High Risk, Low Return (and Vice Versa): The Effect of Product Innovation on Firm Performance in a Transition Economy

Xu Li
Copenhagen Business School
xl.si@cbs.dk
Phone number: +45-38152847

Freek Vermeulen
London Business School
FVermeulen@london.edu
Phone number: +44-2070008715

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ABSTRACT

Common wisdom suggests that high-risk strategies will be associated with high expected returns, and vice versa. Focusing on the effect of new-product development on firm performance, in this paper we argue that this relationship may reverse in a market undergoing substantial institutional transition. We examine domestic pharmaceutical firms in China during the 1990s and find that, in this context, introducing new products was associated with lower average firm profitability but higher variance. In conformity with our predictions, these relationships were stronger in areas where the rate of institutional change was higher and for product types that take longer to develop. Thus, we explain why, for particular strategic actions, high risk may be associated with low returns. A key conceptual corollary of these findings—also for strategic management research in general—is that firms may sometimes be more focused on the potential upside of their actions than on the expected value of those actions.

Keywords: Technology and innovation management, Business policy and strategy, Quantitative Orientation

INTRODUCTION

Strategic decisions are typically associated with risk. In the strategy literature, risk is commonly conceptualized as the variance in returns as a consequence of adopting a particular strategy, in terms of both upside risk (i.e., the return being better than expected) and downside risk (i.e., the return being worse than expected; e.g., Henkel, 2009; Ruefli, 1990). Conventional wisdom suggests that high-risk strategies are normally associated with high average returns, whereas strategies with little risk have lower expected returns. This view of a positive correlation between risk and return originates from the literature in financial economics (Brealey & Myers, 1981; Fiegenbaum & Thomas, 1986; Kim, Hwang, & Burgers, 1993; Van Horne, 1981), where risk-averse actors are thought to require a premium to engage in investments of greater uncertainty. From there, it has gradually found its way into the field of strategy (Bowman, 1980; Henkel, 2009).

By contrast, examining the correlation between the average performance of firms over time and their performance variance, Bowman (1980, 1982) observed that business risk and return

often appeared to be negatively associated. This became known as "Bowman's paradox" (Henkel, 2009), because it ran counter to the common assumption of a positive risk-return relationship, where risk-averse actors would require a higher expected return to engage in risky strategic actions. To explain this puzzle, scholars have offered roughly three possible explanations. First, studies in the traditions of prospect theory and the behavioral theory of the firm posit that a negative risk-return relationship may arise as firms in situations of loss often become more risk-seeking (Fiegenbaum, 1990; Jegers, 1991; Johnson, 1992; March & Shapira, 1987), so that underperforming firms may be causing the general pattern. Second, various authors, including Bowman (1980) himself, speculated that the paradox may stem from heterogeneity in firms' strategic capabilities, in that good management enables firms to better cope with risks (Bettis & Hall, 1982; Bettis & Mahajan, 1985; Bowman, 1980) or adapt more quickly to environmental change (Andersen et al., 2007). Finally, others attributed Bowman's discovery to misspecifications and spurious effects in the empirical analyses (Henkel, 2000; Oviatt & Bauerschmidt, 1991; Ruefli, 1990; Wiseman & Bromiley, 1991).

In this paper, we take a fundamentally different approach. Rather than trying to establish a general correlation in an entire population of firms between the mean and variance of their returns, and then offering a possible explanation for the observed pattern (e.g., Andersen et al., 2007), we examine when *a specific strategic action* undertaken by a firm might concurrently increase risk while decreasing its expected return, to bring about a Bowman-type effect. To do so, we consider a particular strategic action—product innovation—and analyze how it affects two separate dependent variables: average firm performance and its variance. Hence, instead of showing a general negative correlation between risk and return at the population level (and then

speculating about firm-level characteristics that may contribute to such an observation), we explain why a certain strategic action might generate a Bowman effect for firms in the first place.

In particular, we theorize that this effect occurs when firms operating in contexts characterized by uncertainty about value appropriability adopt strategic actions with a long lead time. Specifically, we examine the impact of product innovation on firm performance in an environment undergoing significant institutional change, the Chinese pharmaceutical industry during the period 1991–2000. We chose this setting because in 1991 the industry was still fully government-owned and controlled. By 2000, however, the industry had transitioned significantly toward a market economy, albeit still with considerable government control and interference (Eesley, 2013; Li & Atuahene-Gima, 2001; Luo, 2003; Zhang, Li, Li, & Zhou, 2010). Building on insights from North (1990, 1993), we theorize that institutional transitions lead to unpredictable shifts in the industry's performance landscape (Levinthal, 1997), which limit the ability of firms to appropriate value from their inventions. We posit that such unpredictable changes combined with a lengthy product-development process may concurrently bring about lower average returns with higher variance for innovating firms.

We examine the effect of product innovation in the form of launching new drugs. In our empirical analyses, we adopted multiplicative heteroskedastic models, which enables us to simultaneously estimate the effect of launching new drugs on the level of firm performance and its variance. Furthermore, to rule out potential concerns of endogeneity—particularly reverse causality—we followed a two-stage least-squares (2SLS) approach by instrumenting our independent variable. Our results confirm that, when the product development process is long while the rate of local institutional change is high, new product launches not only have a highly

variable effect on a firm's profitability (as others have noted too; e.g., Anderson & Tushman, 1990; Klepper, 1996), but with a *negative* effect on its expected returns.

We present an extensive set of supplemental analyses – both quantitative and qualitative – to gauge and illustrate, among others, why firms engage in these actions, despite them having low expected return with high risk. Measuring variables such as bribery, intellectual property right protection (IPR), and attention on top innovators, we elaborate on the wider context and mechanisms underlying our findings. Interestingly, we also find that alternative routes to new product introductions – by obtaining inventions from others, through imitation or licensing – also reverses the traditional risk-return relationship, but by being associated with relatively high expected returns with low variability. Overall, an important conceptual implication of our findings is that it may not be organizational deficiencies—such as low-skilled managers (Bowman, 1982), an inferior capability to adapt (Andersen et al., 2007), or financial underperformance (Fiegenbaum & Thomas, 1988)—that cause firms to engage in actions that have low expected return with high risk but that, in their decision-making, firms may simply be driven more on the potential upside of a particular strategic action than on its expected returns (Cyert & March, 1963).

THEORY AND HYPOTHESES

The Risk-Return Paradox

In both the finance and the strategy literatures, expected return is conceptualized as average return on sales, assets, or equity for firms undertaking a particular course of action (Brealey & Myers, 1981; Fiegenbaum & Thomas, 1986; Henkel, 2009). Risk, on the other hand, is conceptualized as the variability in returns, indicating uncertainty about the extent to which the expected return may be realized. In other words, riskier decisions imply a wider probability distribution around the mean, with fatter tails. Because managers are assumed to be risk-averse,

they would only engage in strategic courses of actions with higher risk if the expected return is also relatively high (Henkel, 2009). This view of a positive association between risk and return has received ample empirical support for a variety of investment decisions in different settings (e.g., Ackermann, McEnally, & Ravenscraft, 1999; Campbell, 1996; Cochrane, 2005; Fama & MacBeth, 1973; Levy & Sarnat, 1984) and has come to be accepted as "received wisdom."

In contrast to this conventional view, however, Bowman (1980, 1982) uncovered the seemingly puzzling finding that business risk and return often seem to be negatively correlated. Through analyzing the relationship between the average performance of firms and their variance over time, he discovered that firms with higher average annual returns often seemed to incur less risk than those with lower average returns (Bowman, 1980; Oviatt & Bauerschmidt, 1991). This observation—subsequently replicated by others (for an overview, see Appendix 1; Patel, Li, & Park, 2018)—became known as Bowman's paradox. Bowman speculated that managerial capabilities might underlie this finding: good practices would enable managers to generate higher returns while also controlling risks.

Subsequently, though, in their explanations of the paradox, others pointed out that differential preferences of decision-makers could also underlie the phenomenon. In particular, managers with a preference for risk could self-select into courses of action that lead to higher variance, even if the expected return is low (Miller KD, Leiblein MJ. 1996; McNamara & Bromiley, 1999). Prospect theory (Fiegenbaum & Thomas, 1988; Jegers, 1991; Tversky & Kahneman, 1981), for example, has suggested that in situations of relative loss, managers may prefer and value risk-taking behavior. Similarly, research on the behavioral theory of the firm (e.g., Cyert & March, 1963; March & Shapira, 1987) posited that managers tend to adopt riskier actions when their company is operating below historical or social aspiration levels (Bromiley,

1991; Greve, 1998, 2003). Accordingly, the general negative risk-return relationship that Bowman observed could arise in a population because managers who value risk – for instance because they are facing situation of loss – accept lower expected returns. Firms that operate above their performance aspirations only accept risk if they come with the reward of higher expected returns (Lehner, 2000; Miller & Chen, 2004).

Other studies extended Bowman's (1980) original focus on capabilities as an explanation for the negative correlation between risk and return. In particular, Andersen et al. (2007), through model simulations, showed that the superior abilities of firms to adapt to environmental shocks may enable them to attain greater performance outcomes with less variability. Firms with strong dynamic capabilities adapt quickly to an environmental shift, thus experiencing little performance loss and little variance. By contrast, slow adaptation by others causes their performance during this period to be lower on average, but also with bigger differences between years, thus yielding a negative correlation in the population between variance and average returns. Hence, firms capable of swift adaptation simultaneously achieve higher returns and lower risk, whereas others struggle to do so (Andersen et al., 2007; Bowman, 1980).

The aforementioned studies on Bowman's paradox examined a general correlation within a population of firms, showing that their average returns tend to be negatively correlated with their variability.[1] Possible explanations of why this correlation occurs centered on different firm level behaviors. In this paper, we take a different approach: rather than focusing on the overall correlation between risk and return at the population level, we posit that particular strategic actions adopted by a firm under specific circumstances can negatively affect its average

[1] Also studies that aim to show that a negative correlation between risk and return is due to measurement error, model misspecification, or spurious effects (Brick, Palmon, & Venezia, 2015; Henkel, 2000; Oviatt & Bauerschmidt, 1991; Ruefli, 1990; Wiseman & Bromiley, 1991) generally do not distinguish between different strategic actions undertaken by firms.

performance while increasing its variability. Thus, we examine a specific action, namely product innovation, and explain when it triggers a Bowman type of effect for a firm. Our study represents a fundamentally different approach to studying Bowman's paradox – as we illustrate in Appendix 1 – because it addresses it at the level of the individual strategic action, rather than looking at the overall aggregate outcome of all of a firm's decisions.

Product Innovation in a Transition Economy

New product development. Product innovation is generally expected to enhance firm performance (Barney, 1991; Nelson & Winter, 1982; Schumpeter, 1934). Research has distinguished between various forms and degrees of product innovation, including incremental and radical innovation (Dewar & Dutton, 1986), architectural and non-architectural innovation (Henderson & Clark, 1990), and disruptive and sustaining innovation (Christensen, 1997). In this study, we focus on product innovation in the pharmaceutical industry, in the form of new chemical drugs. Unlike radical innovations such as gene therapy, these new drugs are incremental innovations to varying degrees, in that they can be variants of existing active chemical ingredients or entirely new molecules.

Various authors have identified different stages of the new-product development process. These include an input stage, where the decision to innovate and the level of R&D intensity are determined; a throughput stage, where the transformation process that captures the development of a novel invention occurs; and an output stage that concludes with the commercialization of the innovative outcome (e.g., Coad & Rao, 2008; Mansfield, Rapoport, Romeo, Villani, Wagner, & Husic, 1977). A key attribute of the product-development process is that it is usually lengthy and costly (Ericson & Pakes, 1995; Pakes & Ericson, 1998), which is particularly the case in our setting. For instance, many of the experts from the Chinese pharmaceutical industry we interviewed described elaborate drug-discovery activities that involved lab experiments

concerning the screening and selection of new active chemical components, and multiple stages of clinical trials. This is then followed by the obtaining of formal drug and production approval from the Chinese State Food and Drug Administration Bureau (SFDA) (which could alone take up to 6.5 years) and a further commercialization process.

Institutional change and uncertainty. The extent to which a firm will profit from its product innovation depends critically on the presence of institutions that enable it to appropriate the value created through the invention. Institutions exist in societies, among other things, to guide and shape economic exchange (North, 1990). In this paper, we follow North (1990, 1993) and define institutions as "the rules of the game." These rules can be both formal and informal: formal rules include laws and regulations, and informal rules are culturally derived norms and conventions. When economies are in transition, for instance moving from a central-planning system to market competition (Peng, 2000), the rules of the game change. Although institutions are intended to create stability, moving from one structure to another can create considerable uncertainty (North, 1993). For example, Peng and Heath (1996) explained how, during a period of transition, the lack of a property-rights-based legal framework, combined with the lack of a stable political structure and a lack of strategic factor markets, creates substantial volatility and unpredictability in the environment (see also Oliver, 1992; Peng, 2003; Tan & Litschert, 1994).

In particular, institutional change is likely to generate inconsistencies during economic transitions. Inconsistencies can exist between the old and new rules, of which a mixture exists in the process. Moreover, inconsistencies will likely exist between formal and informal structures. The former can change quickly, but the latter are much stickier (compare Gulati & Puranam, 2009; Nickerson & Zenger, 2002). As North (1990: 6) put it, "although formal rules may change overnight as a result of political or judicial decisions, informal constraints embodied in customs,

traditions, and codes of conduct are more impervious to deliberate policies." Furthermore, insofar as formal rules are developed by governmental agencies, inconsistencies can occur between different parts and layers of these bodies. The different sets of rules may not be reconcilable, and "to the extent that changes must be multifaceted—which all societal, economic, and political changes are—pushing the relatively quicker processes to proceed at full haste generates major imbalances because the other processes cannot keep up" (North, 1993: 58). Hence, institutional transitions may create ample ambiguity in an economic environment, in terms of where attractive opportunities are to be found.

Research setting and hypotheses. The Chinese pharmaceutical industry during the period 1991–2000 is a prime example of an institutional environment in transition. As the central-planning regime in China was gradually abolished, an increasing degree of managerial autonomy was delegated to state-owned enterprises, and numerous private enterprises emerged (Davies & Walters, 2004; Peng, 1997). In the pharmaceutical industry, for example, in 1991 (the beginning of our window of observation), nearly 100 percent of firms in the industry were state-owned; by 2000 (the end our observation period) nearly half the firms were private. Yet, ongoing introductions and revisions of various laws and regulations—including drug-exclusivity periods, the definition of new drugs, reimbursement lists, and drug-approval policies—coupled with state intervention in drug prices and inconsistencies between national and local governmental bodies made the environment turbulent and unpredictable (Deng & Kaitin, 2004; Meng, Cheng, Silver, Sun, Rehnberg, & Tomson, 2005). Many of the industry experts whom we interviewed for this project commented on the frequent and unpredictable changes and the prevalent institutional inconsistencies within the industry. One manager, for example, said about this: "In the early 90s, there were many uncertainties regarding the general policies in China . . . the government itself

was not exactly sure how the economic reform would eventually unfold." Another commented: "You never really know what you should or should not absolutely follow" (see Table 1a for more interview quotes regarding institutional inconsistencies).

