Exploring the Influence of Political Connections and Managerial Overconfidence on R&D Intensity in an Emerging Market Context: the Case of China's Large-scale Private Sector Firms

Abstract: Political ties and managerial cognitive biases, specifically overconfidence, have been identified as affecting firm-level R&D processes and outcomes. Here we further conceptually and empirically explore how these two factors may influence R&D intensity in an emerging market context. Our empirical results, based on panel data from 1,293 Chinese publicly listed firms (between 2010-2014) show, contrary to some previous research, that stronger formal political ties somewhat reduce firm-level R&D intensity. Greater overconfidence in managers, by contrast, increases R&D intensity. Interestingly, moreover, overconfidence positively moderates the relationship between political ties and R&D intensity to the extent that the negative relationship becomes positive in the presence of overconfidence. We discuss possible reasons for these results, which highlight the role of managerial mind-set as an important determinant of R&D intensity in an emerging market context.

Keywords Political connections, Cognitive bias, Overconfidence, R&D intensity, Private enterprise.

1 Introduction

Extant research has identified political ties and managerial overconfidence as important factors shaping innovation processes in developed market firms. But how important are they in emerging market contexts? Strong political ties can create the reassurances and certainty required to undertake large-scale, risky exploratory innovation projects in developed markets. In emerging markets contexts, however, standard reasoning suggests political ties may potentially be of even greater importance. This is because emerging markets typically possess far weaker institutional environments and thus a highly complex nexus of government to business inter-relationships often develops to substitute for formal institutions. These relationships, pervasive as they are, may potentially influence managerial and firm behaviours in important ways, including those related to firm R&D investments. To date, however, comparatively little research has looked at the influence of political connections on firm R&D intensity in emerging market contexts. The findings, moreover, are somewhat mixed (Cumming and Rui, 2015; Gu and Lundvall, 2006; Lin et al. 2011; Song et al., 2015; Wu, 2011; Zhang et al., 2014).

The impact of the psychological traits of key executives has also received considerable attention in the developed market context (Hirshleifer, et al. 2012), though far less interest for emerging market contexts (Li and Tang, 2010; Tang et al. 2015). Managerial cognitive biases, specifically managerial overconfidence (sometimes also referred to as managerial hubris), has consistently been identified as an important positive determinant of firm innovation intensity, output and efficiency in developed markets (where the focus has been upon patenting outputs and risk taking behaviour) (Hirshleifer et al, 2012; Tang et al., 2015). It has been argued that owing to the significant risks involved in much innovation, ignorance of the true magnitude of these risks may actually make overconfident managers more suitable for firms looking to innovate (Galasso and Simcoe, 2011). This character trait, of course, could also be especially important in the more uncertain, difficult and risky context of an emerging market. Again, weak domestic institutions and imperfect markets intensify the potential hurdles and challenges to innovation. We thus also

look to consider the impacts of bounded rationality in an emerging market context (that of China's large-scale private sector). We do so via the use of the now established construct of managerial overconfidence (Bondt and Thaler, 1994; Herz et al. 2014).

Finally, we additionally consider ways in which managerial overconfidence and political ties may interact to influence innovation. In particular, we consider the conditions under which political connections may affect R&D intensity. We argue that cognitive biases may actually play an important role in positively moderating the impact of political connections on R&D intensity. This is because overconfident managers, as well as doing more innovation, also pursue qualitatively different types of innovation project. These are typically more exploratory, as opposed to exploitative projects and thus may more readily benefit more from stronger political ties. Furthermore, overconfident managers may be more adept at fully exploiting political ties.

As well as contributing to the conceptual debate regarding the role of political ties and managerial overconfidence on innovation, our findings also shed potentially important light on the development of the Chinese economy. The emerging market context we consider here is that of China's large-scale private sector. After more than 30 years of rapid development China's private sector has become a major driving force behind economic growth. In 2012 Chinese private firms accounted for approximately 80% of registered enterprises, 65% of GDP, 30% of China's exports, 60% of investment and 80% of Chinese employment (Li *et al*., 2012). China's private sector, however, is still predominantly oriented towards labour intensive low value added products. Sometimes these are referred to as the "three low products" because they are typically oriented towards products: based upon low-level technologies; typified by labour intensive products earning low value-added; commanding correspondingly low prices. As China's demographic dividend has tapered off, however, and labour costs have risen, the private sector has recently encountered severe growth challenges. These have been exacerbated by currency appreciation. With the exception of some very successful private businesses that have managed to develop their own core, proprietary technologies, reputations and brands (e.g. Huawei, Sany

Group, BYD, DJI Group and the like), many private sector firms have struggled in the wake of the global financial crisis and subsequent economic downturn.

This trend has become of considerable concern to Chinese policy-makers. Recent research now recognises the fundamental role that the private sector will play in driving forward innovation and, in turn, pushing China through the middle income trap (Lin et al. 2011; Zhu et al. 2012; Deng et al. 2013; World Bank, 2013). A co-authored report published by the Development Research Centre of the State Council and the World Bank (2013), for example, argues that if China wishes to move from middle to high income status, increased productivity growth is required. This, it argues, can only be achieved by further development of innovation capabilities in the private sector. China's innovation policy, it argues, should "reflect the lesson borne from international experience that most applied research and innovation is done within *large private sector firms*" (World Bank, 2013: 36)(emphasis added). To achieve this target, both extensive (more private firms) and intensive (deepening of R&D intensity) private sector development is required. Promoting private sector R&D investment intensity is also necessary if it is to compete on an equal footing with international peers. The average R&D intensity of China's top 500 private firms is generally considered to be comparatively low (Lin et al. 2011). It stood at only 1.73% in 2013, for example, compared to 2.3% in the UK's top private firms (UK DTI, 2012). Increasing R&D intensity may help these private sector firms progress from more basic exploitative innovation strategies to more advanced, exploratory types of innovation (Nunes *et al*., 2012; Saha, 2014). This is vitally required as China approaches the international technology frontier. At this point remaining supplies of easily imitable available technologies on the international technology market are reduced, leading to a drop-off in productivity growth.

We make three main contributions. First, using a large-scale panel data set we cast further light on the relationship between managerial political connections and R&D intensity in the context of an emerging market (i.e. China's private sector companies). Extant literature has argued that political connections facilitate access to investment capital and substitute for the weak

private property rights found in underdeveloped institutional environments and can therefore be beneficial for innovation (Cummings and Rui, 2015; Lin et al. 2011). Interestingly, however, we find evidence to the contrary, suggesting political ties in isolation may retard R&D intensity, potentially impeding longer-term performance. Secondly, while managerial hubris is often associated with negative outcomes for firms, we advance further evidence for the positive impacts of such hubris with regards to firm innovation intensity. There may be especially good reasons for thinking such biases play an important role in the more unpredictable and challenging market environments of developing economies and those undergoing transition, like China. Thirdly, we identify managerial overconfidence as an important moderator of the relationship between political ties and R&D intensity. We thus identify managerial cognitive biases as a key driver of innovation intensity in China's private sector, suggesting that the mind-set of senior managers may affect innovation strategy in quite important ways in the emerging market context.

The remainder of this paper is structured as follows. Section 2 lays out the research hypotheses; Section 3 presents the research design; Section 4 describes the sample and data, reports the empirical results, and discusses the findings; Section 5 concludes.

2 Conceptual background and hypotheses

Given conflicting evidence and arguments, we first outline two competing hypotheses regarding the possible impacts of political ties on innovation intensity in China. Second, we develop a hypothesis regarding the potentially positive impacts of overconfidence. Thirdly, we consider the possible moderating influences of overconfidence on the impact of political ties on innovation intensity. Specifically, we argue that overconfidence is associated with particular types of innovative activities, ones that more readily benefit from having such ties. Further, overconfident managers are better placed to exploit the potential of such ties.

2.1 The impacts of managerial political connections on firm R&D intensity

There are comparatively few studies looking at the impact of political ties on innovation in China, either in terms of innovation outcomes (like patenting) or inputs (such as R&D intensity) (Cumming and Rui, 2015; Lin et al. 2011; Song et al. 2015; Wu, 2011; Zhang et al., 2014). There are, however, a number of studies on the impacts of political ties on firm performance (i.e. financial performance, share price and so on) (Faccio, 2006). Their findings, however, are rather mixed. Some find that political ties enhance financial performance (Guo, Xu, and Jacobs, 2014; Li, Meng, Wang, and Zhou, 2008; Sheng, Zhou, and Li, 2011; Zhou, 2009). Such ties, it is argued, may do so by providing a number of benefits, including: better financial resources (i.e. via state banks)(Li et al., 2008; Zhou, 2009); intellectual property rights protection in a weak legal institutional environment (Cumming and Rui, 2015); access to reliable, higher quality information (Song et al., 2015); and other supportive policies (i.e. favourable regulations, reduced tax rates and the like). Other studies, by contrast, argue (and empirically verify) that political ties may actually drag firms away from market oriented goals and lead them into a variety of unproductive activities (Fan et al., 2007). Political affiliations, in particular, may "ossify organisational routines" (Jie, 2011: 1151) and lead to involvement in projects that support local political objectives (i.e. fostering employment, short term profit maximisation to sure up local government budget deficits and the like), as opposed to firm profitability (Fan et al., 2007). This school of thought, therefore, shows by contrast that there are negative impacts on performance (Fan et al., 2007).

