) | (0.002) |
| ROA | -0.041 | -0.040 | -0.041 | 0.011\*\* | 0.011\*\* | 0.012\*\*\* | 0.024 | 0.025\* | 0.025\* |
| (0.030) | (0.030) | (0.030) | (0.004) | (0.004) | (0.004) | (0.015) | (0.015) | (0.015) |
| HHI | 2.676 | 2.452 | 2.705 | 0.411 | 0.400 | 0.532 | 0.875 | 0.757 | 0.848 |
| (5.851) | (5.846) | (5.849) | (0.827) | (0.834) | (0.828) | (2.868) | (2.877) | (2.873) |
| Regional GDP | -0.010 | -0.016\* | -0.007 | -0.023\*\*\* | -0.016\*\*\* | -0.015\*\*\* | -0.016\*\*\* | -0.017\*\*\* | -0.013\*\*\* |
| (0.010) | (0.009) | (0.007) | (0.002) | (0.002) | (0.001) | (0.005) | (0.005) | (0.004) |
| Wage | -0.186  (0.146) | -0.159  (0.138) | -0.203  (0.139) | -0.074\*\*\*  (0.025) | -0.161\*\*\*  (0.024) | -0.083\*\*\*  (0.025) | -0.032  (0.078) | -0.053  (0.076) | -0.049  (0.076) |
| Drug Price | -0.128  (0.396) | 0.012  (0.397) | -0.163  (0.386) | 0.097\*  (0.059) | 0.038  (0.059) | 0.057  (0.059) | -0.006  (0.198) | 0.018  (0.198) | -0.028  (0.195) |
| *Predictors* |  |  |  |  |  |  |  |  |  |
| Overall Index | 0.001 |  |  | 0.010\*\*\* |  |  | 0.006\*\* |  |  |
| (0.005) |  |  | (0.001) |  |  | (0.003) |  |  |
| Index I |  | 0.009 |  |  | 0.007\*\*\* |  |  | 0.011\*\*\* |  |
|  | (0.007) |  |  | (0.001) |  |  | (0.004) |  |
| Index V |  |  | -0.000 |  |  | 0.004\*\*\* |  |  | 0.003\*\*\* |
|  |  | (0.002) |  |  | (0.000) |  |  | (0.001) |
| Marginal effects: Overall index | 0.000 |  |  | 0.003\*\*\* |  |  | 0.002\*\* |  |  |
| (0.002) |  |  | (0.000) |  |  | (0.001) |  |  |
| Marginal effects: index I |  | 0.003 |  |  | 0.002\*\*\* |  |  | 0.004\*\*\* |  |
|  | (0.002) |  |  | (0.000) |  |  | (0.001) |  |
| Marginal effects: index V |  |  | -0.000 |  |  | 0.001\*\*\* |  |  | 0.001\*\*\* |
|  |  | (0.001) |  |  | (0.000) |  |  | (0.000) |
|  |  |  |  |  |  |  |  |  |  |
| Log Likelihood | 110.867 | 111.779 | 110.832 | 2167.041 | 2133.222 | 2158.591 | 364.119 | 365.509 | 365.500 |
| Observations | 553 | 553 | 553 | 7503 | 7503 | 7503 | 1152 | 1152 | 1152 |

Notes: All the regressions shown above have controlled for the year dummy and industry dummies. Standard errors are in parentheses. \*, \*\*, \*\*\* denote statistical significance at 10%, 5% and 1% levels, respectively (two-tailed tests).