Institutional inconsistencies will often leave a firm's ability to create value unaffected; the level of demand for a particular drug by consumers, for example, will often remain similar regardless of changes in institutions. However, it may substantially limit a firm's ability to appropriate this value and hence profit from its inventions. Adopting Levinthal and colleagues' terminology (e.g., Gavetti & Levinthal, 2000; Siggelkow & Levinthal, 2003), we picture an industry as a rugged performance landscape where certain positions—its peaks—are inherently more attractive and profitable than others. Institutional change is expected to cause unpredictable shifts in such a landscape (Posen & Levinthal, 2012). As a result, due to the lengthy R&D process, positions in the performance landscape, such as targeted therapeutic areas that appeared attractive at the start of a product-development trajectory, could unexpectedly have disappeared by the time the product materialized, owing to various institutional inconsistencies.

If unpredictable changes are pervasive—as they are in the Chinese pharmaceutical industry—the likelihood that the performance peak the company was aiming for will have diminished or disappeared is substantial. For example, possible interference by various governmental bodies in drug prices and exclusivity rights could make certain performance peaks shrink markedly. One manager pointed out to us the difficulty of appropriating the value of their inventions because of government interventions: "It's uncertain when and how the government would pressure us in terms of introducing specific regulations and also whether they would extend preferential policy . . . The price cutting by the government is often unpredictable and tends to work against us." Similarly, another manager explained how performance peaks might

unexpectedly diminish severely: "Because the system was so underdeveloped from the very beginning, with changes being constantly introduced, it somehow made the whole new drug application process unpredictable . . . it is certainly possible that for some previously approved drugs . . . the approval might end up being withdrawn by the government."

Table 1b summarizes more interview quotes describing how institutional inconsistencies often hampered firms' value appropriation of drug innovations in China during the 1990s. When, after a lengthy development process, a firm finally introduced a new drug to the market, the price it was able to charge often failed to reflect its total cost in R&D. In addition, the unpredictable drug-approval process frequently limited a firm's potential in picking up sales from its inventions, due to rights either being withdrawn or signed over to competitors, rendering the firm unable to recover its initial investment. Thus, with institutional change rapid and inconsistencies rife, and product development lengthy, peaks in an industry's performance landscape will have decreased more often than not, precisely because interventions would often be targeted at the peaks. Confronted with more limited revenues than anticipated, innovating firms would therefore regularly fail to recoup the considerable costs of a product's R&D process. Hence, we expect that developing and launching new product innovations in such a context is unlikely to pay off for the average firm, so that its expected value is negative. Thus, product innovation decreased firm performance, in comparison to others that did not develop any new products during the same period. Formally:

> *Hypothesis 1a: In the Chinese pharmaceutical industry during the period 1991–2000, product innovation was negatively related to firm performance.*

Although in a setting like ours we expect that the effect of product innovation on a firm's profitability is usually negative, sometimes a company's bet pays off. As argued above, in a context characterized by institutional transition (North, 1990), developing and launching new

products will more often than not depress firm performance because the landscape will shift in unpredictable ways (Levinthal, 1990). Owing to arising institutional inconsistencies that limit value appropriability, performance peaks in the landscape will frequently diminish. Yet, the unpredictability of the landscape shifts also suggests that occasionally and serendipitously, some peaks may persist or rise even further. This means that sometimes innovating firms will profit substantially.

For instance, in the Chinese pharmaceutical industry between 1991 and 2000, at times, firms would receive truly exclusive production rights for their drug innovations, and no price caps or other interventions would be introduced by government agencies. As a result, the innovating firm would be able to reap the full benefits of its invention, appropriate its value, and profit substantially (Teece, 1986). Furthermore, although rarely, the government would even unexpectedly subsidize firms' R&D or otherwise give a firm preferential treatment, enhancing its profitability beyond its original expectations. Some of our interviewees recalled such events. For example: "Occasionally, if the government considered a drug innovation to address a certain need of the market [and . . .] if it was considered of great effectiveness, the government might even loosen its price control or include it in the reimbursement list immediately upon approval," causing the firm to reap substantial profits. Hence, although the average performance effect of product innovation may be negative, there is substantial upside risk.

Of course, the downside risk is big, too; performance peaks may sometimes vanish entirely because of a very radical shift in the landscape, leaving a firm with substantial R&D costs but no payoff. In the Chinese pharmaceutical industry, during the 1990s, most innovators would recoup at least part of their R&D costs despite some price caps and other state interventions, but sometimes rights would get signed away completely or the newly developed

drug would be withheld from the government reimbursement list altogether. This meant that the innovating firm would not appropriate any value and hence would recoup none of its investments. As one manager recalled: "Once, when our new drug was still under review for approval, the SFDA approved it to another firm." To conclude, during institutional transition, both upside and downside performance risks are expected to be more significant for innovators than for firms that did not engage in product innovation. Accordingly, we predict the following:

> *Hypothesis 1b: In the Chinese pharmaceutical industry during the period 1991–2000, product innovation was positively related to variance in firm performance.*

Taken together, hypotheses 1a and 1b predict that, in a context of institutional transition, new-product development is a *high-risk, low-return* strategic action, in the sense that it decreases firms' average returns while increasing their variance. Following basic economic theory, one would not expect firms to engage in such actions with lower expected returns and higher risk. However, in a setting like ours with abundant uncertainties, firms may be motivated more by the upside potential of their actions than by their expected returns.

Given the higher performance variance associated with product innovation, despite the comparatively lower average return, the topmost performers in the Chinese pharmaceutical industry will relatively often be innovators. Hence, firms may be inclined to mimic the behavior of the leading firms in their industry (Haveman, 1993; Haunschild & Miner, 1997), unaware that their strategic actions do not enhance returns for most (Denrell, 2003). They may also be making the decision consciously to accept the downside risk associated with production innovation, in return for a shot at becoming one of the top-performing companies in their industry (Cyert & March, 1963). In conformity with this view, one of our interviewees remarked: "New drug development was definitely necessary. For those firms that had come very far, engaging in R&D

was the key." Similarly, another said: "Developing new drugs was a critical strategy to improve profitability . . . for top firms, new drug development was critical."

We return to this issue of motives later, particularly in the section on post-hoc analysis; yet, whatever the precise motives for firms to engage in product innovation that on average negatively affects their profitability, our analysis here is aimed at explaining why, in our type of setting, the returns and risks of product innovation are negatively associated in the first place. In developing Hypothesis 1, a key component of our conceptual mechanism concerned the length of the new-product development process. We predicted that, on average, product innovation negatively affects firm performance because new-product development takes time, and owing to institutional changes, peaks in the industry's performance landscape targeted by innovators when initiating the R&D process will often have diminished by the time a new product emerges from the pipeline. For different product innovations, however, such as different new drugs, development times may vary considerably. When development time is longer, at a given rate of institutional change, the performance landscape is more likely to have shifted by the time the innovation is completed. For a firm it is also more difficult to anticipate such threats to its value-appropriation potential over a longer time horizon. As documented by Van Oorschot, Akkermans, Sengupta, and Van Wassenhove (2013), for example, a long lead time can blind a development team to signals of pending failure, causing them to proceed regardless. Accordingly, we expect the negative association between product innovation and firm performance, as formulated in Hypothesis 1a, to be particularly strong for products with longer development times.

Similarly, we expect the positive association between product innovation and variance in firm performance, as hypothesized in H1b, to be particularly strong when a product's

development time is longer. In the prediction we posited that, owing to institutional transition, compared with firms that do not innovate, firms that developed new products experience larger variance in their profitability. This is because targeted performance peaks may unexpectedly vanish completely or, very occasionally, rise even further. At a given rate of institutional change, we expect that such rare events of peaks vanishing or rising are more likely to occur the longer the period between the firm's decision to develop the innovation and the point when it materializes. Consequently, risks are greater the longer the product's development process. Formally:

> *Hypothesis 2: In the Chinese pharmaceutical industry during the period 1991–2000, the relationship between product innovation and firm performance is moderated by the length of the product-development process, so that the effects explicated in hypotheses 1a and 1b are stronger when the product-development process is longer.*

The second critical component of our conceptual mechanism, outlined for Hypothesis 1, concerns the rate of institutional change. Within different submarkets, however, such as different Chinese provinces, institutions often transition at varying rates (Zhou, Gao, & Zhao, 2017). Similar to the arguments above, we posit that given a particular product-development time, the performance landscape is more likely to have shifted if the rate of institutional change in a market is greater. As a result, we predict a stronger negative association between product innovation and firm performance (i.e., Hypothesis 1a) when the rate of institutional change in a market is higher. Furthermore, we argue that within the same product-development period, rare peaks vanishing or rising in the landscape, which we theorized to enlarge the performance variance of innovating firms, are also more common when the market is undergoing more-rapid institutional change. Accordingly, we expect a stronger positive association between product innovation and the variance in firm performance (i.e., Hypothesis 1b) in a market with a higher

rate of institutional change, in comparison to firms that do not innovate. Thus, we hypothesize as follows:

> *Hypothesis 3: In the Chinese pharmaceutical industry during the period 1991–2000, the relationship between product innovation and firm performance is moderated by the rate of institutional change in the firm's focal market, so that the effects explicated in hypotheses 1a and 1b are stronger where the rate of institutional change is higher.*

Together, our hypotheses specify why, in settings like the Chinese pharmaceutical industry in the 1990s, product innovation negatively impacts firms' expected return while increasing firms' variance in returns (i.e., risk). They unpack the core proposition that a Bowman effect occurs as a result of firms' adoption of strategic actions having a lengthy lead time, such as product innovation, in environments characterized by significant uncertainty about value appropriability, such as markets undergoing fundamental institutional transitions.

METHODS

Our empirical research consisted of three parts. In the first part, we conducted a series of 33 retrospective interviews with industry insiders. We did this to better understand the setting and to generate hypotheses close to the field (Ranganathan, 2018). We included quotes from these interviews in the theory development above and in Tables 1a, 1b, and 4a. The second part concerned quantitative data to test our hypotheses, aimed at explaining when product innovation negatively impacts firm returns while positively affecting variance in returns. We discuss this in the next subsection. Finally, for post-hoc analysis, we collected additional qualitative and quantitative data from our study period (also to mitigate potential retrospective bias among our interviewees), including 22 articles published between 1991 and 2000 in authoritative pharmaceutical news outlets and magazines, all based on in-depth interviews with CEOs and top managers of domestic pharmaceutical companies; and 156 articles acknowledging drug discoveries by domestic firms published in the *People's Daily,* the official news outlet of the

Communist Party. The aim of this last part of our analysis was to further interpret and complement "the hard, objective facts [and to develop] a more complete understanding" of our empirical models (Roth & Mehta, 2002: 138, 139) and thus to "add important information to the bare-bones finding of that quantitative work" (Lin, 1998: 165).

Empirical Setting

The sample for our empirical study consists of all domestic manufacturers of chemical drugs in the Chinese pharmaceutical industry during the period 1991–2000. Until the late 1970s, all industries in China were governed through the mechanism of central planning, which covered all aspects of China's economy. In the pharmaceutical industry, for example, until 1984 all manufacturing decisions regarding the allocation, supply, and volume of drug production for each manufacturer resulted from a cascade of central planning, and all drug prices were centrally determined by the government. Throughout the 1980s, reforms were initiated that gradually introduced elements of a market-based economy, resulting in continuing privatization of certain sectors of the economy. Privatization of the pharmaceutical industry began in the early 1990s. We chose 1991 as the starting year of our window of observation because in 1991 the industry still fully consisted of state-owned companies but from then on began to shift toward private enterprise. We tracked the industry over the subsequent decade, at the end of which about half the firms in the industry were privately owned, as displayed in Figure 1.

——Insert Figure 1 about here——

During this period, central planning of product portfolios and production volumes was abolished, requiring firms to set their own strategies and production planning, although with considerable governmental intervention in both retail and wholesale drug prices (Meng et al., 2005). The industry grew steadily during this decade, with sales increasing from $3.9 billion in 1990 to $19.7 billion in 2000 (Deng & Kaitin, 2004). There were several thousand

manufacturers, about 90 percent of which were small to medium-sized companies, and the top 10 manufacturers produced about 13 percent of the industry's total sales revenue (Zhou, 2007).

Throughout the 1990s, ample regulatory changes were introduced concerning various aspects of the industry, generally moving it from a central-planning toward a market system. The first set of changes concerned governmental interference in drug prices. Beginning in 1984, the government gradually reduced the number of drugs for which prices were centrally determined and expanded the list of drugs for which manufacturers had much greater autonomy in price setting (Chang & Zhang, 2009). However, pressure to keep healthcare affordable and the regular slow implementation by local governments meant that more liberal regulations were not always fully executed, while additional, sometimes ad-hoc regulations introduced price caps and reductions. From example, between 1997 and 2000, the prices of more than 300 types of drugs were cut between 5 and 20 percent through governmental intervention (Zhu, 2006).

Another set of regulatory changes concerned the governance of drug innovation and manufacturing approval. Since the formal establishments of the Drug Administrative Law and the Provisions of New Drug Approval in 1985, there had been frequent changes and revisions to these regulations, including the basic definition of what constitutes a new drug (Drug Administrative Law 1985, 2001; Provisions for Drug Registration, 2002, 2005; Provisions for New Drug Approval, 1985, 1999). Intellectual property rights (IPR) were assigned through a protection system that assigned exclusive production rights for a fixed number of years to the developer, depending on the innovativeness of the drug. Yet, the government retained final authority to assign manufacturing rights and occasionally allotted these "exclusive rights" to multiple firms, including firms that had not developed the drug. The approval system for the new-drug development process also remained opaque and underwent frequent changes at various

governmental levels. See Appendix 2 for further details on the pricing system and on regulatory changes in new-drug approval and exclusivity rights.