Turning to the limited research that talks more directly to the links between political ties and firm-level innovation in China, one is again left with equivocal findings and competing arguments (Cumming and Rui, 2015; Song et al., 2015; Wu, 2011; Zhang et al., 2014). Cummings and Rui (2015), for example, have recently argued that political ties increase access to direct governmental financing for private sector firms. They find there is also a relationship between financing and innovation investment and show that the costs of political instability on

innovation are less severe for politically connected firms (Cummings and Rui, 2015). This suggests some political ties may have a positive impact on investment innovation intensity. Wu (2011) similarly argues that government control of available innovation resources has significantly impacted the R&D investment of Chinese firms. It has done so by appropriating R&D venture capital and investment funds and the transfer of scientific talent to businesses. Consequently, it is argued, close political connections can facilitate access to external innovation resources for Chinese businesses, which in turn improves their R&D intensity. Furthermore, political connections may act as an informal yet effective substitute for formal property rights protection, thereby protecting the infringement of the intellectual property of private firms (Cai et al., 2014; Shi and Gu, 2013; Jiang, 2012). This in turn can help create incentives for private sector R&D activities and lead to greater R&D intensity. Thus, it has been argued R&D intensity may be strengthened via the development of political ties. Empirically, moreover, Lin et al. (2011) have found that firms with political ties had greater R&D intensity than those without links (using a World Bank survey of 1088 private manufacturing firms in the 2000 to 2002 period). This leads to our first hypothesis.

Hypothesis 1a: Stronger political ties lead to increased R&D intensity in China's private sector firms.

In contrast to these positive arguments, however, Zhang et al. (2015), using a World Bank survey of 1,500 Chinese manufacturing firms, draw far more negative conclusions about the impact of political ties on innovation. They firstly consider the specific conditions under which investments in nurturing political ties may improve performance, as well as when they do not. They argue (and demonstrate) that the returns to investing managerial time in cultivating political ties in China depend heavily upon the particular *type* of technological innovation being pursued. They identify two categories of innovation. Exploratory innovation involves novel technological and

market knowledge that departs from the firm's existing knowledge-base and is inherently risky (March, 1991). Exploitative innovation, however, looks to develop existing technological knowledge and buttresses existing technological skills and processes. Exploitative innovation, they argue, in turn involves much lower technological and external market uncertainty. By contrast, with innovation that is more exploratory, considerably higher levels of institutional uncertainty exist. This is because gaining explicit or tacit permission for radically new products or processes requires far more extensive and higher levels of regulatory approval, which often also involves "wide, discretionary interpretations by local government officials" (Zhang et al. 2015: 370). Stronger political ties may facilitate and lower the costs of such approvals, in these cases, and decrease the uncertainty involved in enforcing such things as intellectual property rights. This in turn bolsters R&D intensity. For exploitative innovations, by contrast, existing regulatory approvals may already suffice. Furthermore, as incremental improvements to existing products or processes may be harder to protect (even with the support of political ties), investing in political ties may not make much sense in the case of innovation that is more exploitative in nature. Zhang et al. (2015), therefore, show that in cases where exploratory types of innovation take place, stronger political ties do improve firm innovation performance but for exploitative innovation they do not. Extending this line of reasoning we might also infer a positive relationship for R&D intensity as well as innovation outputs (Zhang et al. (2015) focus upon outputs).

Jie (2011) and Song et al (2015) similarly argue the general impacts of political ties on innovation are negative. Jie (2015), for example, using survey responses from 300 firms in five major Chinese cities argues that while political ties may bring some of the aforementioned benefits (access to resources, information, property rights protection, increased product legitimacy) they do so at a cost. These costs, moreover, quickly outweigh the benefits. They mainly involve adoption of negative "internal routines" (Jie, 2011: 1153). Specifically, this involves reduction in managerial incentives to innovate as managers look to political patronage to

improve firm performance, actively engage in rent-seeking and become distracted by political targets (as opposed to those driven by the market). Similarly, Song et al. (2015) look at 269 listed private firms between 2003 and 2008 and show that political ties come at the cost of reducing innovation efficiency, as firms are forced to bow to "government pressure exerted by those political relations" (Song et al. 2015: 298). This involves additional engagement in non-productive activities, so limiting the amount that can be allocated to innovation. Lin *et al*. (2014) also argue that political ties simply distract managers and take up managerial attention. Owing to the expectations of risk-averse government officials for short-term performance targets, moreover, managers with political ties may invest resources in low-risk projects with short-term pay-offs (rather than longer-term and higher risk R&D projects, decreasing R&D intensity). Political connections, furthermore, also may lead to the softening of budget constraints and reduction in market competition, diminishing the firm's motivation to develop core technological capabilities via innovation (Lin *et al.,* 2014). Lin et al. (2011) also speculate that in general former government officials may simply not be very interested or good at innovation. Thus, there are also good reasons for supposing political ties may reduce R&D intensity in Chinese firms, standing in direct contrast to hypothesis 1a.

Hypothesis 1b: Stronger political ties lead to a reduction in R&D intensity in China's private sector firms.

2.2 Managerial overconfidence and private sector R&D investment intensity

Studies of innovation and cognitive biases in China have drawn from upper echelons theory (Li and Tang, 2010; Tang, et al., 2015). This argues that the psychological traits of managers affect firm decisions and in turn outcomes (Hambrick and Mason, 1984), including investment

decisions. One such trait that has received increasing attention is that of managerial overconfidence, which it has been found, "matters for corporate investment decisions" (Malmendier and Tate, 2015: 39). Managerial overconfidence (and the similar concepts of managerial hubris, optimism, or narcissism, all of which can capture "executive core self-evaluation") is characterised by extreme self-confidence and managerial personal self-assessments which are excessively optimistic (Hiller and Hambrick, 2005). This leads to "a hyper-level" of executive self- appraisal and results in an exaggerated belief personal judgment deviating from objective standards (Tang, et al. 2015: 1701; Hayward and Hambrick, 1997). In general, when an individual's confidence in the accuracy of their own predictions exceeds the actual accuracy of those predictions, this individual can be considered overconfident.

Overconfidence has often been thought of as damaging for firms. It may, for example, negatively influence firm acquisition premiums (Hayward and Hambrick, 1997), corporate financial policies (Malmendier and Tate, 2005), and managerial risk taking (Li and Tang, 2010). Interestingly, when it comes to innovation, however, the opposite has been suggested. It may be beneficial for key executives to be overconfident, owing to the high risks involved in innovating. Managers with inflated views of their own capabilities are more likely to take the greater risks necessary for successful innovation. Indeed, a positive relationship between managerial overconfidence and innovation has been found in developed markets, like the US (Galasso and Simcoe, 2011; Hirshleifer, Low, and Teoh, 2012). Robust support, moreover, has also been identified in more unstable and difficult market environments, like China (Li and Tang, 2010; Tang et al., 2015).

Tang et al. (2015), in their comparative study of innovation and overconfidence in China and the US, have suggested a number of reasons why managerial overconfidence leads to higher levels of innovation. First, overconfident managers overestimate their problem-solving abilities and hence overestimate expected returns from innovation. Such managers, it is argued, may overestimate their own ability, performance and control of a situation and chances of succeeding

(Tang et al. 2015). Such hubris causes executives to take greater risks, which may involve selecting projects that most non-hubristic managers would believe to have only small chances of success. These types of innovative projects are necessarily difficult and risky. They may involve the use of entirely new business methods or technologies, or exploration of new markets and their outcomes are hard to predict. Executives who expect a higher chance of success and a lower chance of failure are thus more inclined to pursue high risk exploratory innovation projects (Galasso and Simcoe, 2011; Hirschleifer et al. 2012).

Second, hubristic decision makers are affected by the "difficulty effect". This means they think themselves better at undertaking relatively challenging tasks than simpler ones (Tang et al. 2015). As the success of innovation projects, moreover, may also be perceived by others as an indication of strong managerial vision or ability, overconfident managers see the exploitation of "talent- and vision-sensitive projects" as a way of promoting their own self-image. In turn this enhances their value job market value (Galasso and Simcoe, 2011). Indeed, overconfident managers generally achieve greater total patents and patent citations than non-overconfident managers in innovation intensive industries. It was found, for example, the former received on average 79 patents compared to 20 in the latter (and three times as many patent citations) (Hirshleifer et al. 2012:1458). Pursuing innovative projects, it is therefore concluded, is "likely to be consonant with the self-image of an executive who is strongly ego driven or self-aggrandizing" (Tang et al. 2015: 1701).

Third, overconfident managers exhibit a strong "internal locus of control". Such individuals are convinced that the outcomes of their behaviors are the result of their own efforts (Rotter, 1966). They believe their decision making is less determined by factors beyond their control and more by those within it. They are more convinced of their own abilities to influence their environments compared with those exhibiting an external locus of control. In the latter case, such managers tend to be more passive, believing events are beyond their control. Executives with an internal locus of control are thus more inclined to towards entrepreneurial activities (Tang

et al.: 2015).

Empirical research has shown that overconfident executives invest more heavily in R&D and achieve greater innovation outputs (by patent and citation counts) (Hirshleifer et al. 2012). While this relationship has been verified in developed markets (i.e. the US) it has also been found in more volatile, high-risk environments. In these market environments, which typically have weak intellectual property rights, innovation may be even more challenging and thus overconfidence may be of particular relevance (Tang and Li, 2010: Tang et al. 2015). Given the difficult market environment found in China (faced by imperfect markets and institutional voids), one might predict overconfidence to be especially important to innovation in China's private sector, which itself faces additional challenges to that of the state sector.

Hypothesis 2. Managerial overconfidence promotes greater R&D intensity in China's private sector firms.

2.3 Managerial overconfidence as a positive moderator of the impact of political connections on private firm R&D intensity

Do any particular factors moderate the relationship between political ties and R&D intensity, amplifying or weakening the link between the two? One possible consideration is that managerial overconfidence itself may positively moderate this relationship. There are several reasons for entertaining this possibility.

