Industry Variety and Innovation of New Ventures

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ABSTRACT

Based on one longitudinal panel dataset of Chinese manufacturing firms, we construct a mechanism to assess whether new ventures with different internationalization strategies benefit differently from different locational advantages in pursuit of innovation performance. In this paper, we argue that innovation depends on knowledge creation and show that industry variety can affect the innovation of new ventures through influencing the amount of external knowledge that is available to a new venture but simultaneously through working on the new venture's learning process. Meanwhile, innovation search processes may differ among new ventures because of their internationalization strategies. By applying a fixed effect model, we find that industry specialization positively promotes the innovation of Born Globals (BGs) and Incremental New Exporters (INEs) but it has no effect on the innovation of Domestic New Ventures (DNVs). Moreover, the positive relationship between industry specialization and the innovation of BGs and INEs becomes stronger as related variety in the same city increases but this positive relationship becomes weaker as unrelated variety in the same city increases.

Key words: industry variety, innovation, new ventures, China

JEL codes: O14, M21

1. INTRODUCTION

In this paper, we test how industry variety at city level influences innovation of new ventures with different internationalization strategies. We explore the possible reasons why these influences vary from domestic new ventures (McDougall et al., 2003; Spence et al., 2011) to international new ventures (e.g., Nemkova, 2017). New ventures in this paper are classified into three types according to their internationalization strategies-internationalization extent and speed, namely Born Globals (Cavusgil & Knight, 2015a), Incremental New Exporters (Choquette et al., 2017:452), and Domestic New Ventures (Spence et al., 2011). Generally, new ventures are young and inexperienced, and they are more likely to fail because they are not well endowed with resources and face more risks (Ucbasaran et al., 2013). Innovation has been proved as a critical driver of emergence and success of new ventures regardless of whether they conduct international entrepreneurship or domestic entrepreneurship (e.g., Piperopoulos, 2012).

One of our theoretical points of departure is International Entrepreneurship (IE), which is a research discipline that has not attracted much attention from scholars until 1990s (McDougall & Oviatt, 2000; Oviatt & McDougall, 1994). IE is different from traditional entrepreneurship in terms of that entrepreneurial activities in IE are crossing national borders and involve internationalization issues (McDougall & Oviatt, 2000). IE scholars have contributed a multitude of studies that proved the importance of innovation for international new ventures from various aspects, such as how to build innovation culture (e.g., Freeman & Cavusgil, 2007), generate innovative end products and solutions (e.g., Kim et al., 2011), among others. Surprisingly, however, little is known about the role of external environment

factors on innovation of international new ventures. Not to say the possible differences in effects of industry variety on the innovation of Born Globals (BGs), Incremental New Exporters (INEs), and Domestic New Ventures (DNVs).

If positioning in the viewpoint of industry variety, it is another story. Industry variety describes the degree to which enterprises operate in different industries that share or do not share similarities (Aarstad et al., 2016:845). According to Frenken et al. (2007:687), three types of industry variety, which we will explain in more depth in next section, are industry specialization, related variety, and unrelated variety. Although scholars have known the importance of industry variety for a long time, scholars preferred to study how one certain type of industry variety influences innovation of new ventures. Gilbert et al. (2008), for example, found that new ventures located in a region with industry specialization tend to have higher growth and better innovation performance.

However, this leaves us two theoretical gaps. In real life, a normal phenomenon is that "no city is really a one-industry town, not even Hollywood or the Silicon Valley" (Helsley & Strange, 2014:1064); in other words, cities, particular large metropolitans, always contain more than one industry (Mukim, 2015). Industry variety essentially uncovers the fact that local new ventures are influenced simultaneously by both the industry it belongs to and other local industries. Thus, one gap is that new ventures with the same internationalization strategy may be exposed to different influences under different types of industry varieties; another gap is that new ventures with different internationalization strategies (BGs, INEs, and DNVs) may be impacted in different ways by the same type of industry variety.

This study intends to fill these two gaps by investigating how three types of industry

varieties (IS, RV, and UV) influence the innovation of new ventures with different internationalization strategies (BGs, INEs, and DNVs) in the city background. The essence of this research question is to show whether BGs, INEs and DNVs benefit differently from different locational advantages in pursuit of innovation performance. Location, or say co-location of enterprises within one region can be a source for new ventures to encounter new knowledge because geographical proximity can indeed promote knowledge spillovers within a region, or at least increase the chances of firms to expose to potential knowledge spillovers (Alcácer & Chung, 2007; Boschma, 2005). However, whether a new venture can effectively learn from this external knowledge depends on its absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002). New ventures with different internationalization strategies may have distinct absorptive capacities to the knowledge from the same industry, related industry and unrelated industry.

This paper is positioned at the intersection of regional science and international entrepreneurship. Accordingly, our paper makes several contributions. Firstly, by showing the effect of industry variety on new ventures with different internationalization strategies, we underscore the importance of the external environment on a new venture's strategic choices and help entrepreneurs know more about how to make better use of local environment to leverage their competitiveness and thus enhance their innovation performance (e.g., Buckley et al., 2017).

Secondly, building on externality theory and organizational learning perspective, this paper extends current "conversation" of international entrepreneurship and regional science by presenting the possible reasons why related variety and unrelated variety exert different

impacts on new ventures with same internationalization strategy and the possible reasons why the same industry variety has different influences on new ventures with different internationalization strategies.

Thirdly, we argue that three types of industry variety are not independent from each other. By introducing the moderating effect, this paper shows and proves that industry specialization is embedded in local industry environment that is constituted by related variety and unrelated variety. In one word, by integrating three types of industry variety simultaneously, we contribute to industry variety argument by adding new theoretical mechanisms.

The remainder of this paper is organized as follow. Section 2 presents concepts and raises hypotheses. Section 3 describes methodology issues, including research background and statistical models, and presents the regression results. Section 4 presents the discussion and conclusion.

2. CONCEPTS AND HYPOTHESES

2.1 Concepts

In order to capture the effect of industry variety on new ventures with different internationalization strategies, this paper introduces three types of new ventures. Born Globals (hereafter, BGs) are characterized by its early and rapid internationalization strategy (Gassmann & Keupp, 2007) and its innovativeness and proactiveness (Knight & Cavusgil, 2004). We follow Knight and Cavusgil (2004: 124) and define Born Globals as “business organizations that, from or near their founding, seek superior international business performance from the application of knowledge-based resources to the sale of outputs in

multiple countries". Domestic new ventures (DNVs) refer to new ventures that employ a strategy of no internationalization and only conduct businesses in the domestic market. The last type of entrepreneurship discussed here is Incremental New Exporters (INEs) – new ventures which falls between DNVs and BGs. INEs are those new ventures that implement an internationalization strategy but not as quick and early as the ones conducted by BGs. They either start to internationalize at their early period but their internationalization processes tend to be slow and modest, or start to internationalize after they have prepared adequately.