The ongoing changes resulting from the shift from a centrally planned to a market-driven industry led to various emerging inconsistencies in the system (North, 1990). Some new regulations, developed to introduce market characteristics, could conflict with other parts of the system that had not yet been transformed, leading to a mixture of different "rules of the game" (North, 1993). Furthermore, a major element of the transition was the process of decentralization, from the state to the province level. Yet, this also led to local governments introducing legislation that could conflict with national objectives (see Table 1a). Inconsistencies also existed between the formal regulations and informal norms, with local governments sometimes not enforcing national legislation or interfering in pricing or production rights in ways that were inconsistent with the espoused regulations (see Table 1b). These various inconsistencies, in terms of interference in pricing and the assignment or rejection of production rights, could lead to major, unpredictable shifts in the ability of firms to appropriate the value embedded in their newly developed drugs.

Data

Our quantitative data were collected from two main sources. We gained access to the so-called Firm-Registration Yearbooks for the period 1991–2000, compiled by the Chinese State Economic and Trade Commission. These books compile proprietary, detailed, firm-level product information concerning all domestic pharmaceutical manufacturers. Industry experts stated that the data in these records were likely to be highly reliable because they are subject to clear regulations and controls and not intended for public use. The second data source concerned the new-drug registration database published by the SFDA, which records all approved new drugs developed by domestic pharmaceutical firms from 1986 to 2000. We used this subscription-

based database (since removed from public access) to assess all product innovations introduced into the market.

We focused our study on the entire population of 3,235 firms that had ever existed in the chemical drug industry from 1991 to 2000. Of these, 892 were subsequently dropped from the analyses mainly because of incomplete data in the Yearbook (e.g., missing product sales, profit, or output value data); this yielded a final sample of 2,343 firms. The industry experts we consulted pointed out that the firms that had missing data were likely short-lived, highly specialized companies that focused exclusively on producing a specific drug for a short period, taking advantage of a temporary shortage in the market.[2] According to these experts, data on "real firms" were unlikely to be missing from the Yearbook. Of the 2,343 firms in our sample, only 501 were present throughout the 10-year period. Another 1,164 firms were established within the period of observation, and 1,028 ceased to exist. These substantial entry and exit rates perhaps provide another indication of the relatively high rate of turbulence in this industry.

The 33 interviews we conducted with people in the industry, at various stages, included representatives of different local firms, general industry experts, such as healthcare consultants and former executives, and a few executives from various foreign companies operating in China. Job titles of quoted interviewees are indicated in the relevant tables. These interviews helped us develop an ex-ante understanding of our empirical context and the exact mechanisms underlying our predictions.

[2] According to the industry experts, these would usually concern opportunistic entrepreneurs that tried to take advantage of a temporary shortage of a particular drug in the market (without "exclusivity rights") by quickly setting up a firm that focused solely on producing that particular drug; dissolving it once the shortage is resolved. Hence, they never focus on product innovation.

Method and Dependent Variables

We wanted to simultaneously model the effect of our predictors on firm performance and on its variance. Therefore, we estimated multiplicative heteroskedasticity models. This regression technique concurrently analyzes the effect of independent variables both on the level of firm performance and on its variance, in terms of the range of performance outcomes generated around the mean (Davidian & Carroll, 1987; Sørensen, 2002; Sorenson & Sørensen, 2001). The basic approach of this method can be described as follows:

$$y_i = \mu_i + \sigma_i \varepsilon_i$$

$$\mu_i = E(y_i) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

$$\delta_i = Var(y_i) = e^{(\gamma_0 + \gamma_1 z_1 + \gamma_2 z_2 + \cdots \gamma_m z_m)}$$

Furthermore, to address potential endogeneity, we performed a 2SLS analysis with instrumental variables, which we present as a robustness check; for details, see below.

We measured *firm performance* using a firm's annual return on sales (RoS), calculated as the ratio of the firm's profit to its product sales that year. Unfortunately, for all but one year, data on the value of firms' assets were not available, so we were unable to compute firms' annual return on assets (RoA). For the one year that information on assets was included (2000), RoA was highly correlated with RoS (0.78, p=0.000). For this reason, prior research has often combined the two measures (e.g., Cool, Dierickx, & Jemison, 1989) or reported highly similar results across them (e.g., Hitt, Hoskisson, & Kim, 1997).

Independent Variables

Product innovation. To create a measure of product innovation, we adopted the following procedure. First, we extracted all new drugs approved by the Chinese SFDA for a firm in any given year, where the focal firm was listed as the inventor of the drug. Of the 2,343 firms in our sample, 486 (20.7%) introduced at least one self-developed new drug between 1991 and 2000.

The total number of new drugs or drug variants approved for firms in our sample during this period by the Chinese SFDA was 1,516.

Subsequently, we needed to determine whether a drug was a new invention or an imitation of a foreign product. For this purpose, we gathered detailed information on the exact active ingredient of each of the 1,516 new drugs listed as innovations. Then, for each drug, we searched the US FDA's "Drugs@FDA" database, which provides detailed information on all prescription and over-the-counter human drugs approved for sale in the United States since 1938, to see whether a drug with the same active ingredient already existed in the United States prior to the Chinese firm registering it in China. We used the US FDA database to identify drug imitations because, according to our interviewees, it is the primary information source for imitators among Chinese pharmaceutical firms. Of the 1,516 new drugs approved by the Chinese SFDA between 1991 and 2000, it appeared that 861, introduced by 339 different firms, were in reality foreign-drug imitations. The remaining 655, introduced by 281 different firms, were not yet in existence in the United States at the time of their introduction in China, so we classified these as innovations in our database. Thus, we measured firm innovation by calculating the total number of drug innovations invented by a firm in a given year. This measure was lagged by one year.

Product development time. To capture the length of the development process of a new drug, we relied on two distinct proxies. As in Western pharmaceutical industries, Chinese firms are required to conduct extensive experiments, to prove both the clinical efficacy and the safety of a new drug. Therefore, following Gaessler and Wagner (2018), as a first measure of development time, we adopted the total series of scientific and clinical experiments required by the Chinese SFDA for a new-drug application. To construct the measure, we used information from the Provisions for New Drug Approval (1985, 1999) by the Chinese SFDA, which divides

new-drug applications into five distinct categories based on how novel a drug is, ranging from an entirely new active compound (Type 1) to an incremental variant of an existing drug, for instance a new application or intake form (Type 5). For different types of new-drug applications, the SFDA's requirements in terms of scientific and clinical experiments vary substantially. For example, for a Type 1 new drug, 25 series of experiments are required for its application. By contrast, only seven experiments are needed for the application of a Type 5 new drug. Using this information from the SFDA's new-drug registration database, for all 655 drug innovations in our sample, we identified their drug application types (i.e., types 1–5) and the corresponding number of experiments required for their applications. We used the log of this measure as our first proxy for drug-development time.[3]

As a second proxy for new-drug development time, we adopted the duration of the SFDA's approval of the drug.[4] For each drug innovation in our sample, we collected information on the date that the application of the new drug was first submitted to the Chinese SFDA by the firm and the exact date that the drug was officially approved for production. The mean approval time was 406 days (i.e., 1.1 years), but there was considerable variance; for instance, the longest SFDA approval time for a drug in the sample was 2,410 days (6.6 years). As for our first proxy, for each innovating firm in a given year, we used approval years of the new drug as our second proxy of development time, lagged one year.[5]

Rate of institutional change. During the period of institutional transition in China, due to privatizations and new firm foundings, the proportion of state-owned enterprises declined, but at

[3] For the minority of firms that introduced multiple new drugs in a given year, we calculated the logged average series of experiments required by the SFDA for its drug innovations. Corresponding to our measure on product innovation, this measure was also lagged for one year.
[4] Unfortunately this information is not available for the year 2000.
[5] In the rare instance that a firm introduced multiple products in one year, we took the average approval time.

different rates in different provinces. Building on insights from prior research (Nee, 1992), we use this information to indicate the rate of institutional change, because particularly in China, economic transition kept pace with the rate of privatization of state-owned enterprises (Child & Tse, 2001). Accordingly, this variable is calculated as the yearly change in the percentage of state-owned firms within the pharmaceutical industry of each of the provinces.[6] Our data cover 30 different Chinese provinces and autonomous regions, which represented distinct submarkets in the pharmaceutical industry in the 1990s. Each region had clear administrative boundaries and its own local government. Furthermore, each area had different local regulations and administrative bodies specific to the pharmaceutical industry. Given that all the firms in our sample were small to medium-sized enterprises, as verified by the different industry experts we consulted, they competed pretty much exclusively within the boundaries of their own provinces. Thus, these areas form clearly distinct environments, with differing rates of institutional transition.

As an alternative measure of the rate of institutional change, we calculated the number of new policies introduced pertaining to price cuts and the process for new-drug approval by the SFDA in each year within our study period. The logic is that the more new policies are introduced annually, the higher the pace of institutional change. To construct this variable, we carefully identified and reviewed each individual piece of new legislation issued by the SFDA concerning new-drug approval and drug price cuts between 1991 and 2000. Although this alternative variable is based on a completely different source and type of data, it led to near

[6] For only 36 observations in our sample, the rate of institutional change becomes negative (because in that year the number of state-owned enterprises happened to increase in their province); our results are fully robust if we assigned these observations the value zero on this variable instead.

identical results in our analyses, as displayed below, which further strengthens our confidence in the empirical results.

Control Variables

In all our models, we controlled for the number of *foreign drug imitations*, as explained above, and the number of *licensed new drugs* that a firm introduced in a given year. Both measures were lagged by one year. In addition, we controlled for *firm size*, measured by a firm's production value in the particular year. Since exact firm-founding dates were unavailable, we included a *new-firm dummy* to indicate whether a firm was established after the beginning of our sample period in 1991. Another dummy was created to specify whether a firm was *state-owned*. This information was available from the yearbooks. Finally, we controlled for the number of *research alliances* that a firm had, captured by the number of partners the firm was collaborating with in its drug-development process that particular year. This information was available from the new-drug registration database.

RESULTS

Table 2 outlines descriptive statistics and correlations for all the variables. The correlations are generally low. The summary statistics show that the average RoS for firms is −0.07, indicating the challenging conditions in the industry, although the standard deviation is relatively large, suggesting substantial differences between companies. The correlation between experiments required and product innovation appears relatively high; likewise for the correlation between approval duration and product innovation, but that is because only firms that innovate have a non-zero observation on these variables. Yet, there is ample variance on both of them to estimate our models.[7]

[7] The number of observations drops when using the second variable (approval duration), because unfortunately we only have data on 9 of the 10 years (the year 2000 is missing).

——Insert Table 2 about here——

Hypotheses Tests

Hypotheses 1a and 1b. Table 3 contains the results of the multiplicative heteroskedastic models testing our hypotheses. Our first prediction was that, in this context, the effect of product innovation on a firm's performance would be negative. As shown in Model 1, the estimated coefficient of the effect of a drug innovation on the mean of a firm's RoS is negative and highly significant. This supports Hypothesis 1a. The size of the coefficient indicates, on average, that the development and introduction of one new drug into the market depressed a firm's RoS by 4.0 percent.

Furthermore, we predicted that the effect of product innovation on the variability of firm performance would be positive. In line with this prediction, according to Model 1, the estimated effect on the variance of firm profitability shows that drug innovations significantly increased the variance in firms' RoS. This supports Hypothesis 1b. Specifically, on average, developing and introducing one new drug increased performance variance by 13.8 percent (i.e., $e^{0.129} - 1 = 0.138$). Hence, overall, product innovation diminished firm performance on average while increasing its variability. This supports our prediction that, in this context, product innovation triggers a Bowman effect, in that it forms a high-risk, low-return course of action.

——Insert Table 3 about here——

Reverse causality. A potential concern with respect to the analysis reported above is possible endogeneity. Endogeneity could, for instance, stem from unobserved heterogeneity owing to omitted variables, or particularly from reverse causality in our case. To address this issue, we performed a 2SLS analysis with instrumental variables. We did this by first regressing our predictor (product innovation) on the relevant instrument. Following this, we next included the predicted values from the first stage in the multiplicative heteroskedastic models. Note that

this procedure addresses endogeneity in the mean regression, but not necessarily in the variance regression of the multiplicative heteroskedastic models. To the best of our knowledge, 2SLS estimation in the variance equation of multiplicative heteroskedastic models has not yet been developed, let alone available in standard software packages. Yet, most endogeneity concerns, such as reverse causality, would concern the mean estimates, for which our procedure is effective.

We instrumented a firm's drug innovation using the logged total number of firms within all provinces other than the focal firm's province that had innovated in the previous year. The logic for this instrument—as confirmed by the industry experts we consulted—is that firms can observe companies in other provinces innovating (and thus become more inclined to innovate too) but that their profitability is not driven by what happens in other provinces, as competition at that time occurred between different firms within a province but not across them, because provinces represented distinct submarkets. Thus, we expected this instrument to influence a firm's propensity to innovate; however, it was unlikely to be related to the residuals of the dependent variable. Indeed, the first-stage estimation indicates that our instrument is significantly positively correlated with firm innovation (0.043, p=0.000). Moreover, the F-statistic (F(1, 10833)=17.16) clearly supported the validity of the instrument, comfortably exceeding the commonly accepted cut-off value of 10. Model 2 in Table 3 displays the results of the second stage of the 2SLS model. In further support of our first hypothesis, the estimates fully replicate the results of Model 1.

As an alternative instrument, we collected information on the number of universities specializing in medicine in each Chinese province in any given year between 1991 and 2000. Drug innovation often happens within Chinese medical schools, but because they lack the

complementary resources to produce and commercialize their inventions, these are commonly licensed to local companies. We reasoned that in provinces with few or no such medical schools, ceteris paribus, firms would be more likely to engage in product innovation themselves but that otherwise the presence of such schools should not severely affect firm profitability. Thus, we instrumented a firm's drug innovation using the total number of medical schools per capita in the firm's province in the previous year. Consistent with our speculation, the first-stage estimation shows that the instrument is negatively correlated with firm innovation (−6.480, $p<0.001$). Again, the F-statistic ($F(1, 10831)=10.71$) supported the validity of the instrument.[8] This alternative specification led to highly similar results in the second stage of the 2SLS analysis (mean effect $\beta=-2.47$, $p<0.001$; variance effect $\beta=65.3$, $p<0.001$).[9]

Self-selection into innovation. Our theory addresses the treatment effect of product innovation, namely how it influences firm performance and risk. However, firms with different ex-ante risk preferences could be more or less likely to engage in new product development in the first place. Our instrumental variable analysis, discussed above, would correct for this unobserved heterogeneity, but only in the mean equation; not in the variance estimation. Hence, our aforementioned test of hypothesis 1a would not be affected by self-selection, but our test of hypothesis 1b might be. Therefore, we engaged in two robustness checks.