Firstly, overconfident managers are not only more likely to do more innovation but are considerably more likely to pursue radical projects that are exploratory, rather than exploitative, in nature (i.e. involving more of the "R" than "D" in R&D) (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). This is important, as Chinese firms have a history of engaging in fairly

conservative imitative types of innovation strategies. For example, Alcorta et al. (2009) undertook a survey of over 300 manufacturing firms. They found most were: "trying tested and proven outside technologies that work" and avoiding "experimenting as much as possible" (quoted in Gu et al. 2009: 380). Those that engaged in what were considered more "ambitious knowledge efforts", moreover, still had a tendency to build upon "existing industry sources and available equipment" (Gu et al. 2009: 380). Al Corta et al. (2009) have referred to this approach as "minimalist" and an "embodied knowledge" strategy (quoted in Gu et al. 2009: 380). Gu et al. (2009) conclude that the findings of the Al Corta survey may be generalizable to China as a whole. They note, for example, that: "a general picture of organizational learning at firm level in China is not encouraging thus far. … by and large, firms in China are weak in innovation" (Gu et al. 2009: 380). This is in part because of the *qualitative* nature of the conservative innovation that Chinese firms pursue, characterised as exploitative in nature (i.e. using "minimalist" or "embodied knowledge" strategies). Breaking away from these more conservative strategies may require a different kind of mind-set, one which overconfident managers may be better equipped to follow. Indeed, it is likely the qualitative nature of innovation that overconfident managers pursue is different to that pursued by non-cognitively biased managers (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). Interestingly, Zhang et al. (2015) have shown that for these types of exploratory innovation strong political ties are of much greater importance in the Chinese context (i.e. *vis* a *vis* exploitative types of innovation which do not benefit so much from political ties).

Explorative innovation benefits from political ties primarily because such ties lower the uncertainty associated with negotiating China's weak institutional environment. In cases of exploratory types of innovation, Zhang et al. (2015) argue, there are far higher degrees of uncertainty in negotiating China's complicated and fickle institutional environment (involving for example approvals of complex patents). Political ties, therefore, may add considerable value in these cases. Exploitative types of "minimalist" innovation (directed towards marginal

improvements in existing technologies, practices and so on), by contrast, are subject to far fewer approvals. In general, the uncertainty involved is far less. In such cases, therefore, political ties are likely to be less beneficial. They may possibly even prove a distraction to managerial attention, so leading to lower R&D intensity. Overconfidence, via its increased focus on exploratory innovation may, therefore, positively moderate the relationship between political connections on R&D intensity. Instead of political connections being superfluous to R&D intensity, in such cases they become beneficial and important to it. They allow private firms to fully extract the rents accruable from innovation, which in turn creates the incentives and motivation to intensify R&D investments.

Secondly, having excessively high degrees of managerial overconfidence may itself also be an important precondition necessary to fully benefit from governmental ties. It cannot be taken for granted that political connections can be equally exploited by all types of managers in the same way. Indeed, firms and their managers vary greatly in their abilities to conform to and manipulate the institutional environment during the innovation process (Oliver, 1991). To exploit political ties, managers may need to be persistently assertive and direct with government bureaucrats, a character trait associated with overconfidence. If pre-emptive enforcement of certain intellectual property rights is required, for example, hubristic managers may be more active in using their existing political ties. Being overconfident, they will place a higher valuation on their intellectual property and thus be more proactive in protecting it. Similarly, they may be more forceful in extracting financing from political connections, believing their projects to be of greater value than non-overconfident managers and thus worthy of additional financing.

Thirdly, it may be equally important that political actors develop their own belief in the managers that they support if such political ties are to be ultimately productive. Overconfident managers may better market and sell themselves as firm custodians. More importantly, they may be better at conveying and convincing political representatives of the excellent growth prospects of their firms. Thus they may present a stronger image of themselves as managing firms with the

potential for very rapid growth. Such managers will be more likely to market their firms as ones with potential to strongly contribute towards the strategic political objectives of their politically affiliated partners (.i.e. with rapid sales and tax revenue growth, local employment creation and the like). Such high growth firms may also offer the greater potential for private kick-backs and insider benefits for government officials. Thus overconfident managers may potentially be able to gain more from political ties as, in the perceptions of government bureaucrats and politically connected elite, they appear more attractive as partners to support. Overconfident managers may capture more of the latent value associated with any given political tie.

There are, therefore, several reasons why managerial overconfidence may positively moderate the relationship between political ties and R&D intensity. In essence, for any given political connection, overconfident managers can extract greater benefit from it. This means that instead of political ties becoming a potential drag on innovation and innovation intensity, they become a benefit to it. As they typically may engage in qualitatively different types of innovation (i.e. explorative, as opposed to exploitative) the returns to political ties increase which in turn strengthens the inclination of managerial attention towards greater R&D intensity.

Hypothesis 3. Managerial overconfidence positively moderates the impact of political ties on R&D intensity in China's private sector firms.

Figure 1 ABOUT HERE

3. Methods

3.1 Sample and data collection

Our sample comes from privately controlled Chinese companies listed on the Shanghai and Shenzhen Stock Exchanges covering the period 2010 to 2014. We use lagged financial data and exclude: financial companies and companies which included financial operating units; companies in the process of transference or other special treatment; those with incomplete data or information disclosure; outlier companies, with R&D intensity and degree of overconfidence winsorized at the 1 and 99% quantiles. The final sample consisted of 1,293 firms.

R&D investment data for the sample firms comes from the China Stock Market and Accounting Research database (CSMAR). Further data was also collected from the information disclosure website, Huge Tide Network (www.cninfo.com.cn), designated by the China Securities Regulatory Commission. Data on political connections was manually extracted from personal data on executives provided by CSMAR. The data on overconfidence in managers and the control variables (including corporate governance, company scale, age, and financial performance, see Table 1), were drawn from the China Centre for Economic Research (CCER) Xenophon database. R&D industry level investment data were extracted from the China Statistical Yearbook on Science and Technology (2011 to 2015).

3.2 Variables and measurements

R&D intensity. We use R&D expenditure to operating income to measure R&D intensity (Chen and Miller, 2007; Gentry and Shen, 2013). Additionally，we use the ratio of firm R&D intensity scaled to the national average (using national industrial R&D expenditure) as an alternative dependent variable.

Political connections. Political connections exist both formally and informally, the latter involving tacit relationships between the enterprise and government officials. They thus manifest

themselves in numerous ways. Faccio's (2010) formal proxy, for example, establishes whether a manager is a government official or a member of parliament. Li *et al*. (2008) following this approach argue that these types of formal political relations are vital for private enterprises. These can be achieved via representation on the National People's Congress (NPC) or the Chinese People's Political Consultative Conference (CPPCC). Alternatively, links with former government officials provide a further strong link to political elites. Such formal and semi-formal channels, it is argued, are more stable, long-term and authoritative and hence facilitate easier access to key resources owing to higher levels of political influence associated with them. Other more informal political relationships, it is argued, are typically rather short-term, unstable and ill-defined in nature thus difficult to usefully quantify (Li *et al*., 2008). Managers who have a publicly recognised political identity, moreover, may more easily participate in government-business interactions, as they have a higher degree of political embeddedness. Following Faccio's (2010) formal approach, we identify whether a director of the board is a representative of National People's Congress, a CPPCC member, a Chinese communist party member. Additionally, we include former government officials, following Li e al. (2008). Using these types of more formal political connections we construct a continuous variable (PC1), measured by the proportion of the directors with these types of political connections on the board of directors (Chen et al., 2011).

Overconfidence. Managerial overconfidence is often measured indirectly. This has been done in a number of ways. For example, using CEO stock options (Malmendier and Tate, 2008), CEO relative compensation (Hayward and Hambrick, 1997), frequency of mergers and acquisitions (Doukas and Petmezas, 2007) and media evaluations of the CEOs' profiles (Brown and Sarma, 2007). One important constituent element of hubris (and how it is measured) relates to direct predictions of future firm performance. Within the literature measurements of over confidence often incorporate as much direct information as they can on managerial forecasting and predictions of the future. For example, previous high profile research often uses

management forecast data regarding firms' future earnings, looking at the difference between what the CEO has predicted and what it actually earns (i.e. the forecast error). Tang and Li (2015) and Ben-David, Graham and Harvey (2006) are good examples. Our approach, in so far as it tries to directly gauge executives' predictions, is similar in principle. We use the comparative investment patterns over time of our sample firms relative to peaks and troughs in the domestic Chinese business cycle (captured using GDP data) and relative to peer group investment behaviours. Business cycles are generally recognised to be difficult to predict and are associated with uncertainty. Our assumption is that a rational manager (i.e. non-cognitively biased) engages in an optimal enterprise investment pattern related to trends in the macroeconomic business cycle (given existing knowledge). We assume overconfident managers, however, overestimate their own capacities and/or the accuracy of the information they possess and thus typically follow different types of investment patterns. The proxy builds from the idea that overconfident managers are more prone to pre-empting changes in macroeconomic conditions. The approach therefore involves estimating an optimal average industry specific investment behaviour corresponding to a non-cognitively biased profit maximising firm manager (given available information) relative to fluctuations in the business cycle. Against this benchmark we then measure the extent to which investment patterns deviate from it. In an ascending business cycle, overconfident managers are more inclined to predict and react to an approaching peak relative to their industry peers (see figure 1). They respond by undertaking reductions in investments in response to the approaching peak when compared with non-cognitively biased peers. By contrast, during a descending cycle, they are more willing and ready to predict the trough and increase investment earlier than non-cognitively biased managers. Conversely, managers with lower confidence levels are less willing to make such judgement calls. Their investment responses therefore lag behind their overconfident peers and move in a comparatively more synchronous manner with the business cycle. Further specific details and a derivation of our proxy is outlined in the Appendix.

