

Challenges in internationalization of R&D teams: Impact of foreign technocrats in top management teams on firm innovation

Abstract

This study explores two reasons for why and when firm innovation may not benefit from the presence of foreign technocrats in top management teams, who represent a 'minority-in-minority' status due to their membership of two minority sub-groups (foreigners and technology experts). First, foreign technocrats may face greater social barriers to exert their human capital because their minority-in-minority status brings about twice as much pressure from the majority (the double jeopardy hypothesis). Second, the similarity resulting from the overlap of the two executive groups may render their sub-group peers apprehensive about a loss of self-identity, thus leading to horizontal hostility (the narcissism of minor difference theory). Using a study of 1,635 Chinese manufacturing firms to compare the joint effects of similar sub-group peers and CEOs, we find that the overlap of two groups is more likely to play a positive role when these two groups are more heterogeneous.

Keywords: innovation; internationalization; top management teams (TMTs); double jeopardy hypothesis; narcissism of minor difference theory

1. Introduction

The challenges associated with managing internationalization of research and development (R&D) have attracted significant attention due to a recent surge in cross-border R&D collaborations (Hsu, Lien, & Chen, 2015; Hurtado-Torres, Aragón-Correa, & Ortiz-de-Mandojana, 2018). A large body of literature examining key actors in the innovation process has focused on the role of staff or technical experts and their interactions in R&D teams (Hoisl, Gruber, & Conti, 2017; Lisak, Erez, Sui, & Lee, 2016). However, relatively less attention has been directed to technocrats in upper echelons in an organization (Talke, Salomo, & Rost, 2010). This paper extends current research on the role of top management teams (TMTs) in leveraging international R&D teams for innovation, by exploring *why* and *when* firm innovation does not benefit from the presence of foreign technocrats in TMTs.

Foreign technocrats are both foreign nationals and technology experts. While prior studies claim that firms increasingly need TMTs to be equipped with deep professional expertise and broad institutional experience to anticipate and respond to innovative opportunities internal and external to their firms (Carpenter & Fredrickson, 2001; Finkelstein, Hambrick, & Cannella, 2009; Schmid & Dauth, 2014), limited empirical investigation is focused on the effectiveness of foreign technocrats in innovation and on the conditions under which the involvement of foreign technocrats is of benefit.

This paper focuses on foreign technocrats in TMTs to explore the challenges they face in their unique roles. We refer to this unique group as *minority-in-minority* because they represent an overlap between two minority sub-groups: foreigners and technology experts. It is notable that foreign technocrats share great similarity with other members in these two sub-groups, namely foreign executives having no technological expertise (hereinafter called

foreign sub-group peers) and domestic executives having technological expertise (hereinafter called *technological sub-group peers*). This is because they all hold positions at the same hierarchical level (similarity in status), share common experience or expertise (similarity in knowledge assets), and their experience and expertise are perceived as valuable strategic capital to firms (similarity in strategic value). However, foreign technocrats are also slightly different from their *sub-group peers* because of their double minority status and dual identity with both foreign experience and technological expertise. In this paper, we combine the ‘double jeopardy hypothesis’ and ‘narcissism of minor difference’ theory, to argue that foreign technocrats may not be able to influence innovation decisions because they suffer from social conflicts with the out-group majority (double jeopardy hypothesis) and from their minority peers within sub-groups (the narcissism of minor difference theory) simultaneously.

Past studies on cross-categorization of groups show that an overlap may act as a bridge between groups and improve inter-group coordination by reducing the distinctiveness of each group and inter-group psychological differences (Bezrukova, Jehn, Zanutto, & Thatcher, 2009; Thatcher & Patel, 2012). This paper uses the ‘narcissism of minor difference’ theory to argue that small differences between people or groups who are otherwise similar are likely to facilitate feelings of hostility because their similarity may create a fear of losing self-identity. We explain this effect by theorizing that whether cross-categorization performs positively or negatively depends on the similarity of the two groups involved. We also compare the moderating effects of the *sub-group peers* (i.e., the individuals who are similar in status and strategic value with foreign technocrats) to the moderating effects of the similar CEO (i.e., the individual who is merely similar in knowledge assets but different in status and strategic value from foreign technocrats). The extent to which *sub-group peers* strengthen the negative effect of foreign technocrats on innovation is likely to be stronger than the similar CEO because the greater similarity enhances the effect of narcissism of minor difference.

This study contributes to the literature in three ways. First, the study enriches innovation studies by exploring the impacts of a particular type of executive who possesses the human capital for innovation in TMTs. In this study, we particularly focus on foreign technocrats in TMTs as their foreign experience and technological expertise provide them with the deep and broad information and knowledge required for facilitating innovation. To the best of our knowledge, our study is among the first to investigate the role of executives with these characteristics. The findings of this research, counter-intuitively, show that the potential human capital advantages, in fact, act as burdens for executives and offset the positive value they bring in terms of knowledge, skill, and ability.

Second, we refine the previous research on the compositional dynamics of TMTs. A focus on foreign technocrats offers us an opportunity to explore the role of overlapping sub-groups and the potential social interactions they may experience. Using the ‘narcissism of minor difference’ theory and ‘double jeopardy hypothesis’, we show that foreign technocrats are not only subject to majority pressure, they are also vulnerable to conflicts from their minority sub-group peers; we find that the negative effect of foreign technocrats on innovation becomes stronger as the percentage of their *sub-group peers* is larger.

Finally, this study also reconciles the two opposing views on overlapping by theorizing a conditional boundary where the positive or negative role of an overlap varies based on the extent to which these two groups are similar. We also provide evidence that executives can better make use of their human capital in innovation when their human capital overlaps with the CEO, but not with their peers.

This paper is organized as follows. Next, we discuss the theoretical background of this paper and develop our hypotheses. We then describe findings from a study of 1,635 Chinese

manufacturing firms along with their theoretical contribution and managerial implications, followed by the limitations of our methodology and future research directions.

2. Theoretical background

2.1. Foreign technocrats in TMTs: An overlapping sub-group

The literature suggests that foreign nationality and expertise in technology are two important characteristics of human capital related to firm innovation (Greve, Biemann, & Ruigrok, 2015). Foreign technocrats in TMTs – those executives who hold foreign nationalities and simultaneously have expertise in technology – constitute an overlapping group between two sub-groups in TMTs that only comprise foreign executives and technological executives respectively (see Figure 1). Despite the rise in number of foreign nationals in TMTs, internationalization of TMTs remains limited and thus foreign executives are still under-represented in TMTs (Finkelstein et al., 2009; Greve et al., 2015). Meanwhile, calls for a greater level of functional diversity (e.g., financial, legal, administration, sales, marketing, R&D, operations) result in fewer executives in TMTs with technological expertise.

< Insert Figure 1 about here >

Westphal and Milton (2000, p. 367) define a ‘minority’ group as those whose salient demographic characteristics are possessed by less than 50 percent of the group. According to this definition, we argue that the group of executives with foreign nationalities and the group of executives with technological expertise are two minority sub-groups in TMTs. As foreign technocrats are members cross-categorized from these two minority sub-groups, we label them ‘minority-in-minority’. Belonging to the overlap of these two sub-groups, foreign technocrats, on the one hand, share certain similarities with their *sub-group peers*. First, they

hold positions at the same hierarchical level. Second, foreign technocrats are similar to foreign executives as both have foreign experience, and they are also similar to technological executives due to common expertise in technology.

On the other hand, foreign technocrats differ from *sub-group peers* in two respects. First, foreign technocrats are small in number in TMTs, when compared to their *sub-group peers*, which makes them more vulnerable to pressure from the majority. Second, foreign technocrats are perceived as being doubly unique and thus valuable for firm innovation because they have both broad institutional experience and deep professional knowledge. Therefore, while they are similar to their *sub-group peers* in terms of status, there are minor differences in human (knowledge) capital and strategic importance. In this study, we argue that foreign technocrats may not only have to face out-group social challenges from the majority but also in-group challenges from the *sub-group peers* with whom they share great similarity and with whom they have minor differences.

2.2. *Minority-in-minority: 'Double jeopardy hypothesis'*

As introduced above, foreign executives and technological executives can be considered as forming two minority groups due to the distinctiveness of their nationalities and functional backgrounds. Prior studies suggest that minority voices are less likely to be heard because minority individuals are typically perceived as less competent and of lower status, and thus they have to conform with the majority's opinion (Alexiev, Jansen, Van den Bosch, & Volberda, 2010; Bear, Rahman, & Post, 2010). The double jeopardy hypothesis assumes that individuals having dual minority status may face a double dose of discrimination (Nicolas, la Fuente, & Fiske, 2017). For example, Berdahl and Moore (2006) argue that black women are likely to be victims of both sex discrimination and race discrimination. Therefore, black

women experience more overall harassment than any other gender–ethnic group. In the context of the labor market, Kim (2017) argues that the size of the pay gap depends on both gender inequality and organization inequality, wherein women from small and medium enterprises experience greater direct discrimination in pay.