Industry variety reflects industrial structure at city level and this paper focus on three levels of industry variety: industry specialization, related variety, and unrelated variety. The extent of specialization of one industry in a given city is captured by the absolute number of enterprises of that industry and industry specialization intends to depicture the Marshall externalities: labor productivity in one industry in a given region is supposed to increase with number of enterprises in that industry. Marshall externalities result from three main sources: intra-industry knowledge spillovers, labor market pooling, and transport cost savings (Beaudry & Schiffaurova, 2009). If a city is characterized by a high level of related variety, then it means that firms in this city "operate in different industries that share several similarities" (Aarstad et al., 2016: 845); if by a high level of unrelated variety, then it indicates that firms in this city "operate in different industries that share few or limited similarities" (Aarstad et al., 2016: 845). As Frenken et al. (2007) did, the purpose of this division is to capture different kinds of knowledge spillovers since a firm can learn from other firms in the same industry, in the related industries, and in the unrelated industries.

Innovation can be regarded as a process through which knowledge is acquired, shared

and assimilated with the purpose of creating new knowledge to facilitate new business outcomes (Harkema, 2003; Plessis, 2007). This indicates that knowledge is a critical factor for a firm to generate new innovation (Mejri et al., 2018): the more internal knowledge a firm owns, the more innovation a firm conducts. Therefore, when external knowledge is available to a firm, such firm needs to be able to recognize the value of this external knowledge, assimilate it, and transform it into the firm's internal knowledge which can be directly applied into production innovation (Zahra & George, 2002). This ability is usually being referred to as "absorptive capacity" and it is critical for effective learning.

In this paper, we combine organization learning perspective and externality theory (Ejermo, 2005; Lee et al., 2010), and argue that industry variety can influence the amount of external knowledge that is available to a new venture through knowledge spillovers, and can simultaneously work on the new venture's learning process - "a process by which a firm acquires information, understanding, know-how, and techniques, and practices to improve task performance" (Zhao et al., 2011: 296). In other words, industry variety offers new, external knowledge to all firms within the location but whether a firm can effectively learn from industry variety and generate innovations depends on this firm's absorptive capacity. The latter process is influenced by both industry variety and international characteristics of new ventures.

2.2 Hypotheses

2.2.1 Direct effect of the industry specialization on the innovation of focal industry BGs, INEs, and DNVs

This part illustrates the relationship between the industry specialization and the innovation of BGs, INEs, and DNVs. To an industry, say industry X, it is industry specialization that deepens and broadens the external knowledge pool of new ventures in industry X. First, higher industry specialization can help its new ventures gather more information about markets, especially about their consumers and competitors (e.g., Noseleita, 2015). Second, more specialized industry can promote the formation of specialized business atmosphere within the industry, which can attract more experienced and competent talents from other regions and build up an even larger labor pool (e.g, Hubbard, 2009). Therefore, through labor flow within the industry, new ventures are more likely to encounter new ideas, information, technology, and tacit knowledge (Beaudry & Schiffaurova, 2009). Third, higher industry specialization enables new ventures to establish stronger network ties, through which these new ventures can explore new knowledge and new opportunities (e.g., Boekema & Rutten, 2004). However, considering that new ventures with different internationalization strategies may have different features, and next we will provide more details for understanding relationship between industry specialization and innovations of each type of new venture.

Regarding DNVs, which implement no internationalization, we argue that specialized industry X may not have much heterogenous and idiosyncratic knowledge that differs from what its DNVs have. Increasing specialization of industry X at city level means that division of labor (firm) in the industry X within that city is more detailed and precise (Parkin, 2016); in that case, firms in the same industry will have gradually similar perceptions of the product, the market and the industry. Therefore, knowledge created and delivered by specialized

industry X may not be useful for innovation of DNVs in industry X. Put differently, according to cognitive proximity argument advanced by Boschma (2005), even though specialization of industry X can enrich the external knowledge pool for DNVs of industry X, cognitive distance between DNVs and industry X might be so small that enriched external knowledge sources will not benefit innovation of DNVs. This is because too much cognitive proximity might be detrimental to DNV's learning processes and there are two reasons for this. First, too much cognitive proximity decreases DNVs' learning potential since the generation of new ideas or knowledge often requires dissimilar or complementary knowledge (Cohendet & Lilerena, 1997). Second, "cognitive proximity may easily lead to cognitive lock-in, in the sense that routines within an organization (or in an inter-organizational framework) obscure the view on new technologies or new market possibilities" (Boschma, 2005:64). In sum, a larger knowledge pool that specialization of industry X brings may not benefit the innovation of DNVs in industry X because of cognitive proximity; instead, specialization of industry X will make the competitions for the financial and physical capital in this region become more fierce, which drive up the costs of conducting business (Arthur, 1990) and then reduce the innovation of DNVs in industry X.

As for BGs, which conduct a rather quick and early internationalization strategy, we propose that BGs can make better use of the knowledge from the specialized industry for innovation because of their multicultural mindset. Here, multicultural means "the ability to deal with differences among groups, societies, and countries in culture, economics, institutions, and so on" (Un, 2016b:46). With a high level of multiculturalism, BGs are more sensitive to and have a better understanding of other national cultural contexts (Un, 2016b).

Under this situation, BGs' knowledge source will not be limited to local or domestic market, rather they will search new knowledge for innovation from diversified international markets. At the same time, BGs might be more creative to combine the specialized knowledge of industry with their own internal knowledge for product innovation since they can imitate others' practices across countries and encounter knowledge and ideas from other countries (Leung & Chiu, 2008; Maddux & Galinsky, 2009). Therefore, for BGs in industry X, their products will be different from those in the domestic markets and their internal knowledge will also differ from the specialized knowledge of industry X. If considering this situation from the perspective of cognitive proximity (Boschma, 2005), we argue that with industry X being more specialized, there still exists a proper cognitive proximity between industry X and its BGs. This cognitive distance will not be too big because they are in the same industry and the substance of their products is the same, and it will also not be too narrow because they have different understandings about markets and customers. Therefore, as industry X becomes more specialized, BGs in the industry X can communicate, understand and process new knowledge from industry X with diversified international knowledge successfully, which can exert positive impacts on innovations.

Regarding INEs, we argue that they can make good use of the knowledge from the specialized industry as what BGs can do. Compared to BGs, INEs do not implement rapid internationalization strategy and therefore do not have deep understandings about global market in their early period, but they still have motivations and ambitious to enter into the international market. Therefore, with time flying, INEs can learn knowledge as what BGs learn from the international market. Compared to DNVs, INEs are exposed more to

international environment that is with diversified knowledge and chance and this enables INEs to have more recombination opportunities to expand their innovation in distant knowledge domains (Scalera et al., 2018). Furthermore, still building on proximity argument (Boschma, 2005), as industry X becomes more specialized, the cognitive proximity between industry X and INEs might be too much when INEs only focus on domestic but it will decrease with their internationalization extent deepened. In other words, although not that fast, INEs can reach an appropriate cognitive proximity. In sum, we believe that, industry specialization can have a positive influence on the innovation of INEs.

Based on above arguments, we propose the following hypotheses:

Hypothesis 1a. The industry specialization is negatively related to the innovation of DNVs in the same city.

Hypothesis 1b. The industry specialization is positively related to the innovation of BGs in the same city.

Hypothesis 1c. The industry specialization is positively related to the innovation of INEs in the same city.

