

# CANINE THEORY OF INNOVATION: EVIDENCES FROM CHINA

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## ABSTRACT

We develop a new theory about innovation called canine theory of innovation in studying corporate innovation in China. This methodology classifies companies into four categories: top dog, old dog, stray dog and run-of-the-mill dog, in terms of their achievement in high performance and strategic innovativeness. We find a very small set of companies belong to the top dog category and they are mostly private companies. We then identify four traits in their innovation activities that are common across the top dog companies.

**Keywords:** innovation, strategic, China

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## 1. INTRODUCTION

Things in China often tend to mystify the west. Innovation in China also possesses its own unique characteristics that sometimes appear to stay out of the established strategic management framework in the west. Chinese companies often get mixed assessment on innovation capabilities and achievements. Many foreign scholars believe Chinese companies only derive low margins from their traditional positions (processing, assembly and production) in the global value chain, and therefore lack the resources to support groundbreaking innovations. Western critics also sharply criticize

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Chinese companies' innovation capability for rampant copycat practices and lack of innovation drive, which are often attributed to the lax intellectual property right protection environment. Critics also believe China's technological innovation and industrial upgrading are mainly driven by national industrial policies, resulting in unproductive and uncompetitive innovation activities. Another view believes that despite extensive transfers of foreign technologies, China still performs poorly in terms of knowledge digestion, absorption and re-innovation, which causes repeated and redundant introductions of and dependence on foreign technologies. Finally, the so-called recombinant innovations popular at Chinese companies are mostly duplication and combinations of existing technologies.

However it is an indisputable fact that both the Chinese government and companies attach great importance to innovation and R&D. As early as in February, 2006, the State Council published the National Guideline on Medium- and Long-Term Program for Science and Technology Development (2006-2020) (hereinafter referred to as the Outline) as an overall strategic blueprint for China's scientific and technological development in the following 15 years. According to the Outline, by 2020, the total investment in scientific and technological R&D shall exceed RMB900 billion, and the total revenue from R&D activities will account for more than 2.5% in GDP. Currently, China's R&D investment amount takes up 2% in GDP, totaling about 38% of the R&D investment amount in the US.

In recent years, China has witnessed many remarkable achievements, which seems to shake off China's status as a third-world country overnight. According to the EU Industrial R&D Investment Scoreboard in 2012, the top 2000 global companies in terms of R&D expenditures included 658 American companies, 527 European ones, 353 Japanese ones and 93 Chinese ones. Furthermore, 50 publicly listed Chinese companies are among the Top1000 and 3 are among the Top100, namely Huawei, CNPC and ZTE. In this scoreboard, Huawei ranked 31st with US\$3.5 billion of R&D investment, a little less than Cisco (which was ranked 18th with US\$4.5 billion of R&D investment); in 2012, Huawei became the fourth largest patent applicant in the world with a total of 1,801 PCT patents. CNPC was ranked 66th with US\$1.7 billion of R&D investment, surpassing all other peers in the oil and gas industry. ZTE was ranked 98th with US\$1.17 of R&D investment and was the global No.1 company in patent application numbers, totaling 3,906 PCT patents in 2012.

In this paper, we introduce several innovations in studying innovation in China by devising a new analytical framework. Our framework carefully identifies winners from losers in terms of the interface between corporate high performance and their innovation capabilities. Our framework, which we call the canine theory of innovation, essentially enables depicting a realistic picture of the distribution of innovation success relative to company success across our entire sample. Our analysis shows that a very few elite list of companies in China are able to achieve success on both accounts, and they are mostly private companies as opposed to state-owned enterprises (SOE).

Another innovation in our study of innovation is to distinguish between strategic innovativeness and organizational creativity. Strategic innovativeness refers to a company's capacity of converting developed products or services into real market value. Companies with high R&D investment or possessing numerous patents are not necessarily bound to achieve strategic innovativeness. Conversely, companies can be strategically innovative without being organizationally creative – they can be technology followers but still marketing leaders, or they can buy up patents and technologies

**Figure 1.** High Performance, Strategic Innovativeness and Organizational Creativity



and quickly turn them into revenue deriving products, as for example Tencent has been consistently doing in recent years. Companies with organizational creativity among the high achievers in both high performance and strategic innovativeness are even a smaller minority – less than 18% among the less than 6% group which we call top dog companies. In other words, only roughly 1 out of 100 companies in China is like, for example, Huawei, who is highly successful financially, highly successful in churning out new products and services, and highly successful in doing almost everything in house related to R&D.