**Table 6. Instrumental Variable Tobit Regressions Examining the Effects of Subnational Institutions on Corporate R&D Intensity in Wholly Owned Foreign Subsidiaries, Indigenous Firms and Joint Ventures**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Wholly Owned Foreign Subsidiaries | | | Indigenous Firms | | | Joint Ventures | | |
|  | Model 17 | Model 18 | Model 19 | Model 20 | Model 21 | Model 22 | Model 23 | Model 24 | Model 25 |
| *Control Variables* |  |  |  |  |  |  |  |  |  |
| Slack Resources | 0.010\* | 0.011\* | 0.010\* | 0.027\*\*\* | 0.026\*\*\* | 0.028\*\*\* | 0.059\*\*\* | 0.047\*\*\* | 0.061\*\*\* |
| (0.006) | (0.006) | (0.006) | (0.002) | (0.003) | (0.002) | (0.009) | (0.013) | (0.009) |
| Firm Size | 0.813\*\* | 0.607 | 0.772\*\* | 0.272\*\*\* | 0.284\*\*\* | 0.271\*\*\* | 0.139\* | 0.172\* | 0.098 |
| (0.325) | (0.447) | (0.310) | (0.030) | (0.039) | (0.030) | (0.073) | (0.098) | (0.069) |
| Fixed Asset | -0.031 | -0.026 | -0.030 | 0.000 | 0.000 | 0.000 | 0.008 | 0.029 | 0.002 |
| (0.021) | (0.022) | (0.021) | (0.000) | (0.000) | (0.000) | (0.026) | (0.034) | (0.026) |
| Human Resources | 0.053\*\* | 0.072\*\* | 0.055\*\*\* | 0.036\*\*\* | 0.041\*\*\* | 0.036\*\*\* | -0.008 | -0.022 | -0.004 |
| (0.021) | (0.029) | (0.018) | (0.005) | (0.005) | (0.005) | (0.011) | (0.018) | (0.010) |
| Firm Age | -0.000 | 0.000 | -0.000 | 0.000\*\*\* | 0.000\*\* | 0.000\*\*\* | 0.001 | 0.000 | 0.001 |
| (0.001) | (0.001) | (0.001) | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) |
| Export Ratio | -0.010 | 0.003 | -0.008 | 0.006 | -0.009 | 0.011\*\* | -0.026\*\* | -0.045\*\*\* | -0.019\*\* |
| (0.017) | (0.021) | (0.015) | (0.005) | (0.008) | (0.005) | (0.010) | (0.017) | (0.009) |
| TFP | -0.005 | -0.005 | -0.005 | 0.000 | 0.001\*\* | 0.000 | 0.000 | -0.001 | 0.000 |
| (0.004) | (0.004) | (0.004) | (0.000) | (0.001) | (0.000) | (0.002) | (0.002) | (0.002) |
| ROA | -0.041 | -0.045 | -0.040 | 0.011\*\* | 0.026\*\*\* | 0.012\*\*\* | 0.030\*\* | 0.055\*\* | 0.029\* |
| (0.030) | (0.032) | (0.030) | (0.004) | (0.006) | (0.004) | (0.015) | (0.023) | (0.015) |
| HHI | 2.710 | 3.177 | 2.784 | 0.335 | -0.298 | 0.530 | 0.431 | 1.721 | 0.672 |
| (5.874) | (6.149) | (5.873) | (0.830) | (1.001) | (0.828) | (2.925) | (3.621) | (2.891) |
| Regional GDP | -0.020 | 0.027 | -0.011 | -0.031\*\*\* | -0.083\*\*\* | -0.015\*\*\* | -0.039\*\*\* | -0.109\*\*\* | -0.017\*\*\* |
| (0.024) | (0.067) | (0.009) | (0.005) | (0.017) | (0.002) | (0.011) | (0.042) | (0.005) |
| Wage | -0.110  (0.215) | -0.384  (0.375) | -0.172  (0.146) | -0.030  (0.035) | -0.137\*\*\*  (0.030) | -0.081\*\*\*  (0.029) | 0.098  (0.098) | 0.184  (0.143) | -0.014  (0.079) |
| Drug Price | 0.026  (0.510) | -0.903  (1.468) | -0.098  (0.399) | 0.156\*\*  (0.068) | 0.553\*\*\*  (0.150) | 0.059  (0.060) | 0.270  (0.236) | 1.270\*\*  (0.620) | 0.046  (0.201) |
| *Predictors* |  |  |  |  |  |  |  |  |  |
| Overall Index | 0.009 |  |  | 0.015\*\*\* |  |  | 0.021\*\*\* |  |  |
| (0.017) |  |  | (0.003) |  |  | (0.007) |  |  |
| Index I |  | -0.039 |  |  | 0.064\*\*\* |  |  | 0.108\*\* |  |
|  | (0.074) |  |  | (0.014) |  |  | (0.044) |  |
| Index V |  |  | 0.002 |  |  | 0.004\*\*\* |  |  | 0.005\*\*\* |
|  |  | (0.004) |  |  | (0.001) |  |  | (0.002) |
| Observations | 553 | 553 | 553 | 7,503 | 7,503 | 7,503 | 1,152 | 1,152 | 1,152 |