2.2.2 Moderating effect of the related variety on the innovation of focal industry BGs, INEs, and DNVs

This sub-section discusses how related variety as an external environment moderates the three relationships mentioned in H1a to H1c. The theoretical origination is from Jacobs (1969,

in particular chapter 2), who argued that being different constitutes the foundation for making innovations. The process of creating innovation is “adding new work to old”. Following this argument, it is reasonable to infer that being in a city with strong related variety benefits firms to generate more innovations.

Based on Maskell (2001), We argue that when a city is featured by strong related variety, it implies that such city contains a lot of related industries, which will enlarge local existing knowledge pool through two dimensions: vertical dimension and horizontal dimension. We use an example to articulate these two dimensions. Let’s assume that there is a cotton mill in the textile sector at one specific region. When related variety of this region strengthens along the horizontal dimension, it means that this region will have more rivals and competitors that are doing not the same but similar businesses, such as wool mills and silk factories (again, they do not produce cotton, but they are in textile sector). This cotton mill can closely and constantly monitor their competitors and know more about competitors’ strengths and weaknesses (Maskell, 2001); at the same time, an increase of number of similar companies enlarges variation in the ways of doing things or solving problems, and this leads to an accumulation of new knowledge in this region. When related variety of this region increases along the vertical dimensions, to the cotton mill it means that there are more business partners in this region, such as cotton planters and clothing retailers, etc. This cotton mill can build up strong networks with its business partners, which will enable it to access to the latest market information both forward and backward in the value chain; at the same time, firms in this region will become more specialized and may find solutions to problems otherwise overlooked and bypassed (Maskell, 2001), which leads to an extended division of labor and

then increase external knowledge that this cotton mill can encounter. Next, we will further explain how related variety moderates relationship between industry specialization and innovation of new ventures that adopt different internationalization strategies.

We argue that related variety positively moderates the negative relationship between specialization of industry and innovation of its DNVs. Our argument is divided into two steps. We first argue that the knowledge base of industry X would become more diversified when related variety increases. Specifically, the knowledge base of industry X would be deepened through an increase in the possibilities for industry X to find "new uses or applications for existing products and create new combinations of existing products, processes and materials" (Desrochers & Leppala, 2011:852). At the same time, foreign multinational enterprises are more likely to locate their subsidiaries in a region with related variety because of knowledge externality benefits and probably better infrastructure (Birkinshaw & Hood, 2000), and this will also further expand the knowledge base of industry X by allowing it to access to ideas and knowledge from abroad. We second argue that with a deepened and expanded knowledge base, new knowledge generated by the specialized industry X is then somewhat different from what DNVs have. Therefore, DNVs in the industry X can enhance their product innovations by selecting and utilizing new knowledge from the specialized industry X and by observing and imitating innovations of other firms in the industry X. In sum and drawing on proximity argument (Boschma, 2005), because of a high level of related variety in the region, the cognitive proximity between the specialized industry X and DNVs in the industry X expands and so DNVs can learn more from the industry for their innovations and the direct negative influence of industry specialization on DNVs' innovation is being reduced.

When it comes to BGs, we believe that as related variety of a region increases, positive impacts of industry specialization on its BGs' innovations are reinforced through a more diversified knowledge stock of the industry. Even if with a deepened and expanded knowledge base resulted from leveraged related variety of the region, industry X would still keep a proper cognitive distance with its BGs (Hassink et al., 2014) and thus exert positive impacts on its innovation. Meanwhile, it is worthy to note that BGs "exhibit a high degree of international entrepreneurial orientation [at] founding" (Cavusgil & Knight, 2015b:4) and "seek to derive a substantial proportion of their revenue from exports" (Patel et al., 2018:2010). This implies that BGs will try their best to integrate international knowledge into their innovations so that their products can appeal to foreign customers. When related variety attracts more foreign investors and multinational enterprises to this region, industry X will also attempt to develop more ways to absorb and utilize these new knowledges that foreign actors bring in. BGs thus have more chances to observe and imitate these innovations and to utilize these ways in their own recombination, that is the combination of its existing knowledge with knowledge from diversified international markets, which will affect their innovations positively. In sum, we argue that this positive moderating impact will be more obvious due to the fact that BGs engaged a lot in the international market.

This positive moderating effect of related variety will also hold for INEs. From viewpoint of cognitive proximity, our argument aligns with Aarstad et al.(2016), and Hassink et al. (2014) that cognitive distance between related industrial variety is at a proper amount which allows for innovation and interaction. That is why industry X can have an effective learning from these related industries and accumulate more knowledge inside. At the same time, as

aforementioned, cognitive distance between industry X and INEs of industry X might be too narrow at INEs' early development period since INEs may not pay much attention on international markets; however, with the presence of related variety, this cognitive distance will be more appropriate even if INEs have not started internationalization yet. Cognitive proximity promotes effective communications and learning between two parties, which will positively affect innovation (Boschma, 2005). Therefore, we argue that, related variety of a region can positively moderate the relationship between industry specialization and innovation of its INEs.

Based on above arguments, we advance the following hypotheses:

Hypothesis 2a. The related variety will moderate the relationship between the industry specialization and the innovation of DNVs in the same city. Such relationship will become weaker when the related variety in the same city is high.

Hypothesis 2b. The related variety will moderate the relationship between the industry specialization and the innovation of BGs in the same city. Such relationship will become stronger when the related variety in the same city is high.

Hypothesis 2c. The related variety will moderate the relationship between the industry specialization and the innovation of INEs in the same city. Such relationship will become stronger when the related variety in the same city is high.

2.2.3 Moderating effect of the unrelated variety on the innovation of focal industry BGs, INEs,

and DNVs

This sub-section discusses how unrelated variety as an external environment moderates the three relationships mentioned in H1a to H1c.

Understanding how and why unrelated industries affect a certain industry and its firms is uneasy, but not impossible. Jacobs (1961) probably was the first person who provided insights into this question. She highlighted that if all people are involved in the same industry, city life is boring, hopeless, and unsustainable; on the contrary, if people participate in various kinds of jobs, such difference push healthy city developments (Jacobs, 1961). Building on Jacobs, we argue that with more firms of unrelated industries located in the same city, knowledge stock of such city will be extended and its content will be more diversified. To a textile industry in a city, for example, increasing unrelated variety means that on the one hand, this city embraces more firms that provide textile industry with supporting and professional services, such as financial service, IT service, law service, and business consultancy; On the other hand, such city also contains more firms in industries that are completely unrelated to textile industry, for instance, bicycle manufacturing industry. At the city angle, both financial service industry and bicycle manufacturing industry, etc., are all increasing unrelated variety at city level. New knowledge comes along with these new firms, through which textile industry can search knowledge for generating innovations. In the following paragraphs, more discussions will be conducted about how unrelated variety moderates innovations of new ventures with three different internationalization strategies.