Our two innovations we alluded to in studying innovation in China go back to the heart of the question of what it exactly means by innovation. Despite various definitions of innovation in the literature, we propose a new definition in this paper that is quite different. Innovation in our opinion is fundamentally about turning money into ideas and turning ideas into money. The literature tends to focus more on the former part, turning money into ideas, while largely ignoring the equally important latter part of turning ideas into money. Both components should feed each other in a healthy cycle. Without ideas turning into money, the ideas become quite useless – at least from the company's perspective, and there would be no funding for innovation in the future. The relationships between our three concepts are illustrated in Figure 1. In short, an innovation winner in our mind imparts high achievement in three areas, company wise high performance, strategic innovativeness and organizational creativity. Our analysis shows that very few companies are able to make into this elite list.

## 2. LITERATURE REVIEW

The innovation literature is voluminous. Various aspects of our research framework have been studied before. Here we provide a brief literature review of those papers that have touched up the issues relevant to our study. Capon, Farley, and Hoenig (1990) review a large amount of literature on the relationship between innovation strategy and firm performance. They found mixed empirical results among prior studies, with over two-thirds of the studies finding a positive relationship between product innovation strategy and firm performance, and the rest finding a negative relationship or none at all. This is not surprising in our context, as under our framework investment in R&D does not always translate into financial high performance. Zhou and Wu (2010) examine the role of technological capability in product innovation. They build on the absorptive capacity perspective and

organizational inertia theory and propose that technological capability has curvilinear and differential effects on exploitative and explorative innovations. Tellis, Prabhu and Chandy (2009) stress the importance of corporate culture in innovation, especially radical innovation. Their study suggests that commercialization of radical innovations translates into a firm's financial performance, which is a stronger predictor of financial performance than other popular measures, such as patents. Their study partially echoes our view that innovation is equally about turning ideas into money. There are also several papers focusing on the relationship between ventures and product innovation, which is relevant to our dichotomy between strategic innovativeness and organizational creativity. Ayyagari, Demirgüç-Kunt and Maksimovic (2008) investigate the firm characteristics associated with innovation, finding that access to external financing is associated with greater firm innovation. In technology industries, dynamic market and technology changes require the ventures to constantly cope with environmental volatility, to accelerate development process, and to establish new markets and technologies (Katila and Shane, 2005).

We also cite the literature on China related innovation. Li and Atuahene-Gima (2001) investigate the effect of product innovation strategy on the performance of new technology ventures in China. They found the innovation-performance link was contingent on both environmental factors, including environmental turbulence, institutional support and the relationship-based strategies. Girma, Gong and Görg (2008) estimate the influence of foreign direct investment in innovation activity in Chinese enterprises. They suggest that private and collectively owned firms with foreign capital participation innovate better than their SOE counterparts, which is partially supported by our analysis. Zhang, Di Benedetto and Hoening (2009) examine the interplay of product development strategy, knowledge utilization, and product innovation performance in the context of Chinese subsidiaries of multinational companies.

### 3. METHODOLOGY AND DATA

As discussed in the previous section, our methodology includes three components in terms of identifying the desired group of companies among our sample: high performance, strategic innovativeness and organizational creativity. Our sample data consists of 7 years of annual financial information about the top 500 companies in China from 2007 to 2013. Altogether our sample consists of 793 companies. Arguably these companies represent the most important part of Corporate China. Since our identification of winners and losers has to be sector-wise to make the comparisons meaningful, we classify these companies into 21 industries. We then apply our three identification criteria within these industries to come up with intra-industry-sector comparisons.

#### *High performance*

What does it mean by a high performance company? Our measuring methodology is based on the five performance dimensions pioneered by Accenture Institute for High Performance (AIHP) (Kirby, 2005) with some modest modifications. The AIHP's five dimensions include growth, profitability, growth, positioning for the future, longevity and consistency. Revenue growth and profitability are self-explanatory. Positioning for the future is represented by the portion of share price that cannot be explained by current earnings and by the portion of the industry total each company's future value

represents. Longevity is measured by the duration of out-performance in total return to shareholders. And consistency means the company is able to deliver high performance consistently over many years, and technically measured as seven out of ten years being able to consistently stay in the intra-industry winner group. Since our sample data is not from stock exchanges with detailed financial data, we modify this methodology with a technique called Data Envelopment Analysis (DEA).