2.3. Overlapping with sub-group peers: ‘Narcissism of minor difference’ theory

The faultline literature, which normally focuses on the heterogeneity of sub-groups, argues that the overlaps across sub-groups may perform as bridges because holding a common identity for each sub-group helps to narrow psychological distances between in-groups and out-groups (Levy, Saguy, van Zomeren, & Halperin, 2017; Rupert, Blomme, Dragt, & Jehn, 2016; Singh, Yeoh, Lim, & Lim, 1997). Therefore, this literature emphasizes the importance of similarity in relieving inter-group conflicts. However, Freud (1991) proposes the notion of “the narcissism of minor differences”, providing some interesting counter-examples against cross-categorization predictions. The narcissism of minor difference theory explains the importance of having distinctive social identity between similar individuals or groups. Social differentiation facilitates the pattern for the classification of nature (Blok, 1998). Simmel (1983, p. 265) suggests that an “ideal sphere” should lie around every human being so they can differentiate themselves from others; any individual who trespasses over the radius of this sphere may insult the others’ honor. Thus, approaching ‘too close’ to another can be seen as a threat, offence, or insult. Therefore, given hypersensitivity to differentiation, difference is particularly important for groups sharing similarities because the loss of difference brings about fears of loss of identity, which may eventually lead to conflict (Blok, 1998). However, previous faultline studies do not explore the role of the crossing of sub-group categorization in the context where sub-groups with weak faultlines are very similar to each other. This omission limits our understanding of whether the presence of overlaps contributes to

enhancing or relieving conflict for entire groups.

3. Hypotheses development

3.1. Foreign technocrats and innovation

The ability to absorb knowledge is regarded as an important intangible resource that enables firms to innovate and gain competitive advantage in dynamic environments (Ruiz-Jiménez, Fuentes-Fuentes, & Ruiz-Arroyo, 2016). Although prior studies suggest that a firm's innovation is affected by a range of its executives' characteristics, foreign experience and technological expertise are two such characteristics that are closely related to successful innovation. Executives with international experience may be able to offer more information about cutting-edge technologies on a global scale and thus help TMTs overcome domestic myopia; whereas executives who have expertise in technology may focus their attention more on new technology and then offer deep insights into feasibility of innovation opportunities.

However, whether foreign technocrats can contribute their human capital to firm innovation does not merely depend on the extent of their knowledge and experience, but also on their ability to work with other team members, and on how effectively TMTs function overall. Prior studies identify two types of conflicts among team members (i.e., cognitive conflicts and affective conflicts), which have opposing effects on team effectiveness (Forbes & Milliken, 1999; Korsgaard, Soyoung Jeong, Mahony, & Pitariu, 2008; Amason & Sapienza, 1997). Cognitive conflict (or process conflict) refers to task-oriented differences in viewpoints, ideas, opinions, and judgment among group members due to the different background characteristics of team members. Cognitive conflicts contribute to effective strategic decision-making groups because they allow access to multiple viewpoints and facilitate the exchange of positive and negative comments (Chen, Liu, & Tjosvold, 2005;

Tjosvold, Poon, & Yu, 2005). By contrast, affective conflict (or relationship conflict), which refers to the expressions of anger, hostility, or frustration over task-related or interpersonal issues, usually have a negative impact on decision making (Korsgaard et al., 2008).

As majority peers have diverse functional backgrounds and, it is likely for them to hold a range of viewpoints, thereby leading to disagreement on strategic issues (Greve et al., 2015; Nielsen & Nielsen, 2011). Admittedly, such disagreements may encourage in-depth discussion and consideration of various alternatives, thus arriving at more innovative solutions (Hambrick, Davison, Snell, & Snow, 1998; Nielsen & Nielsen, 2013). However, it is also likely that majority peers hold hostile attitudes toward foreign technocrats if the communication processes are frustrated. Therefore, both cognitive conflicts and affective conflicts are likely to occur between foreign technocrats and their majority peers. When faced with affective conflicts with the majority, foreign technocrats' minority status may prevent their knowledge capital from triggering innovation because they may conform to the majority. According to the double jeopardy hypothesis, foreign technocrats may simultaneously face challenges resulting from their status as foreigners and from their status as technological experts. These two sources of conflict may lead foreign technocrats to suffer from even greater affective conflict. Therefore, compared with their *sub-group peers*, it is more difficult for foreign technocrats to contribute their human capital on innovation.

The social challenges brought about by dual minority identity are not only additive, but also, in most cases, multiplicative. According to the narcissism of minor difference theory, foreign technocrats may also suffer from conflicts with their *sub-group peers*. These conflicts are less likely to be cognitive due to their similarity in international experience and functional expertise. According to the narcissism of minor difference theory, overlapping characteristics weaken the salience of sub-group identity (Blok, 1998), thus bringing about horizontal

hostility. Therefore, these conflicts are most likely to be affective.

Furthermore, the existing literature argues that minority group members show a greater tendency to distance themselves from members of a similar minority group because the distinctiveness of their characteristics is vital for their positive social identity in the entire group (White & Langer, 1999; White, Schmitt, & Langer, 2006). Therefore, such fears may make *sub-group peers* more critical of foreign technocrats in order to show their uniqueness. More importantly, it is easier for them to convince other executives that foreign technocrats' proposals are not feasible because of their experience and expertise. When the *subgroup peers* form allies with other team members, the exchange of different ideas may create a dysfunctional environment and intensify affective conflicts. The prior literature has suggested that affective conflicts erode the cohesiveness of the team, thereby damaging the task performance of the team and eventually firm performance (Forbes & Milliken, 1999). Therefore, the effects of the narcissism of minor difference from *subgroup peers* not only keeps foreign technocrats from contributing to innovation, but also results in intra-team affective conflicts that have a negative impact on the effectiveness of the team. To summarize, their minority-in-minority status and overlapping of human capital with *sub-group peers* traps foreign technocrats between the out-group majority and in-group minority, resulting in potentially more strongly contested intra-team relationships with consequent hampering of their human capital on innovation. Therefore, we posit as follows:

H1. The presence of foreign technocrats in TMTs has negative impacts on innovation.

3.2. The moderating effect of similarity

Many studies suggest that an overlap is an organizational smoothing system that leads to social attraction between members of different involved sub-groups (Chen, Wang, Zhou,

Chen, & Wu, 2017; Lau & Murnighan, 1998; Rico, Molleman, Sánchez-Manzanares, & Van der Vegt, 2007; Thatcher & Patel, 2012). Unlike these studies, we argue that an overlapping group may only be important for relieving conflicts when the groups with which they are associated differ from each other. Therefore, we further compare the joint effects of *sub-group peers* who are very similar to foreign technocrats in status, knowledge assets and strategic values and of CEOs who are only similar to foreign technocrats in knowledge assets, but distinctively different in status and strategic value. Thus, we explore two sets of boundary conditions when the negative impacts of foreign technocrats are stronger or weaker.

3.2.1. *The comparison of the overlaps of similar sub-group peers and the similar CEO*

It has been noted that overlaps bring about perceived similarities (Bezrukova et al., 2009; Nicolas et al., 2017). In the case of foreign technocrats, they are perceived as similar to their *foreign sub-group peers* due to their foreign experience, and they are also perceived as similar to their *technological sub-group peers* because of their common expertise in technology. However, the overlapping of two sub-groups makes foreign technocrats slightly more unique than other *sub-group peers* since they simultaneously hold foreign experience and technological expertise that are vital human capital for promoting firms' innovation. Hence, foreign technocrats are the same as their *sub-group peers* in status, but slightly different from them in knowledge assets and strategic important.

By contrast, although TMTs are relatively horizontal teams without clear hierarchy, CEOs are leaders of TMTs as well as organizational leaders holding the most power (Wu, Levitas, & Priem, 2005). The prior literature has suggested that CEOs have the most discretion to decide the vision, mission, and strategies for their firms (Crossland & Chen, 2013; Finkelstein et al., 2009; Quigley & Hambrick, 2015). Carton and Cummings (2012, p.

448) propose that the faultlines in relation to diversity are not only ‘horizontal’ but ‘vertical’. The power and status of CEOs sets them apart from other executives and reinforces a clear hierarchy between sub-groups of the CEO, and sub-groups of other executives. Considering their hierarchical status and power in decision making, CEOs with foreign experience and technological expertise therefore distinctively differ from technocrats in status and strategic importance, but are the same as their foreign technocrats in knowledge assets. To summarize, the overlap in foreign experience or technological expertise with *sub-group peers* reflects great similarities with minor difference; whereas the overlap in foreign experience and technological expertise with the CEO implies distinct difference with minor similarity.