In terms of DNVs, as shown in hypothesis 1a industry specialization and innovation of DNVs is negatively related. We argue that, as unrelated variety increases, such negative

relationship will be decreased because of expanded cognitive distance between DNVs and its industry and enriched mindsets of employees at DNVs. People may argue that cognitive distance between industry X and unrelated industries is so large that industry X is not able to recognize the value of new knowledge, interpret it and then exploit it. However, “unrelated variety provides the building blocks for technological breakthroughs stemming from combinations across unrelated knowledge domains” (Castaldi et al., 2015:768), and it is possible that industry X can generate breakthrough innovation through a combination of its knowledge and knowledge from unrelated variety. Once industry X succeeds, the cognitive distance between industry X and its DNVs expands and the negative influence of industry specialization on innovation of industry X reduces. Moreover, DNVs spend most attentions and resources in the domestic market, which is their main market or probably the only market (Mata & Freitas, 2012). In order to achieve success in the local market, DNVs have to understand “the needs and preferences of domestic customers and generate innovations that are geared toward those needs first” (Un, 2016:47). This limits employees of DNVs “to obtain and integrate diverse knowledge useful for product innovation” (Un, 2016:47). This problem, which is so-called liability of isolation (Monteiro et al., 2008), could be relieved when unrelated variety becomes strong. Enlarging unrelated variety implies that local environment is filled in with totally different chances and knowledge. Such local environment enriches mindset of employees of DNVs. Enriching mindset helps employees of DNVs better absorb and utilize knowledge from the industry they belong to.

With respect to BGs, we argue that unrelated variety negatively moderates the relationship between industry specialization and innovation of BGs. It is well known that

networking capability of BGs plays an essential role in identifying and exploiting both international and domestic market opportunities (Mort & Weerawardena, 2006). With a low level of unrelated variety in the region, except non-local ties, BGs have no choice but to build up social networks within the industry or the sector and expect to strengthen these social networks in order to exchange more valuable information such as tacit knowledge and facilitate their interactive learning (Maskell & Malmberg, 1999). However, as unrelated variety increases, attention of BGs will diverse away from its own industry to other local industries, and BGs may consider setting up strong network ties with firms from unrelated industries, which may benefit themselves. For example, textile BGs may acquire some information about their competitors' innovation plans through a connection with their common financial service companies. Considering that there is no firm that has unlimited resources and capabilities, so to BGs more networks with unrelated industries imply less networks with their own industry, and this indicates that the influence that industry specialization on innovation of BGs reduces. Furthermore, when a city embraces a high level of unrelated variety, at least according to Jacobs' urban economics, such city will develop fast and become more prosperous (Jacobs, 1961). This increases the dependence of BGs on their locations since local environment becomes more important and their network ties within geographical location are developing in a quick way. Nevertheless, this dependence may not necessarily be good. For example, Gassmann and Keupp (2007) did a case study on six BGs in the biotechnology sector and found that BGs' dependence on the location probably leads to 'locked in' resources that are not easy to replicate and their competitive advantages will also be location-bound and depends much on the development of their collaborators. This

dependence may make BGs tend to observe and imitate more within their location and narrow down the cognitive proximity between BGs and its industry, which is not conducive to BGs' innovation. Therefore, based on above reasons, we argue that a higher level of unrelated variety will lead to a weaker relationship between industry specialization and its BGs' innovation.

Regarding INEs, we argue that the moderating effect of unrelated variety on innovation of INEs is similar to that on innovation of BGs: the positive relationship between industry specialization and innovation of INEs will be weakened as unrelated variety increases. Although INEs are able to absorb and integrate knowledge from their industry and combine foreign knowledge with their existing knowledge, it is necessary to point out that being located to firms of unrelated industries in geographical proximity, INEs have more sources to search for new knowledge and are more likely to build cooperation with such firms. Therefore, under such situation, INEs may be less dependent on its own industry for conducting innovations.

Based on above arguments, we advance the following hypotheses:

Hypothesis 3a. The unrelated variety will moderate the relationship between the industry specialization and the innovation of DNVs in the same city. Such relationship will become weaker when the unrelated variety in the same city is high.

Hypothesis 3b. The unrelated variety will moderate the relationship between the industry specialization and the innovation of BGs in the same city. Such relationship will become

weaker when the unrelated variety in the same city is high.

Hypothesis 3c. The related variety will negatively moderate the relationship between the industry specialization and the innovation of INEs in the same city. Such relationship will become weaker when the unrelated variety in the same city is high.

3. METHODOLOGY

3.1 Data Collection

We collect data from the China Industrial Enterprise Database (CIED)[1], 1998-2007. CIED is gathered and published by National Bureau of Statistics of China. CIED only contains manufacturing enterprises. Each Chinese manufacturing enterprise whose annual sales were more than 5 million Chinese Yuan (approximately USD 657,550 using the average exchange rate in 2007) is required by law to report exact firm data. CIED database is reliable and literatures that employed CIED are seen in many top journals such as the American Economic Review (Song et al., 2011) and the Administrative Science Quarterly (Zhou et al., 2017).

Mining industry and public utility such as water and electricity are excluded from our observations. We also exclude Tibet and Hainan province since the former is less developed and the latter is a tourism province. In the end, our sample encompasses an unbalanced panel of 21048 BGs with 68625 observations, 42095 INEs with 123972 observations, and 155478 DNVs with 383925 observations.

[1] Someone translated *CIED* in Chinese to *the Annual Census of Chinese Industrial Enterprises* in English (e.g., Zhou et al., 2017).

3.2 Measures

Born Globals (BGs), Incremental New Ventures (INVs), Domestic New Ventures (DNVs). One key step in our analysis is to identify three kinds of new ventures with different internationalization strategies from our data set (1998-2007). This paper only focuses on newly established firms, thereby we only reserve the sample firms which are founded in the period 1998-2005 but we track them in the data until they cease to exist or until the end of our observation period in 2007. Next is to classify all remained firms into three groups based on their internationalization strategies. DNVs are easily quantified as new ventures that had no exporting business during the observation period. However, there is no consensus on the exact internationalization speed and extent to quantify BGs and INEs. Fortunately, Choquette et al. (2017) has done a review on means of quantification of BGs and they argued that quantifying BGs as "firms that within three years from inception export at least 25% of their turnover" seems to be an acceptable benchmark for most scholars (Choquette et al., 2017: 451-452). Therefore, we decide to employ this classical criterion to quantify BGs. INEs are accordingly quantified as new ventures that are not BGs but have done exporting within our observation period.

Innovation. We quantify innovation by using "new product output value" (Hitt et al., 1996) as it can better "indicates the commercial significance of the firm's product innovation" (Zhou et al., 2017:385). New products are those that either "are based on substantially new technologies and designs" or "make substantial improvements to functionality and

performance" (Zhou et al., 2017:385). Such definition is given by the National Bureau of Statistics, China.

Another two popular approaches of quantifying innovation at firm level are measuring patents (e.g., Lahiri, 2010) and self-evaluation by questionnaires (e.g., Bell, 2005). However, employing patents as a proxy to measure innovation has two problems (Acs et al., 1992:364): one is that some innovations can directly be introduced into the market without patenting; another is that some patents do not necessarily encompass economic values. Meanwhile, we cannot employ approach of questionnaires, because such approach could only apply to a small number of observations, and it is infeasible to investigate all new ventures in the CIED.