FIGURE 2 ABOUT HERE.

Control variables. Guided by existing approaches, we included a number of control variables that influence the intensity of private sector R&D. We include company characteristics, including size, profitability, age and industry (Lee, 2009; Griffiths and Webster, 2010). Corporate governance variables, such as ownership concentration, equity checks and balances, and manager shareholdings are also included (Tribo *et al*., 2007; Dong and Gou, 2010). Table I outlines the relevant variables selected for this research.

INSERT TABLE I ABOUT HERE

3.3 Models

Ordinary least squares (OLS) multiple linear regression is used to model the influence of managerial political connections and cognitive biases on private sector R&D intensity. The regression model is as follows:

$$R\&D = \beta_0 + \beta_1 PC + \beta_2 OCD + \beta_3 PC \times OCD + \sum_{i=4}^{11} \beta_i Control + \varepsilon \qquad (1)$$

where β_i （$i = 0,...,11$）is the regression coefficient, ε act as residuals, and PC stands for the political connection variables (we use PC1, the continuous measurement and also PC2, the dummy variable, as a robustness test). To avoid the potentially high correlation between the interaction terms related to the political connection variable we use the hierarchical block method when introducing the regulating variables (i.e. OCD). Normalized explanatory variables were used following this procedure: step 1, included all control variables; step 2, introduced the political association variable (PC1); step 3, introduced the managerial cognitive bias variables OCD; step 4 introduced their interaction.

4 Results

4.1 Descriptive statistics and correlation coefficient analysis

Figure 3 illustrates the measurement of the degree of managerial overconfidence in the 1,293 sample companies. Table II provides sample descriptive statistics.

INSERT FIGURE 3 ABOUT HERE.

INSERT TABLE II ABOUT HERE.

The average R&D intensity in our sample enterprises was 2.1% (Table II). The R&D intensity of 69% of the enterprises is below 5%, indicating private sector R&D intensity is generally low in China. The mean value of our recorded managerial overconfidence is 0.155 (maximum value 0.564, minimum value -0.383). Across these measures, 67% are greater than zero. Of the 2,012 chairmen and general managers in the sample enterprises, 28.1% of them have political associations, as do 15.2% of the 11,362 board members. Overall, 942 companies in the sample have political associations and the proportion is as high as 72.85%, suggesting the managers of China's non state-owned listed companies frequently establish governmental political associations. In addition, there are 896 manufacturing enterprises constituting 69.3% of the sample and 397 non-manufacturing enterprises (30.7% of the sample firms).

In order to measure the correlation between and among the dependent and independent variables and determine whether there is multicollinearity among the explanatory variables we report Pearson and Spearman correlation coefficients (Table III). As well as ownership

concentration (SHARE), some of the explanatory variables are highly correlated with R&D intensity, indicating they may have explanatory power relating to our dependent variable (R&D intensity). Managerial political association (PC1), for example, is significantly negatively related to enterprise R&D intensity (preliminarily supporting Hypothesis 1b, namely that political association significantly inhibits R&D intensity). Managerial overconfidence (OCD) is significantly positively related to enterprise R&D intensity, suggesting managerial overconfidence may play a role in promoting R&D intensity (hypothesis 2) . Further, the data in Table III show that the correlation coefficients among the explanatory variables are less than 0.3, suggesting multicollinearity is not a serious concern (Lind, 2006). The Variance Inflation Factors (VIF) were also less than 5 (Table IV), confirming this view.

INSERT TABLE III ABOUT HERE.

4.2 Regression analysis of managerial political connections, overconfidence, and R&D intensity

Table IV reports the regression results of the impact of managerial political connections and overconfidence on R&D intensity. The Hausman test assesses whether the the random-effect coefficients are biased and thus whether a fixed-effect model should be used (as shown in Table IV). The Hausman null hypothesis was rejected and thus the fixed-effect model was adopted. Model 1 assesses the impact of the control variables on R&D intensity. Model 2 includes the impact of the political connection variables on R&D intensity. Model 3 examines the impact of managerial overconfidence on R&D intensity. Model 4 examines the moderating effect of managerial overconfidence. These models were analyzed using Hayes SPSS macro (Hayes, 2013). Model 5 examines the marginal effects of political connection and managerial overconfidence on R&D intensity.

INSERT TABLE IV ABOUT HERE

According to the results of model 2, the regression coefficient of the political connection variable PC1 is negative and significant at 5% level. One additional political connection thus leads to 0.122 unit decrease in R&D intensity, meaning managers with weaker political connections invest more in R&D projects, supporting Hypothesis 1b. According to the results of model 3, the regression coefficient of managerial overconfidence is significantly positive at the 5% level (coefficient of 0.062). Moreover, the Adj-R^2 significantly improved relative to Model 2, suggesting that overconfidence influences enterprise R&D intensity. This supports Hypothesis 2. In model 4, the coefficient of the interaction of managers' overconfidence and political connection (OCD×PC1) is significantly positive at the 5% level. The adjusted R^2 again significantly improved, justifying addition of the interaction. This supports hypothesis 3, namely that managerial overconfidence positively moderates the relationship between political ties and R&D intensity. Further, comparisons between models 2 and 4 show that the regression coefficient on PC1 decreases from -0.122 to -0.078, implying that the impact of political connections is considerably reduced when the interaction term is included (its significance, moreover, changes from the 5% to 10% level). In model 5, the marginal effects of political connection and managers' overconfidence on R&D intensity are -0.029 and 0.063, namely that one percent change in political connection tends to decrease the R&D intensity by 0.029% and one percent change in managers' overconfidence tends to increase the R&D intensity by 0.063%. Political connections and managerial overconfidence therefore have decreasing and increasing marginal effects on R&D intensity, respectively.

The impacts of the control variables on R&D intensity are consistent with findings in the literature (model 1). Looking at firm-level characteristics, company age (AGE) has a negative and significant relationship with R&D intensity, possibly because more recently established companies are found in more innovative sectors (i.e. internet companies). Company performance (ROA) and R&D intensity (R&D) are significantly positively correlated, indicating that the better

the company's performance, the stronger the financial intensity and the greater the investment in R&D. As technical characteristics and market competition patterns vary across industries, the industry that an enterprise belongs to will also affect its R&D intensity (R&D). Compared with manufacturing companies, non-manufacturers are more inclined towards technological innovation activities according to our sample. This is mainly because most private listed companies in China are in technology intensive industries, such as the internet and information technology, where technological innovation is high. With regards corporate governance, CEO share-holdings (MSH) and R&D intensity (R&D) are positively correlated and significant, indicating equity incentives for private enterprise executives positively influence innovation. The coefficient of equity balance degree (RSH) is positive and significant, suggesting that equity balances can promote innovative investment by private enterprise. However, the influence of board size and ownership concentration on R&D intensity are not significant, perhaps due to fact that the governance level of boards of directors of China's private listed companies is generally low and equity is often relatively scattered, which limits the power of board members to intervene in the management of investment behaviour.

To describe the moderating effect of managerial overconfidence, we follow the method proposed by Aiken and West (1991) by adding and subtracting one standard deviation on the mean of the independent variable (PC1) (see Figure 4). Figure 4 shows the higher the degree of managerial overconfidence, the greater the positive slope of the line segment. This means that the more overconfident managers are, the stronger the positive influence of political connections on R&D Intensity tends to be. Furthermore, the positive moderation of a negative main effect has the potential for a switching effect. These results are consistent with those of the regression analysis.

Figure 4 ABOUT HERE

4.3 Robustness tests

In order to test the robustness of the results, further regression analysis was carried out

using the dummy variable approach to empirically explore the impact of formal political connections. To recall, this approach has sometimes been used in other studies. A dummy variable approach to capture overconfidence (OCD) was also tested. Specifically, observations with values greater than the median OCD median were assigned 1, or 0 otherwise (Table VI). There were no substantive changes in sign or statistical significance of the coefficients on the key variables in both cases.

4.4 Endogeneity tests

Managerial cognitive bias and the R&D intensity may influence each other. On the one hand, managerial cognitive biases may influence R&D intensity; on the other hand, the greater the R&D intensity of private firm, the stronger the firm's technical capacity, and the more likely the managers tend to be overconfident. And this endogeneity of sample selection may lead to biased research conclusions. Thus, we use the Heckman two-step method to correct for this selection bias. First, a selection model of managerial cognitive bias is built. Then we calculate the Inverse Mills Ratio (IMR) in order to control for the possible endogeneity of managerial cognitive bias. As to the selection model of managerial cognitive bias, we adopt the industry average of the degree of overconfidence of the executives of listed companies. These variables can be regarded as exogenous variables for they are not influenced by managers directly. Thus, the selection model is as follows:

$$OCD = \alpha_0 + \alpha_1 VOCD + \varepsilon$$

The result from the regression analysis is:

$$OCD = \underset{(-4.328)}{-0.019} + \underset{(3.766)}{0.96} VOCD$$

The number in brackets is the matching *Z* statistics. Based on the selection model above, we calculate the IMR respectively, and then enter the IMR into measurement model to perform

further regression analysis. The results show that all the IMRs failed to pass the test of significance and the relationship between managerial overconfidence and R&D intensity is correspondingly consistent with table 4. This illustrates that, taking account of possible endogeneity and sample selection bias, the conclusions regarding the influence of managerial overconfidence and over-optimism on private firm's R&D intensity remain robust.