3.2.2. *The moderating effects of similar sub-group peers*

As discussed above, foreign technocrats are vulnerable to the narcissism of minor difference from their sub-group peers because the overlapping of their human capital makes their sub-group peers less unique and thus leads to resistance as the result of a fear of identity loss. Under these circumstances, the presence of overlap indicates a decrease in inter-group attraction because the minor differences between foreign technocrats and their *sub-group peers* step over the boundary of the ‘comfortable sphere’ for self-identity and trigger hypersensitivity to differentiation (Blok, 1998; Simmel, 1983). Admittedly, these *sub-group peers* may have limited ability to successfully influence team decisions regarding firm strategies because they belong to two minority sub-groups.

Nevertheless, occupying more positions in TMTs is likely to offer them greater power to influence team decisions, either positively or negatively. The plurality of minority on teams has been regarded as a proxy for power (Adhikari, Agrawal, & Malm, 2019). Drawing on critical mass theory, studies show that having more than one minority group member (e.g.,

independent directors, women directors) on teams significantly influences group decision outcomes (e.g., Dezsö & Ross, 2012; Triana, Miller, & Trzebiatowski, 2013). Moreover, by increasing the number of positions on teams, minorities gain more power to pursue their preferences (Torchia, Calabrò, & Huse, 2011; Adhikari et al., 2019), and their view points are more likely to be incorporated into group decisions (Westphal & Milton, 2000).

In the case of *subgroup peers* of foreign technocrats, occupying more positions on teams may provide them with greater power, enabling them to form alliances and coalitions with other team members and initiate political contests toward foreign technocrats (Torchia et al.; Ocasio, 1994). This increased power may intensify the negative effect of narcissism of minor difference on firm innovation as *subgroup peers* focus their attention on how to compete with foreign technocrats, rather than exerting their knowledge and experience to improve the quality of team decisions. Thus, the cohesion of teams weakens, which eventually damages firm innovation decisions. Therefore, we hypothesize:

H2. The negative effect of foreign technocrats on innovation is stronger when the percentage of foreign sub-group peers is larger.

H3. The negative effect of foreign technocrats on innovation is stronger when the percentage of technological sub-group peers is larger.

3.2.3. *The moderating effects of similar CEOs*

As CEOs sit at the peak tier in their firms, they are distinct from other executive positions and of utmost importance to their firms' strategic decisions and future success (Finkelstein et al., 2009). In this situation, the presence of overlap in experience and expertise indicates an increase of similarity, which is likely to increase inter-group attraction as the CEO and

foreign technocrats are distinctively different from each other in status and strategic importance. Accordingly, it may help to narrow the vertical distance perceived by these two sub-groups at different levels in the hierarchy. Research on strategic leadership has identified that CEOs are inclined to favor individuals demographically similar to them (Westphal & Zajac, 1995; Zajac & Westphal, 1996; Zhu & Westphal, 2014), and also more likely to support the sub-group of executives who specialize in their area of expertise (Georgakakis, Greve, & Ruigrok, 2017; Zajac & Westphal, 1995).

Therefore, unlike *subgroup peers*, CEOs who share the same experience and expertise may support foreign technocrats because their status and strategic importance significantly distinguishes them from foreign technocrats, and the narcissism of minor difference from CEOs is thus not likely to occur. Moreover, having foreign experience and technological expertise enables CEOs to better understand the feasibility of proposals on innovation initiated by foreign technocrats or by *subgroup peers*, and therefore CEOs are more able to recognize whether disagreements between foreign technocrats and *subgroup peers* are the result of cognitive conflicts or affective conflicts. Hence, CEO with such experience and expertise may be better able to navigate the conflicts and avoid being persuaded to form alliances with *subgroup peers*. Therefore, we hypothesize as follows:

H4. The negative effect of foreign technocrats on innovation is weaker when the CEO has foreign experience and technological expertise.

Figure 2 shows all the hypotheses in our conceptual model.

< *Insert Figure 2 about here* >

4. Methodology

4.1. Sample and data sources

We test our hypotheses with a sample of 6,479 firm-year observations from 1,736 manufacturing firms in China between 2007 and 2015. Our data is from the China Stock Market and Accounting Research (CSMAR) database. CSMAR is a leading database that offers comprehensive information on the financial performance, corporate governance, and innovation of Chinese listed firms. It has been extensively used in recent management studies (Peng, Sun, & Markóczy, 2015; Zhu & Yoshikawa, 2016). We focus on manufacturing industries as firms in these industries are typically R&D-intensive.

China is chosen as an appropriate research context for two reasons. First, Chinese culture is characterized by collectivism and Confucianism, which emphasize group orientation and interpersonal harmony (Crossland & Hambrick, 2007; Qian, Cao, & Takeuchi, 2013). The level of affective conflicts in the Chinese TMT context is likely to be lower than that in more individualist culture because Chinese people tend to prefer persuasion over direct confrontation (Li & Li, 2009, pp.268). Thus, if the negative impacts of foreign technocrats brought about by the narcissism of minor differences issue are significant in the Chinese context, this issue is worthy of greater attention in the context of individualist cultures where TMT members tend to be more competitive than cooperative. Second, it is more difficult for an emerging economy to attract foreign executives and nationality diversity is accordingly lower in Chinese firms than for those in advanced economies. These difficulties may arise from lower pay and benefits. Thus, foreign executives in China are more likely vulnerable to social conflicts as they occupy fewer positions in TMTs.

4.2. Measures

4.2.1. Dependent variable

We used R&D investment intensity (*rd*) as a primary proxy for the level of firms' innovativeness for two reasons. First, R&D investments are the primary resource for creating technological inventions (McDonald, Westphal, & Graebner, 2008). Thus, it is the most direct and relevant outcome of executives' technological expertise. Second, innovation comprises two stages: initiation (e.g., R&D investment) and implementation (e.g., patenting outcomes, new product portfolios) (Auh & Menguc, 2005; Talke et al., 2010). We consider that intra-team conflicts may first affect consensus on investment decisions made by TMTs and then the effectiveness of the implementation of the investments. Therefore, the relationship between the presence of foreign technocrats and R&D investments seems more direct than that between the presence of foreign technocrats and other investment outcomes.

R&D investment was calculated as the firms' R&D expenditures as percentage of total assets (Duran, Kammerlander, Van Essen, & Zellweger, 2016; Wu et al., 2005) to standardize each firm's R&D investment intensity because some firms have little or no sales in the early years of product development (Kor, 2006). We adopt the ratio of a firm's R&D expenditures to sales as an alternative measure to check robustness. To rule out potential endogeneity, we create a one-year lag for R&D expenditure and total assets respectively.

4.2.2. Independent variables

We employed a dichotomous variable to measure the presence of foreign technocrats in TMTs (*foreigner_tech*). It was coded as 1 if a TMT has at least one executive who is both a foreign national and has expertise in technology. It is important to note that the notion of

foreignness is complex as it may mean nationality and/or residency (Miletkov, Poulsen, & Wintoki, 2017). We used nationality as the proxy as it can capture one of the key constructs of foreignness (Thams, Kelley, & Von Glinow, 2018), and we consider this offers a more appropriate context to test our assumption regarding the social barriers resulting from the perceived distance but not actual geographic distance between TMT members. Thus, foreign nationality was defined as an executive having a different nationality from that of the country of the firm based on previous research (Estélyi & Nisar, 2016; Greve et al., 2015; Thams et al., 2018). We identified the executives as having technological expertise if their current or prior core-functional background was in design and/or R&D (Chatterji, 1993).

4.2.3. *Moderating variables*

We created two proportional variables to measure similar sub-group peers. The percentage of *technological sub-group peers* (*technological_peers*) was measured as the ratio of the number of domestic executives having technological expertise to the total number of members in TMTs. Even if executives with foreign experience (i.e., having overseas education or overseas working experience) do not fall in the subgroup of foreign executives, they are likely to be a functional replacement for foreign executives as their foreign institutional experience offers them a similar international vision and logic (Schmid & Dauth, 2014). Considering that foreign executives are normally under-represented in TMTs (Finkelstein et al., 2009; Greve et al., 2015), we consider the executives who either have overseas experience or foreign nationalities but no technological expertise to better illustrate the power of resistance from *foreign subgroup peers*. Accordingly, the percentage of *foreign sub-group peers* (*foreign_peers*) was calculated as the ratio of the number of this type of executive relative to the total number of executives in TMTs.

The dichotomous variable was adopted to measure similar CEOs. As firms rarely hire a foreigner as their CEO, we also used overseas experience (i.e., having overseas education or overseas working experience) to reflect foreign experience of the CEO. A CEO with foreign experience and technological expertise (*ceo_foroversea_tech*) was coded as 1 if the CEO simultaneously has foreign experience and technological expertise, and 0 otherwise.