Related Variety, Unrelated Variety, and Industry Specialization. Frenken et al. (2007) adopted entropy method to quantify industry variety and this entropy measure was influential and proved to be feasible (e.g., Aarstad et al., 2016; Castaldi et al., 2015). We then decide to employ the same measure, which is built on standard industrial classification code (SIC). One thing to be noted here is that the European SIC code contains five levels whereas the Chinese SIC code contains only four levels. However, this will not influence the application of entropy measure because for a four-digit code in the CIED, the first two digits indicates the overall sector and the complete four-digit code represents an industry under this overall sector. The key in this entropy measure is that relationships between two-digit sectors are assumed to be unrelated, and relationships among four-digit industries under the same two-digit sector are assumed to be related.

As Aarstad et al. (2016) did, we use number of firms to compute the following entropy.

First, for city k in year t, we calculate the share of each two-digit sector, P_g, by summing up the shares of all four-digit industries under this two-digit sector, p_i. Mathematically, it is:

$$P_g = \sum_{i \in S_g} p_i \qquad (1)$$

Then unrelated variety (UV) for city k in year t is calculated by the entropy of the two-digit distribution:

$$UV = \sum_{g=1}^{G} P_g \ln(\frac{1}{P_g}) \qquad (2)$$

Related variety (RV) for city k in year t, which is indicated by the weighted sum of the entropy at the four-digit level within each two-digit class (Frenken et al., 2007), is calculated as:

$$RV = \sum_{g=1}^{G} P_g H_g \qquad (3)$$

Where

$$H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \ln(\frac{1}{p_i/P_g}) \qquad (4)$$

Inspired by Frenken et al. (2007), we compute industry specialization by using absolute number of firms that are classified into a four-digit industry. In city k year t mathematically, industry specialization is:

$$IS = \ln(\text{total number of firms}) \quad (5)$$

If such above equations are hardly to understand, Appendix one provides a concrete example that shows how such equations work.

Controls. We control for *firm size* by using a logarithm transformation of firm employment as a multitude of studies have shown that firm size may bring either positive or negative impacts on firm innovation in different situations (e.g., Cohen & Klepper, 1996; Fritsch & Meschede,

2001). Second, we control for firm *ownership* since foreign-invested enterprises (FIE) often performed differently from domestic-owned enterprises in China (Xu et al., 2006). Chinese law requires that if more than 25% capital of a Chinese enterprise is invested by foreigners (i.e., non-Chinese investors), such enterprise is registered as a foreign-invested enterprise (FIE). Therefore, we use a dummy variable to control firm ownership: it is 1 when a firm is a FIE; otherwise it is 0. Third, Considering that firms in different life phase may employ different innovation strategies (Coad et al., 2016), we set *firm age* as a control variable. Fourth, we control for competition intensity as facing fierce competition or not would influence firms to employ different innovation strategies (Bonanno & Haworth, 1998). We use concentration index as a proxy to reflect *competition intensity*: when a market is featured by fierce competition, such market is impossible to be controlled by few firms, and vice versa. The concentration index is calculated as follows:

$$lnhhi_{kt} = \ln\left(1 \Big/ \sum_{i=1}^{N} \left(\frac{market_{ikt}}{market_{kt}}\right)^2\right) \qquad (6)$$

Where $market_{ikt}$ refers to the market size of firm i in industry k (four-digit level) in year t. $market_{ikt}$ is measured by the industry output value of the firm. $market_{kt}$ refers to market size of industry k (four-digit level) in year t, and $market_{kt}$ is measured by the gross output value of the industry. N refers to total number of firms in industry k (four-digit level) in year t.

This paper also controls for fixed effect of individual firms and time fixed effect.

Table 1, 2, and 3 provide descriptive information on our data.

<Insert Table 1, 2, and 3 about here>

3.3 Regression Models

In order to test hypotheses raised by this paper, we build the following statistic regression model.

$$IF_{ijkt} = \lambda_0 + \lambda_1 \mathrm{IS_{ijkt}} + \lambda_2 \mathrm{RV_{ijkt}} + \lambda_3 \mathrm{IS_{ijkt}} \times \mathrm{RV_{ijkt}} + \lambda_4 \mathrm{UV_{ijkt}} + \lambda_5 \mathrm{IS_{ijkt}} \times \mathrm{UV_{ijkt}} + \lambda_6 \mathrm{X_{ijkt}} + \mathrm{u_i} + \mathrm{d_t} + \upsilon_{\mathrm{it}} \quad (7)$$

Where $\mathrm{IF_{ijkt}}$, $\mathrm{IS_{ijkt}}$, $\mathrm{RV_{ijkt}}$, and $\mathrm{UV_{ijkt}}$ stand for the innovation variable, industry specialization variable, related variety variable, and unrelated variety variable of firm i in industry k at city j in year t. It is obvious that if λ_1 is significantly greater than 0, it implies that industry specialization positively influences innovation of firms. If λ_3 is significantly greater or less than 0, it means that moderating effect of related variety exists. By the same token, if λ_5 is significantly greater or less than 0, it means that there exists a moderating effect of unrelated variety.

$\mathrm{X_{ijkt}}$ refers to control variables, which include firm size, firm age, firm ownership, and intensity of competition. u_i refers to firm fixed effect, which controls for features that do not change with time at firm level. d_t refers to time fixed effect. υ_{it} refers to error term.

In addition, we do not employ standard error method but cluster standard error at industry level for the following considerations. On one hand, error term may have serial correlation problem; on the other hand, local government policy or industry policy may influence innovation of new ventures, but the effect of local government policy or industry policy is hardly to be measured. Therefore, the error terms of new ventures in the same location or in

the same industry may be correlated and clustering standard error method can provide a more conservative significance level and a more robust result.

3.4 Analysis and Results

Table 4 presents an overall table for regression results of BGs, INEs, and DNVs.

<Insert Table 4 about here>

As shown in the Table 4, it presents a summary of the estimation results for the impact of industry variety on innovation of BGs, INEs, and DNVs. Hypothesis 1b and hypothesis 1c suggest that the industry specialization is positively related to the innovation of BGs and INEs in the same city. Consistent with this assertion, the coefficient of IS (industry specialization) in the models for BGs and INEs is greater than 0 and statistically significant, so hypothesis 1b and hypothesis 1c receive supports. Meanwhile, hypothesis 1a predicts a negative effect of industry specialization on the innovation of DNVs, but the results in table 7 show a positive but not significant coefficient of IS, which means that there does not exist a direct influence of industry specialization on the innovation of DNVs.

Hypothesis 2b and hypothesis 2c suggest a stronger positive effect of industry specialization on innovation of BGs and INEs when the related variety in the same city is high. Our findings in the table 7 confirm that the interaction between industry specialization and related variety exerts a positive impact on product innovation of BGs and INEs, in support of hypothesis 2b and hypothesis 2c. At the same time, hypothesis 1a suggests a weaker negative

effect of industry specialization on the product innovation of DNVs when the related variety in the same city is high, but the results in table 7 show a positive but not significant coefficient of interaction term (IS*RV), which does not lend support to hypothesis 2a.