[8] It seems possible that these instruments are not entirely exogenous, for example because firms could potentially also mimic other competitive actions from their peers in neighboring provinces, but the finding that our models are robust for these various alternative specifications raises confidence in our results and suggests that they are not spurious.

[9] For a third type of instrument, we also collected information on different types of patent applications in each of the provinces between 1991 and 2000, because they indicate the general level of innovativeness of a region, which we reasoned should be correlated with the innovation propensity of pharmaceutical firms within that region. Concurrently, they are highly unlikely to be correlated with the residuals of our dependent variable, because new drugs were governed separately by Chinese SFDA's unique drug administrative protection system (Drug Administrative Law, 1985, 2001; Provisions for New Drug Approval, 1985, 1999), so that the patent applications in each province exclude new drugs. This instrument again led to highly similar results, but the F-statistic was just below 10.

First, we created a matched sample design, using coarsened exact matching (CEM). We matched on firm size, new firm, state-ownership, and research partners, retaining a firm's imitation and licensing as control variables (because they are alternative means to develop and launch new products). Because a multiplicative heteroscedasticity regression does not allow for the application of weights in the regression, we had to produce a 1-to-1 matched sample (rather than 1-to-many), using the k2k option for CEM in STATA, which significantly reduced our sample size from 10,841 to only 588 observations (i.e., 294 innovator-year observations + 294 non-innovator-year observations). Nevertheless, our tests of hypotheses 1a and 1b were fully replicated: product innovation reduced average firm performance (β = -.096, $p<.01$), while increasing performance variance (β = 1.88, $p<.001$).

We also wanted to proxy firms' ex-ante risk preference directly. For this purpose, we measured the standard deviation of each of the firms' profitability over the preceding five years and interpreted this as their revealed risk preference. The logic is that firms with an ex-ante preference for risk will have displayed a higher variability of their returns during those years. We added the variable to our models as an additional control. The results are displayed in Model 3. Once again, product innovation significantly reduced average firm performance, while increasing its variance, in full support of both hypothesis 1a and 1b.[10] The results were robust if we used the preceding three years to measure ex-ante performance variability (-.092, $p<.001$ in the mean regression; .427, $p<.001$ in the variance equation).

Longitudinal effects. One might wonder whether the performance benefits of new product innovation simply take longer to emerge than the one-year lag we estimate; put differently,

[10] Interestingly, the estimate on the control variable ex-ante risk preference is also significantly negative for the mean equation and positive for its variance, in line with our general conceptual notion that risky actions in this context imply a combination of high risks and low returns.

whether the pay-offs occur over an extended horizon. To test for this possibility, we estimated the four-year *cumulative effect* of product invention on firm profitability through the linear combination of the four yearly estimates.[11] The results are displayed in Model 4. At 8.2 percent, the estimate is negative and significant, again in full support of our hypothesis. Hence, it is not the case that any positive effects of product innovation on profitability just take longer to materialize.

Hypotheses 2 and 3. Our second and third hypotheses predicted that the aforementioned effects of product innovation on the mean and variance of firm performance are stronger when the product-development process is longer (H2) and when the rate of institutional change is higher (H3). Model 5 displays the results when the *number of experiments required by the FDA* is used as a proxy for the length of a firm's new-drug development process. In conformity with our predictions, as shown in Model 5, the estimated interaction effect between *number of experiments required by the FDA* and *product innovation* on the mean of firm profitability is negative and significant, whereas its effect on the variance in firm profitability is positive and significant.[12] We obtained highly similar results, as displayed in Model 6, when *FDA approval*

[11] We took four years, in spite of losing four years of data as a consequence, because 80 percent of the new drugs in our sample have a maximum of four years of exclusivity protection. Taking the six-year cumulative effect, which covered 99 percent of new drugs in our sample, estimated the effect of product development on profitability to be −2.02 percent, which did not reach statistical significance (p =0.690). Although this is likely partly due to the loss of six years of data, the size of the estimate suggests that several years after the introduction of the drug, firms still did not accrue additional losses as a result of it.

[12] To interpret the size of the coefficients, for instance, in our baseline model (Model 1), the estimated coefficient for product innovation on the mean of firm performance is −0.040, and on the variance of firm performance is 0.129. Looking at Model 5, after including the interaction term between product innovation and experiments required by the FDA, the estimated coefficient for the main effect of product innovation on the mean of firm performance becomes 0.459, and on the variance of firm performance becomes −7.612. Note that these coefficients capture the estimated effects of product innovation when "experiments required by FDA" equal 0. The average experiments required by the FDA among all drug innovations is 2.89, with a range between 2.08 and 3.26 (note that this is the logged total experiments required). Considering Model 5 again, if we take the estimated coefficients of the interaction between product innovation and experiments required by the FDA into consideration, for instance, when the "experiments required by FDA" equals 3 (i.e., slightly above average), then the overall effect of product innovation on the mean of firm performance equals 0.459+3*(−0.169)=−0.048; and the overall effect of product innovation on the variance of firm performance equals −7.612+3*2.585=0.143. These two overall effects are the

duration was used as a proxy for the length of the drug-development process. Both findings indicate that product innovation decreased firm performance but increased performance variance, particularly when the product-development process was longer. These results were fully replicated even if we only adopted the subsample of innovating firms. Thus, Hypothesis 2 is supported.

To test Hypothesis 3, we added the interaction term between *product innovation* and *provincial institutional change*, measured through the yearly change in the proportion of state-owned firms within a province, to the previous models. The estimation results are displayed in models 7 and 8. In conformity with our prediction, the estimated interaction effect between provincial institutional change and a firm's product innovation on the mean of firm profitability is negative and significant, and positive and significant on the variance of firm profitability. Again, we obtained highly similar results using the alternative measure based on the annual count of new policies issued by SFDA, as displayed in models 9 and 10. Hence, as predicted in the hypothesis, product innovation diminished average firm performance while increasing its variance, particularly in markets where the rate of institutional transition was comparatively high. These results support Hypothesis 3.

Post-hoc Analysis 1: Appropriability Protection

Our main analysis aimed to show that a particular strategic action—here, product innovation—can trigger a Bowman effect, in that it reduces the average performance of firms but enhances their performance variance. Our moderators were intended to explicate the components of the mechanism that explains why this happens, namely when the long development time for innovation is combined with unpredictable institutional changes, which hamper the ability of a

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same order of magnitude as the main effects displayed in Model 1. The same logic applies to the models when we include the interaction terms with institutional change.

firm to appropriate the value it creates through its inventions. In our first post-hoc analysis, we wanted to focus on and confirm the role of appropriability, as hitherto this element in our conceptual mechanism has remained unobserved. If a firm's ability to appropriate value is indeed at play, we should see that our findings are weaker where appropriability receives legal protection. Specifically, we examined the moderating effects of IPR and the prosecution of corruption cases in the different provinces.

Intellectual property rights. One way that appropriability is protected is when the institutional change in a province results in a well-functioning IPR protection system. Therefore, we collected data for a measure of *provincial IPR protection,* as published by the China Reform Foundation at the National Economic Research Institute in Beijing. It captures the "legal framework for property-rights protection and contract enforcement" (Fan, Wang, & Zhang, 2001: 4), which consists of the weighted average of an indicator for the development of legal institutions, measured as the number of intermediate institutions (e.g., law firms, accounting offices, independent auditing offices) and several indicators of the actual protection of IPR, measured as the number of cases of trademark violation, the ratio of patent applications to gross domestic product (GDP), and the ratio of patent registrations to GDP.[13] The indicators range from zero to 10; zero represents the province with the least IPR protection, and 10 represents the province with the most advanced IPR protection regime in 2001.[14]

To test whether the Bowman effect of product innovation was weaker in provinces in China where IPR-related institutions were more developed, we formulated an interaction between this measure for provincial IPR protection and our product innovation measure and included it in our models. The results are displayed in Model 11. The positive and significant

[13] Weights were determined through principal components analysis.
[14] This measure only exists from 1997 onward.

interaction in the performance-level regression, combined with the negative and significant interaction in the variance regression, confirms that the effects as formulated in hypotheses 1a and 1b are significantly weaker in provinces that have a relatively advanced IPR protection regime.[15] Overall, these findings suggest, in conformity with our theory, that the Bowman effect of new product development on firm performance is reduced when barriers to appropriability are diminished through IPR protection.

Corruption. One way that the ability of an individual firm to appropriate the value of its invention is reduced—at least in our context—is through corruption. Through bribery, for example, other companies may appropriate the value of the focal firm's invention. Several of our interviewees hinted at such incidents, for example: "Sometimes, under the guise of higher standards, the government still extends preferential policy towards certain firms. . . . or, there are certain cases where the drug application cycle is shorter for [some] firms . . . Such things happen quite frequently and are sometimes disturbing." A different interviewee relayed: "The new drug approval process . . . if the SFDA officials didn't like you, they wouldn't approve your new drug even it met all their standards." In some provinces, though, local governments would clamp down on corruption and illegal preferential treatment, by prosecuting the individuals involved. We reasoned that this means that in some markets, more than in others, firms experienced stronger legal support and protection against corruption affecting their appropriability rights. As

[15] Additional computations using these estimates show that introducing one new product in a province with the lowest IPR protection (Hebei) reduced a firm's return on sales by 14.1 percent, whereas such a product would *increase* the return on sales of firms in the province with the highest IPR protection (Beijing)—by about 13.0 percent. The effect flips from negative to positive if a province has an IPR protection score of about 5.21 on a scale of 0 to 10—which is actually substantially higher than the average across provinces of 2.94 (SD = 1.26). This suggests that the IPR regime in most provinces was sufficiently imperfect to cause firms to lose money from new drug development, although it seems that in a minority of provinces there was enough IPR protection to enable companies to profit from it. During our sample period, three provinces—Guangdong, Beijing, and Shanghai—had an IPR score above 5.21. This concerned a total of 192 firms, 26 of which had engaged in new product development. Hence, our conclusion that some firms, in those provinces, seem to have benefited from product development is based on relatively small numbers.

in the case of IPR protection, we expected the Bowman effect of product innovation to be smaller in those markets.

To test for this assertion, we collected the annual Procuratorial Yearbook of China edited by the Supreme People's Procuratorate of China between 1991 and 2000. From these yearbooks, we identified the total number of legal cases concerning bribery and corruption for each province in each of our sample years.[16] One might think that those provinces with more bribery prosecutions simply had higher levels of corruption to begin with. However, Xie and Lu (2005) developed a separate ranking of the severity of bribery in different regions in China. Zhang et al. (2007) used this ranking to analyze its correlation with the number of legal cases concerning bribery (our measure) and showed that they are inversely related. Therefore, the authors concluded that the bribery measure captures local governments' anti-corruption efforts rather than the level of bribery within provinces. This view has become the consensus in the Chinese management literature.

We next created an interaction term between this bribery prosecution measure (adjusted by dividing by 1,000) and our independent variable on firm's product innovation and included it in the regression. The results are displayed in Model 12. The positive and significant interaction in the performance-level regression, combined with the negative and significant interaction in the variance regression, again confirms that the effects as formulated in hypotheses 1a and 1b are significantly weaker in provinces having higher levels of bribery prosecution. Although both findings—on IPR protection and anti-corruption efforts—offer only indirect evidence and we have to be careful in terms of assuming causality, they together suggest that appropriability

[16] From 1991 to 2000, the total number of legal cases per province ranged from 110 to 7,714 per year, with a mean of 1,754.

concerns are a key component of the conceptual mechanism that brings about a Bowman effect for firms engaging in product innovation.

Post-hoc Analysis 2: Focus on Upside Risk

Our theory and main analysis aimed to show when a Bowman effect occurs. Implicit in our theorizing, however, is the assumption that firms sometimes engage in actions that have lower expected returns because they are focused on their upside potential. Put differently, they value the enlarged performance variance more. In our second post-hoc analysis, we collected additional qualitative and quantitative data to provide some evidence for this effect of organizational focus on the upside risk associated with strategic actions.

Qualitative findings. To understand firms' motives to engage in product innovation, among other things, we probed our interviewees' perceptions of whether product innovation was indeed a successful strategy for firms during the era 1991–2000. In addition, and to mitigate possible retrospective bias, we scanned CNKI (the leading online database for news, magazines, and scientific journals in China) for publications concerning drug innovations and their performance implications for domestic pharmaceutical firms between 1991 and 2000. We collated a sample of 22 articles specifically on the topic. Most are articles by economic journalists, based on in-depth interviews with CEOs and top managers of domestic pharmaceutical firms, describing company success stories or reviewing the development of the industry as a whole. Several pieces are written by top managers of pharmaceutical firms themselves, reflecting on their firms' R&D efforts and the performance consequences. We used this qualitative data in interaction with our quantitative findings to create a visual framework describing the wider context in which the Bowman effect happens. These findings are summarized and illustrated in Figure 2.

——- Please Insert Figure 2 about here ——-

The first motive that emerged from our interviews is that, given the characteristics of the setting, companies often valued the heightened risk of product innovation more highly than the lower expected returns because the enhanced variance gave them a chance to become one of the industry's top performers. Table 4a displays sample quotes along these lines from our interviews. For example, one interviewee stated, "When it comes to drug innovation . . . the potential profit it can bring to a firm is huge"; another said, "For top firms, new drug development was critical." Considering the high level of turbulence in the industry, firms' decision-makers noted that, although risky, product innovation gave them a chance to do well and to come out on top. Thus, decision-makers' propensity to engage in a high-risk course of action, namely new-product development, despite its low expected return, stems from the challenging industry conditions.

——- Please Insert Tables 4a and 4b about here ——-

In Figure 2 this is captured in the path from institutional change through "high risk environment" to *risk preference*. By high-risk environment we mean that in this industry setting, as we reported earlier, the average firm experienced negative RoS and high exit and entry rates. Hence, in a context where the average return for one course of action (not innovating) is unattractive, firms may prefer an alternative course of action despite its having an even lower expected return (innovating), because of its upside potential. Our interviews suggest that at least some innovators were aware of this trade-off for their firms and hence accepted it consciously. One interviewee, for example, who commented on institutional uncertainty and the many bankruptcy cases in the industry, said: "These policy changes were out of a firm's control. Oftentimes, firms simply took a bet."[17]

[17] We also probed in our interviews whether managers perhaps overestimated their abilities to control the downside risks. That is because March and Shapira (1987: 1410) observed that managers often "do not accept the idea that the risks they face are inherent in their situation. Rather they believe that risks can be reduced by using skills to control the dangers" (see also Strickland, Lewicki, & Katz, 1966). However, we did not observe any such indications that

The interviews suggested a second explanation for why firms focused on product innovation. Surprisingly, many respondents indicated that they believed product innovation had generally enhanced firm performance when we asked them about the expected return to product innovation. One said, "[At that time], I think the return of developing new drugs to a firm was definitely huge . . . I think inventors certainly outperformed others." Another interviewee similarly opined, "In the industry at that time, those who performed better had already started developing new drugs on their own . . . They [inventors] definitely performed better." It seemed that many of our interviewees thought that new product development had, on average, been a profitable strategy. Yet, the quantitative evidence we presented above showed that our interviewees' common beliefs were wrong and that product innovation was generally associated with lower profitability.