4.2.4. Control variables

We incorporated several characteristics of TMTs, boards, and firms to control for confounding influences on R&D that are identified in the literature. At TMT level, we controlled for the size and demographic attributes (e.g., age, gender, overseas experience, country origins) of TMTs overall, and the size of two subgroups of executives (i.e., percentage of foreign executives and percentage of technological executives). As our focus is particularly placed on foreign technocrats and their *subgroup peers*, we also controlled for the gender of these three types of executives. The characteristics of boards, such as size and independence, were considered because they may affect corporate R&D by monitoring, and the provision of advice and resources (Chen, Ho, & Hsu, 2013). We also incorporated firm characteristics, such as firm size, ownership structure (i.e., controlling shareholding, state shareholding), leverage, performance, growth, age, and firm types (i.e., subsidy, high-tech, overseas) as summarized in Table 1.

< Insert Table 1 about here >

4.3. Regression

Consistent with the existing R&D literature, we employed Tobit regression for our analysis to better account for the left-hand censoring of the dependent variables because some firms did

not have R&D investments in certain years (Awate, Larsen, & Mudambi, 2015; Bravo & Reguera-Alvarado, 2017; Bromiley, Rau, & Zhang, 2017; Chrisman & Patel, 2012). As the level of R&D investments may be more common in certain industries, we adjusted standard errors for clustering at industry level (2-digit) to rule out possible autocorrelation problems (Flickinger, Wrage, Tuschke, & Bresser, 2016; Stern & Westphal, 2010).

5. Results

5.1. Descriptive statistics

Table 2 presents the descriptive statistics and the correlation matrix of all variables. Although some variables suggest significant correlations with each other, the largest variance inflation factor (VIF) was well below the acceptable level of 10 (Cui & He, 2017; Pathak, Hoskisson, & Johnson, 2014). Thus, our data appears not to suffer from any serious multicollinearity.

< Insert Table 2 about here >

5.2. Empirical findings

Table 3 shows our Tobit regression results. Model 1 includes control variables. Model 2 incorporates the presence of foreign technocrats, the independent variable. Model 3, 4, and 5 add moderating variables and their interaction terms. Model 6 is the saturated model with all the variable and interaction terms. Because *foreign subgroup peers* is highly correlated with the size of foreign executives, we excluded the size of foreign executives and only controlled for the size of technological executives when testing the moderating effect of *foreign subgroup peers* to rule out potential multicollinearity issues. Likewise, we excluded the size of technological executives and only controlled for the size of foreign executives when testing the moderating effects of *technological subgroup peers*.

H1 predicts that the presence of foreign technocrats negatively influences innovation. Model 2 in Table 3 shows a significant and negative relationship between the presence of foreign technocrats and innovation ($\beta=-0.61$, $p<0.001$), providing support to H1.

H2 and H3 propose that the percentage of similar *sub-group peers* strengthens the negative relationship between the presence of foreign technocrats and innovation. As predicted, Model 3 illustrates that the interaction terms of the percentage of the *foreign sub-group peers* ($\beta=-3.83$, $p<0.05$) is significantly negative, and Model 4 shows the interaction terms of the percentage of *technological sub-group peers* ($\beta=-2.31$, $p<0.01$) are significantly negative. H2 and H3 are supported. The sign and the significance of the two coefficients remain consistent when adding all variables and interaction terms together in Model 6 ($\beta=-5.79$, $p<0.01$; $\beta=-4.59$, $p<0.01$).

H4 predicts that the presence of a similar CEO weakens the negative relationship between the presence of foreign technocrats and innovation. Model 5 shows significant positive coefficients of the interaction term of the presence of the CEO with foreign experience and technological expertise ($\beta=1.30$, $p<0.05$). This result is consistent with the result in Model 6 ($\beta=1.40$, $p<0.01$), thus H4 is also supported.

To better demonstrate the substantive and practical significance of the findings, we also plotted the marginal effects of the presence of foreign technocrats (Huang, Tafti, & Mithas, 2018; Williams, 2012). By plotting the output elasticity with a 95% confidential interval, Figures 3 and 4 show that the average marginal effects of foreign technocrats decrease with the larger percentage of *foreign sub-group peers* as well as with the larger percentage of *technological sub-group peers*. This intuitively illustrates the negative moderating effects of the percentage of two similar sub-groups on innovation. Figure 5 shows that the average

marginal effects of foreign technocrats increase when there is a CEO with foreign experience and technological expertise, implying the positive moderating effect of the presence of the CEO with foreign experience and technological expertise on innovation is significant.

< Insert Table 3 and Figures 3-5 about here >

5.3. Robustness checks

We conducted a set of robustness checks to evaluate the robustness of our findings. First, we recalculated R&D as the ratio of a firm's R&D expenditures to the total assets in year $t+1$ adjusted by subtracting average industry-level R&D expenditure intensity in the same year (in Models 1 and 2) to rule out confounding influences from counterparts in the same industry (Chrisman & Patel, 2012). Second, consistent with the existing literature, Models 3 and 4 present the results obtained by adjusting R&D investments with total sales (Guldiken & Darendeli, 2016; Honoré, Munari, & de La Potterie, 2015). Finally, considering that multiple-firm observations in a panel dataset may result in possible autocorrelation issues, we ruled out possible autocorrelation problems with adjusted standard errors for clustering at the firm level (Flickinger et al., 2016, Stern & Westphal, 2010). All the findings are consistent with the primary results.

5.4. Additional analyses

We also conducted several additional analyses to exclude alternative explanations and further confirm our assumptions on the mechanism through which foreign technocrats influence innovation¹. First, to confirm our assumption that foreign technocrats who have dual minority identity suffer from greater conflicts than executives with a single minority identity, we compared the effects of the presence of foreign technocrats, the presence of foreign

¹ The complete results of additional analyses can be provided by the authors upon request.

executives, and the presence of technological executives on innovation. The results show that the presence of both foreign executives and technological executives are significantly and positively related to innovation ($\beta=0.28, p<0.01$; $\beta=0.18, p<0.01$). Therefore, the negative effects of dual minority identity on innovation are more pronounced than those of single minority identity.

Second, as patents have been extensively recognized as an established proxy for innovation outputs (Auh & Menguc, 2005; Talke et al., 2010), we considered the number of patents (*patent*) as the other proxy to measure firms' innovation (Boeing, Mueller, & Sandner, 2016). R&D can merely reflect the level of investments in innovation (i.e., the input of innovation). That foreign technocrats hamper innovation cannot simply be concluded based on the negative relationship between the presence of foreign technocrats and R&D investment because it is possible that those foreign technocrats help firms make more efficient R&D investments. Accordingly, we further conducted Poisson regressions to test the relationship between the presence of foreign technocrats and the number of patents. We established a two-year lag of the number of patent because it is unlikely that any outputs will be achieved in the same year as R&D investments are made. The findings show that the presence of foreign technocrats also hampers the output of innovation ($\beta = -0.30, p < 0.01$), and this negative effect is more salient when the percentage of *foreign subgroup peers* is larger ($\beta = -4.21, p < 0.01$). Therefore we can exclude the possibility that the presence of foreign technocrats improves the efficiency of R&D investments.

Third, consider that it is more difficult for an emerging economy to attract foreign executives. Such difficulties not only arise from the relatively lower pay and benefits offered, but also from institutional barriers. While there is a lack of direct evidence, it is possible to assume that foreigners recruited by Chinese firms may be of lower capabilities due to the

absence of economic and institutional incentives. In other words, the negative impacts of the presence of foreign technocrats may result from the lower capability of the foreigners recruited rather than from sub-group conflicts or social barriers. To rule out this alternative explanation, we first split our sample into two subsamples. The first is firms listing overseas or having overseas subsidiaries (hereafter called *overseas firms*), the other is firms listing domestically and having no overseas subsidiaries (hereafter called *domestic firms*).

Operating overseas requires firms to satisfy international business standards, therefore it can be expected that these firms are similar or equal to those in advanced markets. Then we compared the effects of the presence of foreign technocrats on innovation in two subsamples. It shows that the presence of foreign technocrats is significantly and negatively related to innovation in the sample of *overseas firms*, but not significantly associated with innovation in the sample of *domestic firms*. We used further estimation to confirm a significant difference between two groups of conditions, and found that the differences in the effects of foreign technocrats between the two subsamples are insignificant ($\chi^2=0.02$, $p=0.88$). It suggests that the capabilities of foreign executives recruited by Chinese firms should not be considered as a major factor hampering innovation.