Hypothesis 3b and hypothesis 3c predict that unrelated variety would weaken the positive effect of industry specialization on new product outputs of BGs and INEs. As table 4 shows, the coefficients of interaction term (IS*UV) for both BGs and INEs are smaller than 0 and statistically significant. Thus, both hypothesis 3b and hypothesis 3c are supported. However, the interaction term (IS*UV) for DNVs is negative but not significant, and this is in contrast with our prediction that unrelated variety would weaken the negative effect of industry specialization on innovation of DNVs.

With respect to control variables in table 4, the coefficients of firm size are always positive and significant for all BGs, INEs, and DNVs. This indicates that a larger firm size can enhance the innovation performance of all kinds of new ventures. Meanwhile, as the regression results for BGs and DNVs show, the coefficients of firm age are negative but not significant. However, the coefficient of firm age is negative and significant for INEs, which means that firm age exhibits a negative effect on innovation output of INEs. Furthermore, the coefficient of ownership is not significant for BGs and DNVs but significantly greater than 0 for INEs. This implies that foreign-invested INEs have a better innovation performance than domestic-owned INEs. Lastly, competition intensity has no significant effect on the innovation output of BGs and DNVs whereas it exerts a significantly negative influence on the product innovation of INEs.

3.5 Robustness Tests

We test the sensitivity of the results in several ways. First, instead of using absolute value of new products to measure innovation, we measure the innovation output of a firm as the ratio of new product output value to this firm's total industrial output. Such measure is a relative indicator. Second, internationalization extent dimension is changed to distinguish different internationalization strategies. In the first scenario, we increase export intensity from 25 percent to 30 percent to define BGs and the observations of INEs will automatically change. In the second scenario, we decrease export intensity from 25 percent to 20 percent to define BGs and INEs observations will also change here. Third, internationalization speed aspect is also changed. We first change the standard of "three years from inception" to "two years from inception" to define BGs and then change this standard to "four years from inception" to quantify BGs. Other exporting new ventures except BGs are INEs in the above two cases. In all these variations, the regression results are entirely consistent with our primary results. Appendix 2 provides a detailed regression results for each robustness test.

4. DISCUSSION AND CONCLUSION

This is one of the first longitudinal studies on the relationship between industry variety and innovation performance of new ventures with different internationalization strategies. The three types of industry variety, *industry specialization, related variety* and *unrelated variety* at a city level, were examined in relation to the innovation of new ventures with distinct internationalization strategies. According to internationalization speed and extent, this paper introduces three types of internationalization strategies and thus classifies new ventures into

Born Globals, Incremental New Exporters, and *Domestic New Ventures*. Based on the large panel data sets of Chinese firms, we find that industry variety exerts impacts on innovation performance of new ventures and the way the innovation of a new venture is affected by industry variety indeed depends upon its internationalization strategies.

To be more specific, our results show that industry specialization positively affects the innovation of BGs and INEs, which is consistent with H1b and H1c, but it has no significant effect on the innovation of DNVs. According to Marshall (1890), specialization facilitates innovation by providing a larger labor pool, more specialized input-and-output system, and knowledge spillovers benefits. As our findings show, industry specialization does not necessarily exert positive impacts on all kinds of new ventures. One of possible reasons for this is that the cognitive distance between DNVs and its industry might be so small that enriched external knowledge sources due to industry specialization will not benefit innovation of DNVs. By considering both enriched resource advantage and a narrowed cognitive distance disadvantage associated with industry specialization, this paper provides a more thorough understanding of the role of industry specialization, or say Marshall economies, in the innovation of new ventures.

According to Jacobs (1969), the variety of industries within a geographic region improves the opportunities to imitate, share and recombine ideas, practices and technologies across industries. Put differently, industry diversity within a city promotes innovation. We integrate industry specialization, related variety and unrelated variety simultaneously into this paper to show a new theoretical mechanism on how external environment as a whole affects innovation of different kinds of new ventures, while other scholars still separate specialization

from diversity and try to prove one is better than another for regional and firm development (Beaudry & Schiffaurova, 2009).

Consistent with our expectations in H2b and H2c, the positive relationship between industry specialization and innovation of BGs and INEs will become stronger when high related variety presents in the same city. However, there is no moderating effect of related variety on the innovation of DNVs. Two possible explanations exist for this finding. First, both BGs and INEs implement internationalization strategies, no matter aggressive ones or modest ones, and thus focus more on satisfying foreign customers' needs. The cognitive distance between BGs/INEs and their industries is at a proper level and their industry's deepened and expanded knowledge base due to increasing related variety within the city will be beneficial for the innovation of BGs/INEs. Second, DNVs focus on merely domestic markets and there might exist too much cognitive proximity between DNVs and their industry. An increasing level of related variety in the city can indeed diversify the focal industry's knowledge base but whether this diversification is enough for DNVs to absorb new knowledge from their industry is at question.

Our results also confirm that the positive relationship between industry specialization and innovation of BGs and INEs will be weakened when high unrelated variety presents in the same city, in support of H3b and H3c. The hypothesis H3a did not receive supports, which means that unrelated variety has no moderating effect on the innovation of DNVs. As discussed above, a city that is characterized by a high level of unrelated variety is more likely to develop fast, embracing more advanced producer services and adding diversity to the existing knowledge stock of each industry. However, this may result in a high dependence of

BGs on their locations and lead to ‘locked in’ resources that cannot be transferred abroad. This is the same for INEs. This indicates that located in a city that is featured by both high industry specialization and high unrelated variety is not a good choice for international entrepreneurship. Even though high industry specialization can facilitate the innovation of international entrepreneurship, this positive influence will be decreased as unrelated variety in the city increases.

Another explanation can be found from international business perspective. This paper focuses on the manufacturing industry in China and use exports to describe internationalization strategies. Therefore, both BGs and INEs tend to produce domestically but sell abroad. This is similar to the concept of supply driven (competence-creating) activities that is developed by Goerzen et al. (2013). Even though Goerzen et al. (2013) are intended to use this term to describe the underlying motives of the MNEs, international new ventures in our paper, especially BGs, tend to make use of location advantage of emerging market to produce domestically and create their competences internationally. BGs and INEs then prefer to choose the location that can help them increase the production efficiency or search for new knowledge. A city with both high industry specialization and high unrelated variety can provide BGs/INEs with professional knowledge, various production services and better infrastructures, but as the density of economic activities increases factor price inflation occurs (Duranton & Puga, 2004). Spending on rents, salaries, transportation and so on might be so high for BGs/INEs to render those benefits insufficient and this might prevent BGs/INEs from achieving its potential efficiency or economies of scale. Therefore, for BGs

and INEs in the manufacturing industry, choosing a location that embraces both specialization and diversity might not be a wise choice.

This study has several limitations that maybe improved in the future research. Due to data insufficiency, we only applied internationalization speed and extent dimensions to define an internationalization strategy and overlooked the dimension of internationalization scope. Adding internationalization scope aspect to refine an internationalization strategy can help us better understand our research question and may give a different and more complete result. Sui & Baum (2014) provided a good example. They collected information on internationalization scope and distinguished born-global strategy from born-regional strategy to study whether internationalization strategy affects the survival of SMEs. Future research may add one more layer for internationalization strategy as born-global firms face with a larger liability of foreignness compared to born-regional firms (Minbaeva et al., 2003) but they are also more likely to hold multi-cultural mindsets and be exposed to diverse foreign knowledge (Un, 2016a).