5 Discussion

We firstly recap on why better understanding Chinese private sector R&D intensity is of potential importance. Secondly, we reconsider the reasons for what some may consider the counter-intuitive results regarding the negative impact of political ties on innovation intensity. Thirdly, we further reflect upon the considerable impact of cognitive orientation in Chinese senior management on R&D intensity, as well as the import of these findings for managers and policy-makers.

5.1 Private sector innovation and the importance of R&D intensity

The role of private sector innovation in China is attracting increasing research attention (Lin et al. 2011: Deng, et al. 2013; Zhu et al. 2012). Innovation in the private sector, by driving greater productivity growth, may facilitate China's drive to break through the so called "middle income trap" (World Bank, 2013). China's innovation policy, it has been argued, should now evolve "to reflect the lesson borne from international experience that *most applied research and innovation is done within large private sector firms*" (World Bank, 2013: 36)(emphasis added). Both extensive (more private sector firms) and intensive development (deepening of innovation capabilities within firms) are mechanisms by which this end might be achieved. Increased R&D intensity, however, is arguably important if China's private sector firms are to successfully compete internationally, particularly in technologically advanced sectors. As noted, Chinese

businesses have relied considerably upon imitation, adoption and importation of foreign technologies to date. Explorative innovation has been identified as somewhat lacking in Chinese businesses (Al Corta et al.2009; Gu et al. 2009; Lin, 2013; World Bank, 2013). As these businesses move closer to the international technology frontier, however, imitative innovation strategies of the "minimalist" or "embodied knowledge" types are, arguably, less likely to succeed. This is because "innovation at the technology frontier is quite different in nature from simply catching up technologically" and thus the role of private sector, some argue, becomes "critical" (World Bank, 2013: 17). Greater private sector R&D intensity could be one important step towards achieving higher levels of explorative innovation.

5.2 The influence of political ties on R&D intensity

To further explore what determines R&D intensity in the private sector we considered the impact of formal political ties, likely of importance in a transition economy like China with institutional voids (Gu and Lundvall, 2006). Interestingly, private sector R&D intensity in our sample was negatively impacted by formal political connections. This stands in contrast to some earlier studies that find positive links between political ties and innovation (Cummings and Wu, 2015; Lin et al. 2011). It may also appear counter-intuitive in light of how China's private sector has emerged. This has involved close links between private businesses and different levels of government. State linkages, at various levels (including the township and village level), for example, have historically provided access to financing for local firms (Gu et al. 2009; Naughton, 2007). We therefore might expect political ties to be influential in securing additional financing for innovation. Our empirical findings on the impact of political ties therefore require further consideration. We outline beneath several possible reasons for our results.

First, as our findings on the interaction between managerial overconfidence and political ties imply, in instances where the qualitative nature of innovation is largely exploitative, it is possible investment in political ties may be of limited commercial value. Owing to the incremental nature

of exploitative types of innovation, regulatory approvals and intellectual property rights protection (and general interaction with government bureaucracy) may be unnecessary. In the case of intellectual property rights protection, for example, it may well be difficult, if not impossible, to meaningfully protect innovations that are exploitative in nature. These innovations are easily copied and cannot be protected via either formal or informal channels. In the case of government approvals, moreover, these also may not be required for exploitative innovative activity. Thus, political ties only provide marginal benefits, if any at all. They may in fact, as our results suggest, be outweighed by the associated costs of having political ties (i.e. interference, monetary bribes associated with corruption and the like) (Zhang et al. 2015). Thus the link between political ties and innovation is attenuated in these circumstances. Developing political ties incurs costs but yields comparatively little by way of return. Political ties may, therefore, lead to marginally lower levels of innovation intensity.

Secondly, it is widely thought that financial markets are imperfect when it comes to provision of venture capital for the purposes of innovation and that firms may typically face a "funding gap" (Hall, 2005). Thus, as noted, if political ties can facilitate access to capital they should in theory be beneficial. Yet our results imply that the potential benefits of political ties are more than offset by their other downsides. One explanation for these counterintuitive results could relate to the fact that our sample firms are all publicly listed. They therefore have greater access to direct finance than unlisted firms. This may alleviate, to some extent, the financing constraints they face via other indirect financing channels (i.e. the banking sector).

Thirdly, it is worth noting that when managerial overconfidence is incorporated and our model is fully specified (i.e. the interaction term is included), the size of the negative coefficient on political ties is reduced considerably (and its significance drops to the 10% level instead of 5%). This suggests that even if political ties have an independent negative impact, it may be comparatively small and open to a higher degree of uncertainty (given the lower level of significance). This is somewhat in line with the arguments presented earlier suggesting

competing possibilities with regards to the impact of political ties on innovation (see hypothesis 1a and 1b). Thus in some cases they may potentially beneficial, but in others not, although on balance the negative impacts appear to outweigh the positive in our sample of firms.

5.3 The role of managerial overconfidence in transition economies and emerging markets

Managerial overconfidence has positive impacts on firm innovation in developed markets (both in terms of volumes of inputs and outputs, as well as innovation efficiency) (Galasso and Simcoe, 2011; Hirshleifer et al., 2012). Compared to firms in developed markets, however, those in China's private sector arguably face far greater uncertainty and risks when innovating. This is caused by an underdeveloped and capricious institutional environment as well as comparatively high levels of market volatility. Imperfect markets also constrain innovation. Under such circumstances, it should perhaps not be so surprising to find that managerial overconfidence influences R&D intensity in China's weak institutional environment.

Interestingly, two other studies have specifically explored the impact of managerial overconfidence in China (Li and Tang, 2010; Tang et al., 2015). Tang et al. (2015) use survey responses from 2,820 firms for the year 2000 and Li and Tang (2010) use similar data, looking at a variety of moderating influences. Tang et al. (2015) find a strong positive relationship between innovation and overconfidence, albeit they consider innovation outputs (new product sales as opposed to R&D intensity). Li and Tang (2010) also find a positive relationship between overconfidence and risk-taking. However, in both studies the observation period is now quite dated (i.e. their studies come from the year 2000). Furthermore, their samples consist of a large number of state-owned enterprises (Li and Tang, 2010; Tang et al., 2015. By contrast, we specifically consider privately controlled (i.e. non state-owned) businesses and do so for a more recent period (2010-14). We conjecture, based on our results, that it is possible that managerial overconfidence may work differently for private firms in influencing innovation in China (as might political ties, and the interaction between the two). Given the additional challenges private

sector firms may face when innovating compared to state-owned firms (lack of financing and intellectual property rights protection, for example), managerial overconfidence may be particularly important for private sector firms. In Li and Tang's (2010) study, for example, they found that managerial overconfidence was actually insignificant as a determinant of risk-taking in state owned firms. In the private sector sample (using a sample of 2,790 firms), by contrast, it was highly significant. This suggests that hubris may work differently in China among firms of different ownership class, with its impact being felt more strongly in the private sector. It is also possible, of course, that managers in private firms may be less constrained and enjoy greater autonomy in decision making, allowing them to engage in greater risk-taking. Our results certainly reinforce the idea that the mind-set of managers is influential in driving more intensive innovation in China's private sector.

Why might a hubristic mind-set be important in fostering greater innovation in China in future? As already noted, imitative "minimalist" or "embodied knowledge" approaches to innovation have been common to date (Gu et al. 2009: 380). A considerable level of managerial confidence may be required to facilitate the movement from an exploitative minimalist mind-set to more explorative approaches. Our findings are suggestive of this, as they show that it is specifically overconfident managers that can redirect their firms towards higher levels of R&D intensity. Thus overconfidence appears important for innovation intensity in the context of a weak institutional environment with businesses that have historically been strongly wedded to exploitative innovation. The historical context of Chinese innovation, which has been considerably shaped by imitative learning, reinforces why managerial overconfidence may be an important factor in driving forward qualitatively different types of innovation in China's private sector.

In future, further research should examine what the outcomes of higher R&D intensity strategies have been. It should examine whether innovation efficiency is also higher in overconfident managers in China, as it has found to be in the US. As well as looking at the

impacts across ownership classes, future research could also try and systematically investigate the impacts of managerial overconfidence across different national contexts. For it may be that managerial overconfidence plays a more significant role within the context of markets that suffer from institutional voids and imperfect markets, like China's transition economy.

5.4 Managerial overconfidence and its interaction with political ties

The finding that overconfidence positively moderates the impact of political ties on R&D intensity is striking. The moderation effect, moreover, switches the relationship from a negative to a positive one in private sector firms with overconfident executives. This means managerial character traits seem to play a central role in shaping innovation intensity in China's private sector. Our preferred interpretation, as discussed, is that overconfidence drives qualitative changes in the nature of innovation taking place, which is akin to a switch mechanism (illustrated clearly in our results). Overconfidence breeds greater explorative activities (Hirshleifer et al. 2012). This in turn benefits from the additional certainty associated with political ties in negotiating an uncertain institutional environment (Zhang et al. 2015). Political ties foster the assurances required for approval of more intense exploratory research. Additional political ties in the presence of overconfidence, therefore, may lead to greater R&D intensity. They drive greater R&D intensity as they allow the full rents to be appropriated from such investments (via regulatory or informal approval or protection of intellectual property rights).

Additionally, overconfident managers may well be able to extract greater value from political ties, owing to their more assertive character dispositions and their ability to breed confidence in the projects they undertake. Managerial overconfidence, for example, has sometimes been measured by the frequency of positive, self-promoting news stories that have appeared in media outlets. Unlike non-cognitively biased managers, overconfident managers are therefore likely to be more active at being heard promoting themselves and their businesses. This could be important in winning political support and also help in maximising the returns from any given

political affiliation.