Fourth, as it is likely that foreign technocrats prefer, or are more likely to be selected by, certain types of firms (e.g., *overseas firms*), we attempt to alleviate this concern by employing the two-stage Heckman model. According to prior studies (Cheung, Naidu, Navissi, & Ranjeeni, 2017), we calculated the inverse Mills Ratio (*imr*) in the first stage using a probit model that predicts the likelihood a firm appoints foreign technocrats, and we included the inverse Mills Ratio into the second stage regression. The results remain consistent.

Finally, to mitigate the potential endogeneity arising from reverse causality, we first established a lag between the presence of foreign technocrats and R&D investment (Dalziel, Gentry, & Bowerman, 2011). Furthermore, we employed the propensity scores matching method (PSM) to compare firms having foreign technocrats (i.e., treatment firms) to a sample of control firms having no foreign technocrats (i.e., control firms). We chose kernel matching (KL) as matching algorithms because it is a nonparametric matching estimator that uses weighted averages of almost all observations from the control group to construct the counterfactual outcome, which produces lower variance (Caliendo & Kopeinig, 2008). The results show that our results are also robust in the PSM sample.

6. Discussion and Conclusion

6.1. Key findings and discussion

Our study is the first to investigate the impacts of foreign technocrats on firms' innovation, aiming to answer the questions why and when foreign technocrats in TMTs hamper innovation. Prior studies find that executives who have international experience or those who have technological expertise have either positive or negative impacts on innovation (Carpenter & Fredrickson, 2001; Finkelstein, Hambrick, & Cannella, 2009; Schmid & Dauth, 2014). However, in this study, we propose that foreign technocrats in TMTs who are both foreign nationals and technology experts can hardly contribute their human capital to innovation by integrating the double jeopardy hypothesis from minority studies and the narcissism of minor difference theory from socio-psychology studies. Specifically, it is argued that the social barrier resulting from out-group prejudice is doubled when compared to that of foreign technocrats' *sub-group peers* due to their status as a minority-in-minority sub-group in the entire team. However, social barriers are also caused by hostility within sub-

groups to which foreign technocrats belong because minor differences threaten the uniqueness of identity of group members. As expected, our results show that the presence of foreign technocrats has a negative impact on the level of innovation. Thus, possessing two types of human capital may not translate into double advantage, instead allocating multiple burdens for individuals with minority-in-minority status.

The negative effect of foreign technocrats on innovation also provides interesting evidence showing that the overlapping of a group's characteristics cannot always act as a bridge across these groups. This finding differs from the existing research on cross-categorization (Bezrukova et al., 2009; Chen et al., 2017; Homan et al., 2008; Rico et al., 2007). We propose that one reason for this empirical inconsistency may be a lack of consideration of the characteristics of the associated groups. Prior studies examine the moderating effects of overlapping groups on the relationship between faultline strength and firm outcomes. Therefore, they naturally assume that differences exist across the associated groups as they are split by faultlines. By contrast, foreign technocrats, in our study, overlap experience or expertise with their *sub-group peers* who hold the same status and only have minor differences in knowledge capital and strategic importance. Therefore, our findings may suggest an important conditional boundary where the overlapping of characteristics of groups could perform a positive or negative role in team performance.

By comparing the moderating effects of sub-group peers and the CEO having similar experience/expertise, on the one hand, we find that both the percentage of *foreign sub-group peers* and the percentage of *technological sub-group peers* strengthens the negative effect of foreign technocrats on innovation. These findings support the narcissism of minor difference theory, which proposes that being too alike triggers fears of losing one's unique identity, and thus the foreign technocrats' *sub-group peers* are more likely to be hostile to them. Therefore, as there are more sub-group peers in TMTs than foreign technocrats, they are more able to

sabotage foreign technocrats.

On the other hand, we find that the presence of a CEO who is similar only in foreign experience weakens the negative impact of foreign technocrats. However, this significant moderating effect is not found for the CEO who is similar only in technological expertise. These results partly support our prediction that the overlapping of characteristics of heterogeneous groups may play a positive role in facilitating coordination of the entire team, whereas the overlapping of characteristics of groups that are very alike but have minor differences may play a negative role due to the effects of narcissism of minor difference. Moreover, the contrasting moderating effects also indicate that having experience/expertise overlapping with the leader is beneficial for the exertion of human capital; whereas overlapping, either demographically or functionally, with peers is not.

6.2. Theoretical implications

The study makes three incremental contributions to the extant literature. First, this study contributes to the innovation literature by investigating a particular group of executives in TMTs who possess the most valuable human capital for innovation to establish whether, in fact, this experience actually hampers innovation. Numerous studies have examined the role of key actors in the innovation process. However, these studies primarily focus on the role of staff or technical experts in the R&D team (Hoisl et al., 2017; Lisak et al., 2016; Talke et al., 2010). While increasing attention is directed to the role of the human capital of executives who are part of TMTs in promoting innovation (Alexiev et al., 2010; Daellenbach, McCarthy, & Schoenecker, 1999; Qian et al., 2013), very few focus on the human capital of the executives who are most related to innovation and how they influence innovation.

In this study, we also recognize foreign nationality and technological expertise as two

direct and important capital imports to innovation as they provide executives with deep and broad information and knowledge about technology and market demands. To the best of our knowledge, ours is the first study to examine the role of executives who simultaneously are foreign nationals and have technological expertise in innovation. In the context of leveraging international R&D teams for innovation, the findings of this research, counter-intuitively, show that the human capital advantages of foreign technocrats may also be a burden.

Second, we contribute to enriching the faultline and sub-group literature. A focus on foreign technocrats offers an avenue to examine the effects of particular overlapping sub-groups. Drawing on the double jeopardy hypothesis and the narcissism of minor difference theory, our results suggest that foreign technocrats not only suffer from their double jeopardy from out-group majority peers, but also from fierce hostility from their peers within the sub-groups to which they belong. By incorporating the narcissism of minor difference theory, our findings indicate an important new mechanism through which foreign technocrats in TMTs, as a unique sub-group overlapping with foreign executives and technological executives, are prevented from exerting their human capital on innovation. By so doing, we refine the previous research on the compositional dynamic of TMTs by looking at why and when a particular type of sub-groups in TMTs improves or hinders firm outcomes.

Third, our research extends studies on the role of overlapping by resolving two competing theoretical perspectives. On the one hand, findings from a number of studies on faultline and sub-groups find that the presence of overlap between sub-groups is an important contextual factor that weakens the negative effects of faultlines on firm outcomes (Bezrukova et al., 2009; Chen et al., 2017; Homan et al., 2008; Rico et al., 2007). These studies conclude that the overlap of groups with dual identify may perform as a gateway between the groups because it helps to reduce the perceived 'gulf' between the two groups (Bezrukova et al.,

2009). On the other hand, the narcissism of minor difference theory proposes that holding common identities is likely to lead to contempt and conflict due to hypersensitivity in regards to differentiation. To make sense of these two divergent theoretical underpinnings, we begin with the hypothesis that the role of overlap among groups depends on the extent to which these associated groups are similar to each other or otherwise.

We argue that the fault-line and sub-group studies naturally focus on the overlaps among the groups that are distinctively different from each other, whereas the narcissism of minor difference theory applies to the overlap among groups that are very alike. Therefore, we rationalize why foreign technocrats may increasingly hinder innovation by employing the narcissism of minor difference theory as the gaps in status, knowledge asset and strategic value between foreign technocrats and their sub-group peers are perceived as minor. In contrast, the negative impacts of foreign technocrats are weakened as the differences between the associated groups increase when examining the moderating effect of the similar CEO (i.e., adding differences in status and strategic value). As a result, we argue for a contingent perspective on the moderating effects of sub-group peers and CEO.

6.3. Managerial implications

This study also has important implications for executive human resource practice. First, understanding why and when the alignment of certain human capital triggers more collaboration or conflict may help firms in the effective appointment of executives. As foreign nationality and technological expertise are viewed as key strategic human assets, firms tend to offer generous compensation to attract executives with global perspectives and professional skills and knowledge. However, the results suggest that the presence of foreign technocrats does not improve a firm's innovation. Therefore, it is more sensible for firms to

adopt diverse TMTs rather than individual executives with diverse experience/expertise. Second, our findings demonstrate that the overlap in experience/expertise with the CEO weakens the negative effects of foreign technocrats. This suggests that the CEO should consider CEO–TMT configuration and set about selecting executives who best complement the CEO (Georgakakis et al., 2017; Heyden, Reimer, & Van Doorn, 2017). A good fit between CEO and TMT characteristics facilitates innovation.

Third, it is also critical for firms to consider background diversity when appointing the CEO. As CEOs tend to favor the opinions of the executive sub-groups that are similar to their own specialization, CEOs are less likely to give preference to one particular sub-group if they are simultaneously identified with multiple experiential backgrounds. Therefore, possessing a wide variety of functional and international experience allows CEOs to welcome opinions from multiple knowledge-based sub-groups, which helps to reduce vertical fragmentation in TMTs and to promote cross-sub-group integration (Georgakakis et al., 2017).