While we posit that the influence of industry variety on the innovation of new ventures depends on their internationalization strategies, we only test the moderating effects of related variety and unrelated variety in this paper. The empirical results in the table 7 seem to suggest a different, direct effect of related variety and unrelated variety on the innovation of BGs, INEs and DNVs. Further research may need to examine whether the direct influence of related variety and unrelated variety on the innovation of new ventures will also be related to their internationalization speed and extent. If the results are as expected, it should also delineate the mechanism behind this.

Another meaningful direction is to classify innovation into radical innovation and incremental innovation since Castaldi et al. (2015) have found that unrelated variety enhances the regional ability to produce technological breakthroughs. The effects of industry variety may exert different impacts on radical innovation and incremental innovation of new ventures with distinct internationalization strategies. A plausible approach is to investigate a number of new ventures within a specific geographical location through questionnaires to record radical and incremental innovations.

Our framework also sheds new light on previous findings: prior studies considered more on the direct effect of industry variety on the regional development or on the performance of all kinds of firms (Beaudry & Schiffaurova, 2009; Frenken et al., 2007) and thus different internationalization strategies of these firms are being ignored. Therefore, it is worthwhile to examine my findings on all kinds of firms, whether their internationalization characteristics will lead to a different influence of industry variety on their innovations.

Finally, our research context may limit the generalizability of our findings because we only use large-scale Chinese data. Whereas China is the biggest exporting country, it is still a developing country where its government exerts strong control over its economic activities. Additional research should refine our framework with a longer time period in other large data sets from America or Europe to understand the role of internationalization strategy when studying the effect of industry variety on new venture innovation.

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Table 1: Descriptive Information of Variables: Variable names

Variable name	Kind of variable	Remarks
Innovation	Dependent variable	Innovation of BGs, INEs, and DNVs. It is measured by output of new products (1,000 Chinese Yuan, logarithm).
Industry specialization	Independent variable	Measured by equation 5
Related variety	Moderator	Measured by equation 3
Unrelated variety	Moderator	Measured by equation 2
Firm size	Control variable	Employment of a firm (logarithm)
Firm age	Control variable	Age of a firm (logarithm)
Ownership	Control variable	Firm registration type. It is 0-1 dummy
Competition intensity	Control variable	Intensity of competition, measured by equation 6

Table 2: Descriptive Information of Variables: Mean, min, max values

Variable	Obs	Mean	Std. Dev.	Min	Max
Innovation	576,597	0.3326	1.2650	0	13.9128
Industry Specialization	576,598	2.9752	1.6304	0	6.9037
Related variety	576,531	0.5173	0.2361	-3.1997	0.7839
Unrelated variety	576,595	1.0347	0.0806	-0.5757	1.1403
Firm size	576,598	4.5178	1.0184	0	12.1450
Firm age	576,590	1.4715	0.5149	0	2.3026
Ownership	576,598	0.2138	0.4100	0	1
Competition intensity	576,598	4.8505	1.1012	0.1453	6.8763

Table 3: Correlation Table

	Innovation	IS	UV	RV	Firm size	Firm age	Ownership	Competition intensity
Innovation	1							
Industry specialization	0.0046	1						
Related variety	0.0174	0.1327	1					
Unrelated variety	0.0337	0.3500	0.6736	1				
Firm size	0.1368	0.2305	-0.0639	-0.0419	1			
Firm age	0.0386	0.1298	0.0472	0.1455	0.0415	1		
Ownership	0.0264	0.1464	0.0713	0.1501	0.2245	0.0308	1	
Competition intensity	-0.0733	0.3739	-0.0030	-0.0018	0.0240	0.0561	0.0042	1

Table 4: Overall Regression Results

	BGs IFCF	INEs IFCF	DNVs IFCF
Firm size	0.1453***	0.2061***	0.0624***
	(0.0135)	(0.0146)	(0.0050)
Firm age	-0.0618	-0.1332**	-0.0136
	(0.0406)	(0.0550)	(0.0137)
Ownership	0.0583	0.1360***	-0.0071
	(0.0532)	(0.0411)	(0.0308)
IS	0.9070***	0.4169**	0.0479
	(0.3196)	(0.1985)	(0.0437)
UV	2.5000***	-1.5135**	0.5077***
	(0.7417)	(0.6126)	(0.1227)
IS*UV	-1.1575***	-0.5593***	-0.0535
	(0.3835)	(0.2082)	(0.0472)
RV	-0.3633	-0.5006**	0.0181
	(0.2780)	(0.2248)	(0.0496)
IS*RV	0.6250***	0.3293***	0.0257
	(0.1548)	(0.0697)	(0.0179)
Competition	-0.0215	-0.0292*	-0.0032
	(0.0171)	(0.0158)	(0.0051)
Intercept	-3.0512***	0.9107	-0.6465***
	(0.7642)	(0.6390)	(0.1333)
firm fixed effect	√	√	√
time fixed effect	√	√	√
N	68625	123972	383925

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *Standard errors in parentheses; check marks imply that a certain fixed effect (which could be firm or year) is controlled.*

Appendix 1: A concrete example of related variety, unrelated variety, and industry specialization

Appendix one will provide a concrete example that helps understand the mathematical meaning of related variety, unrelated variety, and industry specialization.

Considering that not everyone who studies new ventures knows regional science well, and also considering that math equations given may not be easily understood, here I give a concrete example for further exampling how to quantify related variety.

Assuming that in year t, city j only contains three two-digit level industries: namely textile industry, electric equipment industry, and food processing industry. Textile industry has two four-digit level industries, namely silk industry and cotton industry; Electric equipment industry has two four-digit level industries, namely motor manufacturing industry and cable manufacturing industry; food processing industry has two four-digit level industries, namely fish processing industry and meat processing industry. Silk industry contains 5 employees, cotton industry contains 5 employees, fish processing industry contains 2 employee, meat processing industry contains 1 employee, motor manufacturing industry contains 1 employee, and cable manufacturing industry contains 1 employee.

Because $P_g = \sum_{i \in S_g} p_i$

$$P_{textile} = \frac{silk\ industry}{all\ regional} + \frac{cotton\ industry}{all\ regional} = \frac{5}{15} + \frac{5}{15} = \frac{2}{3}$$

$$P_{food} = \frac{fish\ industry}{all\ regional} + \frac{meat\ industry}{all\ regional} = \frac{2}{15} + \frac{1}{15} = \frac{1}{5}$$

$$P_{electric} = \frac{motor\ industry}{all\ regional} + \frac{cable\ industry}{all\ regional} = \frac{1}{15} + \frac{1}{15} = \frac{2}{15}$$

Therefore,

$$\mathrm{UV} = \frac{2}{3}\ln\left(1\Big/\left(\frac{2}{3}\right)\right) + \frac{1}{5}\ln\left(1\Big/\left(\frac{1}{5}\right)\right) + \frac{2}{15}\ln\left(1\Big/\left(\frac{2}{15}\right)\right)$$