Our interview data suggest that the enhanced variance for firms that engaged in drug innovation may cause our interviewees' spurious perceptions. Because, in our setting, product innovation was associated with significantly higher variance in firm performance despite generally depressing firm profitability, the topmost performers in the industry were often innovators. The fact that many of the top-performing companies engaged in new-product development might have led our interviewees to overestimate the general effectiveness of product innovation during that period. That is because, as the quotes in Table 4a's subsection "Generalizing from top-performing companies" testify, people seemed to focus on the highest-

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the managers in our setting thought that the downside risks were manageable, perhaps because (in contrast to March & Shapira, 1987) they clearly concerned exogenous circumstances, caused by external institutional inconsistencies. For example, one manager commented that these "were extremely difficult for firms to predict and to manage"; another said, "There's nothing you can do about it." MacCrimmon and Wehrung (1986) observed that, when assessing alternative courses of action, managers often focus disproportionally on the possibilities for gain. The managers in our setting, as suggested by the interviews, also focused on the possibilities of gain, but not necessarily by underestimating the likelihood of having to address the possible downside; they just valued the upside risk more highly.

performing companies in their industry (Haunschild & Miner, 1997; Haveman, 1993) and to generalize from those, basing their perceptions of successful strategies disproportionally on those observations (Denrell, 2003).[18] Our analysis of the qualitative evidence from archival sources from the period confirms this view. Without exception, the articles and interviews we uncovered highlighted success stories and the benefits from innovation, which might have strengthened our interviewees' perception that it is a strategic action with positive expected returns. Please see Table 4b for sample quotes.

Thus, it appears that this selection bias, brought about by differences in variance between the different strategies and exacerbated by the media (Rindova, Pollock, & Hayward, 2006), created false perceptions of a strategy's expected return. This reason for firms to engage in product innovation—people's misconceptions about its average return—displayed at the bottom-right in Figure 2, thus stems from the high variance it induces, which leads them to overestimate the strategy's average efficacy. We therefore labeled this process *variance-induced perception bias*.

Quantitative findings. In addition to these qualitative findings, we endeavored to find some quantitative evidence proving that a focus on the upside potential of product innovation spurred firms to engage in it too. For this purpose we first created a variable that measures for each

[18] All our interviewees—even those who did not personally think that product innovation had generally enhanced firm performance—concurred that the general perception in their industry seemed to be that it had increased firm performance. Yet, three interviewees, independently from each other, expressed doubts about whether this was generally true. One said: "Regarding developing new drugs, most of the time, people only noticed the huge payoffs from doing so. In fact, there were so many failures in the meantime. It seems people tend to ignore those innovating firms that failed miserably." A second said: "It was a common belief . . . many concluded this from the examples of successful domestic firms. Looking around, one could easily notice that nearly all top pharma companies in China were profiting significantly from drug innovations." The third concluded: "Many only saw how much others were making from selling new drugs . . . They seemed to have ignored the extremely high rate of failure of doing so." Our quantitative results on the effect of product innovation, presented earlier, suggest that these three people were right: the failures outweighed the successes during this period, but people based their beliefs about the past on their observations of the successes alone.

province *the total number of top 10 firms that are innovators* in a given year. We used the top 10 most profitable firms (measured by RoS) because it was a communist tradition in China during the 1980s and 1990s for each province to commend their top 10 most profitable firms on a yearly basis. These firms would usually receive substantial local media exposure and were heralded as "models" for other firms of the same industry in that province. We lagged this variable by one year (results were robust when using the cumulative value for the previous 3 years) and estimated its effect on local firms' likelihood of engaging in product innovation in the following year. We ran a logistic regression with firm random effects.[19] The results are displayed in Model 13 in Table 5. According to Model 13, the estimated coefficient of the variable is positive and highly significant, confirming the view from our qualitative data that a relatively high focus on innovators within the industry stimulated other firms to engage in product innovation too.

——Insert Table 5 about here——

As a second piece of analysis, we further looked up news articles on drug innovations by domestic pharmaceutical firms in China published in the *People's Daily* between 1991 and 2000.[20] We selected the *People's Daily* because it is by far the largest and most influential newspaper in China and the official outlet of the Communist Party, and all firms at the time would have subscribed to and used it as learning material.[21] Our measure, *press on innovators*, equaled the number of articles published in a given year by the *People's Daily* that acknowledged and celebrated the new-drug development by domestic pharmaceutical

[19] We adopted firm random effects in the analysis because fixed-effects logistic regressions would drop all the firms in our sample that had never innovated during the observation period.
[20] Only issues of the *People's Daily* published after 2000 are included in the CNKI database, so there is no overlap between our quantitative data collected from *People's Daily* with the 22 articles we used in our qualitative analysis.
[21] Much of the government policies are issued to the public through this particular newspaper. It is considered a major honor for a firm to be featured, because they will most likely be advertised/highlighted by the Communist Party as "model firms," for all other pharmaceutical firms to look up to and to learn from. It is generally seen as the highest and most prestigious publicity that a firm can receive within China.

companies. Between 1991 and 2000, we found a total of 156 articles of this nature, ranging from 7 to 24 articles per year. Similar to the previous analysis, we lagged this measure (results were robust when using the cumulative value for the previous 3 years), and tested its impact on firms' likelihood to innovate in the following year. Once again, we ran a logistic regression with firm random effects. The results are displayed in Model 14. The estimated effect of this measure is positive and significant, suggesting that (over and beyond the measure for top 10 firms that are innovators) articles in the *People's Daily* on successful innovators further spurred firms to engage in product innovation. Although we should be careful interpreting the causality of these findings, in combination, and in accordance with our theorizing, they suggest that attention on successful innovators, hence on the upside potential of engaging in product innovation, stimulated other firms to engage in new product development too.

DISCUSSION

The aim of our paper was to show that particular strategic actions—in our case new product development—can trigger a Bowman effect (Bowman, 1980), lowering the firm's performance while increasing its variance. We theorize about the conditions under which this happens, namely when the long development time of product invention (which makes accurate predictions difficult for firms) is coupled with a high rate of unpredictable institutional change (because that makes value appropriation uncertain). In doing so, we show that firms engage in such actions not necessarily because they are in financial distress or lack capabilities, for instance in terms of their ability to adapt to change (Andersen et al., 2007), but because they are focused on the potential upside of their actions. Traditionally, strategy research focuses on the mean performance effects of a particular strategic decision. Our research shows that understanding its effect on performance variance, although generally neglected, may sometimes be at least as important.

The Bowman effect. The literature in strategy, in the wake of finance and economics, has generally adopted the notion that high-risk strategies will normally be associated with higher expected returns; otherwise, firms would not engage in them. Bowman (1980), by contrast, showed that risk and return often seem to be negatively correlated in industries. Since then, literature on the topic has been locked in a debate about different potential explanations for and about whether the negative correlation really exists or is spurious and the result of research design issues (for reviews, see Holder, Petkevic, & Moore, 2016; Patel et al., 2018). In this paper, we offer a new approach to examining the risk-return relationship: we theorize about a Bowman effect at the level of the particular strategic decision, rather than it necessarily being a general correlation in an entire population.[22] We documented that in the pharmaceutical industry in China in the 1990s, product innovation was associated with low expected returns, in comparison to firms that did not innovate, yet with higher risks.

Thus, we studied variance in performance as a result of a specific strategic action, whereas Bowman and others studied risk and return exclusively at the firm level. Consequently, prior research addressed a pattern in the "net-effect" in financial performance at the level of the firm. This net-effect in firms' performance is undoubtedly the outcome of a whole set of strategic decisions pertaining to various issues and actions. These issues and decisions may be hierarchically layered and inter-dependent. The fact that our study exposes the influence of a single strategic action means we do not know how they all add up to the firm level. Concurrently, however, this suggests an array of potential new research questions, regarding various other strategic choices, including how they might be interdependent, and how they

[22] Because our research focuses on the consequences of a particular strategic action, it is less relevant whether the negative correlation exists across the board in a whole population. Firms could potentially be engaging in different strategic actions, some of which come with high variance and low expected returns, whereas others have low variance with positive returns, and vice versa.

aggregate into the overall firm effect that prior studies have publicized. Strategic courses of action, such as mergers and acquisitions, international expansion, top management turnover, or the adoption of new management techniques, to name a few, will likely influence both firm performance and its variance, and in different contexts, and may therefore potentially display Bowman effects too. Disentangling these effects would enhance our understanding of what drives the performance of firms and in what ways.

Boundary conditions. Whereas past studies have emphasized the role of firm capabilities (Andersen et al., 2007; Bowman, 1980) and managerial preferences (Fiegenbaum & Thomas, 1988; Jegers, 1991; March & Shapira, 1987) to explain the risk-return paradox, our research emphasizes the environmental context and the specific nature of strategic decisions. Although our setting is idiosyncratic, and we can only speculate about the exact generalizability of our findings, we contend that our conceptual mechanism—of uncertainty induced by institutional transition combined with lengthy development time—potentially applies to a range of other settings and sources as well. Although our current theory does not encompass this, it seems possible that similar arguments could be developed regarding uncertainty that arises from other sources (e.g., market; technology) (Jacobides, Knudsen, & Augier, 2006). Furthermore, with respect to the conceptual component of development time, the consequences of strategic decisions made at one point in time often materialize only after considerable time has passed (e.g., Pacheco-De-Almeida, Henderson, & Cool, 2008; Stan & Vermeulen, 2013). Thus, although the current theory does not reach beyond these points, we would welcome efforts to extend it to other types of settings.

A limitation of our data is that we do not observe the pre-transition period in our setting. Our theory and moderators suggest that product innovation should not trigger a Bowman effect

in that period, because of the absence of institutional change, but we cannot offer direct evidence of this. Another limitation, which future research might be able to address, is that we observe whether a new product emerges from the invention pipeline and whether the firm asks for production permission; unfortunately, however, we do not know whether a firm might have abandoned an invention process halfway, or whether it generated a product but opted not to ask for production permission (for whatever reason), and so forth. Furthermore, in our context, data on R&D expenditures are not available; nor can we assess a new product's inherent promise. Although we think these data limitations should not bias our findings, future research that, for instance, observes aborted new-product development processes should add important insight to our study. Finally, our sample contains mostly small to medium-sized firms, for which the influence of a single new product on firm performance is likely to be substantial. The processes we theorize about, however, should equally apply to large firms.

Product innovation. Although not the main emphasis of our paper, our findings also provide insights for the literature on product innovation. Although various authors acknowledge that product innovation is often risky and yields negative returns (Anderson & Tushman, 1990; Klepper, 1996), average performance consequences are generally assumed to be positive because of the substantial profits when it succeeds. Therefore, extant theory on new-product development generally regards it positively, arguing, for example, that "the growth and development of a firm depend on its ability to introduce new products" (Nerkar & Roberts, 2004: 779). Notwithstanding its potential benefits, however, we nuance the general stance of positive expected returns. First, we document a particular historical setting in which new-product development on average negatively influenced firms' profitability: the Chinese pharmaceutical industry during the period 1991–2000, an era characterized by fundamental transition and

unpredictable market conditions. Moreover, we theorized not only about the average effects of the strategy but also about the variance in performance outcomes that it generated, showing that the strategy followed by the most successful companies in the population may not always have enhanced the profitability of the majority of firms that tried it. Without a proper understanding of the differences in variance that various strategic courses of action produced—including innovation—industry observers may retrospectively develop spurious beliefs about the past, and particularly about the general effectiveness of the different strategies that firms in the industry adopted.

Interestingly, in our models, the estimates of the effect of our control variables *foreign imitation* and *licensing* show that both were on average positively associated with firm performance, while decreasing variance, in comparison to firms that did not introduce any new products.[23] Hence, for these two strategic courses of action, the risk-return relationship also reversed, but in such a way that low risk was associated with high expected returns. Foreign imitation and licensing are both alternative ways to introduce new products into the market that have been developed by others, and hence with considerably shorter development time for the firm that launches them. We suspect that the shorter development time would have enabled firms to anticipate industry conditions, so that they would not have engaged in them if appropriation were highly uncertain and therefore the expected return not positive (Mansfield, Schwartz, & Wagner, 1981; Zhao, 2006),[24] which would also explain the relatively low downside risk. Yet,

[23] Specifically, each foreign imitation enhanced a firm's performance by 1.5 percent, whereas licensed drugs increased performance by 2.3 percent. Furthermore, on average, the introduction of one foreign-drug imitation reduced the variance in a firm's return on sales by 63.7 percent ($e^{-1.013} - 1 = -0.637$), whereas the introduction of a licensed drug reduced the variance in a firm's return on sales by 66.3 percent ($e^{-1.089} - 1 = -0.663$).

[24] Note that the Chinese IPR system at the time did not prevent the imitation of foreign drugs; yet, in this industry, imitation was not costless. Firms had to scan foreign markets for drugs that could be imitated, that would likely be in demand in the Chinese market, and that would fit their complementary assets in terms of drug production capabilities and facilities (Teece, 1986). Moreover, a drug had to be re-engineered before it could be taken into production.

because of this, upside risk would also have been limited, as licensors would be able to bargain for and appropriate a considerable amount of the potential value, whereas in the case of foreign imitation, other domestic firms would also jump in and appropriate the product's value.[25] Hence, these two findings—of low risk with high return—also seem in conformity with our general line of theorizing.

Conclusion. We plead for studying variance as a dependent variable in its own right, particularly when retrospectively studying the effectiveness of a specific strategy. A strategy—such as product innovation—that enhances the probability that a company becomes a top performer in its industry does not necessarily lead to success for the average firm. The statistical technique used most often in our literature concerns some form of regression analysis. By definition, regression explains the effect of certain explanatory variables on the average level of a particular dependent variable, for instance firm performance. However, we can also expect different strategies to be associated with different levels of variance. Studying how different strategic alternatives influence the variability in a firm's profitability, for example causing a different range of possible performance outcomes, could enrich our understanding of the workings of various strategic decisions, including new product development.