Of course, there are alternative explanations for the positive interaction between overconfidence and political ties. Research on overconfidence, for example, has focused on exploring the boundary conditions of the relationship between overconfidence and innovation (Tang et al. 2015; Galasso and Simcoe, 2011). It has been found, for example, that environmental munificence, complexity and dynamism weaken the positive relationship between overconfidence and innovation (Li and Tang, 2015). Further, when a manager holds dual roles as CEO and board chairman, or when cash-flow is strong, there is an increased positive moderation in the relationship between overconfidence and innovation (Galasso and Simcoe, 2011). Thus overconfidence itself is both positively and negatively moderated, depending upon context. It is also not inconceivable that political ties positively moderate overconfidence. Perhaps, for example, overconfident private sector managers feel particularly emboldened regarding their innovation prospects when in receipt of political support. Further research is required to explore these alternative possibilities.

5.5 Managerial and policy implications

Overconfidence strongly influences Chinese innovation intensity. Chinese firms hoping to increase R&D spending may therefore have to think carefully about recruiting managers with these personality traits, or encourage incumbents to become bolder in their thinking and approaches to innovation. Political strategies, moreover, under certain conditions are also important for China's large private sector firms looking to intensify their innovation efforts. In the presence of overconfident executives political ties appear to add value in the private sector. Developing a managerial ethos of overconfidence therefore appears particularly beneficial for the fostering of greater innovation intensity in China's private sector. This is because it not only has an independent influence but it also works to further intensify the value of political ties. Future research may also consider whether and China's educational system fosters (or retards), if at all, a

particular cognitive orientation.

From a broader policy perspective more can still be done to improve the soft institutional environment in which the private sector attempts to innovate. Our findings point to the pervasive existence of complex relationships formed between the private sector and political actors. For firms that do not have overconfident top managers, these relationships in general act as a drag on innovation intensity. If the large-scale private sector is to thrive and engage in more intense innovation activities, better formal institutions are therefore still required. Even for firms with overconfident managers, there are still likely to be costs associated with the development of political ties (costs that we do not measure here). And while some firms may be better able to benefit and thus justify these costs, the first best solution will be to create a level playing and reduce the costs across the board associated with firm innovation. By doing so China's private sector firms will be able to fully contribute towards increased innovation led productivity growth.

5.6 Limitations and future research directions

We measure the political connections of private corporations based on whether the senior executives are deputies in the NPC, members of the CPPC, party representatives or former public officials. This approach, however, covers only those cases in which formal contacts exist, arguably capturing only the tip of the iceberg when it comes to actual political connectedness. Future research could attempt to capture political connections in a more thorough manner, accounting for the complex web of informal relationships that also typify many political to business relationships in China. Second, our sample is made up of Chinese listed companies, and no comparative or cross-cultural approach was conducted. Previous research suggests that Chinese psychological features differ somewhat from those of other countries, especially some Western countries. For example, Chinese may have a higher degree of overconfidence than Americans (Lee et al., 1995). In future research, the influence of managerial cognitive bias on firm R&D intensity in different cultural and institutional contexts should be further explored, so

as to ascertain the relative impact and importance of this managerial trait across international settings.

Appendix

Estimating a managerial overconfidence proxy

Our approach involves firstly calculating the degree of rationality of the manager. This is given by the weighted average distance between the macroeconomic conditions at the time of investment and the turning-point of the macro-economic business cycle. Secondly, managerial overconfidence is estimated by estimating the difference between the degree of rationality of the manager and the industry average.

Managerial overconfidence is initially measured relative to the macroeconomy (ME) . Key points in the macroeconomic business cycle should therefore firstly be defined (see figure 1).The point $t_{ascent}^{i-start}(t)$ represents the turning point corresponding the i^{th} *ascending* half-cycle, which is equal to the turning-point of the $i-1^{th}$ *descending* half-cycle ($t_{descent}^{i-1-end}(t)$).

Correspondingly, $t_{descent}^{i-start}(t)$ represents the start of the i^{th} descending half-cycle, equivalent to the end of the i^{th} ascending half-cycle ($t_{ascent}^{i-end}(t)$). Furthermore, $ME_{T_{ascent}^{i-start}(t)}$ denotes the macroeconomic state at the starting point of the i^{th} ascending half-cycle and $ME_{T_{ascent}^{i-end}(t)}$ at the end; and, $ME_{T_{descent}^{i-start}}$ and $ME_{T_{descent}^{i-end}}$ reflect the states at the starting point of the i^{th} descending half-cycle and $ME_{T_{ascent}^{i-end}(t)}$ at the end.

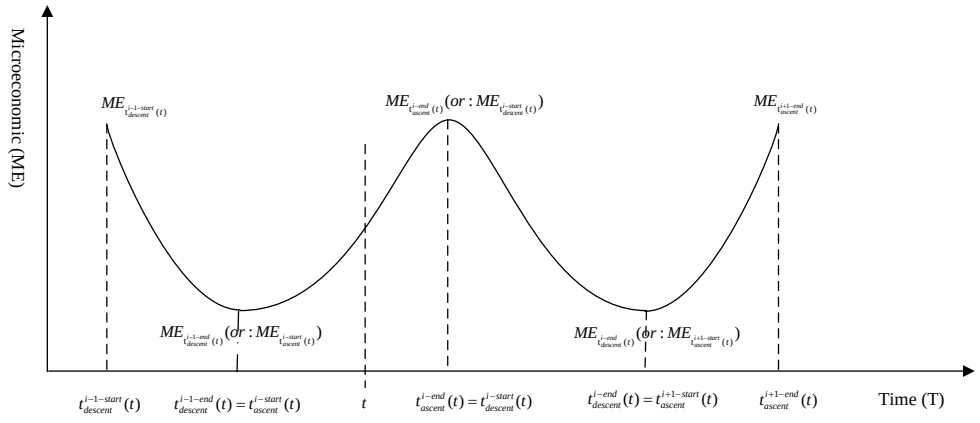

Fig.5. definitions of key points in the business cycle

Managerial investment behavior within the macroeconomic business cycle can be divided into additions (increments) and reductions (decrements) in investment undertaken with a view to

maximizing profits over time. To evaluate the efficiency of managers' investment behavior with respect to two decision-making goals of saving costs and increasing returns, several parameters are specified. The first relates to the efficiency of incremental investment's saving ($EIIS$) and second to the efficiency of incremental investment's income ($EIII$). These respectively represent: the enterprise's cost saving efficiencies by carrying out the incremental investment below that of the previous peak in the business cycle; and growth efficiency of the return on investment by carrying out the incremental investment below the next peak in the business cycle. The second involves the efficiency of decremental investment's saving ($EDIS$) and efficiency of decremental investment's income ($EDII$), which represents: the enterprise's cost saving efficiency by carrying out the decremental investment before the next trough in the business cycle; and growth efficiency of the return on investment by carrying out the decremental investment above the previous trough in the business cycle, respectively.

These are expressed thus:

$$\mathrm{EIIS}_t=\begin{cases}\dfrac{ME_{t_{descent}^{i-1-start}(t)}}{ME_t}\text{-1, } t\in[t_{ascent}^{i-start}(t),t_{ascent}^{i-end}(t)]\\ \dfrac{ME_{t_{descent}^{i-start}(t)}}{ME_t}\text{-1, } t\in[t_{descent}^{i-start}(t),t_{descent}^{i-end}(t)]\end{cases} \quad (2); \qquad \mathrm{EIII}_t=\begin{cases}\dfrac{ME_{t_{ascent}^{i-end}(t)}}{ME_t}\text{-1, } t\in[t_{ascent}^{i-start}(t),t_{ascent}^{i-end}(t)]\\ \dfrac{ME_{t_{descent}^{i+1-start}(t)}}{ME_t}\text{-1, } t\in[t_{descent}^{i-start}(t),t_{descent}^{i-end}(t)]\end{cases} \quad (3)$$

$$\mathrm{EDIS}_t=\frac{ME_t}{ME_{t_{descent}^{i-end}(t)}}\text{-1,}t\in[t_{ascent}^{i-start}(t),t_{descent}^{i-end}(t)] \quad (4); \qquad \mathrm{EDII}_t=\frac{ME_t}{ME_{t_{ascent}^{i-start}(t)}}\text{-1, } t\in[t_{ascent}^{i-start}(t),t_{descent}^{i-end}(t)] \quad (5)$$

Further, in order to comprehensively evaluate the efficiency of managers' decremental investment and incremental investment behavior in saving costs and increasing returns, we construct the efficiency of incremental investment (EII) which is the mean value of $EIIS$ and $EIII$, and the efficiency of decremental investment (EDI) which is the mean value of $EDIS$ and $EDII$ .The equations of EII and EDI are expressed thus:

$$\begin{cases} EII_t = \dfrac{EIIS_t + EIII_t}{2} \\ EDI_t = \dfrac{EDIS_t + EDII_t}{2} \end{cases} \tag{6}$$

Subsituting formulas (2)~(5) into (6) we are given:

$$\mathrm{EII}_t = \begin{cases} \dfrac{ME_{t_{descent}^{i-1-start}(t)} + ME_{t_{ascent}^{i-end}(t)}}{2ME_t} \text{-1, } t \in [t_{ascent}^{i-start}(t), t_{ascent}^{i-end}(t)] \\ \dfrac{ME_{t_{descent}^{i-start}(t)} + ME_{t_{descent}^{i+1-start}(t)}}{2ME_t} \text{-1, } t \in [t_{descent}^{i-start}(t), t_{descent}^{i-end}(t)] \end{cases} \tag{7}$$

$$\mathrm{EDI}_t = \frac{ME_t}{2}\left(\frac{1}{ME_{t_{descent}^{i-end}(t)}} + \frac{1}{ME_{t_{ascent}^{i-start}(t)}}\right) \text{-1, } t \in [t_{ascent}^{i-start}(t), t_{descent}^{i-end}(t)] \tag{8}$$

where ME is measured using GDP data, $t_{ascent}^{i-start}(t)$ and $t_{ascent}^{i-end}(t)$ represent the starting and end points of the i^{th} ascending half-cycle respectively, $t_{descent}^{i-start}(t)$ and $t_{descent}^{i-end}(t)$ represent the starting point and ending point of the i^{th} descending half-cycle respectively.