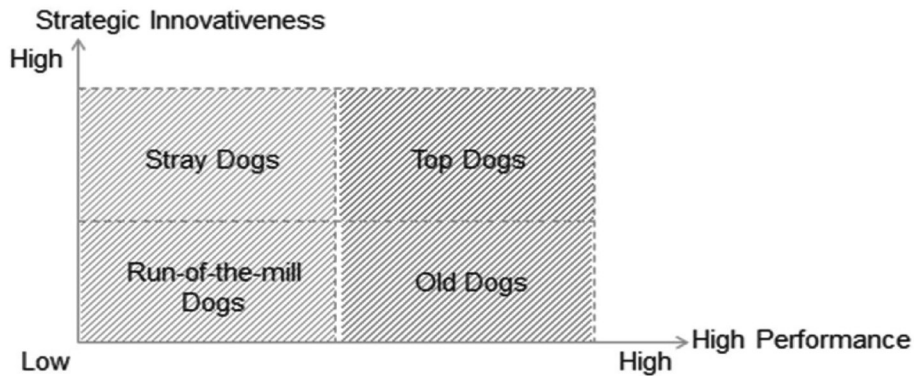
The DEA method is now widely used in operations research since Charnes et al. (1978). For study of high performance companies, Zhu (2000) apply a DEA model on the Fortune 500 companies. We follow his methodology to study our list of 793 companies. The model was designed with three input factors, the number of employees, assets and owner's equity, and two output factors, operating revenue and profits. The DEA algorithm then ranks companies in terms of approaching the output performance frontier (revenue growth and profitability) within each of the 21 industry sectors. We then categorize companies in each sector into two groups, the A list and the B list. The A list consists of top 20% as our candidate high performers. We then apply several filters on list A to reflect the other three performance dimensions of the AIHP methodology. For example, we require high performers to show up in the Top 500 list at least 4 times out of the past 7 years and their DEA score shall not be lower than their industry sector median. This is to reflect consistency. We also filter out companies with a history of less than 10 years, to reflect the longevity requirement.

### ***Strategic Innovativeness***

Strategic innovativeness refers to companies' capability of converting research ideas and outcomes into products or services to create real market value. It is clear that companies with high R&D investment or possessing a large number of patents are not bound to achieve strategic innovativeness. In this paper, the strategic innovativeness is measured by the percent of revenue attributed to new products and services. Data for this variable is obtained from the enterprise database from the National Bureau of Statistics of China (NBS). It contains firm-level information based on the annual accounting briefing reports filed by all "above scale" industrial firms in China. On average it contains about 200,000 firms per year in our sample, spanning 37 two digit manufacturing industries and 31 provinces including 4 province-equivalent municipal cities. They account for most of China's industrial value added and have over 20% of China's urban employment.

In some cases, the companies in the NBS database may not match perfectly with the Top 500 company database, since the latter is reported based on the holding company data, while the former is based on the concept of registered legal entity which is essentially equivalent to an operating company. In these instances we have to manually reconcile the two sides by identifying operating companies in the NBS database that belong to the holding company in the Top 500 company database. It should be noted that the NBS enterprise database only includes companies in the manufacturing industry. So due to missing data of companies in the service industry, we obtain data for 506 companies in 14 industries. After sequencing them by the revenue ratio as discussed, we pick the top 20% companies within each industry sector as those with high strategic innovativeness. This exercise identifies 134 companies as winners.

**Figure 2.** Canine Theory of Innovation



### ***Organizational Creativity***

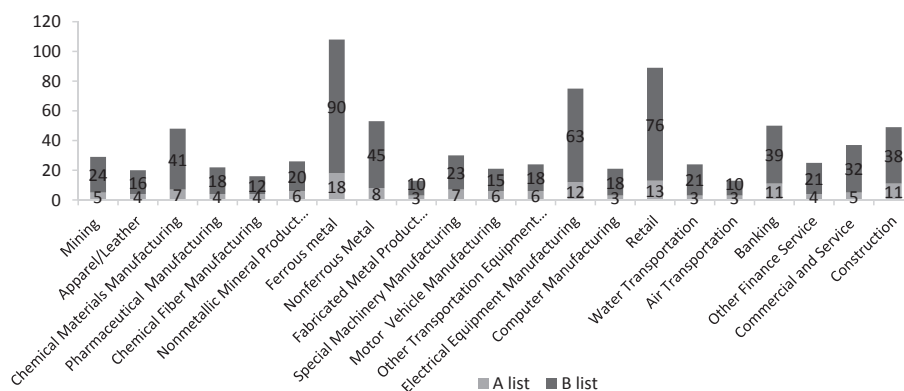
A company's organizational creativity indicates its in-house capability of creating new ideas and new inventions at the organizational level. Many companies have R&D departments and industrial laboratories. Organizational creativity intends to quantify the productivity of these departments. Organizational creativity is inherently a difficult thing to measure. The only available quantifiable means is patent data from the China Patent Office, although some companies' inventions may not be patented at all. Now it is important to note that patent filings in China include three types, invention patent, utility patent and exterior design patent. Exterior designs do not impart much creative complexity or the innovation value. Therefore, this paper only looks at the sum of invention patents and utility patents to measure a company's organizational creativity. Again we use the 20% threshold. In other words, the top 20% companies in terms of ranking of total amount of invention and utility patents are regarded as organizationally creative within their respective industry sector.