Notes: All the regressions shown above have controlled for the year dummy and industry dummies. Standard errors are in parentheses. \*, \*\*, \*\*\* denote statistical significance at 10%, 5% and 1% levels, respectively (two-tailed tests).

|  |  |
| --- | --- |
|  | **Pei Sun** received the Ph.D. and M.Phil. degrees in economics from the University of Cambridge, U.K., in 2006 and 2001 respectively; and the B.A. degree in economics from Peking University, China in 2000.  He is currently professor of economics and strategy at the School of Management, Fudan University, China. His research focuses on nonmarket strategy and corporate governance and is concerned with how firms manage and exploit institutional complexity and changes in emerging economies. He has published papers in renowned academic journals such as *Academy of Management Journal*, *Academy of Management Perspectives*, *Cambridge Journal of Economics*, *Economics Letters*, *Journal of International Business Studies*, *Journal of Management*, *Journal of Management Studies*, and *World Development*. |
|  |  |
| **photo** | **Zhe Qu** received the Ph.D. degree in information technology management from Georgia Institute of Technology, United States, in 2008.  She is currently an Associate Professor in the School of Management at Fudan University. She was a visiting scholar in the Sloan School of Management at MIT in 2012. Her research takes an organizational view of Information Systems (IS) and addresses the relationship between IS/IT and strategy. She has received grant from the National Natural Science Foundation of China for her research on R&D offshoring of multinational enterprises and learning of host country firms in ICT industry. Her work has been published in *Decision Support Systems, Research Policy, Journal of International Marketing, European Journal of Marketing, and Information Systems Frontiers*. |
|  |  |
|  | **Zhixiang Liao** received the Master’s degree in management science and engineering from Fudan University.  He is currently a Data Support Engineer at China Unionpay Data Services in Shanghai. His research focuses on data science and deep learning. He specializes in software requirements specifications and algorithm implementations in the system development process. |

1. Foreign R&D investments can be market-seeking because the expenditures are used to support existing manufacturing or marketing activities in host countries and to develop new products/processes specifically for the host countries. Foreign R&D investments can also be resource-seeking when they aim to tap into high-quality, low-cost talents in emerging economies to conduct basic research in support of the development of global product/technology platforms [19]. [↑](#footnote-ref-1)
2. As mentioned in our subsequent empirical analysis, R&D intensity at the top 1st percentile, 5th percentile, and 10th percentile of the sample firms is 11.3%, 4.3%, and 2.4%, respectively. [↑](#footnote-ref-2)
3. 80% of drugs went to hospitals and clinics, with the remaining 20% distributed through retail pharmacies [59]. [↑](#footnote-ref-3)
4. Unfortunately, we do not have data access to the absolute levels of regional drug prices and wages. [↑](#footnote-ref-4)
5. Due to space limit, the detailed first-stage results are not presented in the paper, but they are certainly available from the authors upon request. [↑](#footnote-ref-5)
6. Due to space limitations, the results are not reported here; they are available upon request however. [↑](#footnote-ref-6)
7. This might also explain the relatively higher R&D intensity in the joint ventures group shown in Table 2. MNEs may have to commit more resources to R&D in the joint ventures *in exchange for* policy favors and financial resources at the disposal of the Chinese state. [↑](#footnote-ref-7)
8. We thank one of the reviewers for calling our attention to this important limitation. [↑](#footnote-ref-8)