6.4. Limitation and future research

This research has a few limitations that future research may address. First, consistent with the majority of TMT studies, this study uses out-group conflicts and in-group peer hostilities as possible reasons why foreign technocrats cannot make use of their human capital to promote innovation (Carton & Cummings, 2013; Lau & Murnighan, 2005; Talke et al., 2010). Using archival data enables us to get more reliable data over a window of several years (Barkema & Shvyrkov, 2007) but future studies may complement our study by developing more fine-grained measures of the mechanisms and testing with survey data. In particular, an in-depth case study may reveal the process and mechanism to investigate why and how the human capital of foreign technocrats does not translate into innovation advantage.

Second, our study is one of the first to explore why foreign technocrats hamper firms' innovation. While the Chinese context is appropriate for the exploration of the negative role of foreign technocrats in TMTs in innovation, the findings from a single-country study may not be generalizable (Schmid & Wurster, 2017). Additional research is needed to investigate the role of foreign technocrats in other countries such as the US where nationality diversity is greater and affective conflicts tend to outweigh cognitive conflicts among TMT members. A two-country or multiple-country comparative study would enhance the generalizability of our findings and enable us to further consider the joint effects of institutional factors (e.g., collectivism and individualism) and team factors on innovation. This research effort would advance our knowledge of how foreign technocrats cooperate with their team peers and contribute their human capital to their firms in different institutions.

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Figure 1. Foreign technocrats and sub-group peers