## **4. CANINE THEORY OF INNOVATION**

On the basis of our concepts of high performance and strategic innovativeness, we are able to classify the Chinese companies in our sample into four types, which we call the canine classification (see Figure 2 above). If a company excels in organizational creativity, we call it a purebred; otherwise a mutt. That means the company resorts to outside help with coming up with new ideas and inventions.

The four types of dogs under our conceptual framework impart the following meaning:

- **Top dog:** These are companies that deliver high performance as well as strategic innovativeness. They are usually methodological, persistent and purpose-driven when it comes to investment in R&D.
- **Old dog:** These are high performance companies but lack strategic innovativeness, much like an old dog struggling to learn new tricks. These companies most likely are corporate behemoths having had their glorious days, but decidedly lack innovation drive or performing poorly in coming up with new products and services. This category includes many large state-owned companies enjoying substantial market power.
- **Stray dog:** companies with strategic innovativeness but not up to high performance. They

**Figure 3.** Distribution of High Performance Companies across Industries

might be boisterous in terms of innovation activities, but for some reason they have not been able to translate innovation into the company bottom line. This is like a stray dog that is lost in direction, although working very hard.

- Run-of-the-mill dog: These are losers in both categories, in high performance and strategic innovativeness. They constitute a large percentage in our sample.

After explaining our conceptual framework, we next present our results. We first show the results with respect to high performance. Our A list consists of 143 high performance companies from the 793 companies in 21 industries. Figure 3 above shows their distribution across the 21 industry sectors.

As expected, companies in the A list differ remarkably from companies in the B list. In terms of the compound average growth rate, companies in the A list averages 21.4% versus 17% in the B list B over our sample years. Although this difference may not appear very significant, the net profit margin difference appears to be much more prominent. With respect to the average profit margin, companies in the A list averages 7.29%, which is far higher than the 0.05% average for the B list. That means a large percentage of the Corporate China is barely above the break-even condition.

The list of top 500 companies in China, as well known, is dominated by state-owned enterprises (SOEs). The most recent tally shows 310 SOEs versus 190 private companies. However our A list shows a decidedly different picture. There are slightly more private companies (75) than state-owned companies (68), taking up 52.4% of the total number. We next show the distribution of companies based on our canine theory of innovation. The results are summarized in Table 1.

According to our canine theory of innovation, we divide all the companies into four groups (see Figure 2). In the end, only 29 companies enter the top dog category, which is less than 6% of the total samples. Run-of-the-mill dogs took up more than 60%, constituting the largest proportion of the sample with a total of 308 companies. Stray dog companies hold about 21% of the total, compared to 13% old dog companies. This indicates that quite a large percentage of Chinese companies invest actively in R&D and are constantly churning out new products and services, but for some reason they have not been able to translate these investments into real value.

When further looking at the companies that achieve most of its research capabilities in-house, the percentage is even smaller. Among the top dog companies, only about 17% of them are deemed as

**Table 1.** Distribution of Companies by Canine Theory of Innovation

	Number	%	Organizational Creativity	%	Ownership	%
Top dogs	29	5.73%	Purebred	17.24%	State owned	31.03%
			Mutt	82.76%	Private	68.97%
Stray dogs	105	20.75%	Purebred	27.62%	State owned	46.67%
			Mutt	72.38%	Private	53.33%
Old dogs	64	12.65%	Purebred	6.25%	State owned	35.94%
			Mutt	93.75%	Private	64.06%
Run-of-the-mill dogs	308	60.87%	Purebred	20.78%	State owned	46.10%
			Mutt	79.22%	Private	53.90%

purebred companies. The similar can be said regarding stray dog and old dog companies. By corporate ownership nature, private companies account for 69% in top dogs, 64% in old dogs, and 53% in stray dogs, demonstrating absolute advantages in high performance and innovativeness. This appears to be the consistent theme throughout our study. The best breed of corporate China seems to be mostly coming from private companies.