The measurement of managerial overconfidence

Following this definition of the rational level of investment, we construct the degree of rationality of both decrements in investment ($RDDI$) and increments ($RDII$) in investment behaviour. $RDDI$ is the relative distance of the decrements in investment efficiency to its minimum, while $RDII$ is the relative distance of the incremental investment efficiency to its minimum. The equations for $RDDI$ and $RDII$ are as follows:

$$RDDI = \frac{\sum_{t\in T_{half}}\left(\frac{DI_t}{\sum_{t\in T_{half}} DI_t} EDI_t\right) - \min_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{DI_t}{\sum_{t\in T_{half}} DI_t} EDI_t\right)\right)}{\max_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{DI_t}{\sum_{t\in T_{half}} DI_t} EDI_t\right)\right) - \min_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{DI_t}{\sum_{t\in T_{half}} DI_t} EDI_t\right)\right)} \tag{9};$$

$$RDII = \frac{\sum_{t\in T_{half}}\left(\frac{II_t}{\sum_{t\in T_{half}} II_t} EII_t\right) - \min_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{II_t}{\sum_{t\in T_{half}} II_t} EII_t\right)\right)}{\max_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{II_t}{\sum_{t\in T_{half}} II_t} EII_t\right)\right) - \min_{t\in T_{half}}\left(\sum_{t\in T_{half}}\left(\frac{II_t}{\sum_{t\in T_{half}} II_t} EII_t\right)\right)} \tag{10}$$

Substituting formulas (7) and (8) into (9) and (10) respectively:

For the ascending business cycle, we are given;

$$RDDI_{T_{ascent}} = \frac{\sum_{t \in T_{ascent}} (\frac{DI_t}{\sum_{t \in T_{ascent}} DI_t} ME_t) - ME_{T_{ascent}^{start}}}{ME_{T_{ascent}^{end}} - ME_{T_{ascent}^{start}}} \quad ; \quad RDII_{T_{ascent}} = \frac{\sum_{t \in T_{ascent}} (\frac{II_t}{\sum_{t \in T_{ascent}} II_t} \frac{1}{ME_t}) - \frac{1}{ME_{T_{ascent}^{end}}}}{\frac{1}{ME_{T_{ascent}^{start}}} - \frac{1}{ME_{T_{ascent}^{end}}}}$$

For the descending business cycle, we are given;

$$RDDI_{T_{descent}} = \frac{\sum_{t \in T_{descent}} (\frac{DI_t}{\sum_{t \in T_{descent}} DI_t} ME_t) - ME_{T_{descent}^{end}}}{ME_{T_{descent}^{start}} - ME_{T_{descent}^{end}}} \quad ; \quad RDII_{T_{descent}} = \frac{\sum_{t \in T_{descent}} (\frac{II_t}{\sum_{t \in T_{descent}} II_t} \frac{1}{ME_t}) - \frac{1}{ME_{T_{descent}^{start}}}}{\frac{1}{ME_{T_{descent}^{end}}} - \frac{1}{ME_{T_{descent}^{start}}}}$$

The degree of rationality (RD) is the weighted average of $RDDI$ and $RDII$, expressed here as:

$$RD_{T_{half}} = -\frac{\sum_{t \in T_{half}} II_t}{\sum_{t \in T_{half}} \psi_t} RDII_{T_{half}} + \frac{\sum_{t \in T_{half}} DI_t}{\sum_{t \in T_{half}} \psi_t} RDDI_{T_{half}} \quad \text{, and } \sum_{t \in T_{half}} \psi_t = \sum_{t \in T_{half}} II_t + \sum_{t \in T_{half}} DI_t$$

Where $ME_{T_{ascent}^{start}(t)}$ denotes the state at the start of the ascending half of the business cycle and $ME_{T_{ascent}^{end}(t)}$ at the end; correspondingly, $ME_{T_{descent}^{start}}$ and $ME_{T_{descent}^{end}}$ reflect those at the start of the downward half of the macroeconomic business cycle. Further, II_t and DI_t indicate the firm's increments and decrements in investment (at time t). $\frac{II_t}{\sum_{t \in T_{half}} II_t}$ and $\frac{DI_t}{\sum_{t \in T_{half}} DI_t}$ as weights to calculate the weighted average distance to the macroeconomic business cycle (ME_t) (i.e when decrements in investment to that in the wave trough $ME_{T_{ascent}^{start}}$ or $ME_{T_{descent}^{end}}$, for two adjacent half cycles, the end of the last descending half cycle is the valley which is the start of next ascending cycle). T_{ascent} and T_{descent} are the states at the beginning of the ascending and descending halves of the business cycles and ME_t denotes the macroeconomic state at time t .

Here our degree of managerial rationality degree is weighted by $\frac{II_t}{\sum_{t \in Thalf} II_t}$ and $\frac{DI_t}{\sum_{t \in T_{half}} DI_t}$ so as to calculate the weighted average of the difference in value. We employ the weighted average to indicate the degree of managerial overconfidence using the following for the ascending and descending business cycles:

$$OCD_{T_{ascent}} = \frac{\sum_{t \in T_{ascent}} DI_t}{\sum_{t \in T_{ascent}} \psi_t} \max(\overline{RDDI} - RDDI_{T_{ascent}}, 0) - \frac{\sum_{t \in T_{ascent}} II_t}{\sum_{t \in T_{ascent}} \psi_t} \max(\overline{RDII} - RDII_{T_{ascent}}, 0)$$

$$OCD_{T_{descent}} = \frac{\sum_{t \in T_{descent}} II_t}{\sum_{t \in T_{descent}} \psi_t} \max(\overline{RDII} - RDII_{T_{descent}}, 0) - \frac{\sum_{t \in T_{descent}} DI_t}{\sum_{t \in T_{descent}} \psi_t} \max(\overline{RDDI} - RDDI_{T_{descent}}, 0)$$

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Figures

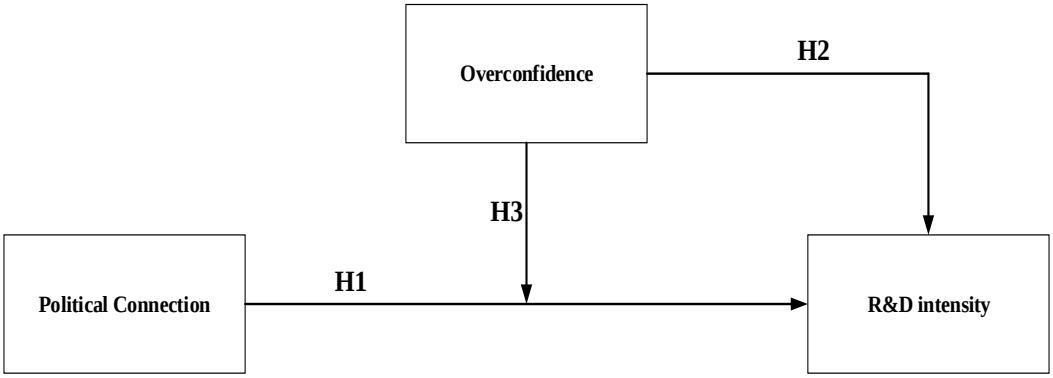

Figure 1: conceptual model of political connections, overconfidence and firm R&D intensity

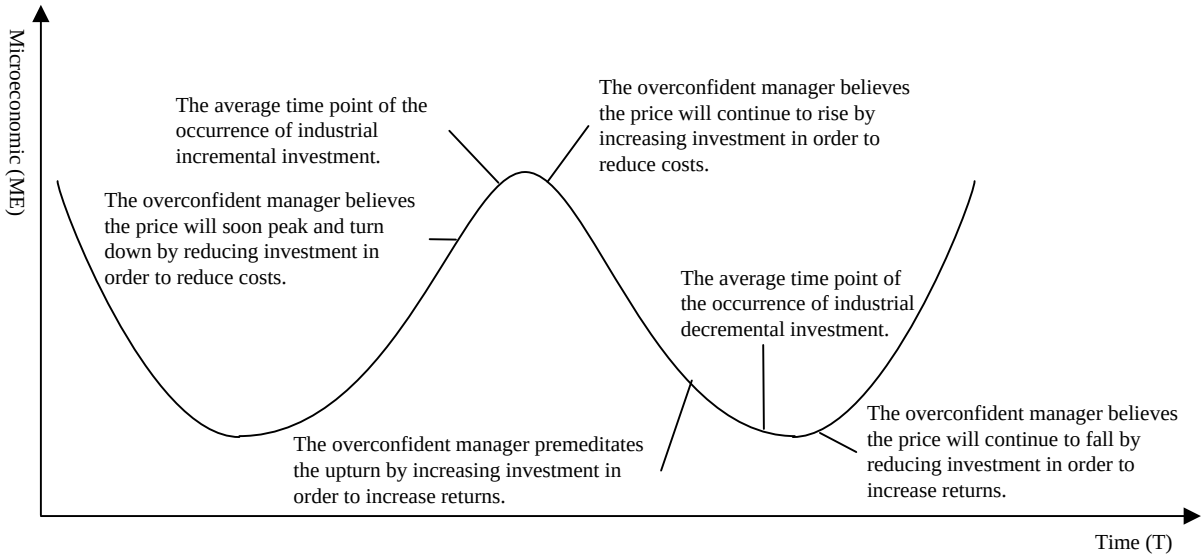

Fig. 2. The investment behavior of overconfident managers relative to the business cycle.