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[25] This finding suggests that, in this context too, the market for inventions (Gans, Hsu, & Stern, 2008), facilitated by institutional change, enabled firms with complementary resources to create and appropriate value based on products developed by others (Arora, Fosfuri, & Gambardella, 2001; Teece, 1986). Future studies could focus on the division of labor in product development and the role of complementary resources in generating and trading-off risk and return.

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TABLE 1a Institutional Inconsistencies

Item	Interviewee comment
Institutional inconsistencies: different levels of government	"The Chinese SFDA works on both the province and the national level, with each level regulating certain specific issues. For a firm, if you conduct R&D in a certain province, you would sometimes need to apply through the province first before moving up to the national level. Because there are many different provinces, the enforcement of regulations during the approval process is sometimes inconsistent. And communications tend to be inefficient between the province level and national level FDAs as well." (Director of Medical Technology) "Sometimes, there are special connections between a local pharmaceutical company and the government of the province. For instance . . . As a result, the government of the province extends many preferential policies towards that company. Officials from the province even help that company to deal with the higher level regulations from the national level." (Director of Commercial Operations)
Institutional inconsistencies: formal rules versus informal rules	"In the early 90s, there were many uncertainties regarding the general policies in China. In other words, the government itself was not exactly sure how the economic reform would/should eventually unfold. On paper, there might be new regulations being introduced, but the interpretation of such policies among the general public tended to be vague and inconsistent." (Director of Medical Technology) "I think there are lots of uncertainties in the general legal environment in China. In other words, uncertainties are embedded in laws and regulations. Maybe you know that sometimes in China, the enforcement of laws and regulations is not always very strict. Even though there might be specific requirements described in the law on certain things, people/firms may not indeed necessarily follow those regulations. And you never really know what you should or should not absolutely follow. It's uncertain because someday the government may suddenly tighten up the enforcement of certain regulations and if you don't follow them you might end up in big trouble." (Manager in Research & Development) "The new drug approval process with the SFDA . . . sometimes requires companies to establish 'guanxi' with the SFDA officials to facilitate the process. The approval process is quite opaque. I almost felt that if the SFDA didn't like you, they wouldn't approve your new drug even it met all their standards." (Healthcare Consultant & Account Manager)
Institutional inconsistencies: old versus new rules	"Sometimes, under the disguise of 'higher standards,' the government still extends preferential policy towards certain firms. . . . Or, there are certain cases where the drug application cycle is shorter for [some] firms . . . Such things happen quite frequently and are sometimes disturbing." (Chief Director in Research & Development) "Another thing is that the government imposes limitations on how a firm can price a new drug. Such policy can hurt the profitability of a firm significantly. For me, I think the government intervention in setting drug prices is against how a market economy should work. But as a firm, there's nothing you can do about it and it's difficult for firms to face and to adapt to such uncertainties." (Manager in Research & Development) "There are so many changes going on, including political changes, healthcare system changes and changes in the general economic environment. Although our GDP is improving fast, it does not disguise some of the major issues underneath." (Sales Manager). "Although many government regulations or instructions may seem unreasonable to us, we still need to follow them." (Chief Director in Research & Development)

TABLE 1b Unpredictable Change and Value Appropriation

Item	Interviewee comment
Unpredictable limits to value appropriation	" . . . there are many uncertainties regarding operating in the Chinese market. For instance, it's uncertain when and how the government would pressure us in terms of introducing specific regulations and also whether they would extend preferential policy . . . Secondly, we do not have autonomy in price setting and are not even sure about the prices of our own drugs sometimes. The price cutting by the government is often unpredictable and tends to work against us. Finally, the whole system including the health care system, hospital system, etcetera is full of uncertainties . . . Such processes usually involve human factors that are quite unpredictable." (Financial Planning & Reporting Manager)
	"Because the system was so underdeveloped from the very beginning, with changes being constantly introduced, it somehow made the whole new drug application process unpredictable from a firm's perspective. For instance, I imagine that it is certainly possible that for some previously approved drugs, because of the amendment or introduction of a new policy by the SFDA, the approval might end up being withdrawn by the government. Thus after all, lots of uncertainties were due to such frequent policy changes, which were extremely difficult for firms to predict and to manage." (Project Manager in Drug Discovery)
	"It is quite possible that once the new drug is developed, there are unexpected changes in the market so that the potential profits the firm could exploit from the new drug are significantly reduced." (Director in Research & Development)
	"As a firm, you can never expect when and how certain specific changes by the government will happen and those 'higher standards' imposed by government are sometimes quite vague. Anyway, we need to follow these changes no matter what." (Chief Director in Research & Development)
	"Within our company, we have a team in charge of dealing with government policy and regulation changes. For instance, the government often cut prices for certain drugs to make sure the general public can afford it in medical treatment. But such price cut is often quite random and without a pattern. You never know when a price cut will occur or which product will be cut in which therapeutic area. Thus by having this team, we try our best to gain 'market access' of such information." (Director of Commercial Operations)
	"Once, when our new drug was still under review for approval, the SFDA approved it to another firm." (Chief Director in Research & Development)

TABLE 2 Descriptive Statistics and Correlations

Variable	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11
1 Firm performance	-0.07	1.23	-38.86	34.84											
2 Product innovation	0.06 (1.53)	0.34 (0.86)	0 (1)	7 (7)	0.03										
3 Experiments required by FDA	0.11 (2.89)	0.56 (0.13)	0 (2.08)	3.26 (3.26)	0.02	0.87 (0.18)									
4 FDA approval duration	0.04 (1.09)	0.25 (0.82)	0 (0.02)	6.60 (6.60)	0.00	0.72 (0.05)	0.79 (0.04)								
5 Provincial institutional change	0.05	0.05	-0.17	0.50	-0.01	0.04	0.04	0.02							
6 Foreign imitation	0.08	0.41	0	8	0.03	0.21	0.18	0.14	0.03						
7 Licensed product	0.04	0.29	0	8	0.01	0.05	0.06	0.05	-0.01	0.06					
8 Firm size	5.24	19.76	0	1112.21	0.08	0.15	0.12	0.12	0.04	0.20	0.06				
9 New firm	0.34	0.47	0	1	0.02	-0.02	-0.02	-0.04	0.10	-0.02	-0.04	0.01			
10 State-owned	0.79	0.41	0	1	-0.04	-0.04	-0.03	0.00	-0.13	-0.04	-0.02	-0.09	-0.43		
11 Research alliance	0.05	0.28	0	7	0.02	0.15	0.12	0.06	0.01	0.17	0.06	0.14	-0.01	-0.02	
12 New SFDA policies	1.69	2.15	0	7	0.06	0.07	0.05	-0.02	0.23	0.07	-0.04	0.06	0.21	-0.22	0.06

* n = 10,841 (10 years of data); row 4 and column 4 are based on n = 9,549 (9 years of data).
* Descriptive statistics in parentheses are based on the subsample of firms that have introduced drug inventions.

TABLE 3 Multiplicative Heteroskedastic Regressions Predicting the Mean and Variance of Firm Performance

	Model 1		Model 2		Model 3		Model 4	
Variable	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
H1: Product innovation	-0.040***	0.129***	-1.412**	19.160***	-0.091**	0.977***		0.310***
	(0.012)	(0.041)	(0.682)	(1.030)	(0.043)	(0.065)		(0.053)
H1: Product innovation (4 years cumulative)							-0.082**	
							(0.032)	
H2: Product innovation × Experiments required by FDA								
H2: Product innovation × FDA approval duration								
H3: Product innovation × Provincial institutional change								
H3: Product innovation × New SFDA policies								
Product innovation× Provincial IPR protection								
Product innovation × Bribery prosecution								
Experiments required by FDA								
FDA approval duration								
Provincial institutional change								
New SFDA policies								
Provincial IPR protection								
Bribery prosecution								
Ex-ante risk preference					-0.730***	1.106***		
					(0.087)	(0.014)		
Foreign imitation	0.015***	-1.013***	0.227**	-3.785***	-0.006	-0.877***	0.017***	-1.315***
	(0.003)	(0.035)	(0.102)	(0.156)	(0.008)	(0.057)	(0.003)	(0.044)
Licensed product	0.023***	-1.089***	0.068***	-1.654***	0.032	-0.276***	0.016*	-1.284***
	(0.002)	(0.048)	(0.021)	(0.056)	(0.023)	(0.088)	(0.009)	(0.071)
Firm size	0.002***	0.007***	0.004***	-0.023***	0.004***	0.022***	0.003***	0.009***
	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.001)
New firm	0.026*	-0.675***	-0.015	-0.223***	0.051*	-0.804***	0.005	-0.638***
	(0.014)	(0.032)	(0.020)	(0.038)	(0.027)	(0.073)	(0.022)	(0.052)
State-owned	-0.079***	-1.166***	-0.112***	-0.787***	-0.099***	0.777***	-0.120***	-0.841***
	(0.027)	(0.037)	(0.030)	(0.044)	(0.027)	(0.068)	(0.033)	(0.054)
Research alliance	0.007	-0.321***	0.177*	-2.788***	0.029***	-1.486***	-0.038**	-0.281***
	(0.011)	(0.050)	(0.091)	(0.143)	(0.005)	(0.084)	(0.016)	(0.066)

Constant	-0.023	1.482***	0.057	0.370***	0.036	-0.728***	-0.007	1.610***
	(0.027)	(0.039)	(0.044)	(0.071)	(0.028)	(0.067)	(0.035)	(0.054)
Number of observations	10841		10841		3131		5016	
Number of firms	2343		2343		1018		1429	
Log-likelihood	−16665.076		−16523.676		-4587.116		-8780.925	
P-value	0.000		0.000		0.000		0.000	

Standard errors are reported in parentheses. * $p < .1$; ** $p < .05$; *** $p < .01$ (two-tailed tests)

TABLE 3 continued.

	Model 5		Model 6		Model 7		Model 8	
Variable	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
H1: Product innovation	0.459***	-7.612***	0.044**	-2.182***	0.459***	-8.900***	0.055***	-2.858***
	(0.149)	(1.028)	(0.017)	(0.085)	(0.106)	(1.031)	(0.017)	(0.099)
H1: Product innovation (4 years cumulative)								
H2: Product innovation × Experiments required by FDA	-0.169***	2.585***			-0.167***	2.961***		
	(0.052)	(0.348)			(0.037)	(0.348)		
H2: Product innovation × FDA approval duration			-0.111**	1.779***			-0.067*	1.991***
			(0.048)	(0.088)			(0.040)	(0.090)
H3: Product innovation × Provincial institutional change					-0.356***	2.270***	-0.548***	11.407***
					(0.121)	(0.663)	(0.180)	(0.945)
H3: Product innovation × New SFDA policies								
Product innovation× Provincial IPR protection								
Product innovation × Bribery prosecution								
Experiments required by FDA	0.006	0.083*			0.030***	0.111**		
	(0.008)	(0.050)			(0.010)	(0.050)		
FDA approval duration			0.113*	-0.331***			0.062	-0.660***
			(0.059)	(0.124)			(0.054)	(0.126)
Provincial institutional change					-0.185	-0.395	-0.401**	-1.626***
					(0.154)	(0.260)	(0.181)	(0.309)
New SFDA policies								
Provincial IPR protection								
Bribery prosecution								
Ex-ante risk preference								
Foreign imitation	0.014***	-1.059***	0.031***	-1.042***	0.021***	-1.066***	0.022***	-1.068***
	(0.003)	(0.035)	(0.006)	(0.043)	(0.004)	(0.035)	(0.006)	(0.043)
Licensed product	0.024***	-1.059***	0.025***	-1.082***	0.021***	-1.074***	0.023***	-1.019***
	(0.002)	(0.048)	(0.002)	(0.048)	(0.002)	(0.048)	(0.003)	(0.048)

Variable	Model 5		Model 6		Model 7		Model 8	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Firm size	0.002***	0.007***	0.002***	0.010***	0.002***	0.007***	0.002***	0.010***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)
New firm	0.016	-0.634***	0.037**	-0.490***	0.045***	-0.642***	0.047***	-0.453***
	(0.013)	(0.032)	(0.018)	(0.035)	(0.016)	(0.032)	(0.017)	(0.035)
State-owned	-0.087***	-1.126***	-0.076***	-1.071***	-0.080***	-1.129***	-0.057***	-1.002***
	(0.025)	(0.037)	(0.023)	(0.042)	(0.025)	(0.037)	(0.022)	(0.042)
Research alliance	-0.001	-0.287***	0.056***	-0.278***	-0.011	-0.282***	0.054***	-0.350***
	(0.009)	(0.050)	(0.016)	(0.059)	(0.009)	(0.050)	(0.014)	(0.059)
Constant	-0.007	1.440***	-0.050**	1.292***	-0.021	1.464***	-0.051*	1.290***
	(0.025)	(0.039)	(0.025)	(0.043)	(0.028)	(0.041)	(0.026)	(0.045)
Number of observations	10841		9549		10841		9549	
Number of firms	2343		2171		2343		2171	
Log-likelihood	−16652.059		−14307.893		−16644.616		−14268.263	
P-value	0.000		0.000		0.000		0.000	

Standard errors are reported in parentheses. * $p < .1$; ** $p < .05$; *** $p < .01$ (two-tailed tests)

TABLE 3 continued.