Our analysis so far reveals that finding an innovative and successful company that also prides in its in-house creative capability is truly a rare event in China. Our screening exercise only identifies a handful of such companies. We then conducted onsite interviews and surveys among a subset of these companies, including those in the telecommunications, automobiles and heavy machinery sectors, to explore if there are any commonalities among them. The following shows our results.

### ***Combinatorial and incremental innovation***

Great Chinese companies appear to emphasize more on incremental innovation and many of their innovations are indeed of combinatorial nature. This strategy also appears to play the follow-the-leader card. In fact, one company specifically says that it does not want to fund research that is too much forward-looking. We conjecture that Chinese companies take a more realistic and risk-averse approach in consideration of their technology position compared to their global competitors. However, Chinese companies must also bear in mind that combinatorial plus incremental innovation can be difficult to lead them to become global industry leaders.

### ***Market-driven Innovation***

Our research found successful Chinese companies approach innovation with a close eye on the market. That is also one area where top dog companies differ from stray dog companies. In essence, companies focused on market-driven innovations do a better job at turning ideas into money. Take one successful company in our top dog list as an example. This company is in the heavy equipment business. Its innovation management system involves professional R&D personnel, the company's marketing staff, and a top-level specialized design division. It explicitly says that its innovation mission is to find customers, understand customer needs, understand the needs of the market, understand competitors, and then, propose the concept of a new product, the performance of the product to be



achieved, its cost control, and competitiveness of the product. Its research organization is ostensibly different from that of its global competitor, whose research institute is a centralized and independent unit. Our top dog company's research institute is a decentralized system imbedded within its several product line business units. Here the innovation focus on the market cannot be over emphasized more.

### ***Right incentive mechanism***

We think a right innovation incentive mechanism is different from conventional wisdom in that it has to be asymmetric. The asymmetry of incentive mechanism is reflected in high rewards to winners and low punishment to losers. Innovation is inherently a risky business, and also risky business for those involved as well. The right incentive system should encourage employees to take on more risks while mitigating the penalizing side if things do not turn out as expected. Great companies in our top dog list do precisely that. They provide a long-term incentive scheme for innovation talents, like stable work environment, generous compensation packages, chances of participating in challenging projects, career development opportunities, and sometimes equity incentives.

### ***Innovation culture throughout the company***

Innovation does not only belong to the R&D department. Successful companies have a corporate innovation culture throughout the company. In fact, one company in the automobile window business told us that one of its greatest innovations actually comes from a frontline assembly worker. This innovation greatly improves workplace safety and production efficiency. This company holds a company wise innovation contest every year, where every employee is allowed to participate. The winners of the contest are heavily awarded.

## **5. CONCLUSION**

For years, innovation of Chinese companies made a negative impression like low innovation impetus and over reliance on government industrial policies. With a new research framework and methodology, our research provides a more organized picture of Chinese companies' innovation capability. The canine theory of innovation classifies companies into one of four categories, top dog, old dog, stray dog and run-of-the-mill dog, to characterize their high performance and strategic innovativeness achievements. They are further classified as purebred or mutt based on their organizational creativity.

Our analysis reveals truly successful companies in our context are a very small minority. Only one out of a hundred companies we studied can be regarded as belonging to this elite list. And most of these companies are private companies as opposed to SOEs.

When studying the commonalities among these companies, we identify four traits as being prominent across the board. First these companies' innovation activities are mostly combinatorial and incremental in nature. They seldom invest a lot in radical innovations. Second, their innovation activities are highly market-driven. Third, they have an incentive system that is asymmetric in terms of rewarding success and penalizing failure. Employees involved in innovation processes are to be encouraged and protected for taking on more risks. And last but not least, our elite list of companies has a corporate wise innovation culture, in terms of encouraging every employee and particularly not

just those in the R&D department, to participate in and contribute to innovation.

Today more and more Chinese companies have realized the importance of innovation, and they are willing to make huge investment in innovation. However, there is still a long way to go before Chinese companies enhance their innovativeness and really rank among global technology leaders. We hope this report would be a good reference to Chinese companies that pursue innovativeness and high performance at the same time. Just like top dogs in our canine theory of innovation, companies with an innovative drive should not only generate new ideas, new methods and new products and services, but also should translate innovation achievements into market value and achieve high performance. Innovation and high performance ought to be a healthy feeding loop supporting each other. At a more fundamental level, innovation activities, at least from a corporate perspective, need to be purpose-driven.

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