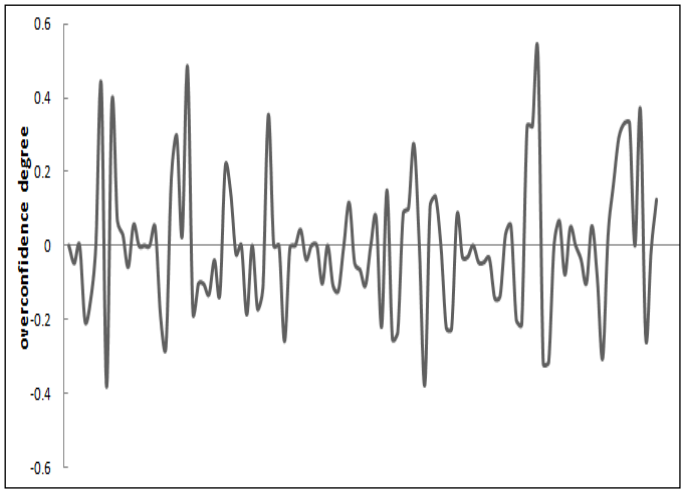

Figure 3 Measurement results for the degree of managerial overconfidence

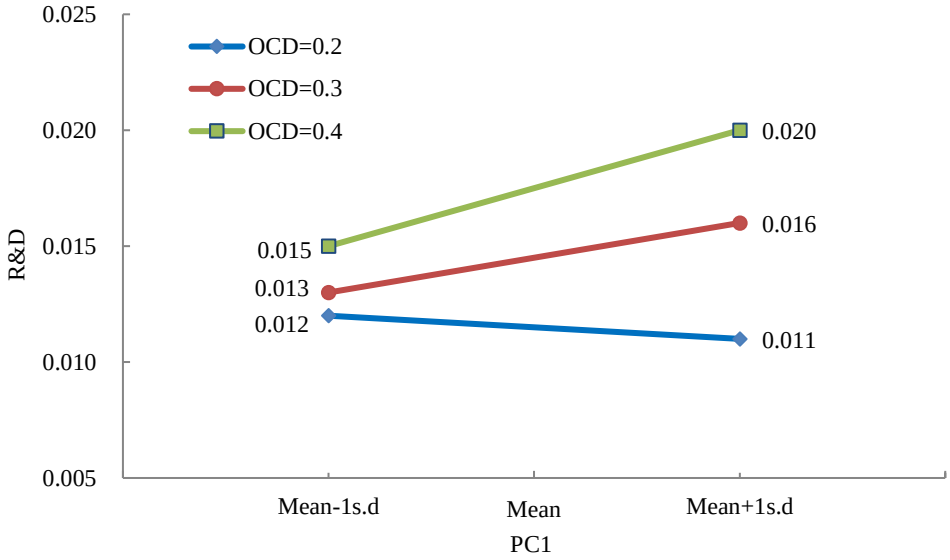

Figure 4 The moderating effect of managerial overconfidence on the relationship between political connection and R&D Intensity

Tables

Table I.

Summary of variables.

type	name	sign	definition	references
Dependent variables	R&D Intensity	R&D	The company's annual R&D expenditure proportion of total annual sales revenues	Chen & Miller, 2007; Gentry & Shen, 2013
Independent variables	political connection	PC1	The proportion of board numbers with political connections	Li et al., 2008，Chen, 2011
		PC2	A dummy variable that equals 1 if the chairman of the board or general manager is a representative of the National People's Congress, a CPPCC member, a Chinese communist party member, or a former government official or a former military membership, and 0 otherwise.(robustness test)	Chen et al., 2011
	overconfidence	OCD	Managers' overestimation of their management ability or of the accuracy of the information they possess.	Wang, 2011
Control variables	company scale	ASSET	Natural logarithm of total assets of the company	Griffiths&Webster,2010; Lee, 2009
	corporate age	AGE	The duration of Company's registration date to the year-end date of observation	
	industry type	INDUS	Manufacture=1；service=0	
	profitability	ROA	The company's total return on assets last year	
	ownership concentration	SHARE	Sum of squares of the top five shareholders' company shares	Tribo et al., 2007; Dong & Gou, 2010
	the proportion of executives shareholding	MSH	The proportion of executives with equity shares	
	board size	SIZE	The total number of the company's directors at the end of the year	
	ownership balance	RSH	The sum of shareholding of second to fifth big shareholder of the company	

Table II.
Summary of statistics.

Variables	R&D	PC1	OCD	ASSET	ROA	SHARE	RSH	MSH	AGE	SIZE	INDUS
Mean	0.021	0.155	0.171	23.558	0.079	0.195	0.236	0.129	16.553	5.961	0.693
Median	0.013	0.128	0.151	22.336	0.071	0.168	0.207	0.033	16	7	1
Maximum	0.281	0.500	0.564	26.101	0.425	0.692	0.551	0.856	61	10	1
Minimum	0	0	-0.383	17.399	-0.238	0.003	0.004	0	10	2	0
Std. Dev.	0.059	0.161	0.182	6.527	0.114	0.188	0.170	0.294	8.87	1.706	0.659

Table III.
Pearson correlation coefficients and Spearman correlation coefficients.

Variables	R&D	PC1	OCD	RSH	ROA	SIZE	AGE	INDUS	SHARE	ASSET	MSH
R&D		-0.153**	0.087*	0.216***	0.187***	0.038**	-0.291***	-0.355***	0.021	-0.238***	0.033***
PC1	-0.175**		-0.034	-0.066	-0.029	-0.033	0.073*	-0.005	0.061	0.235***	-0.056
OCD	0.068**	-0.021		0.040	-0.122	0.030	0.036	0.033	0.043	-0.017	-0.022
RSH	0.271***	-0.050	0.037		0.192***	0.037	-0.270**	-0.071	-0.042	-0.236**	0.266**
ROA	0.159*	-0.042	-0.130	0.159***		-0.068	-0.126**	-0.085	0.188***	-0.039	0.171**
SIZE	0.041*	0.041	0.049	0.018	-0.091		0.117*	0.051	-0.129*	0.262***	-0.089
AGE	-0.223***	0.113**	0.038	-0.240**	-0.109	0.091		0.218***	-0.028	0.279***	-0.283***
INDUS	-0.320***	0.021	0.059	-0.101	-0.118*	0.028	0.173**		0.086	0.127	-0.164**
SHARE	0.033	0.056	0.055	-0.127***	0.137**	-0.105	-0.013	0.110*		-0.021	-0.030
ASSET	-0.194***	0.199***	-0.008	-0.259***	-0.034	0.213***	0.225**	0.136	0.011		-0.271***
MSH	0.039	-0.042	0.013	0.233***	0.160**	-0.101*	-0.230**	-0.119*	0.028	-0.230***	

Notes: The lower left corner is the Pearson correlation coefficient, the top right corner is the Spearman correlation coefficient; *, * *, * * * indicates statistical significance at the 10%, 5%, and 1% levels.

Table IV. Regression results of R&D intensity on managerial political connections and overconfidence.

	Model 1	Model 2	Model 3	Model 4	Model 5 (Marginal.effect)
Constant	0.418	0.403	0.560	0.603	1.103
	3.362***	3.655***	3.922***	2.598**	2.252**
PC1		-0.122	-0.099	-0.078	-0.029
		-2.631**	-1.807**	-1.855*	-2.135**
OCD			0.062	0.054	0.063
			2.520**	2.709**	2.278**
OCD×PC1				0.134	0.119
				2.505**	2.418**
ROA	0.077	0.051	0.060	0.043	0.031
	1.806*	1.964*	1.877**	2.502**	2.660**
SHARE	0.005	0.008	0.007	0.008	0.005
	0.756	0.122	0.690	0.429	0.734
RSH	0.113	0.135	0.143	0.220	0.395
	2.269**	2.774**	2.388**	2.490**	1.813*
MSH	0.038	0.050	0.051	0.075	0.056
	2.433**	2.330**	2.431**	2.470**	2.609
AGE	-0.019	-0.004	-0.012	-0.011	-0.023
	-1.832*	-1.763*	-1.720*	-1.903*	-1.857*
SIZE	-0.008	-0.009	-0.01	-0.013	-0.016
	-1.291	-1.139	-1.122	-1.008	-0.974
INDUS	-0.487	-0.568	-0.637	-0.526	-0.447
	-5.536***	-5.252***	-4.346***	-4.623***	-3.341***
ASSET	-0.055	-0.055	-0.029	-0.036	-0.019
	-2.398**	-2.761**	-2.365**	-2.427**	-2.158**
F	10.378***	21.627***	39.451***	13.615***	9.097***
(P-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Adj-R^2	0.212	0.226	0.274	0.295	0.306
ΔAdj-R^2		0.014**	0.048***	0.021**	
(P-value)		(0.023)	(0.001)	(0.018)	
VIF	1.097	1.219	3.204	4.099	3.872
Hausman	9.282**	11.326**	23.490***	20.327***	22.018***
test(P-value)	(0.029)	(0.011)	(0.000)	(0.000)	(0.000)
Observations	1293	1293	1293	1293	1293

Notes: Statistically significant at: *10, * *5 and * * *1 percent levels; the t-statistics are below the estimates.