Variable	Model 9		Model 10		Model 11		Model 12	
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
H1: Product innovation	0.545***	-16.231***	0.044***	-2.628***	-0.170***	1.169***	-0.096***	0.706***
	(0.046)	(1.055)	(0.007)	(0.103)	(0.052)	(0.153)	(0.032)	(0.089)
H1: Product innovation (4 years cumulative)								
H2: Product innovation × Experiments required by FDA	-0.189***	5.189***						
	(0.016)	(0.353)						
H2: Product innovation × FDA approval duration			-0.025***	0.983***				
			(0.005)	(0.089)				
H3: Product innovation × Provincial institutional change								
H3: Product innovation × New SFDA policies	-0.009***	0.149***	-0.038***	0.841***				
	(0.002)	(0.014)	(0.009)	(0.051)				
Product innovation × Provincial IPR protection					0.033***	-0.323***		
					(0.009)	(0.040)		
Product innovation × Bribery prosecution							0.026**	-0.362***
							(0.011)	(0.040)
Experiments required by FDA	0.003	0.337***						
	(0.008)	(0.052)						
FDA approval duration			0.031	-0.001				
			(0.023)	(0.124)				
Provincial institutional change								
New SFDA policies	0.009**	0.124***	0.035***	0.476***				
	(0.004)	(0.007)	(0.011)	(0.015)				

	Model 9		Model 10		Model 11		Model 12	
Variable	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
Provincial IPR protection					-0.012	0.303***		
					(0.009)	(0.016)		
Bribery prosecution							-0.016***	-0.505***
							(0.005)	(0.012)
Ex-ante risk preference								
Foreign imitation	0.010**	-1.099***	0.005	-1.030***	0.015***	-1.209***	0.015***	-0.994***
	(0.004)	(0.035)	(0.004)	(0.043)	(0.003)	(0.046)	(0.003)	(0.035)
Licensed product	0.025***	-0.984***	0.022***	-0.983***	0.036***	-0.708***	0.016***	-0.802***
	(0.003)	(0.048)	(0.003)	(0.048)	(0.006)	(0.072)	(0.005)	(0.048)
Firm size	0.002***	0.008***	0.002***	0.007***	0.002***	0.006***	0.003***	0.008***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)
New firm	0.033**	-0.563***	0.035*	-0.333***	0.034	-1.833***	0.008	-0.480***
	(0.015)	(0.032)	(0.018)	(0.035)	(0.020)	(0.044)	(0.016)	(0.032)
State-owned	-0.069***	-0.949***	-0.031*	-0.723***	-0.086**	-1.626***	-0.064***	-0.844***
	(0.022)	(0.037)	(0.016)	(0.042)	(0.034)	(0.046)	(0.025)	(0.037)
Research alliance	0.021*	-0.361***	0.039***	-0.431***	0.027*	-0.359***	-0.013	-0.245***
	(0.011)	(0.050)	(0.011)	(0.059)	(0.015)	(0.065)	(0.010)	(0.050)
Constant	-0.056**	1.038***	-0.103***	0.437***	0.026	1.908***	0.015	2.145***
	(0.024)	(0.041)	(0.020)	(0.046)	(0.040)	(0.069)	(0.030)	(0.047)
Number of observations	10841		9549		4920		10841	
Number of firms	2343		2171		1836		2343	
Log-likelihood	−16447.324		−13915.112		−8554.981		−15867.052	
P-value	0.000		0.000		0.000		0.000	

Standard errors are reported in parentheses. * $p < .1$; ** $p < .05$; *** $p < .01$ (two-tailed tests)

TABLE 4a Sample Interviewee Comments on the Effect of New Product Development

General perception of the performance effects of new product development in the 1990s

"[At that time], I think the return of developing new drugs to a firm was definitely huge . . . I think innovators certainly outperformed others." (Financial Planning & Reporting Manager)

"In the industry at that time, those who performed better had already started developing new drugs on their own . . . They [innovators] definitely performed better." (Chief Director of Research & Development)

"I think during the 1990s, research and development was a critical strategy to improve the profitability of a firm. [A firm] needed to increase the frequency of introducing new products. If we could introduce, say two new drugs a year, our sales would certainly have thrived." (Chief Director of Research & Development)

"It took much longer to develop an original drug by a firm than simply imitate others, but the outcome is certainly greater; innovators definitely outperformed those who didn't innovate." (Director of Medical Technology)

"Introducing new drugs of course will boost a firm's profit, even in the 1990s. Those new drugs, despite being incremental, were innovations after all." (CEO)

Generalizing from top-performing companies

"At that time, if you look at those top pharmaceutical companies such as **, they had already been engaging in new drug development for quite some years." (Chief Director of Research & Development)

"When looking at successful firms such as ** and **, I think the ultimate reason for their success was their ability in developing new drugs." (Director of Research & Development)

"If you were a pharmaceutical company that didn't develop your own drug, you would never get bigger and stronger. You would only make small money." (Sales Manager)

"New drug development was definitely necessary [to enhance profitability]. For those firms that had come very far, engaging in R&D was the key." (Manager in Research & Development)

"Based on my 17 years of experience in ** [a top pharmaceutical firm in China], [developing and] introducing new drugs to the market certainly helped firms to climb the ladder within the industry." (Director of Commercial Operations)

"I definitely think developing new drugs was a critical strategy to improve profitability . . . for top firms, new drug development was critical." (Healthcare Consultant)

TABLE 4b Sample Quotes from Archival Publications (1991–2000) on the Effect of New Product Development

General perception of the performance effects of new product development

"For a firm to grow and to maintain long-term advantage in this market, it is absolutely necessary for it to continuously invest in new drug development and launch new products." (*China Pharmaceuticals,* 1998)

"Once a new drug is launched, huge profits can often be expected." (*Outlook Weekly,* 1992)

"The key for a pharma company to evolve is constant innovation, which is also the driver behind its success." (*Industrial Technology Development,* 1995)

"To enhance competitiveness . . . researching and developing new drugs is the only way to go." (*Chinese Pharmaceutical Affairs,* 1992)

"In today's market . . . if a pharma company doesn't have its own drug inventions, it is extremely difficult to attain competitive advantage and survive." (*Qilu Pharmaceutical Affairs,* 1994)

"In the Chinese pharmaceutical industry, competition is increasingly intense. For any firm to avoid losing the battle, new drug development is absolutely necessary." (*Shanghai Pharmaceuticals,* 1994)

"You got to launch novel drugs." (*Outlook Weekly,* 1995)

Generalizing from top-performing companies

"If a company doesn't do any of these [launch new drugs], it would never have any competitive advantage and may never grow bigger or attain leadership in the market . . . It is through developing and launching drug innovations, ** managed to achieve their success and get to the leading position." (*China Science and Technology Information,* 1996)

"One thing that enhanced their competitiveness is to focus on new product development . . . 30% of their overall production value is delivered by new drugs." (*China Pharmaceuticals,* 2000)

"Their success is entirely due to their drug innovation." (*Qilu Pharmaceutical Affairs,* 1994)

"New drug development is the key for firms to survive and become competitive in this industry. It is through introducing drug innovations that the many successful firms we are seeing nowadays quickly got to where they are." (*Supervision and Selection,* 1997)

Showcasing companies that attribute their success to innovation

"For our company, the key to success is to develop and launch new products." (*Shanghai Pharmaceuticals,* 1994)

"One reason that stimulated our growth is new product development . . . Doing so enhanced our profitability and enabled us to be competitive." (*Factory Management,* 1994)

"Despite many pharma companies suffering badly in this turbulent industry, our company enjoyed great success . . . developing and launching new products is the key." (*Inquiry into Economic Issues,* 1996)

"As top manager Liu commented, one of the reasons the company is doing well . . . is the belief that innovation is the key." (*Theory and Learning,* 1998)

"The launch of these drug innovations has substantially enhanced our profitability and enabled us to have long-term competitive advantage." (*Urban Technology Supervision,* 1997)

Focusing on upside potential

"If we never make any changes and keep producing what we have, we wouldn't catch ** , ** and ** [i.e., three leading Chinese pharma companies] even in 10 years. Instead, we focus on new product development." (*Corporate World,* 1999)

"For any pharma company to attain industry leadership, it needs to continuously develop and launch new drugs into the market." (*Shandong Pharmaceuticals,* 1995)

"Those who are doing great in new drug development are those who will occupy leadership positions in the market." (*Tianjin Economy,* 1998)

TABLE 5 Logistic Regressions
Predicting a Firm's Likelihood of Launching a New Drug

Variable	Model 13	Model 14
Number of top 10 firms that are innovators	0.165***	0.172***
	(0.050)	(0.051)
Press on innovators		0.024*
		(0.013)
Firm profitability *t-1*	0.002	0.002
	(0.002)	(0.002)
Foreign imitation	0.425***	0.420***
	(0.103)	(0.104)
Licensed product	0.022	0.024
	(0.197)	(0.195)
Firm size	0.006**	0.006**
	(0.003)	(0.003)
New firm	-0.136	-0.086
	(0.160)	(0.161)
State-owned	-0.646***	-0.678***
	(0.169)	(0.171)
Research alliance	2.953***	2.979***
	(0.210)	(0.211)
Provincial institutional change	-1.096	-1.447
	(1.113)	(1.144)
Constant	-3.986***	-4.337***
	(0.225)	(0.298)
Number of observations	10194	10194
Number of firms	2228	2228
Log-pseudolikelihood	-1433.922	-1432.352
P-value	0.000	0.000

Robust standard errors are reported in parentheses.
* $p < .1$; ** $p < .05$; *** $p < .01$ (two-tailed tests)

FIGURE 1 Percentage of State-owned Firms in the Chinese Pharmaceutical Industry, 1991–2000

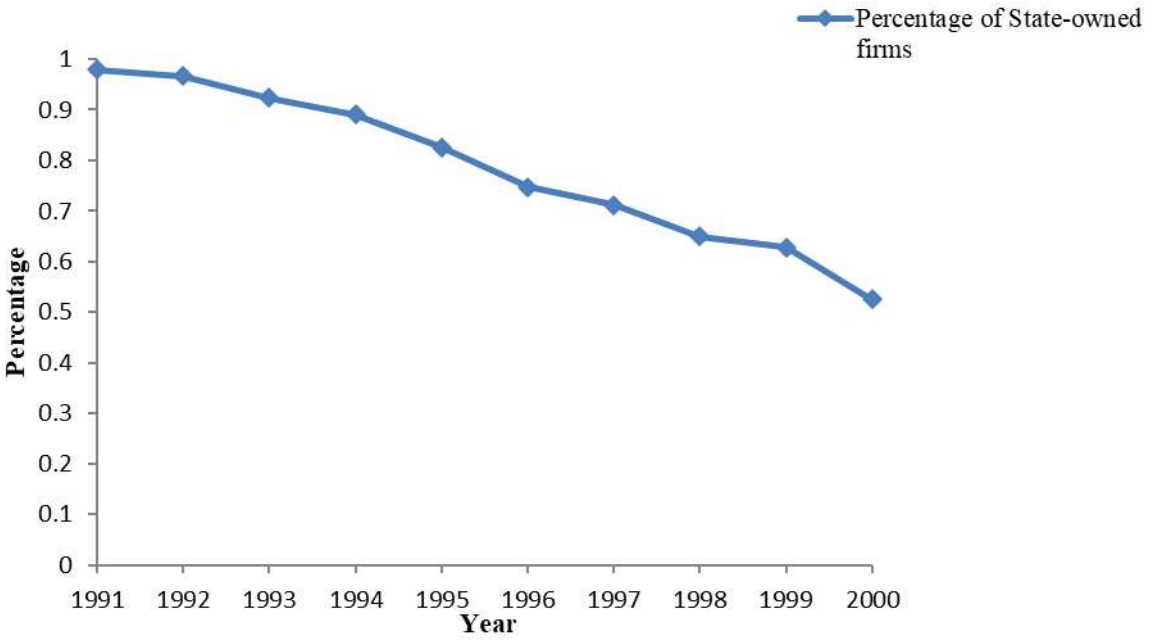
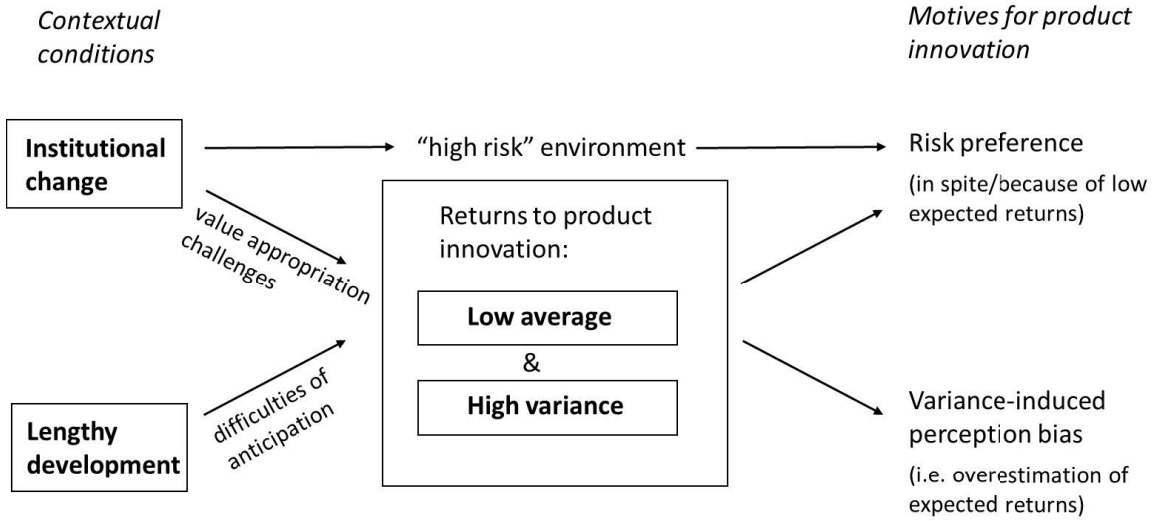


FIGURE 2 Interpretative Model



* The variables displayed in bold concern our empirical measures, as included in the multiplicative heteroskedastic models; the left side represents our conceptual mechanism, in terms of institutional inconsistencies, as we reported in Tables 1a and 1b, and the length of the product-development process. The right side concerns the possible motives that people expressed for engaging in product innovation, even though it is, according to our quantitative results, a high-risk, low-return course of action.