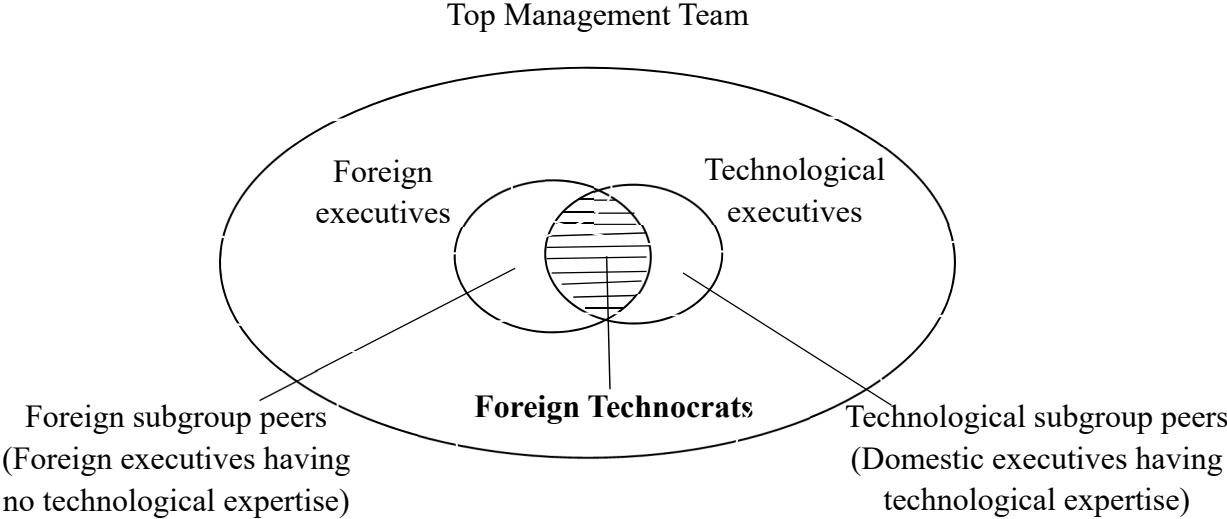


Figure 2. Conceptual model

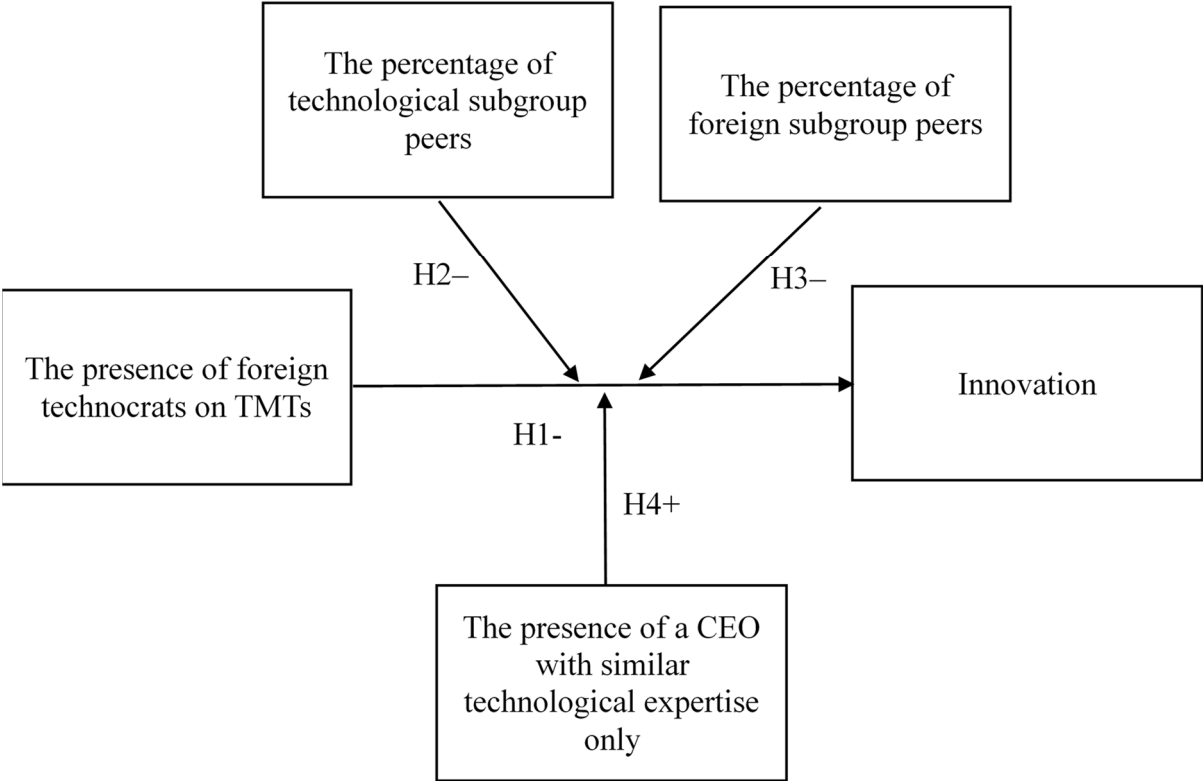


Figure 3. Moderating effect of foreign sub-group peers

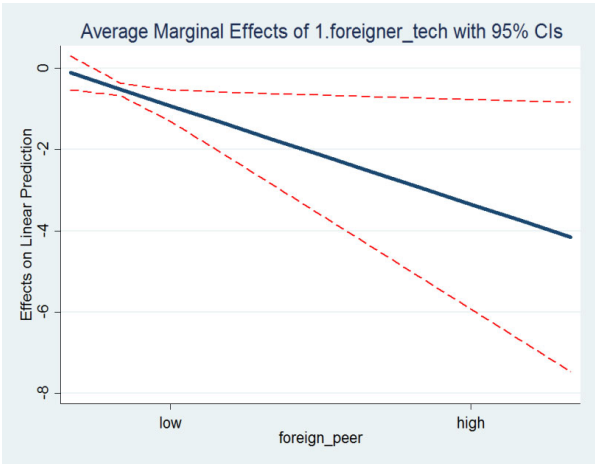


Figure 4. Moderating effect of technological sub-group peers

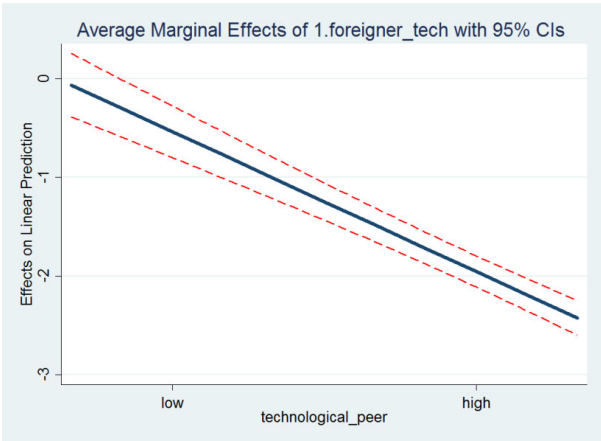


Figure 5. Moderating effect of a CEO with similar characteristics

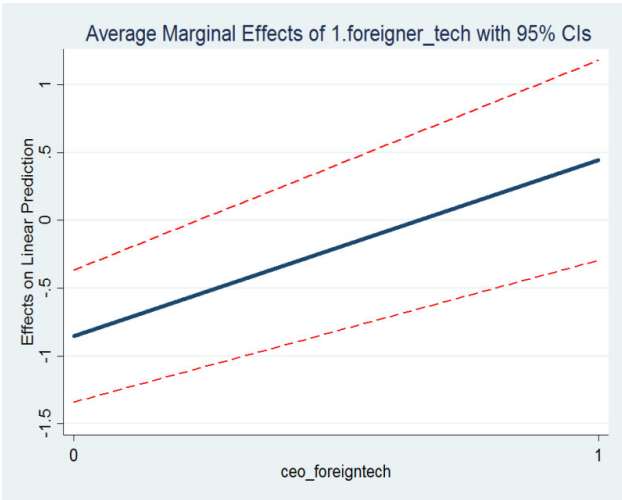


Table 1. Definitions of variables

Dependent variables	
R&D (t+1)	= The ratio of R&D investment to total assets
patent (t+2)	= The number of patents issued in the given year
Independent variables	
foreigner_tech (t)	= An indicator equal to 1 if there is at least one foreign technocrat in the TMT, and 0 otherwise
Moderating variables	
foreign_peer (t)	= The ratio of the number of foreign executives (either with foreign nationalities or with foreign experience) having no technological expertise to the total number of executives in the TMT
technological_peer (t)	= The ratio of the number of domestic executives having technological expertise to the total number of executives in the TMT
ceo_foreigntech (t)	= An indicator equal to 1 if the CEO has foreign experience (i.e., foreign degree or working experience) and has technological expertise, and 0 otherwise
Control variables	
tmtsize (t)	= The total number of executives in the TMT
aveage (t)	= The average of the age of executives in the TMT
maleratio (t)	= The ratio of the number of male executives to the total number of executives in the TMT
oversea (t)	= An indicator equal to 1 if there is at least one executive having foreign experience in the TMT, and 0 otherwise
similarity (t)	= An indicator equal to 1 if foreign executives are from advanced economies, and 0 otherwise
foreign_ratio (t)	= The ratio of foreign executives (either with foreign nationalities or with foreign experience) to the total number of executives
technological_ratio (t)	= The ratio of technological executives to the total number of executives
foreigner_tech_male (t)	= An indicator equal to 1 if there is a male foreign technocrat, and 0 otherwise
female_foreign_ratio (t)	= The ratio of female foreign subgroup peers to the total number of executives
female_technological_ratio (t)	= The ratio of female technological subgroup peers to the total number of executives
boardsize (t)	= The total number of directors on the board

independent (t)	=	The ratio of independent directors to the total number of directors on the board
state (t)	=	An indicator equal to 1 if the firm is state-owned, and 0 otherwise
top (t)	=	The ratio of the largest shareholders' shareholding to the total shares
size (t)	=	Natural log of total assets since their establishment plus one
leverage (t)	=	The ratio of total liability to total asset
roa (t)	=	The ratio of operating income to total assets
subsidy (t)	=	The ratio of the amount of subsidy to sales
growth (t)	=	The annual rate of sales growth
age (t)	=	The years since the firm has established
hightech (t)	=	An indicator equal to 1 if the firm belongs to a high-tech sector, and 0 otherwise High-tech sector was manually identified based on the high-tech industry (Manufacturing) Classification (2013) issued by the National Bureau of Statistics of China. High-tech manufacturing industries include: (1) Pharmaceuticals, (2) Aircraft and spacecraft, (3) Electronics and communication equipment (4) Computer and office equipment, (5) Medical equipment and instrumentation and (6) Information chemicals.
overseafirm (t)	=	An indicator equal to 1 if the firm has branches or son-companies in foreign countries, and 0 otherwise

Table 2. Correlations and descriptive statistics (N=6479)

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1 R&D	.16	.52	1.00										
2 patent	61.32	237.22	.09***	1.00									
3 foreigner_tech	.01	.11	-.01	.00	1.00								
4 foreign_peer	.03	.08	.01	.04***	.16***	1.00							
5 technological_peer	.17	.18	.10***	.06***	.03***	-.08***	1.00						
6 ceo_foreigntech	.01	.10	.04***	.00	.14***	.05***	.12***	1.00					
7 tmtsize	6.45	2.33	.04***	.20***	.05***	-.00	.14***	-.02*	1.00				
8 aveage	45.51	3.59	-.03**	.03***	.02	.00	.02	.02	.14***	1.00			
9 maleratio	.87	.15	-.00	.03**	.00	-.06***	.07***	.03**	.12***	.13***	1.00		
10 oversea	.03	.16	.03**	.03***	.13***	.33***	.03**	.13***	.01	-.01	-.01	1.00	
11 similarity	.03	.18	.02	.04***	.44***	.37***	-.03**	.14***	.13***	.03**	-.02	.17***	1.00
12 foreign_ratio	.04	.10	.03**	.05***	.27***	.90***	.01	.27***	.00	.02	-.04***	.39***	.42***
13 technological_ratio	.18	.18	.10***	.06***	.10***	-.03**	.99***	.16***	.14***	.02*	.07***	.05***	.04***
14 foreigner_tech_male	.02	.13	-.01	.03**	.49***	.25***	-.02	.19***	.08***	.04***	.01	.16***	.53***
15 female_foreign_ratio	.01	.04	.04***	.06***	-.00	.00	.25***	-.00	.03**	.00	-.29***	-.01	-.01
16 female_tech_ratio	.00	.03	-.01	-.01	.12***	.43***	-.04***	-.00	-.02*	-.04***	-.20***	.11***	.21***
17 boardsize	8.85	1.65	-.02	.10***	.01	-.04***	.02*	-.01	.21***	.11***	.09***	-.02*	.02*
18 independent	.37	.05	.03***	.05***	-.00	.02**	-.04***	-.00	-.02**	-.03**	-.03**	.01	-.01
19 state	.38	.49	.01	.06***	-.05***	-.15***	.04***	-.00	.15***	.23***	.18***	-.06***	-.09***
20 top	.36	.15	-.05***	.01	-.00	.02*	-.01	-.02	.02*	.05***	.02	-.02**	-.01
21 size	21.48	1.09	-.01	.34***	-.00	-.00	-.03**	.00	.34***	.21***	.14***	.00	.04***
22 leverage	.43	.25	-.08***	.08***	-.04***	-.05***	-.13***	-.05***	.06***	.05***	.11***	-.03**	-.04***
23 roa	.04	.07	.06***	.04***	.02*	.04***	.07***	.03**	.05***	-.03**	-.07***	.01	.04***
24 subsidy	.01	.02	.11***	-.00	.01	.00	.08***	.00	.00	-.03**	-.05***	.01	.02*
25 age	2.51	0.43	-.02**	.00	-.03**	-.04***	-.14***	-.01	.02*	.17***	.02	-.03***	-.02*
26 hightech	.27	.44	.21***	.05***	.05***	.02	.09***	.04***	-.02	-.06***	-.06***	.04***	.05***
27 overseafrm	.31	.46	.04***	.18***	.06***	.15***	-.01	.06***	.11***	.03**	-.03**	.07***	.12***

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
12	1.00															
13	.09***	1.00														
14	.44***	.12***	1.00													
15	.01	.25***	-.02*	1.00												
16	.39***	-.01	.13***	.02	1.00											
17	-.04***	.02*	.05***	.01	-.03**	1.00										
18	.02*	-.04***	-.02	.03**	.01	-.36***	1.00									
19	-.16***	.03**	-.07***	-.03**	-.07***	.24***	-.05***	1.00								
20	.01	-.01	.00	-.03**	.02*	-.02*	.06***	.11***	1.00							
21	-.00	-.03***	.02	-.03**	-.04***	.28***	-.01	.29***	.18***	1.00						
22	-.08***	-.14***	-.05***	-.08***	-.05***	.14***	-.01	.30***	-.03***	.22***	1.00					
23	.05***	.07***	.04***	.07***	.02*	.00	-.01	-.19***	.08***	.06***	-.42***	1.00				
24	.01	.08***	.01	.05***	-.01	-.07***	.03***	-.07***	-.06***	-.13***	-.11***	.06***	1.00			
25	-.06***	-.14***	-.03**	-.03**	-.05***	.06***	-.04***	.23***	-.11***	.14***	.27***	-.15***	-.05***	1.00		
26	.05***	.10***	.05***	.04***	-.02	-.05***	.05***	-.05***	-.05***	-.14***	-.14***	.10***	.10***	-.03***	1.00	
27	.17***	.00	.09***	-.01	.05***	.02*	.05***	-.08***	.02*	.27***	.01	.07***	-.06***	.01	.07***	1.00