Moreover,

$$H_{textile} = \left[\left(\frac{5}{15}\right) \div \left(\frac{10}{15}\right)\right] ln\left[\frac{1}{\left(\frac{5}{15}\right) \div \left(\frac{10}{15}\right)}\right] + \left[\left(\frac{5}{15}\right) \div \left(\frac{10}{15}\right)\right] ln\left[\frac{1}{\left(\frac{5}{15}\right) \div \left(\frac{10}{15}\right)}\right]$$

$$H_{food} = \left[\left(\frac{2}{15}\right) \div \left(\frac{3}{15}\right)\right] ln\left[\frac{1}{\left(\frac{2}{15}\right) \div \left(\frac{3}{15}\right)}\right] + \left[\left(\frac{1}{15}\right) \div \left(\frac{3}{15}\right)\right] ln\left[\frac{1}{\left(\frac{1}{15}\right) \div \left(\frac{3}{15}\right)}\right]$$

$$H_{electric} = \left[\left(\frac{1}{15}\right) \div \left(\frac{2}{15}\right)\right] ln\left[\frac{1}{\left(\frac{1}{15}\right) \div \left(\frac{2}{15}\right)}\right] + \left[\left(\frac{1}{15}\right) \div \left(\frac{2}{15}\right)\right] ln\left[\frac{1}{\left(\frac{1}{15}\right) \div \left(\frac{2}{15}\right)}\right]$$

Therefore,

$$\mathrm{RV} = P_{textile} * H_{textile} + P_{food} * H_{food} + P_{electric} * H_{electric}$$

All industry specialization is calculated at four-digit level. Mathematically, for example, it is:

$$\mathrm{IS}_{silk} = \ln(\text{number of silk firms}) = \ln 5$$

Appendix 2: Robustness Tests Results

The following three tables present the results for our robustness tests.

Table 2.1 Robustness Tests (Innovation is measured by the ratio of new product outputs)

	BGs IFC	INEs IFC	DNVs IFC
Firm size	0.0054***	0.0086***	0.0019***
	(0.0016)	(0.0015)	(0.0006)
Firm age	-0.0212***	-0.0123**	-0.0101***
	(0.0049)	(0.0057)	(0.0018)
Ownership	-0.0010	0.0146***	-0.0023
	(0.0055)	(0.0050)	(0.0038)
IS	0.0860**	0.0365*	-0.0016
	(0.0367)	(0.0193)	(0.0055)
UV	0.1994**	0.0293	0.0236
	(0.0834)	(0.0588)	(0.0159)
IS*UV	-0.1092**	-0.0488**	0.0004
	(0.0435)	(0.0204)	(0.0059)
RV	-0.0315	-0.0205	-0.0124**
	(0.0308)	(0.0221)	(0.0062)
IS*RV	0.0607***	0.0287***	0.0042*
	(0.0168)	(0.0068)	(0.0022)
Competition	-0.0037*	-0.0028*	-0.0020***
	(0.0019)	(0.0015)	(0.0007)
Intercept	-0.1896**	-0.0334	0.0101
	(0.0851)	(0.0606)	(0.0171)
firm fixed effect	√	√	√
time fixed effect	√	√	√
N	68625	123972	383926

In this table, innovation is measured by the ratio of new product outputs to its total industrial outputs.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *Standard errors in parentheses; check marks imply that a certain fixed effect (which could be firm or year) is controlled.*

Table 2.2 Robustness Tests (Quantification of internationalization extent has changed)

	BGs IFCF	INEs IFCF	BGs IFCF	INEs IFCF
	>=30%		>=20%	
Firm size	0.1443***	0.2062***	0.1407***	0.2092***
	(0.0137)	(0.0145)	(0.0135)	(0.0147)
Firm age	-0.0636	-0.1292**	-0.0669*	-0.1101*
	(0.0409)	(0.0539)	(0.0400)	(0.0562)
Ownership	0.0527	0.1397***	0.0903*	0.1141***
	(0.0539)	(0.0408)	(0.0531)	(0.0413)
IS	0.9156***	0.4223**	0.9007***	0.4104**
	(0.3213)	(0.1974)	(0.3163)	(0.1928)
UV	2.5399***	-1.4789**	2.3022***	-1.4761**
	(0.7301)	(0.6147)	(0.7276)	(0.6177)
IS*UV	-1.1673***	-0.5664***	-1.1447***	-0.5555***
	(0.3864)	(0.2071)	(0.3779)	(0.2032)
RV	-0.3505	-0.5078**	-0.2903	-0.5577**
	(0.2768)	(0.2243)	(0.2726)	(0.2277)
IS*RV	0.6291***	0.3330***	0.6234***	0.3258***
	(0.1571)	(0.0693)	(0.1523)	(0.0695)
Competition	-0.0195	-0.0304*	-0.0265	-0.0263*
	(0.0171)	(0.0157)	(0.0176)	(0.0155)
Intercept	-3.0943***	0.8605	-2.8621***	0.8933
	(0.7554)	(0.6389)	(0.7475)	(0.6463)
firm fixed effect	√	√	√	√
time fixed effect	√	√	√	√
N	66884	125713	70574	122023

In this table, internationalization extent used to define BGs and INEs have been changed from 25% to 30% and to 20%. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *Standard errors in parentheses; check marks imply that a certain fixed effect (which could be firm or year) is controlled.*

Table 2.3 Robustness Tests (Quantification of internationalization speed has changed)

	BGs IFCF	INEs IFCF	BGs IFCF	INEs IFCF
	2 year		4 year	
Firm size	0.1490***	0.1903***	0.1437***	0.2281***
	(0.0187)	(0.0122)	(0.0121)	(0.0167)
Firm age	-0.1051**	-0.0604	-0.0528	-0.2148***
	(0.0478)	(0.0459)	(0.0367)	(0.0623)
Ownership	0.0863	0.1086***	0.0634	0.1547***
	(0.0652)	(0.0370)	(0.0414)	(0.0505)
IS	1.0342***	0.4123**	0.9137***	0.3064
	(0.3430)	(0.1963)	(0.2701)	(0.2251)
UV	2.6736***	-0.9662*	2.2491***	-1.9875***
	(0.8903)	(0.5619)	(0.6257)	(0.6973)
IS*UV	-1.3178***	-0.5703***	-1.1479***	-0.4327*
	(0.4124)	(0.2132)	(0.3217)	(0.2374)
RV	-0.5402	-0.3837**	-0.1561	-0.7300***
	(0.3807)	(0.1953)	(0.2397)	(0.2525)
IS*RV	0.7371***	0.3574***	0.5713***	0.3014***
	(0.1802)	(0.0710)	(0.1290)	(0.0834)
Competition	-0.0209	-0.0254*	-0.0174	-0.0364**
	(0.0239)	(0.0137)	(0.0155)	(0.0179)
Intercept	-3.1650***	0.3172	-2.8886***	1.4269**
	(0.8994)	(0.5888)	(0.6488)	(0.7249)
firm fixed effect	√	√	√	√
time fixed effect	√	√	√	√
N	34500	158097	97624	94973

In this table, internationalization speed used to define BGs and INEs have been changed from 3 years to 2 years and to 4 years. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. *Standard errors in parentheses; check marks imply that a certain fixed effect (which could be firm or year) is controlled.*