APPENDIX 1: LITERATURE ON BOWMAN'S PARADOX

Article	Main findings	Approach identifying Bowman's paradox	Suggested mechanism
Bowman, E.H. 1980. A risk–return paradox for strategic management. ***Sloan Management Review,*** 21: 17–31.	Among the majority of the 85 industries studied, firms with higher average profit tended to have lower risk (i.e., variance) over time.	Within each industry, for every firm, the average profit and the profit variability over a 5 or 9-year period were calculated (and categorized as either high or low by comparing to industry medians). Next, the association between firm average profit and profit variability was calculated for the entire population of firms in the industry.	Good management will bring about both higher returns and lower variance in returns.
Bowman, E.H. 1982. Risk seeking by troubled firms. ***Sloan Management Review***, 23: 33–43.	Annual report content analysis from 3 different industries reveals a positive association between low profitability and risk taking by firms.	It is simply shown that of the entire population of firms in each industry, those engaged in risky actions (e.g., acquisitions, litigation, new activities, etc.) had lower average profitability to begin with.	Troubled firms take bigger risks.
Bettis R.A., & Hall, WK. 1982. Diversification strategy, accounting-determined risk, and accounting-determined return. ***Academy of Management Journal***, 25: 254–264.	For 24 firms (COMPUSTAT data) that engaged in related-linked diversifications, there was a significant negative association between risk and return.	For each firm, the average ROA and the standard deviation of the ROA (i.e., risk) over a 5-year period were calculated. The correlation between ROA and risk was identified using the entire sample of firms by regressing ROA on the standard deviation of ROA.	The authors concur with Bowman's (1980) explanation that a well-devised strategy could concurrently reduce risks and increase returns.
Fiegenbaum A., & Thomas H. 1986. Dynamic and risk measurement perspectives on Bowman's risk–return paradox for strategic management: An empirical study. ***Strategic Management Journal,*** 7: 395–407.	Bowman's risk-return paradox appears more evident across industries in the less predictable environments of the 1970s than in the more stable 1960s.	The exact approach used in Bowman (1980) was adopted. The association between firm average profit and profit variability was calculated for the entire population of firms in the industry (within different time periods).	When an environment is less predictable and ill-structured, greater capabilities are required from firms to recognize the limited market opportunities.
Fiegenbaum A., & Thomas, H. 1988. Attitudes toward risk and the risk–return paradox: Prospect theory explanations. ***Academy of Management Journal,*** 31: 85–106.	A negative risk-return association was discovered for U.S. firms (COMPUSTAT data) that had returns below target levels, whereas the association appeared positive for those with returns above target levels.	Following Bowman's (1980) methodology, the association between firm average profit (i.e., ROE) and profit variability was calculated for the entire population of firms in each industry, for each time period studied, and for all firms across industries. In addition, Spearman rank order correlations were measured in a similar fashion.	Consistent with Prospect Theory, the authors expected risk-seeking attitudes below target return levels and risk-averse attitudes above target return levels.
Ruefli, T.W. 1990. Mean–variance approaches to the risk–return relationship in strategy: Paradox lost. ***Management Science,*** 36: 368–380.	The negative risk-return associations discovered using the mean-variance approach are specific to the data and period examined and are not necessarily generalizable.	In the illustrative example using data from U.S. airlines, the Spearman rank correlation between the average RoA of a firm and its standard deviation was calculated for the entire population of firms for different time periods on a rolling five-year basis.	It is thought to be generally impossible to correctly identify whether the association between mean and variance was driven by movements along a mean-variance curve or by shifts in unspecified relationships between the two in different subperiods; the nature of the association between the two variables is inherently unverifiable.

Oviatt B.M., & Bauerschmidt A.D. 1991. Business risk and return: A test of simultaneous relationships. ***Management Science,*** 37: 1405–1423.	For 132 non-diversified firms in 8 industries, a significantly negative risk-return relationship was found through OLS regression. However, this relationship disappeared when 3SLS was adopted as the estimation approach.	For each firm, the average return and the variability of annual returns over the study period were calculated. The correlation between risk and return was identified for the entire sample of firms by regressing return on risk and vice versa (using both OLS and 3SLS models).	The discovery of Bowman's paradox may have been due to improperly specified estimation approaches.
Bromiley, P. 1991. Testing a causal model of corporate risk taking and performance. ***Academy of Management Journal,*** 34: 37–59.	Using accounting data from COMPUSTAT and analyst forecast data from IBES for manufacturing firms, the authors discovered that firm performance has a strong negative influence on risk taking, and risk reduces subsequent performance.	For each firm, risk was measured by the variance in security analysts' forecasts of its income in a given year; return was measured using a firm's ROA. The correlation between ROA and risk was identified upon the entire sample of firms by regressing ROA on the risk measure and vice versa.	Low performance drives risk taking rather than that slack allows room for risk taking.
Miller K.D., & Leiblein, M.J. 1996. Corporate risk-return relations: Returns variability versus downside risk. ***Academy of Management Journal,*** 39: 91-122.,	Analyses using data from U.S. manufacturing companies indicated that a positive association exists between a firm's downside risk and subsequent performance, whereas a negative relationship exists between firm performance and subsequent downside risk.	The authors conceptualized risk in terms of downside outcomes rather than outcome variance. For each firm, return was measured using average RoA over a five-year period, and downside risk was measured as a function of performance shortfalls relative to an aspiration level (i.e., target returns). The correlation between return and risk was identified using the entire sample of firms by regressing return on the risk measure and vice versa.	Firms avoid uncertainty unless performance shortfalls motivate problematic search. In other words, poor performers are more likely to engage in risky strategies.
Wiseman, R.M., & Bromiley, P. 1996. Toward a model of risk in declining organizations: An empirical examination of risk, performance, and decline. ***Organization Science,*** 7: 524–543.	Analyses of a sample of 323 declining firms reveals that risk has a significant negative influence on future performance.	For each firm, risk was measured using the variance in security analysts' forecasts of a firm's income. Firm performance was measured using its RoA, RoE and RoS. The correlation between return and risk was identified for the entire sample of firms by regressing each of the measures for firm return on the measure for risk.	For firms facing a loss context, lower risk projects guarantee failure to meet aspiration levels, whereas higher risk projects offer a small probability of success. Yet, on average, firms pursing higher risk projects will experience loss, which may exceed that of lower risk projects.
McNamara, G., & Bromiley, P. 1999. Risk and return in organizational decision making. ***Academy of Management Journal***, 42: 330–339.	Data on commercial lending reveals that the nature of the risk-return association is contingent on the measures adopted, and that the association appears negative when the return measure takes into account the costs associated with decisions of varying risk.	The association between return (e.g., interest rate charged and risk-adjusted expected return) and risk (e.g., assessed risk rating) was identified for the entire sample of borrowers by regressing the return measures on the assessed risk.	Decision makers likely misestimate the risk and return of the decisions they face. Alternatively, they simply accept riskier choices without risk premiums that are high enough to compensate for the costs associated with the risky choices.
Lehner, J.M. 2000. Shifts of reference points for framing of strategic decisions and changing risk-return associations. ***Management Science,*** 46: 63–76.	Data on chemical firms (data from COMPUSTAT) reveals different degrees of negative correlations between risk and return for different time periods.	For each firm, average ROE and its standard deviation within each period studied were calculated. The correlation between return and risk was identified upon the entire population of firms by regressing average ROE on its standard deviation for each period (the author adjusted the model by	Different proportion of firms operated below the reference point within different time periods; as long as a firm is operating above its reference point, the risk-return relationship appears positive.

		dividing the standard deviation on both sides of the equation to correct for heteroscedasticity).	
Miller, K.D., & Chen, W. 2004. Variable organizational risk preferences: tests of the March-Shapira model. ***Academy of Management Journal***, 47: 105–115.	Using data from U.S. manufacturing firms, the authors categorized firms into those threatened by bankruptcy, those not threatened by bankruptcy but performing below aspiration levels, and those performing above their aspiration levels. They discovered that within all categories, a negative association between risk taking and recent firm performance exists.	For each firm, risk was measured using the standard deviation of quarterly RoA over a two-year period. Firm performance was measured using both the equity market-to-book ratio and RoA for the year prior to the period used to measure risk. The association between risk and performance was identified in the entire sample of firms by regressing risk on either performance measure.	Risk monotonically decreases as performance rises relative to aspirations.
Andersen, T. J., Denrell, J., & Bettis, R. A. 2007. Strategic responsiveness and Bowman's risk-return paradox. ***Strategic Management Journal***, 28: 407–429.	Through both a series of simulations and empirical analyses using firm accounting data from COMPUSTAT, the authors rfound a negative correlation between firm performance and the standard deviation of performance; such a relationship was found to be especially pronounced in dynamic industry settings where environmental parameters are exposed to substantial change.	In both the simulation and empirical analyses, for each firm, average performance and the standard deviation of performance over a 10-year period were calculated. The correlation between firm average returns and its standard deviation was calculated using the entire population of firms in the simulated industry and in each industry in the empirical data.	Consistent with Bowman's (1980) initial speculation, good management enables firms to adapt quicker toward a closer match with their environmental conditions; a greater strategic fit is associated with higher performance.
Henkel, J. 2009. The risk-return paradox for strategic management: Disentangling true and spurious effects. ***Strategic Management Journal***, 30: 287–303.	Using U.S. firm data from COMPUSTAT, the author discovered that, on average, spurious effects due to skewness of the individual firms' return distributions explain the larger part of the observed risk-return paradox.	Consistent with Bowman's (1980) original approach, for each firm, return and risk were measured using firm average returns (RoE in the empirical analysis) and the variance of it over a 10-year period in both simulation and empirical analyses. The association between firm average returns and the variance in returns was calculated using the entire population of firms in the simulated industry and in each industry in the empirical data.	Skewness of firms' return distributions causes a biased observation of the risk-return relationships in the empirical analyses.
Andersen, T.J., & Bettis, R.A. 2015. Exploring longitudinal risk-return relationships. ***Strategic Management Journal,*** 36: 1135–1145.	Through both simulation and empirical analyses, the authors concluded that both imperfect learning and appearing mindless in the form of a random walk by firms could lead to the negative longitudinal risk-return relationship observed empirically.	For each firm, the average performance (i.e. ROA in empirical analysis) and the standard deviation in performance were calculated over 5-year intervals in both simulation and empirical analysis. The risk and return relationship was calculated upon the entire population of firms in the simulated industry and in each industry in the empirical data as the correlation between the average performance over the first 5-year period and the standard deviation of performance over the subsequent 5-year period.	The negative longitudinal risk-return relationship appears to be related to imperfect firm adaptation in more unpredictable environments.

APPENDIX 2: REGULATORY CHANGES IN THE CHINESE PHARMACEUTICAL INDUSTRY 1991-2000

Price Setting

In the Chinese pharmaceutical industry, throughout the period 1991–2000, various regulations were introduced to either govern or liberalize the prices of drugs. On the one hand, policies were released to let prices vary according to market conditions. One explicit objective of these changes was to stimulate indigenous product innovation in the industry. Yet, other policies were aimed at controlling and curbing prices, to keep healthcare affordable and prevent social unrest. Extensive disagreements regularly occurred within the national government and between the state and provincial regulatory bodies regarding the necessity of economic reform in the industry and how exactly it should unfold. Therefore, despite regulatory change, the actual implementation of the proposed changes could be slow and inefficient across different provinces.

Until 1996 the lack of a unified guideline from the government on price setting was seen as contributing to considerable chaos in terms of drug prices within the Chinese pharmaceutical market (Chang & Zhang, 2009; Meng et al., 2005). Following this period, the implementation of the interim version of the Regulation of Drug Pricing Policy in 1996 represented a major government effort to reform the drug-pricing system. These regulations, together with nine other supplemental regulations issued by the government over the subsequent four years, specified detailed instructions and guidelines (e.g., specific formulas) for how different types of drugs should be priced (Chang & Zhang, 2009). Meanwhile, to incentivize pharmaceutical firms to engage in new-product development, limited autonomy in price setting was delegated to manufacturers that introduced "better quality" drugs.

As part of the process of healthcare reform, beginning in 1996, the lists of drugs eligible for reimbursement under the Urban Health Insurance Scheme were also adjusted frequently and were later separated into two categories: retail price ceilings for drugs within "category A," which would still be centrally determined by the state, and only guiding prices, to be set by the state, for drugs within "category B" (i.e., usually the more expensive drugs). Different provinces could determine their final retail price ceilings within a 5 percent range of the guiding prices (Meng et al., 2005). Furthermore, in 2001, as another way to cap drug prices, a bidding system was introduced whereby drug procurements by hospitals were centrally organized in each province.

Drug Approval

Despite ample regulatory changes, throughout our window of observation (1991–2000), the approval process for new drugs remained complex and opaque, involving various institutions at both the state and the provincial levels (Deng & Kaitin, 2004). Before 1999 all new drug applications were required to be initially submitted to and reviewed by the Provincial Drug Administration. The applications for Type 1, 2, and 3 new drugs (more-innovative new drugs) were then forwarded to the State Drug Administration through the Provincial Drug Administration, based on the examination of provided drug samples conducted by the Provincial Institutes for the Control of Pharmaceutical Products. Final decisions on the approval of these three types of new drugs were made by the State Drug Administration, whereas decisions on Type 4 and 5 new drugs (less-innovative new drugs) were delegated to the Provincial Drug Administration. Yet, ample exceptions and other routes to approval also seemed to apply (Deng & Kaitin, 2004).

After 1999 the revised government regulations allowed more-innovative (e.g., Type 1) drugs to apply directly through the State Drug Administration to facilitate the approval process, whereas the provincial drug administrations were still in charge of pre-evaluating all other types of new drug applications. Meanwhile, clinical trials for new-drug applications

were required to be conducted at hospitals approved and appointed by the State Drug Administration. Detailed requirements on clinical trials varied significantly depending on the innovativeness of the new drug under consideration; usually the more innovative a new drug, the more elaborate the applicable requirements. Because such specific arrangements of the new-drug approval process involved decisions by both state and provincial drug administrations, according to our interviewees, ample inconsistencies in the evaluation standards existed both across different provincial drug administrations and between the provincial and state drug administrations. The complex nature of the various processes, including drug approval, led many companies to set up specific teams to address governmental interactions.

Intellectual Property Protection

A drug administrative protection system (equivalent to the patent system) was launched in 1987 to address concerns about intellectual property rights within the Chinese pharmaceutical market. This system grants market-exclusivity rights to innovating firms for a certain number of years, depending on the innovativeness of the new drug (Deng & Kaitin, 2004). Although the system was generally considered to work well, in terms of enforcing production permission, the government had final authority and sometimes awarded multiple firms the "exclusive" right to produce a particular drug, that is, multiple drugs with the same active ingredients (Deng & Kaitin, 2004). The system was enhanced in 1992, in response to global pressure, through the provision of 7.5 years of administrative protection to foreign pharmaceutical companies to prevent their drugs patented in their home countries from being imitated or illegally imported by Chinese pharmaceutical firms (Regulation on Administrative Protection of Pharmaceuticals, 1992). To incentivize domestic pharmaceutical firms to conduct more genuine product innovation, in 1999 the government further extended the period of market exclusivity for new drugs, particularly for those drugs that were more innovative. Subsequently, more Chinese firms began engaging in innovation (Rezaie, McGahan, Daar, & Singer, 2012; White, 2000). However, most innovations continued to consist of new variants of existing drugs or new applications of existing drugs.

Xu Li (xl.si@cbs.dk) is an Assistant Professor of Strategy and Innovation at the Copenhagen Business School. He received his PhD in strategy and entrepreneurship from the London Business School. His main research explores when innovation is beneficial, and more critically, when it is less useful or even detrimental to firm performance.

Freek Vermeulen (FVermeulen@london.edu) is a Professor of Strategy and Entrepreneurship at the London Business School. He earned a PhD in economics from Tilburg University and a PhD in sociology from Utrecht University, the Netherlands. He's been told his work appears to focus on the limitations of organizations, and particularly on when they don't work.