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

Table 3. Tobit regression results

	Model 1 R&D	Model 2 R&D	Model 3 R&D	Model 4 R&D	Model 5 R&D	Model 6 R&D
tmtsize	.04* (.02)	.04* (.02)	.04* (.02)	.04* (.02)	.04* (.02)	.04* (.02)
aveage	-.01 (.03)	-.01 (.03)	-.01 (.03)	-.01 (.03)	-.01 (.03)	-.01 (.03)
maleratio	.12 (.22)	.12 (.22)	.14 (.21)	.14 (.22)	.13 (.22)	.15 (.21)
oversea	.17 (.13)	.19 (.13)	.23* (.13)	.18 (.12)	.14 (.10)	.10 (.10)
similarity	.04 (.13)	.13 (.14)	.14 (.14)	.19 (.16)	.16 (.14)	.15 (.13)
foreign_ratio	.55** (.22)	.52** (.23)		1.56*** (.20)	1.76*** (.53)	1.89*** (.60)
technological_ratio	.76*** (.19)	.77*** (.18)	1.44 (1.45)		-.73 (1.82)	-1.11 (2.11)
foreigner_tech_male	-.68*** (.14)	-.53*** (.14)	-.62 (.38)	-.59*** (.16)	-.48 (.35)	-.54 (.42)
female_foreign_ratio	.63 (1.06)	.62 (1.06)	.67 (1.05)	.65 (1.06)	.65 (1.06)	.66 (1.05)
female_tech_ratio	.37 (.76)	.40 (.75)	.80 (.89)	.77 (.81)	.83 (.89)	.99 (.89)
boardsize	-.02 (.05)	-.02 (.05)	-.02 (.04)	-.02 (.04)	-.02 (.04)	-.02 (.04)
independent	1.28*** (.33)	1.30*** (.34)	1.30*** (.33)	1.30*** (.33)	1.30*** (.34)	1.32*** (.34)
state	.36* (.20)	.36* (.20)	.35* (.19)	.36* (.19)	.36* (.20)	.36* (.20)
top	-.97** (.42)	-.96** (.43)	-.95** (.43)	-.95** (.43)	-.95** (.43)	-.95** (.44)
size	.17*** (.03)	.16*** (.03)	.17*** (.03)	.16*** (.03)	.16*** (.03)	.17*** (.03)
leverage	-.45* (.23)	-.45* (.23)	-.45* (.24)	-.45** (.23)	-.45** (.23)	-.45* (.24)
roa	.69 (1.15)	.68 (1.14)	.66 (1.17)	.70 (1.15)	.72 (1.13)	.69 (1.15)

subsidy	9.76***	9.73***	9.74***	9.82***	9.66***	9.72***
	(3.76)	(3.70)	(3.71)	(3.66)	(3.64)	(3.68)
age	-.04	-.04	-.04	-.04	-.04	-.04
	(.17)	(.17)	(.18)	(.18)	(.17)	(.18)
hightech	1.03***	1.03***	1.03***	1.02***	1.02***	1.03***
	(.37)	(.37)	(.36)	(.36)	(.36)	(.36)
overseafirm	.12	.12	.13	.12	.12	.12
	(.10)	(.10)	(.10)	(.10)	(.09)	(.09)
foreigner_tech		-.61***	-.17	-.09	-.85***	.88***
		(.14)	(.19)	(.24)	(.25)	(.24)
foreign_peer			.33	1.40***	1.50***	1.51***
			(.34)	(.08)	(.24)	(.25)
technological_peer			-.67	.73***	1.45	1.85
			(1.45)	(.16)	(1.78)	(2.05)
ceo_foreigntech			.15	-.05	-.27	-.28
			(.28)	(.24)	(.29)	(.29)
foreigner_tech*foreign_peer				-3.83**		5.79***
				(1.75)		(1.75)
foreigner_tech*technological_peer					2.31***	4.59***
					(.35)	(.43)
foreigner_tech*ceo_foreigntech					1.30**	1.40***
					(.58)	(.41)
_cons	-	-	-	-	-	-
	5.83***	5.81***	5.83***	5.80***	5.84***	5.90***
	(.79)	(.79)	(.78)	(.78)	(.77)	(.75)
Pseudo R ²	.07	.07	.07	.07	.07	.08
N	6479	6479	6479	6479	6479	6479

Robust standard errors are clustered by industry and reported in parentheses

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

Appendix

Table A1. Results for robustness checks

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	R&D_ adjust	R&D_ adjust	R&D_ sales	R&D_ sales	R&D	R&D
tmtsize	.04 (.03)	.04 (.03)	.07 (.05)	.07 (.05)	.04* (.02)	.04* (.02)
aveage	-.02 (.03)	-.02 (.03)	-.02 (.05)	-.02 (.05)	-.01 (.01)	-.01 (.01)
maleratio	.18 (.25)	.21 (.23)	.09 (.34)	.15 (.33)	.12 (.35)	.15 (.35)
oversea	.15 (.11)	.04 (.14)	.30 (.25)	.09 (.18)	.19 (.18)	.10 (.18)
similarity	.21* (.12)	.23* (.14)	.38 (.37)	.44 (.31)	.13 (.29)	.15 (.31)
foreign_ratio	.64** (.32)	1.98*** (.73)	1.14** (.47)	4.18*** (1.31)	.52 (.49)	1.89 (1.23)
technological_ratio	.92*** (.16)	-2.00 (2.69)	1.77*** (.47)	-2.16 (4.93)	.77** (.30)	-1.11 (2.68)
foreigner_tech_male	-.77*** (.13)	-.65 (.51)	-1.02*** (.31)	-1.12 (.94)	-.53 (.36)	-.54 (.53)
female_foreign_ratio	1.12 (1.24)	1.20 (1.23)	1.31 (2.13)	1.43 (2.11)	.62 (1.03)	.66 (1.04)
female_tech_ratio	-.54 (1.28)	.19 (1.49)	-.28 (1.56)	1.17 (1.75)	.40 (1.79)	.99 (1.82)
boardsize	-.01 (.05)	-.01 (.05)	-.07 (.09)	-.07 (.09)	-.02 (.03)	-.02 (.03)
independent	1.78*** (.42)	1.80*** (.41)	2.11*** (.72)	2.16*** (.73)	1.30 (.86)	1.32 (.86)
state	.36 (.26)	.36 (.26)	.71* (.42)	.71* (.42)	.36*** (.13)	.36*** (.13)
top	-1.22** (.57)	-1.20** (.59)	-2.15** (.94)	-2.12** (.97)	-.96*** (.34)	-.95*** (.34)
size	.10* (.05)	.10** (.05)	.40*** (.07)	.41*** (.06)	.16*** (.05)	.17*** (.05)
leverage	-.57*** (.22)	-.56** (.22)	-1.44*** (.55)	-1.43** (.56)	-.45** (.22)	-.45** (.22)
roa	.42 (1.24)	.42 (1.26)	.38 (2.41)	.40 (2.46)	.68 (.74)	.69 (.74)

subsidy	10.36***	10.37***	27.41***	27.38***	9.73***	9.72***
	(3.95)	(3.90)	(9.58)	(9.56)	(1.91)	(1.91)
age	-.08	-.07	-.14	-.13	-.04	-.04
	(.19)	(.19)	(.38)	(.39)	(.12)	(.12)
hightech	1.14***	1.14***	2.20***	2.20***	1.03***	1.03***
	(.41)	(.41)	(.70)	(.69)	(.12)	(.12)
overseafirm	.10	.09	.23	.21	.12	.12
	(.09)	(.08)	(.23)	(.21)	(.11)	(.11)
foreigner_tech	-.74***	.56***	-1.32***	1.92***	-.61*	.88
	(.08)	(.14)	(.33)	(.67)	(.33)	(.59)
foreign_peer		-1.58***		-3.48***		-1.51
		(.31)		(.44)		(1.40)
technological_peer		2.87		3.83		1.85
		(2.61)		(4.71)		(2.67)
ceo_foreigntech		-.05		-.43		-.28
		(.34)		(.54)		(.47)
foreigner_tech* foreign_peer		-4.80***		-13.48***		-5.79*
		(1.16)		(5.21)		(3.21)
foreigner_tech* technological_peer		-5.20***		-10.16***		-4.59***
		(0.39)		(1.35)		(1.65)
foreigner_tech* ceo_foreigntech		1.96***		3.36***		1.40*
		(.41)		(1.01)		(.79)
_cons	-4.58***	-4.68***	-12.45***	-12.65***	-5.81***	-5.90***
	(1.27)	(1.21)	(1.59)	(1.57)	(1.26)	(1.26)
Pseudo R ²	.07	.08	.06	.07	.07	.08
N	6479	6479	6475	6475	6479	6479

Year effects are controlled;

Robust standard errors are clustered by industry and reported in parentheses in models 1-4;

Robust standard errors are clustered by firm and reported in parentheses in models 5 and 6;

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